THE ROAD TO NetZero

SUMMER 2022

ALESSIO TERZI DISCUSSES THE GREEN INDUSTRIAL REVOLUTION AND FUTURE GROWTH

THE ROLE OF COMPETITION IN THE CLIMATE TRANSITION IS LOOKED AT BY GEORG ZACHMANN

HOW PREPARED IS THE UKS FINANCE SECTOR IS TO CLIMATE CHANGE. SAM WOODS REVIEWS

SUSTAINABLE DEVELOPMENT

Foreword

Welcome to the Summer edition of The Road to Net Zero, a *World Commerce Review* supplement. This publication has been prepared in response to readership demand for an overview of the steps being taken in the transition to a cleaner and greener sustainable world.

All aspects of climate action are examined, with the most respected authors providing the reader with the most comprehensive information available. Our brief is to provide all the data necessary for the readership to make their own informed decisions. All editorials are independent, and content is unaffected by advertising or other commercial considerations. Authors are not endorsing any commercial or other content within the publication. ■

CONTENTS

CONTENTS

A green industrial revolution is coming

Many question the usefulness of economic growth, concerned about the environment. Alessio Terzi believes the green transition can usher in prosperity for people and the planet

Pressing social and environmental concerns are leading many to question the usefulness of economic growth. This column argues that there is nothing intrinsic in the concept of growth that makes it incompatible with environmental protection. Growth and technological progress are two sides of the same coin. The green transition can contribute to the creation of 'good jobs' that are less prone to geographical concentration, dehumanising repetitive tasks, and automation or delocalisation. It can usher in prosperity for the combined benefit of people and planet.

As humanity grapples with the existential challenge of climate change, what will happen to the size of the economy? This question is not only being asked by heterodox scholars belonging to the 'degrowth movement', who see shrinking incomes and consumption as instrumental to reaching climate targets (Hickel 2020, Jackson 2021).

Within the mainstream economic profession as well, the idea that decarbonisation will fail to stimulate growth and jobs, contrary to the promises of plans such as Build Back Better or the European Green Deal, has some notable patrons (Claeys *et al* 2019, Pisani-Ferry 2021).

Macroeconomic modellers have tried to quantify the impact of the green transition and concluded that overall aggregate benefits in terms of GDP impact and net jobs created will be muted, oscillating between marginally positive to marginally negative depending on the assumptions used (European Commission 2020, IMF 2020, OECD 2017). Econometricians have teased out the effect of past carbon-pricing exercises to conclude likewise that the impact on GDP and jobs is limited (Metcalf and Stock 2020, Yamazaki 2017).

In a new book, *Growth for good: Reshaping capitalism to save humanity from climate catastrophe,* I come to radically different conclusions. All these modelling approaches take too narrow a perspective to appropriately answer questions on long-term economic growth in the era of climate change.

For starters, most of the economics literature has concentrated its efforts on carbon pricing, generally reducing climate mitigation and adaptation packages to a mere shift in taxation away from labour income and towards carbon emissions.

On the other hand, 'green deals' will push early adopting countries towards developing a comparative advantage in advanced green technologies. Mastering technological knowhow in the production methods of the future will inevitably have important rebalancing effects on competitiveness across the globe (Lund and Bughin 2019).

Given the wide-reaching implications for production, consumption, energy, agriculture, housing, and transport, the green transition is probably closer to a technological and industrial revolution

Another way of putting it is that climate mitigation agendas will radically modify production and the very structure of the economy, making standard macroeconomic models poor tools to assess their overall impact. In jargon, this would be a green version of the famous 'Lucas critique'.

Empirical evaluations based on past moderate attempts at introducing some form of carbon pricing are unlikely to be of great help when trying to predict the economic consequences of fully-fledged green deal packages. Aghion *et al* (2021) laid out the properties of technological revolutions.

These are characterised by a fundamental innovation, which (i) has scope for improvement, implying a sustained cost reduction; (ii) is pervasive, spreading to all sectors in the economy; and (iii) spawns successive waves of secondary innovation, as the original technology gets adapted in the various sectors.

Given the wide-reaching implications for production, consumption, energy, agriculture, housing, and transport, the green transition is probably closer to a technological and industrial revolution than some isolated public policy to be evaluated linearly through marginal effects.

The Adam Smith fallacy

When taking this view, extrapolating empirical estimates of past mild exercises of carbon pricing to conclude that the green transition will have muted economic impacts is a mistaken approach.

It would be like observing limited productivity gains in firms adopting the early mechanisation of cotton spinning in England in the second half of the 18th century and concluding that the First Industrial Revolution would have muted effects on the economy.

We could call this the 'Adam Smith fallacy', as the founding father of classical economics entirely failed to see the crucial repercussions that the then-nascent mechanised cotton spinning and steam engine technology would soon have on the wealth of nations (Wrigley 2011).

This oversight can be entirely justified by the fact that in the early stages of an industrial revolution, the economic impact of novel technologies is indeed rather muted (Pezzoni *et al* 2019). Juhász *et al* (2020) show how 'trial and error' with mechanisation in the 18th century initially led to widely dispersed productivity draws and low initial average productivity.

Only in the subsequent decades was high productivity growth observed, as new entrants adopted improved methods of production and organisation. When electricity first reached companies during the Second Industrial Revolution, a similarly muted initial economic impact was encountered until the benefits of electrification could be leveraged fully in assembly-line production, abolishing the older line-shaft system (Aghion *et al* 2021, McAfee 2019, Smil 2017).

Fast-forwarding to the 21st century, as companies start innovating through technological diffusion, inventing new solutions to adapt their business lines to the changing (green) economic landscape, we are likely to observe significant productivity boosts.

This is a possibility because – in contrast to mature technologies like hydropower or fossil fuels – green technologies are likely to have still a long way to go in cost reduction. Renewable energies could easily become by far the cheapest energy source in history (International Energy Agency 2020), leading to a generalised productivity boost across the economy. In the words of Stern and Stiglitz (2021: 61):

For two hundred years, technologies based on fossil fuel have been explored. Diminishing returns may have set in. Climate change has induced new searches in other parts of the technology frontier. […] the green economy may usher in a new era of high productivity growth.

Good green jobs

In the initial phase, green deals will be characterised by large investment programmes on infrastructure, climate adaptation, renewable energy installations and renovations throughout the national territory. Most of these activities are expected to boost the construction sector – one of the most labour-intensive sectors in the economy.

Following the early construction wave, renewable energy sources are expected to require regular maintenance services, which need to be carried out in situ and can therefore hardly be relocated abroad.

