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# Regional Cooperation Strategies for Air Quality Management Technologies in Asia - From Pilot Projects to Scalable Solutions

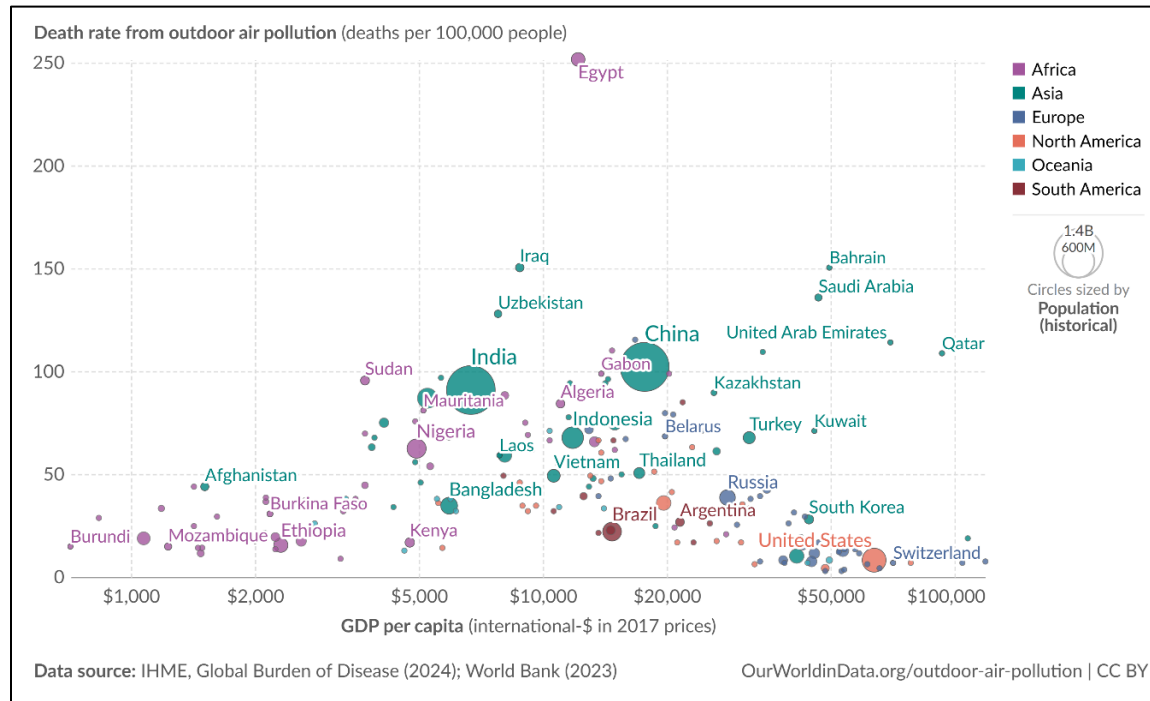
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# Research background and goals

# Why This Matters

## □ Air pollution remains one of the most critical challenges in Asia



Rank	City & Country	2023 Annual Average PM 2.5 ( $\mu\text{g}/\text{m}^3$ )	Rank	City & Country	2023 Annual Average PM 2.5 ( $\mu\text{g}/\text{m}^3$ )
1	Begusarai, India	118.9	26	Noida, India	79.8
2	Guwahati, India	105.4	27	Bhagalpur, India	79.7
3	Delhi, India	102.1	28	Meerut, India	78.9
4	Muzzafarpur, India	100.4	29	Muzaffarpur, India	77.5
5	Lahore, Pakistan	99.5	30	Agartala, India	77.4
6	New Delhi, India	92.7	31	Bhiwadi, India	77.1
7	Siwan, India	90.6	32	Bandhwari, India	76.8
8	Saharsa, India	89.4	33	Baghpat, India	76.6
9	Gosaingaon, India	89.3	34	Peshawar, Pakistan	76.5
10	Katihar, India	88.8	35	Ghaziabad, India	76.1
11	Greater Noida, India	88.6	36	Charkhi Dadri, India	75.9
12	Faisalabad, Pakistan	88.2	37	Araria, India	75.8
13	Hotan, China	87.3	38	Alandi, India	75.7
14	Bettiah, India	85.7	39	Rajgir, India	75.3
15	Samastipur, India	85.3	40	Bahadurgarh, India	75.2
16	Muzaffarnagar, India	85.0	41	Munger, India	73.1
17	Gurugram, India	84.0	42	Kashgar, China	72.3
18	Ara, India	83.6	43	South Tangerang, Indonesia	71.7
19	Dadri, India	83.6	44	Karaganda, Kazakhstan	71.2
20	Patna, India	82.2	45	Mushalpur, India	69.9
21	Chapra, India	81.4	46	Vapi, India	69.9
22	Dharuhera, India	81.1	47	Rohtak, India	69.2
23	Hanumangarh, India	80.9	48	Kaithal, India	68.5
24	Dhaka, Bangladesh	80.2	49	Dholpur, India	68.4
25	Faridabad, India	79.9	50	Ganganagar, India	68.3

✓ According to Our World in Data (2024), most of the countries where the death rate due to outdoor air pollution exceeds 50 per 100,000 people are located in the Asian region.

✓ According to IQ Air's 2023 World Air Quality Report, all 50 cities with the worst air quality in the world are located in Asia.

