Application of GHGs and Air Pollutants Monitoring Data: Emission Mitigation and Formulation of Control Policies

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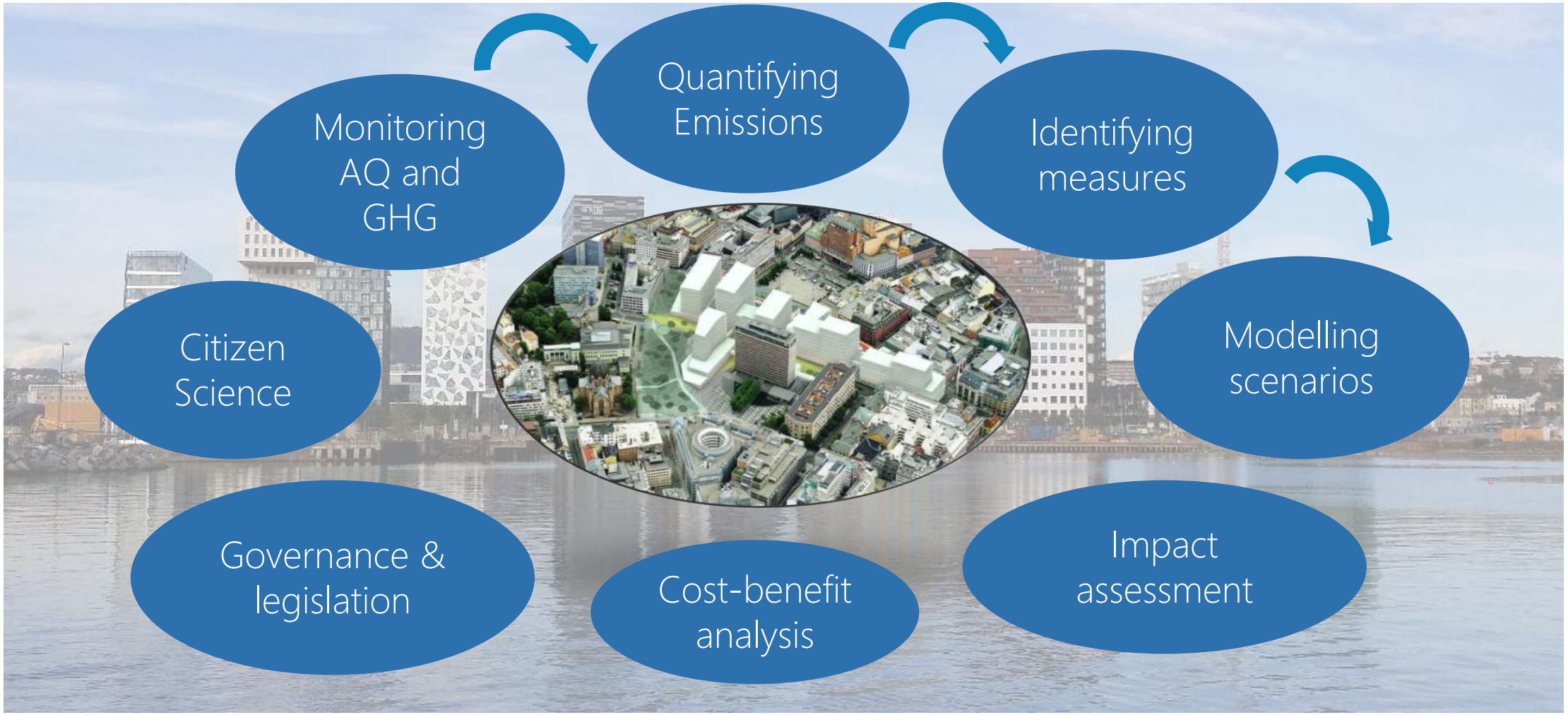
Klima- og miljøinstituttet NILU
En del av forskningsalliansen NORIN

Outline

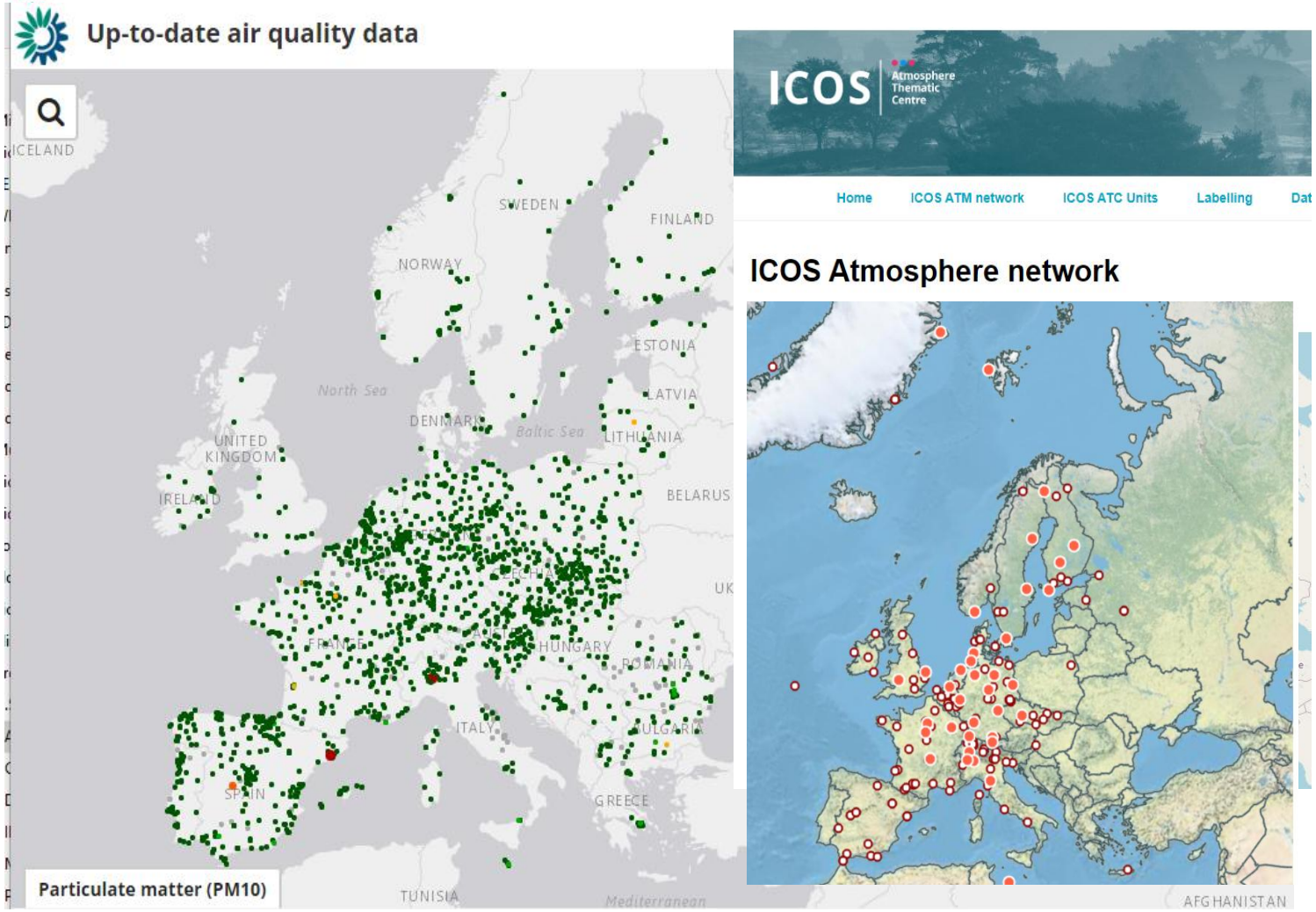
- Main elements for air quality management in urban areas

