

ENERGY FOR
HUMANITY_

European Climate Leadership Report 2017

Measuring the Metrics that Matter

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Links and references

Please check PDF File online for all links and references.
www.energyforhumanity.org/climateleadership2017

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Preface

Dear Reader,

The urgency of climate mitigation is getting worse by the day. With the CO₂ concentrations in the atmosphere rising at record speeds, we need to take a critical and intellectually honest look at why and how we have largely failed in our attempts so far to decarbonize our economies.

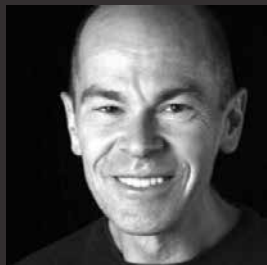
This report assembles data that clearly show that nations with high levels of hydro-electric power and strong nuclear energy programmes are cutting emissions much faster than those advancing 100 % renewable policies.

Today, strong promises must be backed up by equally strong and effective policies, leading to decisive action on climate change. A focus in the climate and energy policy world on increasing percentages of new renewable electricity generation has proven to be an insufficient path to limit the climate threat. We think it is high time that we concentrate on what really matters: Reducing absolute CO₂ emissions to best meet the goals of a 2 degree limit as soon as possible.

This Climate Leadership Report takes a close look at the actual carbon emission reduction efforts of different countries in recent years and aims to spark a debate on how to track success in a straightforward way.

Energy for Humanity





ROBERT STONE

FILMMAKER, CO-FOUNDER

With his documentary “Pandora’s Promise”, Robert Stone has built a bridge from nuclear energy to climate change and environmental protection. He travelled with former anti-nuclear activists to Chernobyl and Fukushima. The documentary gives a vision on what nuclear energy would be capable in doing to protect the environment, especially when future reactor concepts will be used that can also recycle nuclear fuel. Robert Stone lives in the metropolitan area of New York and is currently working on a new film project.



KIRSTY GOGAN

ENVIRONMENTAL ACTIVIST, CO-FOUNDER

Kirsty Gogan works from London on the global activities of the Energy for Humanity. These include the building of the organization, the participation in conferences and cooperation with similar minded people. Kirsty has participated in Paris at the climate summit COP21 and was invited to the White House and was featured as a speaker at a variety of conferences. Thanks to her commitment, Energy for Humanity was shortlisted for the award “Green NGO of the Year” in 2016.



DANIEL S. AEGERTER

ENTREPRENEUR, CO-FOUNDER

The Swiss entrepreneur Daniel Aegerter co-founded Energy for Humanity to further his philanthropic agenda with regards to future energy supply. As one of the most successful Swiss tech-entrepreneurs, Daniel Aegerter is convinced that clean electricity is the form of energy with the highest quality and that its share needs to be dramatically increased at the expense of fossil fuels.



Energy for Humanity

Energy for Humanity (EFH) was founded in 2014 by documentary filmmaker Robert Stone, Swiss entrepreneur Daniel Aegerter and environmental activist Kirsty Gogan. EFH is a non-profit funded by philanthropists and foundations, focused on two of the great environmental and humanitarian challenges we face in this century: how to dramatically reduce carbon emissions to avoid catastrophic climate change within mid-century timescales, and how to enable billions of people to gain increased access electricity in order to achieve modern standards of living.

Both of these challenges are connected by the means through which we generate the energy used to power our world.

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Measuring the metrics that matter on climate

When we set out to write this report on climate leadership, the main question we were asking ourselves is: “What really matters?” Is it the Paris Accord and its commitment to limiting the increase of the temperature of the atmosphere to 2 degC? Is it installed capacity of renewable energy? Is it the development and implementation of the national or supranational energy transition plans? No. When it comes to reducing our chances of runaway climate change, the first thing that really matters is how many tons of CO₂ and other climate gases are present in the atmosphere. Secondly, to address that, what matters is how fast we limit the amount we emit in the atmosphere (=CO₂eq).

This report has led us to the following main conclusions:

- Carbon intensity of electricity (net CO₂/kWh) is a far more important indicator than installed capacity of renewables.
- The real climate leaders are those with

the lowest average carbon intensity of electricity supply, especially those that combine this with high GDP.

- Countries with an energy mix that combines renewables with nuclear power and hydro are clearly Europe’s climate leaders.
- Countries with strong reliance on coal are at the bottom of the range. Germany, the COP23 host, emits the most carbon in absolute terms (18.3% of the EU plus EFTA & Turkey) and appears to have locked itself into a fossil dependent future as a result of its energy policy.
- We need to urgently increase the volume of low-carbon electricity generation in order to lower both the average carbon intensity of electricity production and the absolute volumes of carbon emitted.

Here are different ways of evaluating the success of climate policies of European countries in recent years. Using official

Eurostat data [1], we considered three metrics to capture most of the important aspects of climate progress:

Metric 1: Total GHG emissions per GDP 2010 baseline

Metric 2: Absolute reduction in GHG from 2010–2015

Metric 3: Average yearly decarbonization rate from 2010–2015

Metric 1 measures where a country is in terms of CO₂-emissions related to GDP. This depends on the primary energy use, the topography, the existence of natural resources like coal and the historical decisions made, for example with regards to fossil fuels or nuclear power. The year 2010 is taken as the baseline reference year to include all progress made until then.

Metric 2 measures the absolute reduction of CO₂eq emissions into the atmosphere in millions of tons (Mt) comparing the year 2015 to the year 2010.

Metric 3 looks at the average decarbonization rate of the economy per year over the course of the 5 years from 2010 to 2015.

All of these metrics deliver different results but show important aspects of the decarbonization progress. We believe these metrics need to be used when assessing climate leadership, and overall progress towards the goals of the Paris Accord.

Furthermore, in this 2017 edition of our Climate Leadership Report we are focusing on carbon intensity of electricity generation in Europe. Electricity-related emissions are only a part of the total emissions arising from our energy consumption. However, transitioning our electricity generation system away from fossil fuels can then enable the decarbonisation of the heat and transport sector. Electricity generation is an important step because a reliable, secure and affordable low-carbon electricity system is able to deliver sufficient low carbon energy that can assist the decarbonisation of heating and many aspects of transportation. All three of these major sources of carbon pollution must be addressed in order to deliver meaningful net carbon reduction.

The data used for our analysis of the electricity generation and consumption comes

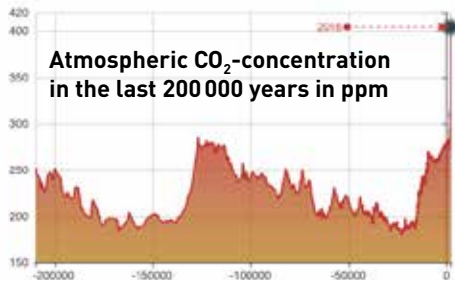
from Electricitymap [2]. In contrast to other analyses that calculate carbon emissions based on electricity produced nationally, this approach also accounts for the flow of electricity across national borders. Looking only at the national level fails to account for carbon emissions imported and exported. We urge policymakers to better take this into account. National policies can have effects beyond borders, where an apparent national carbon reduction may merely out-source emissions to another country.

If low-carbon nuclear electricity production is shut down and not replaced, the overall result will be increased imports from neighbouring countries that may have dirtier electricity. A seemingly well intentioned national policy can therefore increase burning of fossil fuels in other countries. Strengthening the Emissions Trading System (ETS) may solve both the need for national energy-related emissions policies and potentially counterproductive results climate mitigation may have on a European level.

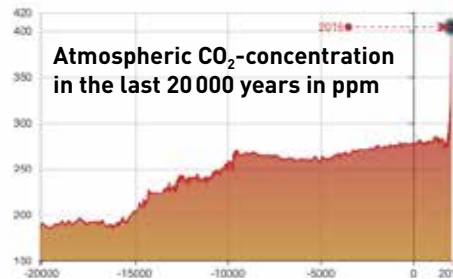


CO₂ in the atmosphere

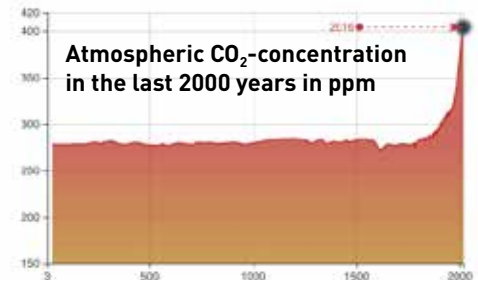
Human activities cause CO₂ emissions. Since the industrial revolution, our standard of living has gone up dramatically largely thanks to the growing use of coal, oil and natural gas. Burning fossil fuels releases CO₂, which is a greenhouse gas and remains in the atmosphere for centuries. When looking at a chart over the last 200 000 years, we can see that the levels used to stay within a band of 170 and 300 ppm but have recently increased to over 400 ppm. It can also be seen that there has been seemingly “sharp” increases of CO₂ concentration before.



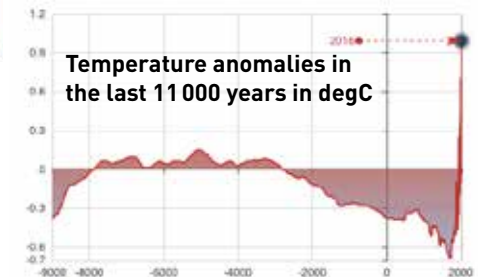
However, when “zooming in” (try for yourself on the website <https://www.tmrw.com/climatechange.html> [3]), we see that other “sharp” increases were actually much slower than we are seeing over the last decades. In the past it took 5000 years for the concentration to increase from 200 ppm to 250 ppm.



And over the last 100 years, the CO₂ concentration went from 300 ppm to 400 ppm. 100 ppm increase over 100 years compared to 50 ppm increase in 5000 years is one hundred times faster.



The CO₂ in the atmosphere leads to higher temperatures. While the measurements don't date back as far, we can still see the similar phenomenon that while there have been temperature increases, the speed of the temperature rise is unprecedented.



The Kaya Identity: linking GDP and CO₂

CO₂: CO₂ emissions resulting from human activities

E: Primary energy consumption

G: GDP

P: Population

Kaya Identity: Formula that represents the relationship between human activities and CO₂ emissions

$$CO_2 = \frac{CO_2}{E} \times \frac{E}{G} \times \frac{G}{P} \times P$$

CO₂ emissions per unit
energy consumption

Energy efficiency of
economic activities

Economic level
per capita

An equation developed by Professor Yoiichi Kaya from University of Tokyo, the so-called “Kaya Identity”, shows factors that influence national CO₂ emissions.

The CO₂ emissions per GDP (CO₂/E x E/G = CO₂/G), the GDP per capita and the absolute population. The lower each of the fac-

tors is, the lower our CO₂ emissions. Since the publication of the Club of Rome Limits to Growth report in the 1970s, and more recently with initiatives such as “one earth footprint” or 2000 Watt society, a common opinion of the green movement has been that GDP per capita should be low rather than high, and economic growth is a bad

thing. Some even propose we need to stifle population growth for environmental reasons. These are hotly debated issues but do not inform the analysis in this report, which is concerned with the national CO₂ emissions resulting from current levels of population.

Ending the Age of Combustion

Today, humans live safer, more comfortable, longer, healthier lives than ever before. Between 1990 and today, the number of people living in poverty, worldwide, has been cut in half. Six million fewer children die every year. Literacy rates have risen, and the global well-being of women and children continues to rise. With the fall in poverty, average family sizes are also falling; although by 2050, the global population could grow from 7 billion today to 10 billion, and the global economy could triple in size. This population will inevitably seek to consume energy, and companies and governments will inevitably seek to provide it.

Social progress therefore comes at an environmental price. Already, average global temperatures have risen by 1 degree since the industrial revolution. The speed

and scale of change in the climate system is unprecedented in Earth's history.

The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment report [\[4\]](#) concluded that it is extremely likely that human influence has been the dominant cause of global warming, particularly emissions of greenhouse gases such as carbon dioxide, methane and nitrous oxide.

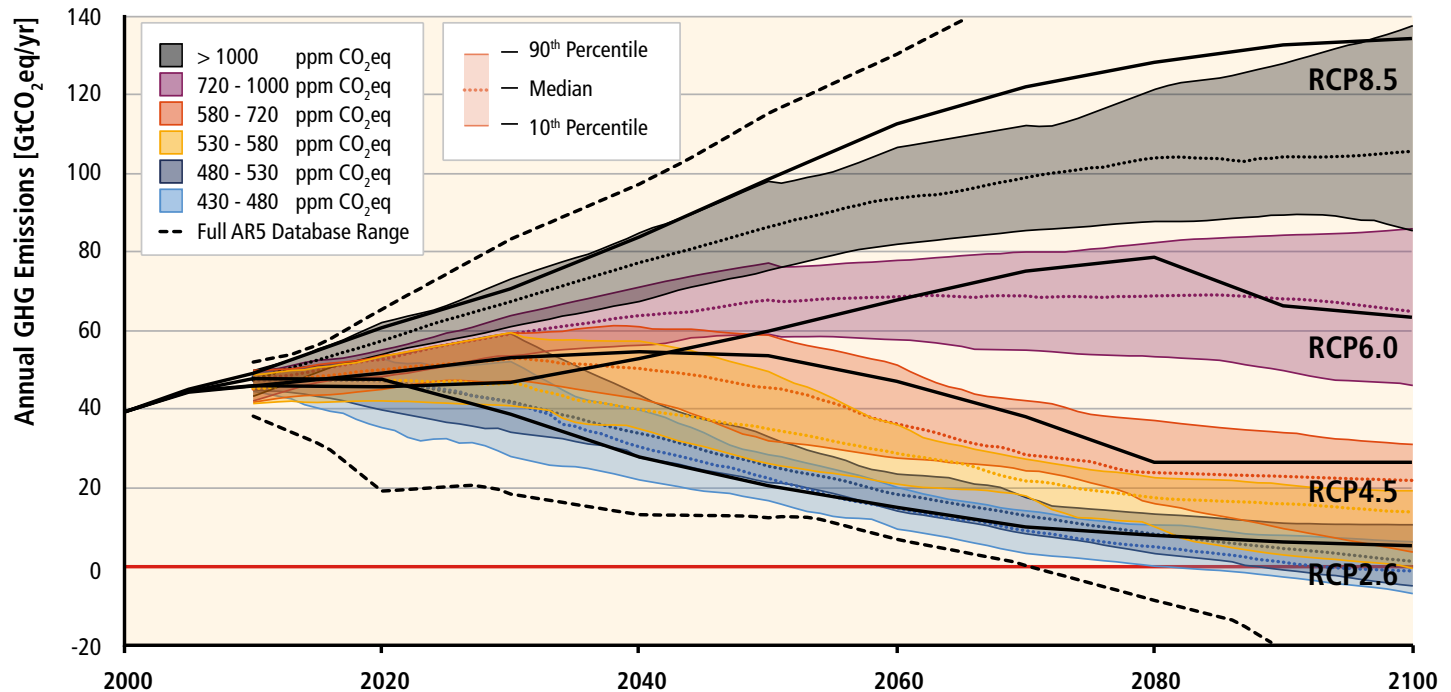
Climate model projections by the IPCC indicate that during the 21st century, global surface temperature is likely to rise a further 0.3–1.7 degrees C in the lowest emission scenario, and 2.6 to 4.8 degree C in the highest emission scenario. These findings are not disputed by any scientific body of national or international standing. This means that by 2050, the world needs

to cut annual emissions to around half of today's levels to have a chance of keeping global mean temperature increase to 2°C. Beyond that threshold, scientists say severe and irreversible changes are likely. Stabilizing CO₂ concentrations in the atmosphere requires reducing emissions to near-zero after mid-century.

If every country met the pledges it has made to date through the Paris Accord, we would still be looking at a rise in greenhouse gas emissions. Average global temperatures would likely rise by between 3°C to 4°C by 2100 (depending on your level of optimism or pessimism) compared to 6°C increase with no action.

