NO.1, MARCH 2019

Acid News

The health costs of dirty diesel revealed

Air pollution from road traffic causes damage worth at least €80 billion every year in the EU, with diesel fumes responsible for three-quarters of the harm.

► Page 3

CCS 2001–2018: Expectations and results

Carbon capture and storage is not a real mitigation option. There are faster, cleaner, surer, safer, more durable, more effective and cheaper ways to cut CO_2.

► Page 10

Set strict emission limits for power plants

It is now up to the member states to set ambitious emission standards for large combustion plants, in line with the strictest recommended air pollution limit values.

► Page 14

Investing in electricity from renewables

Ambitious countries and companies are showing the way with a strategy that could help eliminate the risk of unmanageable climate change.

► Page 16

A win-win for health and environment

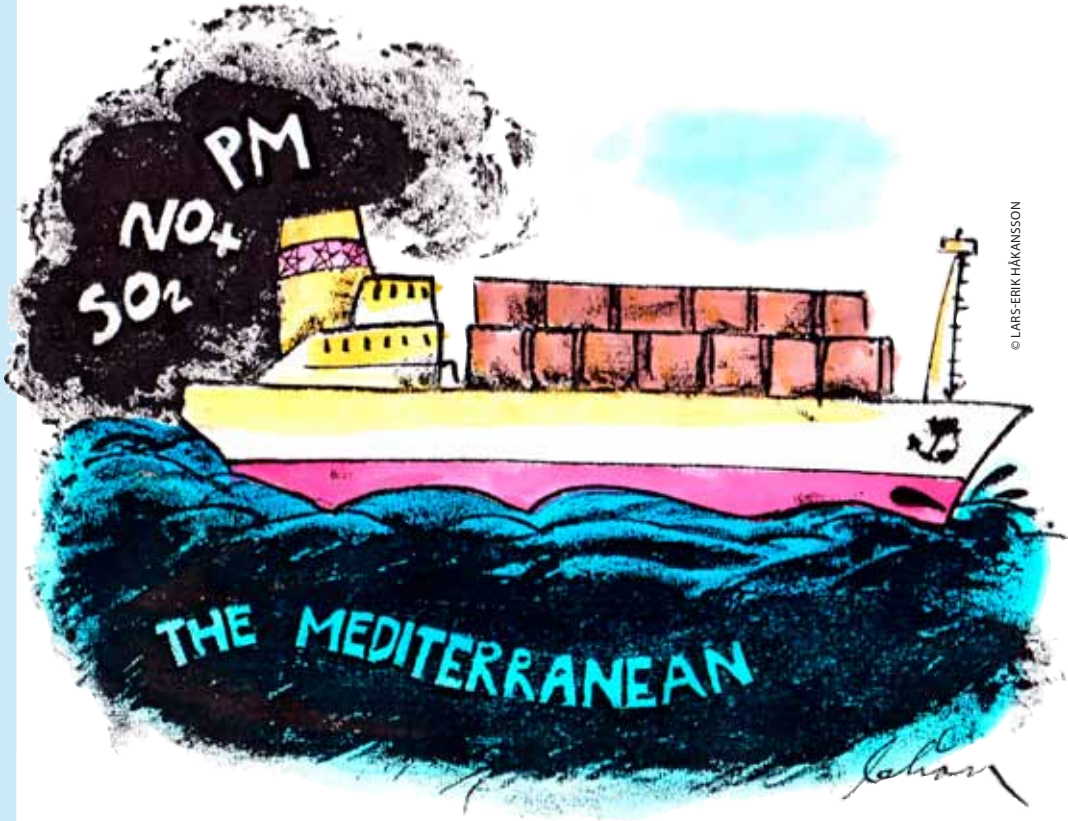
A great food transformation could save 11 million lives a year and mitigate climate change. This would however require new institutions such as an IPCC for our food system.

► Page 22

Opportunity to sharpen CAP proposal

For the CAP to deliver on environmental and climate goals, policy makers must specify targets and ring-fence funding for green interventions.

► Page 24



16,000 lives could be saved

Full implementation of emission control measures in all European sea regions would provide net socio-economic benefits of up to €19 bn in 2030, rising to €40 bn in 2050.

On 31 January the International Institute for Applied Systems Analysis (IIASA) published a comprehensive study on the potential for additional cost-effective measures to reduce air pollutant emissions from international shipping in all European sea regions, but with a special focus on the Mediterranean Sea. The study was produced on behalf of the European Commission's DG Environment.

A series of alternative emission control measures was explored, including the establishment of new Emission Control Areas (ECA) for sulphur and nitrogen oxides (SECA and NECA), as well as the retrofitting of exhaust gas cleaning to existing ships to further cut emissions of NOx and particle matter (PM).

In brief, the report:

- Updates the projections of the likely development of maritime transport activities and the resulting emissions of air pollutants and carbon dioxide;
- Provides new assessments of costs of compliance with current legislation;

Page 4 ►

Acid News

A newsletter from the Air Pollution & Climate Secretariat, the primary aim of which is to provide information on air pollution and its effects on health and the environment.

Anyone interested in these matters is invited to contact the Secretariat. All requests for information or material will be dealt with to the best of our ability. Acid News is available free of charge.

In order to fulfil the purpose of Acid News, we need information from everywhere, so if you have read or heard about something that might be of general interest, please write or send a copy to:

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The Air Pollution and Climate Secretariat

The Secretariat has a board consisting of one representative from each of the following organisations: Friends of the Earth Sweden, Nature and Youth Sweden, the Swedish Society for Nature Conservation, and the World Wide Fund for Nature (WWF) Sweden.

The essential aim of the Secretariat is to promote awareness of the problems associated with air pollution and climate change, and thus, in part as a result of public pressure, to bring about the needed reductions in the emissions of air pollutants and greenhouse gases. The aim is to have those emissions eventually brought down to levels that man and the environment can tolerate without suffering damage.

In furtherance of these aims, the Secretariat:

- Keeps up observation of political trends and scientific developments.
- Acts as an information centre, primarily for European environmentalist organisations, but also for the media, authorities, and researchers.
- Produces information material.
- Supports environmentalist bodies in other countries in their work towards common ends.
- Participates in the lobbying and campaigning activities of European environmentalist organisations concerning European policy relating to air quality and climate change, as well as in meetings of the Convention on Long-range Transboundary Air Pollution and the UN Framework Convention on Climate Change.

AirClim

Editorial

Over the last thirty years, fuel and emission standards for land-based transport have been dramatically strengthened over most of the world. But international shipping – which is primarily regulated by the International Maritime Organization (IMO) – has for a long time resisted similar legislation for emissions of both air pollutants and greenhouse gases.

"designate all sea areas around Europe as full Emission Control Areas"

Currently, most ocean-going ships burn extremely dirty fuels that may contain up to 3500 times the sulphur content of road diesel fuel, and even after implementation of the new global 0.5 per cent sulphur limit in 2020, they are still allowed to burn fuels with 500 times more sulphur.

Moreover, the globally applicable nitrogen oxides Tier 2 limit values for ship engines are very weak, and as they only apply to new ships it will take around 30 years until all ships comply.

Outdated and lax emission regulations explain why ship emissions are a major contributor to bad air quality and why air pollution from shipping is responsible for around 50,000 annual cases of premature deaths in Europe.

The obvious way forward is for the EU and its member states to quickly follow the example of the United States and Canada and designate all sea areas around Europe as full Emission Control Areas (ECA), i.e. covering the major air pollutants – sulphur dioxide, nitrogen oxides and particulate matter. So far, however, only the Baltic Sea and the North Sea have ECA status.

Compared to the current global requirements, the ECA standards will cut sulphur in fuel by 97 per cent, particulate matter ($PM_{2.5}$) emissions by 75 per cent, and NOx emissions by 75 per cent.

According to recent studies, such action would be highly cost-effective and save many thousands of lives every year. For example, the monetised health benefits of designating the Mediterranean Sea as an ECA would already amount to more than €10 billion per year by 2030 – up to ten times more than the estimated emission abatement costs (for details, see articles on page 1 and page 6).

Focussing on reducing ship emissions in the Mediterranean Sea, a coalition of six environmental groups in Mediterranean countries together with the German Nature and Biodiversity Conservation Union (NABU), has agreed a set of demands[1], including:

- The designation of the Mediterranean Sea as a combined SECA and NECA by 2020;
- A coherent ECA for all European waters that covers all major air pollutants (SO_2, NOx, PM and BC);
- Cooperation of EU states with non-EU coastal states to establish a Mediterranean ECA;
- A ban on toxic heavy fuel oil and consequently a ban on the use of scrubbers;
- A harmonised and effective control and enforcement scheme.

Applying new and improved emission control techniques must be part of the solution, but quickly phasing out the use of fossil fuels is key to resolving both climate change and air pollution, as it cuts emissions of the main greenhouse gas carbon dioxide as well as those of health-damaging air pollutants.

It is not acceptable for the shipping industry to keep on transferring the cost of its pollution to society at large. The IMO and EU regulations must be strengthened and fully implemented. To encourage the use of the best techniques, to improve energy efficiency and to speed up the introduction of cleaner fuels and alternative (zero-CO_2) propulsion systems, regulations should be complemented by economic instruments, such as emission charges.

Christer Ågren

[1] *https://en.nabu.de/imperia/md/content/nabude/verkehr/hg_mediterranean_eca_final.pdf*

The health costs of dirty diesel revealed

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Air pollution from road traffic causes damage worth at least €80 billion every year in the EU, with diesel fumes responsible for three-quarters of the harm.

Commissioned by the European Public Health Alliance (EPHA), the new CE Delft study ("Health impacts and costs of diesel emissions in the EU") assesses the current social costs of road vehicle emissions in the EU on people's health and government budgets, as well as the social benefits of phasing out diesels and switching to electric road and other mobility alternatives, such as public transport, walking or cycling.

There should be tougher EU-level regulation of emissions, said Zoltán Massay-Kosubek, policy manager at EPHA, to the Guardian, but there is also a need for city-based initiatives such as diesel bans, pollution charges and car-free days.

The publication of the report followed the first European Diesel Summit, held in Brussels in November 2018 – three years after the Dieselgate revelations. It has been estimated that NOx emissions from diesel cars and light commercial vehicles caused about 10,000 premature deaths in the EU in 2013, and that half of these would have been avoided had the on-road NOx emissions been at the level of the laboratory tests (see AN 4, 2017).

The inequalities of air pollution are noted by EPHA. Although everyone is affected, the most vulnerable (children, elderly, pregnant women and people with diseases such as asthma and chronic obstructive pulmonary diseases) are suffering more. Those living on low-incomes, more likely to live next to main roads or industrial areas, are exposed to more concentrated air pollution for a longer period of time with a greater impact on their health.

EPHA also points out that the treatment of those costly diseases associated with diesel pollution puts significant financial burden on society, affecting not only individual patients and their carers but also straining national healthcare systems. Ultimately, the social costs of diesel pollution are met by taxpayers, not the car industry.

The main air pollutants from road transport are particulate matter (PM) and NOx. But vehicle emissions also include other pollutants, such as non-methane volatile organic compounds (NMVOC) and polycyclic aromatic hydrocarbons (PAH) and contribute to excessive levels of ground-level ozone.

Using a new method to analyse the total costs of road emission air pollution, the study estimates the total cost for governments and compulsory insurances at €79.8 billion, with 75 per cent of these costs caused by diesel pollution. About 90 per cent of the total costs are linked specifically to health damage. The valuation takes a rather conservative approach by only including health impacts conclusively linked to toxic air, such as heart attacks and lung diseases, and by using the lower economic valuation of premature death (known as "value of a life year" or "VOLY").

The situation in nine EU member states (Austria, Bulgaria, Estonia, Germany, Hungary, Poland, Romania, Slovenia and Spain) is examined in more detail, looking at the levels of national public budgets allocated to health costs related to diesel road vehicle emissions and how much can be saved by their governments through various emission reduction measures.

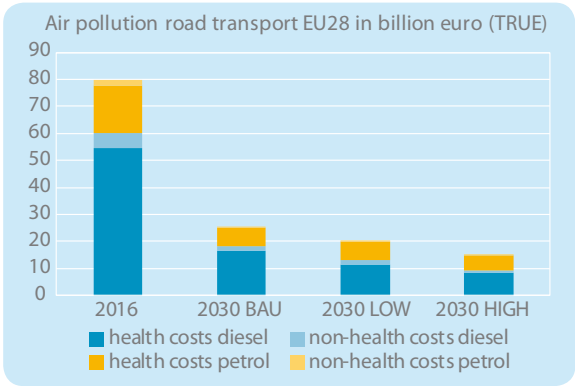

Figure: Comparison of total Air Pollution Costs EU28 in 2016 and 2030 BAU, low and high ambition policy scenarios – adjusted emission factors(TRUE).

Air pollution from road traffic is expected to come down significantly between 2016 and 2030, as are the related costs. In the baseline scenario, the total air pollution costs in 2030 are estimated at €25.6 billion, of which €23.3 billion are health related.

In addition to the baseline scenario, two policy scenarios — a low and high ambition scenario — were defined and investigated to assess how additional policy efforts would impact emission levels and related costs in 2030.

Ambitious action by 2030, including two-thirds of new cars being electric or plug-in hybrid and a ban on all pre-2014 vehicles, could cut air pollution costs by 81 per cent compared with today, down to €15 billion per year. This equals annual cost savings of about €10 billion compared to business as usual. The less ambitious scenario, with a quarter of new cars being electric or hybrid by 2030, could cut costs by 74 per cent, down to €20 billion per year. See Figure.

Yves Brand, Vice-President of EPHA said: "It is not an exaggeration to speak about a public health emergency given that air pollution is the number one environmental health risk factor. This is why the European Public Health Alliance felt the urgency to commission this study aiming to bring the often neglected health perspective into the debate. I am confident that these new insights into health costs and the significant savings for national budgets tackling air pollution could bring should leave no doubt about the need for urgent action by our governments."

Christer Ågren

Link to the EPHA press release and the CE Delft report: *https://epha.org/ce-delft-health-impacts-costs-diesel-emissions-eu/*

16,000 lives could be saved

Continued from front page

- Improves understanding of the role of emissions from vessels in ports and in territorial waters;
- Develops new scenarios for future emissions that would result from different policy measures;
- Assesses their impacts on ambient air quality and resulting population exposure;
- Estimates the associated benefits to human health, and quantifies these benefits in monetary terms; and,
- Compares emission abatement costs with monetised benefits.

