Guidance document on non-technical and structural measures

1st informal draft, TFIAM, 5 April 2024

1. Introduction

The WGSR at its 59th session recommended developing a guidance document on non-technical measures. The development of such a document is included in the workplan 2024-2025 of the Air Convention. The guidance document should be based on best practices at the national level (focused on meeting national emission reduction obligations) and at the local or regional level (focused on reducing health and ecosystem damage in hot spot areas).

Abatement of emissions under the Air Convention is mainly the result of regulation. There is a legal obligation to apply specific add-on technologies or meeting emission limit values in permitting. It is relatively easy for air quality policy makers to assess the additional costs of potential technical 'end-of-pipe' abatement measures for certain sectors, and they can be compared with the expected benefits for health and ecosystems.

Contrary to technical 'end-of-pipe' measures, the implementation of structural innovations of industrial production processes, or transitions towards more sustainable transport systems or food systems, often requires a more complex mix of policy instruments. Apart from regulation, the policy mix could include pricing, research investments, infrastructural planning and awareness raising.

The political assessment of costs and benefits of behavioral and structural measures will often require broader involvement of stakeholders, other ministries, cities and the public at large. Benefits could entail more than better air quality, but also climate benefits, more safety, additional health benefits due to physical activity, less noise, or less nitrate leaching. Costs of behavioral and structural measures could entail more than money. Also, the loss of services, comfort or freedom (e.g. to choose what to eat, how to heat your house or how to move from A to B). Successful implementation of structural and behavioral changes will - at least - require more involvement of the public and of industries in the decision-making process. Their acceptance will also depend on equity issues: who pays, who will benefit? Will small enterprises disappear? Do farmers have to stop their activity? Will prices increase and can low-income groups still pay their energy bill, still access the city or still eat meat?

Decisions on structural and behavioral changes will in many cases raise more political debate, than strengthening technical emission limit values. Implementation will probably require more time. And the acceptability of such measures as well as the acceptable mix of policy instruments may vary across countries, depending on cultural and political preferences.

This guidance document discusses several options for structural and behavioral change and their potential contribution to environmental quality improvements. It defines the basic requirements for successful implementation, gives a few examples with proven success, and addresses the challenges of assessing its costs and benefits. The focus of the measures in this document is on residential heating, mobility and food. The document builds on an earlier informal document prepared under the Gothenburg Protocol review Group (Informal doc on non-technical measures.pdf (unece.org), 2021).

2. Why do we need structural and behaviorial measures?

Implementation of technical emission limit values (ELVs) for installations, vehicles and products is not always sufficient to meet the national emission reduction obligations or the long-term air quality targets to protect human health and ecosystems. In such cases, additional actions in the form of 'non-technical' measures or changes in the structure of the economy could be considered: e.g., less use of fossil fuels, less car traffic of less cattle. Such measures can be initiated at the local or national level but can also be backed by international coordination.

Structural and behavioral measures could include a faster substitution of oldand polluting technologies by new and cleaner technologies, the use cleaner fuels or feedstocks, or a greener behavior of consumers. The latter could include a modal shift from private motorized to public or private non-motorized transport, dietary changes or cleaner residential energy use. Sometimes such measures prove to be more efficient and less costly than implementing stricter ELVs, but there can also be hidden non-monetary costs, such as longer travelling time, less comfort, loss of freedom to eat what you want.

Definitions

Such additional voluntary, innovative or non-regulatory measures that are not included in the technical annexes of the Gothenburg protocol are, for that reason, sometimes referred to as 'non-technical' measures.

In reality, these 'non-technical' measures can still have highly technical components. For example, in the case of insulation of buildings, the use of solar energy, the redesign of products and processes or advanced public transport systems. Examples of non-technical measures without a technical component include improved maintenance routines (e.g. regular checking of pumps, valves and pipelines for leakages, checkup for cars, heating systems, etc.), reducing indoor temperature, lower vehicle speed or a shift towards public transport, cycling and walking. Examples of hybrid measures (technical "non-technical" measures) are motion-activated light switches, cruise control functionalities in vehicles, or certified product information so people can be sure they select environmental-friendly dish washers, refrigerators, wood stoves, etc.