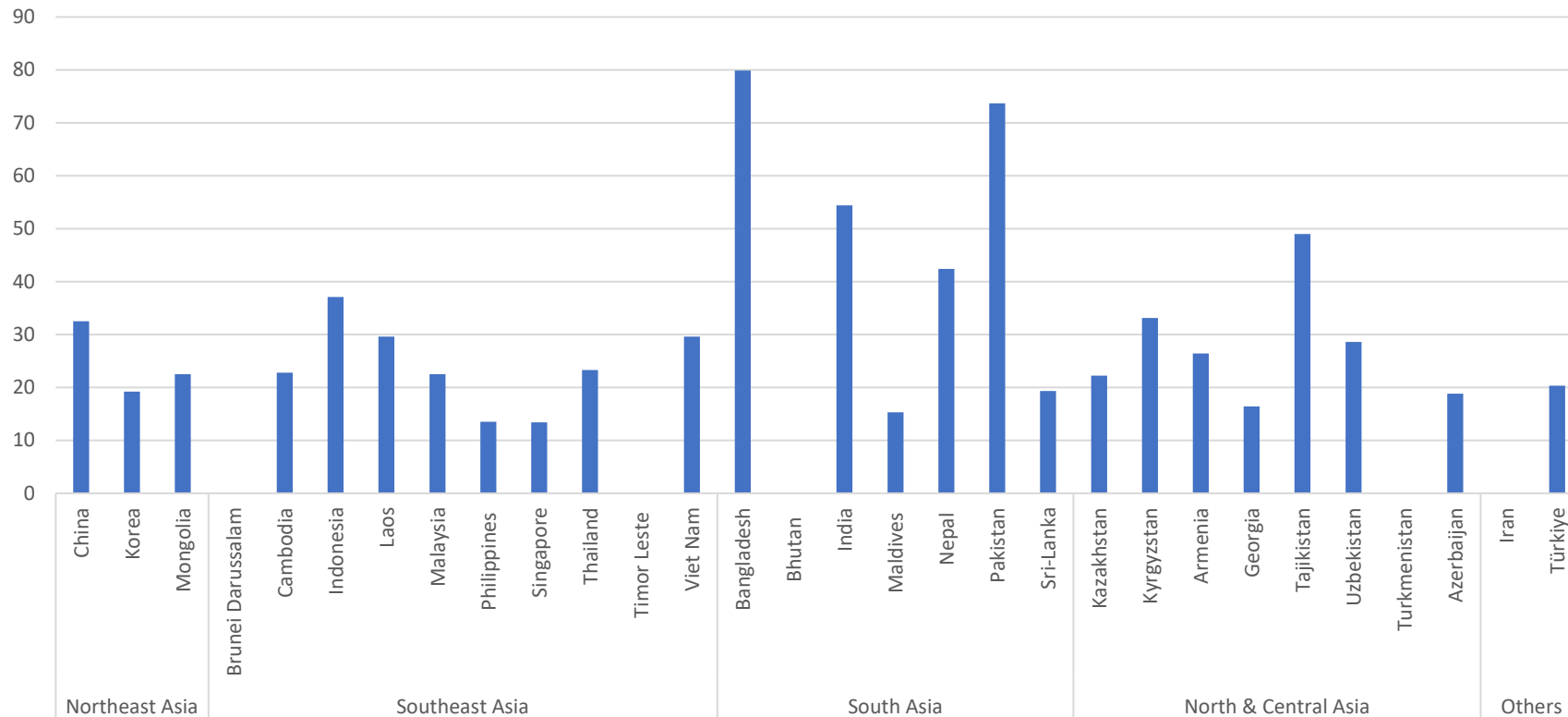


Countries in Asia urgently need effective and scalable solutions



# Air pollution concentration levels in Asian countries

## □ Annually Averaged PM2.5 concentration levels by sub-region of Asian countries in 2024



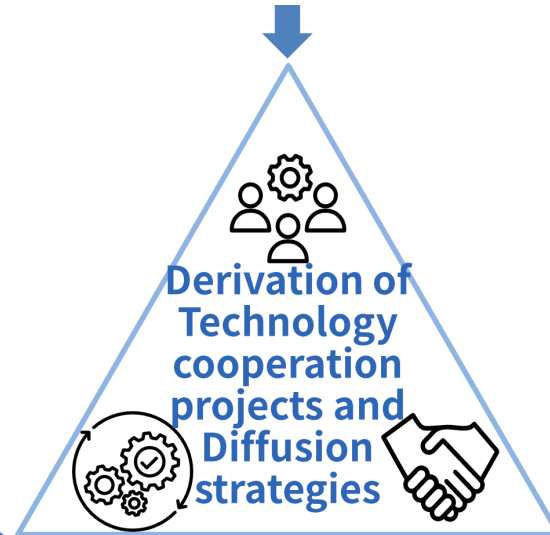
- ✓ According to IQAir's 2024 report, most Asian countries are experiencing air pollution that does not meet WHO recommended standards, and some countries in South Asia and Central Asia in particular are experiencing the world's highest levels of severe air pollution.

# Research Objectives and Methodology

## □ Methods for Deriving Collaborative Projects and Strategies

**Technology Cooperation  
Demand Survey**

- ✓ Survey conducted across multiple Asian countries
- ✓ Identified priority sectors and technology needs



**Feasibility analysis of  
innovative technology**

- ✓ Assessed feasibility of innovative technologies
- ✓ Evaluated cost, impact, and implementation readiness

**Review of  
policy and international  
cooperation status**

- ✓ Reviewed national policies and regulatory frameworks
- ✓ Analyzed international cooperation practices and gaps



Transform the results of technology and international cooperation needs and technology feasibility analyses into actionable and scalable measures.