By employing the same methodologies and computer models that have previously been used by the European Commission when preparing and analysing the National Emission Ceilings Directive and, more recently, the Clean Air Outlook (AN 3/18, pp 6–8), the results are directly comparable.

Emissions from shipping contribute significantly to poor air quality in Europe and have large impacts in port cities and coastal areas. From a health perspective, this is particularly important since about half of the EU population lives within 50 kilometres of the sea.

While regulations already adopted by the International Maritime Organisation (IMO) and EU will markedly cut ship SO_2 emissions up to 2030, expected continued growth in shipping activities imply that – in the absence of additional regulations – emissions will gradually increase after 2030. In contrast, NOx emissions are expected to start rising again from 2020, and shortly after 2030 they will reach levels that exceed total land-based emissions in the EU-28.

However, implementing enhanced controls on emissions from international shipping in European seas could achieve significant emission cuts by 2030. Firstly, an extension of the SECA to all European sea regions would reduce emissions of SO_2 by over 90 per cent and $PM_{2.5}$ by nearly half. Secondly, applying the IMO's Tier III standards – which are mandatory for new ships in NECAs – could lower NOx emissions by nearly 30 per cent. And, thirdly, introducing diesel particulate filters (DPF) could further cut $PM_{2.5}$ emissions to levels nearly 80 per cent below those in 2015 (see Table 1).

In 2050, despite the expected continued growth in shipping, these new measures could reduce emissions of SO_2, $PM_{2.5}$ and NOx by 87, 92 and 56 per cent respectively, as compared to 2015.

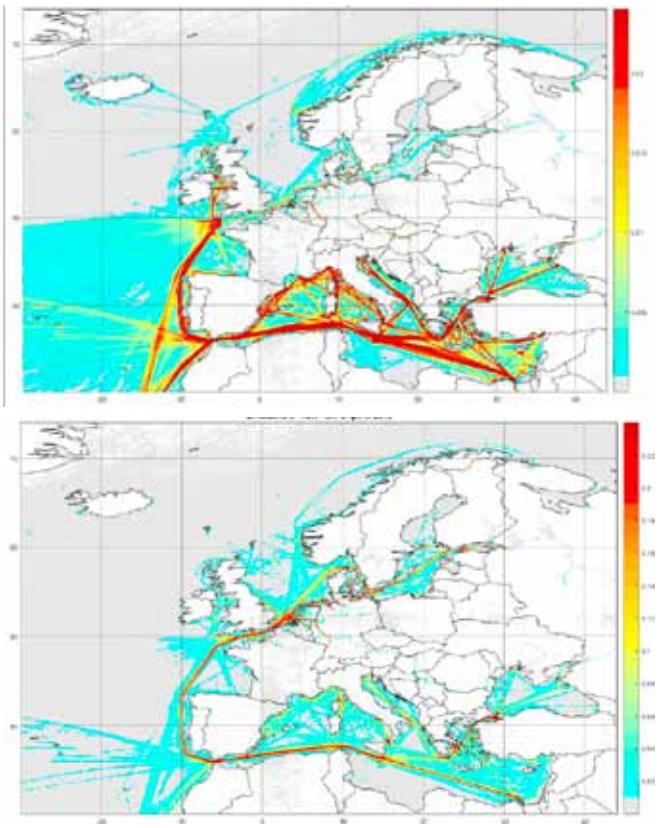

Figure: Ship emissions of SO_2 (top) and NOx (bottom) in 2015 in kt per grid cell (note that the scales are different).

Moreover, by reducing fuel consumption, climate policy measures for shipping have significant co-benefits for air pollutant emissions. As an alternative to the 130 per cent increase in CO_2 emissions by 2050 that would emerge from current growth trends, the study has investigated a scenario that assumes climate measures which result in stabilisation of CO_2 emissions from shipping by 2050. Even though this alternative scenario clearly falls short of achieving the at least 50 per cent CO_2 emissions cut recently established by the IMO, it would result in more than halving SO_2, $PM_{2.5}$ and NOx emissions, compared to what would be achieved with the full set of emission controls in the baseline scenario.

Enhanced sulphur controls through additional SECAs would quickly deliver significant benefits: by 2030 more than 4000 cases of avoided premature deaths annually, and 8000 cases by 2050. In the longer run, by 2050, application of additional NOx control measures could double these health benefits.

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The judge handed the captain a fine of €100,000, but the owner, US-based Carnival, should pay €80,000 of the sum.

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Table1: Total annual air pollutant emissions in all European sea areas under the baseline scenario for future fuel consumption and under four different emission abatement scenarios (thousand tonnes).

	2015	2020	2030				2050			
			H1	H3	H7	H9	H1	H3	H7	H9
SO_2	1230	308	435	116	116	116	640	165	165	165
NOx	2835	2794	3532	3532	2020	2020	4500	4500	1326	1326
$PM_{2.5}$	175	89	125	94	94	41	180	135	135	14

H1: No additional measures (max 0.5% sulphur in fuels from 2020)
H3: Sulphur Emissions Control Area (SECA) in all seas (max 0.1% sulphur in fuels)
H7: As H3 + NECA in all seas from 2021 + some retrofits of NOx control on existing ships
H9: As H7 + PM emission control (DPF) on both new and existing ships

Table 2: Monetised benefits and costs for emission control scenarios within 2030 and 2050 under the baseline scenario for future fuel consumption (billion euro).

	Year	Benefits (low-high valuation)	Costs (low-high estimate)	Benefits/costs ratio
All European sea areas[1]	2030	11.0-20.9	2.2-2.6	4.3-9.4
	2050	19.8-42.0	1.9-3.4	5.8-21.8
Mediterranean Sea[2]	2030	6.0-10.7	0.9-1.1	5.3-12.0
	2050	14.4-29.3	1.2-2.2	6.6-24.9

[1] Assumes both SECA and NECA plus some retrofits of NOx and PM controls for all sea regions, except the NE Atlantic, where ECA is limited to the 12 nm zone.
[2] Assumes both SECA and NECA; no retrofits.

Since most of the emission reductions will take place in the Mediterranean Sea, the largest air quality improvements will occur along the coasts of Mediterranean countries, including North African and Middle East countries and Turkey. Of the approximately 16,000 avoided cases of premature death in 2050, about one third are in the EU-28.

It is concluded that the benefits of further emission controls outweigh the costs by a wide margin. Even when using the lower (most conservative) health valuation, all the policy measures examined in the report emerged as cost-effective, with monetised benefits typically exceeding emission control costs by a factor of 6 in 2030 and by a factor of 12 in 2050.

Assuming full implementation of all policy measures in all sea regions results in annual costs of €2.2–2.6 bn in 2030, while the benefits are estimated to amount to €11–21 bn. For the year 2050, the costs would be €1.9–3.4 bn and the benefits €19.8–42 bn. This means that if the higher health valuation is used, the resulting net socio-economic benefits could be up to €19 bn by 2030, rising to €40 bn by 2050 (see Table 2).

Focusing specifically on the designation of the Mediterranean Sea as a full Emission Control Area could avoid 4100 cases of annual premature deaths by 2030, increasing to more than 10,000 avoided cases by 2050. Using the most conservative assumptions for health valuation, the monetised benefits are on average six times higher than the costs by 2030 and nearly ten times higher by 2050.

In a similar way this implies that when the higher health valuation is used, the resulting net socio-economic benefits of a full Mediterranean ECA could be up to €10 bn by 2030 and €28 bn by 2050.

According to IIASA, the results of this study will assist the European Commission in its activities and negotiations within the International Maritime Organization on further reductions of emissions from maritime transport in European seas. It is expected that the study will be a subject of discussion at the next session of the IMO's Marine Environment Protection Committee that takes place in London in May 2019.

Christer Ågren

The IIASA report "The potential for cost-effective air emission reductions from international shipping through designation of further Emission Control Areas in EU waters with focus on the Mediterranean Sea" and the annex can be downloaded from:

http://www.iiasa.ac.at/web/home/research/researchPrograms/air/news/190131_SR13_shipping.html

Cruise ship captain fined for using dirty fuel

The captain of a cruise ship found to be burning fuel with excessive sulphur levels has been fined €100,000 in a Marseille court, the first such ruling in France. According to the prosecutors, the captain knew the fuel was illegal – it contained 1.68% sulphur, 0.18% above the EU limit – and the company was using it to save money. The judge handed the captain a fine of €100,000, but specified that the parent company of P&O Cruises, the US-based Carnival, should pay €80,000 of the sum. The company had "wanted to save money at the expense of everyone's lungs", the prosecutor Franck Lagier told the court in October.

Source: The Guardian, 26 November 2018

Denmark vows to shame sulphur cheats

Starting this year, ships and owners that violate sulphur regulations will be publicly named and shamed. In early December, Denmark adopted a new law that allows for increased fines and publication of the names of carriers that violate sulphur regulations. All Danish waters are within Sulphur Emission Control Areas (SECA) where only fuel with a sulphur content of max 0.1% is permitted.

Penalties for violating the sulphur limit range from DKK 30,000 to 300,000. The Danish EPA will impose a fine of DKK 200,000 if the sulphur content is between 0.50 and 0.99% and DKK 300,000 where sulphur content is 1% or above. It will be the most serious cases where shipping companies receive fines of more than DKK 200,000, which will be published.

Source: ShipInsight, 14 December 2018

Next step in Danish control of SECA compliance.

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Great benefits of cutting ship emissions in the Mediterranean Sea

Implementation of a full Emission Control Area could slash air pollutant emissions by between 77 and 95 per cent and avoid more than 6000 premature deaths every year.

A new study shows that taking additional measures to control ship emissions in the Mediterranean Sea would bring significant improvements to air quality, resulting in additional health benefits worth up to €14 billion per year.

Following the adoption of a new national air pollution reduction plan for France in 2017, which envisages the introduction of low-emission zones for shipping in the Mediterranean Sea, the French ministry of environment (MTES) commissioned the French national institute for industrial environment and risks (INERIS) to lead the work on a feasibility study.

The study includes a new inventory of air pollutant emissions from ships in the Mediterranean Sea, valid for the years 2015–2016. Based on this data, emissions for four different scenarios were calculated:

- REF-MGO: A reference scenario that shows the situation after implementation of the already established IMO global limit of 0.5 per cent sulphur in fuel, which enters into force from 1 January 2020;
- SECA: A Sulphur Emission Control Area scenario, where the sulphur content in ship fuels is further reduced to 0.1 per cent;
- SN50: A combined SECA and NOx Emission Control Area (NECA) scenario, which assumes that 50 per cent of the ships fulfil the IMO's Tier III emission standard for NOx. The Tier III standard reduces NOx emissions by approximately 75 per cent, compared to the currently applicable Tier II standard;
- SN100: A second combined SECA and NECA scenario, which assumes that 100 per cent of the ships fulfil the IMO's Tier III emission standard.

Table: Annual air pollutant emissions from ships in the Mediterranean Sea, under current situation and under four different emission reduction scenarios (thousand tonnes).

	NOx	SO_2	$PM_{2.5}$
Current	1,332	759	79
REF-MGO	1,264	153	22
SECA	1,264	35	16
SN50	823	35	16
SN100	303	35	16

Current: Emissions from ships in 2015
REF: Max 0.5% sulphur in fuels
SECA: Max 0.1% sulphur in fuels
SN50: Max 0.1% sulphur in fuels + 50% of ships complying with the Tier III NOx standard
SN100: Max 0.1% sulphur in fuels + 100% of ships complying with the Tier III NOx standard

It should be noted that the emission estimates for the four scenarios (see Table) were applied to the shipping fleet and activity level of 2015–2016 – no projections about future changes in the shipping fleet or activity levels were done in this study.

Implementing a full Emission Control Area (ECA), which is illustrated by the SN100 scenario, in the Mediterranean Sea results in significant emission cuts – sulphur dioxide (SO_2) comes down by 95 per cent, nitrogen oxides (NOx) by 77 per cent and particulate matter ($PM_{2.5}$) by 80 per cent, compared to the current emission levels.

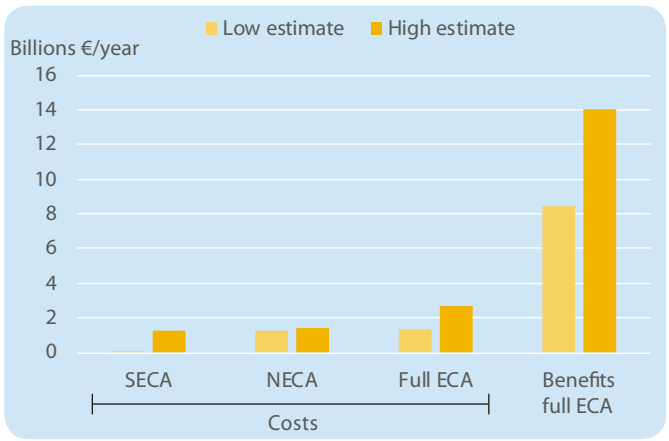

Figure: Comparison of the estimated annual costs and monetised health benefits of implementing additional emission abatement measures for ships in the Mediterranean Sea (€billion/year).

Advanced computer modelling showed that the additional emission reductions bring clear improvements to air quality, especially in the densely populated coastal areas.

Implementing the already established 2020 global sulphur limit of 0.5 per cent will in itself markedly reduce levels of SO_2 and $PM_{2.5}$, but the study also shows that taking the next step by introducing a full ECA provides significant further improvements. The SN100 scenario results in an additional (on top of the REF-MGO scenario) lowering of ambient levels of harmful SO_2 and nitrogen dioxide (NO_2) by up to nearly 80 per cent and levels of $PM_{2.5}$ by up to 11 per cent.

Moreover, the deposition of nitrogen in sensitive ecosystems is reduced by up to 40 per cent, which is of importance to protect biodiversity because of the eutrophication problems caused by the current over-supply of nitrogen to terrestrial and marine ecosystems.

The report provides detailed maps showing the location of the biggest improvements in air quality, and it includes detailed analyses of the air quality in a number of Mediterranean port cities.

By using established concentration-response functions, the study calculated that the REF-MGO scenario would result in about 4500 annually avoided premature deaths due to $PM_{2.5}$, and that the SN100 scenario would increase this figure to about 6200. On a country-by-country basis, the main beneficiaries are Italy, Algeria, Egypt, Turkey and Greece.