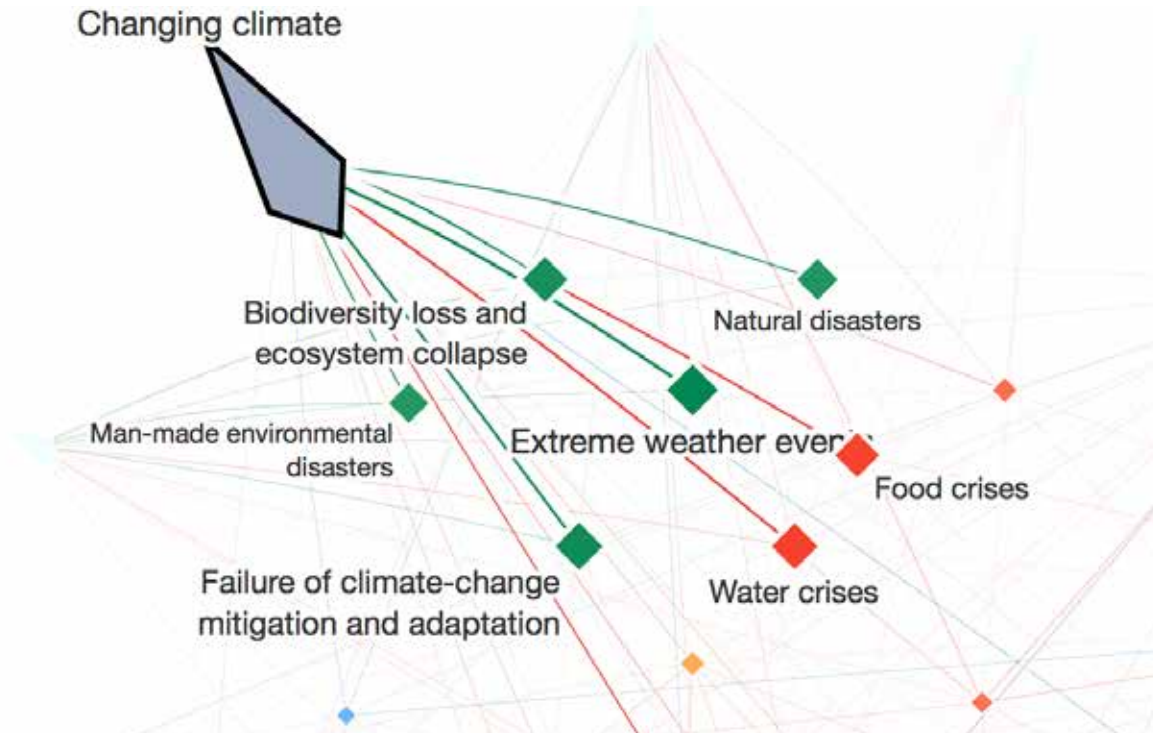
Such rapid destabilising of our climate system will cause enormous disruption

IPCC GHG Emission Pathways 2000 – 2100



IPCC, 2014: Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. [4]

Global risks most connected to Climate Change



Excerpt of: The Risks-Trends Interconnections Map 2017, World Economic Forum [\[5\]](#)

for humans and nature. Anticipated effects include: Increasing global temperatures; rising sea levels, changing precipitation, expansion of deserts, and major changes to wildlife. Many signs of this change are already evident.

Warming will be greater on land than over the sea, and greatest of all in the Arctic, causing of glaciers, melting of permafrost and sea ice, adding to sea level rise already increased by thermal expansion from rising water temperatures. Melting permafrost will also lead to the release of large quantities of methane into the atmosphere, multiplying the greenhouse effect.

Other likely changes include greater frequency and severity of extreme weather events such as heat waves, droughts, heavy rainfall with floods, ocean acidification and mass species extinction, by the end of the century.

Effects on people include the threat to food security from decreasing crop yields, forced migration and the abandonment of populated areas due to rising sea levels, droughts or other extreme weather events. The World Economic Forum annual global risk register lists climate change as a growing problem because of the ways that altering the climate is “strongly interconnected with many other risks, such as conflict and migration” (see page 12).

The poorest have been the first to suffer; droughts and food shortages are already imperilling the lives of countless millions [6], with conflict ever more likely as a result, threatening even more. Already, some areas have been rendered uninhabitable, and numbers of de facto climate refugees will only increase. Everywhere, the dangers are steadily encroaching and eroding the potential to create a world where a minimum level of prosperity is available to all [7].

The scale and complexity of global warming, and its causes and impacts are so large, that it is not a threat we are naturally attuned to respond to, like a tiger coming to our village, or even like other environmental problems we’ve encountered and solved, like, say, acid rain. Climate is a cumulative problem. People think they can wait until it’s got bad, look out the window and say ok it’s bad now let’s solve it. But it doesn’t work that way. Then it will be too late. Because the climate system has a large inertia and greenhouse gases will remain in the atmosphere for a long time, many of these effects will persist for not only decades or centuries, but for tens of thousands of years to come. Changes to the Earth’s environment may be one-way, and unrecoverable. If a tipping point is passed and the climate shifts to a new stable state, far from the norm we have long been used to, there is no known technological solution that can bring it back.

By 2017, remaining on the right side of the current estimates for a safe level means all of our budgeted future emissions are "locked in"

- Factories and industry
- Power stations
- Buildings
- Vehicles
- Other infrastructure

So, from now on, we should only build infrastructure that is fundamentally free of greenhouse gas emissions. Such zero-emissions infrastructure may seem hard to imagine, but, as the late, Cambridge University Professor, Sir David MacKay said: the climate problem is mostly an energy problem.

Possible societal responses to global warming include mitigation by emissions reduction; adaptation, by building systems resilient to climate impacts; and possible future climate engineering to bring down

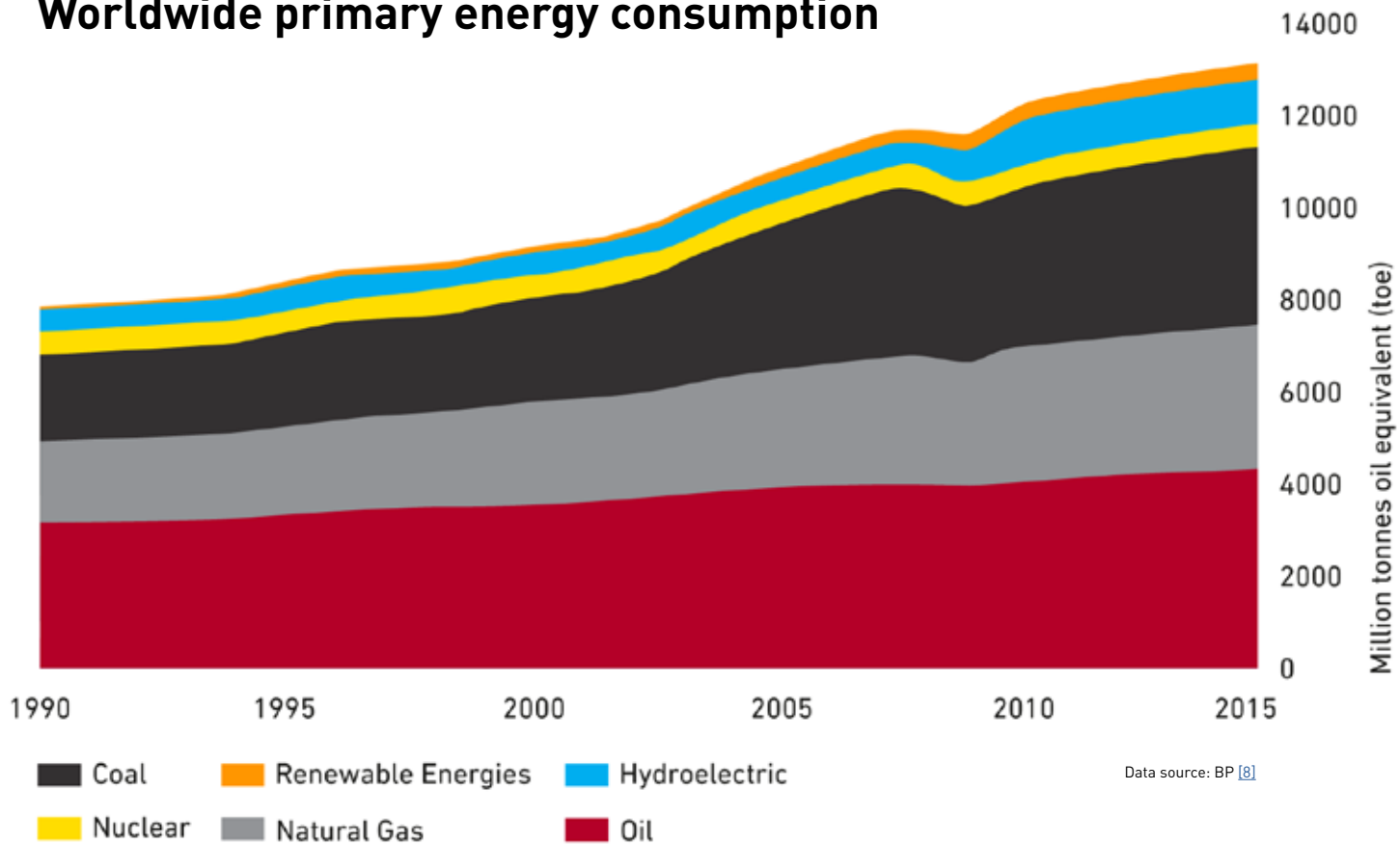
the level of greenhouse gases already in the atmosphere.

Broadly speaking, solving climate can be boiled down to a simple two stage strategy: clean up electricity generation and then use electricity to decarbonise everything else (heat and transport). There is a third, supplementary step, which is to make everything as efficient as possible, reducing current levels of wastefulness in energy consumption.

But we have a long way to go. Fossil fuels continue to dominate the energy mix. When looking at the worldwide trend of primary energy use, it is absurd to propose we could get anywhere close to replacing coal, natural gas and oil with wind and solar PV alone. Putting such ideas in the heads of the people, as prominent actors like Leonardo di Caprio or Mark Ruffalo do, is dangerous and counterproductive. All technological efforts must be

made, carbon capture must be developed at maximum speed, nuclear energy used to the maximum, and of course new renewable energies expanded. All solutions must contribute, otherwise we have no chance. Understanding the scale of the required solution demands a clear headed look at the numbers. The next section of this report turns to the metrics of establishing which countries have run energy systems that are exemplary in their efforts to cut carbon while maintaining prosperity, and which have so far proved failures.

Worldwide primary energy consumption



New climate metrics

The EU-28, plus Iceland, Liechtenstein, Switzerland, Norway and Turkey combined, emitted 5052 million tonnes of CO₂ eq in the year 2015 (Table A, Eurostat). Compared to the total of 5443 Million tonnes in 2010, this is a reduction of 391 Million tonnes. By far the largest share of emissions in 2015 still came from Germany, which emitted 20.8% of the EU-28 countries and 18.3% of all European countries including EFTA, plus Croatia and Turkey. The absolute emissions from this table shall form the basis for our analysis.

Official emissions reduction targets are often compared to a reference year of 1990 – the date of the first UN climate summit. This is problematic in two ways. First, it ignores what has so far been the fastest per capita national emissions cuts in modern history, namely the policies that enabled nuclear build-out in coun-

tries such as France, Sweden, Belgium, Switzerland and some others in the decades of 1970s to 1990s. The choice of 1990 as the base year also obfuscates important recent policies. In the 1990s, a lot of inefficient power plants and industries of the former East Germany were shut down. These shutdowns, done mostly for non-climate related reasons, cannot be repeated and therefore have very little to do with current and future climate policies.

When evaluating climate leadership today, it is important to look at the success of recent policies and that we learn from what really worked. We have analysed the emissions reductions from 2005 to 2010 as well as from 2010 to 2015. We think it is important to evaluate recent performance by comparing carbon emissions from 2010 to 2015.

For the sake of simplification and better overview, countries with small absolute emissions have been grouped to “Others” in the overall Table A and excluded in the further analysis. The countries were Croatia, Cyprus, Estonia, Iceland, Malta, Latvia, Liechtenstein, Lithuania, Luxembourg, Slovenia. Combined, those countries had an absolute emission of 120 Million tons of CO₂eq in 2015, which corresponds to 2.4% of the total emissions as per Table A. Those countries managed to reduce their emissions by almost 15 million tons compared to 2010, which is an important effort for the total emissions reductions.

Total GHG emissions by country in mio t of CO₂ equivalents (Table A)

Country	2000	2005	2010	2015	% of total emissions 2015		% reduction 2000 - 2005	% reduction 2005 - 2010	% reduction 2010 - 2015
Germany	1062.2	1014.9	966.0	926.5	18.3 %	80 %	-4.46 %	-4.82 %	-4.09 %
United Kingdom	739.8	724.5	643.9	536.9	10.6 %		-2.06 %	-11.12 %	-16.62 %
Turkey	298.1	340.5	412.7	486.2	9.6 %		14.23 %	21.20 %	17.81 %
France	566.4	569.1	527.7	474.6	9.4 %		0.49 %	-7.28 %	-10.06 %
Italy	560.9	588.3	514.1	442.8	8.8 %		4.89 %	-12.61 %	-13.88 %
Poland	391.4	399.8	408.4	387.7	7.7 %		2.16 %	2.15 %	-5.06 %
Spain	395.8	451.6	369.6	350.4	6.9 %		14.10 %	-18.16 %	-5.18 %
Netherlands	229.7	225.4	224.5	206.7	4.1 %		-1.88 %	-0.40 %	-7.90 %
Czech Republic	150.0	148.6	140.6	128.8	2.5 %		-0.92 %	-5.41 %	-8.35 %
Belgium	154.2	148.7	136.6	121.6	2.4 %		-3.57 %	-8.10 %	-10.98 %
Others (EU & EFTA)	119.4	136.4	134.5	119.7	2.4 %	20 %	14.20 %	-1.36 %	-11.01 %
Romania	140.6	146.8	121.4	117.8	2.3 %		4.44 %	-17.32 %	-2.96 %
Greece	128.9	138.9	120.9	98.6	2.0 %		7.77 %	-12.94 %	-18.45 %
Austria	82.2	94.6	87.1	81.0	1.6 %		15.05 %	-7.92 %	-7.03 %
Portugal	84.5	88.6	72.1	72.1	1.4 %		4.83 %	-18.61 %	-0.05 %
Ireland	70.9	72.5	64.0	62.4	1.2 %		2.26 %	-11.69 %	-2.51 %
Bulgaria	59.6	64.3	60.8	62.0	1.2 %		7.80 %	-5.37 %	1.99 %
Hungary	74.2	76.6	66.1	61.6	1.2 %		3.26 %	-13.67 %	-6.78 %
Finland	71.1	70.9	77.3	57.5	1.1 %		-0.28 %	9.09 %	-25.58 %
Sweden	70.7	68.8	66.7	55.9	1.1 %		-2.61 %	-3.08 %	-16.20 %
Norway	55.6	56.1	56.5	55.4	1.1 %		0.89 %	0.80 %	-1.87 %
Switzerland	57.3	58.5	58.8	53.1	1.1 %		2.18 %	0.46 %	-9.65 %
Denmark	73.1	68.9	65.6	51.0	1.0 %		-5.73 %	-4.77 %	-22.33 %
Slovakia	49.9	51.5	46.7	41.4	0.8 %		3.26 %	-9.40 %	-11.30 %
Sum/Average	5686.3	5804.8	5442.8	5052.0	100.0 %		3.35 %	-5.85 %	-8.25 %

Metric 1 – Total GHG emissions per GDP 2010 baseline

Metric 1 is calculated by dividing absolute carbon equivalent emissions by GDP for the year 2010, the starting point of the time period observed. The relative performance of countries within metric 1 is influenced by several factors such as the energy resources every country has and how they were used for domestic primary energy consumption. Countries with large domestic coal reserves use them to run their power plants. Furthermore, the topography helps countries such as

Norway, Switzerland or Austria significantly, as they have the possibility to cover a large portion of their electricity needs with hydropower; something that The Netherlands cannot do. Apart from that, GDP is strongly influenced by past policy decisions. Metric 1 is therefore a way to honour decisions of the past whereas it cannot be avoided that countries also are merited or penalized for something they did not influence themselves.

