Project number 327341
ACT – Accelerating CCS Technologies

SCOPE – Sustainable OPEration of post-combustion Capture plants

SPRINT events overview and highlights

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WP4 | TNO

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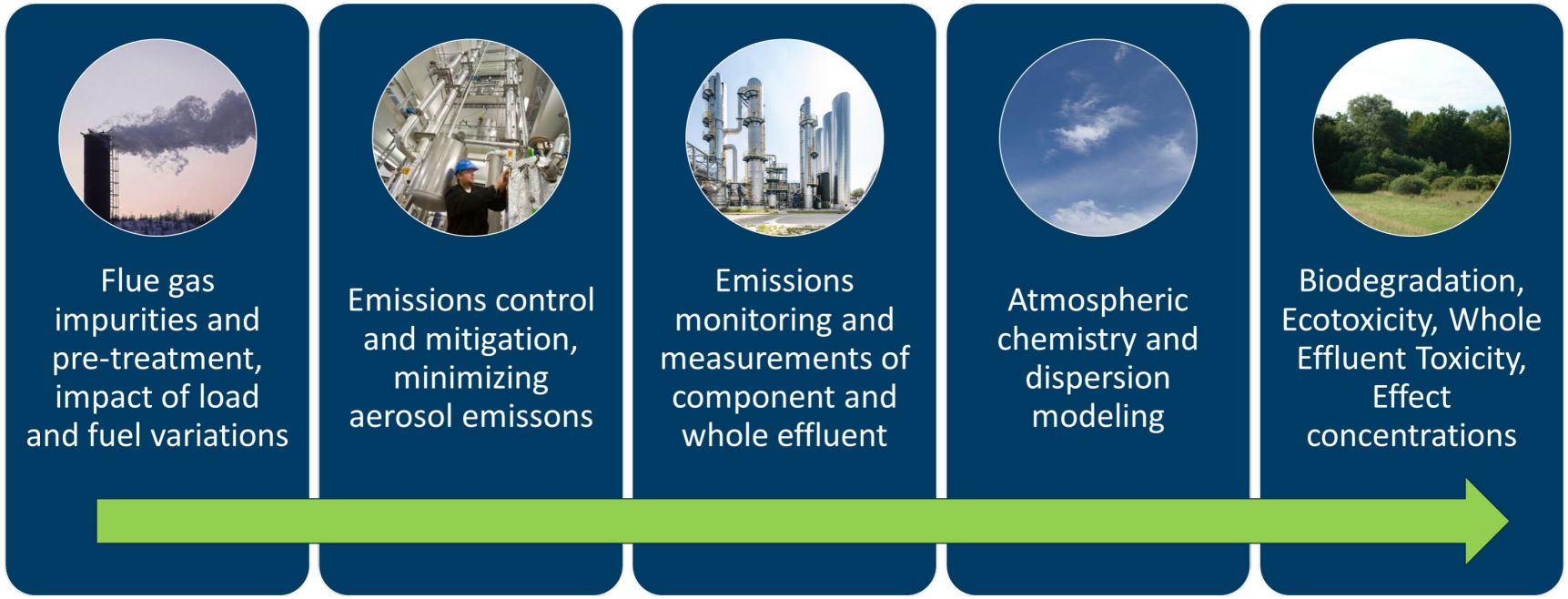
SCOPE – Sustainable OPEration of post-combustion Capture plants

Follow the continuous path of the treated gas from source to recipient and ensure a sustainable and environmentally safe operation of the capture plant



SPRINT (Stakeholder, Policy, Research and Industry NeTwork)

Led by TNO, involvement of all partners

The goals of SPRINT will be to share knowledge between universities, research institutes and industry operators, relevant governmental and non-governmental organizations including regulators, and any other stakeholders involved in or having expertise on permitting processes, and industry and regulatory developments.