The cost-benefit analysis (see Figure) accounts for the inherent uncertainties in estimating the costs of the emission abatement measures by including both low and high cost estimates. The REF-MGO scenario, which is already a legal commitment, is estimated to cost €1.25–1.83 billion per year. Moving to implement the SECA scenario would cost an additional

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€0.10–1.25 bn/yr, and going for a full ECA by also introducing NOx emission controls would add €1.27–1.41 bn/yr, i.e. the total costs for the SN100 scenario would be €1.37–2.66 bn/yr.

Similarly as for the cost estimates, the study includes both lower and higher valuations of the health benefits. Implementing the new global sulphur limit (REF-MGO) is calculated to bring health benefits valued at €8.9–14.5 bn/yr, i.e. between 5 and 12 times the cost.

The monetised additional health benefits of moving from REF-MGO to a full ECA (the SN100 scenario) are estimated to amount to €8.1–14 bn/yr, which means that the benefits are between 3 and 10 times higher than the costs.

Commenting on the study, Charlotte Lepitre, at France Nature Environnement (FNE), said: "The study shows the need for a Mediterranean Emission Control Area. The French Environment Ministry must now take its role as a leader and search for support in as many Mediterranean countries as possible."

Christer Ågren

The French study "ECAMED: A technical feasibility study for the implementation of an Emission Control Area (ECA) in the Mediterranean Sea": *https://www.ineris.fr/sites/ineris.fr/files/contribution/Documents/R_DRC-19-168862-00408A_ECAMED_final_Report_0.pdf*

NGO factsheet: "Emission Control Area (ECA) for the Mediterranean Sea – Effective measure to tackle air pollution from ships": *https://en.nabu.de/imperia/md/content/nabude/verkehr/hg_mediterranean_eca_final.pdf*

Sweden plots course to zero-emissions shipping

The Swedish Shipowners' Association is currently preparing a roadmap with the government initiative Fossil Free Sweden to totally decarbonise domestic shipping by 2045, five years ahead of the International Maritime Organization's deadline for a mere halving of emissions.

The roadmap for domestic shipping will not be published in its entirety until the spring, but the two organisations behind it outlined seven proposals for action, including:

- Create an industry-supported carbon dioxide fund, to support investments in technology that will reduce the climate impact of shipping.
- Improve fairway dues so that they are more clearly differentiated in favour of vessels using alternative fuels.
- Introduce tax exemptions for electricity in ports for vessels whose gross tonnage is below 400 when charging batteries for electrically powered ships and for directly transferred electricity to cable ferries.
- Increase and earmark state funding for a special research and innovation programme for energy-efficient and fossil-free shipping, and to encourage more marine transport.

Sources: Dagens Industri, 8 February 2019 and Ends Europe Daily, 11 February 2019

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EU wants urgent clarity on scrubbers

The EU demands clear guidelines on the discharge of washwater from scrubbers, amid fears that the by-product could cause irreparable environmental damage. In order to comply with the sulphur regulations, several shipowners have installed exhaust gas cleaning (EGC) technology known as scrubbers on their vessels. Having a scrubber that reduces the emissions of sulphur dioxide (SO_2) allows a ship to continue to run on cheaper high-sulphur heavy fuel oil.

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EU countries stress the need for clear regulations on where and how ships can discharge washwater from scrubbers.

In a document issued by the EU Council to the International Maritime Organization (IMO), EU countries stress the need for clear regulations on where and how ships can discharge washwater from scrubbers. Critics of scrubbers have pointed out in particular that open-loop scrubbers have created a new environmental problem while striving to solve another. A study from the German environmental agency recently showed that the washwater discharge from scrubbers is a direct source of pollution.

Several countries have already either banned or flagged an upcoming ban against open-loop scrubbers where water discharge is released into ports, including major bunker ports in Singapore and Fujairah.

The EU shares concerns that scrubbers could end up polluting the sea and impacting marine flora and fauna. "The potential toxicity of EGCS water discharges, due to the very nature of the pollutant substances present in the exhaust gases, and the increase in the number of these systems require careful consideration to avoid irreversible pollution of the marine environment," states the document.

Source: ShippingWatch, 8 February 2019

Number of flights in EU and EFTA is expected to grow by 42 per cent from 2017 to 2040.
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Transport's true cost to the environment

The European Commission has shared the preliminary results of a study on the negative effects that transport has on the environment, health, air quality and climate – the so-called external costs. The study also looks at infrastructure costs and how these are covered by relevant taxes and charges. The overall annual external costs of transport are estimated at around €1000 billion, corresponding to almost 7 per cent of the gross domestic product of the EU-28.

The main contributors to these external costs are the environment (CO_2, noise and air pollution), accidents and congestion. Road transport is the largest contributor, accounting for three-quarters of the total, and is also the mode that leaves the largest share of external costs unpaid. Currently, society as a whole largely pays for these costs, rather than the user or polluter. This is generally true for all transport modes.

Insights from this study will provide input to the Commission's thinking on the further internalisation of these costs and possible policy measures to achieve this. The study will be finalised in May 2019.

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Source: European Commission, 17 December 2018

Link: *https://ec.europa.eu/transport/themes/logistics/news/2018-12-17-costs-of-eu-transport_en*

Emissions from aviation keep on rising

Improving technology, more efficient operations, better airports and market-based measures have not been enough to mitigate the aviation sector's growing impacts on the environment, climate and people's health, according to the European Aviation Environmental Report 2019.

Some key findings of the report:

- The number of flights in the EU and EFTA increased by 8 per cent between 2014 and 2017, and is expected to grow by 42 per cent from 2017 to 2040.
- In 2016, domestic and international aviation together accounted for 3.6 per cent of total EU28 greenhouse gas emissions.
- By 2040, emissions of CO_2 and NOx from aviation are expected to increase by at least 21 and 16 per cent, respectively.

Source: EEA News, 24 January 2019
The report: *https://www.easa.europa.eu/eaer/*

Transport is not on track to implement the Paris Agreement in the EU

GHG emissions from transport are still rising in the EU, despite calls by the environmental movement to cut GHG emissions to almost zero by 2040 at the latest.

Emissions from the EU transport sector are not reducing enough to limit its environmental and climate impacts in Europe says the European Environmental Agency, which last November presented the latest emission data up to 2017.[1] Transport emissions were around 26 per cent higher in 2016 than in 1990, and by 2017 they were 28 per cent higher. Between 2007 and 2013, emissions decreased each year. But since 2014 total greenhouse gas emissions from transport, including carbon dioxide, methane and nitrous oxide have been rising again. Since this period, GHG emissions from transport have risen by almost 3 per cent compared with 2015. International aviation experienced the largest percentage increase in greenhouse gas emissions over 1990 levels (+114%), followed by international shipping (+33%) and road transport (+22%). In 2016, the transport sector contributed 27 per cent of total EU-28 greenhouse gas emissions. The figure decreases to 20 per cent if international aviation and maritime emissions are excluded.

GHG emissions in Europe need to fall to near zero by 2040 to fulfil the Paris Agreement, says Climate Action Network (CAN) Europe.[2] Friends of the Earth Europe argue that this target should be reached by 2030 to help achieve the climate goal of the Paris Agreement and to assure that global temperature rise stays below 1.5°C. [3]

The EU motor vehicle fleet is getting older every year. Passenger cars are now on average 11 years old, vans 10.9 years and heavy commercial vehicles 12 years. For ships, the regular lifetime span is usually from 15 to 40 years, and for airplanes it is common for a jet to remain in service for 25 years or more.[4]

We have just 21 years left until 2040, and the EU must therefore decide as soon as possible to reduce emissions from transport to near zero by 2030–2040, so that the transport industry can adjust to this target in time. AirClim has published reports[5] that show instruments and ways to achieve this goal in Northern Europe, and the conclusions apply to the rest of Europe as well.

Reinhold Pape

[1] *https://www.eea.europa.eu/themes/transport/term/term-briefing-2018*
[2] *http://www.airclim.org/acidnews/eu-needs-net-zero-emissions-2040*
[3] *http://www.foeeurope.org/climate-justice-in-depth*
[4] *https://www.acea.be/statistics/tag/category/average-vehicle-age*
[5] What will it take to phase out greenhouse gas emissions from road traffic in the Nordic-Baltic region by 2030–2035? *http://www.airclim.org/sites/default/files/documents/apc-39-4.pdf*

Since 1990 emissions from road transport have increased by 22 per cent.

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Retrofitting instead of banning old diesel vehicles.

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Germany to spend €2 bn to avert driving bans

The German government had previously pledged €1 billion to help improve air quality, but after meeting with municipal representatives in December, Chancellor Angela Merkel said this program would be increased to €1.5 billion by 2020. She said the federal government would also set aside an additional €432 million for hardware retrofits of small trucks with older diesel engines.

One way to clean up older diesel cars is to fit more effective exhaust filters to cars. The issue of hardware retrofits, which municipalities want, was not resolved at the meeting. German Transport Minister Andreas Scheuer said his ministry would, by the end of 2018, present new guidelines, and that he expected it to take around six months after that to develop hardware retrofits, which would then need to be approved by the Federal Motor Transport Authority too.

In November, a German court ruled that the western state of North Rhine-Westphalia must ban older diesel vehicles in Gelsenkirchen and Essen. Other German cities also face the risk of diesel driving bans imposed by judges, including Aachen, Berlin, Frankfurt, Stuttgart, Düsseldorf and Mainz.

Merkel said 249 German cities had nitrogen oxide concentrations below the EU limit of 40 µg/m^3, while 65 cities had higher concentrations than that. Of those 65 cities, 40 had a reading between 40 and 50 µg/m^3 and should therefore not have driving bans because the measures already agreed are expected to reduce the concentrations quickly, Merkel said.

Source: Reuters, 3 December 2018

Europe's poorest hit hardest by air pollution

The more disadvantaged of Europe's citizens are also the most exposed to the negative consequences of air pollution and other environmental issues, a report from the European Environment Agency (EEA) has found. The report investigates the links between social and demographic inequalities and exposure to air pollution, noise and extreme temperatures at various scales in Europe.

Regarding air pollution, it was found that eastern European countries – Poland, Slovakia, Hungary, Romania and Bulgaria – and regions in southern Europe (including Spain, Portugal, Italy and Greece), where incomes and education are lower and unemployment rates higher than European averages, were more exposed to air pollutants, including particulate matter (PM) and ground-level ozone (O_3).

Source: EEA News, 4 February 2019

Link to the report "Unequal exposure and unequal impacts: social vulnerability to air pollution, noise and extreme temperatures in Europe": *https://www.eea.europa.eu/publications/unequal-exposure-and-unequal-impacts*

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New report examines the links between social and demographic inequalities and exposure to air pollution.

Commission requests Greece, France and Sweden to act on air pollution

According to the European Commission, Greece has failed to ensure compliance with the annual limit value for nitrogen dioxide (NO_2) in Athens for the period 2010–2014 and to establish an Air Quality Plan identifying the necessary measures that would keep the exceedance period as short as possible. Greece has also failed to put in place adequate sampling points in Thessaloniki to ensure proper monitoring of NO_2 concentrations. Moreover, Greece failed to make available a complete air quality report. As Greece has not yet complied with all these obligations, the Commission is sending a letter of formal notice. Greece has two months to reply to the concerns raised, otherwise the Commission may decide to send a reasoned opinion.

Failure to comply with NO_2 limit values.

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The Commission notes that France and Sweden have shortcomings with the enactment of several provisions of the EU's Air Quality Directive in domestic legislation, including the obligation to take appropriate measures to keep periods of exceedance as short as possible. The Commission is, therefore, sending letters of formal notice, giving France and Sweden two months to reply to the arguments raised by the Commission, otherwise the Commission may decide to send a reasoned opinion.

Source: European Commission's January infringements package, 24 January 2019

Not the bridging technology many claimed it to be.

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CCS 2001–2018: Expectations and results

Carbon capture and storage is not a real mitigation option. There are faster, cleaner, surer, safer, more durable, more effective and cheaper ways to cut CO_2: renewables, efficiency measures and the development of carbon-free industrial processes.

High hopes were pinned on CCS in the first decade of the 2000s. It gathered strong support from the US as part of the Bush administration agenda from 2001, and from the EU and the governments of the UK, Canada, Australia and Germany, especially after the IPCC special report in 2005. In 2008, the EU energy and climate package aimed to have 12 large demonstration plants in operation by 2015. The UN general secretary (and Angela Merkel) appointed the CEO of Vattenfall, Lars G. Josefsson, a leading coal apologist and CCS champion, as climate advisor. The Norwegian prime minister, Jens Stoltenberg, declared in 2007 that CCS was "our moon landing".

The IPCC special report in 2005 claimed that "in most scenarios ... and in a least-cost portfolio of mitigation options, the economic potential of CCS would amount to 220–2,200 Gt CO_2 cumulatively, which would mean that CCS contributes 15–55% to the cumulative mitigation effort worldwide until 2100".

Almost every major power company believed coal was the future, and the only way to reconcile this with the belief that global warming was a serious threat was CCS. The European Commission summed up the mood in May 2008:

"Introducing CCS may delay the need to reduce levels of fossil fuel use by at least half a century."

The conventional wisdom was that

- renewables were too expensive to grow fast. "CCS would be a bridge technology while alternatives to fossil fuels are further developed and deployed"

Storage

If CCS is to play a significant role as a mitigation option, it must store several billion tons (Gtons) of CO_2 per year. To store several Gtons, an enormous infrastructure will be needed, in the form of pipelines and/or CO_2 tankers. Even if there were political unanimity, and unlimited finance, such an infrastructure has a long lead time. It must also be coordinated with the capture of CO_2. That is hardly going to take place.

Storage represents a cost for investment, injection and monitoring, but no benefit other than the CO_2 price. Carbon trading and carbon taxes have so far produced a weak and inconsistent incentive.

Carbon storage in geological formations has been tested since 1996 on the scale of up to a few million tons per year. On that scale, it does not matter very much if the storage sites leak. But it is not worthwhile to develop the whole scientific, engineering, political and legal machinery for just a few megatons.

Storage on a meaningful scale must be very resistant to leaks.

Perhaps it is possible to store CO_2 for billions of years, but we cannot know for sure.

The carbon storage problem has parallels with the nuclear waste storage problem, which has not really been solved anywhere, after many decades of research. CO_2 storage is in some respects even more difficult. Nuclear waste is solid and easier to keep in place than a gas or a liquid such as CO_2. Nuclear waste becomes less dangerous over time, but CO_2 maintains its global warming ability forever. Also, nuclear leaks can be measured in minute quantities, so monitoring is much easier than for CO_2.