While some reskilling will be needed, several studies point to the fact that most green professions will not necessarily require completely different levels of schooling or skills. As such, much of the retooling of vocational skills could probably happen through on-the-job retraining, making the odds of a seamless job transition much higher than for other economic transformations, such as the Digital Revolution (Bowen *et al* 2018).

Several recent studies have suggested how these occupations tend to require less repetitive tasks and more interpersonal skills, implying a limited risk of automation in the near future (Consoli *et al* 2016, Vona *et al* 2018). Early evidence from green pioneering countries like the UK also suggests that the job creation potential is spread, including outside cities and in poorer regions (Martin *et al* 2020).

The twists and turns of an incipient industrial revolution are hard to foresee with precision in its early stages. However, the current evidence suggests that the green transition will not only contribute to the creation of jobs,

but specifically 'good jobs' that are less prone to geographical concentration, less characterised by dehumanising repetitive tasks, and less likely to undergo automation or delocalisation (Rodrik and Sabel 2019).

Winners and losers

As a result of changing production and consumption patterns, green deals will redraw completely the map of trade and investment relations between countries, influence geopolitics, and redefine economic winners and losers (Leonard *et al* 2021).

For instance, countries specialising predominantly in fossil-fuel exports, like Russia or OPEC members, will likely be on the losing end unless they manage to diversify their economic model (Gustafson 2021, IMF 2020).

As production and consumption change, comparative advantages shift, and the wealth of nations will be defined and contended on this new technological terrain.

Knowing all this, two conclusions are evident. First, accelerating the green transition makes economic and strategic sense, even without climate considerations. Countries have a strong (self-interested) incentive to fast-track the adoption of these new technologies to gain an edge in what will be the energy and production system of the future.

By so doing, they will be capturing network effects and setting regulatory and technological standards, effectively shaping the very course of future innovation (Aiginger 2020).

Second, this fast economic transformation at the global level will leave some countries behind, notably those that refuse (or are too slow) to adapt to this technological shift. Aware of all this, policymakers should not be deceived

by current estimations of muted economic impacts and fall into complacency. The green industrial revolution is upon us. ■

Alessio Terzi is an Economist at DG ECFIN of the European Commission, and a lecturer at Sciences Po, Lille

References

Aghion, P, C Antonin and S Bunel (2021), The power of creative destruction: Economic upheaval and the wealth of nations, Cambridge, MA: Belknap Press.

Aiginger, K (2020), "A green deal will not work without refocusing productivity", VoxEU.org, 20 January.

Bowen, A, K Kuralbayeva and EL Tipoe (2018), "Characterising green employment: The impacts of 'greening' on workforce composition", Energy Economics 72: 263–75.

Claeys, G, S Tagliapietra and G Zachmann (2019), "How to make the European green deal work", Bruegel Policy Contribution 13: 21.

Consoli, D, G Marin, A Marzucchi and F Vona (2016), "Do green jobs differ from non-green jobs in terms of skills and human capital?", Research Policy 45(5): 1046–60.

European Commission (2020), "Impact assessment, accompanying communication 'stepping up Europe's 2030 climate ambition – investing in a climate-neutral future for the benefit of our people", SWD – Staff and Joint Working Documents, European Commission (176 final).

Gustafson, T (2021), Klimat: Russia in the age of climate change, Cambridge, MA: Harvard University Press.

Hickel, J (2020), Less is more: How degrowth will save the world, London: Penguin.

International Energy Agency (2020), Renewables 2020, Paris.

IMF (2020), Mitigating climate change: Growth and distribution-friendly strategies, World Economic Outlook, Washington DC.
Jackson, T (2021), Post growth: Life after capitalism, Cambridge: Polity.
Juhász, R, MP Squicciarini and N Voigtländer (2020), "Technology adoption and productivity growth: Evidence from industrialization in France", NBER Working Paper 27503.
Leonard, M, J Pisani-Ferry, J Shapiro, S Tagliapietra and GB Wolff (2021), "The geopolitics of the European green deal", Bruegel Policy Contribution (04/21): 1–23.
Lund, S, and J Bughin (2019), "Next-generation technologies and the future of trade", VoxEU.org, 10 April.
Martin, R, S Unsworth, A Valero and D Verhoeven (2020), Innovation for a strong and sustainable recovery, No.14, London: Centre for Economic Performance.
McAfee, A (2019), More from less: The surprising story of how we learned to prosper using fewer resources - and what happens next, New York: Scribner.
Metcalf, GE, and JH Stock (2020), "The macroeconomic impact of Europe's carbon taxes", NBER Working Paper 27488.
Organisation for Economic Co-operation and Development (2017), Employment implications of green growth: Linking jobs, growth, and green policies.
Pezzoni, M, R Veugelers and F Visentin (2019), "Technology diffusion trajectories: New evidence", VoxEU.org, 3 September.
Pisani-Ferry, J (2021), "Climate policy is macroeconomic policy, and the implications will be significant", PIIE Policy Brief: 1–15.
Rodrik, D, and C Sabel (2019), "Building a good jobs economy", working paper.
Smil, V (2017), Energy and civilization: A history, Cambridge, MA: MIT Press.
Stern, N, and JE Stiglitz (2021), "The social cost of carbon, risk, distribution, market failures: An alternative approach", NBER Working Paper 28472.
Terzi, A (2022), Growth for good: Reshaping capitalism to save humanity from climate catastrophe, Cambridge, MA: Harvard University Press.

Vona, F, G Marin, D Consoli and D Popp (2018), "Environmental regulation and green skills: An empirical exploration", Journal of the Association of Environmental and Resource Economists 5(4): 713–53.
Wrigley, EA (2011), "Opening Pandora's box: A new look at the industrial revolution", VoxEU.org, 22 July.
Yamazaki, A (2017), "Jobs and climate policy: Evidence from British Columbia's revenue-neutral carbon tax", Journal of Environmental Economics and Management 83: 197–216.

Author's note: the views expressed here are those of the author and do not necessarily reflect those of the European Commission. This article was first published on VoxEU.org.

Climate capital

The BoE recently tested the UK's largest banks and insurers on how prepared they are for financial risks caused by climate change. Sam Woods reviews the results

Climate change is now firmly in the focus of prudential regulators across the globe. In that context, I want to outline the results of our first exploratory scenario exercise on climate risk – the 'CBES'[1] – which were published 24th May. But before that, I want to put those results in context, and set out how I see climate risk fitting within the Prudential Regulation Authority's (PRA's) wider mission[2].