Total GHG emissions per GDP 2010 baseline (Table 1)

Country	GDP 2010 Million EUR 2010	GHG emissions 2010 Tonnes of CO ₂ eq	GHG emissions per GDP 2010 Tonnes of CO ₂ eq/Million EUR
Switzerland	441 086	58 764 280	133
Norway	324 043	56 501 690	174
Sweden	369 077	66 689 510	181
France	1 998 481	527 682 100	264
Denmark	243 165	65 642 610	270
Austria	295 897	87 130 050	294
Italy	1 604 515	514 136 770	320
Spain	1 080 935	369 564 740	342
United Kingdom	1 841 692	643 931 270	350
Netherlands	631 512	224 451 910	355
Belgium	365 101	136 642 480	374
Germany	2 580 060	965 969 780	374
Ireland	167 583	64 029 690	382
Portugal	179 930	72 120 450	401
Finland	187 100	77 321 490	413
Greece	226 031	120 915 100	535
Hungary	98 826	66 122 360	669
Slovakia	67 577	46 692 960	691
Turkey	581 024	412 713 630	710
Czech Republic	156 718	140 558 690	897
Romania	126 746	121 402 540	958
Poland	361 804	408 416 710	1 129
Bulgaria	38 231	60 811 330	1 591

In metric 1, countries who have chosen to massively expand low-carbon electricity and/or countries gifted with a favorable topography for hydropower are leading the way. It is interesting to see that Austria is doing much worse than Switzerland while having similar topography. The reason for this is that Austria decided to not use nuclear energy but instead fossil fuels in the seventies. By contrast, in Switzerland nuclear energy was promoted in the 1960s for environmental reasons to avoid the construction of fossil fuel fired power stations after the hydropower capacity had reached its limits.

Metric 2 – Absolute reduction in GHG from 2010 – 2015

What matters most to the environment is absolute reduction in carbon emissions. Countries with smaller economies may more easily achieve higher percentage reductions, but once the size of an economy in GDP is considered, actual (absolute) carbon emissions reductions in millions of tons, and how this was achieved, are all important. A larger country that expands renewables or otherwise reduces its CO₂ emissions per kWh in the electricity sector would release more CO₂ to the atmosphere in absolute terms than a smaller one with a higher carbon intensity but lower absolute emissions. By comparing the two metrics of absolute emissions, with the relative carbon intensity of an econ-

omy (Metric 1) we can get a more detailed picture of how well an economy is actually delivering on the goals of decarbonisation. Among the various countries of Europe, we can clearly see how different energy infrastructure policies have made a significant difference to their carbon performance, and the nature of their economy. Clearly, one of the best performing major economies is France, which has a GDP around 80% the size of Germany, but with a carbon footprint just around half the size of that of Germany. This is due to the large volume of zero-carbon energy provided by nuclear, which is sufficient to also electrify the French high speed rail network.

Absolute reduction in GHG from 2010 – 2015 (Table 2)

Country	GHG emissions 2010 Mio t of CO ₂ eq	GHG emissions 2015 Mio t of CO ₂ eq	Reduction 2010 – 2015 Mio t of CO ₂ eq
UK	643.9	536.9	-107
Italy	514.1	442.8	-71
France	527.7	474.6	-53
Germany	966	926.5	-40
Greece	120.9	98.6	-22
Poland	408.4	387.7	-21
Finland	77.3	57.5	-20
Spain	369.6	350.4	-19
Netherlands	224.5	206.7	-18
Belgium	136.6	121.6	-15
Denmark	65.6	51	-15
Czech Republic	140.6	128.8	-12
Sweden	66.7	55.9	-11
Austria	87.1	81	-6
Switzerland	58.8	53.1	-6
Slovakia	46.7	41.4	-5
Hungary	66.1	61.6	-4
Romania	121.4	117.8	-4
Ireland	64	62.4	-2
Norway	56.5	55.4	-1
Portugal	72.1	72.1	0
Bulgaria	60.8	62	1
Turkey	412.7	486.2	74

In metric 2, countries with high absolute GHG emissions are in front with absolute reductions. The most reductions were achieved by the UK followed by Italy, France and Germany.

While absolute reductions from Greece were mainly due to economic factors (see also metric 3), Finland, Denmark and Sweden stand out as countries with already very low levels of absolute emissions which were further reduced quite significantly.

The increase of GHG emissions in Turkey was massive and it shows how important a globally coordinated approach is. It doesn't help to overshoot reduction targets in one part of the world while other countries reverse all the efforts by emitting much more than before.

Metric 3 – Average yearly decarbonization rate from 2010 – 2015

The impact of the policy is measured with metric 3 as a function of the absolute CO₂-equivalent emissions in million tons divided by the GDP of the year 2015, minus the respective values for the year 2010. This is then divided by 5 years to end up with the decarbonization rate the country has achieved. Countries with high emissions per GDP (metric 1) are expected to

be able to achieve a better decarbonization rate in metric 3. Countries which reduce their emissions but at the same time the GDP shrinks by the same percentage amount, the decarbonization rate is zero (example: Greece). Emissions reductions “achieved” with economic and societal collapse is not a sustainable way to try and mitigate climate change.

Looking at a different set of metrics rather than comparing to the year of 1990 should help policy makers to better understand which energy and emissions policies work on country level and should give the possibility to learn from the best. We hope we are able help encourage the use of these metrics into the policy debate.

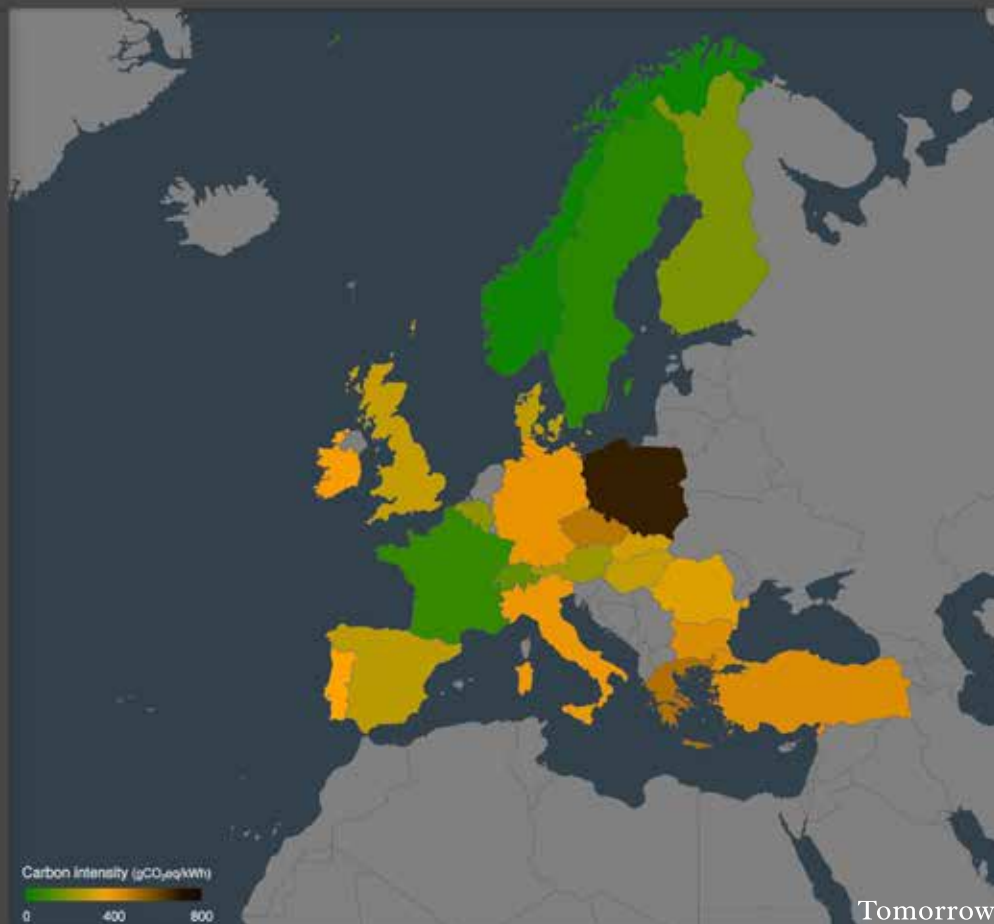
Average yearly decarbonization rate from 2010 – 2015 (Table 3)

Country	GDP 2010	GDP 2015	GHG emissions 2010	GHG emissions 2015	GHG emissions per GDP 2010	GHG emissions per GDP 2015	Av decarbonization rate of the economy per year 2010 – 2015
	Million EUR 2010 chain linked	Million EUR 2010 chain linked	Tonnes of CO ₂ eq	Tonnes of CO ₂ eq	Tonnes of CO ₂ eq/MEUR	Tonnes of CO ₂ eq/MEUR	Tonnes of CO ₂ eq/MEUR/year
Poland	361 804	419 819	408 416 710	387 732 850	1128.8	923.6	-41.1
Slovakia	67 577	76 494	46 692 960	41 415 090	691.0	541.4	-29.9
Czech Republic	156 718	170 326	140 558 690	128 820 670	896.9	756.3	-28.1
Romania	126 746	142 982	121 402 540	117 810 040	957.8	824.0	-26.8
Ireland	167 583	238 677	64 029 690	62 425 330	382.1	261.5	-24.1
Turkey	581 024	818 863	412 713 630	486 235 900	710.3	593.8	-23.3
Finland	187 100	186 537	77 321 490	57 538 900	413.3	308.5	-21.0
Hungary	98 826	108 694	66 122 360	61 639 540	669.1	567.1	-20.4
Bulgaria	38 231	41 274	60 811 330	62 021 120	1590.6	1502.7	-17.6
United Kingdom	1 841 692	2 040 921	643 931 270	536 901 780	349.6	263.1	-17.3
Belgium	365 101	410 247	136 642 480	121 641 890	374.3	296.5	-15.6
Denmark	243 165	257 528	65 642 610	50 983 620	270.0	198.0	-14.4
Sweden	369 077	410 225	66 689 510	55 885 800	180.7	136.2	-8.9
Germany	2 580 060	2 800 913	965 969 780	926 479 010	374.4	330.8	-8.7
Netherlands	631 512	657 561	224 451 910	206 712 600	355.4	314.4	-8.2
France	1 998 481	2 097 166	527 682 100	474 606 680	264.0	226.3	-7.5
Italy	1 604 515	1 558 317	514 136 770	442 777 620	320.4	284.1	-7.3
Austria	295 897	312 614	87 130 050	81 000 490	294.5	259.1	-7.1
Switzerland	441 086	478 556	58 764 280	53 093 870	133.2	110.9	-4.5
Norway	324 043	353 138	56 501 690	55 444 740	174.4	157.0	-3.5
Spain	1 080 935	1 070 710	369 564 740	350 403 200	341.9	327.3	-2.9
Greece	226 031	184 468	120 915 100	98 608 630	534.9	534.6	-0.1
Portugal	179 930	172 190	72 120 450	72 085 210	400.8	418.6	3.6

Countries that are successful in metric 3 have put in place the right policies to quickly reduce their carbon emissions. While mostly countries with high GHG emissions per GDP are in the upper end of the ranking, countries that stand out as positive examples are Ireland, Finland, UK, Belgium and Denmark with an already low ratio of GHG emissions per GDP but still a high average decarbonization rate.

Carbon intensity

Norway	🇳🇴	(18 gCO ₂ eq/kWh)
Sweden	🇸🇪	(50 gCO ₂ eq/kWh)
France	🇫🇷	(76 gCO ₂ eq/kWh)
Switzerland	🇨🇭	(146 gCO ₂ eq/kWh)
Finland	🇫🇮	(182 gCO ₂ eq/kWh)
Belgium	🇧🇪	(204 gCO ₂ eq/kWh)
Austria	🇦🇹	(230 gCO ₂ eq/kWh)
Spain	🇪🇸	(274 gCO ₂ eq/kWh)
Denmark	🇩🇰	(274 gCO ₂ eq/kWh)
Hungary	🇭🇺	(285 gCO ₂ eq/kWh)
Great Britain	🇬🇧	(289 gCO ₂ eq/kWh)
Slovakia	🇸🇰	(305 gCO ₂ eq/kWh)
Romania	🇷🇴	(323 gCO ₂ eq/kWh)
Portugal	🇵🇹	(378 gCO ₂ eq/kWh)
Ireland	🇮🇪	(390 gCO ₂ eq/kWh)
Italy	🇮🇹	(405 gCO ₂ eq/kWh)
Germany	🇩🇪	(412 gCO ₂ eq/kWh)
Bulgaria	🇧🇬	(431 gCO ₂ eq/kWh)
Turkey	🇹🇷	(432 gCO ₂ eq/kWh)
Czechia	🇨🇪	(481 gCO ₂ eq/kWh)
Greece	🇬🇷	(496 gCO ₂ eq/kWh)
Poland	🇵🇱	(686 gCO ₂ eq/kWh)



Tomorrow

Electricity Map

by Tomorrow → www.tmrow.com

Electricity Map is an open-source visualization platform, developed by Tomorrow [10], showing where electricity comes from and how much CO₂eq was emitted to produce it. The real-time visualization is available at www.electricitymap.org. The carbon intensity of each country is measured from the perspective of consumption and represents the greenhouse gas footprint per kWh consumed inside a given country. The footprint is measured in gCO₂eq (grams CO₂ equivalent), meaning each greenhouse gas is converted to its CO₂ equivalent in terms of global warming potential over 100 years. For instance, 1 gram of methane emitted has the same global warming impact during 100 years as about 20 grams of CO₂ has over the same period.

Carbon intensity includes the emissions from the whole life-cycle of the power plant, including construction, fuel production, operational emissions and decommissioning. Carbon-intensity factors come from scientifically peer reviewed literature. In most instances, the IPCC Fifth Assessment Report (2014) is used as reference [4].

Each country has a CO₂ mass flow that depends on neighbouring countries. In order to determine the carbon footprint of each country, the set of coupled CO₂ mass flow balance equations of each country must be solved simultaneously. This is done by solving the linear system of equations defining the network of GHG exchanges.

Energy for Humanity used Tomorrow's Electricity Map Pro [11] in order to gather data & visualizations for this report. For more details on the calculation of carbon-intensity factors, electricity production data, capacity, weather data, price data and methodology please check Github [12].



The carbon intensity of the electricity mix in Europe 2016/2017

This next section looks at the most up to date information on the carbon intensity of the electricity mix of different countries in the EU and neighbouring European Free Trade Area. The period chosen is the latest so-called hydrological year from October 2016 to September 2017. This means the first half of the period is winter, the second half is summer.

The carbon intensity of the electricity mix varies greatly over European countries. One of the major EU initiatives to reduce greenhouse gas emissions is implementing legislation to raise the share of energy consumption produced by renewable energy sources, such as wind, solar and biomass, to 20% by 2020. Not many countries have achieved this goal to date (see orange line in chart 1), three years from the deadline, despite considerable subsidy schemes. The countries with the largest share of power from non-hydro

renewables were Denmark, Ireland, Germany, Portugal and Spain. How much does this matter for the carbon intensity of the electricity generation system and the final absolute carbon emissions of the electricity system? In fact, the data displayed here show that it does not have so much of a significant effect. We can conclude that increase in renewables capacity does not alone correlate successfully to the fastest rate of carbon reduction in absolute or relative terms. Hence that this is not a suitable target to achieve carbon reduc-

tion. Instead, targets should be focussed on the objective, which is to urgently cut the volume of greenhouse gas particles emitted into the atmosphere by human activity. This cut must be undertaken as fast as possible, and at as great a scale as possible. Many of the credible analyses of this problem conclude that a vast increase across all low carbon technologies, and other relevant means of cutting greenhouse gases, must be delivered.