"The fraction retained in appropriately selected and managed geological reservoirs is very likely to exceed 99% over 100 years and is likely to exceed 99% over 1,000 years," according to the IPCC CCS report.

"Very likely" means a probability of 90–99%, which would mean a 1–10 percent probability of faster or bigger leaks. "Likely" is a probability between 66 and 90%, meaning approximately "perhaps". Both assessments are qualified, and apply to appropriately selected and managed sites.

If this assessment stands, it means there is a probability of 10–34 percent that more than 1 percent will leak.

If, as a theoretical example, the leak rate is 0.1 percent per year, after 1,000 years 73 percent will have returned to the atmosphere, to which should be added some 10 percent losses at capture. After 10,000 years 99.995 percent would have leaked.

Small leak rates matter, as the one stable natural sink for CO_2 is silicate weathering, which operates on very long timescales.

The question of what happens at badly managed sites is very relevant in a perspective of several thousand years. We have no experience of international institutions that have such longevity.

Anything from bankruptcy and associated failure of monitoring equipment to war, earthquakes or tsunamis could increase the risk, as could careless mining or drilling.

Large or small leaks over a long period of time pose other hazards than to the climate. In high concentrations, CO_2 is lethal and kills without warning, as the 1986 Lake Nyos disaster demonstrated. The disaster was unrelated to CCS, but if a storage or pipeline breaks in populated areas, the gas is just as deadly. A leak could also pollute groundwater.

CO_2 under pressure is an extremely efficient lubricant and may trigger earthquakes. "Large-scale CCS may have the potential for causing significant induced seismicity," according to the US National Academy of Sciences.

Irrespective of the actual risk, carbon storage has to take public opinion into consideration. Storage projects have been scrapped in Germany, the Netherlands and Denmark, as fossil companies have not been able persuade people that the benefits outweigh the risks.

Carbon capture

Carbon capture from fossil fuel combustion is technically proven on an industrial scale, but it is very expensive.

Capture adds cost and complexity to unabated fossil fuel combustion. The capture plant is the same size or bigger than the power plant itself, so both capital and operational costs are greatly increased.

Carbon capture also consumes energy, so to produce power or some other useful service, around 25 percent more fuel is needed than if emissions were not captured.

Capture is not 100 percent efficient. Some CO_2 escapes, on the order of 10 percent in theory, but often much more in real projects.

Because CCS only captures around 90 percent of CO_2, the carbon footprint of fossil power CCS is greater than that of renewables and efficiency measures.

There are three ways to dispose of the captured carbon: geological storage (above), enhanced oil recovery (EOR) and CCU.

EOR is clearly not a way to cut CO_2 emissions. 17 of the 21 operating CCS projects in the world 2018 are EOR .

CCU (carbon capture and utilisation) in which carbon is used as a feedstock, is not a serious climate mitigation option.

If CO_2 is used to fertilise algae or greenhouses, the harvested plants will have to be stored forever. If they are combusted, all the CO_2 will be emitted.

The same problem occurs if the CO_2 is combined with hydrogen to produce methanol, for example.

Direct air carbon capture takes CO_2 from the air, of which it makes up 0.04%. This is technically possible, but economically absurd, estimated by the American Physical Society at \$600/tCO_2. This does not include transport and storage of CO_2.

CCS 2001–2018: Expectations and results

Continued from page 11

- there was a strong link between economic growth and energy growth, and especially electricity consumption, so the efficiency option was limited
- there was no realistic option to stop coal growth, so the fuel shift option (from coal to gas) was limited
- 550 ppm CO_2 and higher were considered as mitigations.

Some of these assumptions were reasonable at the time. Solar power was indeed very expensive, as was offshore wind. Energy and electricity demand grew with GDP. The coal lobby was a strong political force. The US had abandoned Kyoto, and an international climate policy which did not include the US did not seem realistic or relevant.

Since then, everything has changed. Global CO_2 emissions only rose 0.5% per year in 2013–2017, compared to 2.5% in the previous 10 years. Electricity consumption fell in the US, the EU and Japan. Coal use for power fell in the OECD from >4,000 TWh to <3,000 TWh in 2007–2017. New coal power became a no-no in an increasing number of countries, and a lot of capacity has been phased out. Globally, wind power grew from 104 TWh in 2005, when the IPCC CCS report was published, to 1,123 TWh in 2017, and solar from 4 TWh to 443 TWh.

None of the 12 European CCS demo plants were even started. Several CCS projects were abandoned in the UK, the Netherlands, Germany, Denmark, Algeria and Norway.

CCS was supposed to bridge the gap between a fossil-based world, especially for power, and a renewable world. But renewables have stormed ahead while CCS got nowhere.

The Australian CCS Institute has listed all large-scale CO_2 storage projects around the world.

There are only four storage projects that do not use enhanced oil recovery as of July 2018, two in Norway and one each in Canada and the US, started between 1996 and 2017, and one under construction in Australia. Their combined capacity is stated as 7.4 million tons per year.

None of the five projects take CO_2 from the big streams: fossil power, steel or cement production. Three of the five projects are for gas processing. Since CO_2 is not wanted in natural gas, it has to be removed, and this happens to take place within reasonable distance from a good storage site. This for-free CO_2 is untypical. Gas processing is a minor diversion of carbon from the extraction of fossil gas, as most of the carbon goes with the product, natural gas.

Natural gas production started in 2016 for the Australian project, but CCS has been delayed. The total investment is $88 bn, of which CCS accounts for 2.5 bn. CCS was a political necessity for a project that will emit more than a gigaton of CO_2 when the gas is burned. One of the five projects is for hydrogen production, which is used in tar sand oil production. Globally, wind power produced 1,123 TWh in 2017. Assuming 0.5 kg of CO_2 emissions per kWh, wind power avoided 561 million tons of CO_2. All non-hydro renewables avoided, by the same account, more than 1,000 Mtons of CO_2 in 2017.

Efficiency measures, such as LED lighting and heat pumps, avoid similar amounts of CO_2.

CCS avoided, at most, 3.7 million tons of CO_2 in 2017.

CCS technologies are briefly analysed here, see attached boxes. To summarise all those analyses, carbon capture and storage is not a real mitigation option. There are faster, cleaner, surer, safer, more durable, more effective and cheaper ways to cut CO_2: renewables, efficiency measures and the development of carbon-free industrial processes.

Keeping the CCS option open will only divert attention and resources from the rest.

CCS is not fast. It would take decades for it to make a significant contribution to mitigation.

It is not reliable. Even with a huge effort, there is no way to know that it will deliver.

It is not safe. CO_2 may escape over various timescales, carrying immediate risks to health, for inducing earthquakes and for renewed warming.

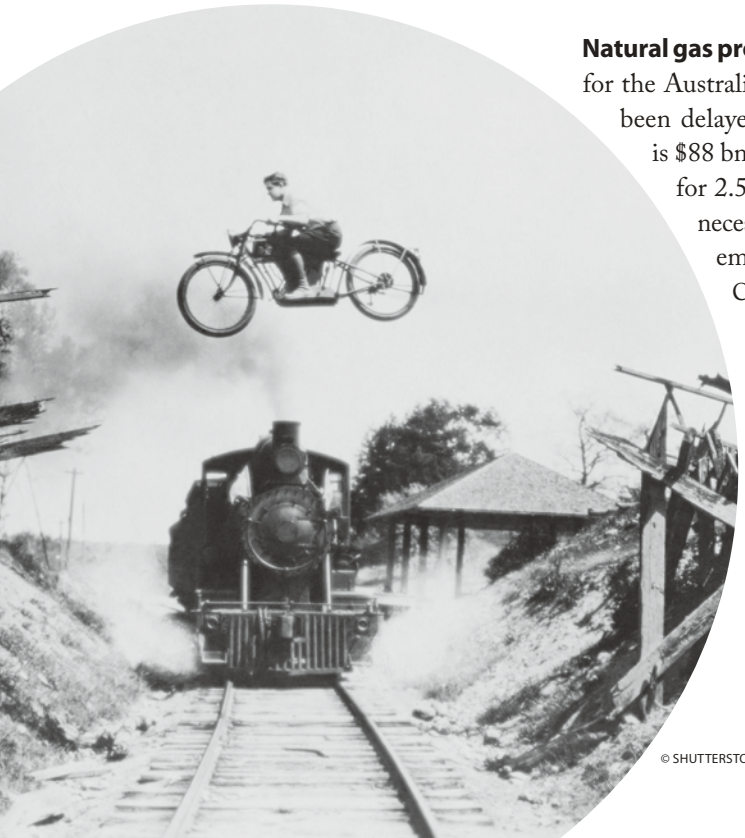
It is not clean. CCS uses about 25 per cent more fuel, which means more fossil extraction with several associated problems. A BECCS plant means more use of biofuel, which is a limited resource.

It is not durable. Fossil fuels are finite, and it is unsustainable to keep extracting them in enormous amounts in one place and burying the CO_2, which has three times as much mass, somewhere else.

It is not effective. The process captures much of the CO_2 but still emits 10 per cent or more directly into the atmosphere. The life cycle emissions from a CCS power plant are much higher than from a renewable plant.

It is not economic. A dollar spent on CCS mitigates less than a dollar spent on renewables etc. for the next year, the next decade or the next century.

Fredrik Lundberg



Carbon Capture and Storage (CCS)

The most obvious candidate for CCS would be coal power. That is where there are very large amounts of CO_2, and in high concentration. Some power stations emit 10 Mt of CO_2, or more, per year, creating an economy of scale for capture, transport and storage. What works well in one coal power station can largely be replicated at another coal power station.

The second biggest stream of CO_2 is natural gas power. It is still worse than coal power, as gas power plants produce less CO_2 per kWh, tend to be smaller, and operate for fewer hours per year.

The economic reality is that fossil power CCS costs much more than renewable power. No such plant exists. No power producer would consider building a new coal or gas power plant with CCS, or retrofit an existing power plant for CCS, unless somebody else pays.

The economic case for power CCS used was originally based on a higher carbon price. But even a much higher carbon price will not necessarily help. Coal and gas are cheap to extract, but wind, solar and efficiency measures have no fuel costs at all. Fossil fuel costs are unpredictable and may increase. It is expensive and time-consuming to open a new coal mine, so the investor faces a lot of economic and political uncertainty.

Fossil power CCS is almost dead before it was born. Most of the opportunities for CCS have now gone, leaving only niche applications, which will then have to carry the full cost of research, development and infrastructure.

CCS for industrial processes is still under discussion. The iron and steel industry uses coal and coke to reduce iron ore (oxide) to metal. Similar processes are used for other metals, such as aluminium and copper. The cement industry uses fossil fuels to heat limestone, which then emits CO_2. District heating and some other industries (e.g. paper and pulp) emit CO_2 from fossil fuels or biofuels or a mix (e.g. household waste incineration). Other potential big point sources are oil or biofuel refineries.

The rationale for industrial CCS is that there is no alternative. There are however good arguments to the contrary, at least in a 2030–2040 perspective.

Iron ore mining should be reduced, through better recycling. Ore can be reduced by using hydrogen from the electrolysis of water, as renewable electricity can deliver vast amounts of cheap electricity. This is the strategic choice of Europe's biggest iron miner, LKAB and the Swedish steel company SSAB.

Aluminium can be produced either with hydrogen, or with inert electrodes instead of graphite electrodes.

CO_2-emitting Portland cement is one way of bonding rocks and sand together to make concrete. There are other binders: geopolymers (clays), pozzolans (volcanic ash, ash from coal combustion), slag, and magnesium-based cements.

Incineration of household and other waste with a large fraction of plastics is unsustainable. Waste prevention should first reduce, then reuse, then recycle the plastic in society.

District heating or industrial heat are far from ideal sources of CO_2 for CCS, because they are typically much smaller than power plants, as they are typically not operated anyway near base-load, so CCS will add greatly to the cost. If district heating costs are excessive, customers will defect and use other heating sources.

If it is recognised that fossil power CCS is too expensive, then more decentralised collection of CO_2 from district heating plants, steel mills, paper mills etc. must be much more expensive. A typical industrial or district CHP/heating plant is 1–100 megawatts. Each plant needs its own tailored engineering design, environmental impact assessment and associated political process. If a single 2 GW coal power plant, capturing 10 Mt CO_2/year does not make sense, 100 smaller plants, 10–100 kilometres apart, make even less sense.

Bio-Energy Carbon Capture and Storage (BECCS)

If biomass is combusted in a power plant and then the CO_2 is captured and stored, we would have a plant with negative emissions.

Biomass is a limited, though large, resource. Bio-CCS requires that it is used in large combustion plants, which may not be the optimal use. They will suffer the same parasitic loss as fossil CCS, so 20 or 25 per cent of the biomass feedstock will be needed for energy for CCS – unless the energy requirements for capture and compression are supplied by other renewable energy. That renewable energy would be better used directly to replace coal power for many years to come.

Market forces and climate considerations will arrive at the same conclusion every time: wind, solar and efficiency measures will always be the preferred alternative to bio-CCS.

The rationale for bio-CCS or other negative emissions comes when the whole power sector, and some other minor large point sources, are decarbonised. Then, bio-CCS could draw down CO_2 from the atmosphere.

It is however very difficult to conceive that such a time will come, when mankind sees that all options to cut emissions are exhausted and that we must switch to draw-down mode. The decarbonisation process is not synchronised between countries and sectors. Some can and probably will achieve near-zero carbon in 10 or 20 years' time, while big emitters will still be operating elsewhere. It is not clear who should shoulder the responsibility of building extremely expensive BECCS plants, and when.

Without a clear picture of how this would happen in the future, we cannot consider it an option. It is morally indefensible to presuppose that people will be different, and better, in the future, and that they will do what we are not doing. BECCS may not be an option in the future, so to bank on it in mitigation scenarios is tantamount to promising life-boats now and letting the passengers find out later that they are not there.

The strategy of overshoot – first use a lot of fossils, then draw down the CO_2 later – suits the fossil industry. It shifts the focus away from what we know can and must be done.

Set strict emission limits for power plants

It is now up to the member states to set ambitious emission standards for large combustion plants, in line with the strictest recommended air pollution limit values.

A recent analysis by the European Environment Agency (EEA) shows that applying strict but realistic emission limits for the power sector could cut emissions of key air pollutants by 79–91 per cent by 2030.

Adopted in July 2017, the new EU air pollution standards are set out in a reference document for best available techniques (BREF) for large combustion plants under the 2010 Industrial Emissions Directive (IED).