The role of prudential policy

Tackling the threat from climate change will involve efforts by governments across the globe, as well as by many other organisations and individuals.

In the UK, the effort to get to net zero greenhouse gas emissions is being led by government, with a wide range of other public bodies doing their part. Where does prudential policy fit into this effort?

The role of prudential policy is to ensure the safety and soundness of banks and insurers, so that they can continue to provide vital financial services to the real economy. Getting our core job right, and so maintaining financial stability, is far and away the most important thing we can do to support the fight against climate change.

Achieving net zero will not be possible unless our societies make considerable investments in developing and disseminating new technologies, and will require major changes across the economy. A stable financial system can support households and businesses through these changes, and channel investment where it needs to go to support the transition.

Transitioning to net zero will be a major challenge for our institutions and societies even in a benign economic environment – doing so without confidence in the basic functioning of the financial system would be near impossible.

It is therefore vital that firms can withstand risks to their safety and soundness, including those that arise as a consequence of climate change – both 'physical' risks like flooding and extreme weather events, and 'transition' risks that arise as the economy moves away from carbon-intensive activities.

Firms therefore need to understand, at a granular level, how their balance sheets and business models are exposed to both present and future climate risks, so that they can take the right risk management actions today.

This includes investing in their data and modelling capabilities, and carefully scrutinising the data they get from third parties. It means ensuring Boards and senior executives see climate risk as a strategic priority[3]. And ultimately, it means ensuring firms hold sufficient financial resources to absorb losses arising from climate change.

More generally these results bring home the fact that uncertainty around the impact of climate change – even given a pre-determined scenario – remains extremely high

Climate and capital

Should climate risk be captured in capital requirements?[4] In one sense, the answer is an obvious yes. Climate change will inevitably drive losses for banks and insurers – even in a scenario where governments around the world take swift and early action to bring us to net zero.

Just as with any other risk, PRA-regulated institutions must have the resilience to keep serving the real economy in the face of these losses. Capital requirements are an important part of how we deliver that resilience.

That said, while capital can address the financial consequences of climate change, we don't think it is the best tool to address directly the causes of climate change – for example by reducing capital requirements to subsidise 'green' assets, or increasing them to penalise carbon-intensive ones. How to address the causes of climate change is a decision for governments and parliaments, not financial regulators[5].

For one thing, by diverting the capital framework from its core goal of keeping the financial system standing, such interventions carry significant risks. At worst, we might end up under-capitalising banks and insurers for the risks they face, raising questions about their overall resilience. Or we could end up over-capitalising them inefficiently, reducing their ability to support the economy through the transition.

And there is little evidence that fine-tuning capital requirements in this way would actually achieve its intended goals. In the EU, changes made to the bank capital framework with the aim of supporting SME lending have had little demonstrable impact[6].

In the absence of evidence that capital requirements actually work as a way of directing lending, it seems unwise to incur these costs – particularly when we have not been given any mandate to do so.

Our focus is therefore on ensuring the financial system can withstand the risks arising from climate change. This raises some fundamental questions. How can we tell whether the capital regime is effectively capturing climate risks? There are two kinds of gap we might need to fill.

The first is 'regime gaps'. These occur when the design, methodology or scope of the capital framework does not adequately cover risks from climate. To give one example: some aspects of the Pillar 1 capital framework for banks use a one-year time horizon for calculating potential unexpected losses.

Of course, as policymakers, we do not have a one-year time horizon: we will need a viable banking and insurance sector right through the transition and beyond. The one-year horizon is, in effect, a modelling assumption.

It may be reasonable for many risks, but seems particularly ill-suited for climate change, a risk which is structurally building over time and will not fully crystallise in a one-year horizon[7].

The second type of gap takes the form of 'capability gaps'. Even if we were satisfied that climate risk was captured by the regime in theory, do firms and regulators have the data and modelling abilities to ensure it is captured in practice?

This is a major challenge: climate risk is very different from traditional financial risks, and we cannot rely on historical data to size it. Another factor that makes this difficult is the need for banks and insurers to understand the carbon impacts of the real economy firms they finance.

It can be hard to judge where real economy firms are, never mind where they are going – and it is the latter that is most important when thinking about future risks.

The Climate Biennial Exploratory Scenario (CBES)

The Bank's exploratory climate scenario exercise – which we call the 'CBES' – was launched last year and is intended to help address these capability gaps.

For the largest UK banks and insurers, we asked for granular analysis of the risks they might face, and their strategic responses, in three stylised 30-year scenarios:

- An 'early action' (EA) scenario where climate policy is ambitious from the beginning, with a gradual intensification of carbon taxes and other policies over time.

  As a result, global warming (relative to pre-industrial levels) is successfully limited to 1.8°C by the end of the scenario, falling to around 1.5°C by the end of century. You could view this as a reasonable best-case scenario for climate risk.

- A 'late action' (LA) scenario where policy measures are delayed by a decade, and then are implemented in a sudden and disorderly way, leading to material economic and market disruption.

  Ultimately, global warming is still limited to 1.8°C by the end of the scenario (2050) relative to pre-industrial levels, but then remains around this level at the end of the century[8].

- A 'no additional action' (NAA) scenario in which governments around the world fail to enact policy responses to global warming, other than those actions already taken. As a result, global temperature levels continue to increase, reaching 3.3°C higher relative to pre-industrial levels by the end of the scenario.

In the scenario this leads to serious environmental impacts, including extreme weather events, destroyed ecosystems and rising sea levels. In some cases these changes are irreversible.

While these changes take longer to manifest, they give rise to increasing and irreversible shocks that continue to grow beyond the scenario: UK and global GDP growth are permanently lower and macroeconomic uncertainty increases.

Broadly speaking, the first two scenarios focus on risks from the transition to net zero, whereas the third one focuses on physical risks from climate change. And to reiterate a theme I will come back to later, the risks from climate change have been managed by the end of the first two scenarios – whereas in the third they continue to build.

CBES headlines

The results of the CBES have been published, and I would encourage anyone with an interest in this topic to read them in full. For me the main headlines from the results publication are:

- The stylised scenarios used in this exercise are illustrations of possible paths for climate policy and global warming, not forecasts. The projections made by banks and insurers are uncertain, but suggest that overall costs will be lowest with early, well-managed action to reduce greenhouse gas emissions and so limit climate change.

- UK banks' and insurers' projections suggest that they are likely to be able to bear the costs of transition that fall on them. In part, that is because a significant portion of these costs may ultimately be passed on to their customers.