  - ✓ The importance of monitoring data
  - ✓ the need to quantify emissions
  - ✓ the identification of co-benefits
  - ✓ the impact of control policies

Urban air quality and GHG management – main elements

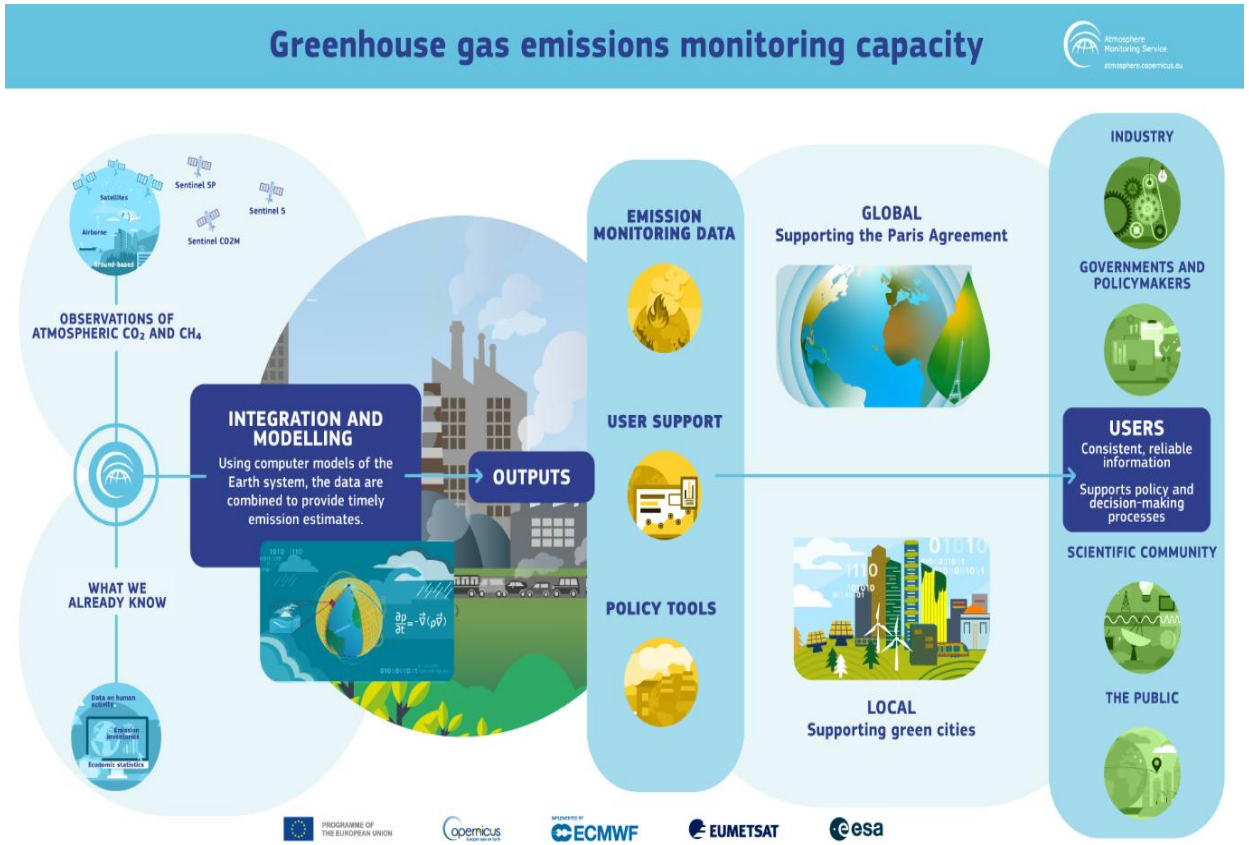


Monitoring Air Quality and GHG in Europe

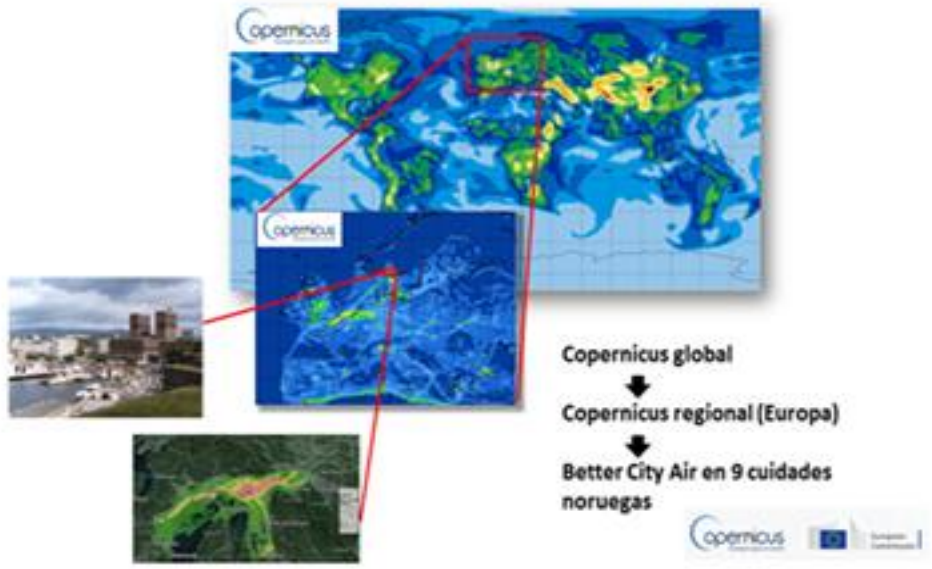


- Air quality and GHG monitoring required by EU legislation
- Up-to-date AQ data in the European Environment Agency (EEA) portal
- GHG atmosphere data in the ICOS portal – Research infrastructure

Monitoring Air Quality and GHG in Europe (I)



- Copernicus provides a complementary approach to traditional air quality and GHG measured information
- Use of satellite data and modelling data



Monitoring Air Quality and GHG in Europe (II)

- Use of indicative measurements
- Low-cost sensors now in the proposal for revision of EU AQ legislation

