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Mitigation analysis for Norway 2021–2030: short-term climate impacts and co-benefits



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Klimakur 2030: Klimaeffekt på kort sikt og tilleggseffekter
Mitigation analysis for Norway 2021-2030: short-term climate impacts and co-bene

Summary - sammendrag

This analysis considers the short-term climate impacts and health and environmental co-benefits of mitigation measures that could help Norway to achieve its 2030 target for non-ETS emissions. A previous analysis considered the long-term climate impacts of the same measures using the global warming potential over a 100-year time horizon (GWP100). The present analysis uses the global temperature change potential over a 10-year time horizon (GTP10). The results show that many of the measures will have substantial climate impacts both in the long term and in the short term, and will also provide health benefits. The analysis can be used to build a portfolio of measures that have long-term climate impacts, measures that have short-term climate impacts and measures that have health benefits.

4 emneord

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Front page photo

Vigdis Vestreng. From the Vestmarka forest west of Oslo, Norway, 15 January 2021

Summary

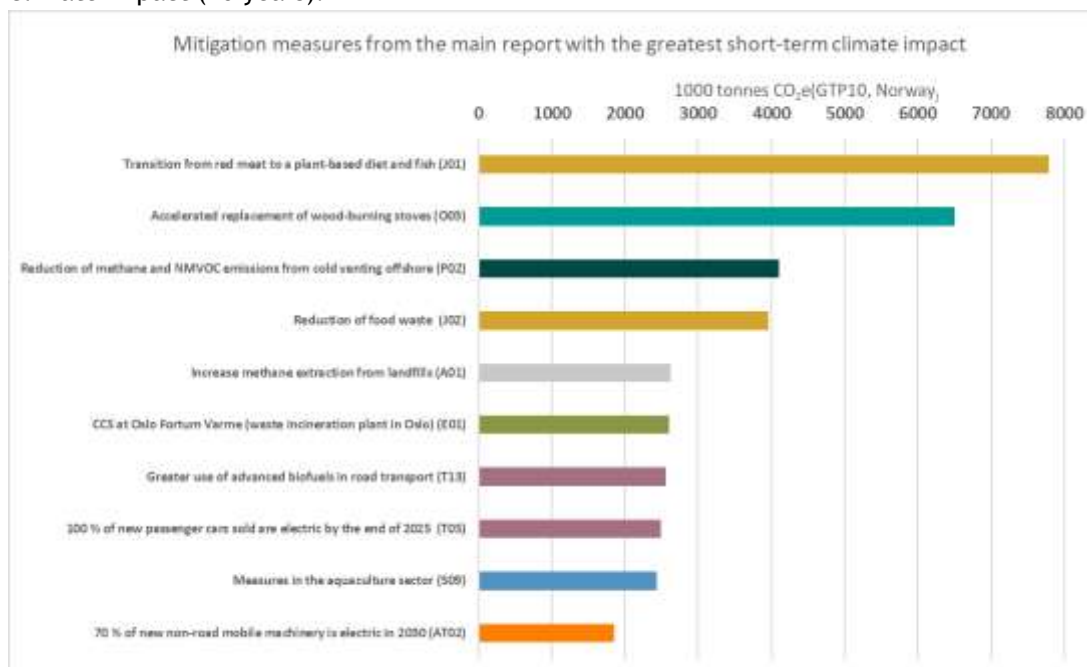
The Norwegian Environment Agency and other agencies have published a mitigation analysis of a range of measures that could be used to achieve Norway's 2030 climate target for non-ETS emissions and the land use, land-use change and forestry (LULUCF) sector,¹ (subsequently referred to as the main report). In the present analysis, the short-term climate impacts of the same measures are considered, together with their health and environmental co-benefits.

In order to compare and aggregate the warming or cooling effects of different substances on the climate, their emissions must be expressed using a suitable common methodology, or emission metric. The main report considered the long-term climate impacts of the measures (time horizon 100 years) using GWP100 as the emission metric, whereas this report analyses short-term climate impacts (time horizon 10 years) using GTP10. Many of the measures also have substantial short-term climate impacts and health effects. Values for health effects were included in the calculations of the economic costs of the measures in the main report, but were not presented separately.

Norway is working towards its climate targets, the sustainable development goals and its targets for the reduction of local air pollution. The present analysis can be used to build a portfolio of measures that have long-term climate impacts, measures that have short-term climate impacts and measures that have health benefits.