- In the No Additional Action scenario, households and businesses vulnerable to physical risks would be

particularly hard hit, as general insurers would pass on the cost of higher claims into premiums, or otherwise refuse to renew insurance for some customers.

- Governments set public climate policy, which will be a key determinant of the speed and shape of changes in the global economy. Banks and insurers have a collective interest in managing climate-related financial risks in a way that supports that transition over time. They will need to improve their management of these risks in order to be able to do so.

Within this, I wanted to pick out a few particularly interesting lessons.

The first key lesson from this exercise is that over time climate risks will become a persistent drag on banks' and insurers' profitability – particularly if they don't manage them effectively. While they vary across firms and scenarios, overall loss rates are equivalent to an average drag on annual profits of around 10-15%.

These are big numbers, and the limits of the exercise mean the actual impact could well be larger due to some significant exclusions[9]. But it bears repeating that based on this exercise the costs of a transition to net zero look absorbable for banks and insurers, without a worrying direct impact on their solvency.

By themselves, these are not the kinds of losses that would make me question the stability of the system, and they suggest that the financial sector has the capacity to support the economy through the transition.

But any positive message needs to be taken with a major pinch of salt: both because there is a lot of uncertainty in these projections and because this drag on profitability will leave the sector more vulnerable to other, future shocks. A world with climate change is a riskier one for the financial system to navigate.

A second key lesson is that how and when we transition makes a big difference. Costs to the financial sector will be substantially lower if early, orderly action is taken. For example, projected climate-related bank credit losses were 30% higher in the LA scenario than the EA scenario.

Among other factors, this reflects that in the scenario, adjusting late and abruptly to climate risk triggers a messy recession – with rising unemployment as the corporate sector adjusts. So early action is important to lower the cost of the transition. If we are ever to reach net zero, a number of sectors are going to have to adapt their business models on a fundamental level.

As the report sets out, it will be in the collective interests of financial institutions to support counterparties that have credible plans to adapt – and ultimately reduce their exposures to those sectors of the economy that are inconsistent with a net zero policy[10].

At the same time, the financial sector cannot run ahead of the real economy: we need real change to make the economy more energy efficient and expand the provision of renewable energy. While that process takes place, banks and insurers need to provide finance to more carbon-intensive sectors of the economy, precisely in order to allow them to invest in the transition.

Cutting off finance to these corporates too quickly could prove counterproductive, and have wide-ranging macroeconomic and societal consequences, including through elevated energy prices – potentially akin to those whose negative effects we are experiencing today.

Another key point for me is that no action on climate delivers the worst outcome from our scenarios. A naïve comparison of loss rates in the two net zero scenarios and the NAA scenario might suggest otherwise; in fact for banks, credit losses were lower under no action than for late action.

But this is misleading because of the very different endpoints of the scenarios. Under both the LA and EA scenarios, climate change has broadly been brought under control by the end of the 30-year period.

By contrast, with no additional action the impacts will persist well beyond the 30 years of our scenario – incurring substantial economic costs not captured in these estimates[11].

Even sticking within the 30-year bounds of the scenario – and focusing on financial sector impacts – the NAA scenario is pretty grim. Projected impairment rates for banks are up 50% compared with normal levels. And whereas the 'transition' scenarios offer clear opportunities for banks to increase their profits by investing the transition, the 'no action' scenario offered no such opportunities.

Instead, the world gets poorer and more uncertain for all sectors, particularly those directly exposed to physical risks. The 'no action' scenario is particularly unpleasant for life and general insurers – even sticking to the 30-year window, their losses in this scenario were worse than in the transition.

For instance, UK and international general insurers, respectively, projected a rise in average annualised losses of around 50% and 70% by the end of the NAA scenario. It's worth emphasising that these costs would be mostly passed on to consumers through higher premiums.

Ultimately, in a 'no action' scenario, we would see a reduction in access to lending and insurance for so-called 'climate vulnerable' sectors and households.

To give an example of what this means, homes at risk of flooding would likely become prohibitively expensive to insure or borrow against.

Like so many of the impacts of climate change, this cost would be borne unequally: 45% of the mortgage impairments in the scenario are accounted for by just 10% of the country[12]. And there is evidence that in areas particularly at risk of flooding, many homes could become uninsurable.

Finally, the CBES exercise is a measure of the progress banks and insurers are making in their climate risk management. Overall, this is a good news story: we were encouraged by the progress firms have made. But there is still much more to do. We will give firm-specific feedback to participants, but key themes include:

- The need for more data on, and understanding of, customers' current emissions and transition plans. This can include looking through complex chains of financial relationships between clients and counterparties to see the underlying emissions.

- The need to invest in modelling capabilities and doing more to scrutinise data and projections supplied by third parties.

- The need for some firms to consider more deeply how they would respond strategically to different scenarios, including thinking through the implications of different paths for climate policy.

More generally these results bring home the fact that uncertainty around the impact of climate change – even given a pre-determined scenario – remains extremely high. As you will see if you read the report, the error bands around all these estimates are very wide[13].

This presents a challenge when considering implications for policy – and highlights the importance of continuing to plug the kinds of capability gaps I discussed earlier. As the results publication sets out, the Bank will engage

with firms individually and collectively to help them target their efforts, and share good practices identified in this exercise.

Implications for policy

I hope it's clear by this point that the CBES will be a valuable tool for helping us and financial firms to understand the challenges ahead. This exercise is not going to be used to set capital requirements for banks and insurers. But it clearly sheds light on that debate.

The CBES results make clear that climate risk is a first-order strategic issue for the firms we regulate. But in my view it is not yet clear that the magnitude of transition costs require a fundamental recalibration of capital requirements for the system[14].

A persistent drag on profitability would be very nasty for firms, but so long as they are able to continue to make sufficient profits to maintain their capital buffers, its impact on safety and soundness might be less material. Had the results of this exercise suggested a fundamental threat to the solvency of these firms, our response would of course have been quite different.

Set against that high level view, though, a world with climate change is without doubt riskier than one without. And so I see a number of challenges which underline the need for further work:

- To the extent that climate change makes the distribution of future shocks nastier, that could imply higher capital requirements, all else equal.

  So a key judgement will be: are current capital levels sufficiently high to guard against unexpected shocks during the transition?

- Even if capital levels are appropriate in aggregate, that does not mean that the capital is held in the right places. As we have seen, some of these risks are highly concentrated in particular sectors.

  A second key judgement will therefore be: does the framework of capital requirements capture climate risk at a sufficiently granular level?

- We also need to ensure firms have the right incentives to continue to improve their capabilities and meet our expectations.