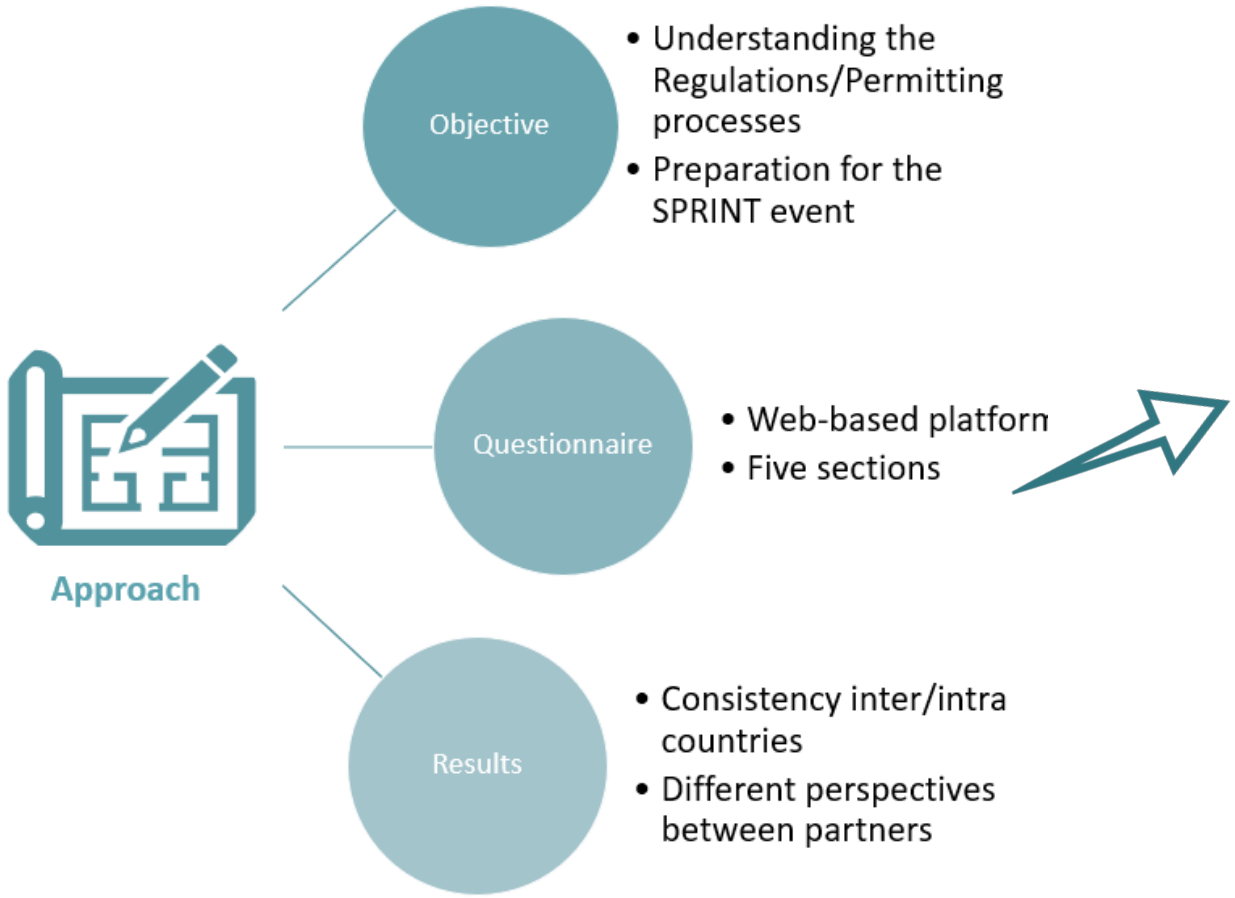
Six SPRINT events over the course of the project will be organized, encompassing, workshops, symposium/courses and site visits to pilot projects. While most events will be local (i.e., within a certain country/region), two global event will be planned: in Trondheim, Norway (in parallel with TCCS12, 2023) and in London, UK (in parallel with the Final dissemination event in SCOPE).

- Event #1: Local workshop, “Regulations, Permitting and a Review of the Guidelines for Emissions Control” workshop (TCM | M6/7)
- Event #2: Local workshop, “Current Emission mitigation technologies for post-combustion capture plants” (RWE, Linde | M13).
- Event #3: Local workshop, “Mitigating environmental impacts" (GGS IPU, MIPL | M25)
- Event #4: Global symposium, “How to address, interact and act on the main knowledge gaps related to emissions” (SINTEF IND | M21)
- Event #5: Local workshop, “Developing best practices for emissions control,” with site visit to a WtE plant (TNO, Twence/HVC | M30).
- Event #6: Global symposium, “SCOPE: Project results and recommendations for future research and policy initiatives.” ” (IMPERIAL | M36).