# Technology Cooperation Demand Survey

## □ Online and offline survey to analyze demand for air pollution reduction technology

**Survey for Policymakers on Air Pollution Reduction Technologies and Best Practices**

1. Background of the Survey

Air pollution significantly impacts human health and ecosystems, with nearly 90% of the population in Asia and the Pacific regularly breathing air deemed unsafe by the World Health Organization (WHO). As a major global environmental cause of premature deaths, air pollution has worsened with the economic growth and rapid urbanization in the Asia-Pacific region.

The Regional Action Programme on Air Pollution (RAPAP), established by ESCAP member States at the 2022 Committee on Environment and Development (CED-7), aims to improve air quality by promoting science-based cooperation, creating a regional platform for best practices, encouraging domestic action and regional collaboration, and fostering dialogue and technical cooperation.

2. Purpose of the Survey

Our research team, comprised of researchers from KEI in Korea and AIT in Thailand, is conducting research to support the implementation of RAPAP at the request of UNESCAP. This study aims to develop air pollution reduction technology cooperation projects in the Asia-Pacific region and establish technology diffusion strategies.

Please tell us your country. \*

Your answer

1. How would you describe the current state of air quality in your country?

very poor (e.g., frequent visibility issues, difficulty breathing outdoors, many health warnings)

poor (e.g., occasional smog, some health warnings, air quality is often not ideal)

Fair (e.g., air quality is generally acceptable but can be poor on certain days)

Good (e.g., clean air most days, rare air quality warnings)

2. How would you assess the trend of air pollution levels over the past decade in your country? Please explain.

Deteriorating rapidly

Deteriorating slowly

Stable

Improving slowly

Improving rapidly

3. What are the primary sources of air pollution in your country? Please rank by priority.

Transportation    Industry    Power generation    Open burning and Forest fire    Residential    Other

1st                       

## ✓ 14 countries in the Asian region participated in this survey

Sub-region	Country
Southeast Asia	Cambodia, Lao PDR, Malaysia, Philippines, Thailand, Vietnam
South Asia	Bangladesh, Bhutan, Maldives, Nepal, Sri Lanka
North & Central Asia	Kyrgyzstan
West Asia	Iran, Türkiye

## ✓ Survey questions consist of 6 sections

- Air quality and emissions status
- Policy status
- Technology status and demand
- Obstacles and opportunities for technology diffusion
- International cooperation
- Future prospects

# Feasibility analysis of innovative technology

## □ Feasibility analysis of innovative air management technologies

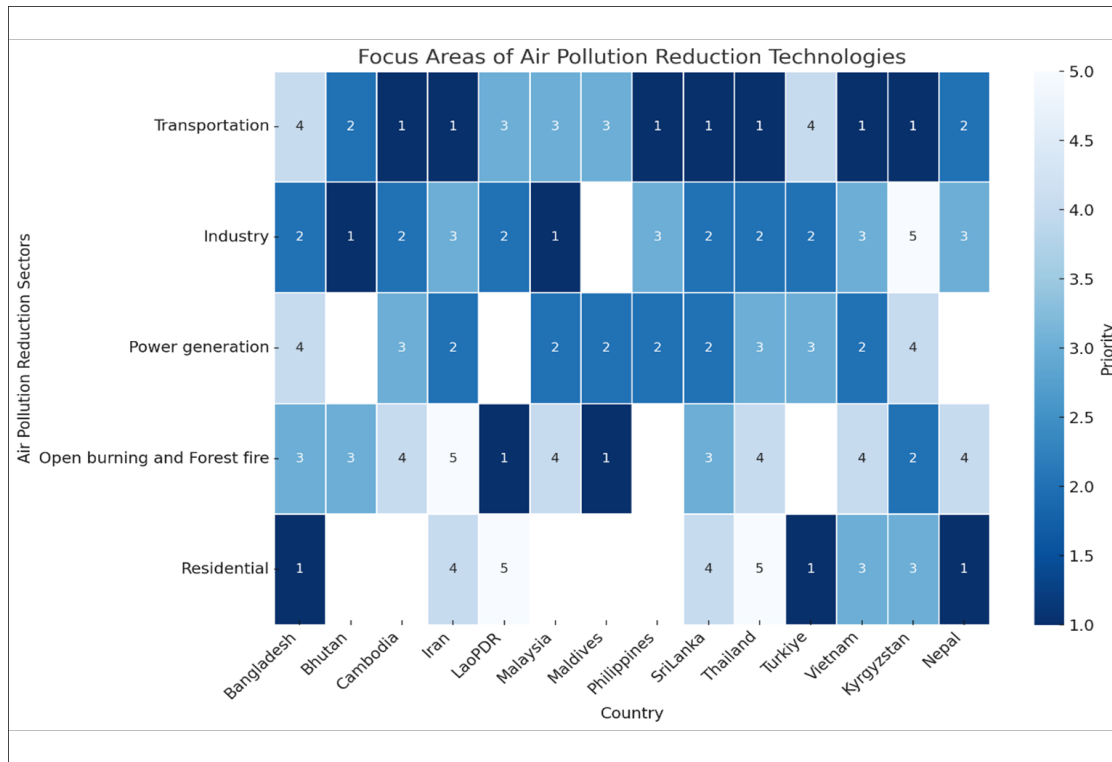
Main Category	subcategory	Technology	Feasibility	Implementation Gaps	Potential PM Reduction
<b>National-level Management Technology</b>		Low-cost sensors (LCS)	High	Small	Low-Medium
		Satellite Detection for Agricultural Burning	High	Medium	High
		WRF-Chem Model	Medium	Large	Low-High
		Continuous Emission Monitoring Systems (CEMS)	Medium	Medium	High
		Remote Sensing for Vehicle Inspection	Medium	Large	High
<b>Emission Reduction Technologies</b>	<b>Transport Sector</b>	Diesel Particulate Filter (DPF)	Medium	Large	High
		Low-emission Zones (LEZ)	Medium	Large	High
		Electric Vehicles (EVs)	High	Medium	High
		EuroVI Standards	High	Medium	High
		Improved Fuel Quality	High	Medium	Low-Medium
	<b>Industry/ Energy Sector</b>	Electrostatic Precipitators (ESP)	High	Small	High
		ESP with Bag Filter	High	Medium	High
		Nano Fibers Bed	Medium	Medium	Medium
		ULPA Filter	Medium	Large	High
		Improved Zig-Zag Kilns (IZK)	High	Medium	High
	<b>Residential/ Heating Sector</b>	Waste-to-Energy Plants (WTE)	High	Small-Medium	High
		Cleaner Cooking Technologies	High	Medium	High