Short-term climate impacts

According to the main report, the following 10 measures will have the greatest short-term climate impact (10 years):



¹ Klimakur 2030. Tiltak og virkemidler mot 2030 [Mitigation analysis for Norway, 2021-2030: possible measures and policy instruments]. Report M-1625 | 2020. Part A of the report reviews measures that could be used to reduce non-ETS emissions by 50 % by 2030. All the measures are listed in the appendix to this summary. The numbering of the measures and sector colours are the same as those used in the main report.

Some of these measures mainly reduce CO₂ emissions and therefore by definition have the same climate impact both in the short term and in the long term. This applies to the following three measures: *CCS at Oslo Fortum Varme*; *greater use of advanced biofuels in road transport*; and *100 % of new passenger cars sold are electric by the end of 2025*. Other measures become much more important if the focus is shifted to their short-term climate impact. The measures that will substantially reduce emissions of short-lived climate forcers such as black carbon, methane or HFCs stand out in this respect. The following 10 measures will have substantial short-term climate impacts, considerably larger than their long-term climate impacts:

- *Transition from red meat to a plant-based diet and fish (J01)*
- *Accelerated replacement of wood-burning stoves (O03)*
- *Reduction of methane and NMVOC emissions from cold venting offshore (P02)*
- *Reduction of food waste (J02)*
- *Increase methane extraction from landfills (A01)*
- *Measures in the aquaculture sector (S09)*
- *70 % of new non-road mobile machinery is electric in 2030 (AT02)*
- *Measures for ferries (S10)*
- *Measures for offshore support vessels (S06)*
- *Increase recovery and destruction of used HFCs (F01)*

There are a few measures that will have smaller short-term than long-term climate impacts, because they will reduce emissions of sulphur (SO₂), nitrogen oxides (NO_x) or organic carbon (OC), or increase emissions of black carbon. SO₂, OC and NO_x all have a cooling effect, and reducing emissions of these components will therefore result in a warming effect. This applies to measures that involve replacing fossil energy carriers with bioenergy in manufacturing industries, thus increasing emissions of particulate matter, and to some transport measures that will result in substantial reductions in NO_x emissions. The reduction of N₂O emissions from fertiliser production also has a significantly lower impact in the short term than in the long term.

The differences between short-term and long-term climate impacts in the various sectors can be summarised as follows:

- **Agriculture:** All measures except *halting new cultivation of peatland* have a greater climate impact in the short term. This is mainly because they will reduce methane emissions.
- **Petroleum:** All measures have a greater climate impact in the short term because they will reduce methane emissions.
- **Shipping, fisheries and agriculture:** All measures, except *use of advanced biofuels in shipping*, will have a greater climate impact in the short term because they will reduce black carbon emissions.
- **Non-road mobile machinery and other transport:** All measures, except *use of advanced biofuels in off-road diesel*, will have a greater climate impact in the short term because they will reduce black carbon emissions.
- **Manufacturing:** Marginal changes, except for the measures involving the use of biomass (their short-term impact will be smaller than their long-term impact because they lead to an increase in black carbon emissions) and the *reduction of N₂O emissions from fertiliser production* (because N₂O has a higher long-term than short-term impact).
- **Road transport:** Marginal changes.
- **Other measures:** *Accelerated replacement of wood-burning stoves* has a much greater short-term than long-term climate impact because it will result in large

reductions in black carbon emissions. *Increasing methane extraction from landfills and increasing recovery and destruction of used HFCs* will also have a larger short-term than long-term climate impact.

Health benefits

Many of the measures will reduce emissions of particulate matter (PM₁₀ and PM_{2.5}) and nitrogen oxides (NO_x), thus improving air quality and reducing adverse health effects. The health benefits of these measures take into account the expected geographical distribution of emission reductions in Norway, and have been estimated using previously established monetary values for health effects, expressed in NOK per kg reduction in emissions. Measures that will reduce emissions in densely populated areas are given a higher value than measures in areas with a lower population density. It should be noted that both the assumptions about the geographical distribution of emission reductions and the monetary values that are used are very uncertain. The 10 measures that will yield the greatest health benefits as a result of improvements in air quality are:

- *Accelerated replacement of wood-burning stoves (O03)*
- *Zero growth in passenger car traffic in the largest urban areas (T01)*
- *Shoreside electric power to ships at berth (S04)*
- *Measures for ferries (S10)*
- *100 % of new local buses sold are electric by the end of 2025 (T09)*
- *100 % of new passenger cars sold are electric by the end of 2025 (T05)*
- *70 % of new non-road mobile machinery is electric in 2030 (AT02)*
- *Measures for high-speed passenger vessels (S11)*
- *Improved logistics and efficiency, transport by truck (T04)*
- *Measures in the aquaculture sector (S09)*

Using these underlying assumptions, the overall value of the health benefits of reduced air pollution is estimated at about NOK 16 billion (approximately EUR 1.57 billion) for the period 2021-2030. About NOK 5 billion is explained by reductions in NO_x emissions and about NOK 11 billion by reductions in emissions of particulate matter. *Accelerated replacement of wood-burning stoves* is found to have by far the largest effect, valued at about NOK 9 billion. A sensitivity analysis shows that the estimated value of the health benefits may be too low. This is particularly true for *accelerated replacement of wood-burning stoves*, where the true health benefits may be more than twice this estimate.

The health benefits of a transition from red meat to a plant-based diet and fish are estimated at NOK 85 billion for the period 2021-2030. The health benefits are primarily linked to higher consumption of fruit and vegetables.

Other co-benefits and adverse side effects

Many of the measures will have environmental effects other than reductions in greenhouse gas emissions and local air pollution. These are summarised in the table in the appendix.

Measures in the agricultural sector that reduce livestock numbers may also cause a decline in biodiversity if livestock numbers on rough grazing are reduced. Manure-related measures may have positive effects by reducing nutrient runoff and emissions of ammonia to air. Halting new cultivation of peatland will contribute to the conservation of threatened species and habitats.

All measures that involve replacing petrol and diesel vehicles and machinery with electric models will reduce noise levels. Some measures in the transport sector will reduce transport

volumes and may thus reduce congestion, encourage more physical activity and reduce the need for road construction.

All measures that involve more use of biofuels could potentially result in a rise in global greenhouse gas emissions, depending on the types of biofuels that are used. The main report assumed that biofuels will meet the sustainability criteria for biofuels and bioliquids established in the EU Renewable Energy Directive and will be advanced (produced mainly from waste and residues), so that the measures also have the greatest possible effect on global emissions.

Some measures will influence employment and value creation. These effects are not considered in this analysis.

Overall assessment

Certain measures stand out as having substantial climate impacts both in the short term and in the long term, and will in addition provide health benefits. The following measures are estimated to have both short- and long-term climate impacts of more than 500 000 tonnes CO₂e and health benefits valued at more than NOK 500 million over the period 2021-2030:

- *Transition from red meat to a plant-based diet and fish (J01)*
- *Accelerated replacement of wood-burning stoves (O03)*
- *Zero growth in passenger car traffic in the largest urban areas (T01)*
- *Shoreside electric power to ships at berth (S04)*
- *Measures for ferries (S10)*
- *100 % of new local buses sold are electric by the end of 2025 (T09)*
- *100 % of new passenger cars sold are electric by the end of 2025 (T05)*

Of these measures, J01, O03, S04 og S10 also have considerably larger climate impacts in the short term than in the long term.

Gaps in our knowledge and the way forward

This report also describes an alternative methodology for estimating and presenting short- and long-term climate impacts, based on a different emission metric (absolute global temperature change potential, AGTP). It will be necessary to evaluate further whether this methodology is more suitable and one that should be used in the future. An assessment of the climate impact of the different measures using AGTP indicates that the methodology we have used thus far, based on GTP10 and GWP100, is robust.

The monetary values for health benefits used in the analysis are based on estimates of the cost of damage caused by local air pollution, and provide only a simplified picture of the health effects of a measure. In addition, the data used to estimate the costs of damage are not very up to date. In the Norwegian Environment Agency's opinion, the knowledge base for quantifying the effects of air pollution needs to be comprehensively updated. Guidance is being prepared for carrying out this work.

In this analysis, no quantitative estimates were made of the health effects of greater physical activity as a result of a reduction in passenger car transport or of the reduction in exposure to benzene due to lower NMVOC emissions offshore and at land-based facilities.

