EUROPE'S GREEN EXPERIMENT

A COSTLY FAILURE IN UNILATERAL CLIMATE POLICY

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The Global Warming Policy Foundation
Report 52

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‘For they have sowen the winde, and they shall reape the whirlewinde:
it hath no stalke: the budde shall yeeld no meale:
if so be it yeeld, strangers shall swallow it up.‘

Hosea, Chapter 8: verse 7

‘I will show you fear in a handful of dust.‘

T. S. Eliot, *The Waste Land*.

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Summary

Since 1990, the European Union has pursued a rapid decarbonisation strategy, at first based largely on emissions trading but increasingly reliant on thermodynamically incompetent renewable energy. The results have been to increase energy costs, suppress energy demand, and prevent recovery after exogenous shocks such as the financial crisis of 2008 and the global pandemic of 2020. Energy consumption, particularly electricity consumption, has been falling steadily in the EU since about 2005, and it is reasonable to infer that these societies are regressing towards thermodynamic equilibrium, with the effects temporarily buffered by fossil-fuel manufactured goods from Asia. A selection of key findings follows.

The European Union Emissions Trading Scheme

- Phase 3 of the European Union Emissions Trading Scheme (EU ETS) ran from 2013–2021 has added €78 billion to consumer costs in the bloc, with the annual cost now amounting to about €17 billion.
- In 2020, EU member states paid €1.2 billion of ETS revenue to electro-intensive industries to compensate them for cost increases caused by the ETS itself in 2019. This amounts to about 12% of total ETS costs in that year and is clear evidence that the ETS has a detrimental effect on competitiveness. Germany paid €546 million, some 17% of its ETS revenue.

Renewables subsidies and renewables growth

- Income support subsidies (*excluding* tax expenditures) to the renewable sector in the EU27 in the period 2008–21 amount to approximately €770 billion.
- The annual cost of renewable subsidies to consumers in the EU27 currently amounts to €69 billion, with no end in sight.
- Renewables capacity has grown from about 100 GW in 1990, nearly all hydro, to over 500 GW in 2020, about 17% of the world total, with the vast majority of the increase being subsidised wind and solar.

Electricity, gas and transport fuel prices

In the period 2008 to 2018:

- Electricity prices to *households* in the EU have been 80% above those in the G20.
- Electricity prices to *industries* in the EU have been about 30% above those in the G20.
- Gas prices to *households* in the EU have been approximately double those in the G20.
- Gas prices to *industries* in the EU have been between 20% and 30% above those in the G20.
- Diesel prices in the EU have been approximately 10% to 40% above those in the G20.
- Petrol prices in the EU have been approximately 30% to 50% above those in the G20.
- The EU's underlying wholesale prices for electricity and gas were similar to those in the G20, and for both petrol and diesel the EU's wholesale prices were below those in the G20, both indicating that the EU's higher energy prices are due to policy.

Energy consumption

- Up to 2005, final energy consumption in the EU followed a rising trend, but has been falling since, and is now at levels not seen since the early 1990s. Such a deep and sustained decline in energy consumption is unprecedented in the modern era.

- Electricity consumption, a strong indicator of a societal complexity and development, followed a rising trend up to 2008, but has been falling since and is now at levels last seen in the early 2000s. This is also unprecedented.
- In the United Kingdom, electricity consumption has fallen by just under 20% since 2005.
- Energy efficiency cannot in principle result in the observed reduction in energy and electricity use, and the likeliest cause is price rationing and demand destruction.

Conventional generation capacity and system load factor

- In the period 1990–2020, total EU electricity generation capacity has nearly doubled due to growth in renewables, while thermal capacity, which remains essential to system stability, has declined sharply due to regulation and lack of investment signals.
- Electricity industry productivity has fallen because the enlarged generation fleet serves a smaller demand. In 1990 the EU's generation fleet load factor was approximately 56%, but by 2020 this has fallen to 37%.

Emissions abatement costs

- Carbon dioxide abatement costs in the EU are on average several times greater than even high-end estimates of the social cost of carbon ($100/t$CO_2$e), indicating that the economic harm of the EU's mitigation policies is greater than is the climate change it aims to prevent.

Green industrial growth

- Employment in the European wind and solar industries has contracted sharply since 2008, with the Spanish industry falling from over 200,000 jobs in 2008 to under 50,000 in 2021, and the German industry halving from over 60,000 to under 30,000 full-time equivalent jobs. Despite a small absolute increase in employment, the EU's share of global renewables industry employment has fallen from 20% in 2012 to 13% in 2021, and the bloc has substantial presence only in those areas of low-carbon technology, such as biomass, where there is little international competition.
- Subsidised deployment in Europe has failed to give European industries a secure position in the world markets for renewable energy equipment. The field is now dominated by China.

The European Green Deal

- In spite of the overwhelmingly negative results from Europe's green experiment 1990 to 2021, the EU Commission appears to have learned nothing; it has announced still more ambitious targets for low-carbon energy, and has even promised to reduce energy consumption still further, in spite of the obvious dangers.
- Distressed policy correction is inevitable but entails significant reductions in European standards of living. Deferring this correction and persisting with renewable energy will increase the depth of economic sacrifice required to put European society back on a thermodynamically sound energetic footing.

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1. Introduction

The European Union prides itself on being the global leader in attempts to mitigate climate change through policies aimed at reducing the emissions of greenhouse gases. The ambition to take on this role emerged during the later 1990s, coinciding, significantly, with the reunification of Germany. It rapidly became prominent and, by the early part of the new millennium, climate change mitigation had already achieved dominance in the economic policy of the EU and its member states. This trend has continued, and today it is no exaggeration to say that climate mitigation exercises a controlling interest in every aspect of the EU's strategy and tactics. The depth to which the abstract goal of emissions reduction and the particular methods, notably renewable energy, are entrenched can be gauged from the fact that four years after voting to leave the EU, and two years after actually leaving, the United Kingdom is still following the path outlined by the Commission.

It is doubtful whether the supervenience of climate policy in EU thinking will survive the current geopolitical crisis. This is not because Europe's unilateralism has been caught out by the recent resurgence of national conflict – geopolitical strife has never been far away, and indeed has been growing – but rather that the war in Ukraine has brought the failures of the EU's climate policies into sharper focus, and sooner than might have been expected. But this does not mean that the harm of the policies is itself of recent origin. On the contrary, the environmental policies have been damaging to the EU's interests and advantageous to those of its rivals from the very beginning. As this study will demonstrate, the enthusiastic adoption of the green agenda in the 1990s and early 2000s has effectively produced gradual industrial and economic disarmament. That makes the error all the more extraordinary, but it also indicates that the EU must now deal, not just with short-run damage of recent origin, but also with the harms accumulated over two decades and its resultant enfeeblement relative to Europe's competitors. Arresting the decline will be difficult; recovering the situation entirely may be impossible.

What was the EU Commission thinking of when they blundered into these disastrous errors? In general, the EU's climate policies are an attempt, through policy, to internalise the externalities of energy consumption, thus creating an incentive to reduce greenhouse gas emissions and pollutants. It was hoped that this would encourage the rest of the world to do likewise, while also – and this was not entirely consistent – giving the EU's member states, and Germany in particular, a commanding and unassailable lead in the emerging markets of the new green economy. Europe had lost its global dominance in the world of coal and oil and gas; it would recover it through wind and solar and the suppression of fossil fuels in an historic energy transition, which after 2011 came to be known by its German title, the *energiewende*.

These policies were built on a long-standing interest in renewable energy flows, stretching back into the 1930s but first prominent in response to the oil shocks of the 1970s. After 1990, this interest crystallised as demanding targets for levels of renewable energy in final energy consumption, starting in earnest in 2009, and the Emissions Trading Scheme, which began in 2005. These policy instruments were supported by a concerted and extensive program of public communications and supplementary environmental regulation, such as the Large Combustion Plant Directive of 2001, and its successor the Industrial Emissions Directive of 2016, both intended to address industrial release of harmful substances.

This general environmental effort has been tremendous, but the results are still poorly understood by the public upon whom the experiment has been performed. A host of pertinent questions hang in the air unanswered:

- Have the EU member states reduced their emissions?
- Have they reduced them in a cost-effective manner?
- Are the policies setting an economically compelling example to other countries?
- Has a self-supporting and internationally competitive green economy emerged in Europe?
- Is Europe a leading developer of low carbon technologies?
- How much has the green experiment cost?
- Have there been any unintended consequences?
- Can it continue?
- What has been learned?

An onlooker, from the United States perhaps, might note that governmental enthusiasm for the green policies continues, and if anything has grown over the thirty years since 1990. They might assume, quite reasonably, that the EU would only forge ahead in this way if the policies were working. But this assumption would be mistaken. Governments persist in their folly not only because they are too close to their own failures to bring them into focus, but sometimes because persistence is the most effective means by which failure can be concealed. There are none so blind as those that will not see.

However, for those that wish to confront the matter without prejudice, there is no shortage of data, and the questions sketched above can be addressed with sufficient accuracy to permit conclusive answers. This study attempts – on the basis of information published by the renewables industry, by the EU's own data resource, Eurostat, and by the Commission itself – to distil an intelligible description of the main policy instruments, their costs, and their consequences. Its conclusions can be briefly stated as follows. The climate policies adopted by the European Union have:

- degraded the productivity of the energy sector, particularly the electricity sector;
- increased the cost of energy, particularly electricity, through the coerced adoption of thermodynamically incompetent renewables;
- created a strong price-rationing effect that has suppressed energy demand, particularly electricity, within the EU's member states;

- made the European region more dependent on goods and services – including renewable energy generation equipment – from without the EU, principally fossil-fuelled Asia and China;
- produced the longest sustained fall in energy consumption in the modern period, perhaps the longest since the late Middle Ages; the onset of societal instability cannot be ruled out.

Distressed policy correction is inevitable, but the timing is uncertain.

The harmful outcomes sketched above have, to some degree, been offset by the adoption of more efficient end-user energy conversion devices, improvements that would in other circumstances have delivered positive substantial increases in societal complexity and welfare, but in the EU have only prevented a precipitate decline. One might say that, alongside the illusion of intrinsic prosperity created by the import of goods from Asia, energy-efficiency measures have anaesthetised the public to the economic damage of the last thirty years.

Of course, it is undeniable that in terms of its principal goal the EU's policy has been successful. Emissions of greenhouse gases have been reduced significantly in nearly all sectors. However, the abatement cost exceeds even higher estimates of the social cost of carbon, indicating that the environmental policies are causing more harm to European welfare than is the climate change that they aim to prevent. The cure is worse than the disease.

Even if the EU and its member states were to acknowledge their error today, it is unclear whether they could recover gracefully and without considerable societal distress. The malinvestment in renewable energy is on a very large scale; writing it off and rebuilding the energy sector on thermodynamically sound lines will require sacrifices in household income for extended periods. However, there is as yet no sign that the Commission is conscious of the structural harm that it has inflicted on member states, and, in the New Green Deal put forward in 2021, it is now proposing to proceed still further along the same policy track.

A change in course is inevitable and will be forced on member states sooner or later, but the deeply embedded harm of nearly thirty years of error means even a prudent policy correction towards fundamentally cheaper energy will require substantial reductions in European living standards. Failing to undertake this correction as soon as possible will result in still deeper damage and even more costly remedial action. Explaining this to the European people will form the greatest political challenge of the next fifty years.

2. The Emissions Trading Scheme

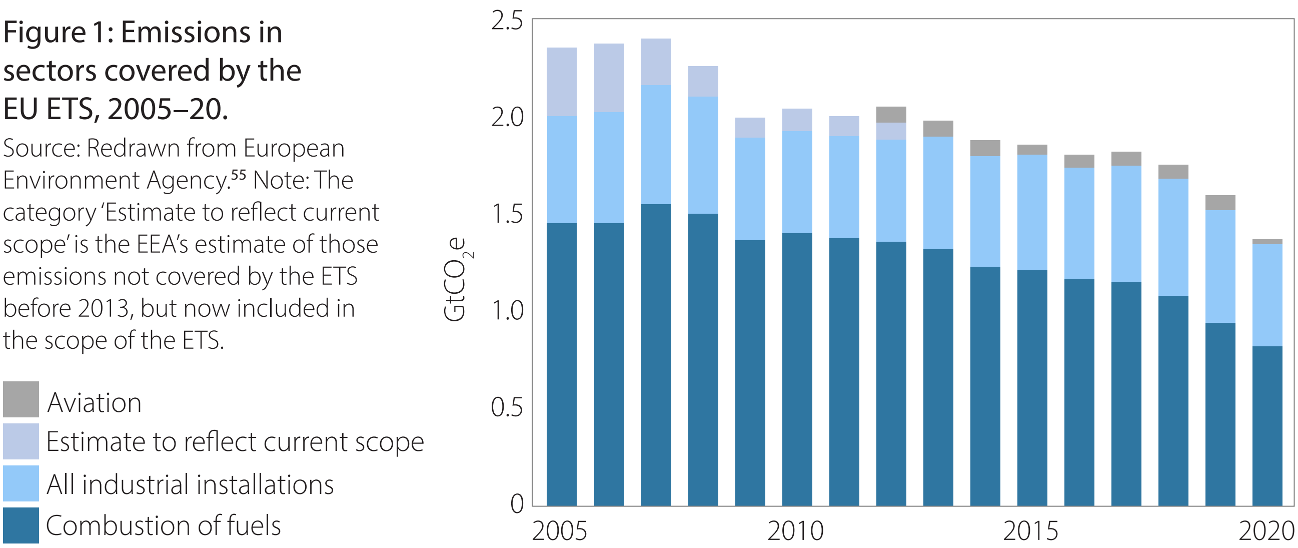
The EU Emissions Trading Scheme (ETS) began in 2005. It is notionally the bloc's principal emissions reduction mechanism and its most powerful attempt to internalise the externalities of energy consumption. In practice, as we shall see, it has been overtaken and marginalised by renewable energy policies, although the ETS remains extremely and increasingly expensive.

The ETS is a cap-and-trade mechanism, covering electricity generation, heat, and energy-intensive industry. The cap guarantees the emissions reduction, while trading of allowances is intended to ensure that reductions can be achieved in the lowest-cost sectors first.

The EU proudly reports that emissions in the sectors covered have fallen by 43% since its introduction and that the scheme is a key contributor to the fact that EU emissions in 2020 are some 31% below 1990 levels, exceeding targets (Figure 1).[1]

Figure 1: Emissions in sectors covered by the EU ETS, 2005–20.

Source: Redrawn from European Environment Agency.[55] Note: The category 'Estimate to reflect current scope' is the EEA's estimate of those emissions not covered by the ETS before 2013, but now included in the scope of the ETS.



However, a causal relation between the ETS and the evident emissions reductions is rather harder to establish than might be imagined. As the authors of one study observe:

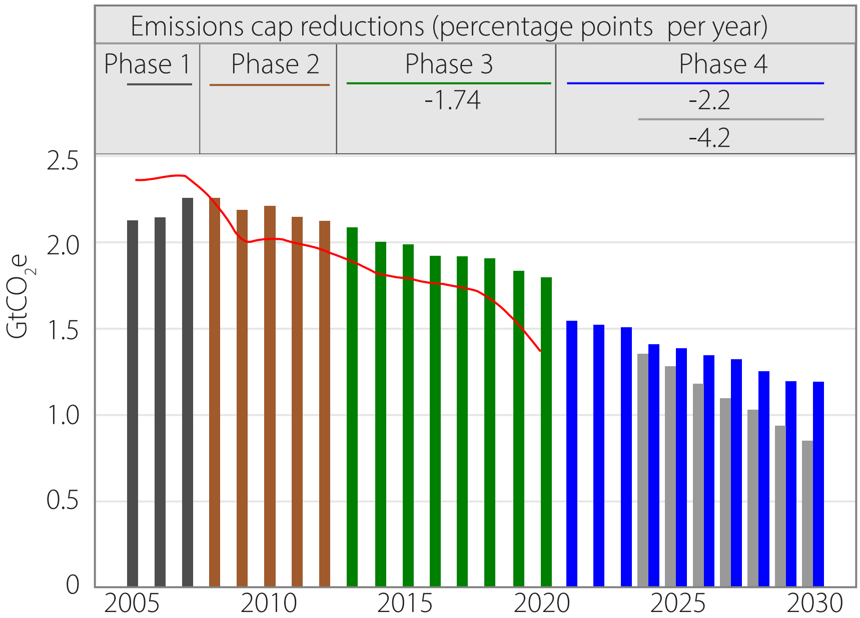
> Changes in emissions depend on both changes in activity levels and the emission intensity of production, influenced by EU and international policies and a wide range of other factors. This makes it challenging to ascertain the extent to which emission reductions are directly attributable to the EU ETS.[2]

While this point may seem subtle – the ETS guarantees the emissions reduction but does not necessarily cause it – the guarantee is real and is created through a cap imposed by legislation, with that cap being reduced by a specified percentage on an annual basis, as summarised in Figure 2. It should be recognised, however, that this decline in emissions is not uniform across all sectors. For example, aviation within the EU exhibits a clear, though undramatic, upward trend over Phase 3 of the ETS, rising

Figure 2: EU ETS emissions cap reduction, 2005–30.

Source: Adapted from COM(2021) 962 final.[56] Commission note: 'The cap for phase 4 reflects the post-BREXIT publication of the EU ETS total volume of allowances in the Commission Decision (EU) 2020/1722.'

— Emissions



from 53.5 $mtCO_2e$ in 2013 to 68.2 $mtCO_2e$ in 2019, only falling in 2020, to 24.9 $mtCO_2e$, as a result of travel restrictions imposed as part of the public health measures addressing the global pandemic.[3] As we shall see, the interaction of climate policies and external shocks acting to reduce economic activity and thus emissions is a recurrent theme in this story.

Aviation is admittedly an exception and its emissions increase should be compared with the 43% reduction at stationary industrial installations (that is, the power sector and industry) cited by the Commission for 2005–20. This would seem to suggest that demand for aviation within the EU was relatively inelastic, while price increases as a result of climate mitigation measures have resulted in demand reduction at stationary installations, a point that will be confirmed when we examine energy consumption in the EU since 1990 and the emissions intensity of industrial energy use (see Figure 35). However, we should not assume that aviation has been unaffected. While demand has increased, it is entirely conceivable that the industry would have grown faster had the ETS not imposed additional costs. There is a strong possibility of lost growth.

Reporting of the revenue received under the scheme was not required until Phase 3 of the EU ETS began in 2013, so the total cost can only be readily assessed after that date. The Commission reports that between 2013 and 2021, approximately €78 billion was raised, a total that is now increasing at about €17 billion a year. These funds are taken as revenue by member governments,[4] and the ETS Directive specifies that at least 50% should be hypothecated for spending on other emissions reduction policies. The Commission justifies this by claiming that overall 'member states spend more on climate- and energy-related purposes than their auctioning revenues'. It is further claimed that as much as 75% of total revenues have been employed for climate-related purposes, with the rest being diverted into consolidated state funds. This must be doubtful, since these other policies, even energy-efficiency subsidies, tend to have dedicated funding streams, usually drawn from consumers.[5] Indeed, the Commission itself now seems to recognise that member states are relying heavily on ETS revenues for their own spending purposes; in documents published to support the European Green Deal in July 2021 (discussed at length below), it is proposed that increased investment in clean technology will be encouraged by 'strengthening rules to ensure that Member States use their EU ETS auction revenues for clean investments'.[6]

On balance, it must be observed that the revenue presented a large opportunity for EU states to increase their incomes, with only doubtful pass-through to other environmental outcomes. It can therefore be seen simply as a tax on energy use. Indeed, member states have on occasion been compelled to redirect a large fraction of the revenues to electro-intensive industries, so as to compensate them for price rises prompted by the scheme. Member states are required to notify the Commission if they spend more than 25% of ETS revenues on such compensation, and in 2020 five member states fell into this category (Table 1).

While the redirection of 37% of French and 25% of Dutch ETS revenues to compensation is striking, the most important finding here is the absolute magnitude of Germany's compensation package for a single year: some €546 million. While this is 17% of Germany's total ETS revenue in 2019, and thus below the notification threshold, it is a very important indicator and, bearing in mind that these payments were permitted within regulations to prevent carbon leakage, is convincing evidence that the scheme has had a strong and harmful effect on international competitiveness. Governments would not intervene in this way if the ETS were neutral or beneficial to national industrial interests.

Table 1: Indirect carbon cost compensation paid out by EU member states in 2020.

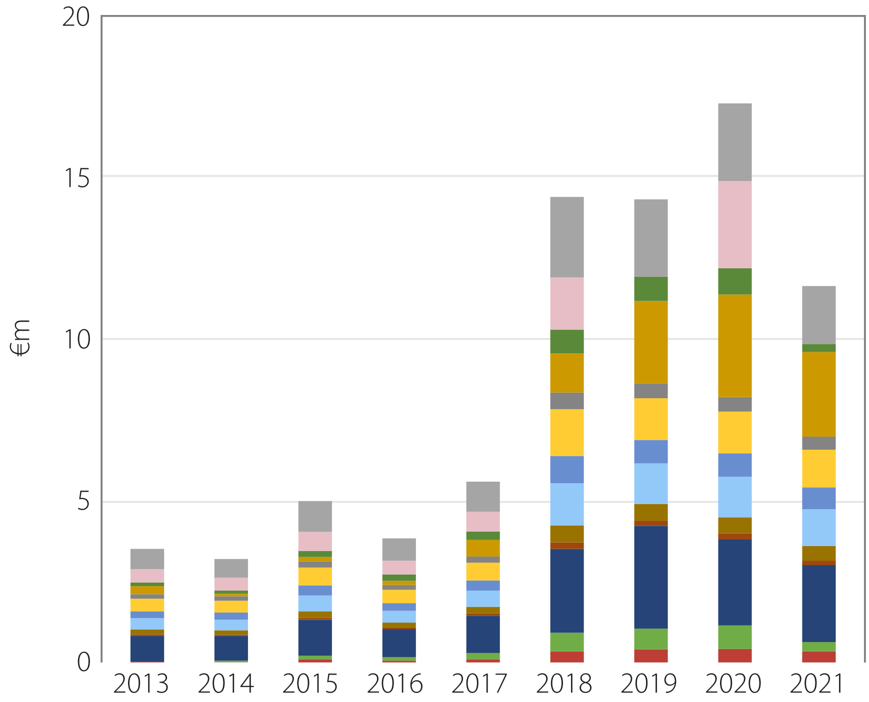
Member state	Compensation (€m)	Auction revenues* (€m)	Percent
Germany	546	3146	17
Belgium (FL)	89	354	31
Belgium (WL)	20		
Netherlands	110	436	25
Greece	42	503	8
Latvia	1	84	1
Sweden	4	244	2
France	266	712	37
Finland	75	217	34
Spain	61	1225	5
Lithuania	11	17	63
Poland	77	2546	3
Romania	–	748	NA
Total	1302	10232	12

*2019, excluding aviation allowances. Source: EU Commission, COM(2021) 962 final.

The macro-economic effects of the costs of the ETS can be assessed from the total cost of auctioned allowances, figures that are readily available but not widely known outside expert circles. Figure 3 is based on data published in a Commission working document that was published alongside a report (COM(2021) 962 final) from the Commission to the European Parliament and the Council.[7]

Figure 3: EU ETS costs (general and aviation) 2013–21, by member country.

Source: EU Commission, and, for UK data 2021, Office for Budget Responsibility. Chart by the author.



The economies of Germany, Poland, Italy, Spain, and the United Kingdom bear the brunt of the EU ETS costs in absolute magnitude, with Poland particularly burdened due to its heavy dependence on coal for industrial use.

Note that receipts for the UK fell to zero in 2019 due to a temporary suspension of the ETS during Brexit negotiations, and the higher costs reported in 2020 are due to the resumption of trading. The UK left the EU ETS in 2021 and now operates its own emissions trading scheme.

In the third trading period, the German state has collected some €15.4 billion in revenue from the EU scheme, the Polish government €10.6 billion, Italy €7.5 billion, and the Spanish and British governments €6.9 billion and €6.7 billion respectively.[8] Together these countries account for €47.2 billion, 60% of the €77.8 billion total revenue taken.

While costs exhibited a weak increase from 2013 to 2017, there was a strong rising trend after 2018, interrupted only by the global pandemic, which caused economic contraction and therefore a reduction in demand for EU emissions allowances. Emissions in the stationary sector were down 11.4% in 2020 and in the aviation sector by 63.5%. The increase in total costs is explained by the fact that prices in the ETS have climbed sharply in Phase 3, as can be seen in Figure 4.

Figure 4: Clearing prices for auctions of general allowances, January 2013 to 30 June 2021.

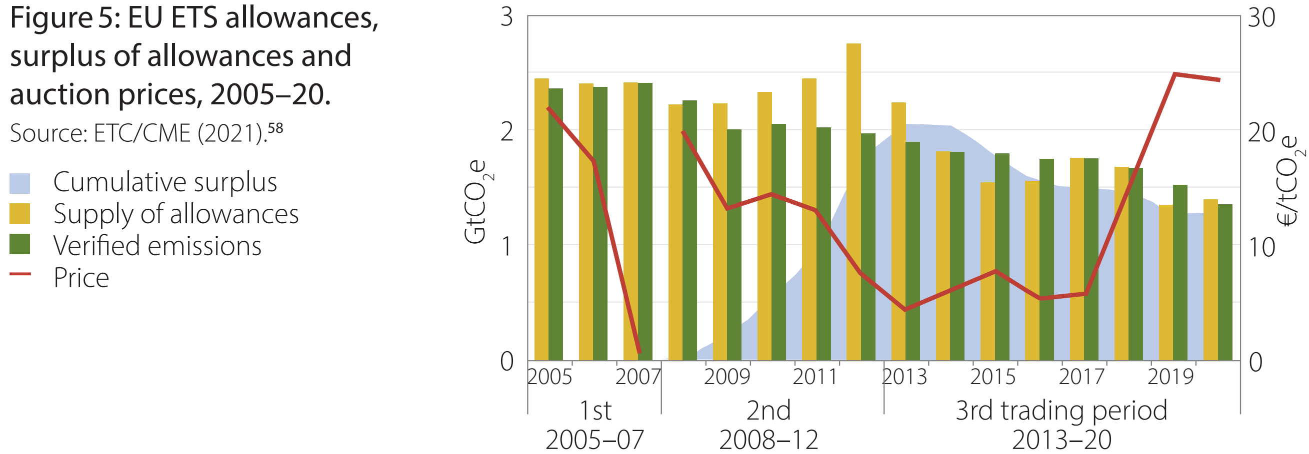
Source: Figure 2 in EU Commission: COM(2021) 962 final.[57]

This increase is the result of:

- the falling cap
- reductions in free allowances
- the withdrawal of 900 million permits by the Commission, in a measure known as 'backloading' (Figure 4)
- the erosion of the cumulative surplus of available certificates (Figure 5).

Figure 5: EU ETS allowances, surplus of allowances and auction prices, 2005–20.

Source: ETC/CME (2021).[58]



The cumulative surplus has been calculated by the original authors as the difference between the allocation of all EUAs, whether allocated for free, auctioned or sold, plus international credits surrendered or exchanged since 2008, minus the cumulative emissions.

Even its critics will concede that, expensive though it has been, the EU ETS might in time have delivered cost-effective results, had it been the sole policy instrument, putting a consistent EU-wide price on carbon and encouraging invention and innovation to reduce emissions and avoid the penalties. But the EU did not permit the ETS to have a clear run, and instead resorted to subsidies for renewable energy. This decision must be regarded as a serious policy design error, since it will have produced no additional emissions savings under the ETS. This is because the ETS not only guarantees the emissions reduction but actually *caps the saving* in those sectors covered. This is little appreciated outside expert circles. The renewables targets and subsidies prevented the ETS from finding the cheapest emissions reductions and instead compelled the adoption of renewable energy regardless. As we shall see in the next section, the cost of reducing emissions through renewable energy have been and continue to be extremely high.

3. Growth in renewable energy

Subsidies to renewables

Subsidies to renewable energy in the EU27 now total €69 billion a year, a sum that vastly outweighs the still very expensive annual €17 billion a year cost of the ETS.

Many members of the public mistakenly believe that fossil fuels in Europe are generously subsidised. The muddle arises because it is uncommon for print and broadcast media coverage of the subject to distinguish between:

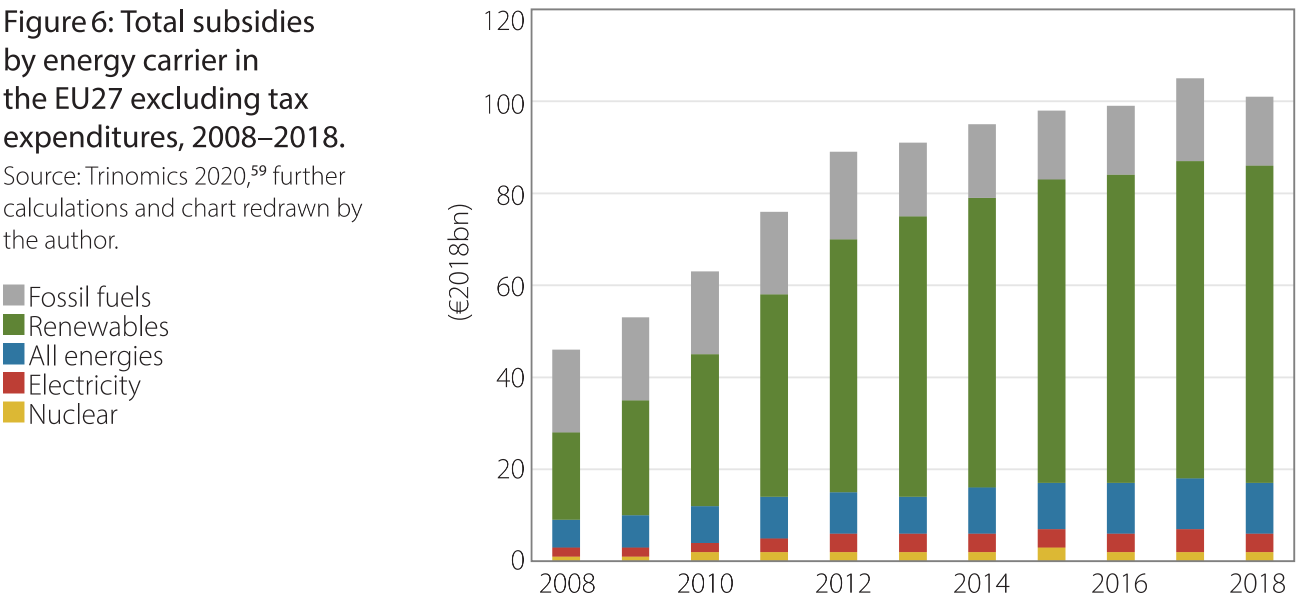
- *tax expenditures* (that is tax exemptions or lower rates of consumption tax)
- direct income support, for example to renewable energy generation plant.