2022 Revised AAQD Improvements intended by the EU proposal

Monitoring & Assessment

- Stronger role of modelling
- Stronger use of sensors - indicative measurements

FAIRMODE

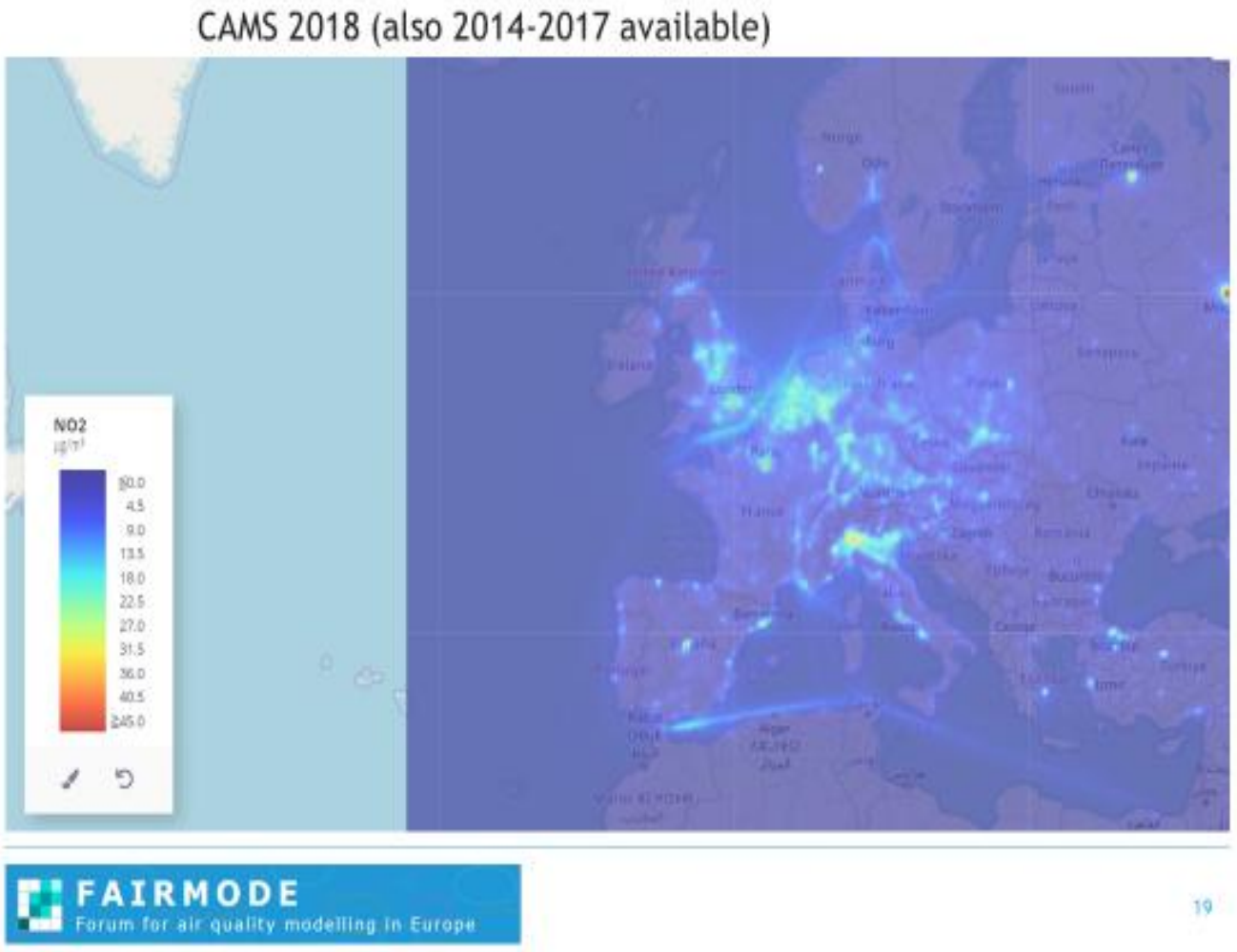
FAIRMODE & GUIDANCE FOR USE OF MODELS

- Exceedance situation indicators & pop exposure
- Spatial representativeness & network design
- Source apportionment
- Forecast
- Planning

Pollutans & New pollutants

- Gases and Vapours
  - Oxides of Nitrogen (NOx)
  - Sulphur Dioxide (SO2)
  - Carbon monoxide (CO)
  - Ozone (O3)
  - Benzene (C6H6)
  - Ammonia (NH3)
- Particulate Matter
  - PM10
  - PM2.5
  - Chemical composition of PM
  - Ultrafine particles (UFP)
  - Oxidative potential of particulate matter (PM)
- Heavy metals and PAHs
  - Lead (Pb)
  - Arsenic (As)
  - Cadmium (Cd)
  - Mercury (Hg)
  - Nickel (Ni)
  - Benzo(a)pyrene
- Volatile Organic Compounds (VOC)
- Black carbon (BC)

Quantifying emissions



Monitoring and reporting emissions of GHG and main pollutants are requested by European and UN legislation

Additional efforts in Europe done for compiling urban bottom-up emission inventories at regional and municipality level

Benchmarking in Europe of local urban emission in Europe use the FAIRMODE QA/QC benchmarking tools