SPRINT Event #1

Regulations, Permitting and a Review of the Guidelines for Emissions Control

Event #1: Regulations, Permitting and a Review of the Guidelines for Emissions Control

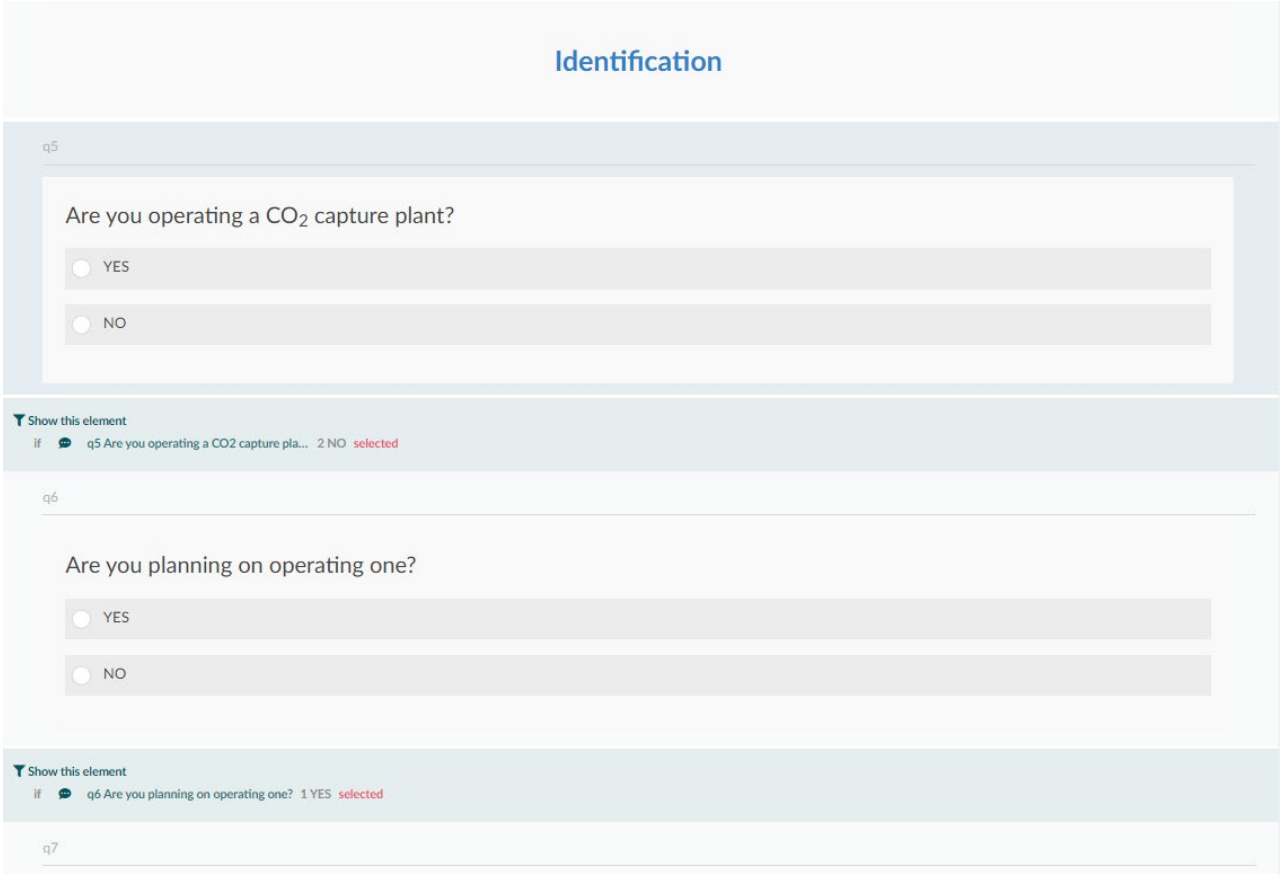


Sections:

1. Identification
2. Regulations
3. Emissions and waste monitoring
4. Permitting
5. Public opinion

Welcome page

Platform



Identification

Identification

- Country
- Type of industry represented
- Size of the company
- Already operating a capture plant
- Degree of state support received

Highlights of the session

- The state support differs depending on the nature of the company. In Germany, for example, the state support is more extensive for R&D in comparison to industrial purposes.