Share of non-hydro renewables wind, solar & biomass Oct 2016 – Sept 2017 (Chart 1)



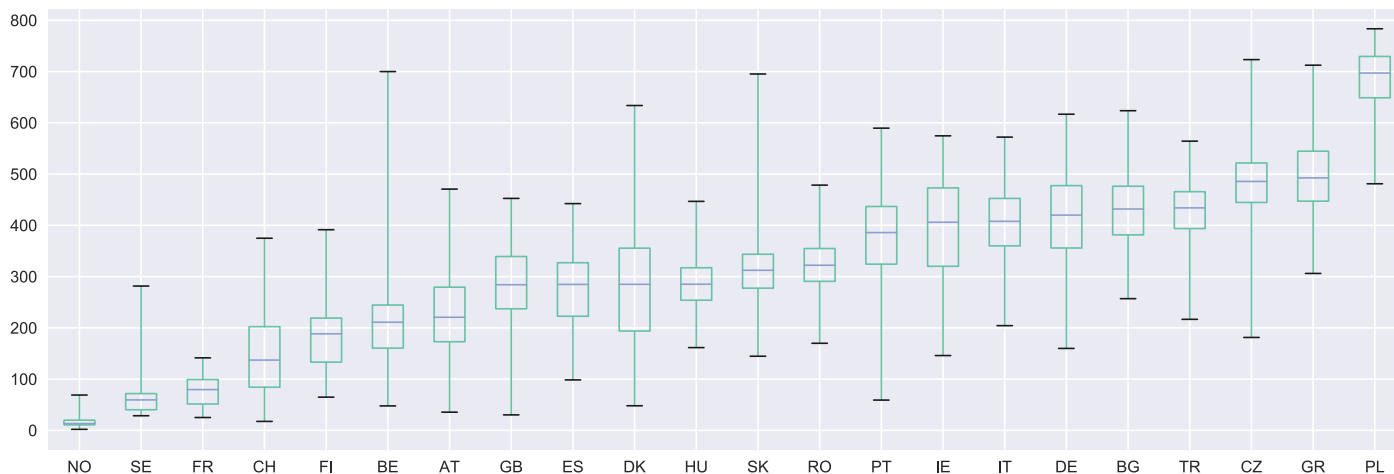
Note: Ranked by median values (blue lines). The box represents 25th and 75th percentile, and vertical lines cover all hourly datapoints.

Source: pro.electricitymap.org [11]

In contrast to non-hydro renewables share (chart 1), the carbon intensity of the electricity generation system is an important indicator for the final carbon emissions (chart 2). The countries with the lowest carbon intensity are Norway, Sweden, France, Switzerland and Finland.

These are not the countries with the highest share in non-hydro renewables, but these are exactly the countries with the highest low carbon electricity from hydro and nuclear, plus non-hydro renewables of solar, wind and biomass (chart 3). We therefore believe that the goal for Europe in order to answer the

Carbon intensity of electricity generation systems Oct 2016 – Sept 2017 (Chart 2)



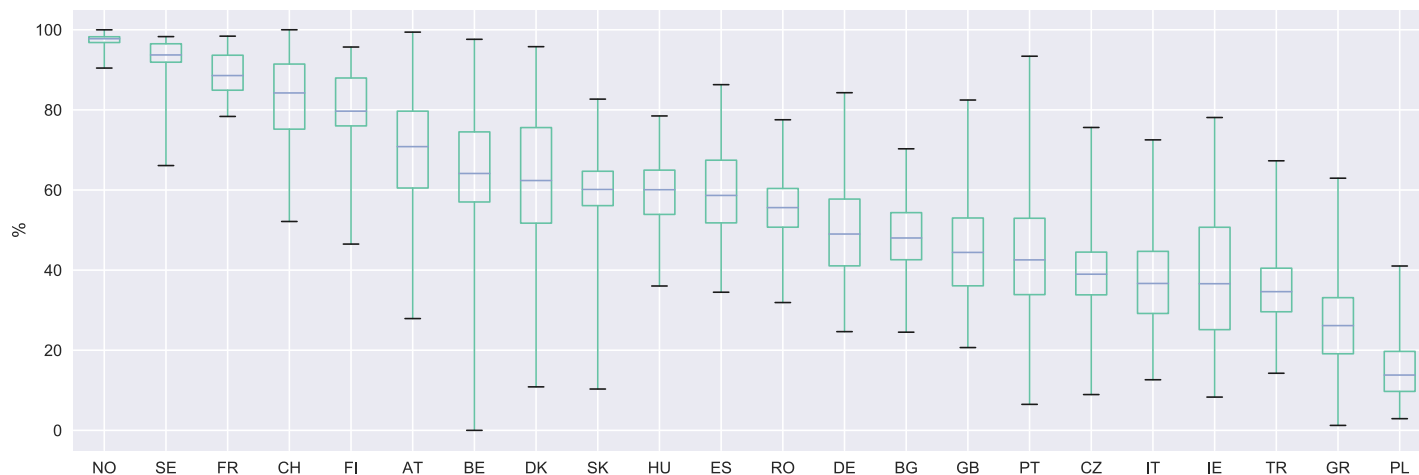
Note: Ranked by median values (blue lines). The box represents 25th and 75th percentile, and vertical lines cover all hourly datapoints.

Source: pro.electricitymap.org [11]

challenge of climate change should be to focus on maximising the increase in low-carbon electricity supply rather than aiming to increase the share of renewables. Rapidly increasing the share of low-carbon sources must include nuclear power. All pronouncements by environmental scientists and campaigners

as to the very limited timescales by which to turnaround the still increasing levels of fossil fuel consumption, generally fails to make this link. Often this is because the anti-nuclear position of the 1970s era Green movement and its successors, is feared to provoke an outcry, and thus produces silence on this issue.

Share of low carbon electricity consumption Oct 2016 – Sept 2017 (Chart 3)



Note: Ranked by median values (blue lines). The box represents 25th and 75th percentile, and vertical lines cover all hourly datapoints. Low carbon technologies comprise of renewables and nuclear.

Source: pro.electricitymap.org [11]

Nuclear currently, even after many politically driven shutdowns, produces almost half of European clean energy, and should be fairly recognized as the enormous asset for decarbonizing our economy that it is. Numerous myths and misconceptions of anti-nuclear campaigners have become widely believed, and evidence-based re-

sponses to many of these are detailed on www.energyforhumanity.org. While we do not wish to dismiss any fears, we do ask that people take an open-minded look at the strength of the evidence that is available.

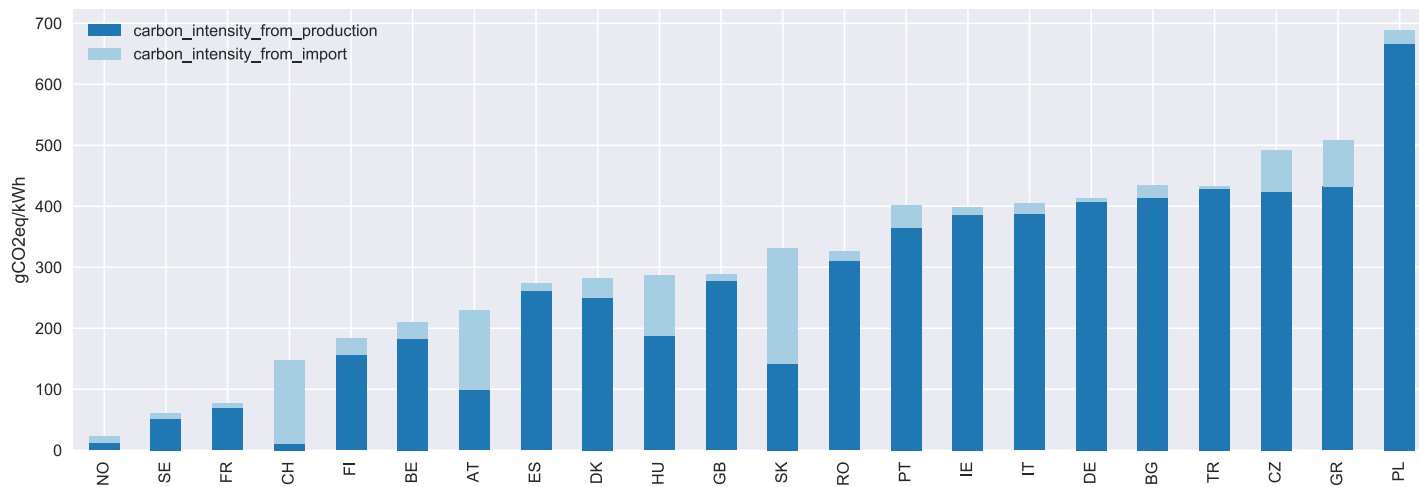
Country Data

by Tomorrow → www.tmrow.com

The following shows the carbon intensity of the electricity mix in Europe (in gCO₂eq/kWh, with maximum value of the y-axis at 800) from October 2016 to September 2017.

Also, for each country, the total carbon emissions from electricity generation for this same period are ranked, marking the difference between domestic carbon emissions and emissions coming from energy imports to determine the net carbon intensity per year.

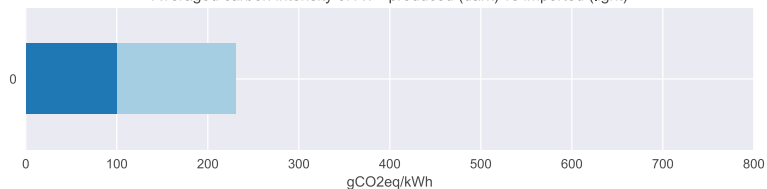
Carbon emissions from domestic consumption and imports Oct 2016 – Sept 2017



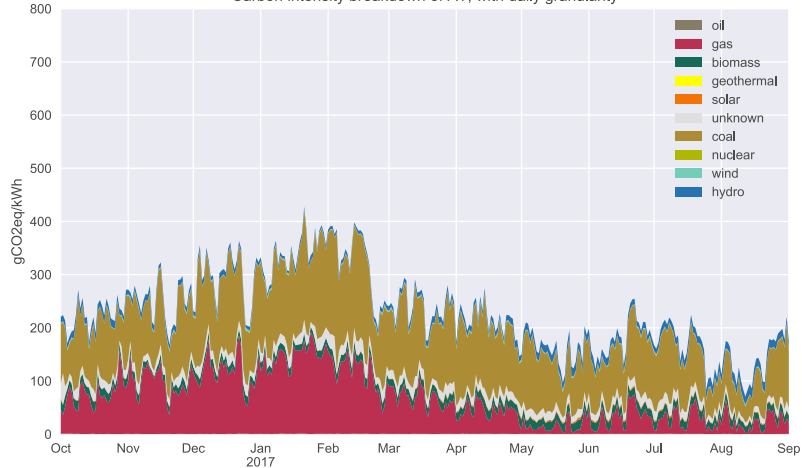


Austria

Averaged carbon intensity of AT - produced (dark) vs imported (light)

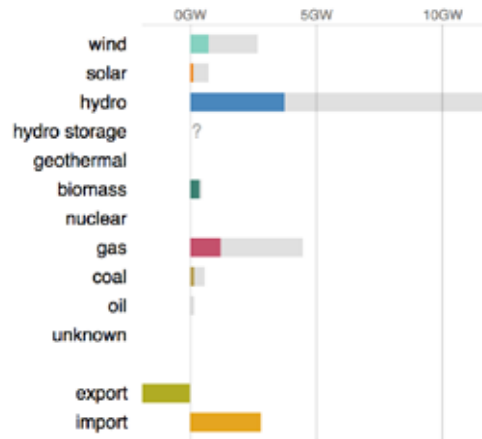


Carbon intensity breakdown of AT, with daily granularity



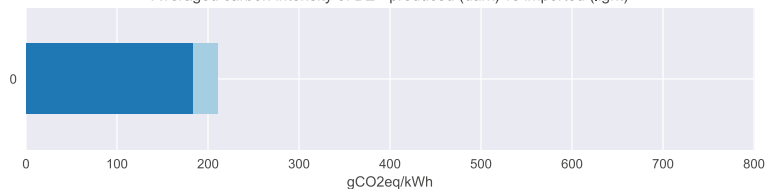
Average capacity feeding to the grid AT

- installed capacity in grey
- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black

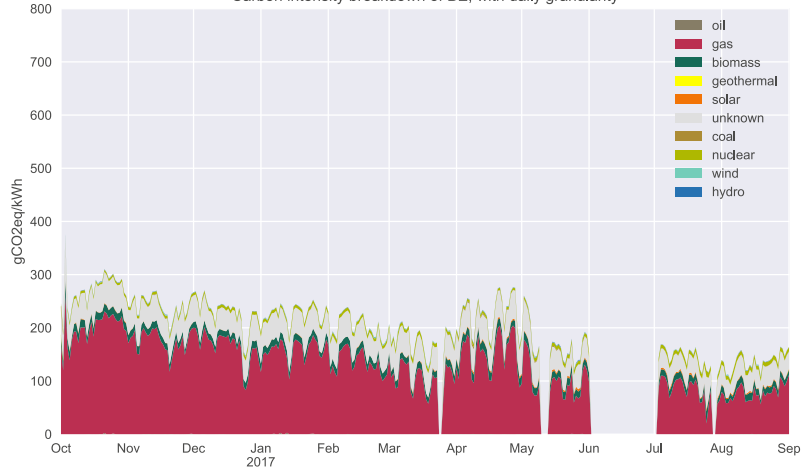




Averaged carbon intensity of BE - produced (dark) vs imported (light)

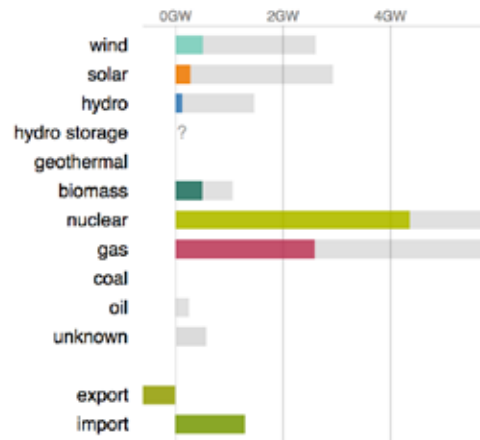


Carbon intensity breakdown of BE, with daily granularity



Average capacity feeding to the grid BE

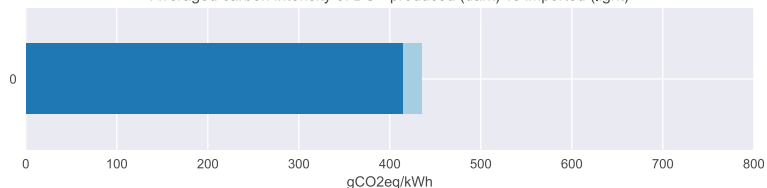
- installed capacity in grey
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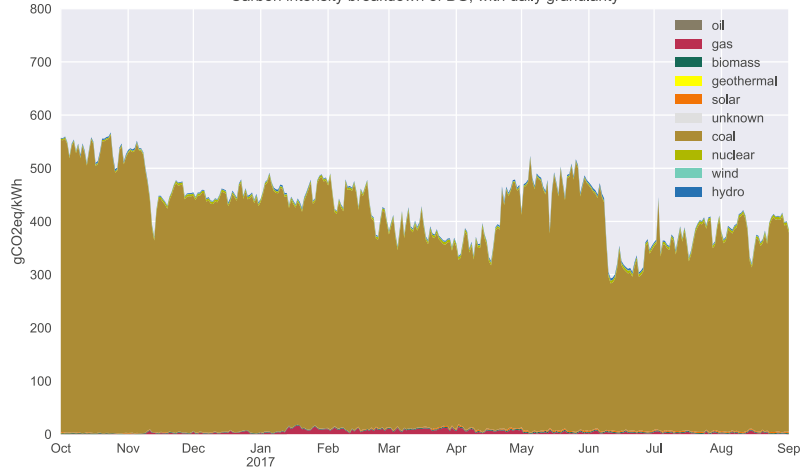


Bulgaria

Averaged carbon intensity of BG - produced (dark) vs imported (light)