The economic effects are very different. Tax expenditures are revenue foregone, and typically reduce costs to consumers, either directly or indirectly. Direct income support typically increases consumer costs, with levies added to bills in order to transfer wealth to a selected recipient, such as the owner-investors of renewable energy generating equipment. Figure 6 charts subsidies, *excluding* tax expenditures, by fuel type in the EU27[9] between 2008 and 2018.

Subsidies resulting in wealth transfers to the energy sector are dominated by renewable energy, which has grown enor-

Figure 6: Total subsidies by energy carrier in the EU27 excluding tax expenditures, 2008–2018.

Source: Trinomics 2020,[59] further calculations and chart redrawn by the author.



mously over this period. Subsidies to nuclear, unlabelled in the chart for reasons of space, are about €3 billion a year or less and are mainly given for decommissioning purposes. Non-tax expenditure, *direct* subsidy to fossil fuels is in large part accounted for by measures such as price support to fossil-fuelled combined heat and power, which amounted to €8.6 billion in 2008 and still stood at €5.4 billion in 2018. Such measures are part of the attempt to improve efficiency and reduce emissions. Thus, and perhaps bizarrely, these subsidies to fossil fuels can be regarded as a climate-policy cost. However, this study does not approach them in this way.

The major recipients of subsidy in the EU27 have been biomass, solar, and onshore and offshore wind, as represented in Figure 7.

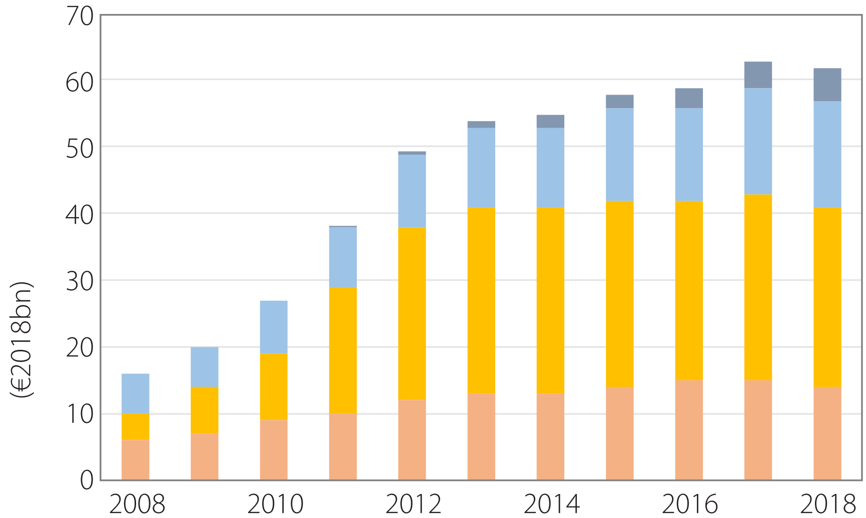


Figure 7: Subsidies to biomass, solar, and onshore and offshore wind in the EU27.

Source: Trinomics 2020,[60] Chart redrawn by the author.

Offshore wind
Onshore wind
Solar
Biomass

Figure 8 represents tax expenditures on the different fuel groups over the same period. The reader should note that by far the largest part of the expenditures charted here are waivers on excise tax on fossil fuels, including carbon taxes. For example, in 2018 total tax expenditures amounted to €57 billion, of which €31 billion were revenue waivers to fossil fuels and €9 billion revenue waivers on electricity, both reducing costs to consumers.

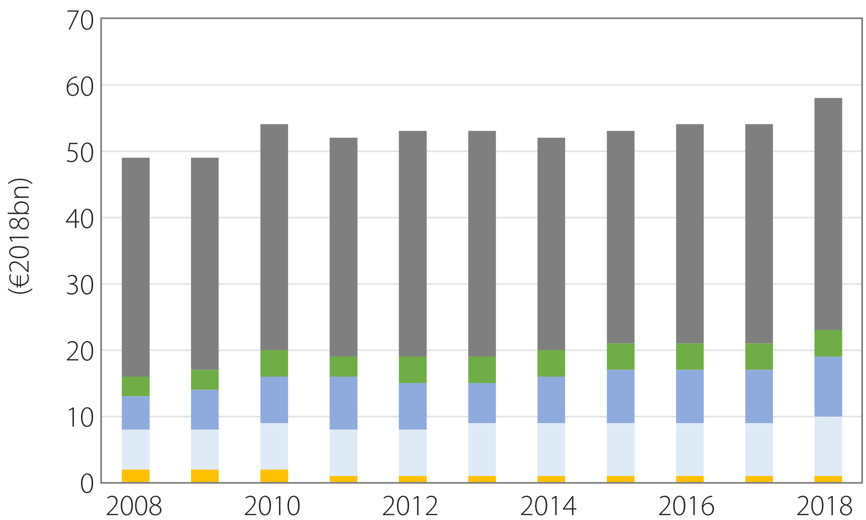


Figure 8: Total tax expenditures by energy carrier in the EU27, 2008–18.

Source: Trinomics 2020,[61] chart redrawn by the author.

Fossil fuels
Renewables
All energies
Electricity
Nuclear

Needless to say, the volumes of tax expenditure to fossil fuels are large because the volumes of fossil fuels consumed in the EU economies are themselves large.

Having distinguished between tax expenditures and direct subsidies, we can now return to the data summarised in Figure 6 and estimate the total non-tax expenditure subsidy to the renewable sector. In the EU27 (excluding the UK, where subsidy costs now total about £10 billion a year) in the period 2008–18 this amounts to about €570 billion, a figure that will have been rising at the rate of approximately €69 billion a year to the present,[10] giving an approximate total to date at the end of 2021 of about €770 billion.

The EU's commitment of subsidies to the renewable energy sector is nearly 70% of the total across major economies, as can be seen in Figure 9, which compares annual subsidies (including tax expenditures) in the EU27, Japan, the UK, the US, and China. Over the period covered in this figure, total subsidies to renewables, including tax expenditures, amounted to €893 billion, of which the EU was responsible for €612 billion.

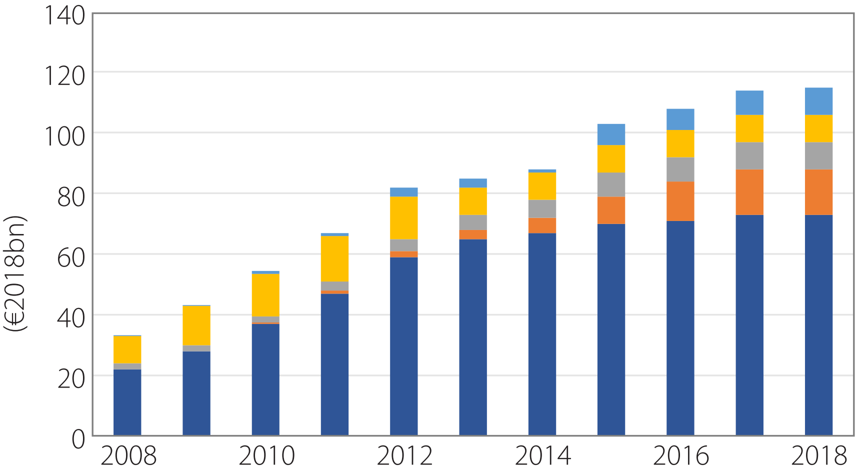


Figure 9: Subsidies to renewables in the major economies, 2008–18.

Including tax expenditures. Source: Trinomics 2020,[62] chart redrawn by the author.

Renewable electricity capacity growth

The scale of the subsidies directed to renewables has had significant effects on the deployment of generation capacity. Figure 10 shows total renewable electricity generation capacity from 1990 to 2020 in the EU28.

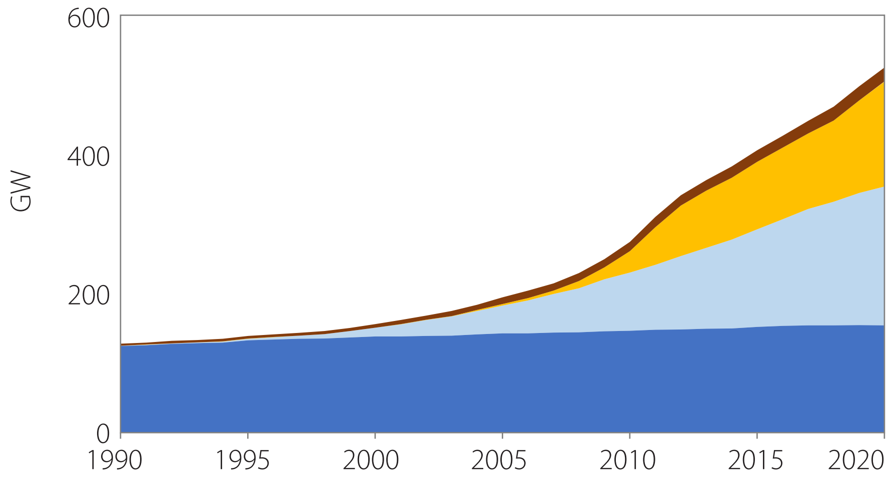


Figure 10: All renewable electricity generation capacity: EU28 1990–2020.

Source: Eurostat. Chart by the author. Note: Hydro includes pumped storage.

Hydropower capacity has hardly changed over the period, indicating that it was a fundamentally economic resource and fully developed, within environmental constraints, before the introduction of climate policies. The principal growth has been in wind and solar – fundamentally uneconomic, high-entropy sources of energy. Their expansion can be seen in Figures 11 and 12, which chart the deployed capacity in selected EU states.

Figure 11: Wind power capacity: selected EU states 1990–2020.

Source: Eurostat; UK Government.

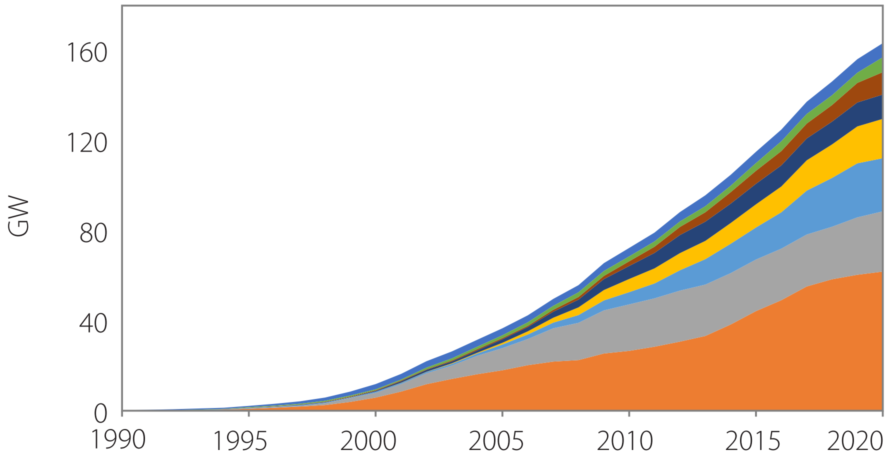
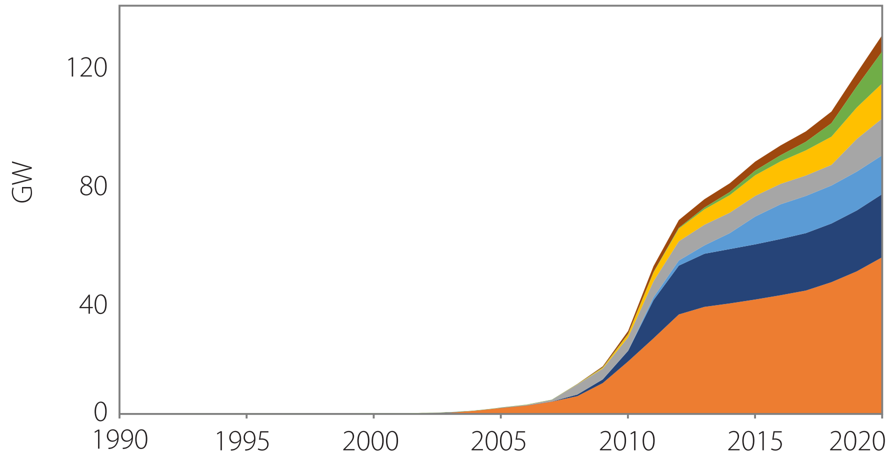


Figure 12: Solar power capacity: selected EU states 1990–2020.

Source: Eurostat; UK Government.



Support for wind began earlier, stimulating rapid growth in capacity, but solar energy is closing the gap, reflecting the generosity of subsidies and its relative ease of development; wind energy provokes fierce opposition, from neighbours onshore and, sometimes, from wildlife protection bodies offshore.

Remarkable though this growth in capacity is in itself, it is even more so in the global context. EU renewables capacity comprised 22% of the global total in 2012 and has only fallen to about 17% in 2021. It exceeds that of the United States and India combined. Indeed, Germany alone accounts for 5% of world total renewable electricity capacity. The EU is, in scale of capacity at least, truly a global leader in the deployment of renewables (see Figure 13), second only to China, whose electricity system, to say nothing of its economy, is very much larger.

These capacity increases have delivered substantial growth in the generation of renewable electrical energy, although due to the poor productivity (load factor, or capacity factor) of both wind and solar, the volumes are smaller than might be expected, amounting

Figure 13: Renewable electricity generation capacity in selected countries, 2012–21.

Source: International Renewable Energy Agency 2022,[63] further calculations and chart by the author.

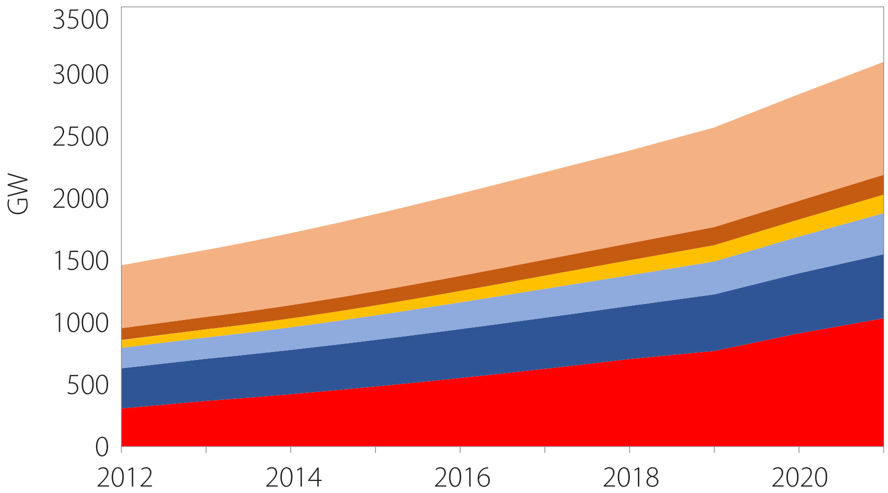


Figure 14: Renewable electricity generation in the EU28, by country: 2004–20.

Source: Eurostat.

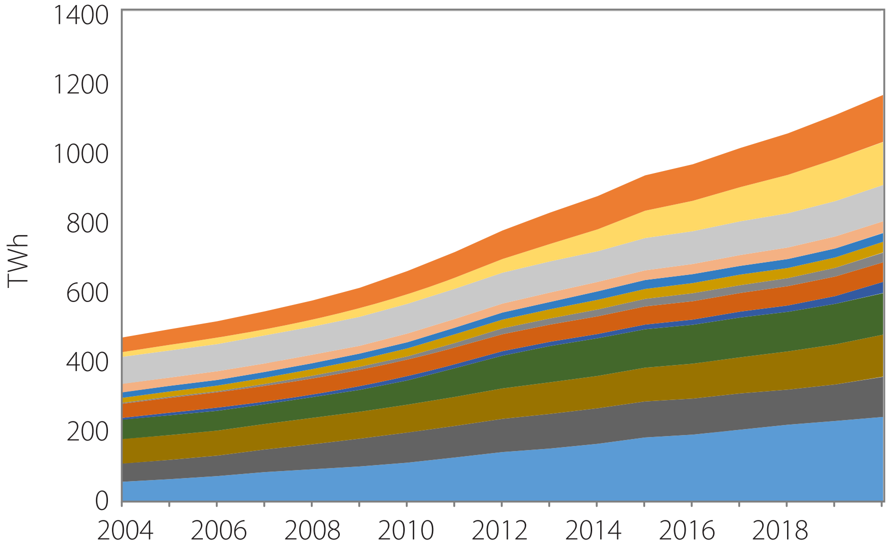
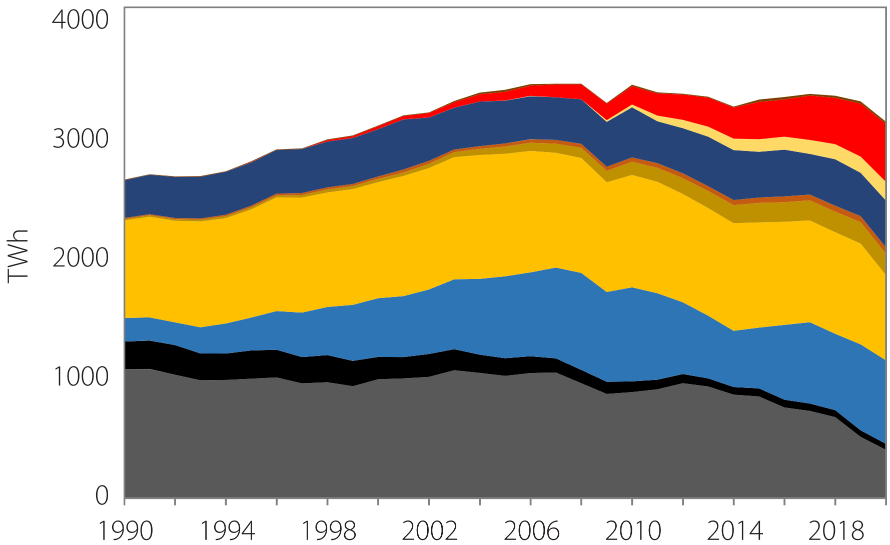


Figure 15: Electricity generation in the EU28 by fuel type, 1990–2020

Source: Data, International Energy Agency, Eurostat, UK Balancing Mechanism Reports. Chart by the author.



only to about 1200 TWh, with the bulk of the contributions coming from Germany, Spain, France, Italy, the UK and Sweden, countries where subsidies have been applied most vigorously (see Figure 14).

This increase needs, however, to be seen in the context of all electricity generation by fuel type, as charted in Figure 15. While the expansion of the renewable sources is large and rapid after

2005, we must observe that, in spite of the very large subsidy expenditures discussed above, renewables still provide only a minority of the electricity required by the EU's member states. Indeed, although fossil fuels have been displaced to some degree, with oil now almost unused, much of the bloc's electrical energy is still supplied by coal, and a very large part now comes from gas. Moreover, it is probable that gas, not renewables, is responsible for the displacement of coal; indeed, it is arguable that a more economically efficient displacement of coal might have been achieved through spontaneous market decisions under the ETS, or even through simple laissez-faire.

The contribution from nuclear was more or less stable until the early 2000s, with few new plants commissioned during the period. However, installed capacity has been declining since 2002, when the EU28 had 138.5 GW, as compared to about 114 GW today; as a consequence, output is declining too.

A similar story can be told for coal, oil, and natural gas, which have seen a fall in output, partly due to coercive market-share allocation to renewables, and partly due to falling demand. Combustion-fuelled generation capacity has fallen sharply in the EU28 since 2012, the result of environmental regulations and a constricted market opportunity. Capacity stood at about 375 GW in 2020, down from a peak of 448 GW in 2012.

A substantial part of the renewables input is derived from hydropower, a mature technology for which the environmentally tolerable opportunities in the EU are largely exploited. Modern renewables – wind and solar – make up 20% of supply, arguably a poor return for such overwhelming market distortions.

But, and this point cannot be overstated, the principal characteristic that stands out from charts such as this is the stagnation and decline in electrical energy use in the EU28 since the middle 2000s. Consumption in the bloc now stands at just over 3000 TWh, a level last seen in the year 2000. Since the peak in 2007, consumption of electricity has fallen by just over 9%. The sharp dip in generation from 2008 to 2009 can confidently be attributed to the financial crash, while the rise in demand in 2010 is the result of the economic recovery consequent on regional and global stimulus packages. But other explanations must be sought for the sustained decline after 2010, which is a departure from the weak but obvious rising trend evident from 1990 to 2007. It is reasonable to infer that the sharply rising renewables input and the subsidy costs required to drive it have had a significant braking effect on the post-crash recovery, resulting in faltering demand for electrical energy. Given the superior, low-entropy characteristics of electricity as an energy carrier and an index of societal complexity and sophistication, this decline must be regarded as extremely unwelcome and deeply concerning. A society in which electricity consumption is falling is almost certainly regressing towards thermodynamic equilibrium, with societal entropy rising across the board, implying a decline in standards of living and a rise in underlying systemic fragility.

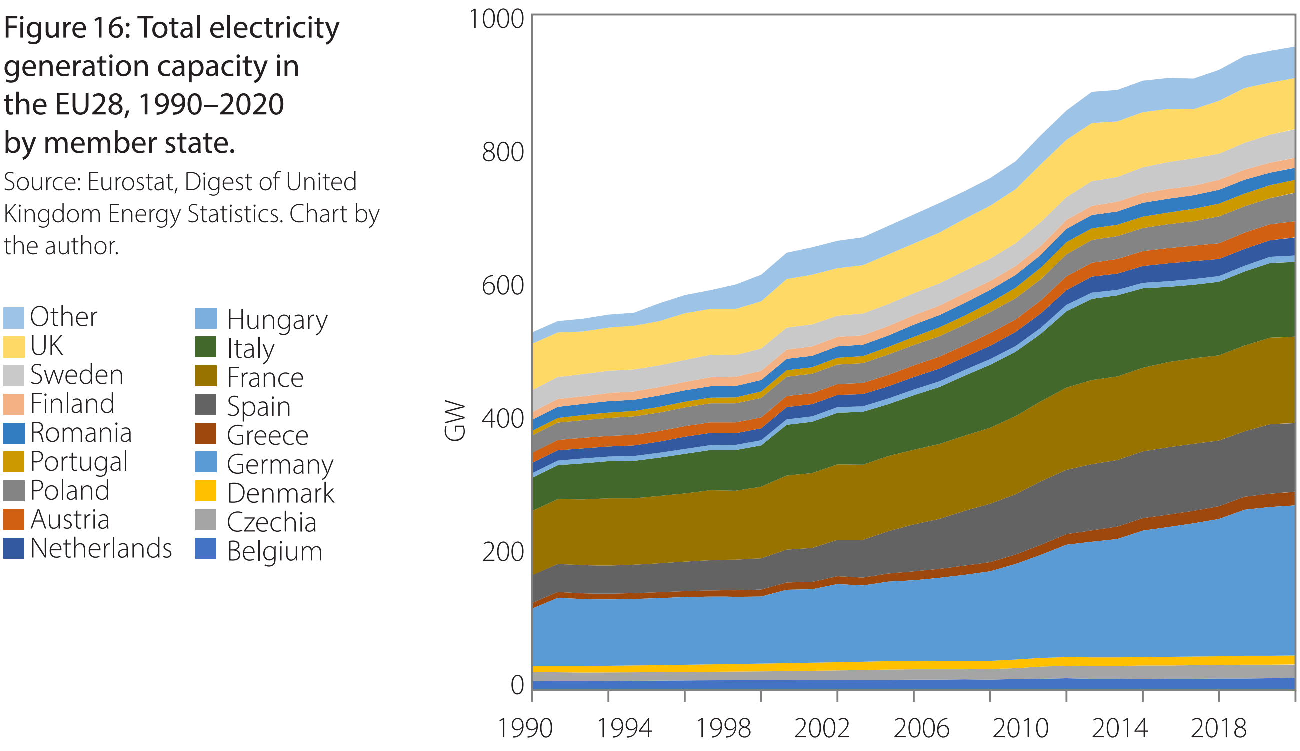
4. Conventional electricity generation

Electricity generation productivity in the EU

We have reviewed renewable generation capacity increases in the EU28 and seen highly significant rises in all technologies, notably wind and solar. The widespread deployment of renewables accounts for the overall increase in the bloc's total generation capacity, which has nearly doubled, from just over 500 GW in 1990 to just under 1000 GW in 2020. Figure 16 charts this remarkable increase, which can be seen in the national fleets of nearly all member states, but with especial prominence in Germany, Spain, and Italy, all countries where renewable development has proceeded at scale. France, which has only recently begun to force renewable technologies into its electricity system, instead relying on its substantial nuclear plant fleet, does not exhibit the same trend.

Figure 16: Total electricity generation capacity in the EU28, 1990–2020 by member state.

Source: Eurostat, Digest of United Kingdom Energy Statistics. Chart by the author.

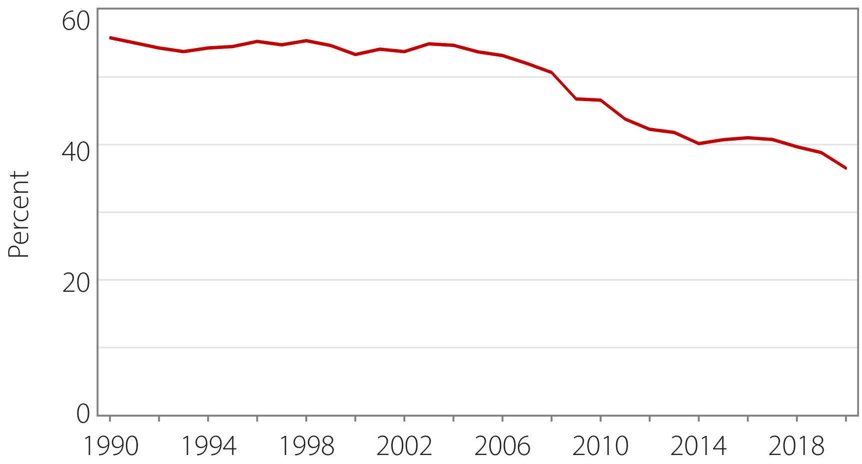


Bearing in mind that this greatly enlarged generation fleet now serves a smaller market, it follows that the productivity of the EU28 electricity sector has fallen. In 1990, the fleet of 531 GW generated 2594 TWh, implying a load factor of 56%, while in 2020 a capacity of 957 GW generated 3065 TWh, with a load factor of just 37%. A collapse in productivity of this order should be a matter for grave concern, particularly given the fact that the unit costs of renewables are so high.[11]

Figure 17 charts the decline in EU generation fleet load factor since 1990, based on the author's calculations from data published by the International Energy Agency and Eurostat. Since fleet capacity figures tend to underestimate the capacity of embedded renewable generation (connected to the low-voltage

Figure 17: EU28 electricity generation fleet load factor 1990–2020.

Source: Author calculations from Eurostat and International Energy Agency data.



distribution network), which is often poorly documented or deliberately excluded from the statistics, it is likely that the decline in productivity is understated.

The figure can be read as showing that the fleet load factor was stable at around 55% from 1990 to about 2005, when it began a steady decline, reaching a plateau in about 2012 as substantial quantities of conventional capacity were closed (discussed in relation to the Large Combustion Plant Directive on page 17), a change that increased the utilisation of the remainder. However, fleet load factor now appears to be entering a new period of decline; from 2005 to 2020 it has fallen by 18 percentage points.

Individual conventional generators will exhibit this decline to different degrees, according to the role that they play in the market but, taken as a general characteristic, falling fleet load factors represent a strong disincentive to invest in any form of dispatchable generation. This destruction of incentive is all the more remarkable and harmful since dispatchable generation remains essential to guarantee security of supply in the face of high levels of wind and solar capacity. As a result, several member states have resorted to Capacity Mechanisms – further subsidies – in an effort to prevent existing plant from leaving the market, and to give encouragement, albeit weak, to investors in new generation.[12] These mechanisms, which are in effect payments to exist – that is, payments to generators regardless of output – are extremely expensive. The UK scheme[13] has cost consumers £900 million in the year 2021–22, a figure that is expected to rise to £1.5 billion per year by 2025. However, as we shall see in the next section, declines in conventional capacity continue at a significant rate, despite these subsidies.

Conventional thermal capacity in the EU

Although there have been large increases in the capacities of renewable generation, the fleets of wind and photovoltaic generators contribute little or nothing to system security, a weakness arising from the high entropy (disorder) of their fuel flows: the wind and the solar flux. Consequently, the national electricity systems of individual member states and the interconnected European system as a whole are still dependent on conventional generators to guarantee security of supply. Given this reliance, it is very striking that both combustion capacity and nuclear capacity show significant declines over time, as can be seen in Figures 18 and 19.

Nuclear capacity rose steadily, though only modestly, from 1990 to the late 2000s, but has declined significantly since that time, as the closure rate has exceeded the replacement rate. On the other hand, generation capacity based on the combustion of fuels, mostly coal and increasingly gas, rose steadily up until 2012, when it abruptly began an equally steady decline. This

Figure 18: Nuclear electricity generation capacity in the EU28, 1990–2020.

Source: Eurostat, Digest of United Kingdom Energy Statistics. Chart by the author.