- In general, it is stated by all participants that the process and communication with the government takes a long time and is extensive. However, overall, the participants were pleased with the support given by the state.

Regulations

Regulations

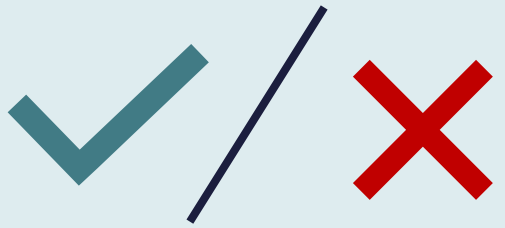
- Are the regulations at a regional, national or any other level?
- Clarity of regulations
- Specific regulations for CO_2 capture plants

Regulations

Are the regulations specific for CO_2 capture plants?

No specific regulations

End-of-Waste status CO_2



The emission permit for an Amine and Ammonia based capture process

Highlights of the session

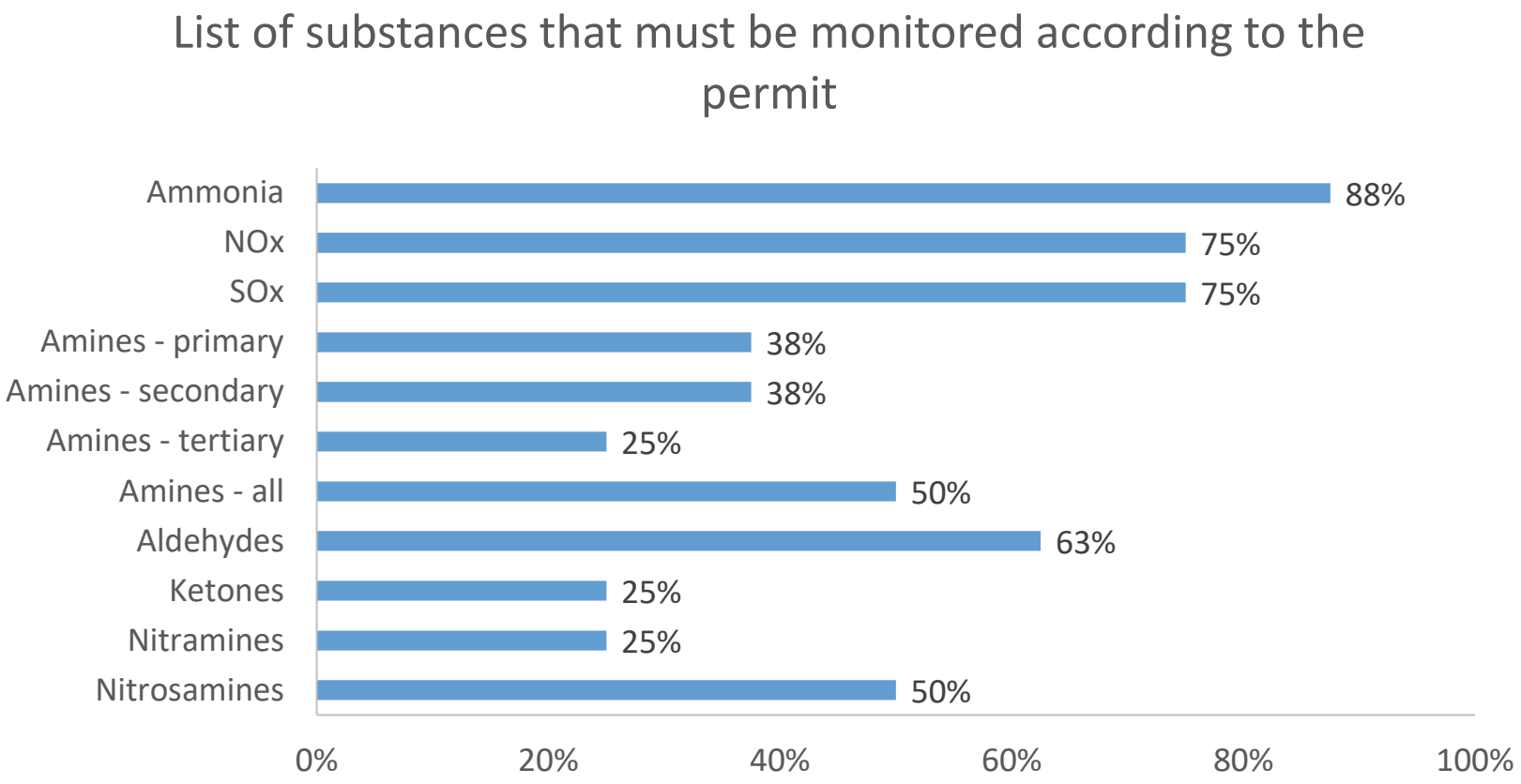
1. There is a difference in regulation for existing and already operating plants in comparison to when new plants are to be built.
2. All the regulations are accessible online and clear in all countries.
3. Although not a lot of specific regulations for CO_2 capture plants are in place nowadays, when more plants will be built, more regulations are expected to come (Germany).
4. Another important parameter to be considered besides the national and international regulations is that we also need to consider the acceptability of methods used for modelling, monitoring and assessment.