The EEA analysis[1] has looked at the potential benefits of an ambitious implementation of the new BREF emission limits in the EU power sector. The BREF document sets a range of emission limits that member states must use for emission permits right now for new plants, and by 2021 at the latest for existing plants. The upper (less strict) emission limits represent the absolute minimum member states must do, while the lower (more strict) emission limits are a reference for more ambitious targets.

According to the EEA, implementing the upper emission limits of the new requirements would, by 2030, result in emission cuts of 66 per cent for sulphur dioxide (SO_2), 56 per cent for particulate matter (PM) and 51 per cent for nitrogen oxides (NOx), compared with 2016 emissions. However, implementing the more ambitious targets would result in significantly more substantial emission reductions of 91 per cent for SO_2, 82 per cent for PM and 79 per cent for NOx (see Figure).

The additional NOx emission reductions associated with achieving the more ambitious level of implementation are, for 2030 alone, comparable to the lifetime NOx emissions of 220,000 modern (average Euro 6) diesel cars on European roads (assuming a lifetime mileage of 150,000 km).

Power plants burning fossil fuels still generate almost half of the electricity in the EU and are responsible for the release of more than half of the total SO_2 emissions, 15 per cent of NOx emissions and 4 per cent of PM emissions, as well as other toxic pollutants, such as mercury.

Emissions of SO_2 and PM from power plants in the EU have decreased by more than three-quarters since 2004, primarily because of environmental regulation, according to a study[2] commissioned by the EEA and carried out by environmental consultants Trinomics.

The study looked at the period between 2004 and 2015 and found that, at EU level, the most important factor in reducing emissions of SO_2, NOx and PM from electricity-generating large combustion plants (LCPs) was improvements in the emission factor – i.e. the quantity of pollutant emitted per unit of fuel consumed for a given pollutant and fuel type.

In particular, for SO_2 and PM, changes in emissions factors would have resulted in 71 and 75 per cent decreases in emissions respectively, had all other factors remained constant. For both these pollutants, the most rapid period of decline in emissions was between 2007 and 2008, which coincides with implementation of the stricter SO_2 standards of the LCP Directive in 2008.

For NOx, the emission factor effect was smaller, but it was still the most important single factor, contributing to a 38 per cent decrease in emissions.

According to the study, other important factors affecting emissions at the EU level as well as for individual member states, were changes in the energy mix of electricity generation, in the energy intensity of the economy, and in the degree of electrification of final energy consumption:

- At the EU level, a general reduction in the energy intensity of economic sectors contributed to a decrease in emissions of between 6 and 11 per cent for all four pollutants.
- An overall rise in economic activity at the EU level contributed to a small increase (4–7%) in emissions of the pollutants studied. There was also an increase in the degree of electrification that increased the demand for electricity from LCPs, which contributed to a rise in emissions of between 6 and 9 per cent, depending on the pollutant.

Power plants burning fossil fuels still generate almost half of the electricity in the EU.

FLICKR:COM / SPIROS VATHIS CC BY-ND

- Finally, shifts in the energy mix of electricity generation helped to reduce emissions at the EU level, by 13, 15, 12 and 17 per cent for SO_2, NOx, PM and CO_2 respectively. The main driver of this effect was a small decline in the use of "other solid fuels" (i.e. coal) in electricity generation (from 31 to 25 per cent share of generation).

The report concludes that, overall, the most important driver of reductions in emissions from electricity-generating LCPs was the change in the environmental performance of coal-burning LCPs. The LCP Directive impacted this change primarily in two ways: firstly, through installation of abatement technologies so that plants could comply with the Directive's emission limit values by 2008; and secondly, through the closure of LCPs that were unable to meet those emission limit values.

LCPs that "opted-out" (i.e. using Article 4(4) of the Directive) closed at various times during the period 2008–2015, because retrofitting abatement technologies was not economically viable for many of these plants, which were often near the end of their operational lifespan.

After some years of levelling off after 2010, emissions from LCPs began to decrease again after 2013, probably in anticipation of the stricter emission limit values imposed by the Industrial Emissions Directive, which fully came into force from 2016.

Christer Ågren

EEA Briefing: "Greening the power sector: benefits of an ambitious implementation of Europe's environment and climate policies" (December 2018). *https://www.eea.europa.eu*

[1] "Emission scenarios for large combustion plants under the IED regime" (November 2018). Eionet Report — ETC/ACM 2018/16. Link: *https://acm.eionet.europa.eu/reports/EIONET_Rep_ETCACM_2018_16_IEDregime_LCPscenarios*

[2] "Decomposition analysis for air pollutants and CO_2 emissions from large combustion plants across Europe" (March 2018). By Trinomics/Aether. Link: *http://www.aether-uk.com/CMSPages/GetFile.aspx?guid=14ca8d73-614e-42db-811d-738425f0b218*

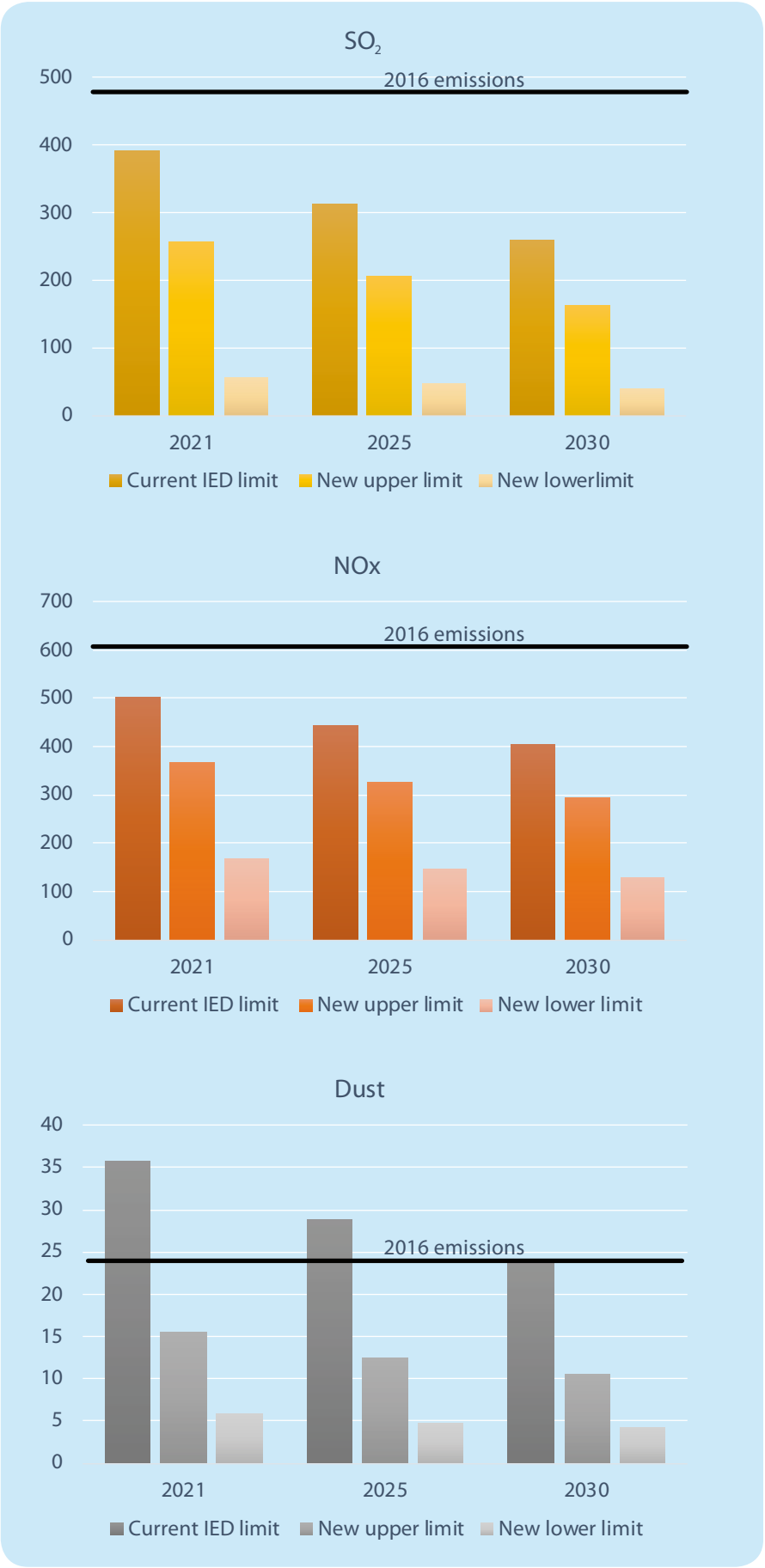


Figure: Total projected annual emissions from large combustion plants (in kilotonnes per year) in 2021, 2025 and 2030 for SO_2, NOx and dust in case current IED limits, upper or lower levels of the new requirements (LCP BREF) are used to set permit conditions.

Investing in development of electricity from renewables

Ambitious countries and companies are showing the way with a strategy that could help eliminate the risk of unmanageable climate change.

The strategy is based on ideas to achieve far-reaching and economically sustainable results. By investing in the industrial development of electricity production from renewable energy sources, electricity could be generated at lower cost than from fossil fuels. Renewable electricity could then reach costs low enough to replace fossil fuels in the transport sector, for industrial processes and partly for heating. This would allow fossil fuels to be completely replaced by renewable energy, including low-cost solar and wind power, together with hydropower, geothermal energy and bioenergy in waste and by-products from agriculture and forestry. Stable electricity supply would then become economically sustainable without any policy support.

This strategy is used in German energy policy[1] and in the US SunShot initiative[2], launched to reduce the cost of solar electricity. A similar strategy was later used in China, and is now pursued with global ambitions by GEIDCO, based in Beijing[3, 4]. More recently, similar ideas have been proposed as a solution by the global Energy Transition Commission[5].

The clear economic logic and growing global support make it likely that this strategy will be realized. Bloomberg New Energy Finance, in its New Energy Outlook 2018, predicts that the cost of producing electricity from wind will drop to less than half by 2050 and solar electricity will cost less than a quarter of the current cost by 2050[6]. But without more support and attention, it will happen too slowly to avoid the risk of dramatic climate change.

Nevertheless, the goal of the SunShot initiative for 2020 was achieved in 2017, well ahead of target[2]. Solar and wind power are already providing cheaper electricity than any other new power plants in most parts of the world according to Bloomberg New Energy Finance[7]. According to Lazard's annual cost study[8], solar and wind power have begun to outcompete existing coal and nuclear power plants in the US. More importantly, renewable electricity has become cheaper than oil and liquid natural gas per energy unit in large parts of the world[9].

This trend is confirmed by the fact that more than 12 GW of coal-fired power stations were closed in the US in 2018[10]. In China, no nuclear reactor construction project has been started since December 2016[11], while solar and wind power are being expanded faster than anywhere else in the world.

Old professors and nuclear power engineers – those who do not see the entire strategy – usually assert that solar and wind power cannot be expanded because they compete with each other by creating overproduction in relation to current demand in the electricity system.

It is true that it is difficult to achieve profitability from a large proportion of solar and wind power if you only see it as a way of replacing coal power plants. But if you start using electricity to charge batteries when the electricity is cheap, during the day, and use longer periods of good access to solar and wind electricity to produce heat, hydrogen or liquid fuels, then it is possible to expand solar capacity and wind power far beyond the traditional electricity demand and at the same time always meet the immediate demand for electricity.

Thus, it can be more profitable to replace all fossil fuels than to do so solely in the electricity sector.

In Sweden, we see this strategy in action in the Hybrit project[12], whose goal is to produce hydrogen from renewable electricity, to replace coal in the steel industry's reduction processes. We can also see this strategy in a project to produce hydrogen from electricity as biomass feedstock for producing biofuels at Preem[13]. We see it in the Liquid Wind project to produce electro-methanol for the shipping industry[14]. But most of all, we can see how electricity is taking over from fossil fuels in cars.

Key developments that support this strategy include major cost reductions in battery manufacturing, information technology for controlling electricity consumption over time, as well as high-voltage electricity transmission with low losses.

Batteries are not just used by vehicles, they also make it possible to supply households with local solar power in large parts of the world that do not have well-developed electricity networks. Batteries can also provide a cheap way of ensuring that electricity networks are even more stable than today.

While expensive electricity distribution networks can be out-competed by batteries, cheaper electricity transmission can ensure that large cities and energy-intensive industries can be supplied with renewable electricity even if the electricity cannot be produced locally.

There are no technical or economic barriers to eliminating the threat of rapid climate change. But other obstacles do exist: Many large energy companies will lose large asset values as fossil energy resources and power plants become worthless. These companies will mobilise governments and

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reactionary individuals who do not want to see new technical solutions. Individuals who oppose this development may have very different viewpoints, from being attached to the old centralised energy technology, to those driven by a desire to see society collapse.

But there are many more who can and want to help solve both their own and the world's problems by building solar and wind power plants and provide an efficient modern energy supply to everyone in the world. Those who go for the solution will win. Let us make it fast enough!

Tomas Kåberger

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Faster melting ice-sheets

Research shows that the tipping point for long-term melting of polar regions and high-mountain glaciers could be close.