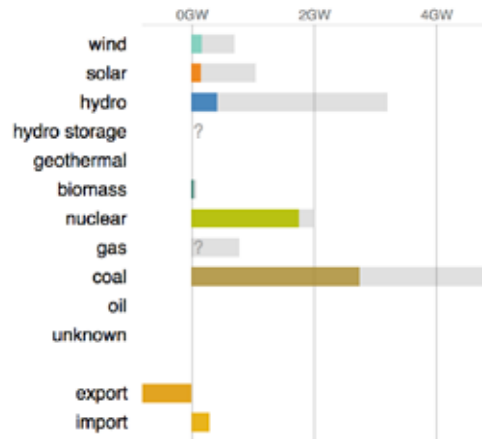


Carbon intensity breakdown of BG, with daily granularity



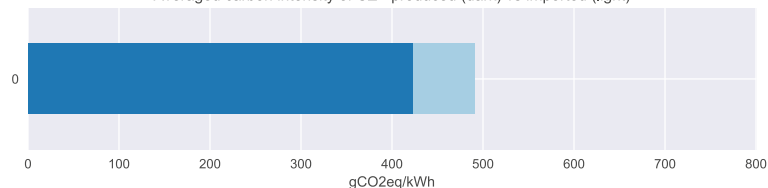
Average capacity feeding to the grid BG

- installed capacity in grey
- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black

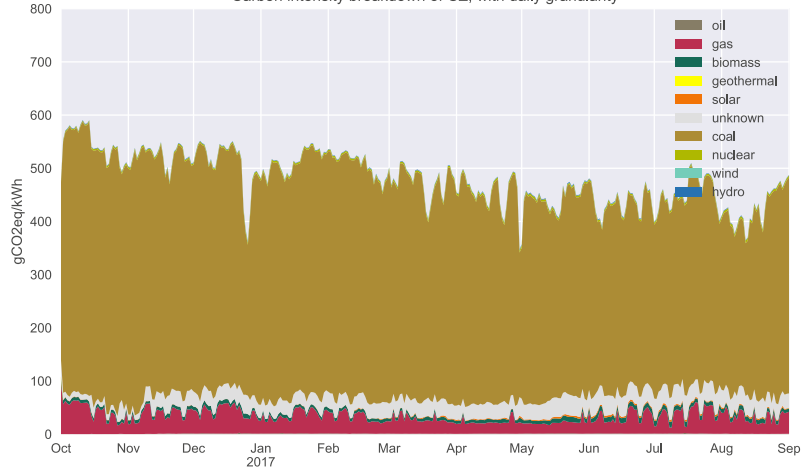




Averaged carbon intensity of CZ - produced (dark) vs imported (light)

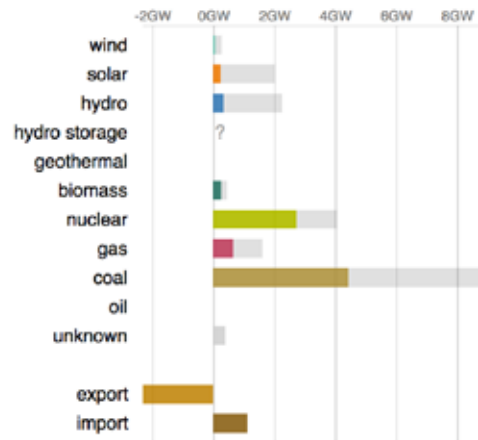


Carbon intensity breakdown of CZ, with daily granularity



Average capacity feeding to the grid CZ

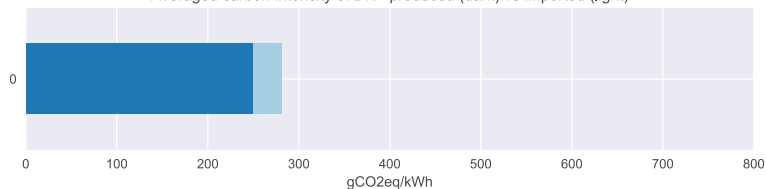
- installed capacity in grey
- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black



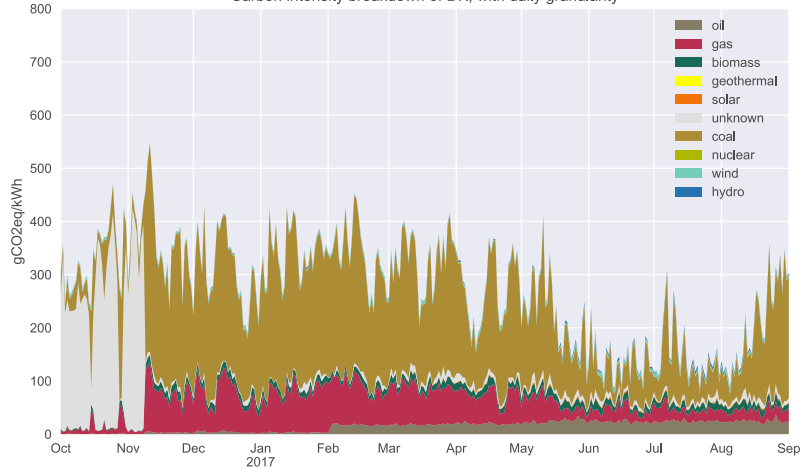


Denmark

Averaged carbon intensity of DK - produced (dark) vs imported (light)

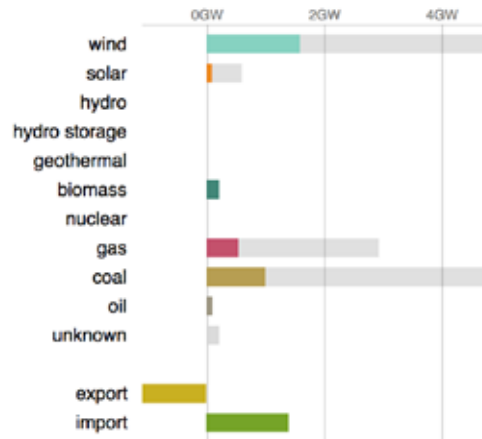


Carbon intensity breakdown of DK, with daily granularity



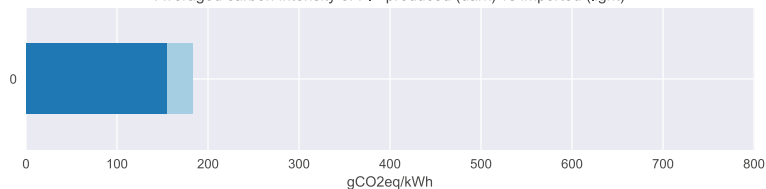
Average capacity feeding to the grid DK

- installed capacity in grey
- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black

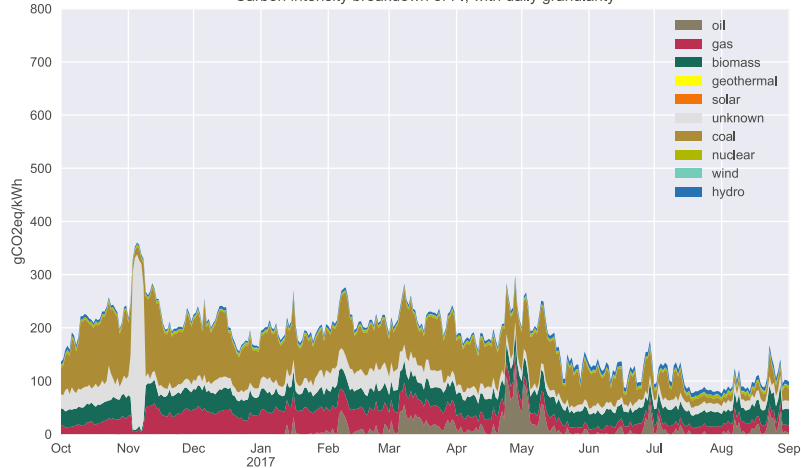




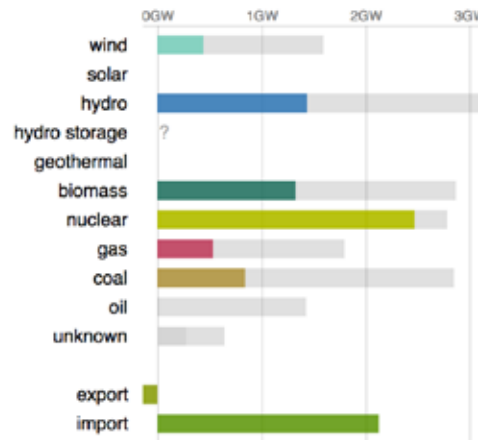
Averaged carbon intensity of FI - produced (dark) vs imported (light)



Carbon intensity breakdown of FI, with daily granularity

**Average capacity feeding to the grid FI**

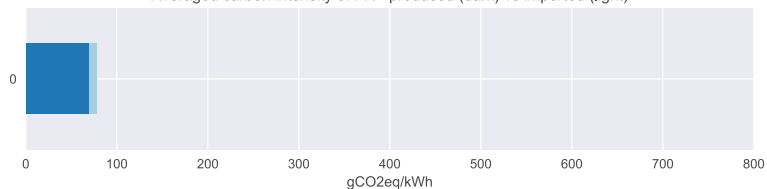
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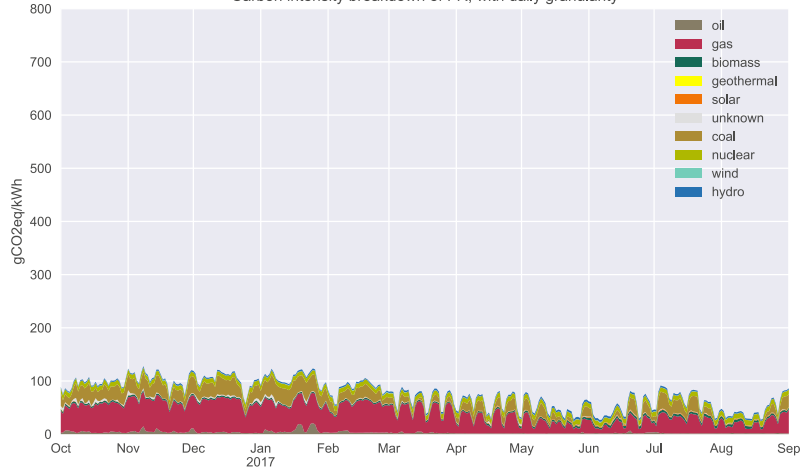


France

Averaged carbon intensity of FR - produced (dark) vs imported (light)

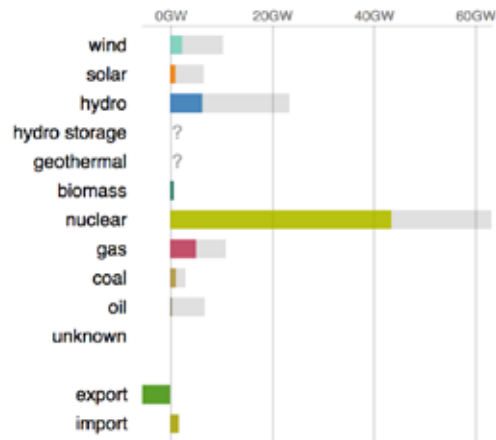


Carbon intensity breakdown of FR, with daily granularity



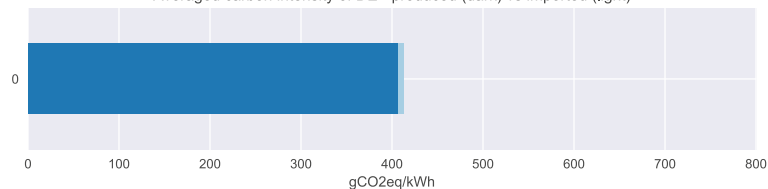
Average capacity feeding to the grid FR

- installed capacity in grey
- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black

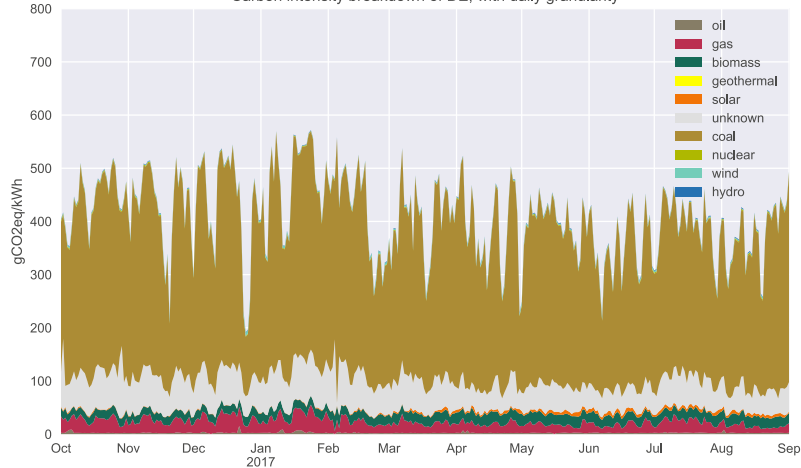




Averaged carbon intensity of DE - produced (dark) vs imported (light)

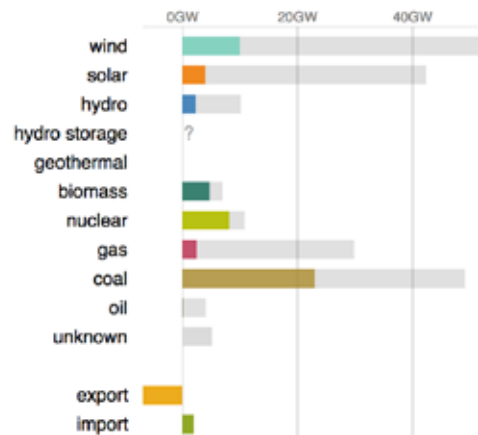


Carbon intensity breakdown of DE, with daily granularity



Average capacity feeding to the grid DE

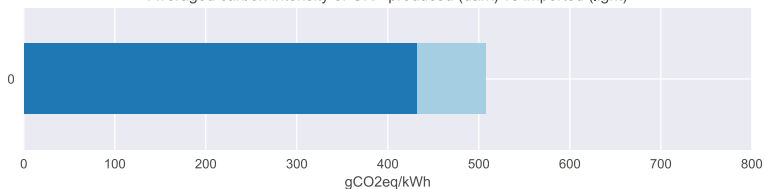
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- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black



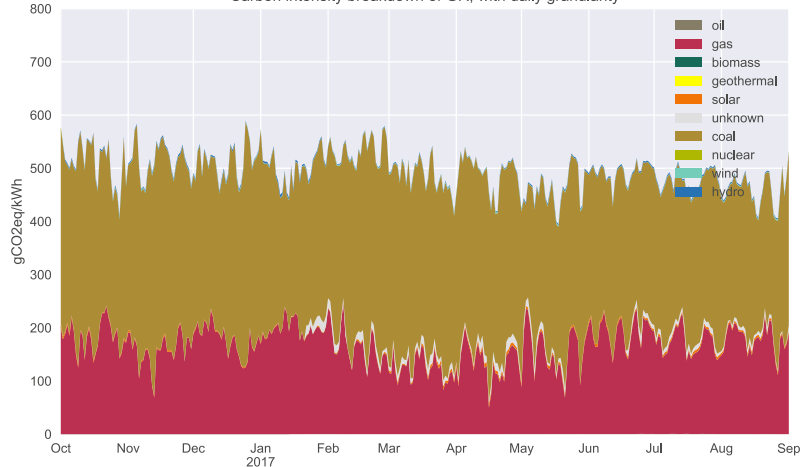


Greece

Averaged carbon intensity of GR - produced (dark) vs imported (light)

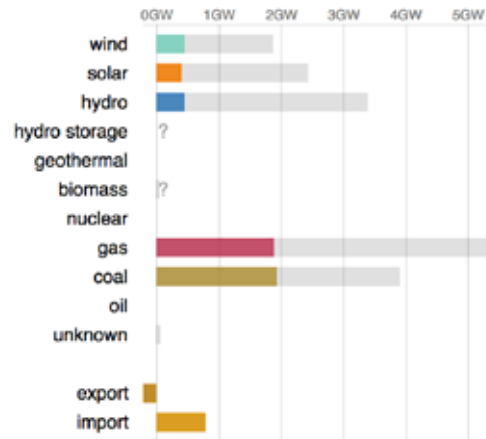


Carbon intensity breakdown of GR, with daily granularity



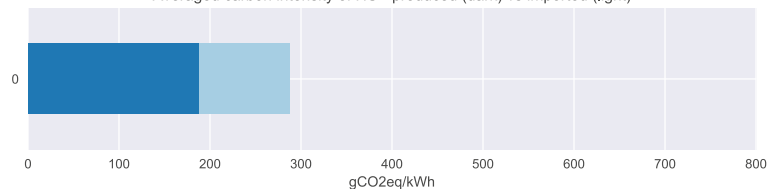
Average capacity feeding to the grid GR

- installed capacity in grey
- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black