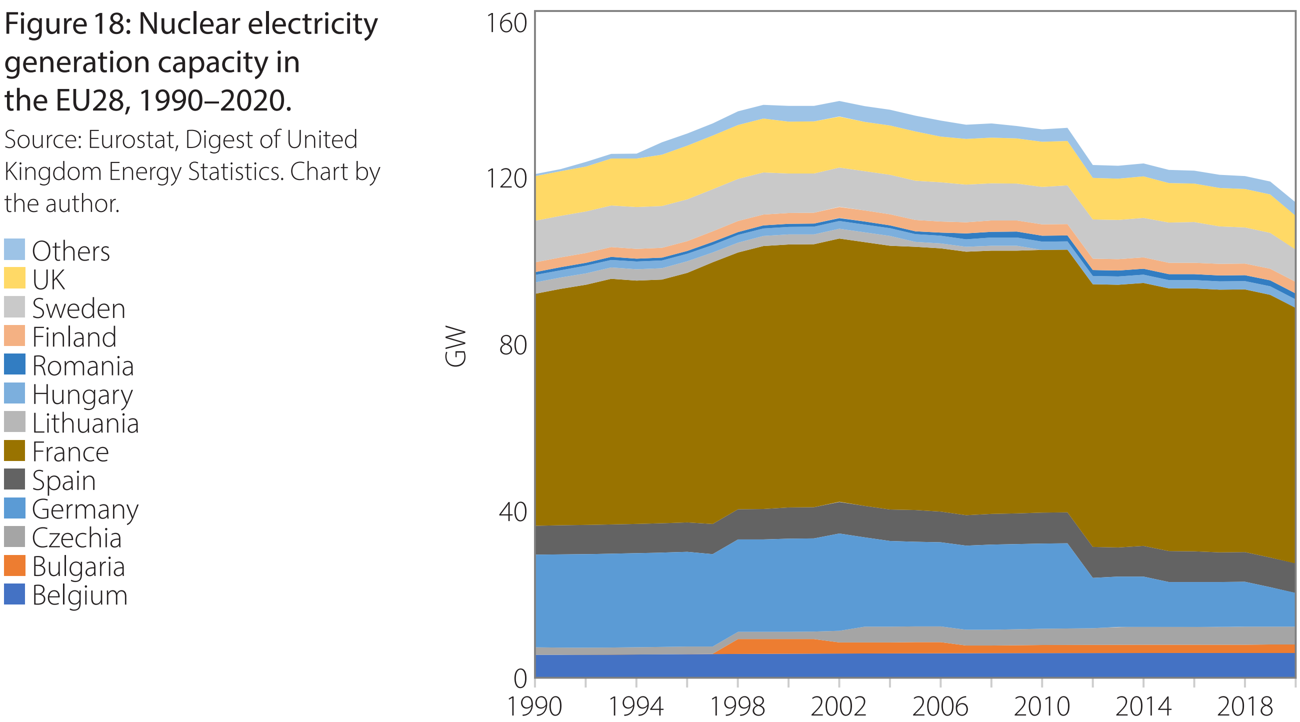
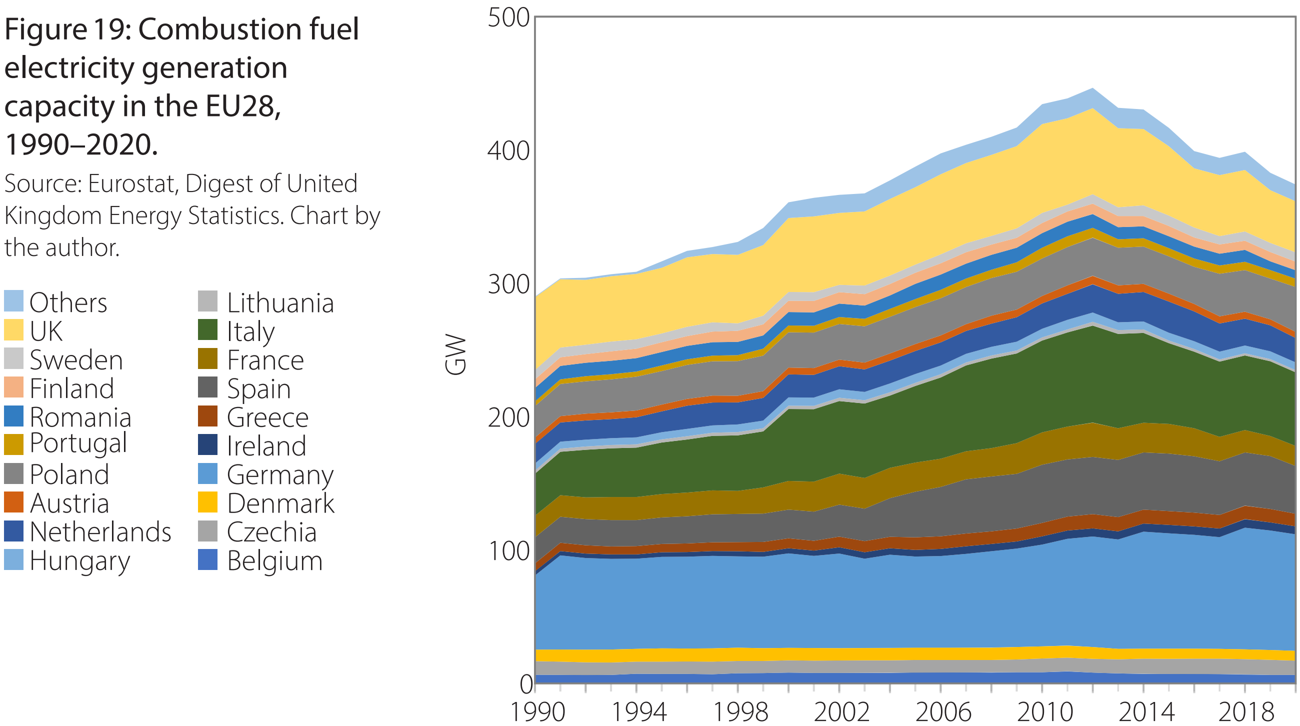


Figure 19: Combustion fuel electricity generation capacity in the EU28, 1990–2020.

Source: Eurostat, Digest of United Kingdom Energy Statistics. Chart by the author.



was the result of the Large Combustion Plant Directive of 2001 (LCPD)[14] and its successor, the 2016 Industrial Emissions Directive (IED).[15] These directives are not part of the climate package, but were intended to reduce the release of pollutants, particularly acidifying pollutants, particulate matter, and precursors to ozone. As the EU itself puts it:

> Control of emissions from large combustion plants - those whose rated thermal input is equal to or greater than 50 MW – plays an important role in the Union's efforts to combat acidification, eutrophication and ground-level ozone as part of the overall strategy to reduce air pollution.[16]

These may have been laudable goals, but in practice they have had damaging consequences. The LCPD limited the operation of older combustion plants unless they fitted costly equipment such as flue gas desulphurisation (to reduce the release of sulphur dioxide), selective catalytic reduction (to limit release of oxides of nitrogen), and measures to reduce the release of fine dust particles. Those plants that chose not to fit such equipment opted out of the scheme and were forced to close after a further 20,000 operational hours, or by 2015 at the latest. Some member states, such as the United Kingdom, whose coal stations were older, had high opt-out rates, and saw quite sharp declines in combustion-fuelled electricity generation capacity, but nearly all EU fleets were affected to some degree, as Figure 19 shows.

The IED applies to industrial operations in general, including electricity generation plant, and requires the use of 'best available technologies' to reduce the release of pollutants. The criteria are so strict and the costs of compliance so high that investment in new power plant has, in effect, been discouraged, and many existing installations have applied for exemption on the grounds that modifications required do not pass a cost-benefit analysis.

The combined effect of the LCPD and the IED, together with the market distortions favouring renewables, can clearly be seen in Figure 19. The EU's fleet of combustion-based electricity generating plant has fallen from a peak of about 450 GW in 2012 to about 375 GW in 2020, a 17% decline in less than a decade. Were the renewables fleet dispatchable and contributing significantly to securing supply, the erosion of thermal capacity might be a matter of little concern, but wind and solar are inflexible and only controllable to a limited degree, and cannot promise with any high degree of confidence to meet demand. Consequently, the rapid decline in thermal capacity, just as wind and solar capacity reached very high levels, is a powerful indicator that the EU's electricity system is becoming fragile. Interruptions in supply are not yet at levels high or widespread enough to cause public anxiety, although the United Kingdom did experience a serious nationwide blackout on 9 August 2019, when a lightning strike on a transmission cable caused a voltage disturbance that resulted in quantities of generation with inadequate fault ride through characteristics, including one large wind farm, to disconnect.[17]

The Electricity System Operator, National Grid, was compelled to disconnect 5% of load – about 1 million customers, including railway networks and airports – in order to protect the remainder of the system. Debate around the proximal causes of the event is largely beside the point. The general and distal cause of the blackout is system fragility. Lightning strikes on transmission cables are not uncommon, and a robust system should be able to manage such events without consumer disconnection. In this case it could not.

But the UK blackout was an exceptional event. For the most part, electricity systems are revealing their fragility and the problems caused by declines in dispatchable capacity through increased balancing costs. Again, the UK provides good evidence. In the early part of the 2000s, annual balancing costs were under £500 million, and they were still at this level in 2015. By 2020 they had risen to £1.3 billion,[18] a trend that has continued, with the costs in the last year, April 2021 to 2022 amounting to £2.2 billion in the Balancing Mechanism.[19] Not all of this increase can be attributed to the presence of renewables, but much of it can be. It would be in the public interest if there were an econometric study of balancing and transmission costs in the European region over the last twenty years; it could determine how much more expensive this essential ancillary service has become as a result of the coerced introduction of renewables and the decline in flexible thermal plant.

5. Renewable heat and cooling

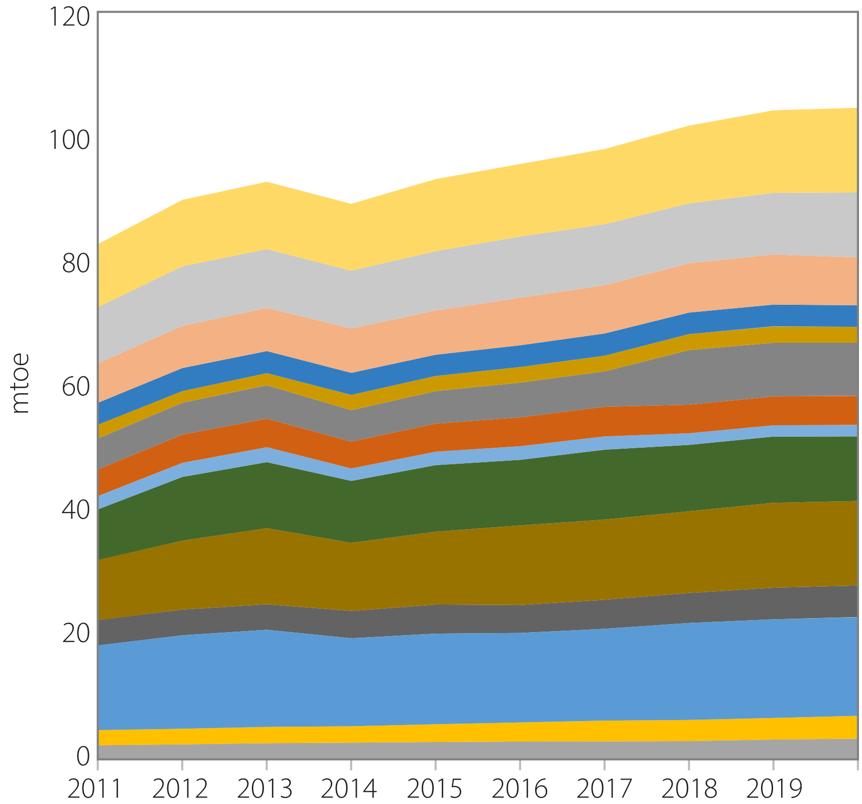
The provision of heating and cooling is one of the most difficult areas to decarbonise. Renewable energy has no direct option for high-temperature heat and relies on low-temperature sources such as the combustion of biomass, gaseous biofuels, solar thermal energy, and geothermal, or on a secondary carrier such as electricity to drive heat pumps. Another carrier, hydrogen, is expected to be deployed for both domestic and industrial heat in the future. However, both electricity and hydrogen are likely to remain relatively expensive ways to provide heat, due to losses and system costs. Figure 20 charts the EU27's progress in increasing the renewable share in energy for heating and cooling, and demonstrates the difficulties experienced by member states.

Progress over the decade has been significant, with a 26% increase on the 2011 level; in 2020, renewables accounted for 23% of the total energy used for heating and cooling in the EU, having risen from 12% in 2004.[20] But the overall total of renewable heating and cooling remains only moderate, at 105 million tonnes of oil equivalent (mtoe) per year. To put this figure into context, the EU27's final consumption of energy is about 975 mtoe per annum, and primary input amounts to about 1,800 mtoe.

But of particular interest is the very broad spread of achievement in this sector, with some countries, such as Sweden, having achieved high shares, and others only relatively low ones. By and

Figure 20: Renewable energy for heating and cooling in the EU27, 2011–2020.

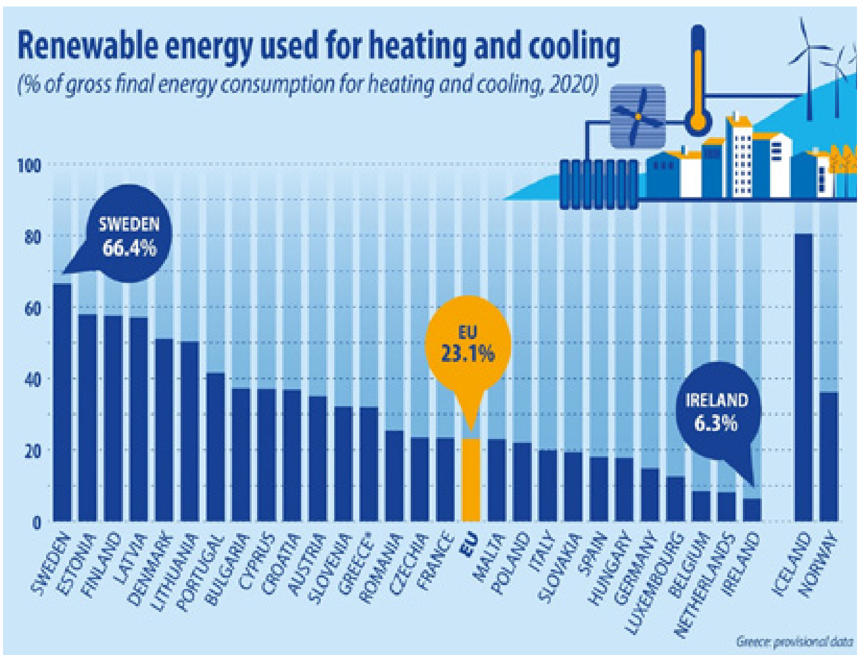
Gross final consumption. Source: Eurostat.



large, those member states with high shares tend to be small, or less industrialised, and with access to low-cost biomass, such as Sweden itself. Larger, more industrialised states, such as Germany, have low shares of renewable energy in their heating and cooling demand, in spite of exceptional efforts in renewable energy overall. Figure 21, an infographic generated by the EU, provides a graphic representation of this variation, with the larger, industrial economies around or below the mean.

Figure 21: Renewable energy used for heating and cooling.

Percentage of gross final consumption in 2020. Source: Eurostat.[64]

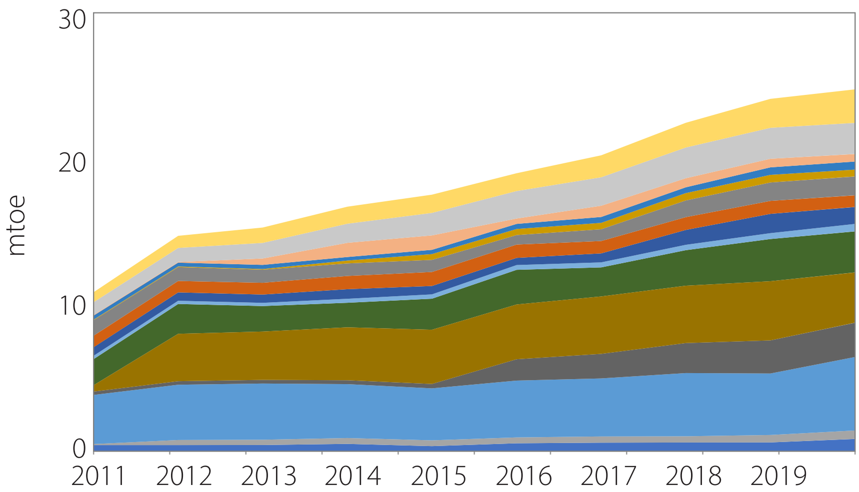


6. Renewable transport fuel

Transport fuels are the only area in EU energy and climate policy where there is a specific and mandatory share of sectoral consumption imposed on member states. The 2009 Renewable Energy Directive (RED; 2009/28/EC) mandated that 10% of energy used in this sector should be from renewables, but allowed member states to make their own decisions elsewhere. The mandatory transport percentage proved to be very difficult, and not all member states were successful in meeting the target. However, at the overall EU level, 10% of transport fuel was derived from renewable sources in 2020. Growth in the sector can be seen in Figure 22.

Figure 22: Renewable transport fuel in the EU27, 2011–20.

Gross final consumption. Source: Eurostat.



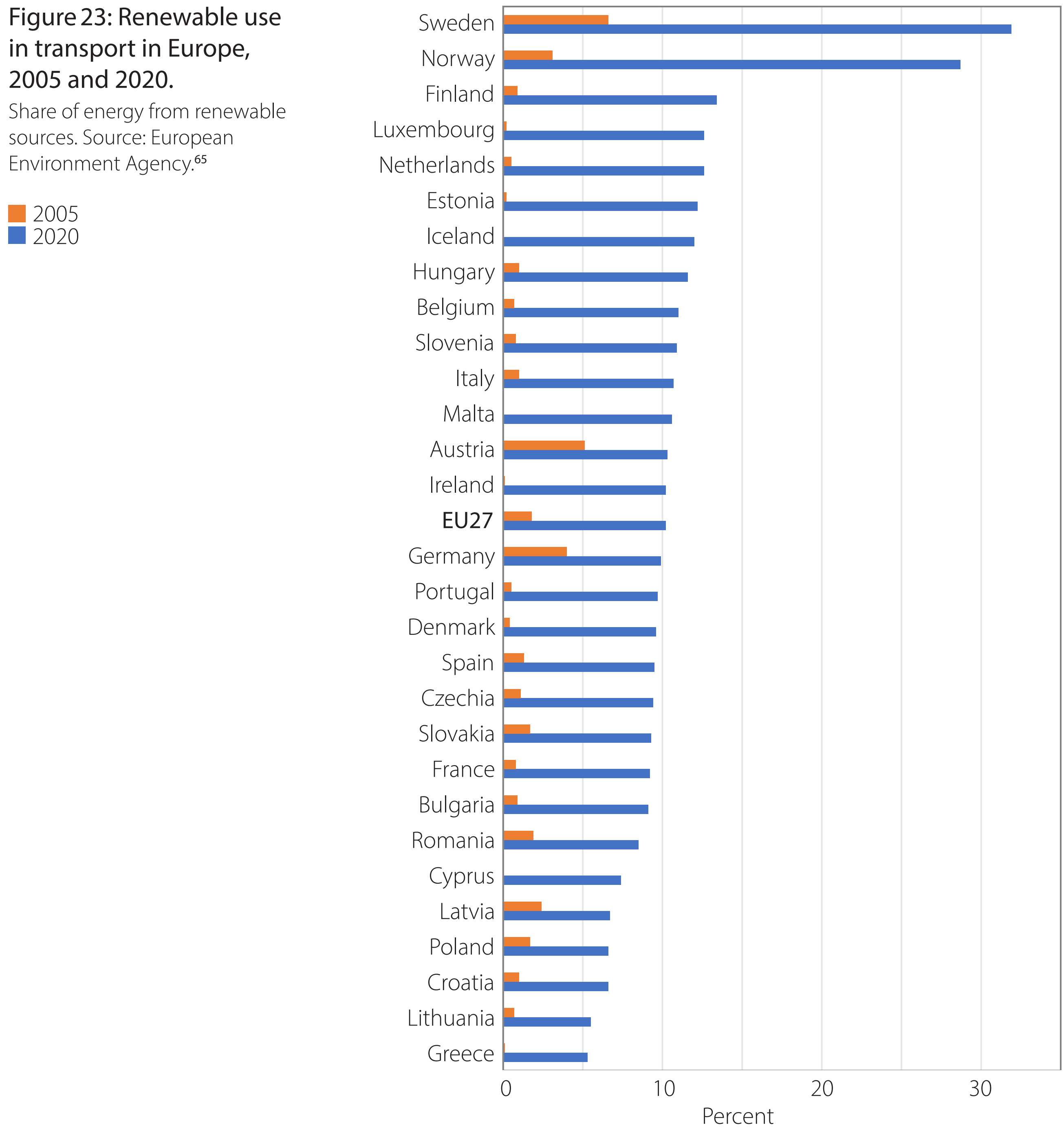
The proportional increase is clearly significant, with 2020 levels 127% above those in 2011, but, as with renewable heat, performance over the EU member states is uneven. As the European Environment Agency itself concedes: 'The overall EU target was reached thanks to overachievement in a handful of countries.'[21] Figure 23, redrawn from an EU Environment Agency chart, represents output in 2005 and 2020, and compares both figures with the 2020 target.

Once again, smaller, less industrial states, and particularly those with access to cheap biomass, tend to have met their targets easily or even exceeded them, while larger, industrial states have only just met them, or missed them by some margin.

Notwithstanding these difficulties, the 2018 Renewable Energy Directive has increased the mandatory target to 14% of transport fuel by 2030. However, the European Green Deal announced by the Commission in 2021 can be read as suggesting that enthusiasm for biofuels is waning. While the Commission insists that 'transport needs to cut emissions by 90% by 2050',[22] the emphasis is now on extending the Emissions Trading Scheme to road transport and the maritime sector, and on electric vehicles and hydrogen-fuelled cars, vans, and trucks. There are references to a 2.2% target for 'advanced biofuels', but overall one has the strong suspicion that the Commission is allowing the liquid biofuel agenda to slip quietly into history.

Figure 23: Renewable use in transport in Europe, 2005 and 2020.

Share of energy from renewable sources. Source: European Environment Agency.[65]



7. Total renewable energy progress

The EU has slightly exceeded its target for renewable energy in gross final energy consumption, as can be seen in Figure 24. However, this achievement must be judged according to its extraordinarily high cost – in the region of €770bn, as we have seen – and against the background of stalling and then falling energy consumption, particularly in electricity. The price of success is not always acceptable, and in this case the long-term damage to the European economies is likely to be substantial and difficult to repair. Putting these questions aside, we can turn to another metric that sheds an important light on the achievement of the targets, namely the emissions abatement costs and their relation to the estimated harms of climate change: the social cost of carbon.

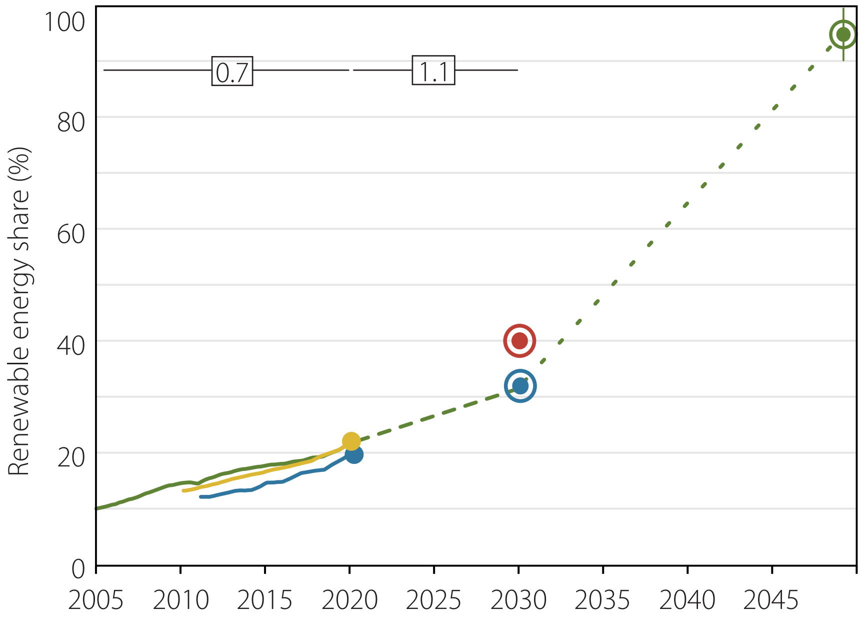
Figure 24: Historical trends and sources on renewable energy shares.

Percentage of renewable energy in gross final energy. Source: European Environment Agency.[66]

- Actual
- Member state action plans
- Renewable energy directive

Targets:
- 2030 proposed (40%)
- 2030 current (32%)
- 2050 (range)

0.7 Rate of change (% points per year)



8. Costs and benefits

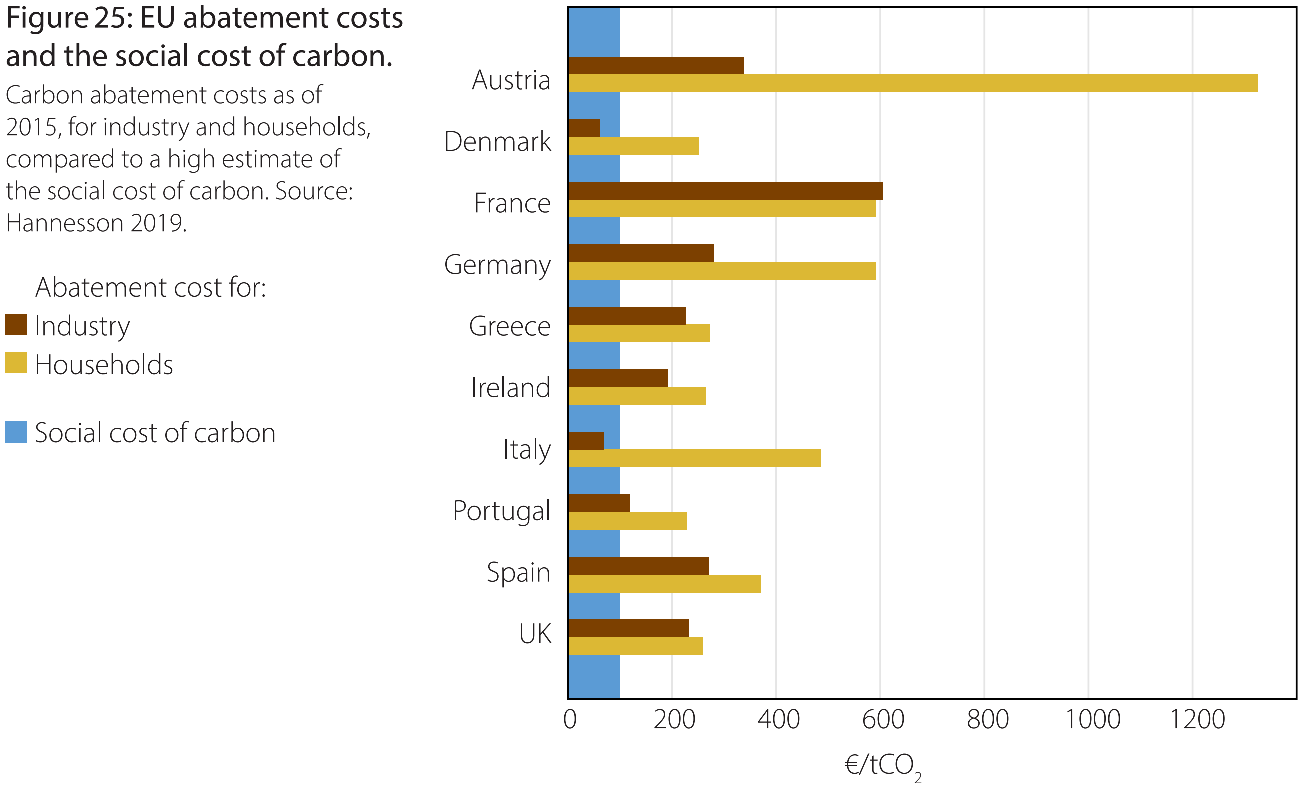
The key test of any emissions mitigation policy is the comparison of the abatement cost and the social cost of carbon. The abatement cost represents the bill to be paid in preventing or avoiding the release of a quantity of carbon dioxide, while the social cost of carbon is a monetised estimate of the harm to human welfare that would be caused by the release of that carbon dioxide. In policy evaluation, abatement costs should, obviously, never exceed the social cost of carbon; otherwise the cure would be worse than the disease.

Abatement costs, though frequently intricate in calculation, are not deeply problematic and there is little real disagreement about them, although there is some uncertainty about the full system cost of renewables. However, estimates of the social cost of carbon are complex and prone to deep uncertainties, because there is so much disagreement about the sensitivity of the ocean-atmosphere system to the release of additional carbon dioxide, and consequently about the scale and pace of climate change and the threat that it poses. This debate results in a broad range of estimates for the social cost. Nevertheless, there is general agreement it is in the region of \$50 (at 2007 prices) per tonne of carbon dioxide equivalent (\$50/tCO_2e), with estimates under that level being regarded as *low* and those above being regarded as *high*. A recent study by Rögnvaldur Hannesson, of the Norwegian School of Economics, has calculated the abatement costs from EU policies and compared them to the 'very high, if unlikely' social cost estimate of \$105/tCO_2e reported by President Obama's Interagency Working Group on Social Cost of Greenhouse Gases.[23] The Working Group's central range was in the region of \$11–56/tCO_2e. Studies prepared for the Commission in 2020 take a somewhat different view and use a figure of about €100/tCO_2e as their central benchmark.[24]

Hannesson's findings are summarised in Figure 25, with the €100/tCO_2e level of SCC represented by the blue area, and abatement costs to households and industries represented by the yellow and brown bars respectively. As can be seen, nearly all abatement costs in these EU economies, whether industrial or household, are very significantly in excess of the estimated social cost of carbon. We should note in particular that abatement costs in France are six times as high, as are those to German households. The harm to human welfare from the mitigation policies is much greater than that of the climate change they aim to prevent. This finding is consistent with the price rises observed in the EU and, this paper argues, with the alarming falls in energy and particularly electricity consumption across all member states.