- ✓ A total of 17 innovative air pollution technologies were assessed across multiple sectors.
- ✓ The assessment considered economic viability, implementation challenges, and potential for particulate matter reduction.
- ✓ This multi-criteria evaluation enabled the identification of technologies with high applicability and scalability potential.

# Survey Results and Implications

# Demand for sectors requiring technology application

## □ Sectors requiring application of air pollution reduction technology



- ✓ The transport sector is considered a top priority for reducing air pollution in many countries.
- ✓ South Asian and Central Asian countries, which suffer from severe air pollution, also showed high demand for reduction technologies in the residential sector, such as those for heating and cooking.
- ✓ Countries near India and some Southeast Asian countries facing fine dust issues from agricultural burning also showed high interest in technologies related to air pollutants entering across borders or agricultural burning.

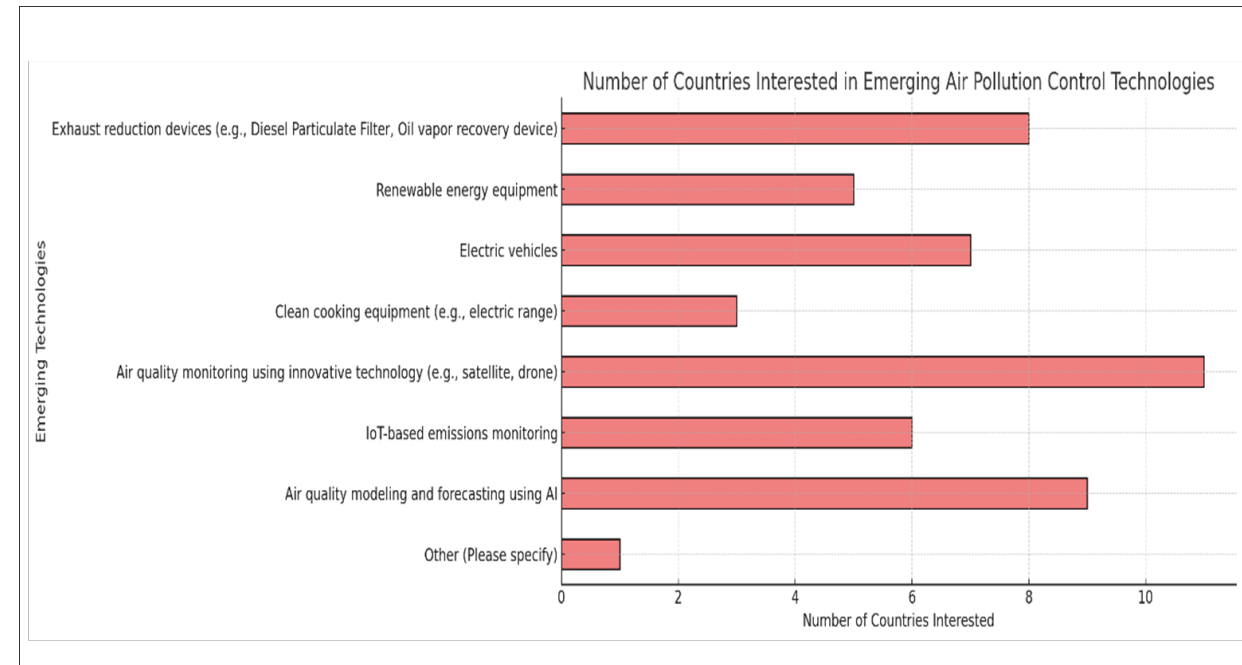


While there are differences depending on the region and country, the greatest demand for the adoption of innovative technologies in most Asian countries is concentrated in the transportation sector.