Essential to the elaboration of mitigation plans and control policies

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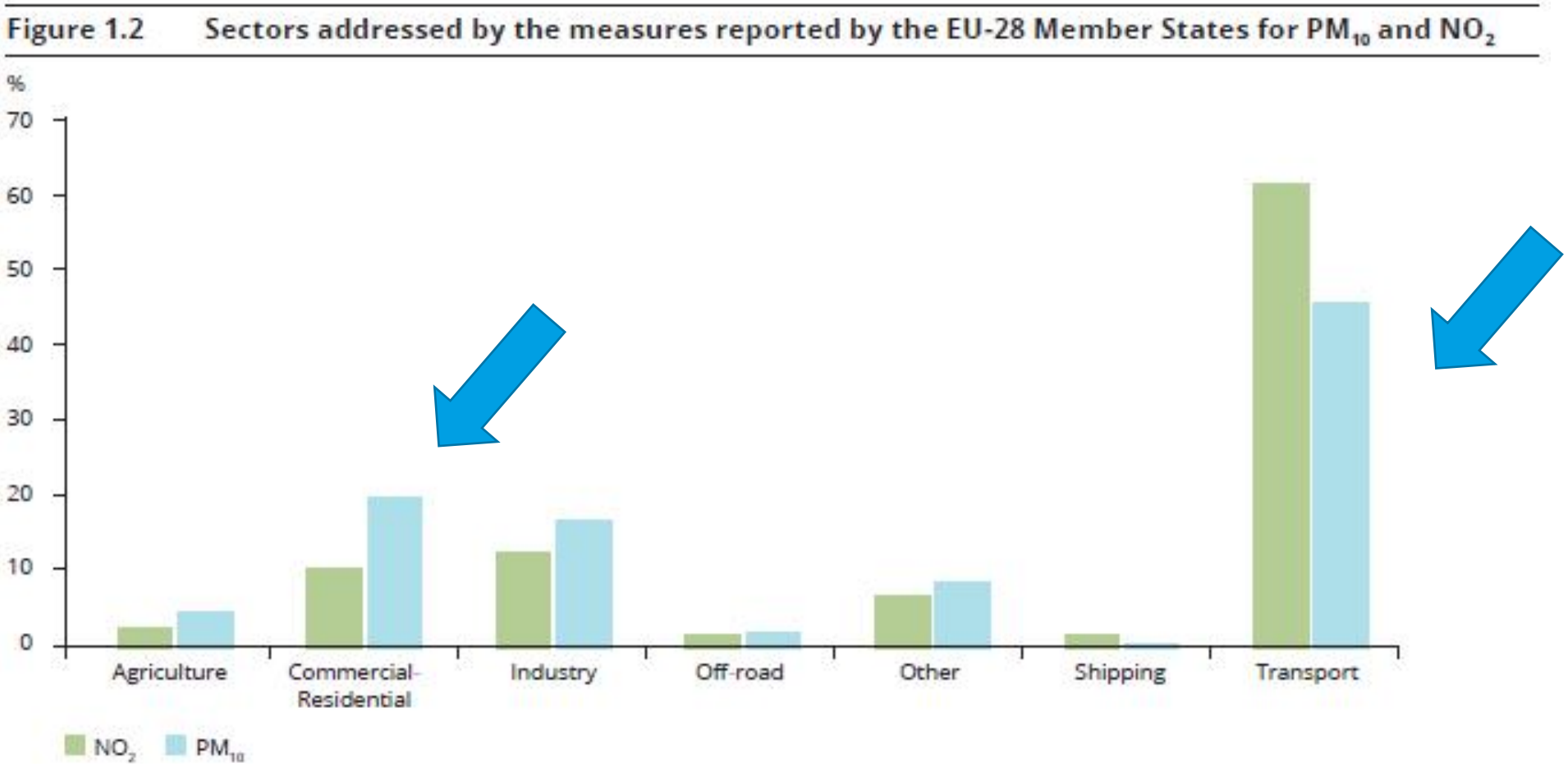
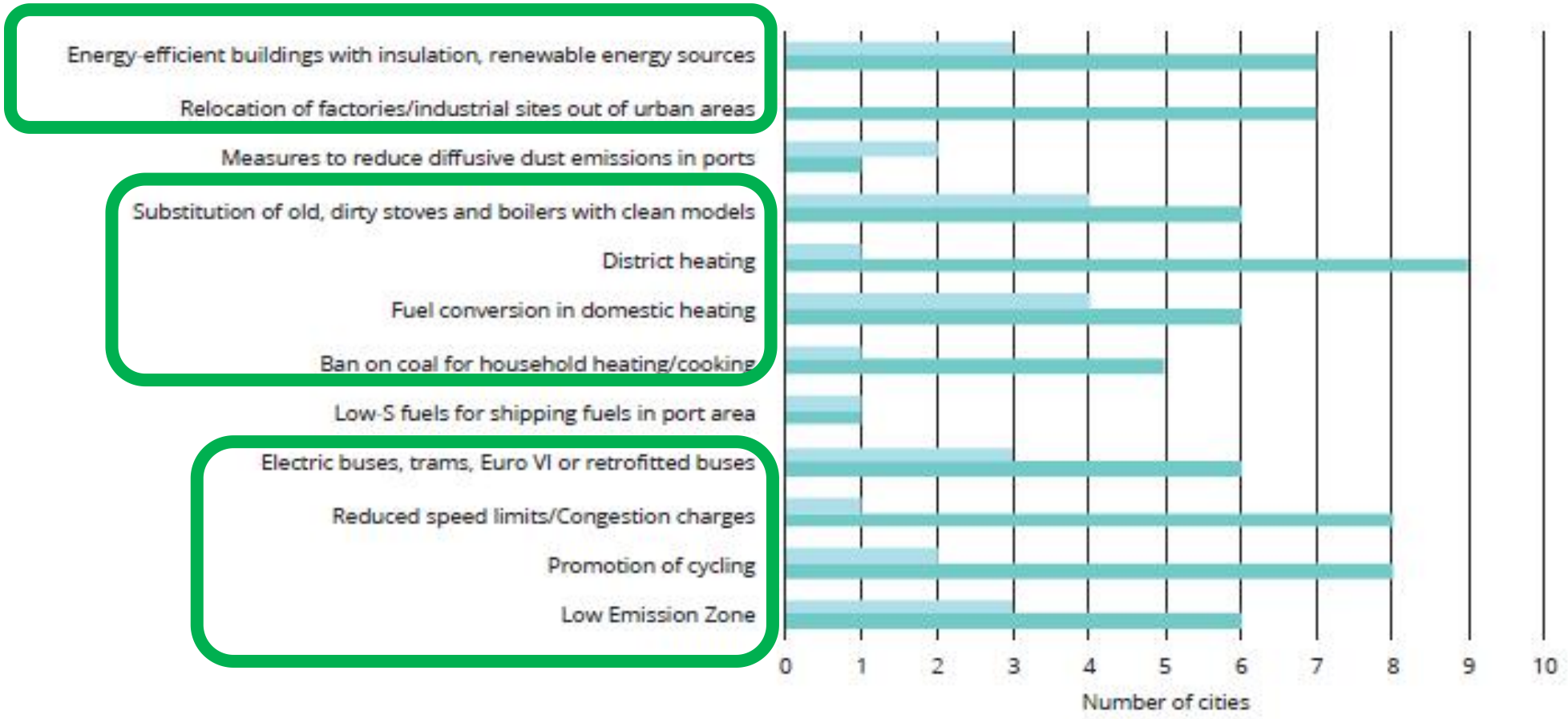
Identifying measures



Source: EEA, 2018, Air quality in Europe

Identifying measures – in European cities

Figure 2.8 Examples of the main air quality measures in place and planned



Source: EEA, 2018b, Europe's urban air quality –re-assessing implementation challenges in cities