Figure 25: EU abatement costs and the social cost of carbon.

Carbon abatement costs as of 2015, for industry and households, compared to a high estimate of the social cost of carbon. Source: Hannesson 2019.



It must be emphasised that these are not controversial findings, and they are readily replicated by examination of the costs of national renewable energy support mechanisms and emissions abatement in the relevant systems. Table 2 is drawn from work published by the present author and Dr Lee Moroney of the Renewable Energy Foundation in 2018, and calculates the abatement costs of various renewable technologies in the United Kingdom.

Such figures can be compared with other estimates of the social cost of carbon, for example, in Marten (2011), which suggests a range of \$0–206/tCO_2,[25] or work by the Environmental Protection Agency of the United States government, which finds a value ranging from \$12–120/tCO_2 in 2015, depending on discount rate, and \$29–240/tCO_2 in 2050.[26]

Table 2: Estimated abatement costs per tonne of carbon dioxide in the United Kingdom.

Technology type and band	Subsidy cost $/$tCO_2$
Roof mounted solar PV	380–1450*
Free-standing solar PV	228
Small onshore wind (<500 kW)	608
Large onshore wind (>1 MW)	137
Offshore wind	274
Dedicated biomass	198
Hydro	0–137–380*
Anaerobic digestion	274–380*
Incinerated municipal biomass	0

Source: Calculations by the authors from subsidy and grid average abatement figures from the United Kingdom's Department of Energy and Climate Change and the Department of Environment, Food, and Rural Affairs; where multiple costs per tonne of CO_2 appear, this reflects the increasing level of subsidy as the size of the generator decreases. Redrawn from Constable and Moroney 2018.[67] *Where ranges of subsidy costs are reported, this results from different levels of subsidy offered to sites of varying generating capacities, smaller sites generally having high levels of subsidy.

Results such as these shed a harsh and critical light on the EU's emissions reduction policies. Regardless of whether one takes Hannesson's position and sees €100/tCO_2e as a high estimate or accepts the Commission's view that this is a central value, the data in Figure 25 indicate that after almost twenty years of subsidy support, the abatement routes selected by EU policymakers remain economically irrational.

9. Energy efficiency

Energy efficiency measures have been central to the EU's climate policies since the introduction of regulations in 2006, but they have become progressively more prominent, and figure very large in the new European Green Deal (see Figure 52 and adjacent discussion below).

The Energy Efficiency Directive approved by the European Parliament on 11 September 2012 set out targets for energy efficiency. It aimed to reduce EU primary energy consumption in 2020 by 20% to no more than 1,474 mtoe at the primary energy level, or no more than 1,078 mtoe at the final energy consumption level. The target was revised on the accession of Croatia to the EU in 2013, and now specifies 1,483 mtoe of primary energy or no more than 1,086 mtoe of final energy.

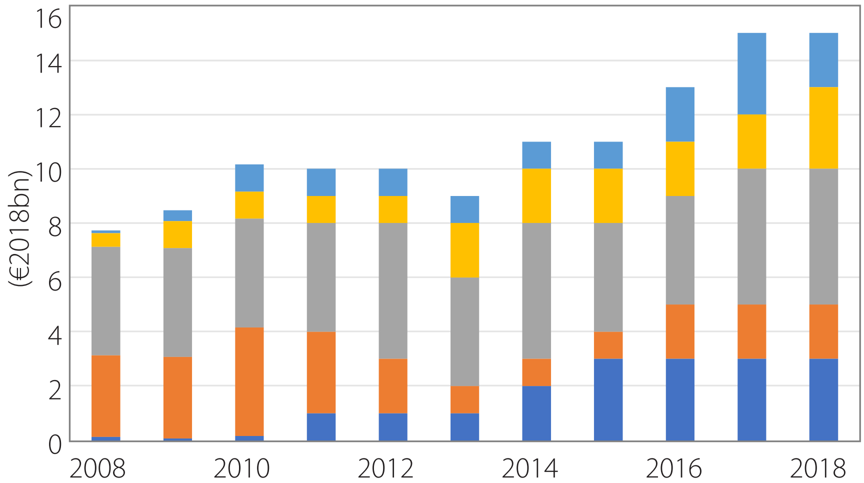
Considerable quantities of public funds have been directed towards encouraging energy efficiency. Figure 26 charts subsidies for energy efficiency in the EU27 from 2008 until 2018, analysed by support type.

For 2008 to 2018, the total committed amounts to about €120 billion. As can be seen, tax expenditures are the single largest type of support, amounting to €5.3 billion in 2018, or about 36% of the total in that year. Tax expenditures in this case seem

Figure 26: Subsidies for energy efficiency in the EU27, 2008–18, by support type.

Source: Redrawn from Trinomics 2020.[68]

- Energy efficiency obligations
- Soft loans
- Grants
- Tax credits
- Tax allowances



entirely legitimate since they remove an artificial discouragement and leave individuals and companies to decide whether and how to make use of the opportunity. Grants, soft loans, and energy-efficiency obligations, on the other hand, run the considerable risk of prejudicing judgment and creating the conditions for suboptimal decisions. Such potentially counterproductive and counter-economic interventions represent the majority of the EU's support for efficency measures – some €79 billion – in the eleven years under consideration. Since there is no reason for believing that households or businesses will neglect energy efficiency – it is, after all, cash on the table – the present author regards this expenditure as either redundant or positively harmful.

However, the deepest problem with the Commission's approach to energy efficiency lies in what was expected and promised from the widespread adoption of measures in this area. From the outset – the 2006 Action Plan for Energy Efficiency[27] – the Commission has believed that improvements in energy efficiency would deliver energy conservation and reduce consumption, writing that 'Europe continues to waste 20% of its energy due to inefficiency':

> A paradigm shift is required to change the behavioural patterns of our societies, so that we use less energy while enjoying the same quality of life. Producers will have to be encouraged to develop more energy-efficient technologies and products, and consumers will need stronger incentives to buy such products and use them rationally. (p. 3)

But this approach is grounded in a simple conceptual error: *efficiency* and *conservation* are entirely distinct concepts. Efficiency does not and cannot lead to conservation. As W. S. Jevons wrote in 1865, it is:

> …wholly a confusion of ideas to suppose that the economical use of fuel is equivalent to a diminished consumption.

Indeed, as he went on to explain:

> The very contrary is the truth. As a rule, new modes of economy will lead to an increase of consumption.[28]

Nothing has changed in the intervening century and a half, and Jevons' contention remains robust. The literature on his observation is now large, and many refinements have been proposed, mostly concerning short-run or localised effects, but nothing has been produced to controvert the fundamental logic of his position as it applies to the macro-economy over time. This was not only brilliantly reasoned in his book, but was entirely free of the wishful thinking that clouds the majority of subsequent analyses.

In essence, Jevons' position is that an improvement in the efficiency of an energy conversion process, a steam engine for example, makes that process more *productive* and thus makes its output *cheaper*. Consequently, demand for the output will tend to rise, and where demand is inelastic the energy conserved will simply be economised for another purpose, thus delivering economic growth. Indeed, Jevons sees improvements in energy efficiency and productivity as the fundamental cause of the observed growth in wealth and in energy consumption over human history:

> It needs but little reflection, indeed, to see that the whole of our present vast industrial system, and its consequent consumption of coal, has chiefly arisen from successive measures of economy.

Paraphrasing the German chemist Justus von Liebig's profound and parallel observations to the effect that 'Civilization…is the *economy of power*', Jevons continues:

> It is the very economy of the use of coal that makes our industry what it is, and the more we render it efficient and economical, the more will our industry thrive, and our works of civilization grow.[29]

That is to say, when demand for a process is elastic, an improvement in efficiency will make it more desirable, and demand for that process will increase, causing an overall increase in energy consumption. Where demand is inelastic, the energy conserved in that area is, as Jevons puts it, 'only saved from one use to be employed in others' (p. 115), causing overall demand for energy to rise.

Thus, energy efficiency improvements have never and *cannot* lead to conservation, though they may offset the downward pressure on human welfare resulting from energy conservation resulting from other causes, such as the rationing of goods and service by legal intervention or by price. We have already noted falling energy and particularly electricity consumption in the EU. Bearing in mind the iron-clad logic of Liebig and Jevons, this decline is unlikely to be the result of energy-efficiency measures, which would deliver economic growth and rising consumption, but must be the outcome of another factor. Bearing in mind the approximately €770 billion added to consumer bills to fund renewables, the likeliest candidate for this pressure is price rationing, and it is to EU energy prices that we will now turn.

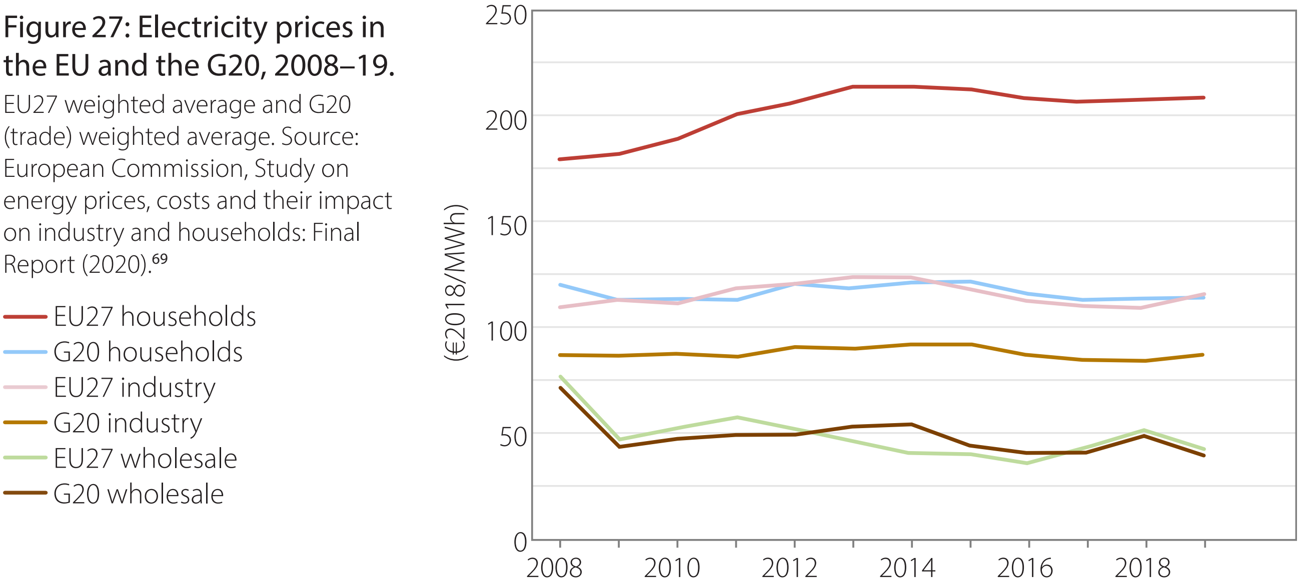
10. Energy prices in the EU

Electricity prices

Figure 27 is drawn from work conducted for the EU Commission by Trinomics. It compares electricity prices in the EU27 with equivalents for the G20, the latter being weighted by trade share with the EU.[30]

Figure 27: Electricity prices in the EU and the G20, 2008–19.

EU27 weighted average and G20 (trade) weighted average. Source: European Commission, Study on energy prices, costs and their impact on industry and households: Final Report (2020).[69]



Household electricity prices in the EU are nearly double those in the G20, and have been so since 2008, with a clear upward trend from 2008 to 2013, and a weak or stagnant trend since.

Perhaps still more remarkably, G20 *household* prices have been comparable to EU27 *industrial* prices over the entire period studied, while G20 industrial prices have been significantly lower than EU27 industrial prices. A bizarre thought experiment suggests itself: an EU business could, as far as electricity goes, profitably relocate to the G20 even if it had to buy its electricity at household prices.

Importantly, wholesale prices in the EU27 and the G20 are comparable, and move in approximate synchrony, indicating that the very salient excess costs in the EU27 result from policy.

Natural gas prices

Trinomics conducted parallel work on gas prices for the Commission, and Figure 28 charts the results.'[31]

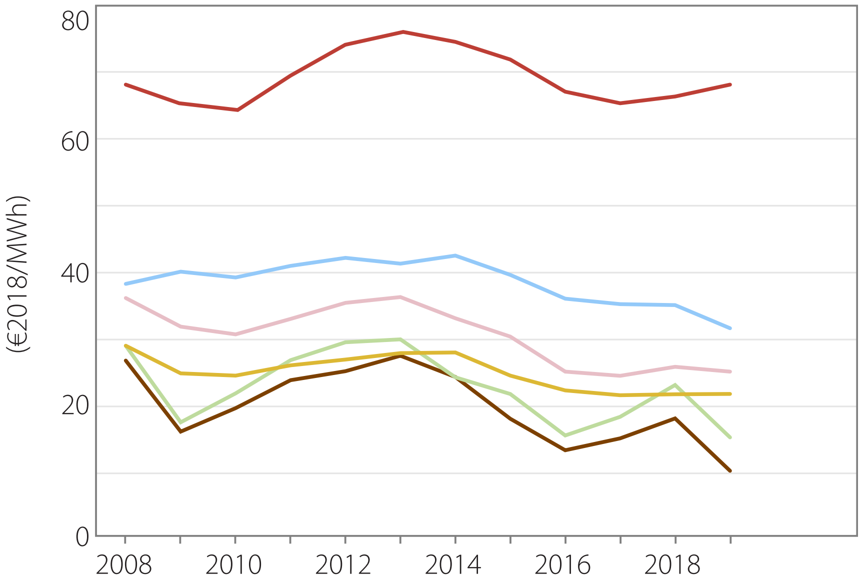
The story for natural gas prices in the EU27 is similar, in broad outline, to that for electricity prices. Household prices in the EU are significantly higher and more volatile than in the G20, where prices were weakly rising from 2008 to 2015, and then fell. EU prices have remained high and exhibited sharp rises and falls around that high level.

G20 household gas prices are only slightly higher than EU27 industrial prices, a very remarkable fact, and G20 industrial gas prices are significantly lower than EU27 industrial prices, al-

Figure 28: Natural gas prices in the EU and the G20, 2008–19.

Comparison of weighted average natural gas prices in the EU27 with weighted average prices in the G20 (trade).[70]

- EU27 households
- G20 households
- EU27 industry
- G20 industry
- EU27 wholesale
- G20 wholesale



though the latter have exhibited a falling trend since 2012, which has to some degree closed the gap.

But once again, EU27 and G20 wholesale prices are similar and closely correlated across the study period, indicating that the differences in retail prices to consumers of all types result in large part from EU policy.

Transport fuel prices

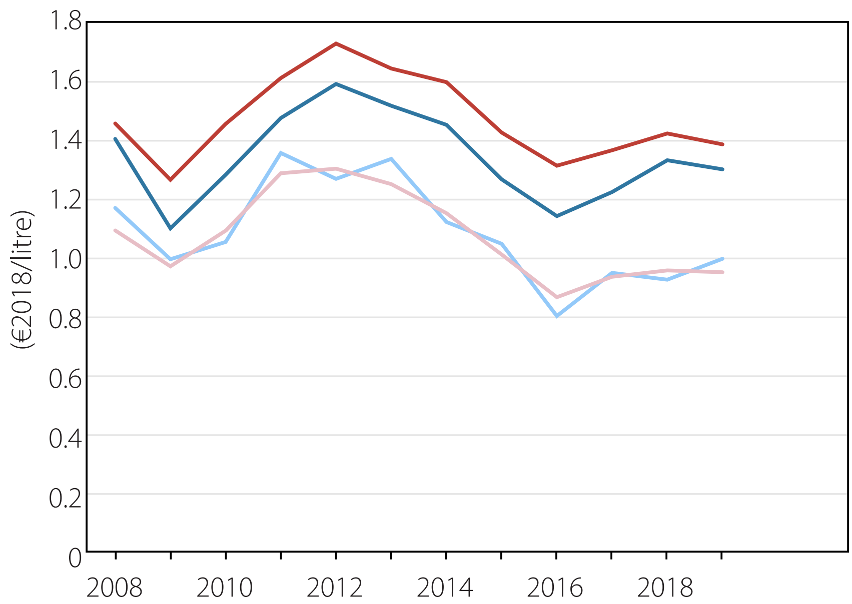
Trinomics also prepared comparisons of EU27 and G20 transport fuel prices (see Figure 29).[32]

The authors note that EU prices are roughly 40% higher than in the G20, and attribute this to taxation in the EU, adding that 'Excluding taxes, EU average prices are comparable or lower than most G20 countries for petrol and diesel.' Once again policies are responsible for the higher costs to EU consumers, and in the case of transport fuels actually seem to have overwhelmed an underlying wholesale price advantage.

Figure 29: Transport fuel costs in the EU and the G20, 2008–19.

Comparison of weighted average transport fuel (petroleum and alternative fuels) prices in the EU27 with weighted average prices in the G20 (trade).[71]

- EU27 petrol
- G20 petrol
- EU27 diesel
- G20 diesel



Conclusion: energy prices in the EU27 and the G20

Combining these three price comparisons, we can see that energy and climate policies in the EU27 have put it at a marked disadvantage. High household prices for gas, electricity and transport fuel will also have placed strong upward pressure on wage demands, while high energy input costs for industry will have made it extremely difficult for manufacturers, in particular, to remain internationally competitive.

The Commission's own study of these matters seeks consolation in the fact that, over the period 2008–17, energy costs were typically only 1–10% of total operational costs (p. 14). But reasoning of this kind is misleading. As already noted, high energy costs to households will have increased manufacturing operational costs *indirectly* via wage demands, and this point can be extended to all other input costs. Since all resources are improbable states of matter, the improbability being the result of energy conversion at points in time both distant and close at hand, high energy costs contribute to the cost of future non-energy inputs. The EU's high energy costs will therefore sooner or later be responsible for an increase in many non-energy input costs.

This may already be a concern, as suggested by the Commission's consultant's note that while 'energy costs increased in absolute terms…total operating production costs increased at a larger scale', resulting in a falling energy cost share in total costs. Unfortunately, the consultants fail to recognise that the rise in total operating production costs will be the result of the delayed pass-through of higher energy costs. But that pass-through is a crucial consideration, and probably plays a very large part in limiting the gross operating surplus of most manufacturing sectors in the EU to a modest 5–10%, meaning that direct energy costs are relatively large in comparison, and that further increases in those energy costs place considerable short-run pressure on profits. Overall, it is not surprising that, as the Commission's authors candidly report:

> EU manufacturing sectors are on average less profitable than non-EU G20 counterparts.[33]

We turned to consider energy prices in the EU27 with a view to evaluating the hypothesis that price rationing was responsible for the observed fall in energy consumption in the EU member states. It seems to the present author that there is ample evidence in these price comparisons to support that view: the Emissions Trading Scheme, the subsidies to renewables, taxes, and other policy measures have contributed to elevating EU energy costs to well above those in the G20. This is the case despite similar wholesale costs, and in the case of transport fuel wholesale costs that may actually be lower. In the light of this conclusion, energy production, consumption and productivity deserve further consideration.

11. Energy production, consumption and productivity

Primary fuel consumption trends

Figure 30 shows total primary energy input in the EU27 from 1990 to 2020.

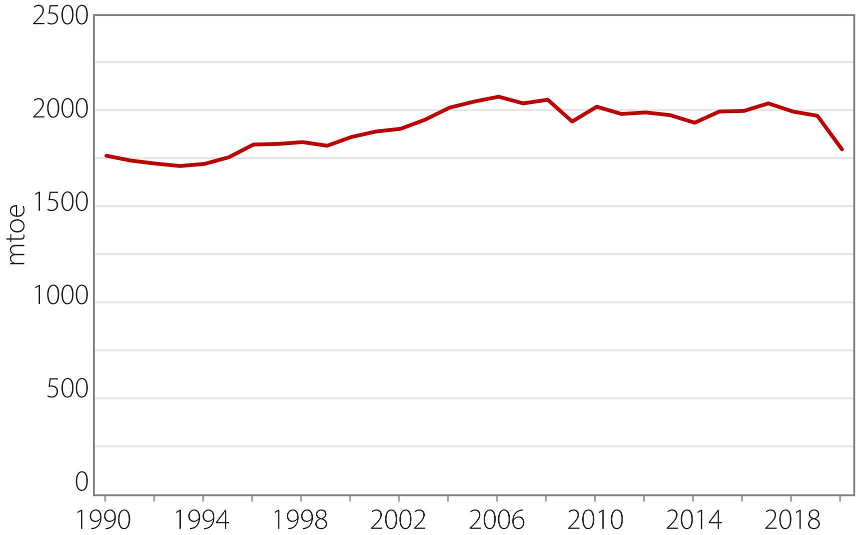


Figure 30: EU27 primary energy input, 1990–2020.
Source: Eurostat. Chart by the author.

We should note the gentle but sustained rising trend up to 2005, the onset of the 2008 financial crisis, a small recovery as the stimulus packages took effect, followed by stagnation and then more recently a decline, made worse by the economic lockdown imposed to address the global pandemic. As with the electricity consumption data examined earlier, it would seem that EU energy consumption did not recover after the 2008 event, in spite of aggressive action from central banks and governments, and has subsequently been sluggish. This gives cause for concern for the post-Covid recovery.

Final consumption trends

Similar observations to those concerning the EU's primary energy input can be made in regard to its final energy consumption, which is represented in Figure 31.

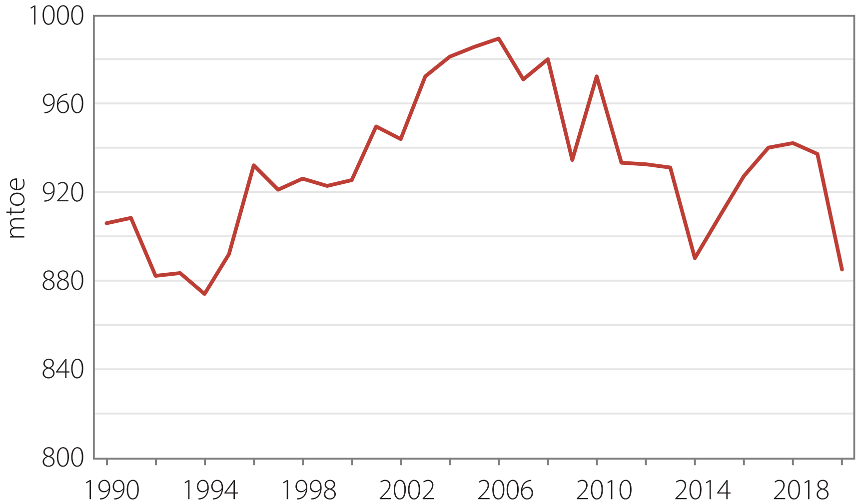


Figure 31: EU27 final energy consumption 1990–2020.
Source Eurostat. Chart by the author.

As with primary energy input, there is a rising trend up to 2005–06 and the onset of the 2008 crash, a short rally, then a marked downturn, and substantial slump caused by coronavirus. We cannot say with any confidence that the rising energy costs resulting from European and global energy and climate policies had a causal role in the 2008 crash, and it should be emphasised that, given the then moderate level of cost impacts, it is unlikely. But we know that costs were rising sharply after the crash, and that prices to EU consumers were high relative to the G20. It is likely that these prices have suppressed and impeded recovery, and there is therefore good reason to fear that they will have the same braking effect on the post-pandemic recovery.

Production and imports

One of the principal benefits claimed for the development of renewable energy in the EU is that it will mitigate dependency on imported fossil fuels. This is clearly an attractive argument, even to those familiar with the pitfalls of the energy sector. But this argument is specious, as we shall see.

The dependence of the EU on imported energy is long-standing and beyond doubt. Figure 32, reproduced from Eurostat, represents energy flows in 1990 and in 2020.

In 1990, the countries of the EU27 were producing more coal than they imported, and domestic production of gas was nearly equivalent to imports. Oil production was, however, a small fraction of total demand and was dwarfed by imports. Total energy supply amounted to about 74 million terajoules (TJ) of which 43 million TJ, or 57%, were imported.

By 2020, consumption of coal had fallen dramatically, with imports and domestic production still roughly balanced. Domestic production of renewable energy had grown significantly, giving the impression that overall import dependency was more or less constant in spite of falling fossil fuel production. In 2020, total energy input to the EU27 amounted to about 76 million TJ, of which 50 million TJ, or about 67%, were imported.

However, as noted above, renewables contribute little or nothing to security of electricity supply because they are weather dependent. Security in this important sector has therefore become increasingly reliant on natural gas, which is the sole remaining scalable and thermodynamically competent fuel, coal having been largely driven from the system. This fact gives particular significance to the sharp fall in European production of natural gas, which is now dwarfed by imports. Fortunately, about 16% of the EU's imported natural gas is obtained from Norway, a stable democratic state, which also has just under half of the European region's proven reserves. On the other hand, 41% of EU natural gas imports come from Russia. Moscow also supplies 27% of the EU's oil and 47% of its solid fuel, although the latter is a relatively small absolute quantity.[34] Options for increasing domestic production of fossil fuels will be discussed further below.

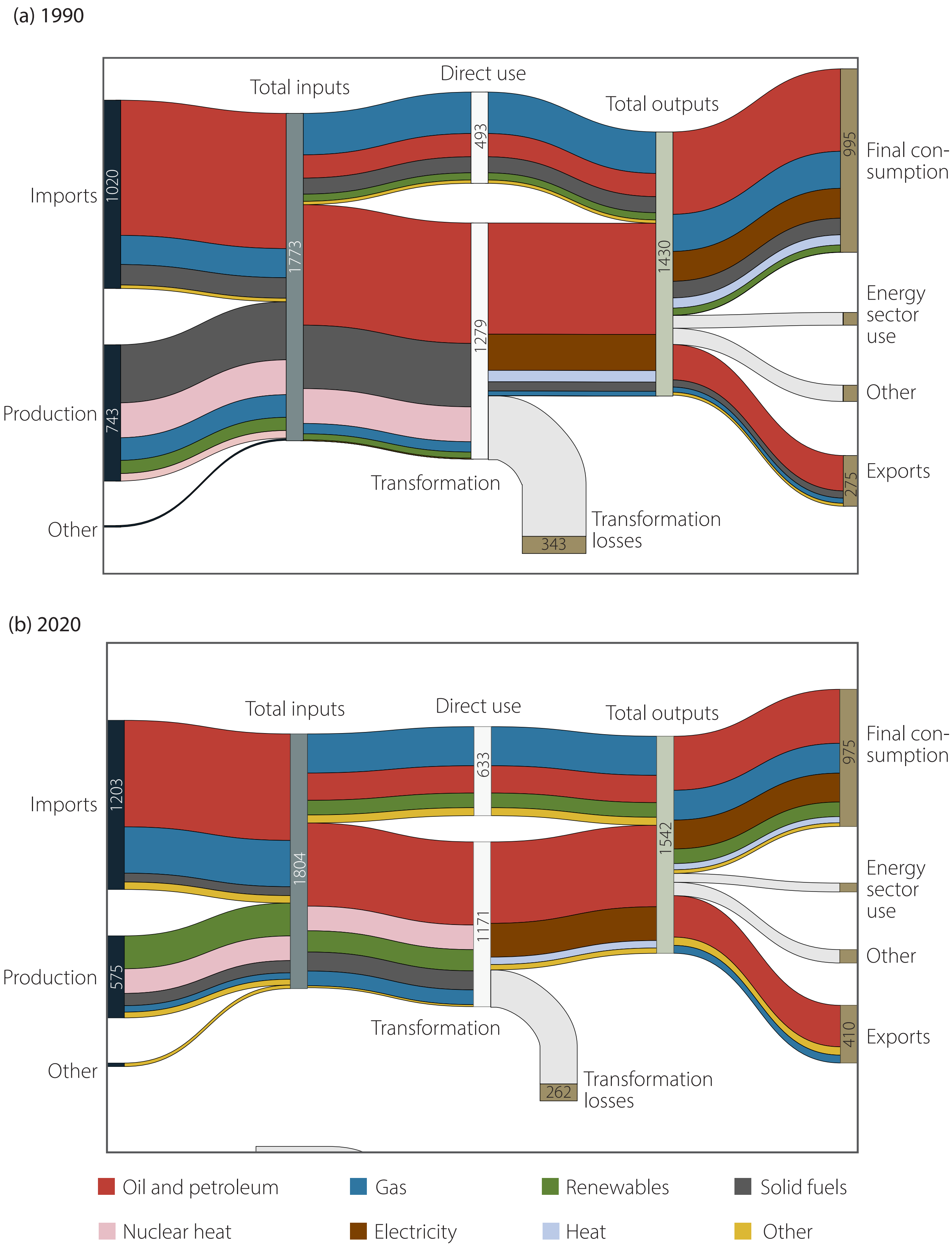


Figure 32: EU27 energy flows.

(a) 1990; (b) 2020. Millions of tonnes of oil equivalent. Source: Redrawn from Eurostat data.

Energy productivity

The EU is keen to draw attention to what appears to be the rising energy productivity of its aggregate economy and of individual member states, pointing to data (see Figure 33) indicating that the ratio of Euros per kg of oil equivalent has been rising since 2000.