Emissions and waste monitoring

Emissions and waste monitoring

- How do you prove you comply with the permit?
- Analysis performed and frequency
- List of substances analyzed
- Consequences of exceeding the permit levels

Emissions and waste monitoring



Emissions and waste monitoring

Reply #	Other substances					
1	Heavy metals	HCl	HF	Dioxines (PCDD/PCDF)	PAHs	Dust
2	CO	VOC				
3	Sum organic compounds	Carcinogenic, mutagen, and compounds that are toxic for reproduction must be classified according to example-compounds				
4	PFAs					

All *Other substances* were mentioned once (13% of participants).

Highlights of the session

1. Everyone has to report emissions but the periodicity changes
   - Level of detail changes according to the plant operation.
   - The frequency of the audits is different between countries.
2. Flue gas emissions are always measured for all cases but where the monitoring needs to be done changes per company, country and region.
3. We must also take into account the toxicity and how hazardous the process is for the population.
4. For test sites, the monitoring can be even more strict since a lot of different conditions are used

Permitting processes

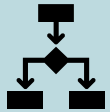
Permitting process

- Responsibility for the permit
- Clarity on information needed
- Type of information to be sent
- Risk analysis
- Duration of the permitting process and permit itself

Permitting

Please provide a list with the information that needs to be provided in order to obtain the permit

Process descriptions: flowsheets, drawings, equipment list



Dependent on the specific country the plant shall operate in

Process data: mass balance, energy use

Capture plant may have a separate license

Process analysis: emissions, waste streams, ground water, noise calculation

Different authorities are involved

Highlights of the session

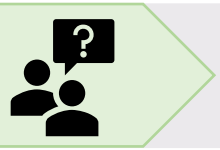
1. The companies are responsible for their own permitting process. Therefore, they do not exchange a lot of information between them.
2. Process is very lengthy with a lot of interactions between the industry and the permitting authorities.
3. Different methods are used in the risk analysis including literature review, modelling and experimental values.
4. Model validation is considered very important, however, it is still not clear how the validation is done and if that is sufficient. Discussions are needed on what laboratory measurements are needed to upgrade models and as such get less conservative models and faster permitting processes.

Public acceptance

Public acceptance

- Is public opinion taken into account?
- Tools used to reach the public

Public opinion



Survey

Public conferences

Involve local community, politicians and stakeholders

Share documents with public (differs per project size/capacity, R&D, commercial application)

Highlights of the session

1. Everyone considers it important to engage the public, but sometimes negative opinion and public resistance make it more difficult.
2. Open days are also available to engage the local community
3. Having the authorities in the debate with the public is very important to get everyone's trust as well. The authorities can assist by highlighting the importance of job creation, for example.
4. Some compensations mechanisms might be in place but those are not very clear.