# Interest in innovative technology

## □ Asian countries' interest in innovative technologies

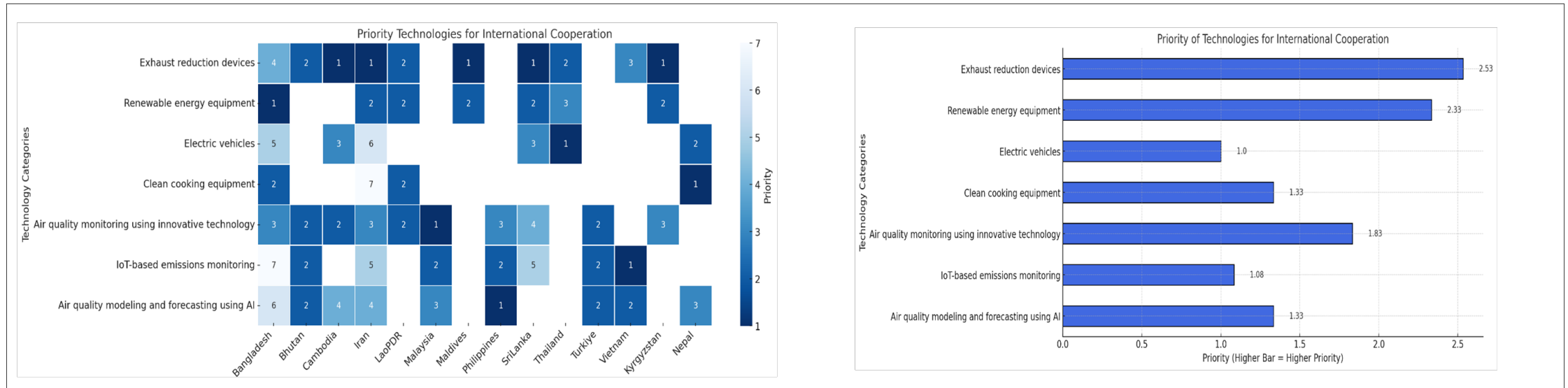
- ✓ The most popular technology is air quality monitoring technology utilizing innovative technologies such as satellites and drones, with 11 countries expressing interest.
- ✓ Next, AI-based air quality modeling and prediction technology is attracting attention in 9 countries.
- ✓ The technology showing the third highest level of interest is exhaust gas reduction device technology, with 8 countries expressing interest.



Asian countries have a high level of interest in technologies related to the development of national management systems, such as air quality monitoring technology using satellites and drones, and AI-based air quality modeling and prediction technology.

# Demand for tech. related to international cooperation

## Technology priorities to be supported through international cooperation



✓ The sector with the greatest interest in international cooperation lies in reduction technologies targeting individual emissions sources, such as emission reduction devices and renewable energy facilities, with air quality monitoring technologies still remaining as a substantial priority

Asian countries have a demand for international cooperation regarding management



technologies necessary for systematic national air pollution control in the medium to long term, as well as reduction technologies capable of producing tangible results in the short term.

# Key Findings

## ❑ Implications of survey results for technology demands

- ✓ In most countries, the emission sector with a common demand for the introduction of innovative technologies is the transportation sector, but in some countries in South Asia and Southeast Asia, there is a demand for the introduction of innovative technologies in the open burning and residential sectors.
- ✓ There is a strong demand for the introduction of innovative management technologies rather than abatement technologies, and it is estimated that there is a demand to upgrade the management system at the national level. However, the technologies that RAPAP member countries want support for through international cooperation are reduction technologies rather than management technologies such as emission reduction devices and renewable energy facilities.
- ✓ From a mid- to long-term perspective, RAPAP member countries are highly interested in the management technology needed for systematic air pollution management at the national level. However, the technical support that many countries seek through international cooperation can be seen as prioritizing the introduction of reduction technologies that can achieve practical abatement effects in a short period of time.

# Proposal for Technology Cooperation Project Model

# Reduction technology cooperation project using DPF technology

## □ Proposal background

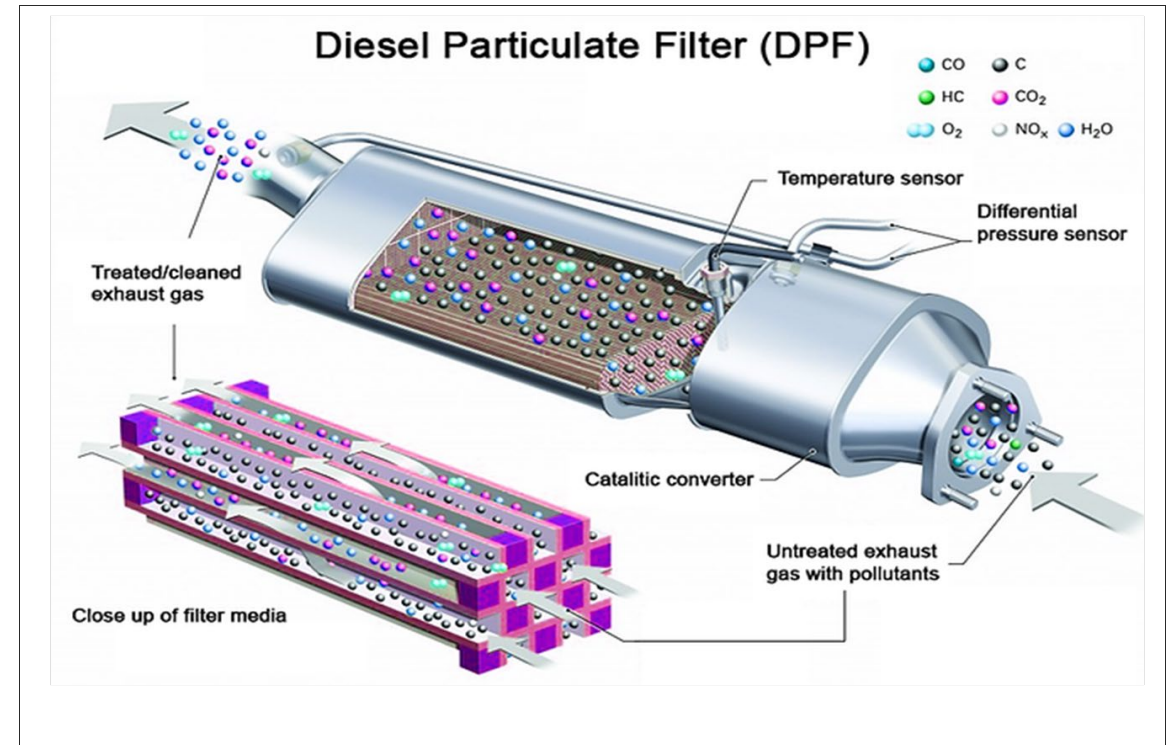
- ✓ Technology demand survey shows that the most important emitting sector for many Asian countries is transportation.
- ✓ Emissions reduction device technologies such as DPF were found to be the most preferred technologies among those seeking support through international cooperation.
- ✓ Preference appears to be high in countries such as Bhutan, Malaysia, the Philippines, and Vietnam. In countries that recently introduced EURO 5 standards, such as Thailand, China, and Vietnam, demand for emission reduction technology using DPF is expected to be significantly high.
- ✓ Although installing a DPF requires a lot of initial costs such as equipment and labor costs (\$5,000 to \$20,000 per vehicle), it is highly effective in reducing PM emissions from cars by up to 99% and can reduce related health costs.
- ✓ Hong Kong implemented DPF retrofitting for pre-Euro 4 diesel vehicles, leading to a 30% reduction in particulate matter emissions within three years.