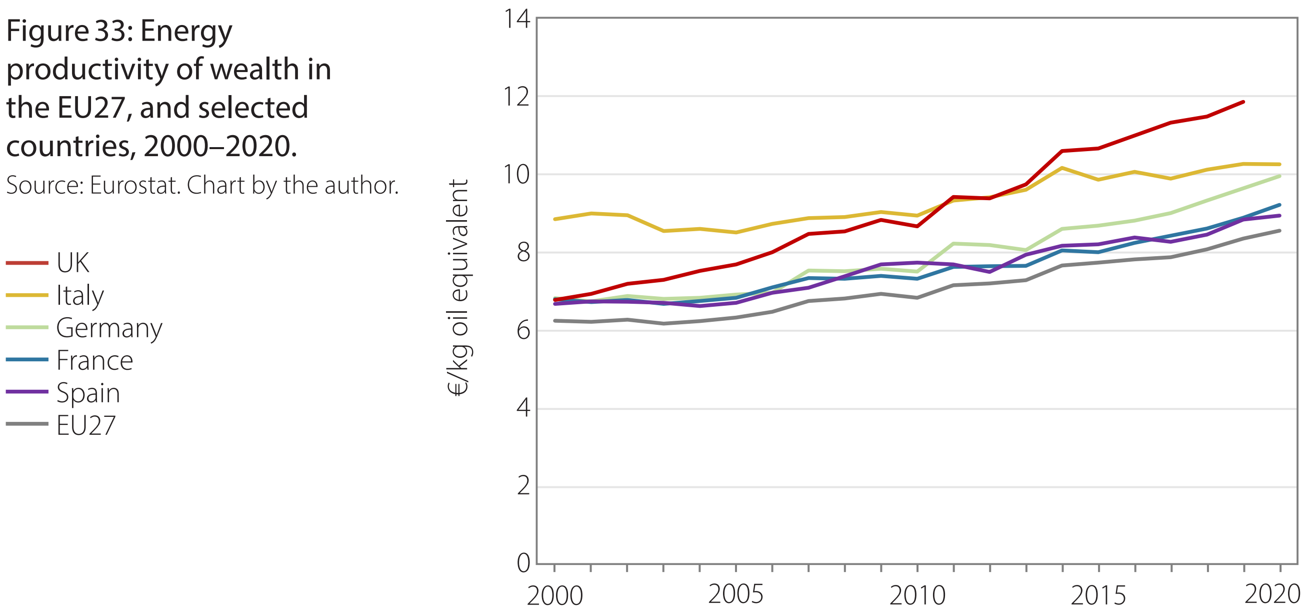


Figure 33: Energy productivity of wealth in the EU27, and selected countries, 2000–2020.
Source: Eurostat. Chart by the author.

But these results follow simply from falling energy consumption and rising Gross Domestic Product, and are therefore vulnerable to criticism of GDP as a relevant measure; few would take GDP simplistically as a fully reliable indicator of societal wealth and wealth production. Moreover, carbon leakage – where GDP is increased by the trading of goods manufactured elsewhere with cheap and higher emitting energy – must be regarded as a significant contributor to these otherwise attractive results. As discussed below in the context of the European Green Deal, the fact that a carbon tax is to be imposed on goods entering at the EU's external borders is an implicit admission that leakage has been taking place, and that a rising GDP-to-energy ratio signifies little. Further data-gathering and econometric analysis of this important area is highly desirable.

12. Emissions in the EU

When lost in the details of support mechanisms for renewable energy and their consequences, it is easy to forget that these are not ends in themselves, but only a means to the end of emissions reduction. We have already noted that the causal efficacy of the ETS is by no means certain, and we have paused to consider the abatement costs of renewables and compared them to the social cost of carbon, finding the policy costs to be economically irrational. But it is as well to re-examine the emissions trajectory itself, since this looms so large in the minds of the EU's most enthusiastic supporters.

Total emissions: society and economy

Greenhouse gas emissions in the EU have fallen very significantly since 1990, as can be seen in Figure 34.

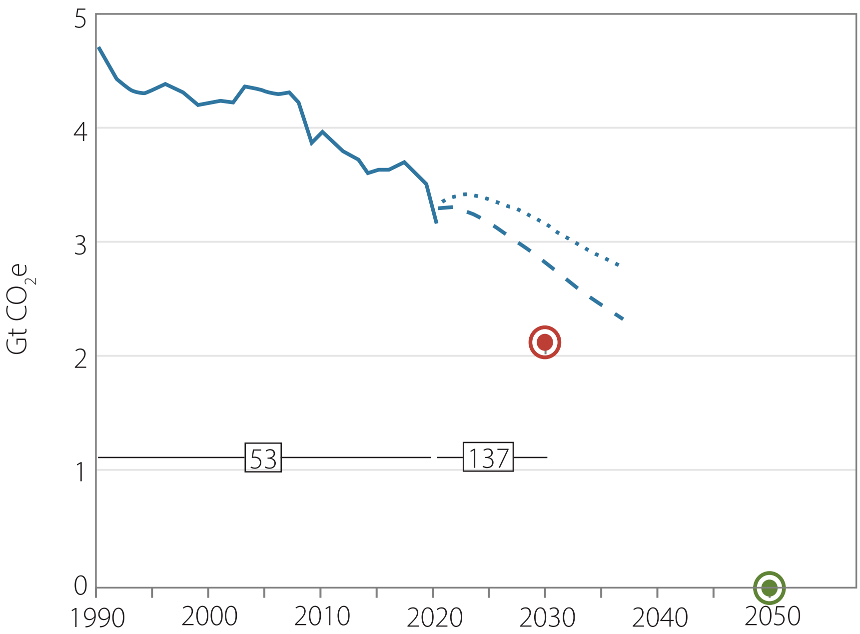


Figure 34: Historical trends and projections of net greenhouse gas emissions, 1990–2050.

Source: Adapted from European Environment Agency, Trends and Projections in Europe (2021), 8.[72]

Historic

Projected:
Existing policy measures
Additional policy measures

2030 target
2050 target

53 Annual reductions (MtCO_2e)

We should, however, note the sharp drop in emissions from 1990 to 1995, caused by the de-industrialisation of the former East Germany. This was followed by a period, up to 2008, during which emissions rose very slightly, and then a sharp drop caused by the global financial crisis. Then there was a brief rise in emissions consequent on the recovery, followed by a further sustained fall as the climate policies prevented a return to the growth trend, and finally a precipitate fall reflecting the impact of public health measures to address the global pandemic. The narrative resembles that given above in relation to total primary energy and final energy consumption, and the consumption of electricity. Insofar as climate policies have reduced emissions, they would appear to have done so in tandem with economic difficulties caused by other, exogenous, factors, and it is perhaps reasonable to conclude that the contribution of climate policies has been largely to prevent the economies concerned from returning strongly to trend after those crises.

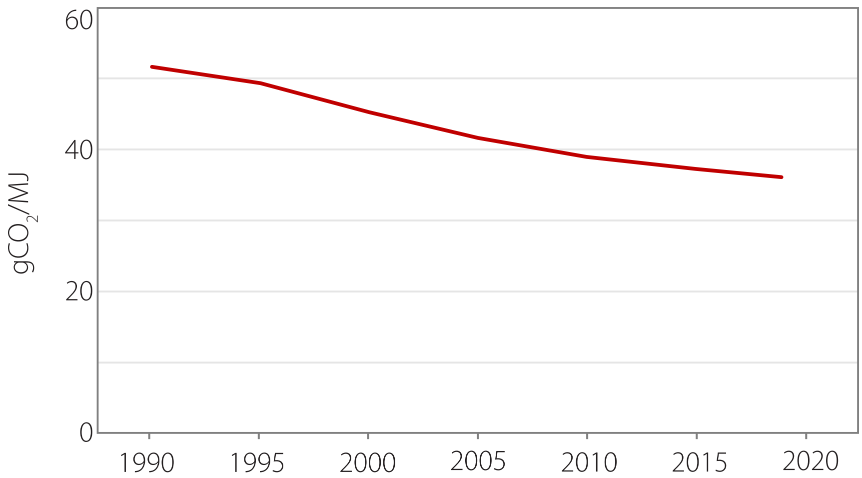
Industrial emissions intensity per unit of energy

The emissions per unit of energy used by industry in the EU28 has fallen since 1990, from just over 50 gCO_2/MJ to 36 gCO_2/MJ, a decline of about 28% (see Figure 35).

This effect would be highly significant if the industrial character of the member states of the EU28 had remained the same over the period. But, as is so well known as to need no demonstration, there has been considerable economic restructuring in most member states, other than Germany, and industries in general and energy-intensive users in particular have not prospered.

Figure 35: Carbon intensity of industrial energy consumption in the EU28 1990–2019.

Source: IEA, chart by the author.



The EU's own statisticians, Eurostat, remark of this phenomenon:

> …outsourcing of production and services from developed countries to low-cost developing countries…is closely related with the industrial restructuring which has been one of the main economic developments in Europe and other developed countries in recent decades. This is seen both in the context of deindustrialisation and concerns regarding social and environmental standards.[35]

The character of the economies in Europe has changed, and it is not unjust to characterise this quite simply as *deindustrialisation*. Consequently, the reduction in emissions intensity cannot be considered in isolation from the overall context. It reflects, in all probability, the closure of higher emitting industries. A very similar phenomenon was seen in the former Soviet Union states, and notably in the former East Germany, as observed above.

Comparison of European industrial emissions intensity with a less flexible sector, such as transport, the emissions of which cannot be exported to another location, is instructive, and is discussed in the following section.

Carbon intensity of energy consumption in transport

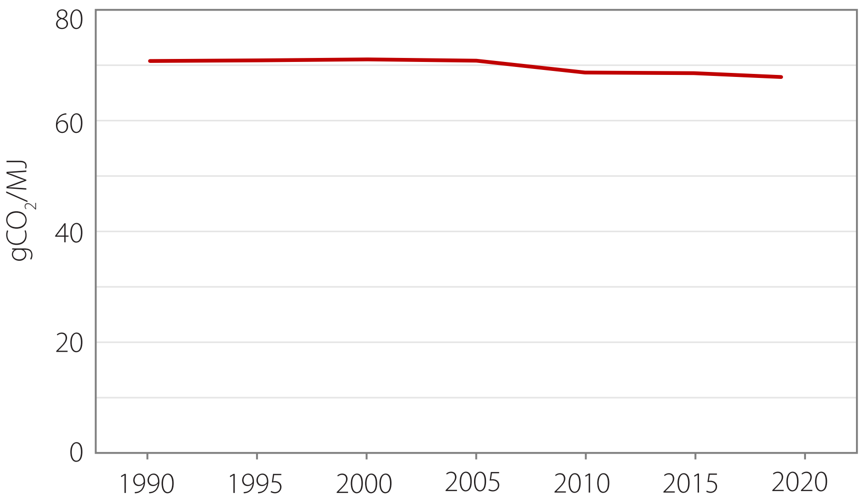
As can be seen in Figure 36, the carbon intensity of transportation in the EU28 fell only very slightly between 1990 and 2019, from 71 gCO_2/MJ to 68 gCO_2/MJ.

For practical purposes the carbon intensity of transport fuels is almost unchanged after nearly thirty years of policy.

Emissions reductions: conclusion

It would appear, therefore, that the emissions reductions observed in the EU member states are only indirectly related to climate-change policies. The principal effect of those policies has been to suppress energy demand and hasten a trend towards economic restructuring, perhaps economic decline, and it is this that has caused the reduction in emissions. This conclusion finds further support from consideration of EU manufacturing and employment, with particular reference to 'green jobs', considered in the next section.

Figure 36: Carbon intensity of energy consumption for transport in the EU28, 1990–2019.
Source: IEA, chart by the author.



13. Green jobs and other jobs

Renewables equipment: manufacturing and jobs

Against the background sketched in a preceding section, comparing energy costs in the EU27 and the G20, it is significant that even Germany is now unable to manufacture renewable energy generation equipment competitively, having lost both its solar industry and, with the recently announced closure of the Nordex plant in Rostock, its last wind turbine blade manufacturing plant.[36] The fundamental reasons for this closure are not difficult to determine, as the CEO of Nordex remarks:

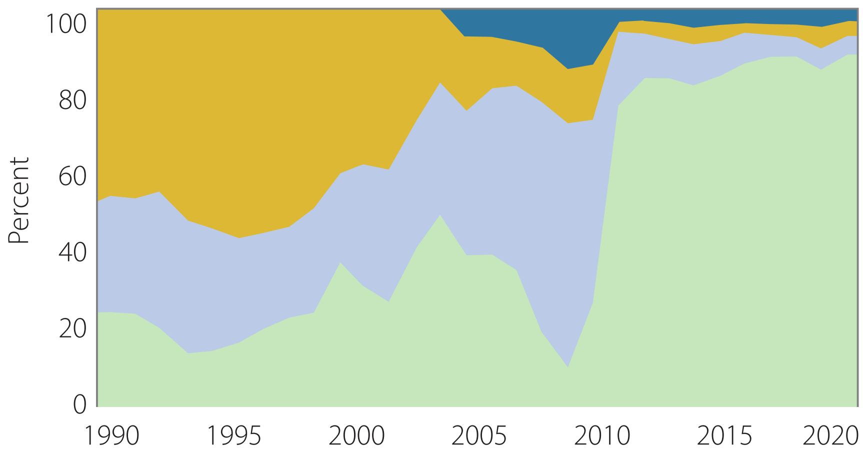
> The wind industry operates in a highly competitive, global market that is mainly cost-driven. Against this background, we must optimize our global production and sourcing processes in order to ensure profitable production and to secure the Nordex Group's competitiveness. As a German and European-based company, we particularly regret that we do not see an alternative to this painful measure. We need an industrial policy that aims for a sustainable and comprehensive way to decarbonize and foster supply chain independency.

A reader might be forgiven for thinking that all markets, except that for military equipment perhaps, were 'mainly cost-driven', but the idea is relatively novel to those in the renewables sector. With governments increasingly under pressure to respond to consumer distress by closing or limiting subsidies, the wind and solar industries have attempted to prolong non-market prices and support by claiming significant progress in cost reduction; honouring this promise has meant moving manufacturing to parts of the world where industry still has unfettered access to low-cost energy sources, mostly fossil fuels. Nordex has sites in Germany and Spain, but also in Brazil, the United States, India, and Mexico.

The parallel collapse of the European solar photovoltaic industry is starkly evident in Figure 37.

Figure 37: Photovoltaic module production by region 1990–2020.

Percentage of global capacity produced. Source: Fraunhofer ISE.[73]



The point at which Asian production came to dominate the sector coincides with the increase in EU energy costs, particularly for households, leading to the suspicion that much of the negative impact of the climate policies has been an indirect one, via upward pressure on wages. In Germany, in fact, industries were protected against direct impacts, since renewable subsidy costs were disproportionately loaded onto domestic consumers.

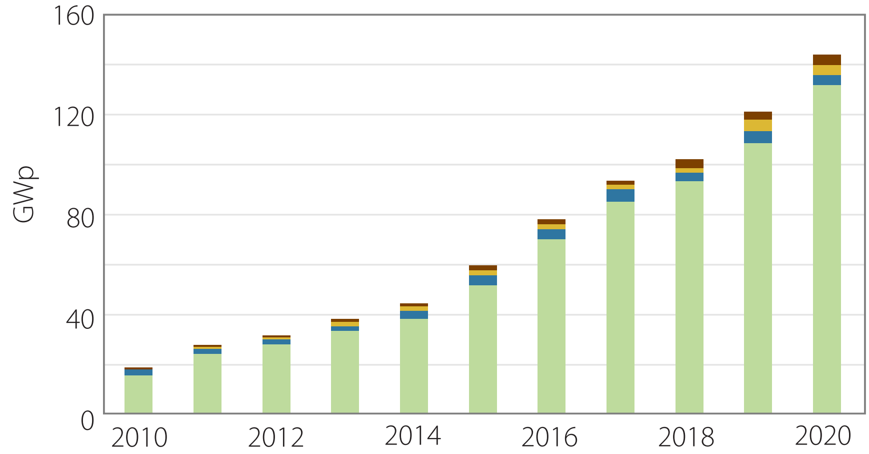
It is also relevant that Asian dominance of the solar panel markets coincided with the absence of a recovery in energy consumption, and by implication a lack of fundamental economic health, after the 2008 crisis. It was not simply that the climate policies harmed European businesses, but that they prevented a vigorous recovery after the crisis. The competition, mainly in Asia, was able to benefit both from supplies of cheap energy and also from rising demand in Europe, prompted by various economic stimulus packages, including subsidies to renewables.

The absolute quantities of solar panels manufactured from 2010 onwards reveal a disastrous picture. While PV manufacturing has grown slightly in Europe, growth in Asian output has been overwhelming (see Figure 38).

It is clear that renewable energy equipment manufacturing has no future in the EU, and indeed manufacturing of any kind exposed to international competition will struggle to survive, except in niche areas. The causes of this constriction were not the result of technological disadvantage, although as China (and Asia generally) bank their fossil-fuelled wealth as progressively great-

Figure 38: Global annual photovoltaic module production by region 2010–20.

Source: Fraunhofer ISE.[74]



er societal sophistication, this is likely to become an increasingly important factor. In the period with which we are concerned, the EU's disadvantage is simply one of proximal input cost, notably through household prices and the upward pressure on wages exerted indirectly by its renewables policies. Circumstantial evidence in favour of this interpretation is that the German PV industry, including installers and other non-manufacturing jobs, has responded to its problems by aggressive improvements in labour productivity, reducing its employee base from 60,000 in 2008 to 20,000 in 2016, a trend that was replicated throughout the European solar industry (see Figure 39).

The all-but-total collapse of the Spanish solar industry in the space of eight years is quite extraordinary, and is doubtless in large part explained by the curtailment of subsidies, which caused a rapid contraction in the installation as well as manufacturing of solar generation. The recovery of employment throughout the EU in the period 2016 to the present is probably the result of an increase in the construction of new solar sites, well-documented in the UK for instance,[37] typically using cheap imported solar panels, but employing Europeans in posts related to development permitting and construction.

Nevertheless, these industries have not been able to recover market share. Global employment in the renewable energy industries is dominated by markets where labour costs are low: China, India, Brazil, and the Rest of the World. High labour cost areas, such as the USA and the EU27, fare less well (see Figure 40).

Figure 39: Employment in the European solar industry.

Total full-time equivalent jobs 2008, 2016, and 2021, by country. Source: Statista. Chart by the author.

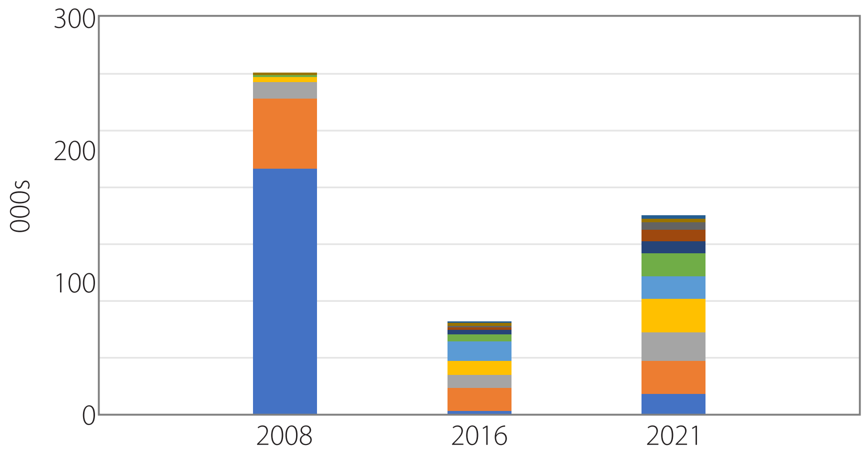
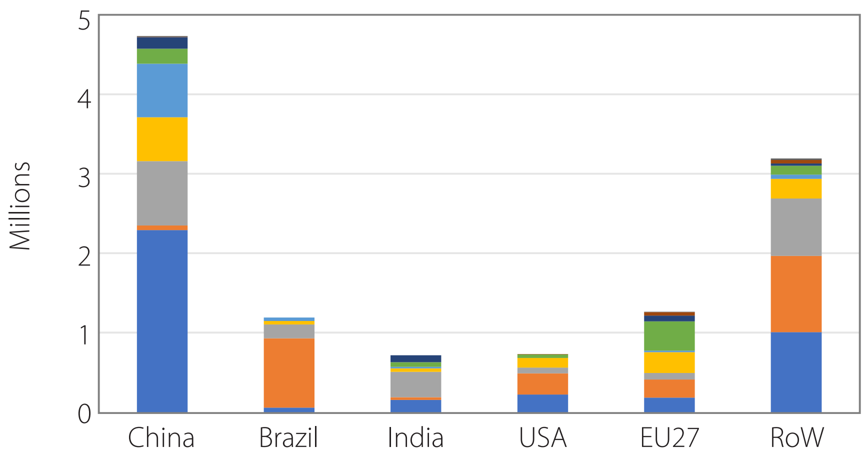


Figure 40: Global employment in renewables, by sector.

Estimated direct and indirect jobs in renewable energy worldwide, 2019–20, by country and technology. Source: IRENA. Chart by the author.

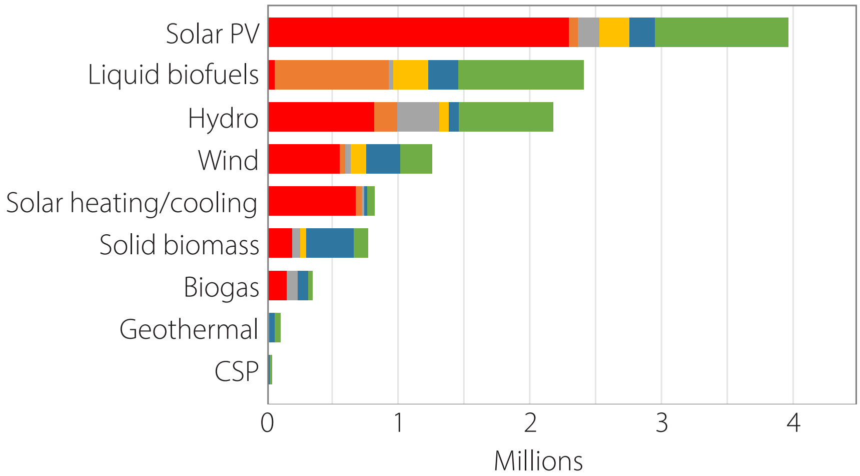


Tellingly, as can be seen in Figure 41, the EU has dominant and substantial market share only in those areas where, due to the nature of the business, there is little international competition, for example biomass.

Figure 41: Employment in renewables by country and sector.

Estimated direct and indirect jobs in renewable energy worldwide, 2019–20, by country and technology. Source: IRENA, chart by the author.

Rest of world
EU27
USA
India
Brazil
China



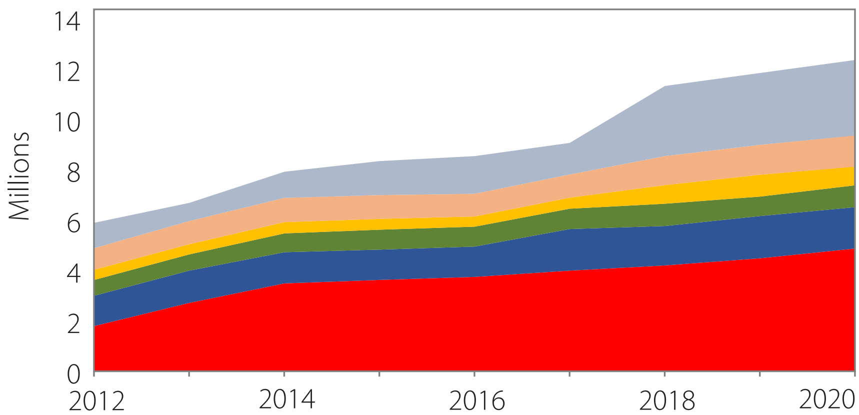
Perhaps most significantly, the large expenditures and extensive market distortions involved in driving the major expansion of renewables capacity in the EU have not given its member states a thriving domestic renewables equipment manufacturing industry. The number of employees in the sector has increased over time, from just under 1.2 million in 2013 to about 1.6 million at present, but this is sluggish growth compared to the rest of the world, and particularly China (see Figure 42).

The EU's share of global employment in the renewable energy sector has declined from about 20% in 2012 to about 13% in 2020, in spite of an increase in absolute numbers. Bearing in mind that the EU still figures very prominently in total capacity of renewable electricity generation installed – capacity remains at around 50% of the total in the much larger Chinese market – this is a matter of concern. As shown above, EU renewables capacity represented 22% of the global total in 2012 and that figure has only fallen to about 17% in 2021. Its capacity share has held up better than its industrial share. It would appear that the EU's policies have created work in China and in the rest of the world. Further, it is probable that estimates of employment in Europe are generous, in the sense that they include many ancillary and clerical positions related to planning and site development, for

Figure 42: Renewable energy sector employment in selected countries, 2012–20.

Source: Base data extracted from the International Renewable Energy Agency (IRENA) annual reports, Renewable Energy and Jobs, which began in 2013. Further calculations by the author.

Rest of World
USA
Brazil
EU
India
China



instance the legal process required for development permitting in heavily regulated societies. Job totals in China are likely to be dominated by positions in manufacturing and industry.

It is also interesting to observe that Germany, the European Union's pre-eminent manufacturing state, has seen a contraction in renewable energy employment since 2012. Figure 43 is derived from the same dataset as Figure 42 but separates Germany's employment totals from those of the rest of the EU, and compares them with that of China.

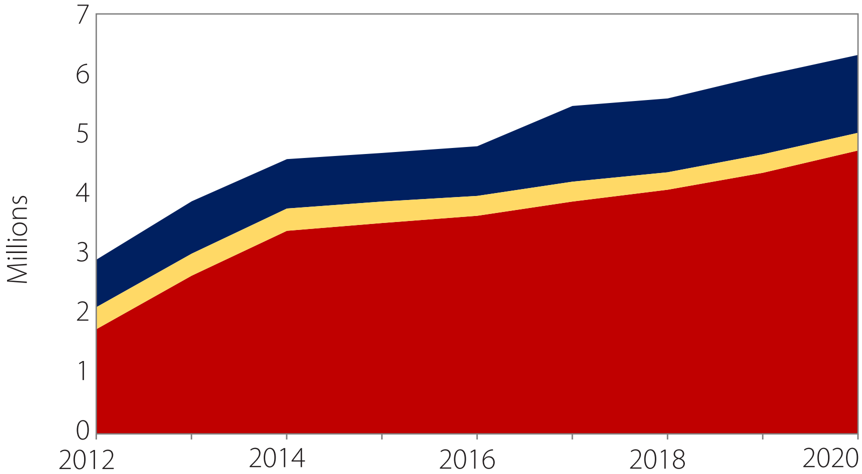


Figure 43: Employment in renewables, Germany, the rest of the EU, and China, 2012–20.

Source: Base data extracted from the International Renewable Energy Agency (IRENA) annual reports, Renewable Energy and Jobs, which began in 2013. Further calculations by the author.

EU
Germany
China

It would seem fair to conclude that Germany has not benefitted from the boom in renewables manufacturing jobs, a particularly surprising fact given that, due to generous subsidies from German consumers, it accounts for about 25% of EU installed renewable electricity generation capacity and a truly remarkable 5% of global capacity. These figures have been stable from 2012 to the present day and have been sustained by a dramatic 77% increase in German capacity over this short period. Figure 44 shows Germany's share of world renewables generation capacity since 2012.

In return for this costly effort, Germany has received little industrial benefit, a conclusion that should be of concern to other European states, and to the EU as an economic entity, since Germany's positive trade balance is at the heart of European prosperity.

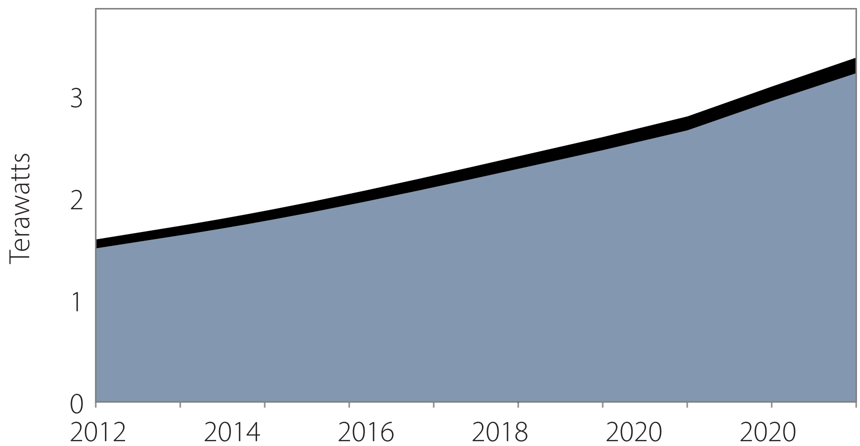


Figure 44: Renewable energy capacity, Germany and the Rest of the World, 2012–21.

Source: Base data extracted from the International Renewable Energy Agency (IRENA) annual reports, Renewable Energy and Jobs, which began in 2013. Further calculations by the author.

Germany
Rest of World

Trade balance

The EU has a positive trade balance, but since 2016 the surplus appears to be on a declining trend. This coincides with the sharp rise of costs in the EU Emissions Trading Scheme, and the onset of substantial renewable energy price impacts (Figure 45).

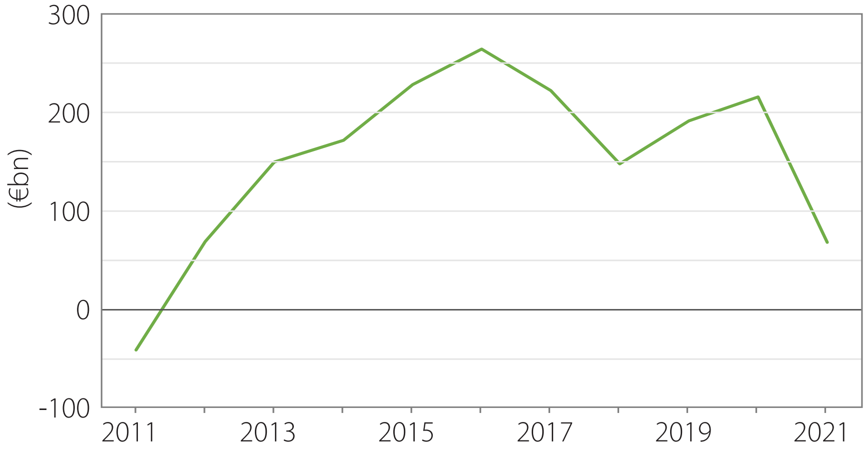


Figure 45: EU trade balance 2011–21.
Source: Eurostat.[75] Chart by the author.