Glaciers and ice-sheets all over the world continue to melt at unprecedented rates. This article presents four examples of new research published since November 2018:

1. Greenpeace China: "This is a wake-up call for China and the world. Glaciers in China supply water to 1.8 billion people, and they're melting, fast. There are more than 48,000 glaciers in China, which form part of the 'Third Pole', the largest concentration of glaciers and snow outside the polar regions. Almost one-fifth of glacier area in China has already disappeared, and the volume of meltwater has increased by 53.5%. Without serious action to limit the impacts of climate change, two-thirds of glaciers in High Mountain Asia are projected to be gone by the end of the century."[1]

2. International Centre for Integrated Mountain Development: "At least a third of the huge ice fields in Asia's towering mountain chain are doomed to melt due to climate change, according to a new landmark report, with serious consequences for almost two billion people. Even if carbon emissions are dramatically and rapidly cut and succeed in limiting global warming to 1.5°C, 36% of the glaciers along the Hindu Kush and Himalaya range will have gone by 2100. If emissions are not cut, the loss soars to two-thirds, the report found. The glaciers are a critical water store for the 250 million people who live in the Hindu Kush-Himalaya (HKH) region, and 1.65 billion people rely on the great rivers that flow from the peaks into India, Pakistan, China and other nations." [2]

3. US National Academy of Sciences: "Greenland Ice Sheet at 'Tipping Point'. Greenland is now losing ice at four times the rate it did 16 years ago. A study released in the Proceedings of the Natural Academy of Sciences finds that meltwater from Greenland's southwest icesheet could become a 'major contributor' to sea level rise as the world continues to warm. This is going to cause additional sea level rise. We are watching the icesheet hit a tipping point." [3]

4. US National Academy of Sciences: "Antarctica is now rapidly melting all over, including parts we thought were safe. Antarctic glaciers have been melting at an accelerating pace over the past four decades thanks to an influx of warm ocean water – a startling new finding that researchers say could mean sea levels are poised to rise more quickly than predicted in coming decades. The Antarctic lost 40 billion tons of melting ice to the ocean each year from 1979 to 1989. That figure rose to 252 billion tons lost per year beginning in 2009, according to a study published in the Proceedings of the National Academy of Sciences. That means the region is losing six times as much ice as it was four decades ago, an unprecedented pace in the era of modern measurements." [4]

In September 2019 the IPCC will publish a special report about climate change and iceshields and oceans. The UN Climate Summit will be held at the same time in New York. This meeting is the main event after the Talanoa Dialogue, which in 2018 discussed increasing the ambition level of the UN Climate Convention (see AN 2018). The summit will decide on the need for increased targets for National Climate Action Plans. The IPCC special reports on 1.5°C (published on 8 October 2018) and on oceans and iceshields (to be published on the 23 September 2019) will be key scientific assessments for this decision.

Reinhold Pape

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Almost one-fifth of glacier area in China has already disappeared.

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Analyzing global energy scenarios

Coal has peaked worldwide and it won't come back, and that is as official as it gets.

It is confirmed by the International Energy Agency (IEA) in its December 2018 Coal report. The IEA has been a staunch coal champion since its inception in 1974, as part of its drive for security of energy supply.

"Global coal demand will be stable though 2023," says the International Energy Agency in its annual coal report: Coal 2018 – Analysis and forecasts to 2023.

This admission stands in stark contrast to the IEA's previous predictions. In 2014 it forecast a global coal demand of 6462 million tonnes for 2019, an increase of almost 16 per cent from 2013.

Less than five years ago, the conventional wisdom was that coal would keep on increasing for a long time to come.

In the real world, it peaked in 2013 at 5588 Mtce[1], fell between 2014 and 2016 and even after an uptick in 2017 it was 4 per cent down on 2013.

Coal is the worst fuel in almost every respect regarding the climate, environment and health.

The difference between +16 per cent and -4 per cent is big: 3 billion tonnes of CO_2 per year, assuming that coal remains flat from 2017 to 2019. Because many of the dirtiest coal power plant have been retired and the newer plants are somewhat cleaner, the health benefits of declining coal are even greater.

The political lesson is just as striking. King Coal is not invincible. Even in China, which uses half of the coal in the world, coal has declined since 2013. It will continue to do so, slowly, according to the IEA.

The agency also predicts declines in Europe, North America and Japan, but expects coal to increase substantially in India and Southeast Asia.

But every new prediction is lower than the previous one. In December 2016, three years after the peak, the IEA reckoned that global demand would be 5469 Mtce in 2019. Two years later that was adjusted to 5389 Mtce, and so on. It has consistently overestimated coal and underestimated renewables.

The economic and political forces against coal are growing stronger, as can be followed on CoalWire at https://endcoal.org. Every issue has more bad news for coal: big financial institutions are no longer financing coal, coal power projects are being abandoned, power plants, mines and harbours are being closed. In the background, the costs for wind, solar and batteries are falling below the remaining coal power plants.

In just the two months since early December, 3 GW of coal power projects have been axed in Japan, 1 GW in Turkey, 3 GW in Thailand, and 12.5 GW are to be phased out in Germany by 2022.

Much of this was not known when the IEA made its forecasts.

So it may be overestimating once again.

The IAE was formed in 1974 as a response from the OECD countries after the 1973 the oil price shock, as a kind of intergovernmenal think tank for what were then known as the rich countries. Ever since then it has promoted coal and nuclear, and to some extent energy efficiency, in order to decrease dependence on oil. It produces a large volume of data and reports, the best known of which is the World Energy Outlook every November. The most recent report appointed itself "The gold standard of energy analysis" on its title page.

If you overlay the curves of the IEA forecasts for coal, the earlier curves point almost straight up, while the later ones become flatter and flatter, like the quills of a porcupine (figure).

The curves for solar and wind form a similar pattern, but the actual values are always higher than IEA's forecasts.

The flaw in the IEA forecasting method is also reflected in oil price forecasts. In 2004, it was forecast that the price would stay at $22 in 2006–2010 and then rise to $29 by 2030. In reality, it rose to $110,

and then fell to $45 by 2016 The track record is not great.

Every year the IEA scenarios have overestimated the amount of coal and nuclear power and underestimated wind and solar. In other words they have been a conservative force. This may be because they have tuned the models to get these results, but could also be because this type of model always shows more resistance to change than we see in real life. They assume that the present energy mix represents an equilibrium that is expensive to deviate from.

The IEA is not alone in this. The forecasts of the US Energy Information Agency and BP show exactly the same flaw, and many national scenarios and even NGO scenarios have persistently underestimated the force for change.

When the IEA was first set up, and for many years afterwards, oil was the yardstick for measuring all energy. Everything was measured in tonnes of oil equivalents. The phrase "security of supply" reflected the unquestionable demand of the US, Europe and Japan for access to oil at a price that they felt to be right.

Oil is much less important today. Europe uses far less oil[2] than it did in 1973, despite enormous growth and a massive increase in transport.

An underlying assumption since the models were first developed is that growth in GDP controls the "demand" for energy sources. This assumption worked fairly well during the development phase of poorer countries, but shows a poor match for developed countries. The geography and history of countries plays a much smaller role now than in the early days of these scenarios.

If you want to cut carbon dioxide emissions, roughly the same formula applies everywhere. We know today that wind and solar power work all over the world. This means we can get as much electricity as we need without fossil fuels or nuclear power[3], and that this electricity will be relatively cheap[4]. Electricity from wind and sun may not always be available when and where we need it, but there is plenty of space for solar and wind within the existing energy system, especially in countries that have hydropower or can use hydropower from other countries. The share of solar and wind power could be still greater with demand management and moderate grid expansion. In dry, sunny countries, concentrated solar power (CSP) can provide energy balancing for several hours.

Hydrogen from electrolysis[5] can enable further balancing, along with electric cars and storage batteries.

Batteries are much too expensive for main grid balancing, but can be economically viable for overstretched local grids or as an alternative to otherwise unavoidable grid expansion. By using methods such as demand management and battery storage, local grids can solve the problems of the main grid faster and cheaper than new 400 kilovolt lines. That is what "smart grid", microgrids and "grid edge" is all about.

Lighting was previously a major consumer of electricity, but with the adoption of technology such as LEDs, timers, presence-sensing and daylight monitoring lighting accounts for no more than 6 per cent of US electricity.[6]

Heating and cooling used to be major consumers of fuel or electricity, depending on the local climate and technical solutions. This is no longer the case. Heat pumps can be used to provide heating and cooling everywhere. There is no strong reason to expand district heating and cooling. Everything can be done locally, within months rather than years. The need for heating and cooling also depends on the performance of building climate shells and ventilation systems. Whatever the climate, it makes sense to have draught-proof, well-insulated buildings with good windows, which either keep the cold out and the heat in, or vice versa. Such buildings must also have effective ventilation systems and efficient refrigerators, freezers and stoves.

The entire transport sector can in principle be powered by electricity, or hydrogen. The technology is there.

Industries that need heat can get it from electricity instead of fossil fuels. Steel can be produced from ore using electricity or hydrogen. In the near future, primary aluminium could be produced using electricity[7], instead of electricity and carbon electrodes, as now.

Biofuels will be used, if nothing else in the form of waste (banana peels, straw, dung, wastewater, residue from the pulp industry), but there is no reason to increase their use significantly, as this leads to conflicts with biodiversity.

Some modellers see "optimisation" as the key, but this is unnecessarily sophisticated. None of the positive developments we

Page 20 ▶

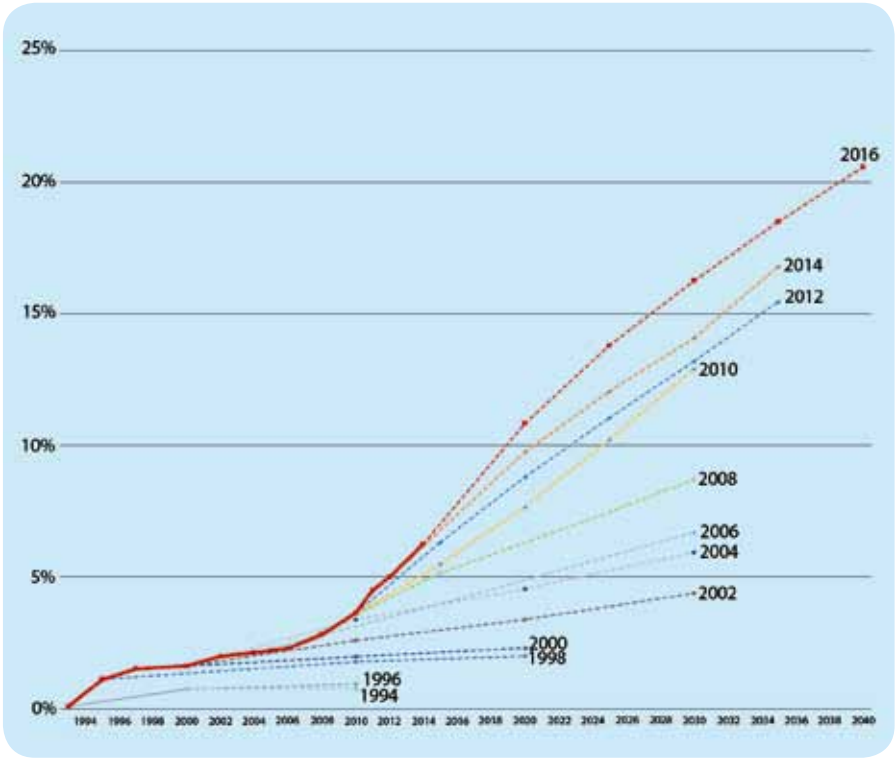

Figure: Share of electricity generation from renewables , except hydro power in different years. Dotted lines indicate projections made by IEA in the years labelled, solid line gives the actual shares according to their definitions.

Analyzing global energy scenarios

Continued from page 19

have seen – the growth of wind power, solar power and efficiency improvements such as Energy Star – have been optimised. They were an expression of political will. The use of solar panels in Germany was far from the optimum solution: it was an absurdly expensive technology in a country where the sun hardly shines and where peak consumption occurs in January, when solar panels provide almost nothing. Nevertheless, political will has transformed the market. Solar panels, wind power and efficient office machinery are taking market share everywhere. In 2017, worldwide[8], solar power grew 35,2%, wind power 17,3 %, much more than gas power (+1,4%) and coal power (+3,2 % an uptick in a declining trend). Oil power decreased 7,6 %.

The vision of the environmental movement could now be close to that of the electricity industry in the 1970s: total electrification. They wanted all this electricity to come from nuclear power, for example, whereas NGOs want renewable electricity. The plan of action could be to pile on more sun and wind, and eliminate fossil fuels everywhere.

The usefulness of huge complex computer models is questionable, if we already know what we have to do.

As we can see in many parts of the world (China, Germany, Denmark and California) rapid growth in renewables does present some problems, but it also delivers solutions.[9]

In addition to more electricity we also need R&D in certain areas, for example in demand management, greehouse gas reduction in agriculture and some parts of the process industry. But these must be prioritised on the basis of our existing knowledge, not a computer model.

They base their results on macroeconomic data, such as GDP growth, population and the oil price.

This is doomed to fail, because there is not much connection between GDP growth and energy or electricity growth, other than in low-income countries

Every year the IEA World Energy Outlook scenarios have overestimated the use of coal and nuclear power and underestimated wind and solar power. They have thus been a conservative force. This may be because they have tuned the models to get these results, but could also be because this type of model always shows more resistance to change than we see in real life.

The models are often based on a business-as-usual scenario in which you change the requirements and get new results. But there is no such thing as "business as usual". Business is always changing.

A plausible future model made 10 March 2011 might have forecast that by 2025 Japan would have 60 nuclear reactors and Germany 20. A few weeks later it was clear that Germany would not have any nuclear power and Japan would have 0–20 reactors by this time.

This also illustrates the danger of trying to incorporate political circumstances into national forecasts. It is clearly a political challenge to phase out nuclear power in France, Sweden or Finland because the nuclear power industry is a big political issue, in the same way as coal power in Poland. But if we make these concerns part of "national circumstances", coal and nuclear will never be phased out.

A few years ago the German lignite industry was planning its operations beyond 2050. But now the phase-out has begun and its final year is set as 2038. The environmental movement is fighting for earlier closure.

National scenarios do not need to be overly refined. Geographical differences can be ironed out through trade. Denmark does not have any hydropower, but could still get 100 per cent (66 per cent wind and solar projected for 2021) of its electricity from renewables over a 12-month period, thanks to hydropower from Norway and Sweden. If there is already some excess capacity, as in Denmark, then the problem already has a solution. Many new distribution lines are already being built, for example between Norway and the UK, and in Germany.

Bottom-up analysis is scientifically sound, but complex and difficult to communicate to politicians and the public. The question is whether there is any great need. The entire analytical apparatus is based on the idea of a "primary energy demand" that can be divided between energy sources. But why? Electricity is electricity and fuel is fuel! No one can picture a mix of electricity and fuel.

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If we are going to do modelling it should be energy backcasting. Start with the 1.5°C target and work out what it will take to get there. The most promising path does not have to be linear, and is unlikely to be the EU's "walk first, run later". The better approach would be "Run first, walk later", as most of the technology is already familiar, cheap and can be applied quickly. We can do the unfamiliar, difficult and expensive bits later, as they may require research, development and scaling up of technologies, as well as testing of new incentives before they can be applied in full scale.

Fredrik Lundberg

[1] Million tonnes of coal equivalent, the energy contents of as many million tonnes of standard coal.

[2] See BP Statistical Review of World Energy June 2018

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Lignite plants should be closed first

Europe accounts for half of global lignite production and combustion, with EU members Germany and Poland the worst offenders in terms of premature deaths from air pollution, according to a report from the Health and Environment Alliance (HEAL). The EU accounted for more than 37 per cent of global lignite consumption overall, with the figure rising to just under 50 per cent when Russia, Turkey and the Balkan countries are included.