Often 'non-technical measures' are associated solely with behavioral change. However, as illustrated above, they encompass much more. Given the possibility of narrow or potentially misleading interpretation of the terminology 'non-technical measures', the broader term 'structural measures' or 'structural changes' may be more appropriate when we refer to measures that are additional to the end-of-pipe techniques prescribed in the technical annexes to the protocol.The common feature of structural changes is that they cannot easily be implemented via permitting ofspecific activities. They often require a combination of actions by various players in the production chain, as well as by consumers. As the term 'structural changes' suggests, it could even include a transition towards a new economic structure that relies less on the use of fossil fuels or animals.

3. Policy instruments to implement non-technical and structural measures

Very simplified, we can distinguish four types of policy instruments: regulatory, economic, social (information and communication) and public investments (including Research and Development[1]): These instruments can be combined in various ways. Below are some examples focusing on these four types of policy instruments in the transport system.

1. Regulatory instruments: some cities have closed parts of the city centers to cars or have withheld permits (e.g. for new roads). The recent lockdown has demonstrated that the regulation of vehicle activity in the event of a societal emergency can be acceptable.
2. Economic instruments: These could include a tax for polluting cars; subsidies for clean alternatives; compensation for the early scrapping of old cars; and increased parking fees in city centres.[2]
3. Social instruments: These could include raising awareness, and public involvement in monitoring and city planning. Incorporating communication strategies that suggest or promotea (modal) shift toward less polluting options. These may not always be sufficient to effectively change individual behavior but can contribute to gaining societal support for the use of one of the other policy instruments mentioned above and to adapting social norms that in turn influenceindividual behavior.
4. Public investments: These could include physical planning and targeted investment in infrastructure that could provide an important opportunity for the public sector to bring aboutstructural change. For example, investment in public transport, the removal of parking spacesand the replacement of car lanes by bus or cycle lanes have a proven effect on traffic intensity and on modal change, and thus on emissions. Additionally, country governments could adopt policies to expand electric vehicle (EV) infrastructure, and to replace government motor vehicle fleets with EVs.

Extensive research has been done into the optimal mix of policy instruments, including policy scientists, economists and other social scientists, such as psychologists and even neurological researchers (see: https://implementconsultinggroup.com/article/harness-the-potential-of-habits-at-work; https://www.visualcapitalist.com/wp-content/uploads/2017/09/cognitive-bias-infographic.html]. Efforts to find a theoretical optimal policy mix do not reveal a single answer. Much depends on the actual preferences and power of stakeholders. In practice, pragmatic policy choices are made in specific situations that acknowledge that public acceptance of certain instruments has limitations, that long-term goals cannot be realized at once, and that policy makers have to be satisfied with small steps in the right direction.

4. Inventory of effective structural and non-technical measures

Energy

Exploring the potential emission reductions from structural changes in the energy sector is well covered by energy models such as PRIMES. The results of energy scenarios show that a shift from fossil fuels to renewables could significantly reduce fuel related emissions like SO2, NOx, PM2.5 and BC. Such co-benefits from climate and energy policies are included in the GAINS-scenarios. However, the side effects of climate measures will not always be positive. The use of carbon-capture and storage would require substantially more energy, and this could increase NOx-emissions, without additional add-on technology. Also, the use of hydrogen or ammonia as energy carriers would require additional (technical) measures to minimize an increase in emissions of air pollutants. These elements are covered in the GAINS-scenarios, which is not always the case for the structural and non-technical measures to reduce emissions from residential heating, transport and food.

Residential heating

For the reduction of emissions from domestic wood burning (a coherent package of) 'non-technical' measures are likely tobe more effective and suitable than technical measures. Examples of such measures, together with the policy instruments thought to induce them, are:

(i) programs providing grants, incentives or rebates to accelerate the removalor replacement of old and polluting wood burning appliances,

(ii) policies for prohibiting use of less efficient devices during high pollution events,

(iii) training programs for proper installation and regular maintenance schemes,

(iv) encouraging good burning practices and use of dry wood,

(iv) energy renovation (reducing heat demand), etc.