The timing is at least worth further investigation, and while no firm conclusions can be drawn, there is no ground for complacency, particularly when seen against a deepening trade imbalance with China, for which the downward trend began somewhat earlier, in around 2013 (Figures 46 and 47).

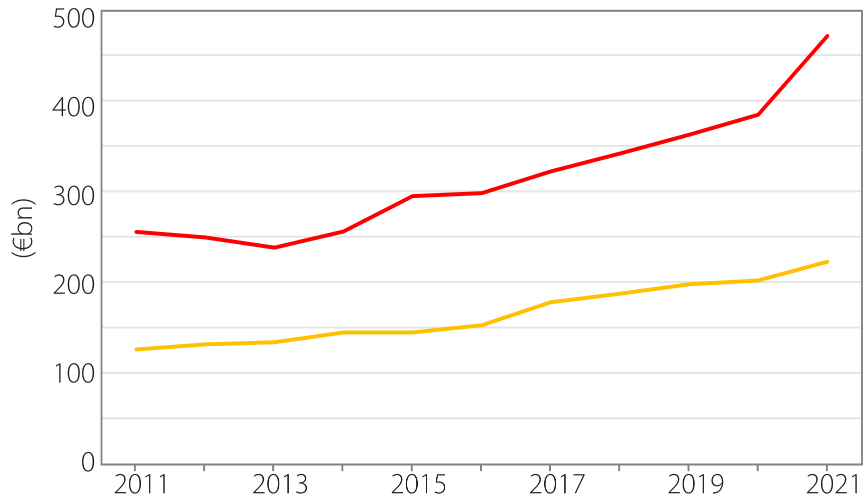


Figure 46: EU imports from and exports to China, 2011–21.
Source: Eurostat. Chart by the author.
Imports
Exports

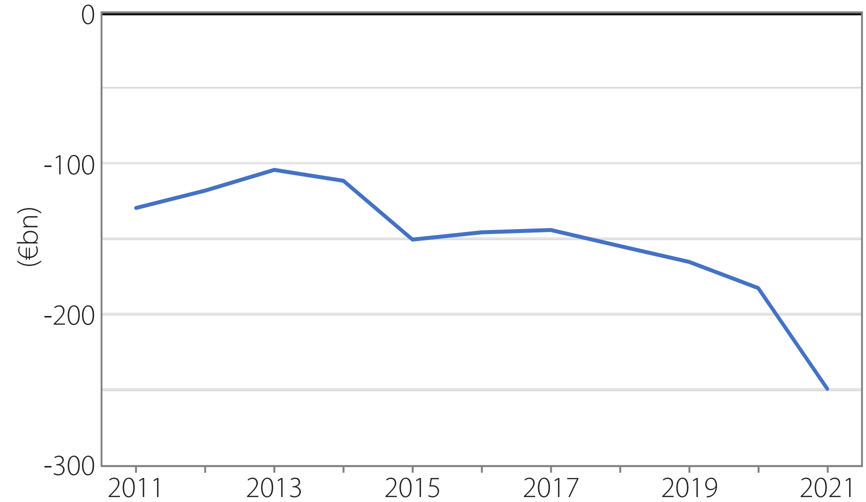


Figure 47: EU trade balance with China, 2011–21.
Source: Eurostat. Chart by the author.

Furthermore, the EU's overall trade balance would appear to be fragile and vulnerable to its climate policies, since it is heavily dependent on exports of chemicals and related products, and on machinery and transport equipment (Figure 48).

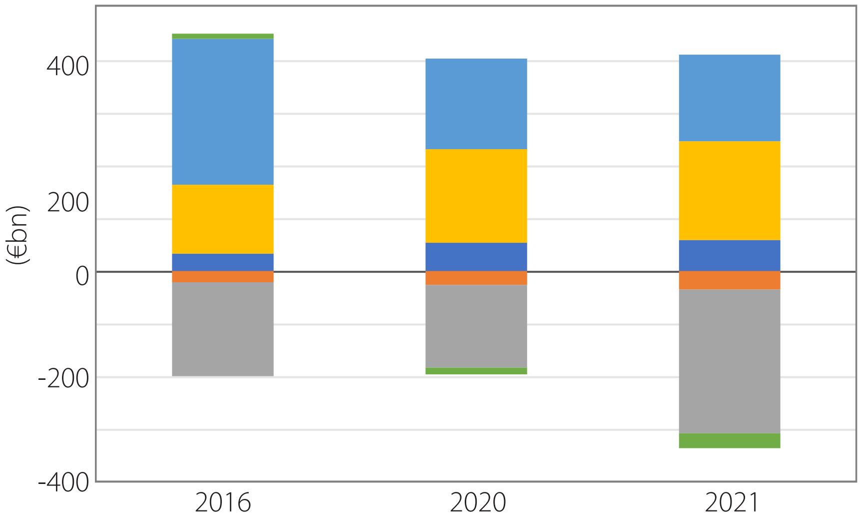


Figure 48: Extra-EU trade balance 2016, 2020, and 2021, by commodity type.

Source: Eurostat. Chart by the author.

- Other manufactured goods
- Machinery and transport equipt.
- Chemicals and related prod.
- Food, drink, tobacco
- Raw materials
- Mineral fuels, lubricants

This relatively narrow base is clearly a cause for concern. Both sectors are vulnerable to high energy costs in the short term, and the declining surplus in machinery and vehicles is perhaps a sign that they are already under pressure. The Commission's official view is that the introduction of low-carbon transport, in particular electric vehicles, will give the EU a distinct advantage. In writing of the European Green Deal, the Commission declares that:

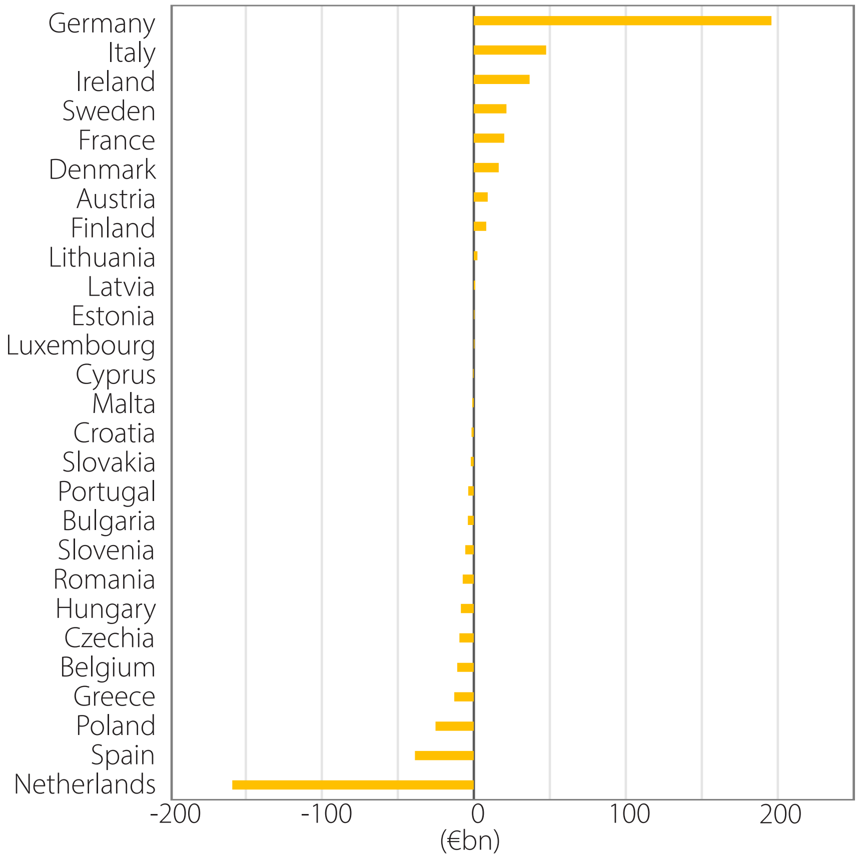
> With our green transport shift, we will create world leading companies which can serve a growing global market.[38]

But this may be wishful thinking. European manufacturers have a strong technological lead in internal combustion engine and power-train design, resulting from historical priority and lengthy experience. A rapid shift to electrical motors, batteries and the new power trains required is very likely to throw this advantage away, and put Asian companies – and particularly Chinese ones – on the same starting line and perhaps even hand them an immediate advantage, since they already have considerable expertise in the fields of electronics. There are reasons, then, for thinking that the EU's positive trade balance is vulnerable to the failure of the EV gamble, handing parity, or even superiority, to China in an area where Europe was struggling to maintain an historical advantage. The decline in the trade surplus in the machinery and transport sector could be taken as an ominous sign.

We should also note that the EU trade surplus is heavily dependent on Germany, and thus on the German motor sector (Figures 49 and 50). Germany has been protecting its industries from renewables costs by charging all subsidies to household consumers in the first instance, but this simply delays the impact. Eventually households will pass high cost of living through to industry as rising wage demands. Industries may respond with attempts to improve labour productivity by reducing employment,

Figure 49: Extra-EU trade balance by EU member state, 2021.

Source: Eurostat. Chart by the author.

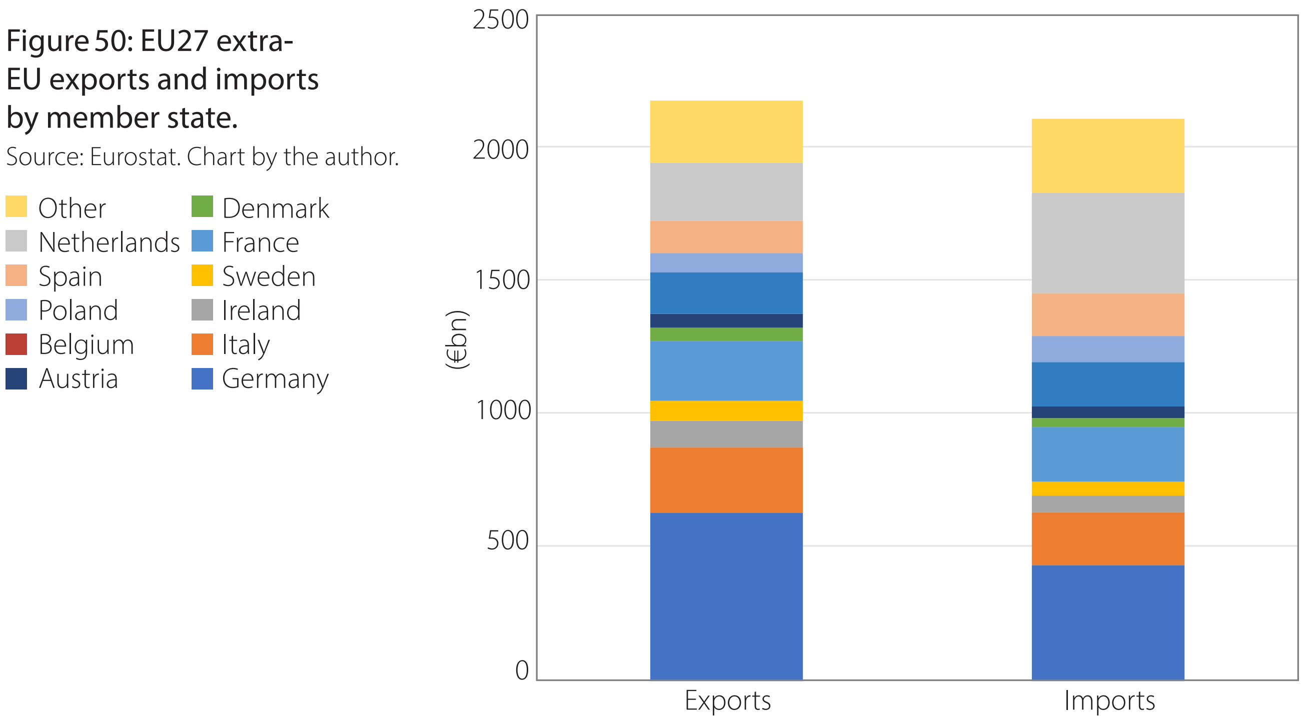


but will then be faced with governments seeking higher corporation taxes to fund social welfare programs. German industry may come to regret not having fought more vigorously against the EU's determination to increase costs when it was first introduced.

Germany's positive trade balance is nearly three times that of the EU overall, and without it the EU would have a large trade deficit. Should German industry falter, the consequences for the EU will be significant.

Figure 50: EU27 extra-EU exports and imports by member state.

Source: Eurostat. Chart by the author.



14. Has the EU learned from its experiment?

In spite of the clear evidence that climate policies have resulted in falling productivity in the energy sector in the European region, there is no sign that the Commission has even recognised the facts, let alone learned from the experience. Indeed, from their response, one would think it had been a resounding success. In December 2019, the Commission declared that the member states would achieve climate neutrality by 2050 and announced that the policies necessary to this end would be known as the 'European Green Deal'.[39] This commitment was made legal in March 2020 with the introduction of the European Climate Law (ECL), and in December of that year an interim target of a 55% reduction in emissions by 2030 compared to 1990 levels was added to the obligations imposed.

The ECL entered into force in June 2021, and in July the Commission presented a package of new policies, and reinforcements of existing ones, 'to transform our economy'. This confirmed the legally binding targets, and added the ambition that economic growth will be 'decoupled from resource use'.[40] This is surely wishful thinking, and without theoretical foundation.

However, the Commission believes that climate change is not only 'the biggest challenge of our time', but 'an opportunity to build a new economic model', comprising a transformation that will 'reduce emissions…create jobs and growth…address energy poverty…reduce external energy dependency and improve our security of supply [and] improve our health and wellbeing'.[41] In pursuit of these outcomes, the Commission proposes: 'greater renewable energy use', 'clean new cars and cleaner fuels for cars, planes and ships already on the market', 'an extension of European carbon pricing to more sectors', 'targets to save energy', 'taxation [of] energy sources in line with climate goals', and 'support for vulnerable citizens, to protect them against additional costs during the transition'.

The regulatory and legal framework required to deliver the targets includes:

- revisions to the Renewable Energy Directive (RED)
- revisions to the Energy Efficiency Directive (EED)
- an energy taxation directive (ETD)
- a carbon border adjustment mechanism (CABM)
- the FuelEU Maritime Initiative
- a new Social Climate Fund (SCF) to mitigate cost increases to those on low incomes
- revisions to the EU Emissions Trading Scheme (EU ETS)
- the Alternative Fuels Infrastructure Directive (AFID)
- the ReFuelEU Aviation Initiative
- a new emissions trading scheme for road transport and buildings

- revisions to the Land Use, Land Use Change, and Forestry (LULUCF) regulations
- the Effort Sharing Regulation (ESR), to set annual emissions targets for member states
- new emissions standards for cars and vans
- a new EU forest strategy.[42]

The Commission chooses to group its policy instruments and detailed targets under the headings *Transport*, *Industry*, *Energy*, *Buildings*, the *Sustainable Use of Natural Resources*, and *Research and Innovation Actions*. The main features of the European Green Deal are summarised under these titles below.

Transport

The Commission proposes that emissions from cars should be reduced by 55% by 2030, and that new cars should be zero-emission by 2035. An emissions-reduction target of 50% by 2030 applies to vans, and new vans must have zero emissions by 2035.

The Alternative Fuels Infrastructure Directive will introduce targets for alternative fuel infrastructure, for example electrical charging and hydrogen refuelling stations. One refuelling station will be available every 150 km along the still-to-be-completed Trans-European Transport Network and in every urban node. The scale of this ambition can be gauged from the nine 'Core Network Corridors', which are due to be completed by 2030, and then supplemented by a comprehensive network that covers all European regions. This is planned for completion by 2050 (see Figure 51).

The Commission expects 30 million zero-emission vehicles to be on European roads by 2030, and notes that 1 million EVs were registered in Europe in 2020, three times the number registered in 2019.

From 2026, road transport will be covered by emissions trading, and fossil fuels used for air travel, maritime transport, and

Figure 51: The core of the Trans-European Transport Network.[76]

fishing within the territory of the EU's member states will not be fully exempt from energy taxation.

The EU ETS already applies to domestic aviation and has done so since 2013. The Commission now proposes to extend the scheme to all international aviation departing from EU airports. In addition, these airports will be required to provide electrical power to all departure gates to reduce aeroengine use while disembarking, refuelling, and boarding.

Carbon pricing will also be extended to the maritime sector, and will apply to any ship arriving at or departing from an EU port. Penalties will be levied on vessels that do not meet certain regulatory requirements. The Commission will also compel ports to provide electrical power to all docked vessels, to reduce fuel use while loading and unloading.

There will be a mandatory blending target for sustainable aviation fuel used by all operators in Europe, a minimum tax on kerosene, and free allowances for aviation will be phased out.

Industry

The EU ETS will be strengthened, with a view to increasing revenues, and a revised Innovation Fund, doubled in size, will aim to ensure that those revenues are directed towards creating further emissions reductions. The fund is currently designed to be supported by the 450 million industrial emissions allowances due to be issued between 2021 and 2030. Under the revised plan, that figure will be increased to 500 million, and the fund will also benefit from 150 million new allowances relating to road transport and buildings, and an unspecified number of allowances 'freed up by the Carbon Border Adjustment Mechanism'. The extended Innovation Fund will have more funding instruments to encourage early uptake of innovative technologies and a selective focus only on those 'projects aligned with the European Green Deal'.

The Commission expects these changes to compel the renovation of 35 million industrial buildings and create 160,000 additional 'green' jobs in the construction sector alone, with many more created across the industrial value chain. The electrification of the economy and the transition to renewable energy are expected to create many of these positions, with the transport regulation 'providing *major opportunities for the European car industry*' (the Commission's emphasis, not mine). The failure of the renewables industry to seize global market share, as described above, does not suggest that these hopes are well-founded.

Revisions to the state-aid rules will permit member states to intervene more forcefully to 'support business to decarbonise their production processes and adopt greener technologies', a tacit admission that spontaneous adoption will not meet the Green Deal targets and that subsidy – that is to say, a coerced transfer of wealth – will be required.

Participants in the EU ETS will be required to cut emissions by 61% by 2030, with a one-off reduction in the annual limit on total emissions to align this cap with actual emissions observed.

The annual rate of reduction required in the ETS will be 4.2%.

Allocation of free allowances will be made conditional on decarbonisation efforts, and there will be new measures to encourage energy-intensive industries to use innovative clean technologies.

The Modernisation Fund, which draws revenue from the ETS, and supports the eleven lower-income member states in their efforts to reduce emissions, will be doubled in size, a clear sign that the Commission recognises that cross-subsidy from richer to poorer member states is required to maintain consensus support for the agenda. The fund's share of ETS revenues will more than double, to 4.5%.

EU industry will be *protected*, and we can use the term advisedly, by a Carbon Border Adjustment Mechanism, which will put a carbon price on imports 'of a targeted selection of products' – in the first instance: cement, iron and steel, aluminium, fertiliser, and electricity – to prevent carbon leakage. The Commission believes that 'this will ensure that European emissions reductions contribute to a global emissions decline', a claim that can be interpreted as a tacit admission that the emissions reductions since 2005, and the introduction of the ETS, have in fact only exported emissions to overseas production. Whether the mechanism will deliver the required outcome is doubtful, particularly in the context of a widening gulf between the Western and Asian economies (China, Russia, India), which may result only in the higher-carbon Chinese and Indian economies preferring to trade with each other rather than face what are in effect hostile and exclusionary tariffs in Europe.

The mechanism will be introduced in a transitional phase by the end of 2025, and will be fully operational in 2026. From that point onwards, EU importers of goods affected will be required to register with national authorities to purchase certificates to cover their imports. The price will be determined by the weekly average auction price of emissions allowances. Importers can reduce the cost by demonstrating that the goods have a low carbon footprint or that a carbon tax has already been paid in the country of manufacture.

European industries will also be required to increase their renewable energy use by 1.1 percentage points per year, presumably up to 2030, with a separate annual target of a 1.1 percentage points increase in renewable energy for heating and cooling.

There will be a binding target, of an as-yet unspecified magnitude, requiring industry to use a certain quantity of non-biological renewable fuel– such as hydrogen – as a feedstock or energy carrier. This measure is intended to prevent switching from natural gas and coal to biomass for process heat. It seems likely to impose very high costs, encouraging closure and relocation to more favourable jurisdictions, probably in Asia where coal use will be tolerated and perhaps even encouraged. As noted above, biomass accounts for some 60% of all the EU's renewable energy and has been preferentially selected by industries for process heat where possible as an alternative to electricity. The Commission presumably wishes to restrict this avenue in the interests of forestry sustainability. That may be admirable in itself, but the economic consequences seem likely to be adverse.

Energy

Energy accounts for about 75% of the total emissions of the EU, and has been a principal focus of its climate policies, as discussed above. The EU currently generates about 20% of its energy from renewable sources, but has a target for that figure to rise to 30% by 2030. However, this is judged to be insufficient to put the EU on course for the Green Deal targets, so the Commission proposes that the target be increased to 40%. Specifically, there will be a binding increase of 1.1 percentage points per year in the use of heating and cooling at a national level, and an indicative target of 2.1 percentage points per year of renewable energy and waste heat and cold in district heating and cooling. A 13% greenhouse gas intensity target in transport will be introduced and, as noted above, industry will be required to increase its use of renewable energy by 1.1 percentage points per year. A new benchmark target requiring a 49% share of renewable energy use in buildings will also be introduced.

A 'credit mechanism' will support electrification of transport, and there will be sub-targets for, and certification of, renewable hydrogen. The Commission will also act to compel member states to accelerate permitting for renewable energy projects and promote cross-border co-operation through the renewable energy financing mechanism.

The Commission will also act to facilitate renewable power purchase agreements, an important development that is likely to be used to provide hidden subsidies to generators, with above-market prices concealed in the costs of goods and services. Commercial consumers will come under great pressure, as they already are in the United Kingdom, to enter into these bilateral deals with renewable energy generators as a means of demonstrating compliance with environmental, social and governance (so-called 'ESG') guidelines. Prices to consumers of goods and services will inevitably rise, but these end-purchasers will be unaware of the causes and will inevitably blame retailers and service providers, who should take warning. Energy companies, particularly in the UK, are now paying the price of having in effect collected green taxes through consumer bills to fund renewables. Shops and businesses who wish to avoid a similar problem should insist that governments levy and collect taxes themselves.

The Commission notes (their emphasis) that '*reducing energy consumption is essential*' to achieving these targets, and proposes a reduction of 39% in total primary energy input, and a reduction of 36% in final energy consumption, as against projections made in 2007. Member states will be required to reduce consumption at a mandatory rate of at least 1.5% per year overall, with the public sector required to deliver reductions of 1.7% per year. This represents a 9% increase in the scale of demand reduction required over the levels pledged in 2020 in member states' National Energy and Climate Plans.

Indicative member state contributions to the demand reduction requirement will be introduced. An 'Energy Efficiency First Principle' is to be applied in policy and investment decisions, although the details are not currently known.

In practice, the Commission calculates that these plans will mean that total primary energy must fall to 1023 million tonnes of oil equivalent (mtoe) in 2030, and that final energy consumption must fall to 787 mtoe.[43] These are very surprising values. Figure 52 displays empirical data for these two measures for the EU27 (i.e. not including the UK) from 1990 to 2019, and indicates the target levels and the percentage reduction required on 2019 levels. A 27% reduction in total primary energy and a 22% reduction in final energy consumption are required in less than a decade. Bearing in mind the demand decline already observed, it is difficult to see how further reductions can be achieved without severe adverse effects on European wealth and standards of living.

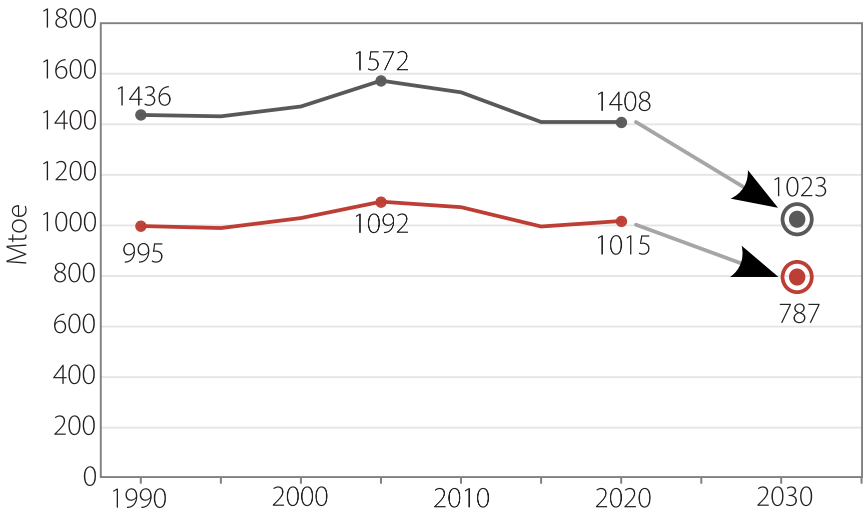
The twin goals of increasing the use of renewable energy and reducing total demand are to be supported by revisions to the tax system, specifically aligning the minimum rates for heating and transport, thus removing the exemptions widely offered in the EU at present to heating fuels. The Commission also proposes to remove exemptions and entitlements to reduced rates for fossil fuels used in industry and commerce, for example in aviation and shipping.

As also noted above, the Commission is concerned, quite reasonably, that heavy dependence on cheap biomass may have undesirable environmental consequences. It therefore proposes to prohibit the use of primary forests, peatlands, and wetlands as biomass sources. There will be no support for forest biomass for electricity-only generators after 2026, and there will be a prohibition on national support for the use of saw or high-quality 'veneer' logs, or stumps or roots, for energy generation. All biomass heat

Figure 52: Energy targets for the EU27.

Source: Empirical data: International Energy Agency; Target magnitude, European Commission.[77] Chart by the author.

Total primary energy
Final energy consumption



and power installations will be required to meet new minimum greenhouse-gas saving thresholds.

We have already seen that hydrogen is to be supported, both for transport and as an alternative to biomass for heat. The Commission will introduce targets for at least 40 GW of renewably fuelled hydrogen electrolysers, with the goal of producing 10 million tonnes of renewable hydrogen per year by 2030. 2.6% of transport fuels must be renewable fuels of non-biological origin – in other words, hydrogen or wind or solar electricity – and industry will be required to show that 50% of the hydrogen it uses has been derived from renewable sources. This is important, since it constricts the market available to the use of steam methane reforming with carbon capture, which is already central to some national plans because it is by far the cheapest means of generating hydrogen. The UK, for example, hopes to produce about 200 TWh of hydrogen from methane in 2050, mostly to decarbonise tricky areas such as agricultural traction and marine transport.

The Energy Taxation Directive will set preferential rates for the use of renewable and low-carbon hydrogen. The directive will also set revised rates for all fuels according to their energy content, rather than their volume, and their environmental impact. Tax exemptions that favour fossil fuels and polluting economic sectors will be removed.

Exemptions for home heating will be phased out, so that member states will be unable to tax heating fuels at lower rates, requiring them to find alternative means to support low-income households. As noted above, fossil fuels used by air, maritime transport and fishing within the EU will not be fully exempt from energy taxation.

Buildings

On the basis that buildings account for 40% of the EU's final energy consumption, and 36% of its greenhouse gas emissions, the Commission proposes a broadscale 'renovation' programme. Member states will be required to renovate 3% of the total floor area of all public buildings annually, to set a benchmark of 49% of renewable energy supply for buildings in 2030, and to legislate so as to increase the use of renewable energy in heating and cooling by 1.1 percentage points per year until 2030.

In the interests of social justice, these measures will also be supported by grants from the Social Climate Fund, amounting to €72.2 billion over seven years. However, some of this will be spent on access to zero- and low-emission transport and 'even to income support'.

Sustainable use of natural resources

The Commission believes that 'Restoring nature and enabling biodiversity to thrive again offers a quick and cheap solution to absorb and store carbon', and therefore proposes to 'restore Europe's forests, soils, wetlands and peatlands'.

Revisions will be made to the Land Use, Land Use Change and Forestry (LULUCF) regulations, with the goal of achieving a new target of 310 million tonnes of carbon in the natural carbon sink. The Commission proposes a roadmap to plant 3 billion trees by 2030. There will be legally binding targets for nature restoration, and 'payment schemes' (subsidies) for forest owners and managers for the 'provision of ecosystem services'. Remote sensing will be used to monitor the state of the EU's forestry, with 'citizen involvement' through a Map-My-Tree scheme to keep track of the 3 billion trees planted.

Given that biomass energy forms so large a part of the EU's renewable energy programme, some 60% of all renewable energy and 12% of all energy, there is concern that the sustainability criteria may not be sufficiently tight, so the Commission proposes the introduction of 'strict new criteria to avoid unsustainable forest harvesting'. How these rules will work on the ground is unclear.

Research and innovation actions

To support all the activities described above, the Commission will ensure that the €25 billion of research funding under the Horizon Europe scheme is co-ordinated with the European Green Deal, so as to 'underpin the implementation of Europe's 2030 climate and energy targets'. It aims to deliver 100 climate-neutral and smart cities in Europe by 2030, as showcases of experimentation and innovation, although funding levels are not specified. Some €4 billion will be directed to the Zero-Emission Waterborne Transport Partnership, to 'eliminate all harmful environmental emissions, including water and noise pollution' in the maritime sector by 2030. The 'Towards Zero-Emission Road Transport' Partnership will receive €1.2 billion to accelerate zero tailpipe emission road transport, in co-operation with the Batteries Partnership. The Clean Aviation Joint Undertaking will invest €3 billion in reducing aviation emissions by at least 30% by 2030. The Clean Energy Transition Partnership will receive €800 million to develop, scale and implement decarbonised technologies and energy systems. The Clean Hydrogen Partnership will receive over €2 billion in funding to 'maintain and strengthen the competitiveness of the EU clean hydrogen value chain'. Finally, the Clean Steel Partnership will receive €1.7 billion over the next decade to develop climate-neutral steel production.

This amounts to a total research and development spend of approximately €38 billion, either directly related to, or at least co-ordinated with, the Green Deal initiative.