  The CBES results show that while progress has been made, there is still much to do. From the point of view of capital, this suggests a third key judgement: are we satisfied that firms are building the capabilities they need – and if not, do we need to introduce more incentives?

Most fundamentally, the CBES results are a snapshot – based on current data and modelling capabilities and focused on a specific set of scenarios and risks. I have highlighted the significant uncertainty as well as the gaps that underlie these results.

To my mind the most notable exclusion is traded or market risk for banks, which might be where a transition shock would be most likely to manifest – indeed current and recent stresses in energy and commodity markets illustrate this point.

As we build capabilities, we will be better able to size the risk and its potential policy implications. We will also learn over time whether the real world looks more like the EA scenario, or if we are living in a 'late' or 'no' action world.

All of this will inform the PRA's judgements about capital requirements and any other responses to climate risks. Today's publication is important step forward, but it is not the last word. ■

Sam Woods is Deputy Governor of the Bank of England and Chief Executive Officer of the Prudential Regulation Authority

Endnotes

1. Climate Biennial Exploratory Scenario.

2. For the purposes of this speech, I focus on the prudential regulation and financial stability aspects of climate risk, as opposed to the Bank of England's other responsibilities as a central bank.

3. The PRA's supervisory statement on enhancing banks' and insurers' approaches to managing the financial risks from climate change.

4. The PRA Climate Change Adaptation Report 2021 set out some of these issues in more detail.

5. My colleague Sarah Breeden also reflected on the role of government, central banks and financial firms in the economy's transition to net zero in a recent speech: Balancing on the net-zero tightrope .

6. For example, EBA research on the 'SME supporting factor' introduced as part of CRR found no evidence that it was effective in reducing pricing or increasing lending. EBA-Op-2016-04 Report on SMEs and SME supporting factor.pdf.

7. That said, there is a legitimate question about how far the current capital framework should capture risks 20+ years in the future. I return to this point later on.

8. You may find it counterintuitive that the 2050 temperature outcomes do not differ wildly across these two scenarios – but that reminds us that changes in climate policy take a long time to feed through to climate outcomes.

9. Risks outside the scope of the exercise include traded risk for banks, and mortality risk for life insurers. It is worth noting

that the impact could also be lower, most obviously because the modelling constraint of a fixed balance sheet in the CBES limited firms' room to adapt to evolving risks.

10. Within the corporate sector, the industries with biggest losses from the transition are mining (including extraction of petroleum and natural gas), manufacturing, transport and wholesale & retail trade. The cumulative impairment rate on lending to these sectors averaged 35%. Insurers projected heavy corporate bond and equity losses in similar sectors, especially oil and gas.

11. It's also probably fair to say that our ability to model the NAA scenario is more incomplete than the EA and LA scenarios – so there are greater risks of uncaptured or unanticipated losses in that scenario.

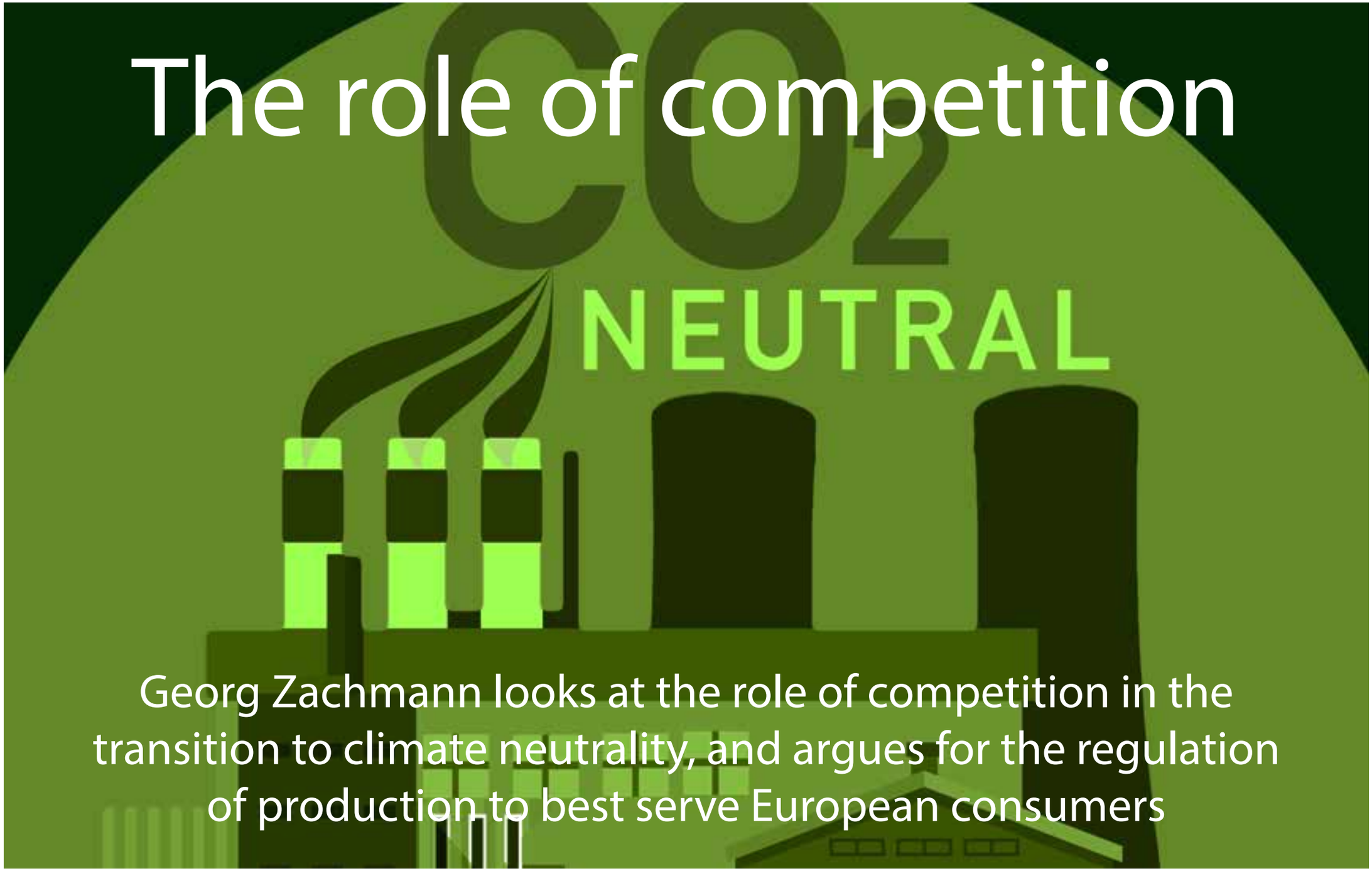
12. Based on analysis on the location of impairments within the four-digit postcodes analysed.