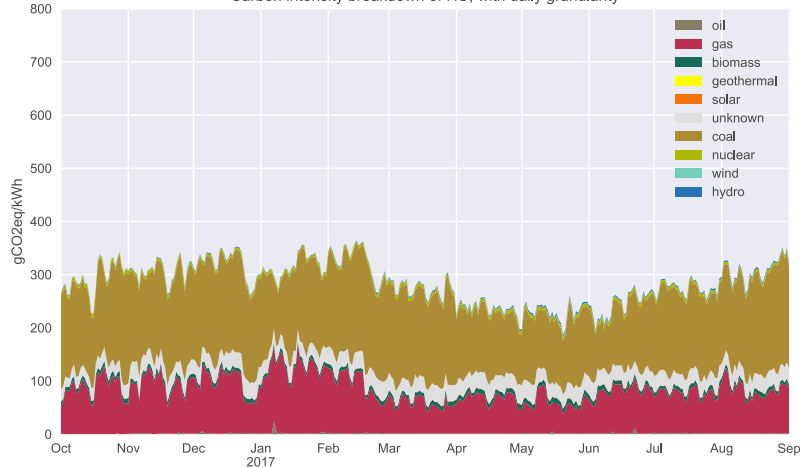




Averaged carbon intensity of HU - produced (dark) vs imported (light)

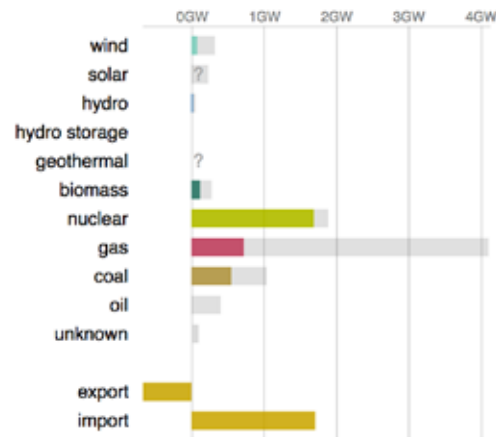


Carbon intensity breakdown of HU, with daily granularity



Average capacity feeding to the grid HU

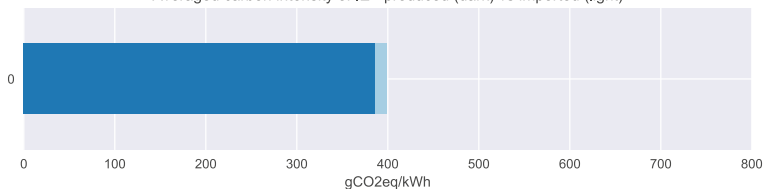
- installed capacity in grey
- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black



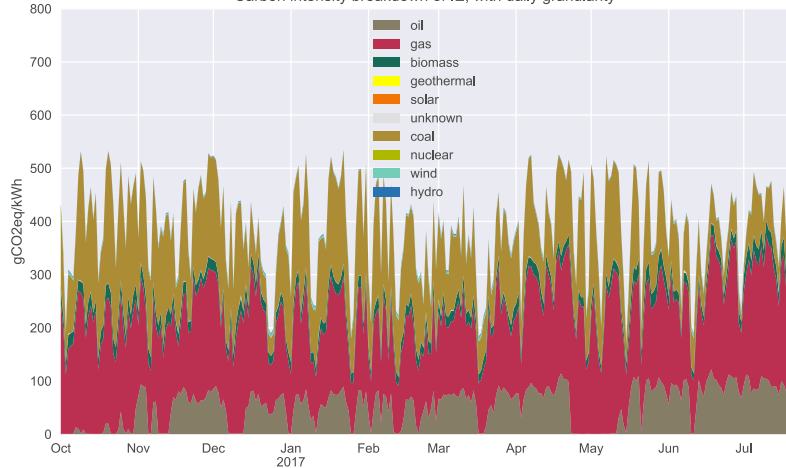


Ireland

Averaged carbon intensity of IE - produced (dark) vs imported (light)

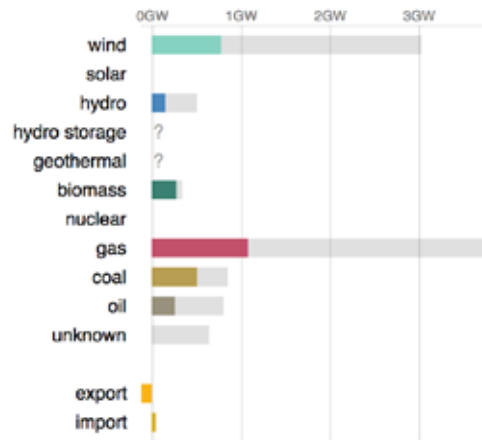


Carbon intensity breakdown of IE, with daily granularity



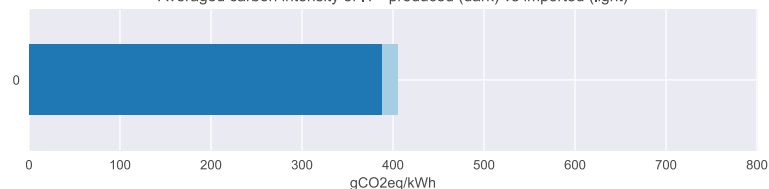
Average capacity feeding to the grid IE

- installed capacity in grey
- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black

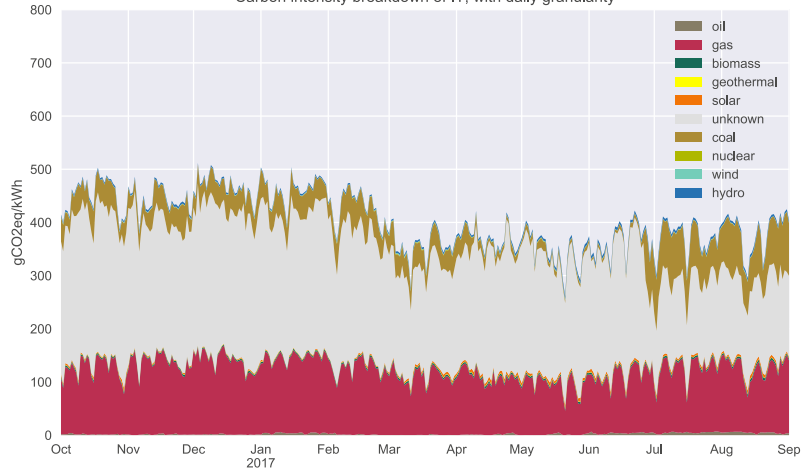




Averaged carbon intensity of IT - produced (dark) vs imported (light)

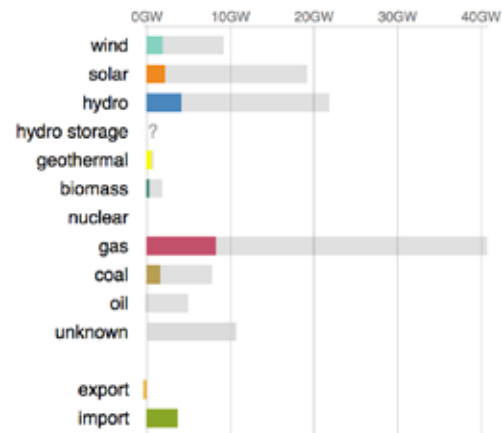


Carbon intensity breakdown of IT, with daily granularity



Average capacity feeding to the grid IT

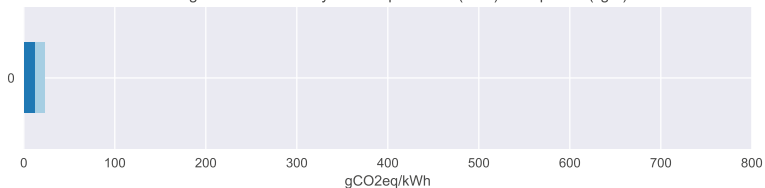
- installed capacity in grey
- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black



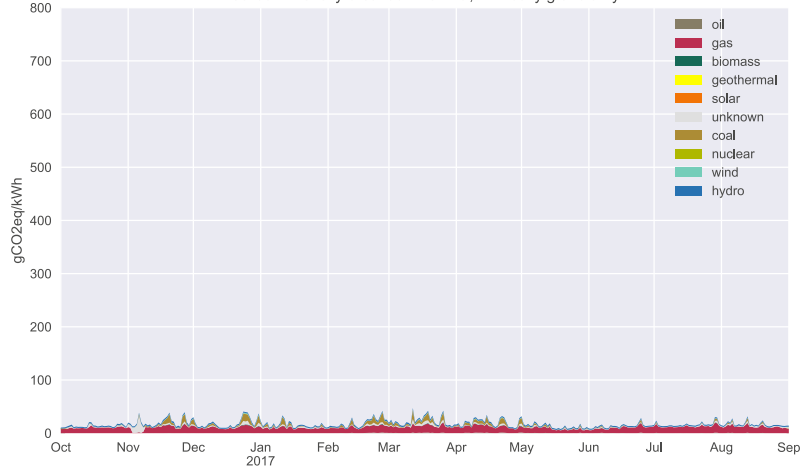


Norway

Averaged carbon intensity of NO - produced (dark) vs imported (light)

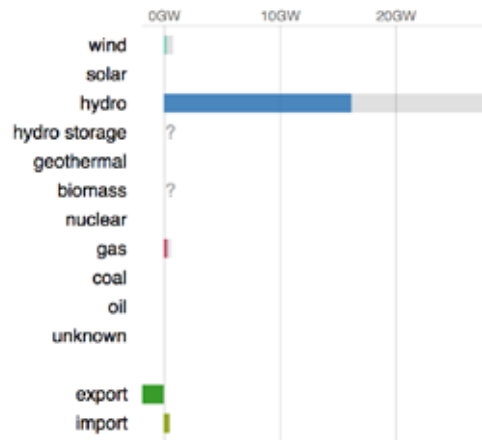


Carbon intensity breakdown of NO, with daily granularity



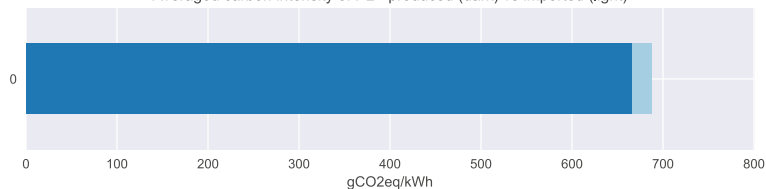
Average capacity feeding to the grid NO

- installed capacity in grey
- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black

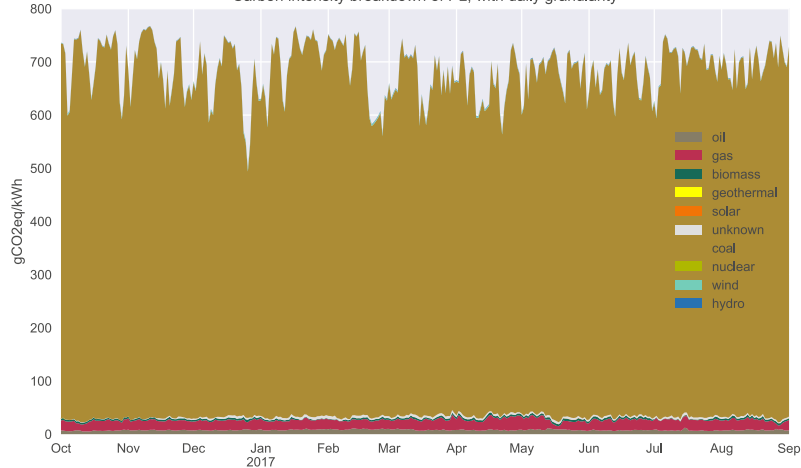




Averaged carbon intensity of PL - produced (dark) vs imported (light)

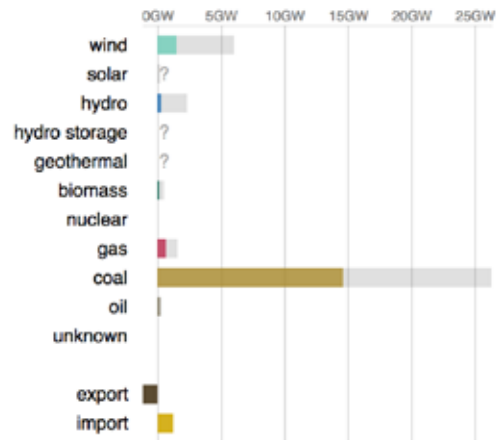


Carbon intensity breakdown of PL, with daily granularity



Average capacity feeding to the grid PL

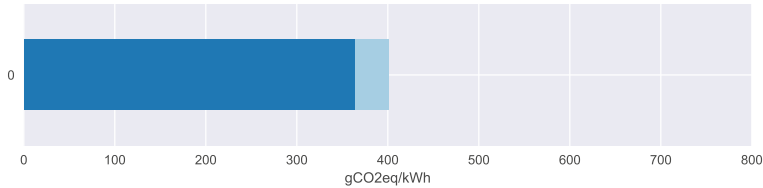
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- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black



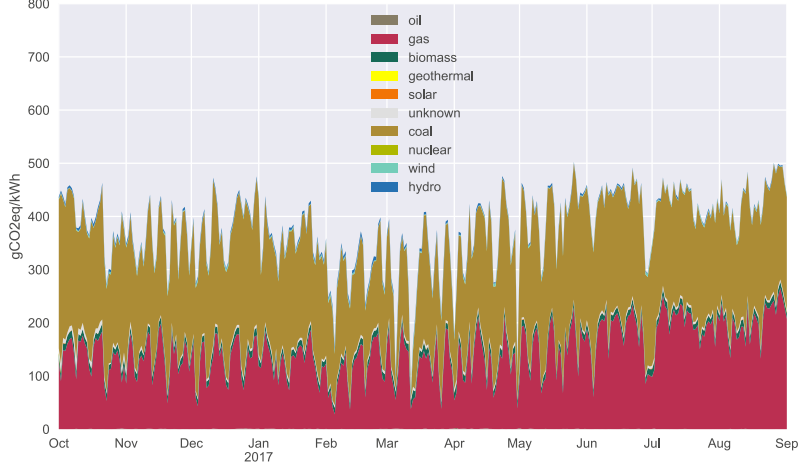


Portugal

Averaged carbon intensity of PT - produced (dark) vs imported (light)

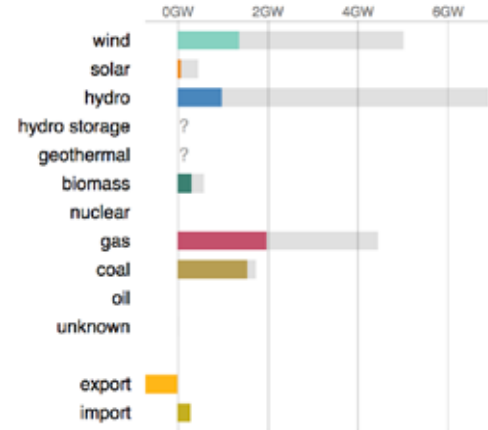


Carbon intensity breakdown of PT, with daily granularity



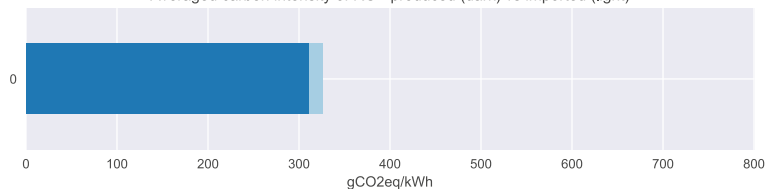
Average capacity feeding to the grid PT

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- import & export colors reflects the average carbon intensity, on a scale from green to black