The Green Deal in summary

The legislative and administrative agenda implicit in the European Green Deal is vast, and suggests that the Commission and the EU itself has become subservient to the climate agenda. The European Commission now appears to identify the moral and political concept of EU with that of climate policy leadership. The bloc is now in effect a climate policy agency, and even the *Grand Projet* itself is a vehicle for protecting the world against global warming. Consider these sentences from the Commission's overview brochure *European Green Deal: Delivering on our targets* (the use of bold type for emphasis is as per the Commission's text):

> **The European Green Deal has already set a positive example** and led major international partners to set their own target dates for climate neutrality. Now we are ready to [sic] **lead show the way again**, with our detailed plan to meet these targets.
>
> Leading the global climate action provides advantages for our companies. With our investment in renewable energy technologies, we are developing expertise and products which the rest of the world also needs. With our green transport shift, we will create world leading companies which can serve a growing global market.
>
> In addition, we are helping raise global ambition to tackle climate change. By working with our international partners, we will **reduce emissions together** in maritime transport and aviation around the world.
>
> […] Through our policy experience, industrial leadership, climate diplomacy and climate finance, the EU is **boosting significantly the global fight against climate change**.[44]

One might quarrel with almost everything here. The example set by the declaration of the European Green Deal is far from positive. Indeed, it suggests a perverse determination to ignore the discouraging results of twenty years of experimentation with a renewables-centric emissions reduction policy. Furthermore, the detailed plan, reviewed above, suggests hubristic bureaucratic overreach rather than sane determination.

Even a sympathetic but historically informed reader will surely be troubled by the possibility that this is nothing less than another warning that 'seeing like a state' comes with terrible disadvantages. Several centralised bureaucracies in modern history have attempted a 'detailed plan' for economic transformation. None have succeeded in the way that they expected, and several have failed catastrophically.

And then there is the extraordinary claim that investment in renewable energy technologies has resulted in Europe 'developing expertise and products which the rest of the world also needs'. On the contrary, as we have seen, Europe has lost its solar industry to Asian competition and is in the process of losing wind power manufacturing to the same low-cost, fossil-fuelled economies. Furthermore, it is Europe, not the rest of the world, that believes it needs these technologies, and is importing them. And as remarked above, in discussing trade balances, the green transport shift will almost certainly be precisely the opposite of what is expected by the Commission, handing China an advantage in the manufacture of electric vehicles.

When the economic claims are put aside, as they must be, we are left with pretentions to moral example, to acting in a way that, perhaps selflessly and with accompanying self-harm, raises global ambition in climate-change policy. At this point it becomes apposite to recall that those states which have experienced the most disappointing results from ideologically driven economic planning – Soviet Russia and Mao's China – were also those that, like the EU, suffered from narcissistic delusions of global moral leadership. This combination occurs because the concept of *virtue* contains and entails the concept of self-denial; to be virtuous is to willingly frustrate one's own wishes and deny self-satisfaction. Thus the manifest failures of the favoured policy to deliver wealth and prosperity become perversely persuasive evidence that the policies are succeeding in a higher and moral sense. The pain is proof of virtue. Whether this will be politically sustainable in the longer term is, however, extremely doubtful.

15. The energy transition illusion and the future of European prosperity

A dark future or a distressed policy correction?

Introducing its climate policy vision, the European Commission describes the next ten years as a 'make-or-break decade'.[45] For once one can agree. The Commission presumably believes that the coming years will *make* Europe a global low-carbon powerhouse and a moral exemplar, but on the evidence of its own policy outcomes since 1990, the new European Green Deal seems all but certain to *break* European economic and socio-political power, rendering it a trivial and incapable backwater, reliant on – and subservient to – superior powers.

We can be certain that there will be an eventual reversal of direction, and there have even been small signs that the EU and its member states are beginning to adjust their positions – if only slightly and without fanfare. One example can be found in the recent revisions to the Green Taxonomy, which offered more tolerance to both natural gas and to nuclear. However, these changes were overtaken by the Russian invasion of Ukraine on 24 February 2022. This has become an extended war, with no rapid culmination likely; its effects on global low-carbon policies are now a key focus of attention.

For the time being, the Commission remains committed to the climate agenda, on the grounds that European dependence on fossil fuels has given the Russian state its power, and that the 'energy transition' (*energiewende)* already required by the emissions reduction policy will pay geopolitical dividends, liberating member states from their need to import gas, and to a lesser degree coal and oil, from companies controlled by Moscow. As should be clear from the material reviewed in previous chapters, this is not a sound response.

Firstly, and simply enough, the concept of an energy transition has no evidential reality in the past or present, and seems unlikely to have one in the future. At *the global level*, there is not, and never has been, any evidence of a transition away from fossil fuels, as demonstrated by the scale and character of Asian, and particularly Chinese, energy use.

Secondly, where renewable energy has increased as a fraction of total supply, mostly in the West, the result has been stagnant or declining energy consumption, and an implicit dependence on manufactured goods from areas where fossil fuels are still consumed, principally China.

Finally, where modern renewables such as wind and solar have been adopted in high proportions relative to the overall energy sector, mostly in Europe, energy systems have become critically dependent on natural gas to guarantee security of supply.

It is these three facts in combination that make the Russian invasion of Ukraine so important. They will also determine the eventual response of the NATO economies, their allies such as Japan, and after that perhaps even the European Commission itself.

It should be emphasised that the EU's environmental measures were already running into difficulties before the war in Ukraine. Russia's invasion has simply accelerated the process through which failure is becoming evident. As gas prices rose as economies recovered from the pandemic, it was already clear that, paradoxically, the states most affected were those that are most heavily committed to renewable energy. European environmental policy was thus revealed as a natural gas strategy, with wind and solar generators deployed as mere status symbols (Veblen goods, in the economic jargon).

The strategic response that must follow if EU member states are to remain capable (and defensible) will recognise that the thermodynamic characteristics of the fuels selected are an essential, not incidental, consideration, and that there is now no alternative but to 'steer into the skid' and wind down all the environmental measures instituted in preceding decades. It is possible, but far from certain, that environmentalism may survive as an end. If it does, a new and pragmatic approach, grounded in robust physical reasoning, such as a gas-to-nuclear trajectory, will be vital. Greenhouse gas emissions would fall over time, but the ambition of achieving Net Zero emissions by 2050 would not be realised.

Governments globally will doubtless take warning from the EU's experience. However, policy correction will proceed at differing paces and with varying priorities according to local circumstances, and will be masked by politically motivated gestures towards renewable energy and emissions reductions. At the general or global level, state action will be characterised by a short-run scramble to acquire non-Russian oil and natural gas, particularly to fuel industrial process heat, with all sources, both conventional and unconventional, being explored. It is likely that coal will be tolerated in the short term and it may return on a larger scale in both the medium and longer terms as an insurance against difficulties in obtaining acceptable gas supplies, and also against delays in the development of nuclear plant. There will be emergency legislation, and perhaps financial support, to allow the continued operation of existing coal and nuclear stations. These measures might be supplemented by the suspension or moderation of emissions trading schemes so as to reduce industrial consumer costs.

Given the pressure on the overall economy, it is highly likely that there will be a broad reconsideration of the scale and pace of measures encouraging electric vehicles and heat pumps, at least until electricity prices can be brought under control and security of supply resolved through diversification of generation technologies.

In countries particularly exposed to the price of natural gas, we can expect to see construction of more modern combined-cycle gas turbines, their higher thermal efficiencies reducing the consumption of gas per unit of electricity generated. Where countries have access to natural gas resources, however modest, there will be efforts to reverse years of policy suppression and once again increase production. At the same time, we may expect to see accelerated plans for nuclear power, both for generation of electricity, and, crucially, production of high-temperature heat, to be used in industrial processes and perhaps also for generation of hydrogen for transport. Nevertheless, prudent governments will also plan for ultra-supercritical coal generation of electricity as a backstop, should nuclear fall behind schedule or gas prices remain high. Coal resources are widely distributed globally, and renewed interest in their extraction cannot be ruled out, even in Europe.

In those jurisdictions, particularly in Asia, where renewables policies have been only token, we may expect to see renewed emphasis on conventional energy development and on more or less aggressive geopolitical moves to secure natural resources worldwide. Renewables are playing an insignificant role in Asian growth and there is no reason to think that this will change. China, in particular, will generate as much wealth and societal sophistication – including military power – as possible from fossil fuels, before proceeding directly to advanced nuclear fission and fusion.

While this necessary retreat from renewable energy has been looming for some time, though little appreciated outside specialist circles, it has been brought into sharp focus, again paradoxically, by gas price increases and a constriction of supply for which the EU was all but completely unprepared. It had been assumed that the only likely cause of interruption would be hostile Russian action, and it was further assumed that Russia's need for overseas income would limit their actions to gestures. The possibility of the West opting to reject Russia's supplies in the longer term has never been debated at the public or political level, and is unlikely to have been considered a significant probability even in far-sighted security circles. Insofar as government departments were concerned about reliance on Russian gas, it was assumed, incorrectly, that renewables would mitigate this dependency rather than creating and compounding it, as is in fact the case. However, the UK's Department of Business, Energy and Industrial Strategy is reluctantly coming to accept that exploration of conventional resources in the North Sea is necessary, though it remains opposed to shale gas for the time being. This is in spite of the fact that the British government's position is that the cost of offshore wind and renewables generally has fallen so significantly that fossil fuels are now intrinsically more expensive. A return to fossil fuel production is seen, or at least presented, as a short-term emergency measure on the path to green energy. However, it will prove to be a permanent feature. The claimed falls in renewable energy costs, always implausible on the grounds of the high entropy of the fuel flows, are readily falsified by reference to the published accounts of offshore and onshore wind companies, where it is clear that capital costs have not fallen significantly, if at all, since the early 2010s, and that operation and maintenance costs, particularly offshore, are actually rising.[46] Solar energy in the UK and in Europe is similarly troubled.

Enthusiasts for renewables will point to the high prices currently paid for fossil fuels as evidence of the incipient competitiveness of renewables, but those prices do not reflect the underlying costs of production, which remain low, but are the result of intense competition for a share of the currently available rates of flow of these superior and highly desirable sources of energy. In this context it is therefore likely that capital that might have been committed to renewable technologies (so as to take advantage of policy support, including subsidies and coerced market share) will now prefer to support fossil fuel exploration, where physical fundamentals rather than political whim underly spontaneous determination of market value. The appearance of a sustained move to renewable energy in Europe will be revealed as a mirage of policy.

That this will come as a severe shock to the EU Commission, and to many member states, is due to an error in the general and even the professional history of energy, namely the concept of *energy transition*, whereby one fuel replaces another. This governing idea is found everywhere in EU documents relating to its climate policies; renewables are consistently projected to replace fossils, and emissions reduction is for practical purposes identical with the imagined move from one source to another. But there is no empirical evidence for the existence of energy transitions in the past, and no theoretical foundation for supposing that one is likely in the future. This is so important an intelligence error that it deserves separate consideration

The myth of the 'Energy Transition'

With the doubtful exception of the decline of hunter-gathering and the expansion of agriculture, there has never been a global energy *transition* in human history, and there is no evidence of such a transition happening today in Europe, or indeed in any other place.

As a matter of demonstrable fact, with small local exceptions such as the decline of firewood in London in the 19th century, the total history of energy is characterised by *expansion* of all sources, and not transition to a new source. Figure 53 charts world total primary energy consumption from 1800 to 2015, and is drawn from the data of Vaclav Smil.

As can be seen, no fuel, not even traditional biofuels, disappear from the global fuel mix, and all fuels tend to expand in quantity over time. The very small contribution from wind and solar, the red line just visible in the 2015 data, does not justify the claim of an energy transition. Reference to EU fuel-mix information from 1990 to 2020 tells the same story (Figures 32 and 57).

The obvious conclusion is that global energy consumption over the last two centuries, as over more recent decades, has been characterised by the expansion of all sources and is dominated by the overwhelming expansion of thermodynamically competent – that is to say, low entropy – sources of energy, such as coal, oil, natural gas and fissile uranium. These fuels have a high energy return on energy invested (ERoEI), rendering the energy sector

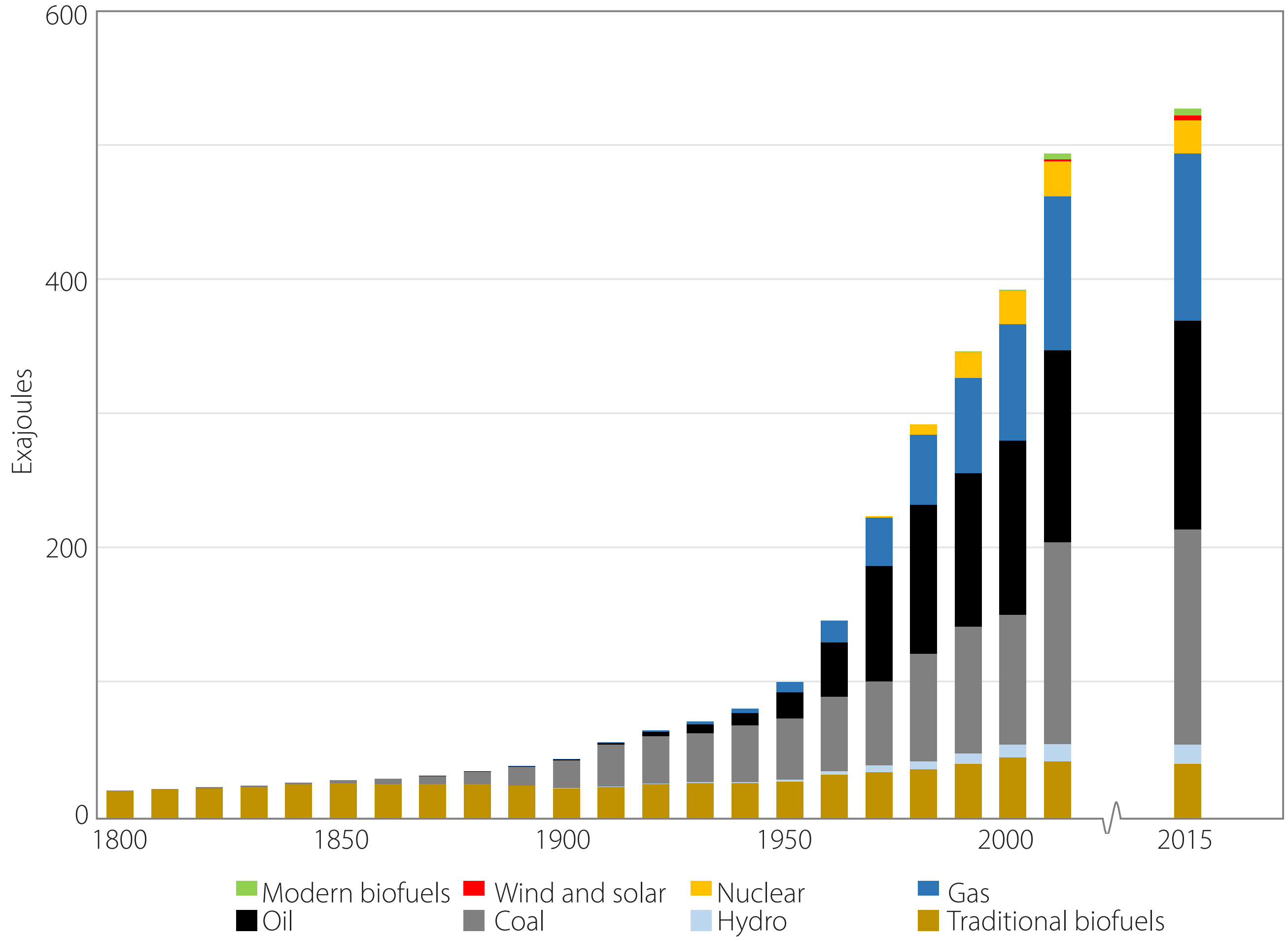


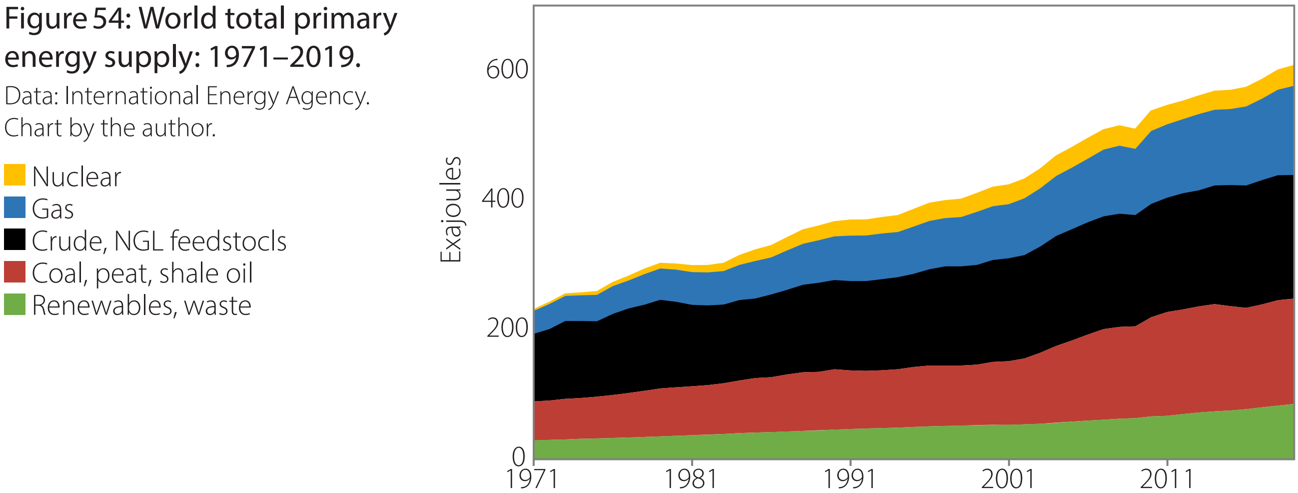
Figure 53: World total primary energy: 1800–2015.
Redrawn by the author from data in Vaclav Smil (2017).[78]

highly productive and permitting vast wealth creation outside it. Organic economies in the past relied on low-ERoEI renewable flows, mostly from farmed crops, and were compelled to reinvest the majority of the available wealth in the energy sector itself, for example in farm wages and the management of land, leaving little over for wealth creation in other areas. An economy based on modern renewables would necessarily be very similar in structure, with wealth and socio-political power concentrated in the hands of those owning the low-productivity energy generation assets. This would be politically unstable.

Energy expansion, not transition, can be confirmed by reference to another data source, that of the International Energy Agency (Figure 54).

Figure 54: World total primary energy supply: 1971–2019.

Data: International Energy Agency. Chart by the author.



Note that all renewables combined, that is modern (wind, solar) and traditional (biofuels and waste, hydro), constituted about 13% of global supply in 1971 and 14% in 2019, almost unchanged proportionally in spite of real absolute growth. Remarkably, given the intense policy pressure, subsidy, and publicity in favour of renewable technologies, particularly in the EU, global markets simply have been unable to reduce fossil fuel input. This is unsurprising. The physical properties of fossil fuels, notably their low entropy, make them superior as a means of changing the world in accordance with human wishes, changes that we refer to as wealth creation. Consequently, when societies wish to augment their own wellbeing, and generally speaking they do nothing else, they increase consumption of fossil fuels as the most effective means of doing so. This overall global rising trend is strongest in Asia, and particularly in China (Figure 55).

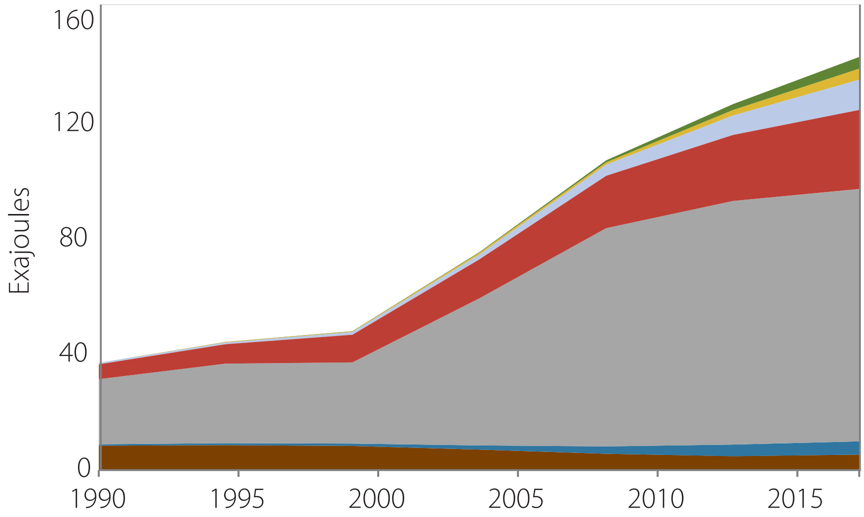
All renewables constituted 24% of China's energy in 1990 but only 9% in 2018, even though the absolute quantity of renewable energy has increased. Again, there is no transition; all sources of supply have increased.

This point should be borne in mind when evaluating reports that China has installed record levels of offshore wind power capacity in 2021 – some 17 GW or so, with a cumulative total of about 26 GW – and has a total onshore wind capacity of about

Figure 55: Total primary energy in the People's Republic of China 1990–2019.

Source: Data from International Energy Agency. Chart by the author.

Wind, solar etc
Nuclear
Gas
Oil
Coal
Hydro
Biofuels



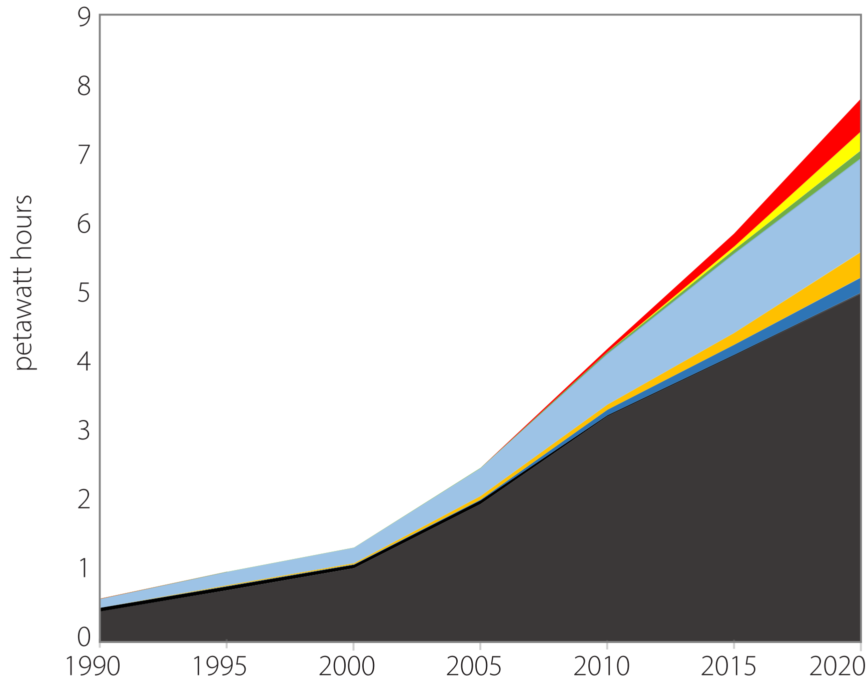
270 GW, with about 20 GW a year being added. By European standards these are large numbers, but in the Chinese context they are a minor contribution. China's total installed capacity of electricity generation in 2016 was about 1800 GW and is probably over 2000 GW at present, with about 1000 GW of that being coal-fired. For comparison, the UK's total installed capacity of all technologies is about 100 GW.

China's 14th Five-Year Plan projects a total addition of 40–50 GW of new gas-fired capacity by 2025, giving a total gas-fired capacity of about 150 GW, but even this is modest by that country's standards. Consequently, 17 GW of offshore wind in one year can be regarded as window dressing, serving to generate good headlines and provide a showcase for its export-oriented renewables manufacturing industry. Even 300 GW of wind is far from overwhelming in the Chinese context, a point confirmed by reference to the overall trend in its generation of electrical energy (Figure 56).

Figure 56: Electrical energy generation fuel mix in China, 1990–2020.

Source: International Energy Agency data, chart by the author.

Wind
Solar
Biofuels
Waste
Nuclear
Hydro
Coal and oil

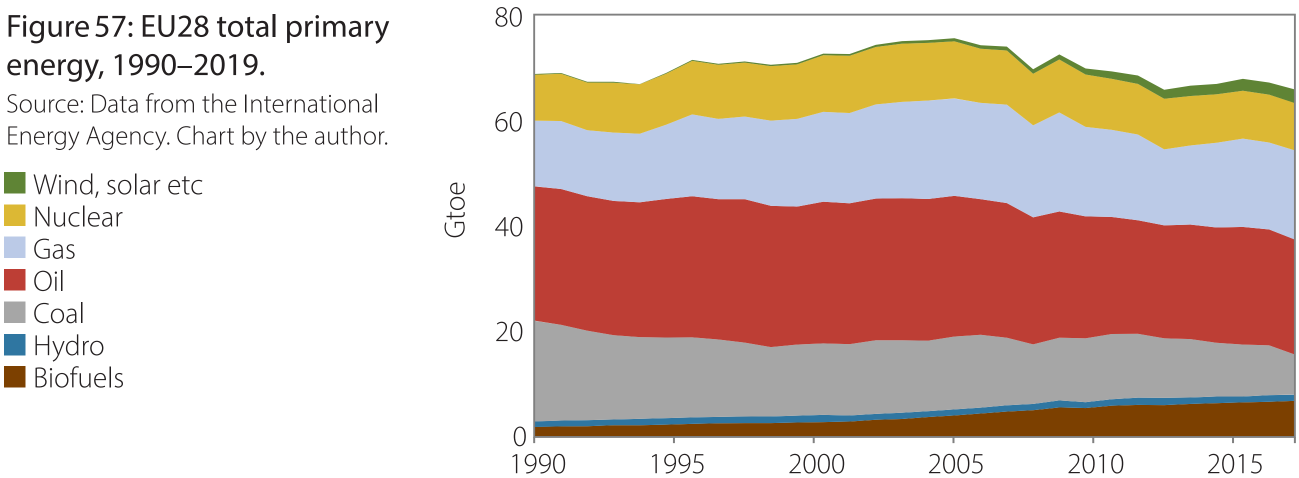


This is exactly what would be expected from the historical record of energy expansion, not least because the progressively wider adoption of electricity as an energy carrier is a basic index of modernity. China is generating just short of 8000 TWh of electrical energy per year at present, mostly from coal and environmentally controversial large hydro. For comparison and scale, the UK generates about 300 TWh per year, and is on a falling consumption trend (discussed below; see Figure 59). Generously assuming a load factor of about 40%, we can estimate the output of the 26 GW of Chinese offshore wind at just under 100 TWh, or about 1% of its electricity generation.

Overall, Chinese energy demand appears to be increasing rapidly in every area, and with all fuels except traditional biomass showing signs of growth. In the EU28, by contrast, energy consumption is falling (Figure 57).

Figure 57: EU28 total primary energy, 1990–2019.

Source: Data from the International Energy Agency. Chart by the author.

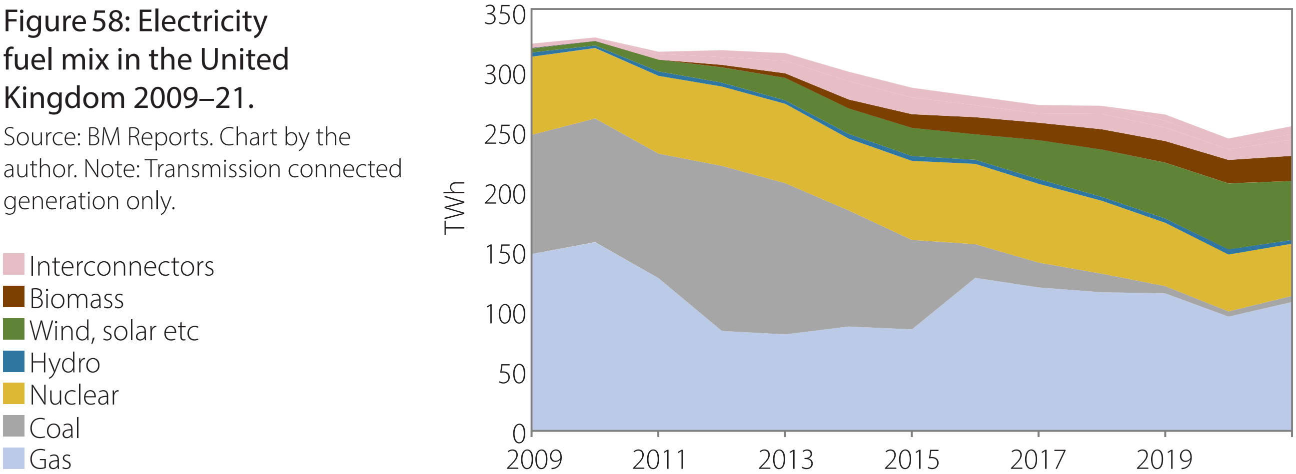


That renewables have grown significantly in the EU in both absolute and relative terms is undeniable: all renewables constituted 4.6% of EU28 supply in 1990 and 16.2% in 2019. But such growth is wholly unsurprising given both the scale of subsidy and the legislative support for that outcome (described above). In any case, some part of the increase is attributable to declining energy input. Assuming total primary energy in 2019 to be about 82 million TJ, as predicted by the very weak linear trend from 1990 to the peak in 2006, renewables would constitute just under 13% of energy supply. Indeed, it is the decline in energy consumption that is the most striking feature of the data, not the expansion of renewables. Sustained contraction of energy use is unprecedented in modern economic history.

Charts for the individual member states of the EU – Germany, or the United Kingdom (a member of the EU until recently) – are very similar to the aggregate picture, although the United Kingdom shows a particularly marked shift to natural gas. Both the decline and the extremely significant dependence on natural gas are particularly evident in the field of electricity generation (Figure 58).