Technology	Feasibility	Gaps	Potential PM Reduction	Recommendations for Implementation	Success Stories
Diesel Particulate Filters (DPF)	Medium	High	High	Provide financial incentives for retrofitting, enforce stringent vehicle emission standards, and support infrastructure for Euro V-compliant fuels.	Hong Kong implemented DPF retrofitting for pre-Euro 4 diesel vehicles, leading to a 30% reduction in particulate matter emissions within three years.

# Reduction technology cooperation project using DPF technology

## □ Project overview

- ✓ Diesel Particulate Filter (DPF) is a device installed in diesel vehicles to filter out particulate matter (PM) in exhaust gas, and has the effect of reducing diesel exhaust gas emissions by up to 80%.
- ✓ Substantial reduction effects are achieved by supporting the attachment of DPFs to old diesel vehicles in Asian countries or urban areas with large emissions from the transportation sector.
- ✓ Infrastructure construction and technology transfer to regions with limited availability of technicians and service centers capable of installing and maintaining DPFs.



(<https://www.philliprads.com/dpfcleaning>)

# Management technology cooperation project using Satellite technology

## □ Proposal background

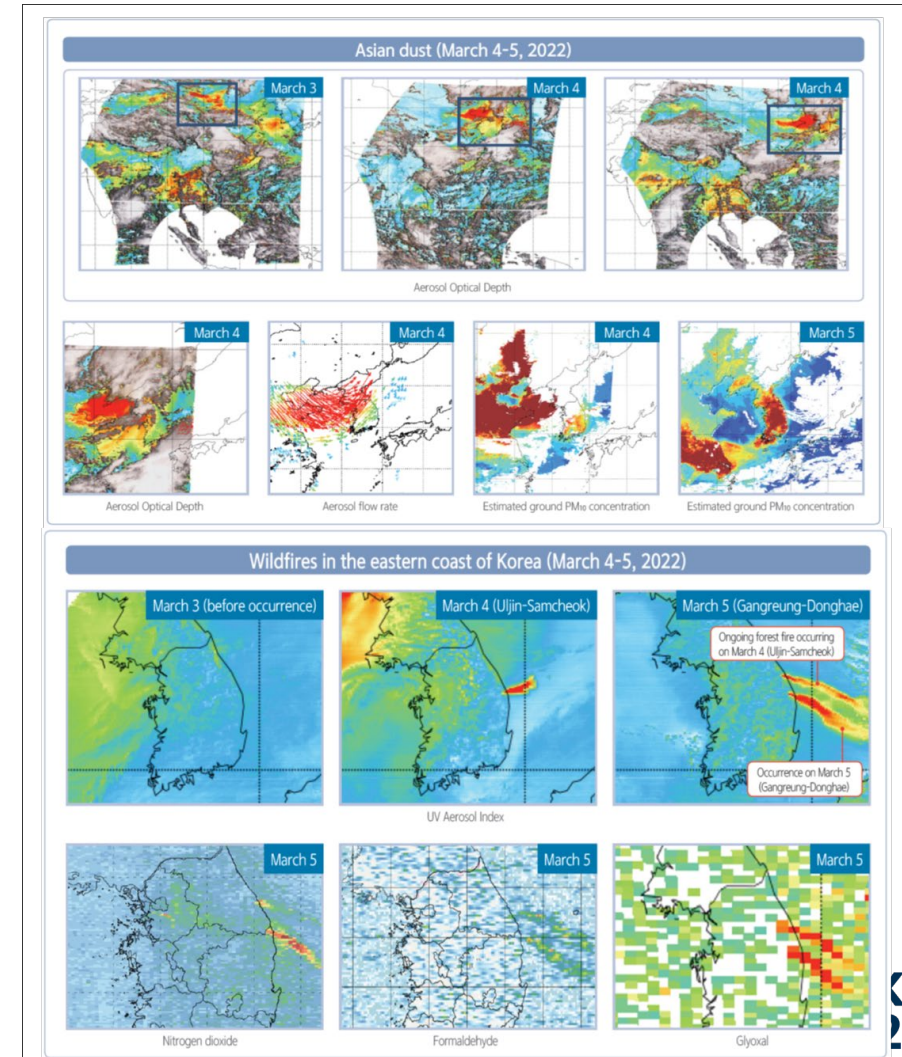
- ✓ A significant number of Asian countries have a demand to upgrade the monitoring system to overcome the weaknesses of the ground observation-centered monitoring network and respond to transboundary pollution problems.
- ✓ Satellite-based monitoring can reduce operating costs by reducing the need for extensive ground-based observations, and can minimize economic and environmental losses by quickly responding to accidents such as fires through real-time data.
- ✓ Some satellite data is freely available on relevant platforms, allowing governments in developing countries to set management priorities and allocate resources effectively without significant initial investments in proprietary technologies.
- ✓ Satellite data sharing among Asian countries can facilitate coordinated efforts to address transboundary pollution and haze from agricultural burning.