Germany is both the world's biggest producer of lignite and the main consumer, with practically all of its lignite burned in domestic power plants. According to the report, 4350 premature deaths in Germany each year can be attributed to pollution from burning lignite and hard coal. In Poland, 5830 annual premature deaths are linked to the burning of lignite and hard coal combined.

HEAL argues that in order to protect both health and climate, European governments should commit to a full phase-out of coal by 2030.

Sources: Ends Europe Daily and HEAL News release, 10 December 2018

Link to HEAL report: *https://www.env-health.org/coal-phase-out-for-health-overdue/*

Better used as paperweight than fuel.

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Air polltion is behind one in eight deats in India.

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India: Toxic air claimed 1.24 million lives

India's polluted air was responsible for 1.24 million premature deaths in 2017, or 12.5 per cent of total deaths recorded that year, according to a study published in Lancet Planetary Health. Of the total, about 670,000 died from air pollution in the wider environment and 480,000 from household pollution related to the use of solid cooking fuels. More than half of the people who died because of air pollution were younger than 70. Average life expectancy in India in 2017 would have been higher by 1.7 years if air quality was at healthy levels, the report said. Earlier this year, the WHO said India was home to the world's 14 most polluted cities.

Source: Reuter, 6 December 2018

Chinese life expectancy can be raised by 3 years

China could raise average life expectancy by 2.9 years if it improves air quality to levels recommended by the WHO, according a new study from the Energy Policy Institute at the University of Chicago. Following a campaign to curb coal use and improve industry and vehicle standards, China has cut average concentrations of hazardous particles ($PM_{2.5}$) to an average of 39 μg/m^3. However, this is still significantly higher than China's own 35-microgram standard, as well as the 10-microgram limit recommended by the WHO.

In China's northern industrial regions, average concentrations are much higher.

Source: Reuters, 11 January 2019

Average $PM_{2.5}$ levels are almost four times above WHO limits.

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Greenpeace Energy wants to buy coal business and replace it with renewables

The Hamburg-based green electricity provider, Greenpeace Energy, wants to shut down RWE's coal power plants and replace them with 8.2 GW of wind and solar systems. Approximately €7 billion would be invested in the new facilities, which would be built without any public support. Key to the initiative will be citizen participation. Greenpeace Energy plans to gradually take over the lignite mines and coal power plants of German utility RWE in the Rheinische Revier region of western Germany from 2020, and shut them down by 2025. This will make room for new PV and wind power plants with a total capacity of around 8.2 GW, it said in a press release.

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Climate activists outside Neurath, one of the coal power plants owned by RWE.

https://www.pv-magazine.com/2018/11/26/greenpeace-energy-wants-to-buy-germanys-rwe-coal-business-and-to-replace-it-with-8-2-gw-of-renewables/

A win-win for health and environment

The EAT-Lancet Commission calls for a great food transformation that could save 11 million lives a year and mitigate climate change. Though that would require new institutions such as an IPCC for our food system.

The report "Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems" got a lot of media attention in connection with its publication on 16 January 2019. Most of it focused on the radical dietary changes proposed in the study.

Reduce your intake of red meat to one serving a week, fill half the plate with fruit and vegetables and the rest with beans, nuts and whole grains. That in short is what you need to do to embrace the EAT-Lancet reference diet. For the detailed version see table 1.

The point of departure in designing this diet was health. The authors have scrutinised scientific reports to find evidence of the effects of different foods categories on disease and nutrition. The intake of red meat and in particular processed meat has been associated with cardiovascular diseases, diabetes and certain types of cancer. High consumption of nuts and legumes have on the other hand been found to reduce the risk of some diseases and overall mortality. Since vegetable oil is found to be more healthy than dairy fats, butter has simply been excluded from the diet. The intake of starchy tubers, such as potatoes and cassava, is also reduced to a low level because of their relatively low nutrient content and high glycaemic load that could be a precursor to diabetes.

Few people eat according to the reference diet today. The consumption of animal-based foods in affluent populations exceeds the recommendations by far. In sub-Saharan Africa and South Asia, where meat intake is low, the share of starch-rich food in the diet is higher than the recommendations. The Middle East is the only region where vegetable consumption is close to being in line with the recommendations.

However, if everyone followed their recommendations it is estimated that around 11 million deaths per year could be avoided. Or a mind-blowing reduction in global mortality by a fifth.

Table 1. Healthy reference diet, with possible ranges, for an intake of 2500 kcal/day.

	Macronutrient intake (possible range), g/day	Caloric intake, kcal/day
Whole grains		
Rice, wheat, corn, and other†	232 (total gains 0–60% of energy)	811
Tubers or starchy vegetables		
Potatoes and cassava	50 (0–100)	39
Vegetables		
All vegetables	300 (200–600)	..
Dark green vegetables	100	23
Red and orange vegetables	100	30
Other vegetables	100	25
Fruits		
All fruit	200 (100–300)	126
Dairy foods		
Whole milk or derivative equivalents (e.g. cheese)	250 (0–500)	153
Protein sources		
Beef and lamb	7 (0–14)	15
Pork	7 (0–14)	15
Chicken and other poultry	29 (0–58)	62
Eggs	13 (0–25)	19
Fish	28 (0–100)	40
Legumes		
Dry beans, lentils, and peas	50 (0–100)	172
Soy foods	25 (0–50)	112
Peanuts	25 (0–75)	142
Tree nuts	25	149
Added fats		
Palm oil	6.8 (0–6.8)	60
Unsaturated oils	40 (20–80)	354
Dairy fats (included in milk)	0	0
Lard or tallow	5 (0–5)	36
Added sugars		
All sweeteners	31 (0–31)	120

The authors then show how this diet, if adopted by a global population of 10 billion in 2050, could be compatible with five aspects of sustainability: climate change, fresh water use, nitrogen and phosphorus flows, biodiversity loss and land-system change.

Concerning climate change, the authors are pessimistic about achieving any greater reductions in methane and nitrous oxide by 2050 since they arise through biological processes in animals and in the soil. However, they see two other vital areas for action. The first is to eliminate the use of fossil fuels along the whole the food chain. This includes fossil-free transportation, storage and processing. The second and more challenging condition is that total emissions from land-use change caused by food production must be zero.

If these two conditions are met the food system would be responsible for 5 Gt of carbon dioxide equivalents a year by 2050. This is nearly half of the allowable global emissions from all sources by then, if we are to achieve a 66 per cent probability of maintaining less than 2°C of global warming. This is significantly higher than the current situation, where the food system accounts for around a quarter of total global greenhouse gas emissions.

Halting the overall expansion of agricultural land is also required to keep species extinction at an acceptable

Table 2: Potential new evidence-based institutions which could champion and monitor the Great Food Transformation.

	Purpose	Tasks 1	Tasks 2
Intergovernmental Panel on Climate Change-type mechanism for healthy diets from sustainable food systems	To be a consortium of scientists which collates and updates data for the UN	Provide regular sources of impartial state-of-the-art summaries, which combine data across disciplines	Review policy options for the UN system
UN Framework Convention on Sustainable Food Systems	To provide a framework for healthy diets from sustainable food systems with functions akin to those of the Framework Conventions on Climate Change and on Tobacco	Produce guidelines and protocols that set targets and enable monitoring	Host a Food Meeting of the Parties akin to the Convention of the Parties process
International Working Party on Sustainable Dietary Guidelines	To produce evidence-based guidelines to add sustainability criteria to existing food-based and nutrient-based dietary guidelines	Provide science-based advice for a wide range of bodies	Set healthy and sustainable dietary guidelines to meet the food-related Sustainable Development Goals
A Standing Panel of Experts on healthy diets from sustainable food systems	To be a subcommittee or standing advisory body to an existing body such as the UN Standing Committee on Nutrition or UN Codex Alimentarius Commission	Produce expert reviews of problem issues for the parent body	Advise national governments on healthy diets from sustainable food systems standards
Roadmaps to healthy diets from sustainable food systems	To generate one-off sector plans for public or private sectors or both	Industry-specific and sector-specific plans to contribute to healthy diets from sustainable food systems	Develop plans with phased processes of change to meet specific targets
Global Food Systems Report	To author an authoritative annual report, ideally under the auspices of a UN or Bretton Woods body, jointly with others	Produce an annual overview report of the world food system	Conduct special reviews attached to the report
Global Food Systems Observatory	Consortium of scientists providing high-quality evidence on interventions, modelled on the Cochrane Collaboration and Health/Obesity Observatories	Create a global working network of universities and scientists to refine evidence-based policy	Monitor regional and national performance in line with agreed targets and criteria

level and safeguard essential terrestrial and marine biomes. It is however noted that in some regions more farmland will be needed to feed a growing population. New land that is devoted to crop production must then be concentrated in areas with low biodiversity that are already affected by human activities, such as already cleared forest, plantations, pastures and rangelands.

Another solution to reduce the demand on land is to increase productivity, particularly in regions with low productivity, a process known in the agronomic literature as closing yield gaps. According to the authors this could be done by shifting nitrogen and phosphorus fertilisers from some regions with over-use to other regions where chemical fertilisers are hardly used at all.

Attaining the sustainable development goal of halving global food waste is also a key to reducing the environmental impact of agriculture. In poor countries, food is often wasted before it reaches consumers. Crops are left in the field because of a lack of storage facilities, or absence of market access. Investments in infrastructure and education in areas such as post-harvest handling could be solutions.

In more affluent countries, more food is wasted at the consumer stage. The authors suggest public information campaigns to promote improved planning of purchases, understanding of best-before and use-by labels, storage practices, assessment of portions needed, food preparation techniques, and knowledge of how to use leftovers.

In the final part of the report they note that the combined challenges of changing diets, improving food production and halving food waste "will require rapid adoption of numerous changes and unprecedented global collaboration and commitment: nothing less than a Great Food Transformation." They also state that "this transformation will not happen unless there is widespread, multi-sector, multi-level action to change".

They look to the efforts at the end of World War II to improve the global food system. At this time international institutions such as WHO, the Food and Agriculture Organization and the World Bank were founded to tackle the current food and agricultural challenges. They also recognise that previous examples of global system change and action, like tackling HIV/AIDS and limiting tobacco, have required profound international cooperation based on science.

The authors present a list of possible institutions that could encourage and facilitate the Great Food Transformation (table 2). A body similar to the Intergovernmental Panel on Climate Change (IPCC), could provide the world with continuously refined scientific targets for health and a sustainable food system, and help to narrow the gap between scientific evidence and policy making. They also call for a new convention on sustainable food systems that could provide a global framework.

Finally, they stress the importance of embarking on this transition now and not later: "data are sufficient and strong enough to warrant action, and delay will increase the likelihood of serious, even disastrous, consequences".

Kajsa Pira

The report Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems can be found here: *https://www.thelancet.com/commissions/EAT*

Opportunity to sharpen CAP proposal

For the Common Agriculture Policy (CAP) to deliver on environmental and climate goals, policy makers must specify targets and ring-fence funding for green interventions.

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The Commission's CAP proposal was published in June 2018 and will be processed in the European Parliament over the coming months, with a possible plenary debate and vote in the second half of April. More than 7000 amendments have been tabled. The Council is expected to present a partial position (articles not related to the budget) in June.

According to the European Court of Auditors (ECA), who published an opinion on the proposal in November, there are plenty of opportunities for improvement. They note that the Commission has stated that environmental and climate objectives would be given a high priority and that there are several tools in the policy architecture with potential to address these objectives. However, according to the ECA, in order for the environmental and climate objectives to be effective they must be more clearly defined and translated into quantified targets. Otherwise it will be difficult to assess whether a greener CAP has been achieved.

The ECA also address the issue of climate accounting and find the Commission's estimates of the CAP's contribution to EU climate change objectives to be unrealistic. For example, they assume that 40 per cent of the direct payments will be spent on climate measures, since farmers need to comply with conditionality. However, most farmers would in practice need to do very little or nothing more than they already do to be in line with the requirements. ECA also write that this type of optimistic accounting "could lead to lower financial contributions for other policy areas, thus reducing the overall contribution of EU spending to climate change mitigation and adaptation". And they suggest that only areas where farmers actually apply practices to mitigate climate change, such as protecting wetland and peatland, should be included when estimating the contribution to climate change mitigation.

Another important piece of criticism is that despite all the claims about renewal, many policy options remain the same. Not least direct payments, which are still the biggest item on the budget. This type of area-based funding is justified primarily by the objective to "Support viable farm income and resilience across the EU territory to enhance food security". The ECA means that there is a lack of comparable statistics on farmers' income from EU countries, which will make it hard to assess where interventions are most needed. There is also a lack of evidence on what effect direct payments have on farmers' income. They are also sceptical about the second part of the objective – food security. They say "the objective's relevance to the European context is questionable. To ensure future food security addressing climate change is likely to be more relevant than supporting farm income".

The Institute of European Environmental Policy (IEEP), a Brussels-based think tank, focuses on eco-schemes, a new type of policy intervention in the proposal, in a report published in January. Eco-schemes are to some extent superseding the greening practices of the previous CAP, as an environmental feature in the first pillar. In the proposal, eco-schemes are mandatory for member states and voluntary for farmers. The main difference from greening is that the exact design is left to member states. This flexibility means, according to the report, that if well targeted and tailored, and backed by a strong budget, eco-schemes have the potential to contribute to maximising environmental and climate benefits.

"If member states are serious about using the CAP to respond to the pressing environmental and climate challenges facing the agriculture sector, they could logically use the eco-scheme to transform the majority of their direct payments into genuine payments for eco-system services," the report states.

But this freedom entails a risk that less ambitious member states will set the budget for eco-schemes close to zero, since there is no minimum spending set on this intervention. The IEEP identifies the "lack of ring-fencing of CAP funding for the eco-scheme" as the "single greatest weakness of the proposal". And they call for EU lawmakers and member states to maintain the 30 per cent minimum level of spending on environmental and climate issues set out in the 2014–2020 CAP budget.