All these measures will likely be more cost-effective than retrofitting the existing stock with a catalyst or an ESP (technical measure). See the new code of good practice for solid fuel burning (TFTEI). [4]

In many countries, there are efforts to raise awareness of the indoors and outdoors health risks of wood burning to stimulate voluntary action. Several countries or cities go further than awareness raising, e.g.:

- The U.S. EPA certifies residential wood stoves for meeting emission limits and efficiency requirements. In this case the government has a unique role as a trusted third party.
- Emissions from wood stoves are the combined result of technical standards and wood burning behavior. Awareness raising is often a first necessary step to change behavior and can help the acceptance of regulation on how and when to burn wood (if awareness raising alone proves to be insufficiently effective).
- Checking the right wood burning behavior by chimney sweepers, such as in Germany.
- The legal obligation not to burn wood in case of unfavorable sweather forecast(such as low wind speed or inversion) in some states in the US.
- Several countries give financial compensation for scrapping old wood stoves, such as Belgium and Denmark.
- Some cities in the Netherlands have introduced wood-burning-free neighborhoods.

These are all examples of policies to further reduce emissions from wood stoves in addition to technical standard setting.

Transport

Measures at the national level to implement structural and behavioral change include e.g. programs to expand EV infrastructure and provide incentives for increasing EV sales; enhanced inspection and maintenance schemes; logistical programs to reduce emissions from goods transport; national speed limits, increase of fuel duties, national road pricing, investments in public transport, agreements with cities on low-emission zones, scrapping schemes and public awareness raising on the health benefits of active mobility (walking and cycling). [5]

There are several extensive inventories of promising local measures, for instance:

- Haneen Khreis et al., [Urban policy interventions to reduce traffic-related emissions and air pollution: A systematic evidence map - ScienceDirect](https://doi.org/10.1016/j.envint.2023.107805), 2023, https://doi.org/10.1016/j.envint.2023.107805
- Public Health England, Improving outdoor air quality and health: review of interventions - GOV.UK (www.gov.uk), 2020

In these inventories around 50 different types of interventions are distinguished (see annex 1). Evaluation of the outcomes of such interventions is mostly based on qualitative judgement of the feasibility and effectiveness or on (ex-ante) modelling results. Measurement of the outcomes in terms of reduced pollutant exposure or health improvements is limited, and outcomes may depend on local circumstances. This hinders the inclusion of the quantitative local impacts of such interventions in a coherent modelling framework such as GAINS.

An exception is the measurement of the impact of low-emission zones (source.. UBA). However, here (at least part of) the impacts are temporary, if we assume that older vehicles will have to be replaced anyhow at the end of their lifetime. Also, for the impact of interventions such as planting trees and scrubs and the use of catalytic paint measurements are available, which show that their impact is not significant (Fernando Martin, Pamplona study, Life-Respira project, 2014-2017).

In general, promotion of cleaner vehicles and limitation of car traffic will be most effective in reducing exposure to NO2 and PM2.5 in a city. Traffic circulation plans to reduce exposure at so-called hotspots could increase the exposure in other parts of the city. Emissions and average exposure (and health impacts) could even increase, if the circulation plan increases total mileage in a city. For PM2.5, the average exposure in many cities depends to a large extent on sources outside the city, such as industry, highways, shipping and ammonia from agriculture. The impact of traffic measures within a city will therefore only have a modest effect on the average exposure to PM2.5 in a city.

There is still much to learn from each other. Effective interventions to reduce car use in cities differ among countries. In some countries road pricing proved to be very effective, while in other countries this measure was not acceptable because it could increase social inequalities. In these countries infrastructural changes, such as providing more public transport, removing parking places and downgrading main roads proved to be more acceptable for a social policy point of view. This shows that there is not one silver bullet for all countries.

Food

For the food system, the most effective behavioral change is to reduce dairy and meat consumption and production. This could form a powerful way to reduce emissions of ammonia and methane. It would mean a structural shift towards less intensive farming, that would also contribute to biodiversity restoration, and improved water quality. See also the 2017 report from IIASA on measures to address air pollution from agricultural sources.[6]

The TFRN-report Appetite for Change: Food system options for nitrogen, environment & health. 2nd European Nitrogen Assessment Special Report on Nitrogen & Food | Task Force on Reactive Nitrogen (clrtap-tfrn.org) (2023) shows how the mix of policy instruments could look like to change the food system, including diets. Changing diets would reduce nitrogen losses and have co-benefits for nutrition and public health. The main message is to engage all stakeholders in the decision-making process. Recent farmer protests in Europe show how important this is. Farmers and rural areas require new economic perspectives if industrial farming becomes restricted. An agreement with large feed and seed producers, food traders, supermarkets and banks would also be needed.