Technology	Feasibility	Gaps	Potential PM Reduction	Recommendations for Implementation	Success Stories
Satellite Detection for Agricultural Burning	High	Medium	High	Invest in capacity-building programs, promote data-sharing agreements, and integrate satellite data with ground observations for comprehensive monitoring.	Thailand's use of MODIS satellite data reduced agricultural fire incidents by 20% through targeted intervention programs.

# Management technology cooperation project using Satellite technology

## □ Project overview

- ✓ Establishment of a more extensive and uniform air quality monitoring network using data from GEMS, Asia's only geostationary satellite
- ✓ Establishment of a real-time monitoring system and related prediction/warning system for fires, forest fires, transboundary pollutants, etc.
- ✓ Projects that can be promoted as a follow-up project to the PAPGAPi project. The Papgapi project is a project to strengthen satellite data utilization capacity and install a ground observation network in 13 Asian countries from 2020 to 2024.
- ✓ The PAPGAPi project required a large budget because it supported the overall project, including equipment installation, system construction, and related training programs, in many countries for five years. However, it is expected that the project can be carried out with a smaller budget if it focuses on only one core project, such as strengthening capabilities to utilize satellite data or building an alarm system.



(NIER, 2025)

# Reduction technology cooperation project using Cleaner cooking technology

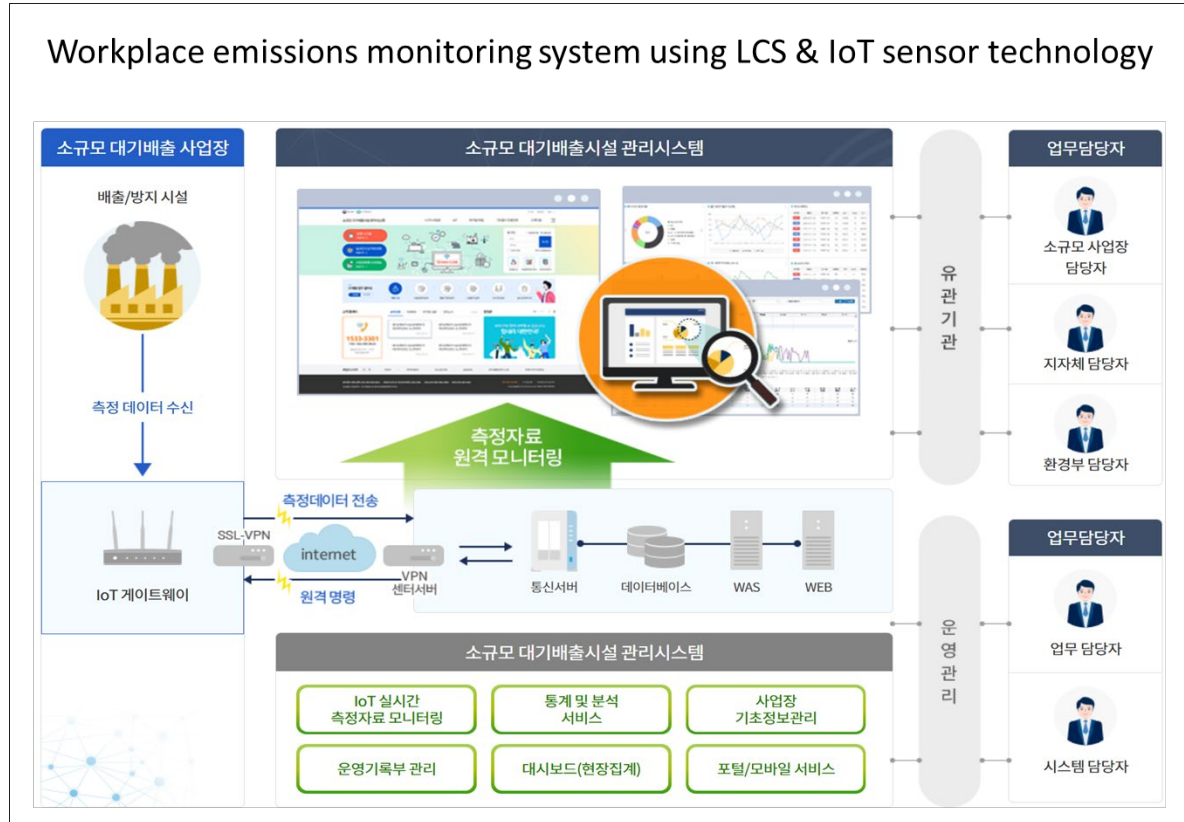
## □ Proposal background

- ✓ In a technology demand survey, the management technology with the highest preference after air quality monitoring technology was found to be air pollution emission management technology using IoT.
- ✓ It is expected that there will be a demand for technical cooperation in countries where the industrial sector is a major source of emissions.
- ✓ The economic feasibility of LCS and IoT systems can provide a cost-effective solution for network monitoring, especially in low- and middle-income countries.
- ✓ The cost per unit of a low-cost sensor (LCS) is \$100 to \$1,000, much less than the \$10,000 to \$100,000 per unit of a standard-grade device.
- ✓ Through real-time monitoring of the emission management situation, events that increase emissions or inappropriate emission management can be monitored, resulting in a practical reduction effect.
- ✓ Continuous monitoring ensures compliance with emission limits. For example, in South Korea, IoT-enabled monitoring has improved compliance rates in industrial zones by 30%