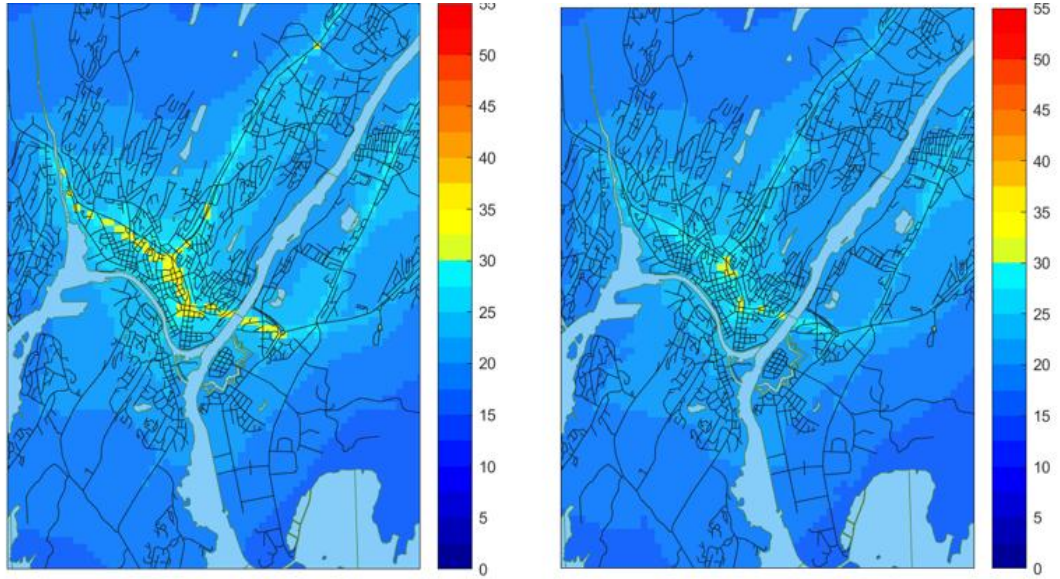
Identifying measures – Traffic

- Low emission zones (LEZ)
- Increased road pricing for diesel vehicles
- Ban cars with odd or even numbers on license plates on alternate days
- Reduced travel rates on public transport
- Parking restrictions
- Electrification of vehicle park
  - Incentives for private electric cars
  - Incentives for electrification of public services (Mail, Taxis, Busses, service vehicles, city cleaning)
- Information campaigns

Identifying measures – Residential heating

- Use of district heating
- Ban on wood and coal burning (in old stoves)
- Incentives for use of new stoves
- Retrofitting heat pump technologies
- Incentives for use of Air Source Heat Pump's (ASHP)
- Information campaigns

Modelling Scenarios



Figur 5-3: Beregnet 31. høyeste konsentrasjonsnivå (µg/m³) for PM_{10} sentralt i Fredrikstad kommune for a) Referanseåret 2022 uten tiltak og b) 2022 med antatt 90 prosent piggfriandel. Overgangen mellom blå og gul fargeskala markerer områder med 31 eller flere døgn over luftkvalitetskriteriet (30 µg/m³)

Source: Weydahl et al., 2018 -NILU report 26/2018

- Improvement of air quality in a Norwegian city when banning the use of studded tyres (PM10 specific measures)
- Study the impact of the emission control measure requires emission scenarios and air quality dispersion modelling

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Use of state-of-art modelling tools

- Europe promotes the use of CAMS regional re-analysis nested to local scale modelling
- State of art models need to be evaluated - with FAIRMODE's Model Quality Objectives
- The use of models is essential to understand mitigation options and identify viable control policies

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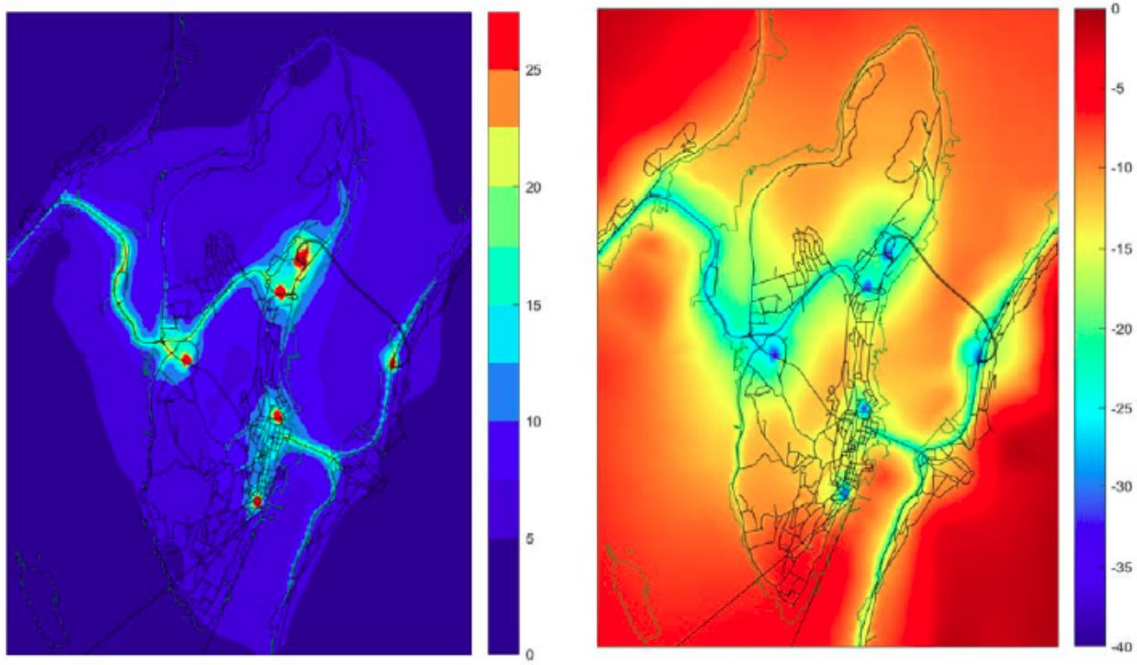
Impact assessment

Tromsø (Norway) example:

Evaluation of the impact of use of studded tyres in 2023 for air concentrations and population exposure of PM_{10}

Prioritized control measures

- ✓ Incentives for use of studded tyres
- ✓ Cleaning of roads - salting & sanding
- ✓ Construction sites



a) Referansesituasjonen 2023

b) Framtidig situasjon 2023 med 50% piggfriandel (prosentvis reduksjon)

Figur 4-1: Årsmiddel konsentrasjon for PM_{10} for a) Referansesituasjonen og b) beregnet prosentvis differanse i årsmiddel PM_{10} mellom Referanseåret 2023 uten tiltak og 2023 med antatt 50 prosent piggfriandel Tromsø kommune. Negative verdier er reduksjon i årsmiddel i forhold til Referanse 2023

Source: Weydahl et al., 2019 -NILU report 26/2019

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Cost-benefit analysis

Tabell 5-1: Anbefalt handlingsplan for lokal luftkvalitet i Tromsø kommune. Tiltak med hvit bakgrunn er rettet mot å redusere kilden til forurensning, mens tiltak med grå bakgrunn i hovedsak er avbøtende tiltak. TK=Tromsø kommune, SVV=Statens Vegvesen, FK = Troms fylkeskommune