SPRINT Event #2

Current emission mitigation and monitoring technologies for post-combustion carbon capture

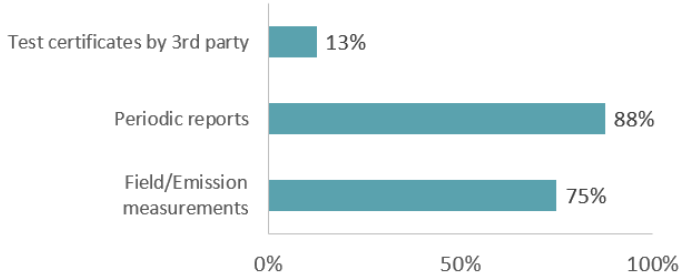
Emission mitigation

Please provide a list with the information that needs to be provided in order to obtain the permit

Emission mitigation is necessary.

- Good HSE practices
- Solvent loss minimization
- Emission information required to obtain and to maintain a permit for CO_2 capture plant operation

How do you prove to the permitting authorities that you comply with the permit?



Emission mitigation

A list of 9 available technologies has been given in the template presentation

- 3 technologies for volatile emission mitigation
  - Water wash
  - Acid wash
  - Lean solvent temperature
- 6 technologies for aerosol emission mitigation
  - Brownian demister unit (BDU)
  - Turbulent pre-treatment
  - Dry bed
  - Wet electrostatic precipitator (WESP)
  - Gas-Gas heater (GGH) systems
  - Upstream base addition

Short description is given for every technology (operating principles, TRL, removal efficiency)

Technology	Used in the past Add X if relevant	Used in present Add X if relevant
Water wash	X	
Acid wash		
Brownian Demister Unit	X	
Turbulent pre-treatment		
Lean solvent temperature		
Dry-bed		
Wet electrostatic precipitator		
Gas-gas heater		
Upstream base addition		

Input from ALIGN-CCUS ACT-project results.

Emission mitigation summary (used in present)

	#1	#2	#3	#4	#5
Water wash	X	X	X	X	X
Acid wash					X
Brownian Demister Unit					X
Turbulent pre-treatment					
Lean solvent temperature		X		X	X
Dry-bed			X		X
Wet electrostatic precipitator	X				
Gas-gas heater					
Upstream base addition	X			X in bag filter	X

Costing models

Technology	TRL	Removal efficiency	OPEX (€ / 1000 m^3)	BEC (k€ / m^3/s)	To be tested in for SCOPE?
Water wash	9	Good	0.0780	11.7	Yes, pilot scale
Acid wash	7	Good	0.0420	7.6	Yes, lab scale
Brownian demister unit	7	Good	0.0900	10.7	Yes, pilot scale
Turbulent pre-treatment	6	Uncertain	0.0830	3.6	Yes, pilot scale
Lean solvent temperature	6	Uncertain	0.0009	0.0	Yes, pilot scale
Dry-bed	6	Uncertain	0.0090	5.2	Yes, pilot scale
Wet electrostatic precipitator	6	Bad	0.1200	24.0	No
Gas-gas heater	6	Good	0.1000	10.0	No
Upstream base addition	6	Good	0.0003	0.5	No

BEC: Bare Equipment Cost

- Costing models were developed in ALIGN-CCUS and are to be updated in SCOPE and used in the TEA work.
- Industrial input is needed.

Monitoring tools

Typical monitoring tools:

- Gasmet FTIR (Fourier-transform infrared spectroscopy)
  - → Gas composition
  - → Total emissions (volatile + aerosol)

- ELPI+ with heated element (High Temperature)- Electrical Low Pressure Impactor
  - → Particle size distribution – relates to aerosol emissions
  - → Particles' size 6 nm to 5.4 µm

- LSAS → optical particle counter
  - → Particle size distribution – relates to aerosol emissions
  - → Particles' size 0.2 µm to 36 µm

Acknowledgements

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