13. And we know there are gaps. Since this was our and the firms' first exercise we deliberately chose not to capture all possible sources of risk.

14. But this is something that the Bank will be exploring further, and where we have invited external analysis and research to inform our views. We will be holding a conference later in the year to discuss.

This article is based on a speech given at a webcast hosted by the Global Association of Risk Professionals, May 2022.

The role of competition



Georg Zachmann looks at the role of competition in the transition to climate neutrality, and argues for the regulation of production to best serve European consumers

Summary

The transition to climate neutrality requires the reallocation of production factors from polluting activities to non-polluting activities. The main push for this reallocation will come from governmental decarbonisation targets that are translated into stringent climate policy tools, such as carbon pricing and emissions standards. But the complex process of recombining production factors will require the coordination of millions of individuals and firms. The efficiency of this recombination process will be a main driver of the cost of the transition.

Based on a consistent analytical framework, I argue that much more political attention should be paid to the markets and regulators that guide the re-allocation of production factors, to bring them in line with a carbon-neutral economy at the best service of European consumers. Three main issues should be considered:

1. The transition will change the role and efficiency of markets in allocating resources;

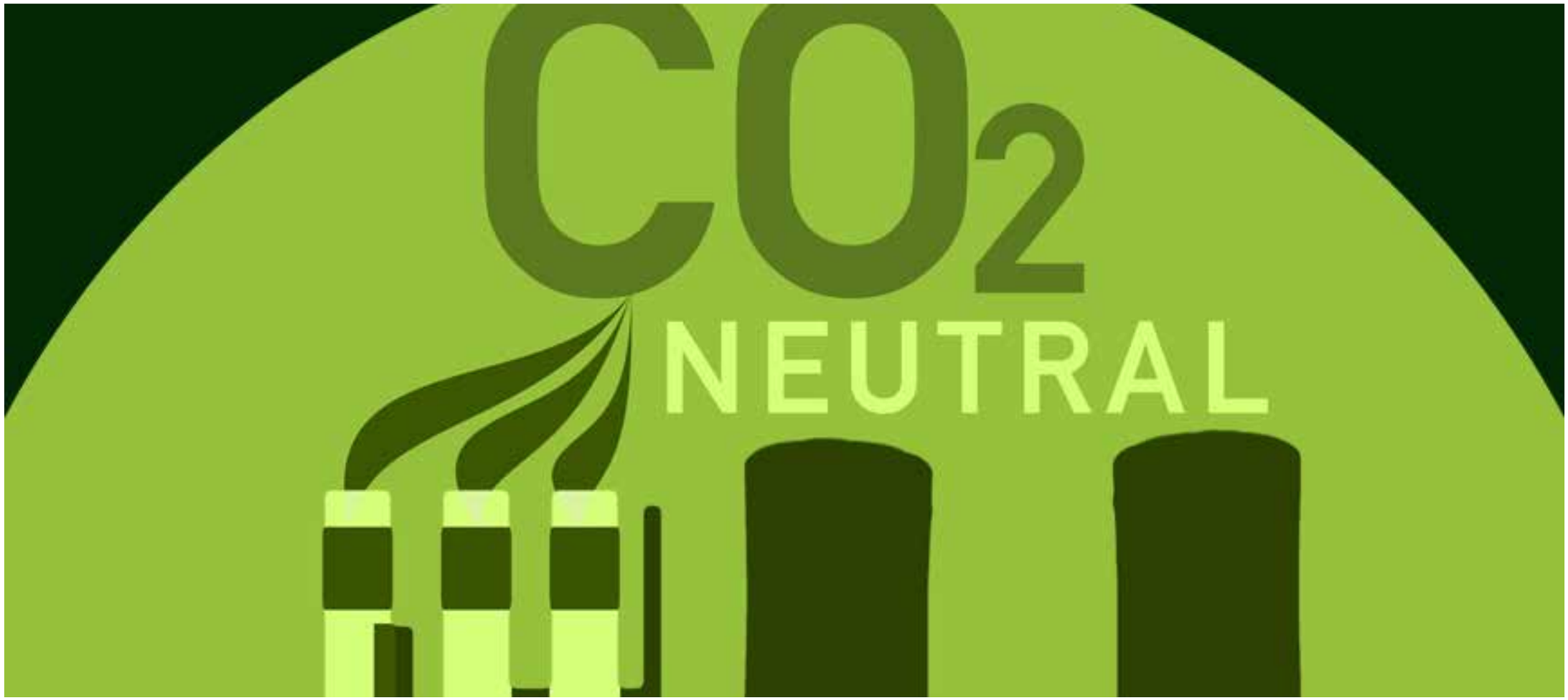
2. Competitive markets can make the transition more efficient;

3. In some areas, a too-narrow focus on competition can be detrimental, and needs to be discussed.

To improve the institutions for resource allocation in the transition, policymakers should revisit three levels of intervention: 1) competition rules and enforcement should be adjusted to meet the new challenges of the transition; 2) efficient markets that are central to a climate-neutral economy – such as for electricity, emission rights or circular logistics – need to be properly designed; 3) the advantages and disadvantages of more direct state control in specific sectors should be revisited in light of the challenges of the transition.

In summary, policymakers need to get away from simplistic state-or-market narratives. The focus should be on developing politically feasible frameworks for leveraging the benefits of competition for efficient resource allocation in the transition.

Institutions should not focus solely on static efficiency, but must forcefully encourage investments in new systems and innovation. The role of institutions that determine resource allocation in the transition is an underappreciated but crucial area for future research and policy action.



1. Introduction

1.1. Markets are important for the transition

Decarbonisation implies a massive re-allocation of resources in our economy. Companies need to change how they produce and sometimes what they produce – occasionally retiring carbon-intensive assets before the end of their economic lifetimes.

Consumers need to reduce their carbon footprint by replacing carbon-intensive by carbon-neutral consumption, which implies buying the appliances that allow them to do so. Workers and capital need to move from brown to green sectors. And the massive transition[1] must happen very quickly.

The transition is also likely to be bumpy. It remains undetermined what will be the most economic technologies, the most efficient systems, the best mix of reduced demand versus more carbon-neutral supplies, and the optimal share of domestic versus imported clean fuels.

Those issues are highly interdependent. Mistakes could be made and their consequences significant. Individual projects might fail completely. Specific technology solutions might cost twice as much as alternatives. Complete systems might be dozens of percent more expensive than others[2].