Handlingsplan for bedre luftkvalitet i Tromsø	Forventet effekt	Ansvar	Status	Kostnad / økonomi
1. Innføre piggdekkgebyr etter prinsippet at forurenser betaler	Stor	TK	Per i dag ingen piggdekkgebyr i Tromsø	Med dagens piggfriandel på 17% hvor det antas at 80% av bilene med piggdekk betaler gebyr på 1.400 kroner, estimeres inntektene til ca. 38 millioner kroner årlig. Dersom piggfriandelen økes til 50% vil inntektene reduseres til ca. 23 millioner kroner gitt de samme forutsetningene. Utgifter til administrasjon av ordningen er anslått til ca. 3 millioner i oppstartssesongen og ca. 2 millioner i påfølgende år basert på erfaringstall fra Trondheim. Dette inkluderer også administrasjon av piggdekkpanten.
2. Videreføre piggdekkpant	Liten alene	TK	I 2018 var det 131 som benyttes seg av ordningen, mens det per november er i overkant av 100 som har benyttet seg av ordningen i 2019.	Dersom man antar at en tilsvarende andel av bileiere med piggdekk i Tromsø benytter seg av ordningen som i Trondheim blir kostnaden ca. 3,4 millioner kroner i oppstartsesongen og 2,4 millioner i påfølgende sesong. Panten er på 1.400 kroner. Utgiften skal dekkes av piggdekkgebyret.
3. Øke innsatsen på renhold og støvdemping av veiene gjennom hele året. Støvdemping skal ses i sammenheng med renhold. På de mest trafikkerte veistrekningene skal kun salt, og ikke strøsand, brukes som middel for friksjon.	Stor, spesielt i forhold til å redusere antall døgn med høye verdier.	TK, SVV, FK	Status er beskrevet i tiltaksutredningen NILU rapport 26/2019. Høsten 2016 utførte SVV fem støvdempingstiltak til en kostnad av totalt 75.000 kroner. Bydrift opplyser at Stakkevollvegen, Dramsvegen og deler av Strandvegen støvdempes, totalt ca. 5 km.	Vegvesenet i Tromsø har kalkulert med 10 – 15 støvdempingstiltak med MgCl2 – løsning i året, som tilsvarer ca. 260.000 per år. Hvis hele det bynære området av fylkes- og riksveger skal støvdempes vil kostnadene øke til ca. 780.000 per år. Hvis en større del av det kommunale veinettet skal være gjenstand for avbøtende renhold og støvdemping vil det gi økte kostnader. Kostnadsøkningen er ikke estimert. Trondheim opplyser i sin tiltaksutredning at totalkostnad for avbøtende renhold og støvdemping var totalt 4 millioner for 90 km kommunal vei i 2017 (40.000 per km vei, spesifikk kost). Kostnaden vil variere med blant annet meteorologiske forhold. Utgiften skal dekkes av piggdekkgebyret

Source: Weydahl et al., 2019 -NILU report 26/2019

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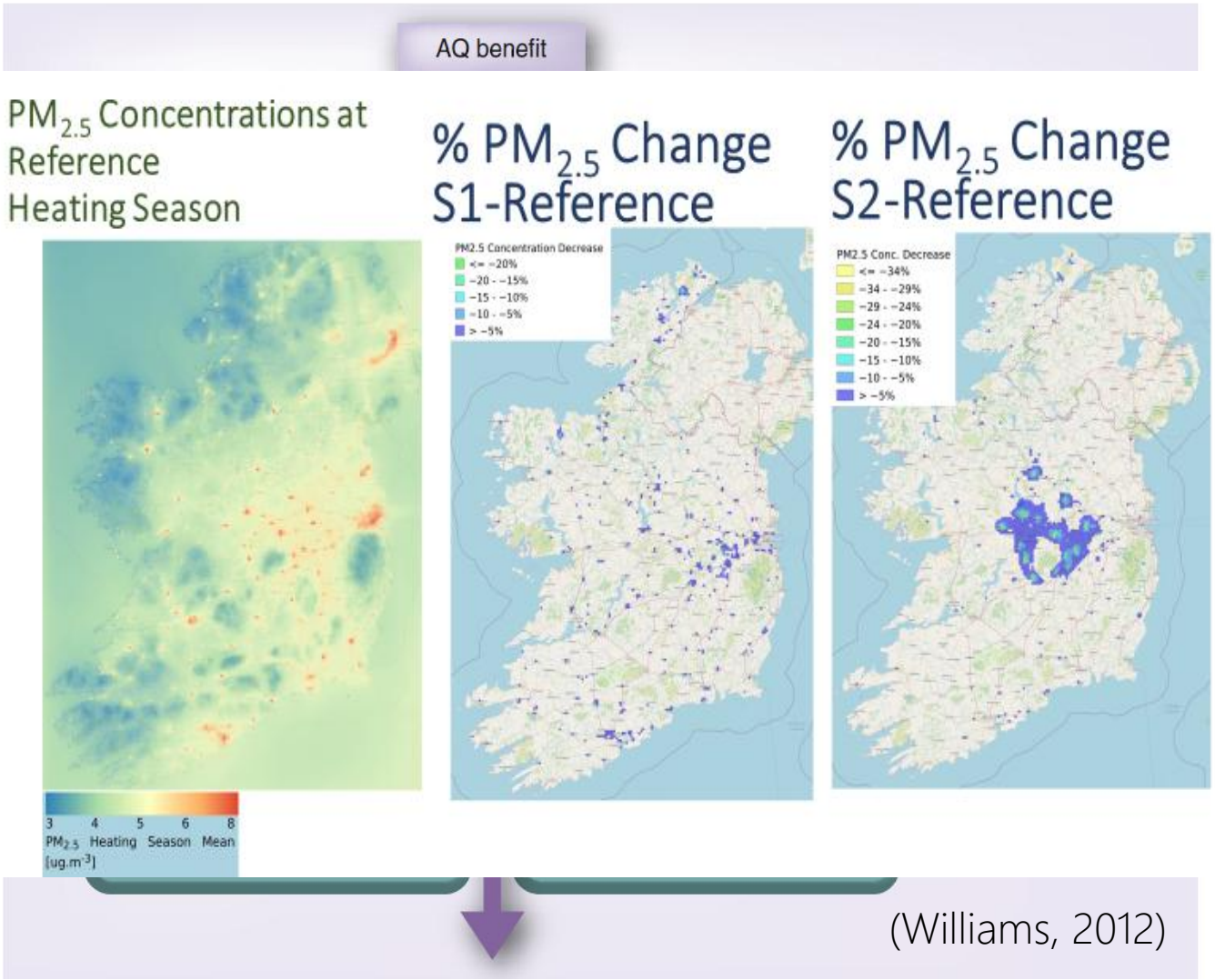
Cost-benefit analysis – Ireland



- The **Irish climate action plan** (DECC, 2021) sets an ambition to electrify residential heating systems in some 600,000 homes across Ireland by 2030.
- **Grant subsidy to upgrade heating system** = installation Air Source Heat Pumps (ASHP) into existing homes, with an initial focus on oil-fired heating systems.
- **CONAIR project** : Retrofitting ASHPs in Ireland will reduce climate emissions and reduce AQ relevant emissions. The targeting of just 3% can deliver $PM_{2.5}$ concentration reductions of 20–34% in hotspots, emitted from solid fuel use. The spatial targeting can improve public health and help tackle fuel poverty.