Kajsa Pira

ECA, Opinion No 7/2018: concerning Commission proposals for regulations relating to the Common Agricultural Policy for the post-2020 period: *https://www.eca.europa.eu/en/Pages/DocItem.aspx?did=47751*

IEEP, CAP 2021-27: Using the eco-scheme to maximise environmental and climate benefits: *https://ieep.eu/publications/cap-2021-27-using-the-eco-scheme-to-maximise-environmental-and-climate-benefits*

Satellite observations reveal ammonia hotspots

Researchers have used daily satellite observations to identify point sources of ammonia emissions over the globe. They found 248 hotspots (defined by the authors as areas with diameters of less than 50 kilometres) and a further 178 regional sources (which have no clearly defined hotspot). By using visible imagery, public inventories and online sources they were able to categorise most of the emitters. Of these hotspots, 83 sites were associated with intensive animal farming, either in open feedlots or within enclosed housing. Another 130 sites were identified as plants producing ammonia fertilisers. Other sources identified were nickel-cobalt mines, soda-ash plants and a complex of geothermal power plants. Only one of the hotspots detected was assumed to have a natural origin. They were also able to calculate nine-year averaged emission fluxes for both regions and hotspots.

Pig farms , Milford USA.

The researchers then compared their findings with the EDGAR register, which is built on bottom-up reporting. One agricultural site and 69 industrial sites were completely missing from the EDGAR inventory. Emissions from almost all the hotspots were also underestimated in EDGAR, no matter their origin. One explanation for the latter could be the use of standard emission factors instead of estimating emissions from local data. This shows that satellite technology has the potential as an auditing tool for the national reporting of ammonia emissions.

Source:

Industrial and agricultural ammonia point sources exposed, Martin Van Damme, Lieven Clarisse, Simon Whitburn, Juliette Hadji-Lazaro, Daniel Hurtmans, Cathy Clerbaux & Pierre-François Coheur, Nature volume 564, pages 99–103 (2018)

Link to EDGAR register: *http://edgar.jrc.ec.europa.eu/*

Pastures thrive under solar panels

Solar panels in pastures increased grass feed for sheep and cows by 90 per cent, according to a study done by researchers at Oregon State University. Measurements at a test site on the campus were done over two years. Significant differences in mean air temperature, relative humidity, wind speed, wind direction, and soil moisture were observed. Areas under PV solar panels maintained higher soil moisture throughout the period of observation. Besides a significant increase in late season biomass under the PV panels, the shaded areas were also more than three times as water efficient.

"Semi-arid pastures with wet winters may be ideal candidates for agrivoltaic systems as supported by the dramatic gains in productivity," the researchers conclude and continue, "the agricultural benefits of energy and pasture co-location could reduce land competition and conflict between renewable energy and agricultural production".

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0203256

Vision of a Common Food Policy for the EU

The International Panel of Experts on Sustainable Food Systems (IPES-Food), propose in a report a new policy architecture for a sustainable food system.

"A Common Food Policy can spark a wholesale transition to sustainable food systems in a way that the CAP, as a Common Agricultural Policy, cannot," said Olivier De Schutter, IPES-Food co-chair and former UN Special Rapporteur on the right for food.

The proposal includes concrete steps forward such as: phasing out routine use of chemical inputs, introducing livestock density limits and introducing an EU-wide "agroecology premium" as a new rationale for CAP.

Besides the panel's own expertise, more than 400 farmers, food entrepreneurs, civil society activists, scientists and policymakers were consulted during the three-year process of research and reflection.

Towards a common food policy for the European Union *http://www.ipes-food.org/reports/*


Time to sprout a new food policy.

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UK Clean Air Strategy targets domestic heating and agriculture

On 14 January the UK government published its much-delayed Clean Air Strategy, which includes commitments to cut emissions from wood stoves and the farming sector. However, other than reaffirming their pledge to ban the sale of new petrol and diesel cars from 2040, the 109-page document includes little in the way of detail regarding transport, as they say the UK is already going further than "almost every other" European nation in tackling emissions from cars.

The government hopes that the number of people living in areas with levels of $PM_{2.5}$ above the WHO guideline level of 10 µg/m^3 will be halved by 2025 due to the measures outlined in the strategy as well as saving the National Health Service £1.7bn a year by 2020, rising to £5.3bn a year from 2030.

Source: Air Quality News, 14 January 2019

Link to the Clean Air Strategy: *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf*

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Uncertain sources claim that the number of squirrels exposed to $PM_{2.5}$ levels above WHO guidelines will be halved due to the new strategy.

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What are the health costs of pollution?

The European Commission has published a Future Brief that explores how to assign an economic value to the health impacts of three types of pollution: air pollution, noise pollution and exposure to toxic chemicals. The report outlines some of the methodologies that have been used to account for health costs, both in Europe and other parts of the world.

Link to the report "What are the health costs of environmental pollution?": *http://ec.europa.eu/environment/integration/research/newsalert/pdf/health_costs_environmental_pollution_FB21_en.pdf*

7 EU countries to close all coal plants by 2025

Seven EU countries have already announced the closure of all coal power plants before or during 2025. They are Austria, Belgium, France, Ireland, Italy, Sweden and the UK. Many other countries have also started to close coal power stations. In Germany the spectacular demolition of the hard-coal Knepper plant could be watched in February 2019.

https://www.youtube.com/watch?v=gu24jgBjNjg.

A welcome sight for anti-coal activits.

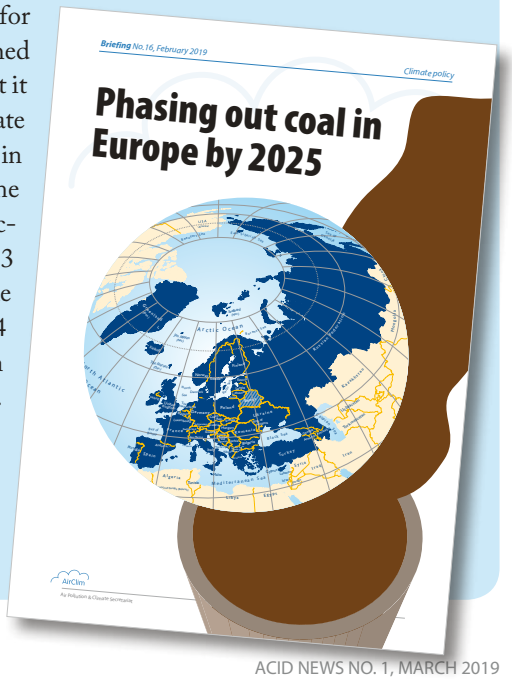
Updated plan for phasing out coal in Europe by 2025

AirClim has published an updated list of coal power stations throughout Europe and a report that proposes phasing out coal by 2025.

Russia and Ukraine are now included in the updated coal phase-out plan for the Council of Europe area published by AirClim. The report explains that it is not easy to find detailed and accurate information about coal power plants in Russia and Ukraine, but "to get some idea of the scale of the problem, according to BP, Russia produced 153 TWh coal power in 2017 and Ukraine 51 TWh, in comparison with 694 TWh in the EU-28, of which 242 in Germany and 134 TWh in Poland. Russia got 14 per cent of its electricity from coal, Ukraine 32 per cent".

AirClim is campaigning for coal to be phased out throughout Europe by 2025 as a key strategy to keep the global temperature increase below 1.5°C.

AirClim Briefing No.16, February 2019



Potential to cut non-CO_2 emissions from farming

Setting a high carbon price for emissions from agriculture combined with changes in dietary preferences could cut methane and nitrous oxide emissions from farming by two-thirds.

Using four different dynamic economic models, researchers at IIASA have estimated the mitigation potential of non-CO_2 greenhouse gases from agriculture. They found that when the carbon price was set at the highest level, US$ 2500 per ton CO_2 eq, emissions could be reduced by 3.9 Gt CO_2 eq by 2050. This represents almost a 68 per cent reduction in these emissions compared to 2015 and an 8 per cent reduction in all current greenhouse gas emissions.

Even at the lowest carbon price tested in the model, US$ 20, there was a significant reduction of 0.8–1.4 Gt CO_2 eq. If this was combined with changes in dietary preferences towards more plant-based diets, emission reductions would increase to 1.7–1.8 Gt CO_2 eq.

The model included three groups of mitigation mechanisms:

- technical, including technologies such as animal feed supplements, nitrification inhibitors or anaerobic digesters;
- structural, such as shifts in management systems, crops and livestock breeds, and international trade;
- production effects, which are changes in overall production levels in regions.

In the low carbon price scenarios, technical interventions, followed by structural changes, represented the greatest share of the mitigation potential. But when the carbon price is increased, production plays a greater part, since technical and structural options become exhausted.

The sectors that are most affected are ruminant production followed by cereal production. Land areas for livestock production will decrease. This could give an extra mitigation potential not accounted for in the models, since this surplus land could be used for afforestation.

The researchers also investigated how changes in dietary preferences towards a more plant-based diet would influence the different carbon price scenarios. In the low carbon price scenario changes in dietary preferences have a greater effect on the mitigation potential, almost doubling it. In the high carbon price scenarios, production of animal products is already reduced and changes in preferences only contribute an extra five percent of mitigation potential.

"The models agree that diet change can contribute only part of the efforts needed to achieve the 1.5°C climate stabilisation target and policymakers should not forget about the production side measures, which in this study provide the large majority of the mitigation potential," says one of the authors, Petr Havlík.

Although the researchers show that when carbon price alone is the driver behind reduced consumption of animal foods this might amplify the differences in animal consumption that already exist. This could mean that more affluent people would continue to eat as before, while reductions would mainly occur among poorer people who already eat less meat. If instead the driver is changes in preferences it is likely to have a more equalising effect on animal consumption, which would be preferable from a health perspective.

Kajsa Pira

Source: Frank S, Havlík P, Stehfest E, van Meijl H, Witzke P, Pérez-Domínguez I, van Dijk M, Doelmann JC et al. (2018) Agricultural non-CO2 emission reduction potential in the context of the 1.5°C target. Nature Climate Change DOI: 10.1038/s41558-018-0358-8

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Första Långgatan 18
413 28 Göteborg
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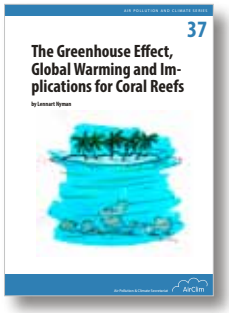
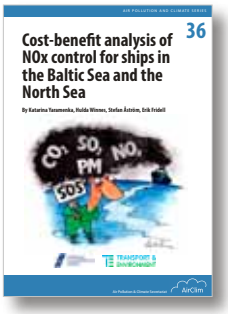


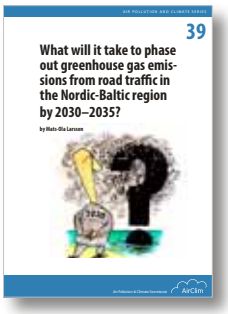
The Greenhouse Effect, Global warming and Implications for Coral Rees (March 2018). By Lennart Nyman. Tropical coral reefs harbour some 25 per cent of all marine species.



Cost-benefit analysis of NOx control for ships in the Baltic Sea and the North Sea (April 2017). By Katarina Yaramenka, Hulda Winnes, Stefan Åström, Erik Fridell.

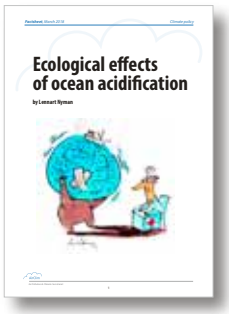
A vision for zero emissions in the Nordic-Baltic region by about 2030 (March 2018). By Fredrik Lundberg. A scenario for the electricity, heat and industrial sectors.

Paths to a sustainable agricultural system (Dec 2017). By Johan Karlsson et al. Exploring ways for sustainably feeding the Nordic countries.



What will it take to phase out greenhouse gas emissions from road traffic in the Nordic-Baltic region by 2030-2035? (March 2018). By Mats-Ola Larsson. A conceivable scenario.

Clearing the air (Feb 2017).A critical guide to the new National Emissions Ceilings directive.



Ecological effects of ocean acidification (March 2018). By Lennart Nyman. By absorbing CO_2 the ocean is becoming more acidic, and this happens at a rate faster than any period in the past 300 million years.

Effects of climate change on some anadromous salmonids in the northern hemisphere (March 2018). By Lennart Nyman. Some direct impacts on salmon can be predicted.

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Coming events

EU Environment Council. Brussels, Belgium, 5 March 2019. Information: *www.consilium.europa.eu/en/press/calendar/*

Reducing air pollution from ships in the Mediterranean Sea. Madrid, Spain, 18 March 2019. Information: *https://contaminacio5.wixsite.com/medeca/events/reducir-la-contaminacion-del-aire-en-el-mar-mediterraneo-reducing-air-pollution-in-mediterranean-sea*

SOFAIR - European Air Quality Conference. Sofia, Bulgaria, 12 April 2019. Information: *https://www.sofiair.info*

IMO Intersessional Working Group on reduction of GHG emissions from ships. London, UK, 6 - 10 May 2019. Information: *www.imo.org*

IMO MEPC 74 (Marine Environment Protection Committee). London, UK, 13 - 17 May 2019 Information: *www.imo.org*

7th International symposium on ultrafine particles. Brussels, Belgium, 15 - 16 May 2019. Information: *http://www.ufp.efca.net*

EU Green Week high-level summit. Brussels, Belgium, 15 - 17 May 2019. Information: *https://ec.europa.eu/info/events/eu-green-week-2019_en*

23rd International Transport and Air Pollution (TAP) Conference. Thessaloniki, Greece, 15 - 17 May 2019. Information: *www.tapconference.org*

EU Informal Environment Council. Bucharest, Romania, 20 - 21 May 2019. Information: *www.consilium.europa.eu/en/press/calendar/*

CLRTAP Working Group on Strategies and Review. Geneva, Switzerland, 21 - 24 May 2019. Information: *www.unece.org/env/lrtap/welcome.html*

UNFCCC SB50. Bonn, Germany, 17 - 27 June 2019. Information: *http://unfccc.int/*

EU Environment Council. Luxembourg, 26 June 2019. Information: *www.consilium.europa.eu/en/press/calendar/*

Air Pollution 2019: 27th International conference on modelling, monitoring and management of air pollution. Aveiro, Portugal, 26 - 28 June 2019. Information: *https://www.wessex.ac.uk/conferences/2019/air-pollution-2019*

CLRTAP EMEP Steering Body and the Working Group on Effects. Geneva, Switzerland, 9 - 13 September 2019. Information: *www.unece.org/env/lrtap/welcome.html*

18th IUAPPA World Clean Air Congress. Istanbul, Turkey, 23 - 27 September 2019. Information: *www.wcac2019.org*

UNFCCC COP25. Chile. 11 - 22 November 2019. Information: *http://unfccc.int/*