And when constraints on production factors (land, specific capital and labour) are binding – which they will likely be – any misallocation will either slow down the transition and/or remove these production factors from other needs. If that becomes too expensive, climate policy might fail.

The transition thus needs mechanisms to ensure reasonably efficient resource allocation in a dynamic interconnected system characterised by uncertainty. Markets are a very powerful tool to coordinate the production,

consumption, investment and innovation decisions of billions of individuals and millions of firms, and thus to enable a high level of consumption given the available production factors.

Markets can deal with explicit constraints, such as emissions limits in cap-and-trade mechanisms, and monetise trade-offs, such as competition for land used for solar panels or food. They are good at determining robust answers to multidimensional questions (what is the best combination of storage and flexible electricity generation?).

Economic policy will have to strike the balance between ensuring that the most productive systems are speedily selected, and that economic actors have incentives to invest in the necessary complementary infrastructure, and making sure that the regulatory framework allows the new systems to be efficiently used and developed

They are innovative in finding new solutions (such as smartphones), facilitate optimal resource allocation across borders and are much better than governments in cancelling wasteful projects.

1.2. Unregulated markets will not efficiently allocate resources

Free markets may be the most efficient mechanisms at allocating resources, but they can also fail to allocate resources optimally, and this is very relevant to decarbonisation:

i) If unregulated, companies tend to discharge too much pollution as they do not face the full societal costs (environmental externalities[3]);

ii) Companies tend to underinvest in developing new technologies that can be reproduced by others which did not spend money on research and development (innovation spillovers);

iii) Private investors would not be able to monetise investments in bicycle lanes or re-wetting moorlands by charging individual beneficiaries (public goods);

iv) The more electric vehicle owners use a specific charging system, the more corresponding charging stations break-even (network effects[4]);

v) Consumers buy cheaper but more energy-intensive appliances as they care more about the price than the long-term cost (such hyperbolic discounting is a form of behavioural bias);

vi) Landlords have less incentive to improve the energy efficiency of apartments rented to tenants than of their own apartment (such split incentives are a form of coordination problem);

vii) Banks do not know whether borrowers will be willing/able to pay back energy-efficiency loans – and hence ask for higher interest rates (information asymmetries);

viii) Companies that face too little competition might provide less of their product to increase market prices and hence earn higher revenues (market power);

ix) Companies and consumers might not believe that governments will implement announced stringent climate policies, such as rising carbon prices, leading them to inefficiently delay investments in low-emission production, infrastructure and appliances (time inconsistency).

As misallocations could be particularly costly in the dynamic process of a whole-economy transition (see section 2), a sound institutional framework to minimise such market failures is crucial.

1.3. Market rules will shape the efficiency of the transition

Policies that address these market failures can drastically improve resource allocation. The Tinbergen Rule ('one instrument per policy target', for example carbon pricing for the environmental externality, or innovation policy for the innovation externality) is a very important first principle for establishing the policy architecture.

But market failures are often complex. Policies to address them face practical limitations, such as the inability to enforce competition policy abroad, or imperfect information on the cost structures of incumbents, and can hence only act as partial solutions.

Moreover, policies to address one market failure might have side-effects. Trade-offs emerge. For example, patents boost innovation at the cost of temporary market power (OECD, 2004). Accordingly, concrete policy design needs

to address these complexities in a way that provides a framework for markets to allocate resources as efficiently as possible.

1.4. Paper structure

In this paper we discuss how competitive markets will have to change to support efficient resource allocation in the dynamic and uncertain transition to a decarbonised economy. In the next section, we discuss transition-related challenges to competitive markets that policy should address.

In the third section, areas where more competition can unleash market forces will be discussed. In section four, we review areas where policymakers might want to balance a too-narrow focus on competition against other policy goals, including environmental benefits.

We conclude with recommendations primarily on the role of competition authorities (though not explicitly discussing the very important issue of state aid[5]).

2. Challenges for efficient resource allocation in the transition

The transition will affect disproportionately those economic activities that are prone to very clear market failures: the transition will require more innovation, new networks and platforms and more coordination on new systems. The transition itself might amplify the detrimental effects of some of the market failures described above.

Moreover, to overcome such barriers, governments might want to resort to policies that put effectiveness before efficiency, for example by prioritising meeting targets over cost-minimisation. But this might create new competition issues during the transition.

For example, the need for energy and material efficiency might require more coordination in some areas than current market structures can provide. Consequently, new market structures with very limited numbers of potential competitors might emerge.

The transition will recalibrate the roles of major economic players. In general, a speedy transition will require more coordination of actions over different time periods. The state will likely take a stronger role in organising the emergence of a sustainable economic system.

But companies will also want to coordinate more. In the following, we describe transition-related trends that reduce the potential of competition to allocate resources efficiently.

2.1. Increasing role of networks and platforms

A sustainable economy will have to be more resource-efficient than today. Corresponding efficiency gains can come from aggressively exploiting economies of scale and scope. Digitisation/digitalisation promises to super-charge the efficiency-potential in many sectors.

The result is that in a number of areas, a role is emerging for centralised platforms or networks to coordinate economic behaviour, with the ability to extract significant rents.

Four examples illustrate this:

> First, resource use can be reduced substantially[6] in a circular economy in which products that lose some of the use-value for consumers (an old smartphone for example) are transferred to that economic actor that can generate most value from reusing, repairing, repurposing or recycling it.

It is easily conceivable that large online retailers that maintain several integrated networks, including customer and supplier bases, logistics and payments, would be best positioned to master this challenge, reinforcing the virtually incontestable position of such firms.

Second, in the electricity system of the future, passive users could turn into prosumers who reduce the cost of the electricity system by supplying, consuming, producing or storing electricity based on real-time system information.

Again, several overlapping networks (standardised appliances, power lines, data networks, information aggregation and payments/billing) would be required to run efficiently a system with a massive number of distributed energy resources. For several years, big players in some of these networks have been trying to position themselves in this market, hoping to benefit from the value that can be created by managing these systems.

A third example is integrated energy solutions for big consumers like a university or groups of consumers like a neighbourhood or even a town or city, for which different heat, electricity and gas networks can be co-optimised with the locally available supply, storage and design of the demand.

Finally, multimodal mobility services that reduce the need for individual vehicles and empty runs work better the more mobility providers are co-optimised; consumers might prefer to use one software tool that deals with planning, buying the service and paying for it.