Source: Broin et al., 2022

Governance & legislation - Role of cities

Figure 2.3 Priority rating of air quality compared with other environmental issues over the past 5 years

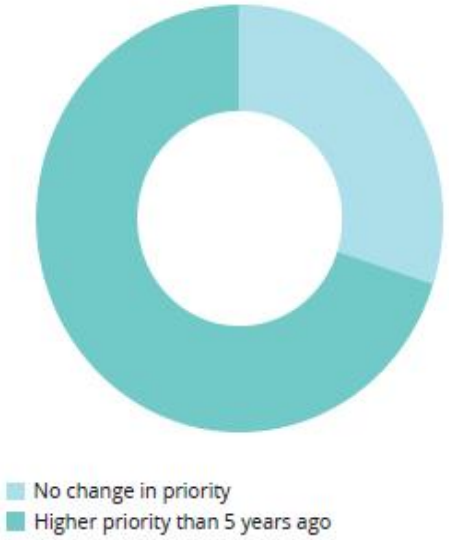
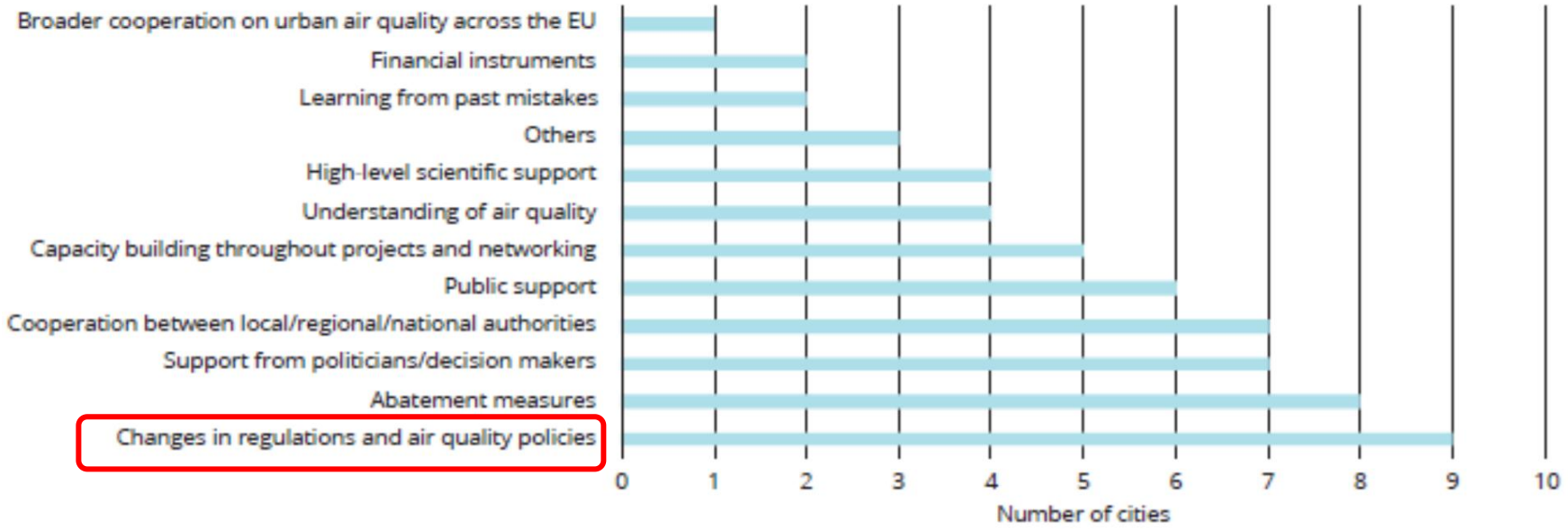


Figure 2.4 Reasons for the observed positive developments in air quality over the past 5 years based on feedback from participating cities



Source: EEA, 2018b, Europe's urban air quality –re-assessing implementation challenges in cities

Governance & legislation - Role of cities

Cities are responsible

- To monitor and assess air pollution levels
- To inform the public
- To identify and implement control measures
- To develop action plans with clear responsibilities and timeframes


Trade-offs and innovation

- Electrification experiences in Oslo
- Trade-offs for city tolls
- Evaluation of new road use taxation system
- Roadways and innovation - energy solutions
- Environmental Finance
- Co-creation approaches

Citizen science is key to AQ control

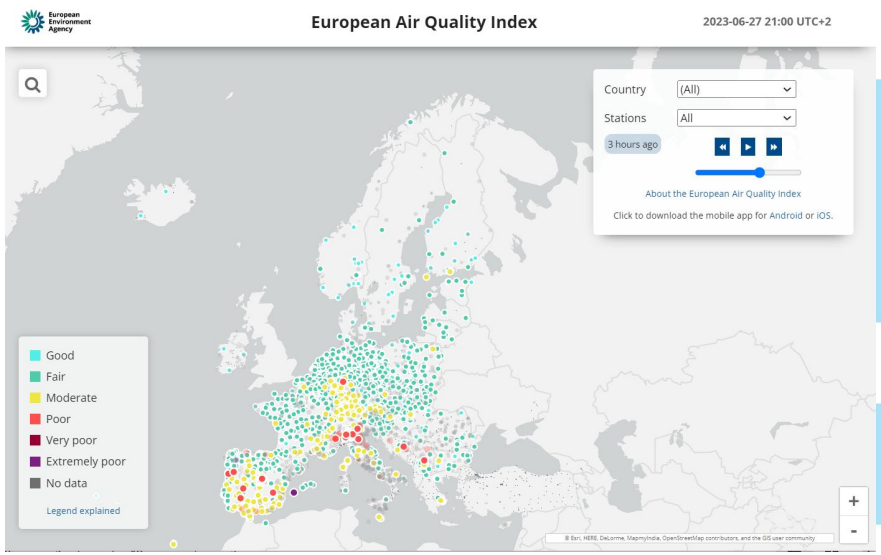
Co-creation approaches

Norwegian cities are successful involving citizens in

- monitoring air quality with low-cost microsensors
- embracing innovation measures through incentives and communication (Environmental Finance and new trade-offs!)

Urban air quality and GHG management

Information & Communication



Stronger focus on information ot the public

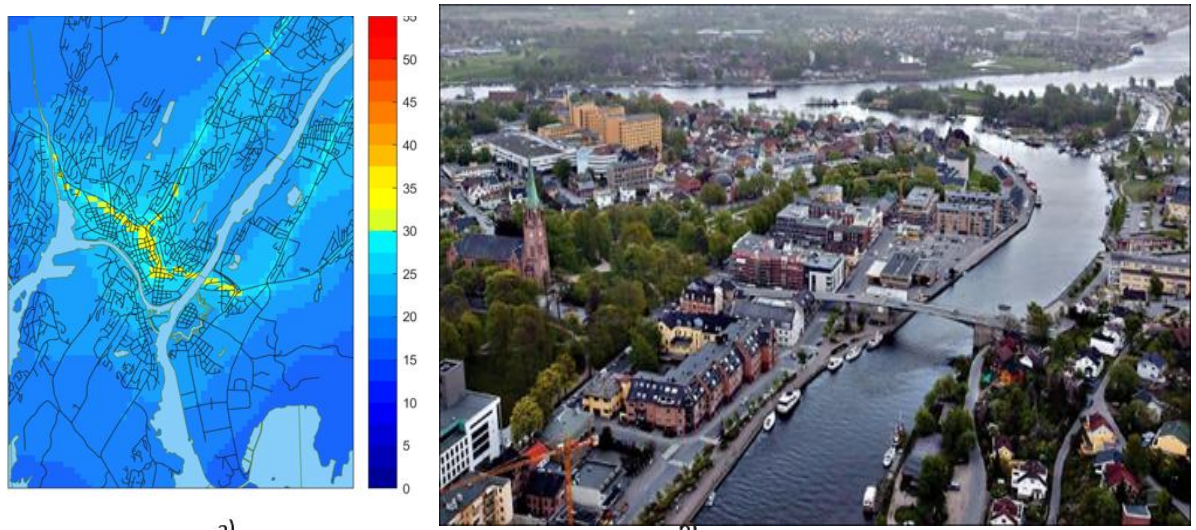
- Air quality indexes up-to date information
- Links to Copernicus Forecasting capablities
- Short-term mitigation actions
- Indicative measurements – sensors