Several (voluntary) bottom-up approaches to sustainable food systems are emerging at the local and regional level. However, large scale reductions in meat and dairy consumption are not yet visible. Still, there are differences in meat consumption across the UNECE region. These can partly be explained by differences in income, but also by cultural differences in diets.

Case study of Finland (Kugelberg et al., 2021).
In 2017, Finland adopted a new food policy, addressing the whole food chain, Food2030. To strengthen directionality for the future Finnish food system, the vision-building process was agreed by the use of a highly iterative consultation approach, a range of expert studies, research and working groups; which resulted in building wide support for Food2030 across political boundaries (Kugelberg *et al.*, 2021).
The range of policy, tools and measures that form the Finnish governance approach to implementing the vision, objectives and priorities of Food2030, includes measures designed to enable information flow, e.g., multi-media campaigns, standards and guidelines (organic and local public procurement and food-based dietary guidelines); to stimulate a demand for organic and local foods. They also include system rules, such as direct funding, certifications, network and support schemes to support responsible production.

Austria managed to have a high share of organic food, due to ...

Denmark introduced a meat tax, which resulted in ...

5. Scope and benefits of structural and non-technical measures

Discussions on structural changes have taken place over many years. The 2007 report of the TFIAM on the review of the original Gothenburg protocol already concluded: "*In addition to availableend-of-pipe emission control measures, non-technical and local measures will be of increasing relevance, especially if multiple policy objectives are* pursued. "[3]

This conclusion is still relevant and has become even more pertinent in order to be able to meet long-term targets of the Air Convention. But what could such measures contribute?

Also, the climate community delved into this question. The Sixth IPCC Assessment Report – Working Group III, 2022, p47 gives an indication of the potential contribution of structural and behavioral "demand-side" changes to emission reductions of greenhouse gasses. It shows that the potential contribution of dietary change could be as large as all measures to reduce residential fossil fuel use together. While reduction of fossil fuel use is linked to emission reduction of both CO2 as well as other pollutants such as particulate matter, SO2 and NOx, dietary change will both reduce emissions of greenhouse gasses, including methane and N2O, as well as ammonia (an important precursor of the formation of secondary particulate matter).

The expected benefits of including structural and non-technical measures in GAINS are:

1. Non-technical measures/structural changes will lead to lower air pollution, or to lower air pollution control costs to reach certain objectives than if estimated on the basis of end-of-pipe measures alone.
2. In general, GAINS optimizations do not consider the potential for structural changes or non-technical and local measures. GAINS has a focus on add-on technicalsolutions (measures with direct impact on the emission factors). Structural changes can be simulated by introducing changes in the baseline activity levels (i.e. the energy scenario inputdata). This requires analyses using a set of linked European wide models, e.g. for energy use (PRIMES), agriculture (CAPRI) and transport (COPERT), but also input from national and local experts on envisaged or potential structural changes would be valuable.
3. Structural measures will have larger (synergetic) reduction potentials than simple add-on controls addressing one pollutant by reducing emissions of different air pollutants (and greenhouse gases) simultaneously.
4. Given policy developments in other areas (climate, energy, nutrient management, transport, agriculture, biodiversity, …) it is more prudent to take into account other measures than only technical end-of-pipe techniques (ELVs in the technical annexes). A switch to cleaner fuels andcleaner technologies, energy saving and energy efficiency action, structural changes in transport or agriculture, behavioral changes in diets, modal shift to public transport could prove to be more cost-effective than applying end-of-pipe technologies. This may reduce the relevance of setting stricter ELVs to further reduce emissions in the longer term.
5. Structural change could play a key role in further reducing emissions in sectors such as domestic wood combustion, transport and agriculture.

However, there are still challenges to be faced when we want to include structural and behavioral changes in decision support:

  - o How can we translate local experiences into reliable estimates of the implementation rates and potential emission reductions applicable for the whole UNECE domain? The LOW-scenario of GAINS (source:) includes dietary measures (the adoption of a diet based on total human energy requirements of 2500 kcal/day (after waste) as laid out in the EAT-Lancet Commission proposal (Willet et al., 2019), and reduction of the number of cattle and structural changes in waste treatment.