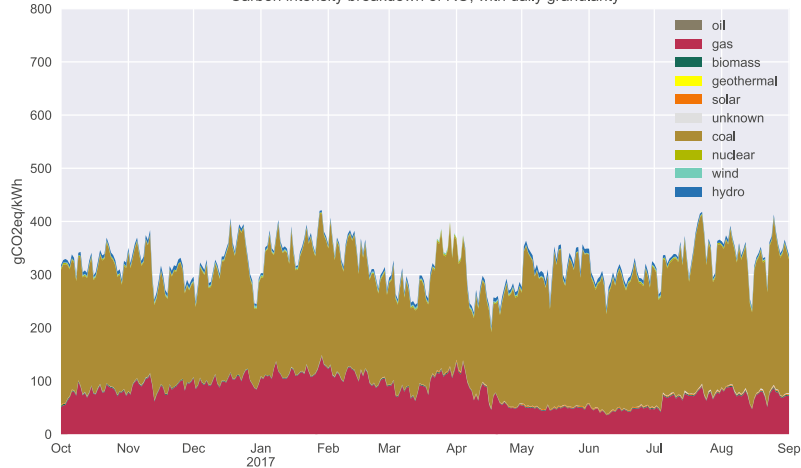




Averaged carbon intensity of RO - produced (dark) vs imported (light)

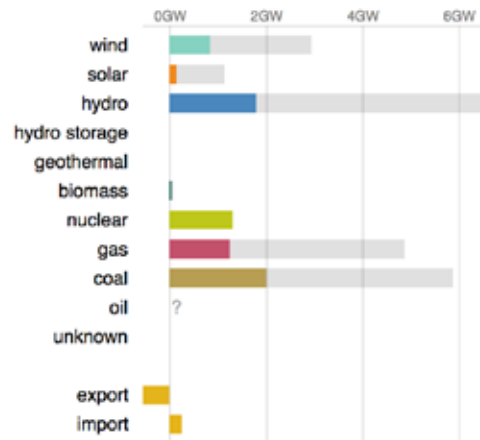


Carbon intensity breakdown of RO, with daily granularity



Average capacity feeding to the grid RO

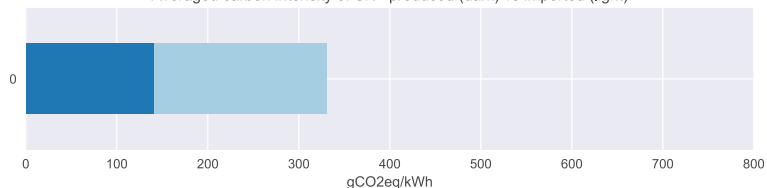
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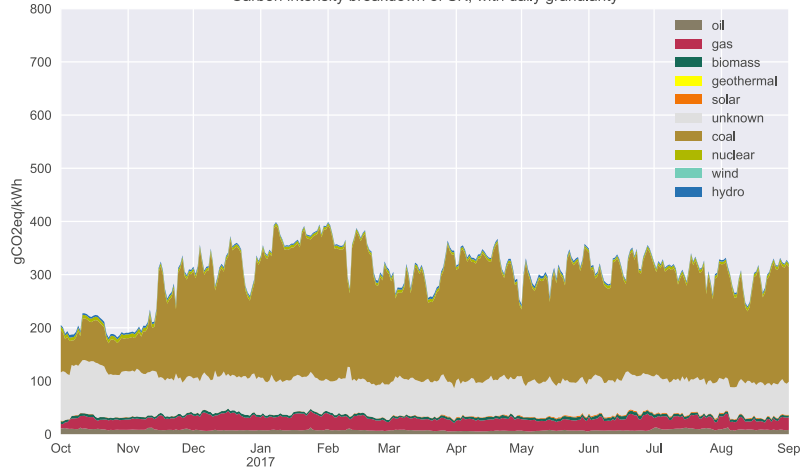


Slovakia

Averaged carbon intensity of SK - produced (dark) vs imported (light)

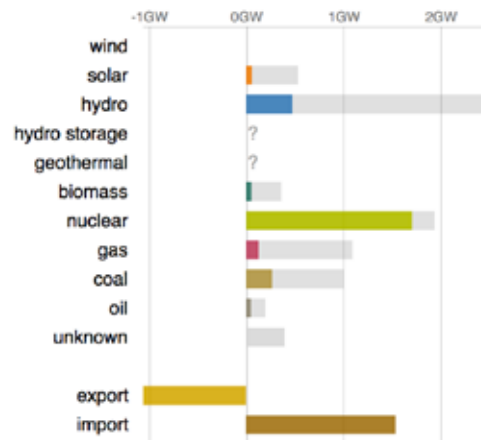


Carbon intensity breakdown of SK, with daily granularity



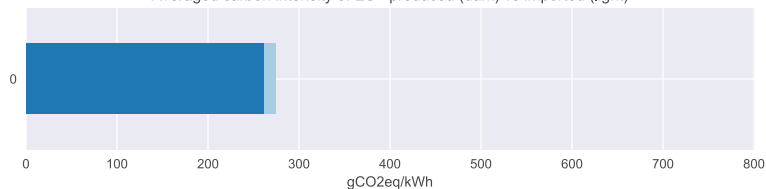
Average capacity feeding to the grid SK

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- import & export colors reflects the average carbon intensity, on a scale from green to black

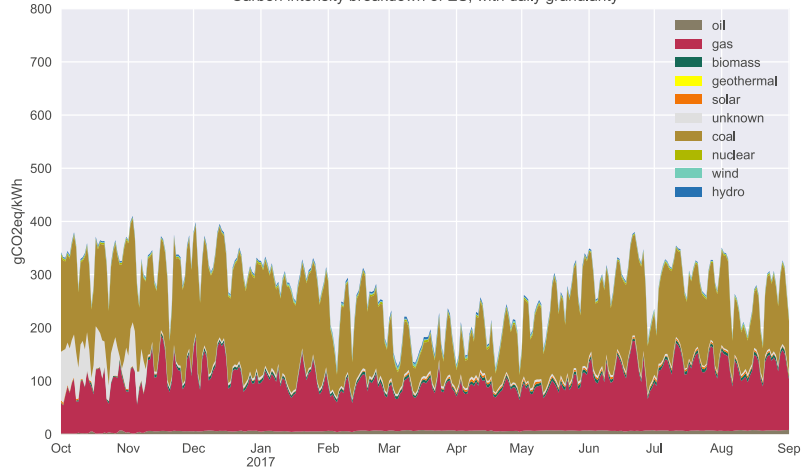




Averaged carbon intensity of ES - produced (dark) vs imported (light)

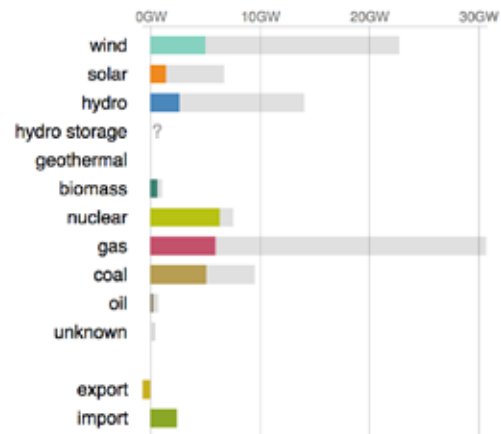


Carbon intensity breakdown of ES, with daily granularity



Average capacity feeding to the grid ES

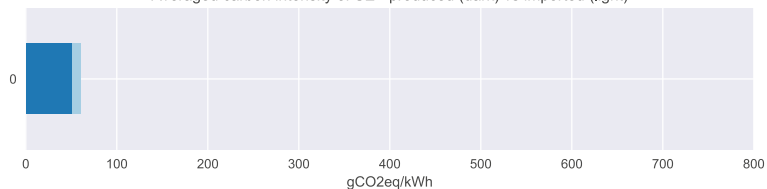
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- import & export colors reflects the average carbon intensity, on a scale from green to black



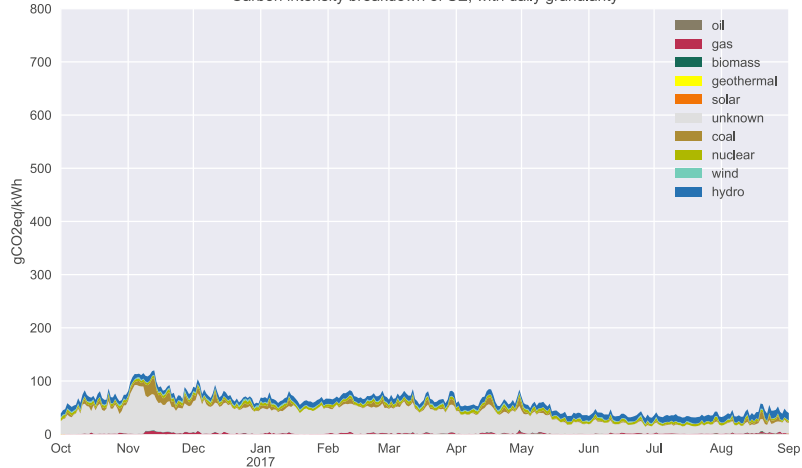


Sweden

Averaged carbon intensity of SE - produced (dark) vs imported (light)

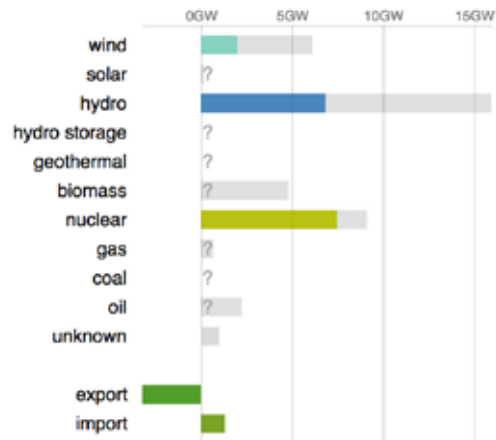


Carbon intensity breakdown of SE, with daily granularity



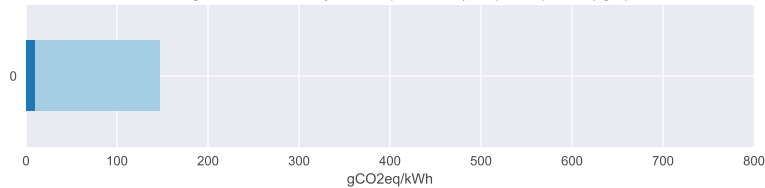
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- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black

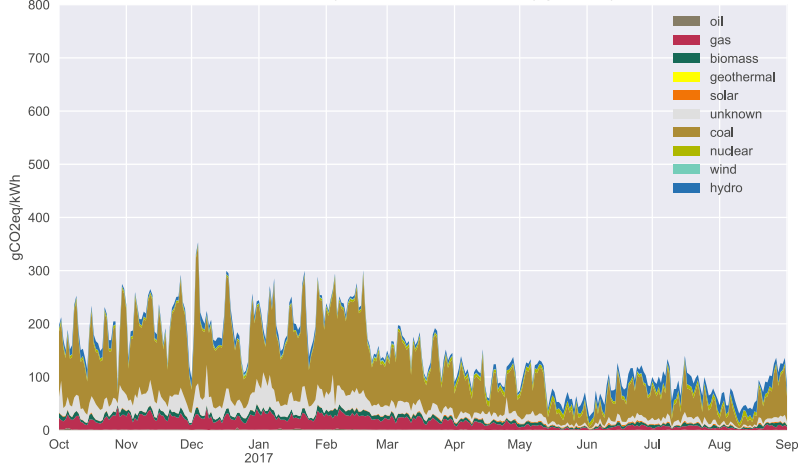




Averaged carbon intensity of CH - produced (dark) vs imported (light)

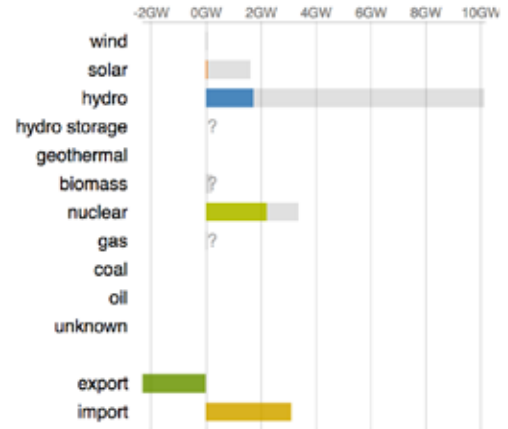


Carbon intensity breakdown of CH, with daily granularity



Average capacity feeding to the grid CH

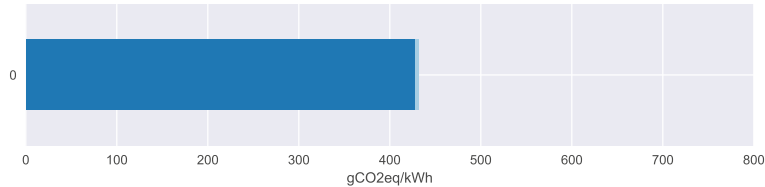
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- import & export colors reflects the average carbon intensity, on a scale from green to black



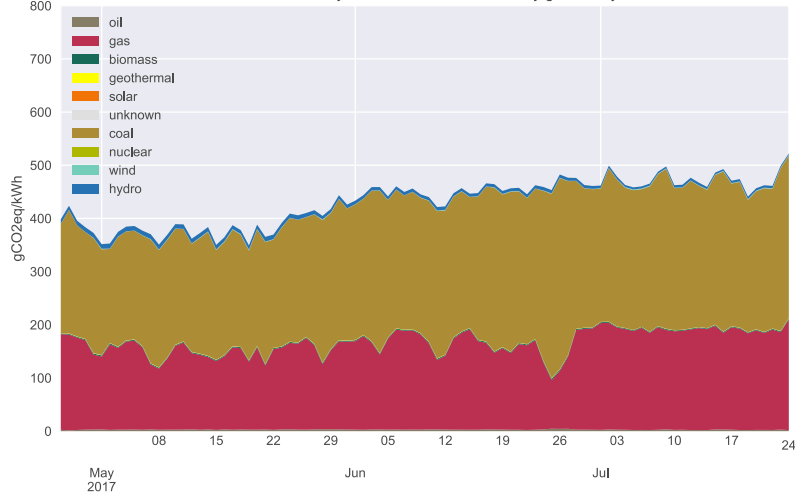


Turkey*

Averaged carbon intensity of TR - produced (dark) vs imported (light)

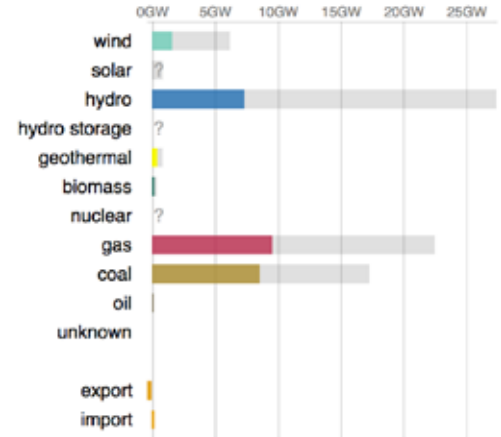


Carbon intensity breakdown of TR, with daily granularity



Average capacity feeding to the grid TR

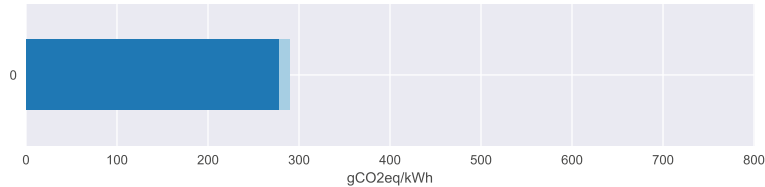
- installed capacity in grey
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- import & export colors reflects the average carbon intensity, on a scale from green to black