- **Article 22** requires Member States to ensure that the public as well as appropriate organisationsare informed, adequately and in good time - made available to the public free of charge by means of **easily accessible media and communication channels**.
- **Article 22** also obliges Member States to establish an **air quality index** providing hourly air quality updates for the most harmful air pollutants (SO2, NO2, PM10and PM2.5and O3).
- **Article 23** adds new requirement: **all data to be reported** (and to be used for compliance assessment purposes), even if they do not meet the data quality objectives.
- **Annex IX** enhances the **air quality information to be provided to the public**, including obligatory hourly updates for fixed measurements of key air pollutants, as well as up-to-date modelling results where those are available.

Governance & Enforcement – Air quality plans

- Air quality plans are made **mandatory** when **limit values**, the **ozone target value** or **average exposure reduction obligations** are exceeded – **Require modelling expertise at urban scale**
- **Improved enforceability**: new provisions on access to justice, compensation and penalties
- More **transboundary cooperation** on air quality

- **Article 19** increases the effectiveness of **ai** soon as possible. This will be achieved by ***standards enter into force*** *in cases of no* *must aim to keep the* ***exceedance period*** *limit values, and (c) mandating* ***regular up***
- **Annex VIII** brings together **requirements f** ozone target value and average exposure r



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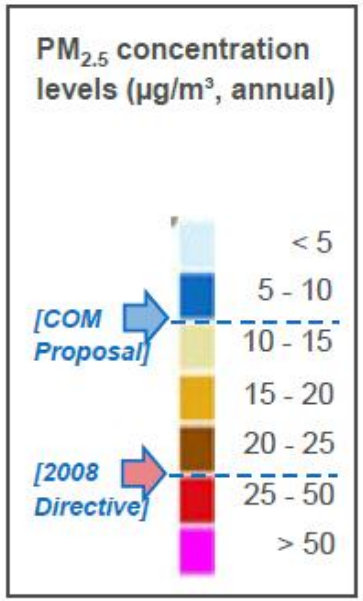
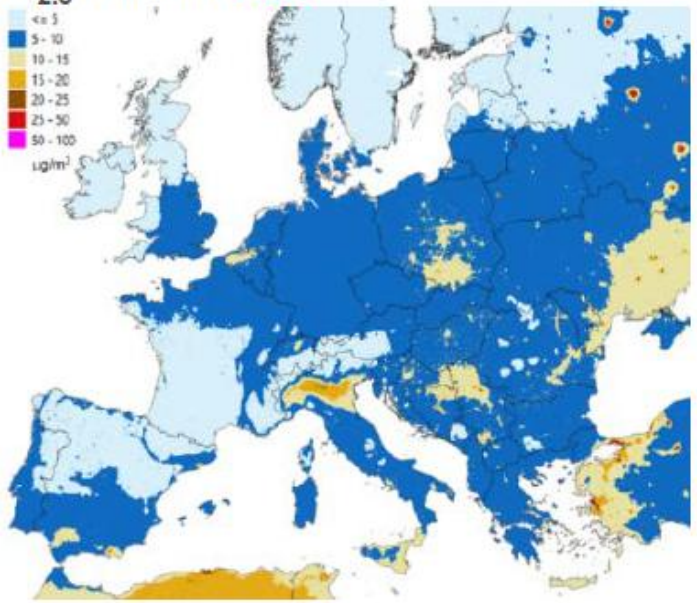
What will the proposal achieve? – Cleaner Air

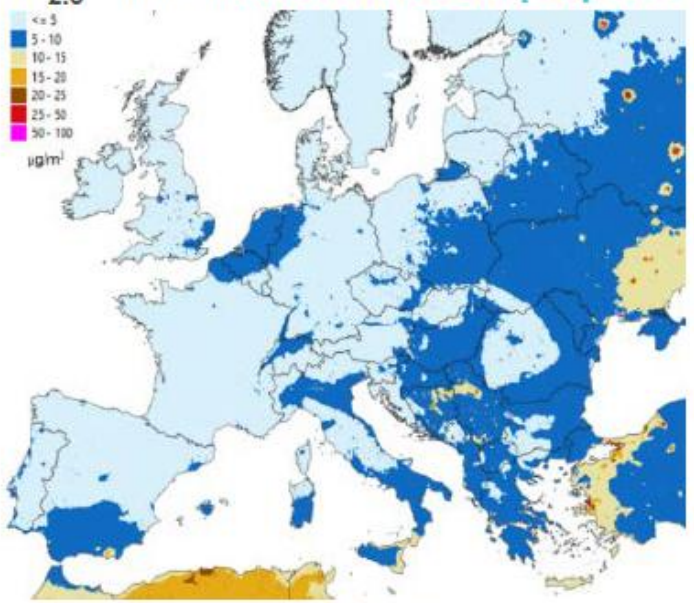
First and foremost, the air quality will improve across the European Union.



$PM_{2.5}$ levels in 2020



$PM_{2.5}$ levels in 2030 with COM proposal



Based on GAINS/EMEP/uEMEP. Note that these maps show the total concentration levels, and include also contributions from natural sources of wind blown dust and sea salt.

What will the proposal achieve? – By 2030

- **Health benefits:** Reduces annual mortality (premature deaths) linked to air pollution by more than 75% (and by 50% more than without this policy)(1) – also reduces related morbidity (illnesses) by 50% more than without this policy.
- **Social benefits:** Stricter limit values particularly protect sensitive populations and vulnerable groups; Directive requires additional health impact information.
- **Environmental benefits**: Decreases in eutrophication (-22%) and acidification (-63%) of ecosystems; less crop losses and damage to forests.
- **Economic benefits:** Benefits far outweigh the costs, with annual total gross benefits estimated at €42 bn (and up to €121 bn depending on the valuation method) in 2030, compared to measures that costs less than €6 bn annually.

European Commission

(1) Note that these estimates refer only to health impacts above the WHO Air Quality Guideline levels. However, air pollution below these levels can also impact human health.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