- It should also be taken into account that while the rates of application (implementation) of most structural measures are predictable in modelling and verifiable (ex-post), the degree of application of certain measures more closely related to behavioral changes is not predictable or verifiable with reasonable certainty (i.e., modal shift from private cars to public transport or the use of best practice in residential wood heating). The same goes for the related costs.
- The costs of integrated city-transport planning (e.g., a metro-connection to a new neighborhood) are difficult to attribute to air pollution, climate and urban accessibility, respectively.
- What are the welfare effects of behavioral changes? Several studies have made theoretical assumptions on how to monetize non-monetary costs, e.g. C. Carnevale, et al. Evaluating economic and health impacts of active mobility through an integrated assessment model - ScienceDirect, 2018.

Emerging challenges are to find answers to questions like:

- What will be required in terms of public expenses for enforcement and how much public money will be needed to convince citizens and industries to adapt? Whilst this is not an important cost item for technical measures, it may very well represent a considerable share for several structural changes.
- What is more cost-effective: additional local measures or additional national and international measures?
- In order to meet WHO-guideline values and critical loads, what could be the maximum livestock and traffic densities after all technical measures have been implemented?

More efforts are needed to understand the perceived welfare effects of structural changes and individual behavioral change. Both diets and domestic wood combustion are household decisions and incentives from the public sector to change these behaviors are often met with strong opposition from citizens, despite their cost-effectiveness. [7]

6. Conclusion

This document gives a concise overview of the potential emission reductions from structural changes and non-technical measures that can be considered during the Gothenburg protocol revision. Further contributions are foreseen from TFRN, TFTEI and the Parties.

There is still much to learn from each other. Effective interventions to reduce car use in cities differ among countries. In some countries road pricing proved to be very effective, while in other countries this measure was not acceptable due to its social consequences. Instead, infrastructural changes, such as more public transport, removing parking places and narrowing main roads proved to be more acceptable. This proves that there is no one silver bullet.

Measures with the largest potential impact, such as dietary change, also seem to encounter most resistance among the public and farmers. Restriction of wood burning receives much opposition in all countries, although the health benefits are clear.

Annex 1: Inventory of local interventions to reduce traffic related emissions

Urban policy interventions to reduce traffic-related emissions and air pollution: A systematic evidence map (376 measures, based on over 9000 references)

Haneen Khreis et al, Env Int Feb2023

Policy Category	Policy Intervention	Frequency Studied
Pricing: 11.8 % (n = 216)	1. Air pollution charging fees	24
	2. Congestion charging	28
	3. Fuel taxes or price increase	26
	4. Mileage-based user fees	4
	5. Parking charges	55
	6. Road pricing	51
	7. Pricing incentives	27
	8. Vehicle ownership taxes	1
Land-Use: 4.2 % (n = 77)	1. Development density and mixed developments	42
	2. Parking expansion	2
	3. Superblock development	2
	4. Transit-oriented development	18
	5. Urban sprawl	8
	6. Urban transport planning	5

Infrastructure: 11.5 % (n = 210)	**1. Active transportation infrastructure**	**26**
	2. Bus rapid transit or mass rapid transit	43
	3. Greenspace or blue space	2
	4. Park and ride	9
	5. Public transportation infrastructure	33
	6. Roadway development	23
	7. Solid roadside barrier	8
	8. Speed bump development	18
	9. Street ventilation	3
	10. Unconventional intersection or intersection alteration	22
	11. Vegetative roadside barrier, surface, or roof	23

https://doi.org/10.1016/j.envint.2023.107805

Urban policy interventions to reduce traffic-related emissions and air pollution: A systematic evidence map – ctd