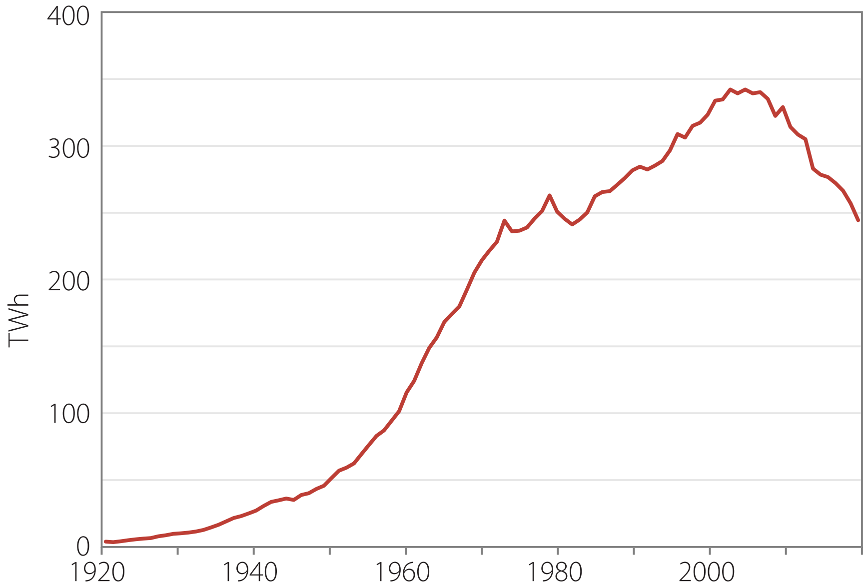
Note in particular the disappearance of coal (to some degree offset by the introduction of biomass burning in converted coal

Figure 58: Electricity fuel mix in the United Kingdom 2009–21.
Source: BM Reports. Chart by the author. Note: Transmission connected generation only.



stations such as Drax), the decline of nuclear, and the expansion of renewables and imports over interconnectors with Europe. However, interesting though these changes in fuel mix undoubtedly are, the most important macroscopic feature of this figure is the overall decline in electricity generation, making a sharp contrast with China. In historical context, this is even more striking. Figure 59 charts electricity supplied by major power producers in the UK in the century from 1920 to 2020.

Figure 59: UK electricity supplied by major power producers 1920–2020.
Source: Dept. Business, Energy & Industrial Strategy. Chart by the author.



Electricity consumption in the UK has falled by just under 20% since 2005, in spite of a much larger population. It goes without saying that the fall in supply is the most sustained and the largest in the record, making it objectively extraordinary that this has not attracted more comment and concern. In all probability, analysts are taking false comfort from the view that this is energy efficiency at work. However, as explained above, this is logically incoherent, since improvements in efficiency deliver growth, not conservation. Some other force is responsible for this decline, and in this case, as with the EU (discussed above), the explanation is almost certainly price rationing and the suppression of demand.

In the UK, as in much of the EU, gas is the only thermodynamically competent and immediately scalable generator left on the system, since plant currently operating at low load factor can increase output when required, as in 2021 when wind power output slumped by about 20% due to unfavourable winds and in spite of an increasing capacity. The electricity mix for the UK, in Figure 60, also shows that security of supply in 2009 was provided by gas and coal, with support from nuclear, whereas in 2020, only gas guaranteed security, with a declining contribution from nuclear. This erosion of fuel diversity is still more clearly manifested in the two flow charts of UK energy supply and consumption in 1995 and 2019 presented in Figure 60.

In 1995, UK fuel inputs were balanced over natural gas, coal, primary electricity from nuclear, and oil, with large fractions of within-country production of both oil and natural gas. While gas was responsible for a large part of domestic heating, and much industrial and commercial heat, the electricity industry was approximately evenly balanced over coal, natural gas and nuclear, all high-grade fuels with superior physical properties rendering them storable and controllable. The UK was clearly exposed to gas, an effect mitigated by domestic production, but with a respectable degree of fuel diversity, underwritten by a substantial and at that time expanding component of nuclear electricity generation. This was an economic and well-engineered system.

In 2019, the system has a fuel input profile that is concentrated on natural gas and oil, both areas where imports have grown significantly to offset falling in-country production. The expected growth in nuclear has not materialised, and in fact its input has halved. Coal has almost disappeared, and gas is the dominant element, not only in domestic heating but also in electricity, where it is the only high-grade fuel that is upwardly scalable – nuclear is operating at close to maximum load factor, whereas gas generation is underutilised.

Renewable energy has grown significantly, but much of this is wind and solar, a low-quality source. Biomass fuel for electricity and heat has grown greatly, with a large fraction accounted for by imported fuels for electricity generation. This does contribute to security of supply, since the stations in which it is burned are similar in character to coal plant, and indeed one of the largest, Drax, is a converted coal plant. However, biomass for electricity is extremely expensive and has questionable environmental credentials, with stack emissions that are actually higher than those of a coal station. It is only regarded as low emitting on the basis of claimed offsets achieved by replanting in harvested areas, claims which are much disputed.

We therefore conclude that Europe and the United Kingdom both exhibit declining consumption of energy, with the UK experiencing a significant decline in fuel diversity and an increasing exposure to natural gas.

We are principally concerned here with the European region, and the harm that these states have inflicted on themselves, but the EU's climate diplomacy has not been without significant col-

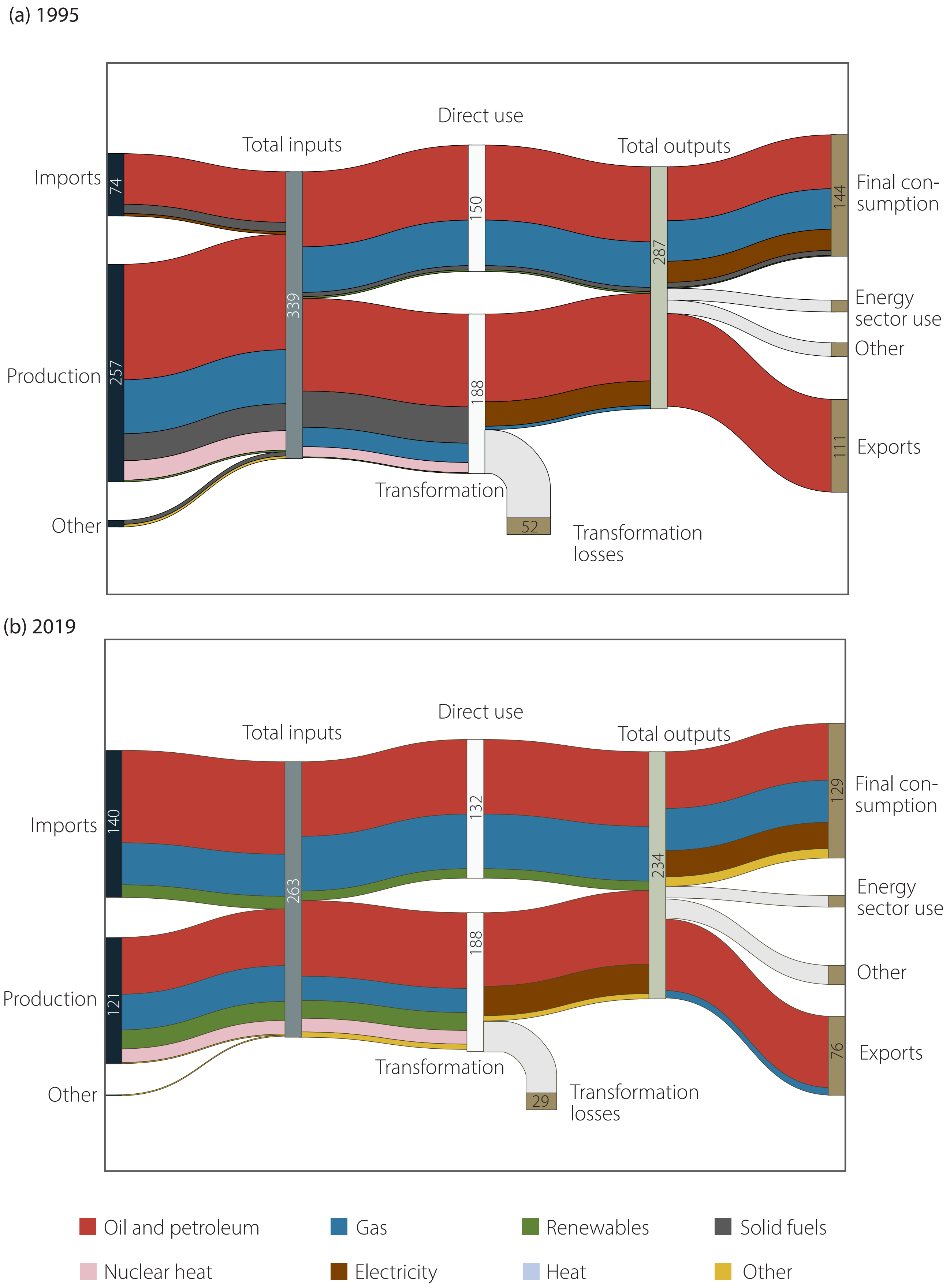


Figure 60: UK energy flows 1995.

(a) 1995 and (b) 2005. Millions of tonnes of oil equivalent. Source: Eurostat lateral damage. Even the United States, long resistant to the EU's global decarbonisation arguments, now also exhibits stagnating energy consumption. However, it is also markedly more fuel diverse than many parts of the EU, with a substantial, though declining, residual input from coal, and an increasing share of natural gas, much of which is produced from within-country resources such as shale deposits (Figure 61).

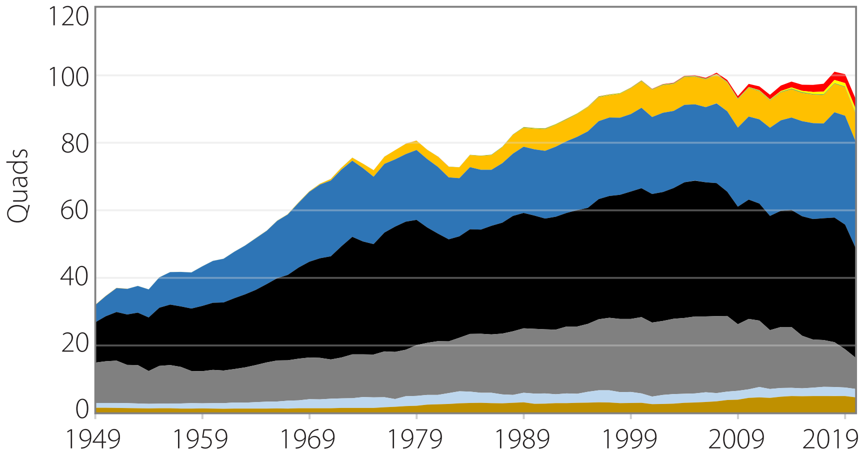


Figure 61: US primary energy: 1949–2020.

Source: Chart by the author, data from the US EIA.[79]

- Wind
- Solar
- Geothermal
- Nuclear
- Gas
- Petroleum
- Coal
- Hydro
- Biomass

In 1949, renewables constituted 9% of supply in the United States, a figure that rose to 12% in 2020. Total consumption seems to have peaked in about 2006, stagnating thereafter, a trend similar to that observed in the member states of the European Union. Indeed, while there have been significant declines in consumption before, during the first oil shock and in the early 1980s, the recovery was rapid and strong. The current flatlining is extended and surely significant. It is interesting to note that this flatlining coincides, as does the decline in the EU, with the onset of climate-change policies in the early 2000s, and with the economic turbulence of 2008, of which energy consumption seems to some degree to have been an anticipatory harbinger, with declines in evidence in 2006–07.

The Western energy anomaly and the return to fossil fuels

We have seen that the concept of energy transition, with one fuel replacing another, has no empirical support, historically or in the present day. As a matter of fact, what we observe currently is global energy expansion, as before in human history, but with strong local perturbations in the developed world, rippling out from the EU, where there is growth in renewables and stalling and falling total consumption. This effect is being offset by supernormal energy expansion in China and Asia generally, where the share of renewable energy has actually fallen very significantly since the early 1970s, in spite of absolute growth. Contemporary patterns of Western energy use, with the coerced introduction of inferior fuels and falling consumption, are highly anomalous when considered historically and are very unlikely to persist for much longer, particularly in the face of growing evidence that Asia is taking advantage of European errors and has maintained authentic and effective fuel diversity, while largely escaping any negative consequences from renewable energy adoption. Indeed, insofar as the West rejects Russian supplies of oil, coal and gas, China/Asia will benefit by purchasing those supplies at favourable prices.

It is possible that the United States will lag behind the EU in changing course. Due to early and successful exploitation of shale gas and oil resources, there will be less pressure for either nuclear or coal, although there are good economic and security grounds for increasing both. The Biden administration is opposed to fossil fuels in principle, and many of its supporters are demanding expansion of renewables. However, the wind resources of the United States are concentrated in three areas, a central zone onshore in the Mid-West, which has been broadly exploited with mixed results, and offshore on the East and West coasts, a resource that has yet to be developed. The onshore zone is very distant from the major centres of load in the bicoastal areas, which explains the current enthusiasm for offshore wind. As noted above, the claimed cost reductions for offshore wind in Europe are false, thus indicating that electricity from these sources will be very expensive by any standards, and certainly by North American ones. This is particularly true for the West coast resource, since the Pacific Ocean shelves rapidly and almost all the offshore wind anticipated for that area must consequently be installed on floating platforms, a technology that is extremely and intrinsically expensive. Nevertheless, there may still be growth in renewables in the United States, because relatively cheap and secure gas supplies will make these gestures politically viable in the short and medium term.

The EU, on the other hand, finds its hopes for an energy transition to be an illusion. The claim that renewables would diversify supply and increase security has been falsified; the appearance of fuel diversity was a mirage concealing a fragile natural gas policy. We may therefore expect, as anticipated above, that the European Union will sooner or later be compelled, *force majeure,* to seek more gas, and more fossil fuel sources generally, from non-Russian sources. Much of this will have to be obtained by trading, where possible, and through increasingly ingenious diplomacy. But in tandem, and as the desperate consequences of the European Green Deal come to bear on the member states, many governments will be under intense pressure to address their difficulties by bringing the European energy anomaly to an end by increasing domestic fossil fuel production. The potential for such expansion is real and valuable, although limited.

Increasing EU fossil fuel production

Europe's proven reserves and contingent resources of fossil fuels – coal and natural gas, and some oil – are large. If swiftly exploited in the short to medium term, they could have a significant effect on the prices of those fuels to European consumers, as well as reducing imports from Russia. This would address the energy security crisis, which has been caused by undue dependence on imported natural gas, and guarantee supply in systems dominated by uncontrollable weather-dependent renewable energy flows. The result would be far short of energy self-sufficiency, which could only be delivered by a long-term gas-to-nuclear strategy, but is nonetheless highly desirable.

Europe is in the midst of the worst energy crisis for a generation or more, a crisis that has been in the making for many years. Since the late 1990s, European policymakers, notably those of Germany and the EU itself, have deprecated fossil fuels in an effort to seize international leadership on climate change. In addition, they have promoted renewable energy through instruments coercing consumers to buy it at above market prices. Together, these policies have discouraged exploration for fossil fuels and the development of available resources of coal, oil and natural gas. For example, output from the North Sea has declined remarkably; UK natural gas and oil production peaked in the year 2000 at about 108 million tonnes of oil equivalent (mtoe) and 138 mtoe respectively. In 2020, these figures had fallen to 38 mtoe and 54 mtoe, the key factor in a dramatic fall in overall UK production of energy, and in spite of an increase in renewable electricity generation. The UK's Department for Business, Energy and Industrial Strategy (BEIS) reports that in 2021, total UK energy production including renewables was 106.9 mtoe, 14% down on that in 2020 and 'the lowest level in over 50 years'.[47]

Furthermore, the United Kingdom, along with all other European states, has rejected the use of hydraulic fracturing for natural gas and oil, a process that has transformed the energy economics of the United States in less than two decades. However, as many analysts predicted in the early 2000s, and in a seeming paradox, the policies favouring renewable energy have also made many European states more exposed to natural gas. This is because only gas-fired power stations are sufficiently flexible to respond to the fluctuating output of wind and solar, and thus guarantee security of supply. Many countries in the European region, with the UK prominent amongst them, therefore find themselves in the strange position of discouraging fossil fuel exploration and development while also creating a critical exposure to the cost of natural gas.

Similar effects were also seen across Europe in relation to oil and coal. The result has been increased imports of all fossil fuels, particularly from Russia. In 2021, as the world's economy recovered after the global pandemic, international competition for fossil fuels began to grow, and the lack of fuel diversity in the European region became apparent. The problem was brought sharply into focus by a slump in wind power output, which was much lower than in 2020, down by nearly 20% in the UK for example, leaving many countries scrambling for additional imports of natural gas. High regional prices resulted.

The subsequent invasion of Ukraine compounded these difficulties. It also confirmed the anxieties raised in 2014, after Russia's annexation of the Crimea, namely that relying on Moscow as a supplier of natural gas might represent a strategic liability, as well as being deeply unpalatable because of the income that gas sales generate for the Kremlin. The naïve response to the crisis is to suggest that Europe should add yet more renewable energy to its supply in the hope of reducing fossil fuel demand. But as already noted, the lack of fuel diversity and the extreme dependency on the availability and price of imported natural gas to guarantee security of electricity supply is the result of policies favouring (inferior quality, high entropy) energy sources such as wind and solar, while suppressing domestic production of (high quality, low entropy) fossil fuels. Writing for Net Zero Watch, my colleague Andrew Montford and I have argued that the correct and indeed the only possible short-term response to the acute aspects of the current crisis is as follows:[48]

- Move as quickly as possible to increase domestic production of fossil fuels, in the North Sea for example.
- Simultaneously reduce renewable energy generation, thus stabilising demand for natural gas, enabling traders to obtain longer-term supply contracts from non-Russian sources at less disadvantageous prices.
- Speedily upgrade gas-fired fleets to the latest models, which are more thermally efficient and therefore use significantly less gas per unit of electricity generated.
- Permit exploratory fracking for natural gas and oil, the full potential of which is unknown, but deserves verification, as will be seen when the scale of the resources is touched on below.
- In the longer term, Europe should clearly be aiming to build new fleets of advanced nuclear reactors for electricity and, in particular, for high-grade heat for industrial purposes, a function currently supplied by natural gas and coal.
- We also noted that it would be wise on security grounds to recognise that the development of nuclear energy might be delayed and that plans should be prepared to instal advanced supercritical coal fired power stations for the generation of electricity.

The urgent need to increase fossil fuel availability from non-Russian sources, and ideally from sources in Europe itself, raises the obvious question as to what quantities of fossil fuels are present in the European region. These may be:

- reserves (deposits that are known to be economic to extract with current technology and at current market prices)
- contingent resources, discovered and understood with a high degree of confidence, but dependent on a higher price to become economic
- prospective resources (deposits that are believed to exist but are as yet unexplored)

Table 3 summarises data from the *BP Statistical Review of World Energy* (2021), reporting the proven reserves of coal, oil and natural gas in Europe, proven reserves being 'those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions'. These are what Europe currently has immediately to hand in spite of more than twenty years of policies discouraging exploration and development. Had the policies not been in place, the proven reserves available today would almost certainly be greater still, as the market responded to the signal of rising prices. But even so, they are far from trivial, with European coal reserves amounting to nearly 13% of the global total, and sufficient to support current, admittedly low, levels of production for nearly 300 years. Europe's oil reserves amount to a little under 1% of the global total, and its gas reserves to just under 2% of the world total but would still be sufficient to meet current production levels for more than ten years and more than fourteen years respectively. There is headroom for increased production.

Table 3: Proved fossil fuel reserves in Europe.

Reserve/Production ratio is calculated by dividing the proved reserves at a given point in time by the production in that year. Source: BP Statistical Review.

	2020	Fraction of global total	Reserve/production ratio (years)
Coal (million tonnes)	137,240	12.8%	299
Oil (billion barrels)	13.6	0.8%	10.4
Natural gas (trillion cubic metres)	3.2	1.7%	14.5

It is, of course, true that European production of fossil fuels is only a small fraction of its total requirements at present, but it is equally clear that both reserves and production would certainly have been higher in the absence of climate policies, and that the current levels of both could be readily increased, with useful effects on prices and security. This can be appreciated by referring to the energy flow diagrams for the European Union in 1990 and in 2020 (see page 33), where the EU's increasing exposure to imported fuels, particularly gas, which guarantees security of supply on many of member state grids, is clearly evident.

In this context, even modest increases in proven reserves and levels of production within the European region could have considerable economic and geopolitical benefits. The potential for such increases can be gauged from estimates of the contingent and prospective resources of these fuels. Such estimates are inherently uncertain, but they provide a reasonable indication of the order of magnitude of a potential fuel resource.

Table 4 summarises data on resources and proven reserves of coal published in 2012 by the European Commission. The study estimates that resources and proven reserves for the EU27 together amounted to over 800 billion tonnes. As noted above, BP's *Statistical Review* estimated that proven reserves in 2020 amounted to about 140 billion tonnes. Thus, the EU27's coal resources are very approximately four times larger than its proven reserves, and could last for many centuries, even at increased levels of consumption. It should be noted that this estimate does not include the very large additional coal resources believed to lie under the North Sea, as reported recently in the industry press.[49]

It is interesting to note in passing that the same study reported substantial resources of hard coal in Ukraine.

Table 4: European coal as at 2012.
Sum of resources and provenreserves.

	Hard coal Mt	Brown coal Mt
Austria	—	333
Belgium	4,100	—
Bulgaria	4,112	4,574
Czech	9,946	16,627
France	160	114
Germany	82,921	77,000
Greece	—	6,430
Hungary	5,351	7,717
Ireland	40	—
Italy	610	29
Netherlands	3,247	—
Poland	176,738	228,183
Portugal	3	66
Romania	2,446	9,920
Slovakia	19	1,061
Slovenia	95	656
Spain	4,231	319
Sweden	5	—
UK	187,071	1,000
Total EU27	481,095	354,029
Croatia	—	300
Macedonia	—	632
Albania	—	727
Bosnia	630	4,182
Norway	78	—
Serbia	855	31,012
Turkey	1,190	12,114
Ukraine	81,045	—
Total other European countries	83,798	48,967

Source: EU Commission DG Energy (2012). https://ec.europa.eu/energy/sites/ener/files/documents/20121217_eu_co_res_report.pdf.

In summary, proven reserves are very substantial, and contingent and prospective resources are still greater. As Table 4 demonstrates, there is a great deal of coal in Europe, and even if consumption were increased considerably there would be sufficient for several centuries.

In 2014, and in response to an earlier phase of the Ukraine crisis, the EU undertook research into regional energy security.[50] This reported work by the German Federal Institute for Geosciences and Natural Resources to the effect that technically recoverable shale gas resources in Europe amounted to some 14 trillion cubic metres (494 trillion cubic feet), between four and five times greater than the proven reserves of natural gas reported for 2020 in the BP *Statistical Review* quoted above. Most of these resources are thought to be concentrated in France and Poland, but the figures for the UK, Germany, the Netherlands, and Denmark add up to a substantial additional resource, equivalent to about half of the French total. Similar findings are reported in work by the United States Energy Information Administration (US EIA) published in 2013 (see Table 5).

This substantial resource remains all but completely unexplored at present due to successful campaigning by environmental pressure groups.

The two most significant holdings of oil and gas in the North Sea are in UK and Norwegian waters. BP's *Statistical Review* reports, for 2020, proven reserves of 7.9 billion barrels of oil and 1.4 trillion cubic metres of natural gas in Norwegian waters, and 2.5 billion barrels of oil and 0.2 trillion cubic metres of natural gas in UK waters.

Table 5: Wet natural gas production in Europe, and resource estimates

	2011 production	Reserves	Unproved TRR*		Total
		Proved	Shale†	Conventional‡	
Europe	10	145	470	184	799
Bulgaria	0	0	17		
Denmark	0	2	32		
France	0	0	137		
Germany	0	4	17		
Netherlands	3	43	26		
Norway	4	73	0		
Poland	0	3	148		
Romania	0	4	51		
Spain	0	0	8		
Sweden	-	-	10		
United Kingdom	2	9	26		

*TRR, technically recoverable resources. †2013 EIA/ARI estimate. ‡2012 US Geological Survey estimate, including reserve growth. Source: Extract from US Energy Information Administration 2013.

Norwegian Petroleum reports that contingent resources – in fields and discoveries and undiscovered resources – probably amount to about 2.5 times proven reserves of oil, and about 1.6 times proven reserves of gas.[51]

The UK's Oil & Gas Authority (recently renamed the North Sea Transition Authority) reports that its contingent resource level of 6.8 billion barrels of oil equivalent of oil and gas (of which about 70% is oil and 30% gas) is about one and a half times larger than the proven reserves that could sustain UK Continental Shelf production to 2030, implying that another decade or more of production at current levels might be sustained from these resources.[52]

In passing, it is interesting to note that other sources report natural gas reserves in Ukraine only slightly smaller than those of Norway.[53]

In reviewing the potential of shale gas to contribute to energy security, in 2014 the European Commission concluded that 'the volumes produced will not make Europe self-sufficient in gas but could help to reduce prices'.[54] That conclusion is obviously correct, and applies with equal force to coal, oil, and conventional natural gas resources. No-one would argue from the data reviewed in this study that the European region can become self-sufficient in fossil energy, but it is equally clear that further exploration of the very substantial resources of these fuels could enlarge proven reserves, increase production, and have a significant effect on regional prices and overall security.

16. Conclusion

The prosperity generated from even a modest increase in domestic fossil fuel production in Western Europe could be the basis for a reversal of energy policy and a return to the gas-to-nuclear trajectory that alone has thermodynamic theory on its side and was being spontaneously adopted by the markets in the early 2000s, but which was mistakenly cancelled by policy intervention. This will require a recognition that the attempt to induce an energy transition by means of intense support for renewable energy has been a mistake and that emergency measures are needed to support a corrective course. Writing off the malinvestments made in wind and solar, many now owned by European pension funds, will be painful in itself, but providing resources to support the required remedial investment in conventional fossil fuels and advanced nuclear will also require considerable sacrifices in European standards of living. There is much lost ground to be made up. Consequently, there is no easy path out of the difficulties, and the future for the European peoples is arduous whichever course, wise or foolish, is taken.

About the author

John Constable is an independent energy policy analyst, and the Energy Director for the Global Warming Policy Foundation (GWPF) in London. Dr Constable has appeared before several parliamentary select committees, including the House of Commons Environmental Audit Committee and the House of Lords Committee on Economic Affairs. He is a frequent invited and plenary speaker on energy and climate policy to both mixed and specialist audiences. In 2009 he delivered the Alworth International Lectures at the University of Minnesota, in 2015 he was a plenary speaker at Kyoto University's 'Global Energy Problems' conference (2015), and in 2016 he delivered a Newcastle University 'Insight' public lecture, now published as *Energy, Entropy, and the Theory of Wealth* (2016). In 2021 he was an invited speaker at the 21st Mont Pelerin Society conference, held in Guatemala City, where he spoke on the relationship between low-entropy energy sources and the emergence of liberal societies. Dr Constable has also worked with the Hartwell Group of international climate policy analysts, being an author in the third Hartwell study, *The Vital Spark* (2013).

The following articles and monographs are a selection from Dr Constable's many other publications on energy policy 'US Offshore Wind Prospects: Overblown Promises and Blown-Up Costs', *National Review* (February 2021); *A Little Nudge with a Big Stick* (2021); *Hydrogen: The once and future fuel?* (2020); *The Brink of Darkness: Britain's fragile power grid* (2020); *Offshore Wind Strike Prices: Behind the Headlines* (with Gordon Hughes and Capell Aris, 2017); *Energy Intensive Industries: Climate policy casualties* (2016); 'Economic hazards of a forced energy transition: inferences from the UK's renewable energy and climate strategy', *Evolutionary and Institutional Economics Review* (with Lee Moroney, June 2016); *Shortfall, Rebound, Backfire: Can we rely on energy efficiency policies to offset climate policy costs?* (2012), *Energy Policy and Consumer Hardship* (2011), and *The Green Mirage: Why a low carbon economy may be further off than we think* (Civitas: London, 2011).

Notes

1. COM(2021) 962 final, p. 3.
2. ETC/CME Eionet, *Trends and projections in the EU ETS in 2021,* 18.
3. ETC/CME Eionet, *Trends and projections in the EU ETS in 2021*, 32.
4. See Table 5.1 in EC SWD(2021) 308 final: https://ec.europa.eu/clima/system/files/2021-10/swd_2021_308_en.pdf.
5. COM(2021) 962 final, p. 14–15.
6. EU Commission, Industry Factsheet, 'Leading the Clean Industrial Revolution' (July 2021): https://ec.europa.eu/commission/presscorner/detail/en/fs_21_3675.
7. https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets_en.
8. Calculated from figures in SWD(2021) 308 final.
9. Much EU and Commission data now removes the UK from its records, though sometimes providing the data in a separate line in the statement. It is not always possible or desirable to recombine the data to provide statements for the EU28, and this study reports data for both the EU27 (excluding the UK) and the EU28 (including the UK) as seems appropriate.
10. The annual increment could begin to decline in the near future if subsidy entitlements expire and no new subsidies are introduced.
11. See Gordon Hughes, *Wind Power Costs in the United Kingdom* (REF: London, 2020), and *The Performance of Wind Power in Denmark* (REF: London, 2020): https://www.ref.org.uk/ref-blog/365-wind-power-economics-rhetoric-and-reality.
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30. As the authors explain: 'The G20 weighted averages are calculated on the basis of all available data for a particular year, weighted in total price by the share a country had in EU imports + exports 2017–2019. Coverage ratios of total trade range from 84–99% (household prices), 76–99% (industrial prices) and 36–74% (wholesale prices).'

31. On the weighting used to construct the G20 averages, the authors comment that these are 'calculated on the basis of all available data for a particular year, weighted in total price by the share a country had in EU imports + exports 2017–2019. Coverage ratios of total trade range from 84–98% (household prices), 77–99% (industrial prices) and 60–97% (wholesale prices)'.

32. The authors explain that the G20 weighted averages 'calculated on the basis of all available data for a particular year, weighted in total price by the share a country had in EU imports + exports 2017–2019'.

33. Trinomics, p. 16.

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