Appendix. Mitigation measures analysed in the report and their emission reduction potentials, costs and effects

		Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GWP100, global)	Cost category NOK/tonne CO ₂ e (GWP100, global)	Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GTP10, Norway)	Health effects in million NOK for the period 2021-2030	Other co-benefits and adverse side effects
Road transport						
T01	Zero growth in passenger car traffic in the largest urban areas	0.76	500–1500	0.74	914	Less congestion, less road construction needed, more physical activity, less local air pollution
T02	Shift of freight from road to rail and/or sea	0.48	> 1500	0.48	14	
T03	Improved logistics, van transport	0.42	< 500	0.44	128	Less congestion, less road construction needed
T04	Improved logistics and efficiency, transport by truck	1.19	< 500	1.18	246	Less congestion, less road construction needed
T05	100 % of new passenger cars sold are electric by the end of 2025	2.54	500–1500	2.50	614	Less local air pollution, some reduction in noise
T06	100 % of new small vans sold are electric by the end of 2025	0.69	500–1500	0.70	182	Less local air pollution, some reduction in noise
T07	100 % of new large vans sold are electric by the end of 2030	0.28	< 500	0.28	63	Less local air pollution, some reduction in noise
T08	50 % of new trucks sold are electric or hydrogen vehicles in 2030	1.13	500–1500	1.11	216	Less local air pollution, some reduction in noise
T09	100 % of new local buses sold are electric by the end of 2025	1.08	500–1500	1.07	621	Less local air pollution, some reduction in noise

		Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GWP100, global)	Cost category NOK/tonne CO ₂ e (GWP100, global)	Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GTP10, Norway)	Health effects in million NOK for the period 2021-2030	Other co-benefits and adverse side effects
T10	75 % of new long-distance coaches sold are electric or hydrogen vehicles in 2030	0.17	500–1500	0.17	31	Less local air pollution, some reduction in noise
T11	45 % of new sales of motorcycles and mopeds are electric in 2030	0.04	< 500	0.04	6	Less local air pollution, some reduction in noise
T12	10 % of new tractor units run on biogas in 2030	0.47	> 1500	0.46	41	Production and use of biogas plays a part in developing a circular economy
T13	Greater use of advanced biofuels in road transport	2.55	> 1500	2.56	-	Unclear effect on air pollution, may have adverse impact on global emissions. Requirement to use advanced biofuels means little risk of adverse impacts in other countries from indirect land-use change.
Sum road transport		11.8		11.7		
Shipping, fisheries and aquaculture						
S01	Technical and operational measures in shipping, fisheries and aquaculture (energy efficiency)	0.13	Variable	0.17	24	Less local air pollution
S02	Lower vessel speeds	Not quantified	Presumed < 500	-	-	Less air pollution. May have considerable impact on international shipping (deep sea shipping)
S03	Use of advanced biofuels in shipping	1.19	> 1500	1.19	-	Production and use of biogas plays a part in developing a circular economy
S04	Shoreside electric power to ships at berth	0.83	500–1500	1.07	881	Also reduces port noise levels. Less local air pollution, particularly in towns
S05	Measures for non-bulk cargo vessels	0.19	Ammonia > 1500 LNG 500–1500 Plug-in > 1500	0.25	31	Will make it possible to require procurement of green transport and to use more biogas. Possible increase in bunkering abroad.
S06	Measures for offshore support vessels	1.02	Hydrogen > 1500 Plug-in >1500	1.36	206	

		Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GWP100, global)	Cost category NOK/tonne CO ₂ e (GWP100, global)	Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GTP10, Norway)	Health effects in million NOK for the period 2021-2030	Other co-benefits and adverse side effects
S07	Measures for fishing vessels	0.18	Plug-in >1500	0.18	72	Possible increase in bunkering abroad. Better working conditions/less noise. Could distort competition between fishing vessels using different types of fuel.
S08	Measures for bulk carriers	0.09	Ammonia > 1500 LNG 500–1500 Plug-in < 500	0.24	71	Possible increase in bunkering abroad. Will make it possible to require procurement of green transport.
S09	Measures in the aquaculture sector	1.97	Ammonia 500–1500 Plug-in > 1500	2.43	244	Less noise during operations. Will improve operational reliability.
S10	Measures for ferries	1.36	Hydrogen > 1500 Plug-in < 500	1.69	769	New technology may result in reduced timetables. Less noise for passengers.
S11	Measures for high-speed passenger vessels	0.52	Hydrogen > 1500 Plug-in 500–1500	0.65	267	New technology may result in reduced timetables. Less noise for passengers.
S12	Measures for cruise ships	0.00	Hydrogen > 1500 Plug-in >1500	0.00	4	Less local air pollution
S13	Measures for other specialised vessels	0.05	Hydrogen > 1500 Plug-in > 1500	0.06	10	
Sum shipping, fisheries and aquaculture		7.5		9.3		
Non-road mobile machinery and other transport						
AT01	Improved logistics and efficiency for machinery at construction sites	0.42	< 500	0.45	72	Less local air pollution and noise. Better working conditions at construction sites.
AT02	70 % of new non-road mobile machinery is electric in 2030	1.75	> 1500	1.86	292	Less local air pollution and noise. Better working conditions at construction sites.
AT03	Zero-emission solutions for railways	0.23	< 500	0.40	60	Will also reduce noise levels and the risk of other pollution, e.g. oil spills.

		Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GWP100, global)	Cost category NOK/tonne CO ₂ e (GWP100, global)	Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GTP10, Norway)	Health effects in million NOK for the period 2021-2030	Other co-benefits and adverse side effects
AT04	Electrification of recreational vessels	0.03	> 1500	0.04	25	Will reduce noise and other pollution.
AT05	Use of advanced biofuels in off-road diesel	1.89	> 1500	1.78	-	Unclear effect on air pollution, may have adverse impact on global emissions. Requirement to use advanced biofuels means little risk of adverse impacts in other countries from indirect land-use change.
Sum other transport		4.3		4.5		
Agriculture						
J01	Transition from red meat to a plant-based diet and fish	2.89	< 500	7.79	84 740	May have adverse impacts on species diversity if pasture becomes overgrown, and lead to lower albedo and less carbon fixation in soils. Runoff from vegetable production may increase; runoff from livestock manure may be reduced.
J02	Reduction of food waste	1.53	< 500	3.96	-	Positive effects on several environmental indicators (e.g. acidification, eutrophication, photochemical oxidation, NO _x and particulate emissions) and reductions in resource use (e.g. water, primary energy, phosphorus).
J03	Use of animal manure in biogas production	0.25	> 1500	0.93	-	Reduced nutrient runoff
J04	Various manure-related measures	0.33	> 1500	0.40	-	May reduce ammonia emissions to air, and reduce nitrogen and phosphorus runoff and thus eutrophication and acidification.
J05	Halt new cultivation of peatland	0.12	< 500	0.51	-	Natural peatlands will be maintained. These have a number of important ecological functions, e.g. as habitats for many species and in some cases in local flood control.

		Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GWP100, global)	Cost category NOK/tonne CO ₂ e (GWP100, global)	Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GTP10, Norway)	Health effects in million NOK for the period 2021-2030	Other co-benefits and adverse side effects
Sum agriculture		5.1		13.6		
Manufacturing, non-ETS emissions						
I01	Energy efficiency measures in manufacturing industries	0.30	< 500	0.27	10	Better indoor climate
I02	Switch to electricity in manufacturing industries	0.61	500-1500	0.60	22	
I03	Switch to biofuels in manufacturing industries	0.15	500-1500	0.14	- 4	
I04	Switch to district heating in manufacturing industries	0.02	< 500	0.02	1	
I05	Switch to hydrogen in manufacturing industries	0.01	> 1500	0.01	0,5	
I06	Switch to solid biomass in asphalt production	0.52	< 500	0.46	- 17	
I07	Switch to renewable energy in metal production	0.11	500-1500	0.06	1	
I08	Switch to renewable energy in the chemical industry	0.08	500-1500	0.05	1	
I09	Increase the proportion of biochar used by the silicon carbide industry	0.04	< 500	0.04	-	
I10	Reduction of N ₂ O emissions from fertiliser production	0.83	< 500	0.78	-	Optimising the process to reduce N ₂ O emissions will result in a rise in NO ₂ emissions, but no major increase is expected.
Sum manufacturing and mining		2.7		1.7		

		Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GWP100, global)	Cost category NOK/tonne CO ₂ e (GWP100, global)	Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GTP10, Norway)	Health effects in million NOK for the period 2021-2030	Other co-benefits and adverse side effects
Petroleum, non-ETS emissions						
P01	Higher recovery rate for methane and NMVOCs during offshore loading of crude oil	0.28	500–1500	1.10	-	Lower exposure to NMVOCs (e.g. benzene) on board ship expected to give health benefits.
P02	Reduction of methane and NMVOC emissions from cold venting offshore	1.16	500–1500 (for 2/3 of the potential, < 500)	4.10	-	Lower exposure of employees on installations to NMVOCs, including benzene, will give health benefits
P03	Reduction of methane and NMVOC emissions from onshore petroleum facilities	0.23	> 1500	1.19	-	Lower exposure of employees at facilities to NMVOCs, including benzene, will give health benefits
Sum petroleum		1.7		6.4		
CCS measures						
E01	CCS at Oslo Fortum Varne (waste incineration plant in Oslo)	2.6	500–1500	2.60	-	
E02	CCS at BIR (waste incineration plant in Bergen)	0.8	500–1500	0.77	-	
E03	CCS at the waste incineration plant in Trondheim	0.8	500–1500	0,65	-	
Sum CCS		4.0		4.0		
Other measures (heating, energy supply, HFCs and waste)						
E04	Replace oil and gas with renewable energy in district heating plants	0.02	> 1500	0.02	2	Possibly less air pollution, depending on what replaces oil, but probably marginal effect since oil is primarily used for reserve/back-up capacity.

		Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GWP100, global)	Cost category NOK/tonne CO ₂ e (GWP100, global)	Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GTP10, Norway)	Health effects in million NOK for the period 2021-2030	Other co-benefits and adverse side effects
O01	Phase out mineral oil and gas for heating and drying buildings during construction	0.89	< 500	0.94	220	Less local air pollution. Better working conditions at construction sites. Depends on what replaces oil/gas (bio-oil, electricity, district heating)
O02	Replace gas in permanent heating systems in buildings	0.95	> 1500	0.87	58	Could have adverse impacts on local air quality, depending on what replaces gas (e.g. pellets, wood). Not calculated.
O03	Accelerated replacement of wood-burning stoves	0.51	< 500	6.50	9 117	Less soot deposition, less need to clean building facades etc. CO ₂ emissions will also drop, but this effect is not included since fuelwood use is considered to be climate-neutral. Switching from fuelwood to electricity should reduce fire hazard considerably. Woodcutting for personal use could have both health benefits and adverse impacts.
E05	Switch from coal-fired power generation to renewable energy in Longyearbyen (Svalbard)	0.43	< 500	0.18	17	<p>Some risk that transport of wood pellets to Svalbard could introduce seeds, insects or other biological material and result in the spread of undesirable species. This could be a threat to biodiversity, especially given the rapid pace of climate change in the Arctic, and rising temperatures are likely to allow southerly species to become established more easily.</p> <p>Fuel storage will require considerably more space. One possible site is Hotellneset (near Longyearbyen airport). Storage here would have a visual impact. Soils in the area are contaminated, requiring action to prevent the spread of pollution during construction. There is also runoff of perfluorinated substances (PFOA) from part of the airport previously used for fire training.</p>

		Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GWP100, global)	Cost category NOK/tonne CO ₂ e (GWP100, global)	Emission reduction potential 2021-2030 Mtonnes CO ₂ e (GTP10, Norway)	Health effects in million NOK for the period 2021-2030	Other co-benefits and adverse side effects
						Coal-fired power generation requires disposal of the coal slag left after combustion. Other waste management solutions will be needed after a switch to pellets.
F01	Increase recovery and destruction of used HFCs	0.65	< 500	1.23	-	
E06	Increase separation of used textiles for recycling	0.20	< 500	0.20	-	More re-use and recycling can reduce demand for new textiles, thus reducing environmentally harmful emissions from extraction of raw materials and production of textiles. Large reductions in water and energy use in production countries.
E07	Increase separation of plastic waste for recycling	0.40	> 1500	0,46	-	More recycling of plastics will reduce demand for plastics from virgin materials, thus reducing environmentally harmful emissions and energy use. May result in more transport of plastic waste than energy recovery, and thus higher local emissions, depending on the transport mode and fuel used.
A01	Increase methane extraction from landfills	0.76	< 500	2,62	-	
Sum other measures		4.8		13.1		
Total emission reduction potential, all measures (2021-2030)		43.6		64.3		

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The Norwegian Environment Agency is working for a clean and diverse environment. Our primary tasks are to reduce greenhouse gas emissions, manage Norwegian nature, and prevent pollution.

We are a government agency under the Ministry of Climate and Environment and have 700 employees at our two offices in Trondheim and Oslo and at the Norwegian Nature Inspectorate's more than sixty local offices.

We implement and give advice on the development of climate and environmental policy. We are professionally independent. This means that we act independently in the individual cases that we decide and when we communicate knowledge and information or give advice.

Our principal functions include collating and communicating environmental information, exercising regulatory authority, supervising and guiding regional and local government level, giving professional and technical advice, and participating in international environmental activities.