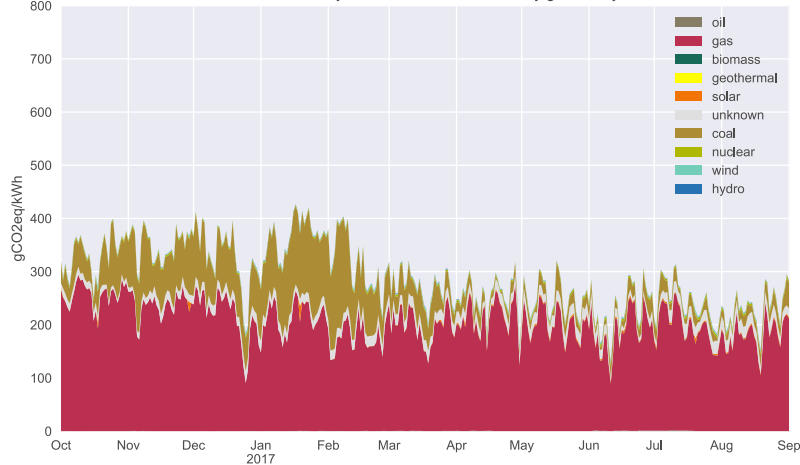
* Data for Turkey only may to July 2017



Averaged carbon intensity of GB - produced (dark) vs imported (light)

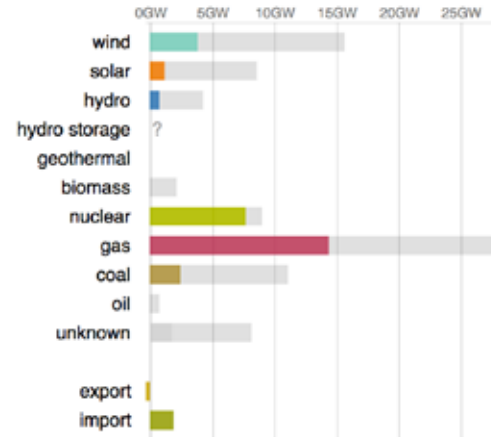


Carbon intensity breakdown of GB, with daily granularity



Average capacity feeding to the grid GB

- installed capacity in grey
- unknown generally refers to undeclared thermal generation, without breakdown per type of fossil fuel
- import & export colors reflects the average carbon intensity, on a scale from green to black



Understanding the German Energy Transition

The end of the Cold War, the fall of the Berlin Wall, the collapse of the communist German Democratic Republic and the reunification of a country and its citizens without a bullet being fired is an absolute miracle. Germany called this the “Wende”, meaning “the transition”. This term, with the positive attributes it had, was later adopted also to their energy transition, the “Energiewende” has been put forward as both an anti-nuclear energy strategy and a carbon reduction strategy. The data presented in this report suggests that these two goals are incompatible. This approach does not acknowledge the serious urgency of the climate change challenge.

The political transition was from a faulty system of authoritarian communism to a proven system of liberal capitalism. The Energiewende intends to replace a well-functioning energy supply system in one of the most industrialized countries in the world with an unproven one.

The four pillars of the Energiewende were as follows [13]:

1. Low-carbon society by 2050, with 80–95 percent less emissions compared to 1990 levels.
2. Economy that runs on renewable energy, with 80 percent renewables by 2050, and fossil energy only as back-up.

3. Closure of the current nuclear fleet by 2022.
4. Increasing demand flexibility and energy efficiency.

The first two are long term goals, while the third was a short term action, and fourth, an intended change to operational practices. The closure of the operating nuclear fleet by 2022 was a political decision, disregarding any climate or emissions goals.

Germany has been one of the most coal-dependent countries in Europe. It would have been extremely challenging to replace coal production with renew-

ables even if it had not chosen to start the Energiewende by removing nuclear power from its energy mix. When the project started, around 80 percent of Germany’s low-carbon electricity came from nuclear power. By 2015, this had fallen to about a third. In absolute terms, nuclear production has fallen from around 170 TWh to 90 TWh by 2016. Coal use was increased. During the last few years, between 50 and 60 percent of German electricity was produced with fossil fuels, mainly by coal and its dirtier cousin, lignite.

Energiewende concept dates back to 1998, when the newly elected government coalition of Social Democrats and

Greens decided to shut nuclear down by 2010 [14].

Several years of negotiations between the government and the nuclear industry led to a deal in 2001. New nuclear power plants were banned, the operational lifetime of the current fleet was limited to 32 years, and various limits were put for electricity produced with nuclear. According to this deal, the last of the nuclear power plants would be shut down in 2022. It was assumed that renewable energy would be able to replace most of the nuclear power. The law that followed in 2000, defining renewable subsidies and support schemes, is considered to be one of the most significant events for kickstarting large scale non-hydro renewable energy production in the world. It was however recognized that renewable energy alone might not be able to do the job. Germany's Chancellor Gerhard Schröder lobbied strongly for Nord-

stream, a natural gas pipeline going under the Baltic Sea to import gas from Russia. After his career as Chancellor, Schröder was hired by the company which built the pipeline. The pipeline can import a volume of Russian natural gas that, if used only for electricity production, could match the output of the country's whole nuclear fleet. Between 2006 and 2008, Germany also granted permits for 10 large coal fired power plants. The combined capacity of these plants, 10.7 gigawatts, is comparable to the combined nuclear capacity of Finland and Sweden in 2016. Clearly, this policy was to increase the use of fossil fuels in the German economy.

People were surprised by this decision, as it was widely known that coal burning should stop as fast as possible. When James Hansen, one of the pioneers of climate science, who first brought the threat of global warming to world's attention

questioned this decision to permit the building of new coal plants, the then environment minister Sigmar Gabriel replied that since Germany was giving up nuclear, it would be impossible to give up coal at the same time. It was a political decision, and it was not negotiable.

In the 2005 elections, Christian Democrats and Liberals took over the government, with Angela Merkel as the new Chancellor. The new government was more favourable towards nuclear, and in 2010 Merkel cancelled the decision to shut down the nuclear fleet prematurely. This complete u-turn was rationalized especially with meeting emissions reduction goals and improving energy security.

The ink barely had time to dry on the new decision, when in March 2011 the tsunami caused by the strongest earthquake ever measured in Japan, killed almost

20,000 people and damaged the Fukushima Dai-ichi nuclear power plant beyond repair. Both the international media as well as the rapidly growing social media swiftly ignored the vast number of victims of the earthquake and tsunami, and started following the events unfolding at the Fukushima plant with unblinking attention.

The huge amount of media attention, along with the fear of radiation planted in people's minds during the Cold War, quickly mobilised anti-nuclear campaigners and influenced German public opinion: Even though it is now well-known that the radioactive elements that escaped from the nuclear power plant won't have any significant health effects to people anywhere, the world was shaken with fear. The polls in Germany showed that the general public remained against nuclear, and the Christian Democrats, led by Merkel,

were facing defeat in the coming state elections, especially from the Greens. So Merkel pulled yet another u-turn and the reactors built before 1980 were closed just three days after the Fukushima accident. Later, Germany announced that it would return to the previous schedule of early shutdowns of all reactors by 2022. Interestingly enough, this was not done on the basis of a technical analysis performed by the GRS (Gesellschaft für Reaktorsicherheit), a company in charge of reactor safety, who concluded that with the safety functions in the German nuclear power plants, a similar accident to Fukushima could not happen in Germany.

The German nuclear phase-out was decided on the basis of an “ethics commission” report, which stated that the nuclear power plants “can be replaced with less risky methods and therefore should be phased out” [15].

After the shut-downs, renewable energy was also granted higher subsidies, and consumers were encouraged in particular by Hermann Scheer's policy of the feed-in-tariff. The environmentalists and Greens around the world cheered Germany's decision, even though it was clear it would lead to much slower reductions of greenhouse gas emissions. Ever since, the “green energy” project of Germany has been as ambitious as can reasonably be imagined. Germany has collected a total amount of over 200 billion euros from electricity consumers (mostly people who are renting flats and apartments) and redistributing them to owners of solar panels, wind turbines and biomass power plants (mostly house owners, land owners or farmers) by paying them feed-in-tariffs independently of the power market prices, whenever the sun is shining and the wind is blowing.

The amount to be redistributed in the future until 2035 from all renewables



Windfarm close to Cottbus
in Germany
(12 x 2 MW = 24 MW)

In the background:
Jänschwalde lignite power station,
(6 x 500 MW = 3000 MW)

2015:
23 mio t CO₂ emissions
4th highest of all European
power plants

installed until the end of 2016 will total at an additional 320 bn EUR [16]. It is remarkable that this sum does not include any additions of new clean energy capacity, but is paid to simply have the current system. With solar, wind and biomass still generating well below 30% of the German electricity (and below 15% of the German primary energy), the total amount of paid and committed subsidies have already surpassed 500 billion EUR. At the same time, emissions have remained at previous levels. Instead of replacing the burning of coal, (let alone tackling gas and oil), the renewables have largely replaced another low carbon energy source, nuclear power.

What will happen when the remaining nuclear plants, which still produced around a third of Germany's clean electricity in 2015, will be closed by 2022? It is absolutely certain that it will be much harder to close down the fleet of coal plants that

currently produces around 40 percent of Germany's electricity – more than all clean sources put together. From a climate perspective, Germany has used over 200 billion euros and almost two decades to stay pretty much at the same emissions levels.

According to McKinsey, Germany will be unable to reach the ambitious climate goals it has set for 2020, even though it has built more renewables than it originally planned [17]. Germany's environment minister said as early as 2014 that Germany will only be able to reduce its emissions by 33 percent instead of the 40 percent target (from 1990 levels). Critics, like the WWF chapter of Germany, have said that even this amount is way too optimistic. Despite Germany's hundreds of billions in annual investments and feed-in-tariffs, their emissions have actually decreased significantly slower (10.4%) than the EU average (14.7%) from 2000 to 2016 (BP 2017) [8]. Germany's claim

to climate leadership appears to be unfounded. Yet the zeal of campaigners who have historically been anti-nuclear and pro-renewables since long before climate change became a mainstream issue, have cheered the energie-wende as the clear example to follow.

McKinsey prepared a report which follows the same, clear message: As Germany will lose roughly 100 TWh of annual clean production due to nuclear closures, it will have to lower its emission reduction goals to less ambitious levels. As news-blog Carbon Brief asked a representative of Germany's energy ministry about quitting coal burning in 2014, the answer was as clear as it was unforgiving: "A simultaneous exit from nuclear energy and coal is not possible in a highly industrialized country like Germany".

To reach the goals for the Paris COP21 agreement, Germany will need to cut

emissions by 95 percent from 1990 levels by 2050. It may need closures of all of its lignite burning power plants by 2020, including the brand-new ones that have technical operational lifetimes reaching to at least 2050.

Yet, a fundamental problem in the German energy discussion is that climate is seen as an important thing, but it is forbidden to even mention that keeping the current nuclear fleet fully operational would mean achieving those climate goals. That would be climate leadership.

Furthermore, even though the *Energiewende* is cited as a “power to the people” project, the tariffs often end up in the pockets of wealthy companies, trust-funds and investors with the ability to invest in large-scale projects. The bill is paid by regular energy users, and disproportionately by the poor. Energy bills represent a smaller percentage of

the income of rich households, and they are also more able to buy newer energy efficient appliances. Poorer households have energy bills as a higher cost, and are faced with paying more to subsidise those able to own their own renewables. Such social factors are an important part of a fact-based and equitable energy policy.



Links and References

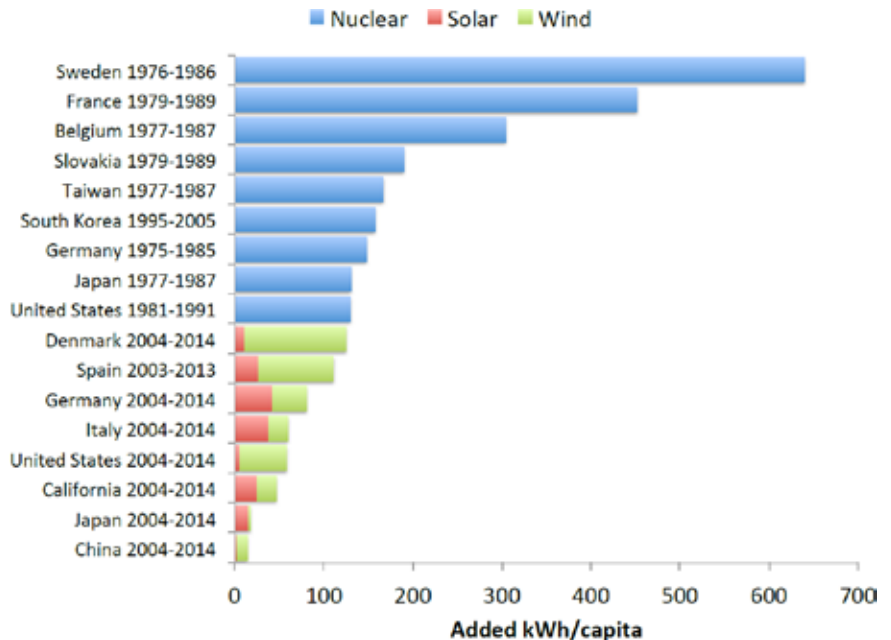
- [1] http://ec.europa.eu/eurostat/statistics-explained/index.php/Greenhouse_gas_emission_statistics
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Based on BDEW data slide 45, the amounts of feed-in tariff subsidies paid from 2000 to 2016 have been calculated and an estimation has been made for the subsidies to be paid until 2035 (20 year duration of feed-in tariff contracts)
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- [18] http://science.sciencemag.org/content/sci/suppl/2016/08/03/353.6299.547.DC1/aaf7131Cao_SM.pdf
Junji Cao, Armond Cohen, James Hansen, Richard Lester, Per Peterson, Hongjie Xu

Nuclear energy: Silver bullet for rapid decarbonization?

History offers some examples of successful rapid emission reductions. In the 1970s and 1980s, France cleaned up their electricity emissions. Carbon intensity plummeted, whilst energy consumption and the economy grew rapidly. This programme, fuelled largely by the 1970s oil crisis, substantially reduced emissions, even though that was not a stated goal for the project. Energy security was. For decades, the French people have been avoiding the release of massive amounts of emissions, benefitting from affordable energy and cleaner air. The fastest decarbonization rate per capita was achieved by Sweden.

The data show clearly: Nuclear energy is the best tool for rapid decarbonization on a large scale. It is about time that the UN Convention on Climate Change (UNFCCC) acknowledged this fact.

Fastest possible decarbonization enabled by adding nuclear power [\[18\]](#)





The Aletsch Glacier in Switzerland is shrinking dramatically by up to 50 metres in length each year and also the edges are retreating significantly.

Conclusion

Climate leaders are countries that combine three elements: a low carbon intensity of electricity supply, a rapid reduction in their absolute level of emissions, and the maintenance of high levels of GDP. Countries which are leading the way in carbon emissions per GDP are those that have chosen to expand the provision of low-carbon electricity and those with good hydro-power resources.

Countries with strong reliance on coal are in the bottom half of the climate leadership ranking. In terms of absolute emissions, the COP23 host Germany is actually a very poor performer. The decision to shut down its nuclear plants prematurely means Germany has to keep its massive fleet of lignite and hard coal power plants on the grid far into the future. Germany is already failing its 2020 emission reduction targets,

and there is currently no indication that it will do much better in the future. Far from advancing decarbonisation, the antinuclear “Energiewende” has locked Germany into long-term carbon dependency.

On the other hand, the U.K. serves as a strong example where carbon reduction is mandated by law. Recent climate policy actions have started to work, and most recently the country has pledged to shut down its coal burning fleet by 2025; new coal plants can only be built if they are equipped with carbon capture and storage technology.

Alongside actions from decarbonizing space heating, industrial processes and transport, to energy efficiency, demand flexibility and energy storage schemes, we must see a massive expansion in low

carbon electricity provision. Not only do we need to replace global fossil fuelled infrastructure, but also double or triple carbon-free generation capacity to meet rising world energy demand. Nothing should be off the table. Wind, solar, nuclear, hydro and others all need to expand as much as possible, as fast as possible.

We are at a watershed moment in protecting the Earth’s climate. Our response to climate change today will have far-reaching implications so we must choose our path wisely to find the fastest, most cost effective route possible, ensuring human development alongside the protection of nature if we are to succeed globally in making a rapid and meaningful transition away from fossil fuels.





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