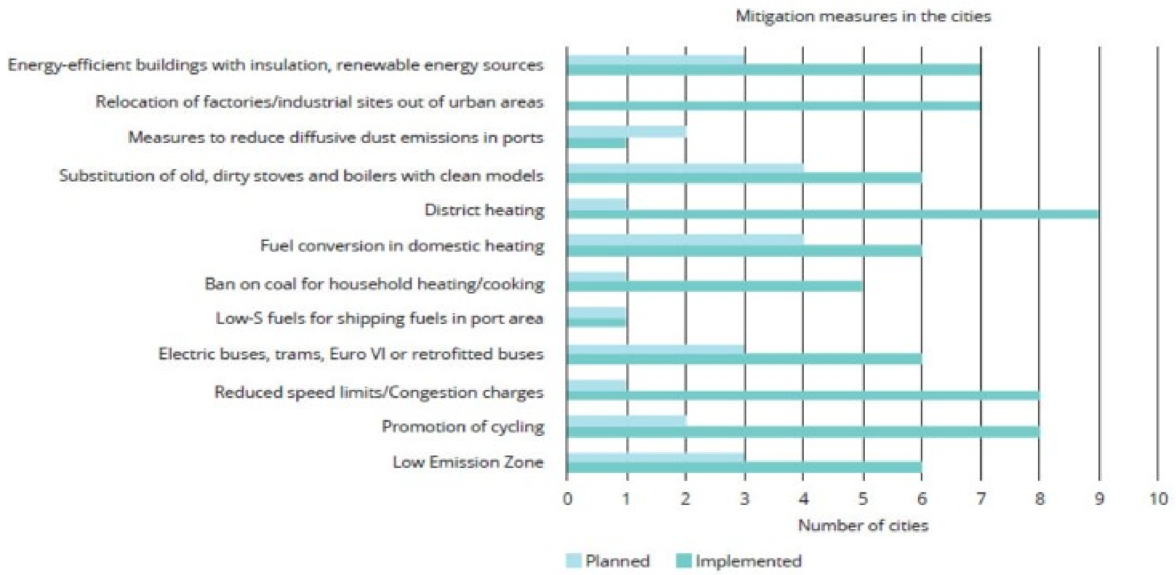
Behavioral: 6.3 % (n = 116)	**1. Active or non-motorized transport (i.e., bike or walk) promotion or shift**	**31**
	2. Flexible work arrangements	26
	3. Public transit promotion or shift	47
	4. Ride sharing promotion or shift	12
Technology: 22.2 % (n = 406)	1. Alternative fuel technology	271
	2. Alternative vehicle technology	12
	3. Electronic toll technology	3
	4. Material coating	6
	5. Real-time passenger information	2
	6. Speed control technology	5
	7. Stop/Start technology	2
	8. Vehicle retrofitting	105

Management, Standards, and Services: 44.1 % (n = 807)	**1. Fleet management**	**59**
	2. Fuel regulation or restriction	35
	3. High occupancy vehicle lane	13
	4. Inspection and maintenance program	18
	5. Intelligent transport system	47
	6. Low emission zone	58
	7. Loading, unloading, and/or idling regulation	18
	8. Parking standards, reduction, or regulation	16
	9. Public transportation expansion	47
	10. Public transportation regulation	31
	11. Speed limit regulation or reduction	42
	12. Street cleaning	4
	13. Studded tire regulation	1
	14. Traffic signal optimization	29
	15. Vehicle or manufacturing alteration	4
	16. Vehicle emission regulation	134
	17. Vehicle purchase restriction	7
	18. Vehicle rerouting or route optimization	18
	19. Vehicle retirement or replacement	112
	20. Vehicle shift	2
	21. Vehicle use restriction	114

NTM overview Italy (Ilaria D' Elia & Antonio Piersanti)