Technology	Feasibility	Gaps	Potential PM Reduction	Recommendations for Implementation	Success Stories
Low-Cost Sensors	High	Low	Low -Medium	Promote hybrid monitoring networks combining low-cost sensors with regulatory-grade monitors, subsidize community-led initiatives, and provide training for calibration and maintenance.	Vietnam's low-cost air monitoring system identified pollution hotspots, enabling targeted mitigation measures and urban planning improvements.

# Reduction technology cooperation project using Cleaner cooking technology

## Project overview



- ✓ A system that installs low-cost sensor measuring devices and communication equipment in prevention facilities and then connects to the Internet to check the normal operation of the prevention facilities.
- ✓ Establishment of LCS and IoT-based monitoring network for appropriate emission management of small-scale emission facilities
- ✓ Through this, compliance with workplace emission standards and reduction of air pollutant emissions are encouraged.

([https://www.greenlink.or.kr/web/contents/contentView/?pMENU\\_ID=2](https://www.greenlink.or.kr/web/contents/contentView/?pMENU_ID=2))

# Proposal for Technology Support Strategy

# Technology project implementation process

## ❑ Roadmap for the implementation of cooperation projects by period

### ✓ Short-Term :

- Launch three pilot projects
- Target countries with high demand and feasibility, using practical and cost-effective approaches.
- Activities: site selection, baseline assessment, initial installation, infrastructure development, and capacity building.

### ✓ Medium-Term :

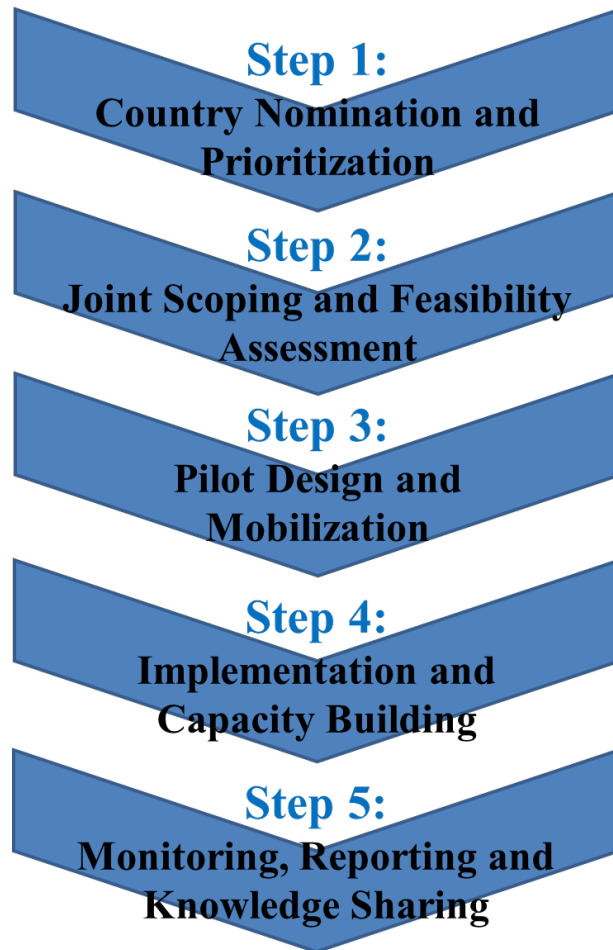
- Scale up initial pilots and replicate in similar contexts.
- Conduct feasibility studies for remaining eight projects.
- Introduce legal and institutional reforms and policy alignment based on pilot results.
- Focus on integration of air quality forecasting and real-time response systems.

### ✓ Long-Term :

- Consolidate national systems for emissions control, transboundary data integration, and regional cooperation platforms.
- Expand capital-intensive solutions like electric fleets and Waste-to-Energy(WtE).
- Develop regional modeling hubs and forecasting networks.

# Technology project implementation process

## □ Step-by-Step Implementation Process



- Identify priority areas and submit project nominations based on national needs and technical demand, as proposed by participating countries.
- Prioritize proposals based on criteria such as feasibility, expected impact, and regional relevance, taking into account national policy readiness and implementation capacity.

- Conduct detailed scoping and feasibility assessments, potentially involving relevant technical experts and institutions.
- Evaluate technical applicability, cost-effectiveness, institutional readiness, and potential emission reduction impacts.

- Design pilot projects with clear implementation plans, timelines, and budget allocations, based on the assessment results, ensuring alignment with national policy frameworks and operational conditions.
- Mobilize consulting entities or technical institutions to support project execution.

- Implement pilot projects at selected sites, alongside efforts to strengthen local capacity.
- Include technology installation, on-site technical support, training programs, and stakeholder engagement to ensure effective operation and long-term sustainability of the activities, including arrangements for ongoing maintenance and institutional ownership.

- Apply a structured monitoring, reporting, and verification (MRV) system to assess project performance and environmental outcomes.
- Document and disseminate lessons learned across member States to support replication and scaling-up, based on performance evaluation and implementation experience.

# Thank you !

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