	Succesful examples	summary	Effective zone (country/area)	Air pollution reduction	Health effects	Costs	reference
Transport	Speed limit highway	reduction of speed limit from 130 km/h to 100 km/h	Italy	Year 2030: reduction of 11.5% of Nox emissions respect to the 2030 baseline. Smaller reduction for PM10 (<2%)	available but not per single measure	not estimated	D'Elia et al., 2018, https://www.sciencedirect.com/science/article/abs/pii/S1309104217306529
	Low emission zones		several italian regions	5% of NOx emission reductions	available but not per single measure	not estimated	D'Elia et al., 2009, https://www.sciencedirect.com/science/article/pii/S1352231009007675
	road traffic restriction	Limitation to vehicle circulation of older Euro vehicles	several italian regions	10% of NOx emission reductions and 5% of PM10 emissions	available but not per single measure	not estimated	D'Elia et al., 2009, https://www.sciencedirect.com/science/article/pii/S1352231009007675
	New heavy duty vehicles	Incentives for the substitutions of heavy duty vehicles	several italian regions	11.4% of NOx emissions	available but not per single measure	not estimated	D'Elia et al., 2009, https://www.sciencedirect.com/science/article/pii/S1352231009007675
	Renew fleet for freight vehicles	Promote the use of methane/liquefied natural gas(LNG)-powered heavy duty trucks. Promote the use of LNG in maritime transport	Italy	NOX emission reduction of 49% at the year 2030 respect to the baseline	available but not per single measure	available but not per single measure as benefits obtained applying a set of measures	Piersanti et al., 2021, https://www.mdpi.com/2073-4433/12/2/196
	Public transport renewal	Incentives for bus substitution, frequency increase, etc	several italian regions	10% of NOx emission reductions and 2% of PM10 emissions	available but not per single measure	not estimated	D'Elia et al., 2009, https://www.sciencedirect.com/science/article/pii/S1352231009007675
Energy	Promotion of photovoltaic integrated in domestic buildings	Incentives to install photovoltaic systems in houses	Italy	negligible emission reductions	not estimated	not estimated	D'Elia et al., 2009, https://www.sciencedirect.com/science/article/pii/S1352231009007675
	Regulation of residential biomass, oil and coal use	ban of these type of fuel	Italy	Reduction of SO2 emissions (36.4%), of 15% of PM10 emissions and 5% of Nox emissions	available but not per single measure	not estimated	D'Elia et al., 2009, https://www.sciencedirect.com/science/article/pii/S1352231009007675
	Efficiency improvements in fireplaces and stoves	Renewal of old biomass heating systems with efficient and low-emission technologies	Italy	PM10 and NMVOC emission reduction of 12% and 20% at the year 2030 respect to the baseline	available but not per single measure	available but not per single measure as benefits obtained applying a set of measures	Piersanti et al., 2021, https://www.mdpi.com/2073-4433/12/2/196; D'Elia et al., 2009, https://www.sciencedirect.com/science/article/pii/S1352231009007675
Agriculture	Lower nitrogen feeding diet for bovines	10% of lower nitrogen feeding diet for bovine (not regulated by EU Directive)	Italy	the two measures were applied together with an overall NH3 emission reductions of 7%	available but not per single measure	not estimated	D'Elia et al., 2018, https://www.sciencedirect.com/science/article/abs/pii/S1309104217306529
	More efficient use of nitrogen fertilizers	Reduction of 50% of nitrogen application in fertilization with an efficiency of 50%	Italy		available but not per single measure	not estimated	D'Elia et al., 2018, https://www.sciencedirect.com/science/article/abs/pii/S1309104217306529
	Incorportate fertilizers	Incorporate urea-based fertilizers	Italy	NH3 emission reduction of 27% at the year 2030 respect to the baseline scenario	available but not per single measure	available but not per single measure as benefits obtained applying a set of measures	Piersanti et al., 2021, https://www.mdpi.com/2073-4433/12/2/196

EEA inventory <u>Dogan Ozturk_Urban Air quality in Europe, 2019</u>



[1] The outcome of Research & Development is per definition, uncertain and is excluded from further consideration. Note thatthe entire concept of 'nudging', which often proved to reduce household energy consumption with some 5-10%, originatedfrom decades of research in behavioral economics.

[2] See Guidance document on economic instruments to reduce emissions of regional air pollutants, 2013: https://www.unece.org/fileadmin/DAM/env/documents/2013/air/eb/ECE_EB.AIR_118_ENG_01.pdf.

[3] See TFIAM report on the review of the Gothenburg protocol, 2007:

http://www.unece.org/fileadmin//DAM/env/lrtap/TaskForce/tfiam/TFIAM_ReportReviewGothenburgProtocol.pdf

[4] See Code of good practice for solid fuel burning and small combustion installations, 2019: https://www.unece.org/fileadmin/DAM/env/documents/2019/AIR/EB/ECE_EB.AIR_2019_5-1916518E.pdf

[5] See Guidance document on emission control techniques for mobile sources, 2016: https://www.unece.org/fileadmin/DAM/env/documents/2016/AIR/Publications/ECE_EB.AIR_138_En.pdf)

[6] See IIASA report on measures to address air pollution from agricultural sources, 2017: https://iiasa.ac.at/web/home/research/researchPrograms/air/policy/SR11-AGRICULTURE-FINAL.pdf

[7] E.g. the potential emission reductions and associated health benefits of changes in wood burning behavior can be very significant. For example, the U.S. Environmental Protection Agency in a study estimating the benefit per ton of reducing PM2.5 precursors from seventeen sectors has estimated that health benefits of reducing PM2.5 emissions from the residential wood combustion sector are on the order of $400,000 per ton. https://www.epa.gov/sites/default/files/2018-02/documents/sourceapportionmentbpttsd_2018.pdf