The better complex multi-actor systems can be designed and coordinated, the less expensive the infrastructure, energy and resources required for the transition will be. Single companies that can coordinate many economic actors, most notably through digital platforms, can operate more efficiently the bigger they are.

As a result, the same efficiency gains that will help with the transition might result in sectors characterised by reduced competition. Some of the current platform-economy incumbents are potentially well positioned to extend their market power to potentially very significant new services. The promise of excessively high rents in the longer term might create a welcome competitive race in the short term[7].

However, as seen with smart grids, such a competition for a new market can also lead to an unproductive paralysis in which different players that each possess essential infrastructure try to secure a central position in new value chains, making it difficult to quickly find good compromises on standards and systems.

Consequently, economic policy will have to strike the balance between ensuring that the most productive systems are speedily selected, and that economic actors have incentives to invest in the necessary complementary infrastructure, and making sure that the regulatory framework allows the new systems to be efficiently used and developed.

2.2. Downscaling of 'brown' systems

The downscaling of fossil-fuel related economic activities and the exit of players from shrinking markets could lead to increasing market concentration in the whole market – when the number of players decreases faster than the volume – or the disintegration of some markets, leading to highly concentrated market segments (for example if connections between market segments become unprofitable and are abandoned).

One example is the natural gas wholesale market. It has already been seen how decreasing gas exploration in the EU resulted in increasing market shares of Russian gas in Europe.

If at some point in the transition natural gas pipelines that connect market areas are decommissioned or converted into hydrogen pipelines, the internal natural gas market might disintegrate and the dominance of gas suppliers will increase in the disconnected natural gas market areas.

Another challenge is that uncoordinated disconnection of users from incumbent gas distribution networks has negative spillovers for the remaining users as the fixed cost of the distribution system then falls on a smaller pool of users.

As it will be mainly more affluent households that can afford to invest in electric heat-pumps, poorer households in particular could be confronted with increasing gas distribution tariffs. If left to the market, this might trigger a chaotic 'doom loop' of cascading disconnections, which would be clearly less efficient than a planned decommissioning of distribution networks[8].

2.3. Reduction in international competition

Import competition can substantially reduce the market power of domestic firms (or at least render markets contestable)[9]. In recent years, trade policy has become increasingly an area of international climate policy. The most tangible example is the carbon border adjustment mechanism (CBAM), proposed by the European Commission in the Fit for 55 package[10].

The CBAM is intended to prevent carbon leakage by requiring EU importers of certain carbon-intensive products to buy an amount of allowances proportional to their products' carbon content, with the carbon content either established individually based on a verification procedure that might be difficult for smaller importers, or based on default values that, if too high, might make importers worse off than most domestic companies[11].

In some of the quite highly concentrated sectors covered by CBAM, there could be significant reductions in the competitive pressure from imports (Baccianti and Schenker 2022)[12]. The increasing market power of EU companies might translate into increasing mark-ups or lower quality[13].

Moreover, CBAM is controversial and could lead trade partners to retaliate, at worst leading to a trade war14. This might further break up international markets, increasing market concentration in many sectors in a way that reinforces the market power of local companies.

Finally, rising fuel costs from the transition to low-carbon fuels and the need to invest in low-carbon ships might cause international transportation costs to increase. This might make imports more expensive and hence increase the local market power of domestic companies.

2.4. Public interventions risk inefficient favouring of incumbents

The transition will require massive government intervention to overcome some of the market failures listed in section 1. But governments are not omniscient, efficient or necessarily benevolent.

Bureaucracies and policymaking have their own failings that systematically prevent stops them achieving efficient results[15, 16]. Government resource allocation, such as through R&D budgets, and administrative decisions, such as on market rules, follow different dynamics than market/price/competition-based resource allocation.

Politicians compete for voters and campaign funding, bureaucracies compete for power, and decision- makers compete for careers. These incentives are often more aligned with the interests of incumbents/insiders ('regulatory capture'), than with those of the general public, who might benefit from fairer treatment of new entrants.

Accordingly, administrations are, for example, worse than companies at stopping projects/policies that turn out inefficient, which is a problem in a transition with a lot of uncertainty. Administrations also set standards and market rules that tacitly form barriers against technological change. Rules to protect specific rights in a status quo market might become so complex that only large players can safely navigate them.

Because government decisions shape the structures of competition in markets that will be crucial for efficient resource allocation in the transition, preventing an undue bias in favour of incumbents goes way beyond the role of competition authorities and courts.

Europe's long-term competitiveness will benefit if it finds ways to strengthen the voice of proponents of new business models, technologies and market entrants in the political/administrative process.

2.5. National transition policies might undermine the internal market

EU countries differ in their preferences for policy tools, market rules, standards, and infrastructure and innovation projects. The transition will require major new policies in many sectors.

While some areas are harmonised through EU-wide rules, tools and programmes, much of the heavy-lifting will come from member-state policies. This provides room for targeting policy to national circumstances and allows testing of different solutions, which at best can result in mutate-and-select-evolution of the fittest policy proposals.

But national policies also carry the risk of increasing market fragmentation in the EU. Decarbonisation policies such as the deployment of renewables through national feed-in tariff systems can result in clear cases of resource misallocation in the EU (Abrell *et al* 2020).

Aggressive uncoordinated national support programmes for industry decarbonisation and hydrogen deployment also run the risk of highly inefficient allocation of resources.

2.6. Strategic behaviour in emerging certificate markets

The carbon market is crucial for decarbonisation. The EU emissions trading system is characterised by the presence of a relatively limited number of important players that compete in the same commodity markets, including electricity, steel and cement.

The structure of these markets implies that higher carbon prices can be largely passed through to consumers (European Commission, 2016), and some companies obtain significant volumes of allowances for free. This structure might make it profitable for individual companies or colluding entities to manipulate the carbon price, for example by buying up more allowances than a company in perfect competition would do, in order to increase the price of their products and hence their profits[17].

Given this tail-wag-the-dog market, close monitoring is needed and it would be beneficial to increase the number of players – for example by extending carbon trading to cover more sectors – or reduce the volumes of free allowances. Measures to reduce competition, such as CBAM (see above), meanwhile, would be detrimental for competition.

2.7. Risk of 'green-washing' anti-competitive arrangements

There are good reasons for competition policy to permit arrangements that improve the coordination of companies during the transition (section 4). But there is a risk that companies will seek such arrangements primarily to reduce competition.

One challenging area is green alliances of companies. Such alliances agree environmental standards among each other – and jointly promote corresponding labels. They are clearly anti-competitive if they do not allow other companies that meet their same standards to join.

But also if they are open to all companies, by letting the insiders establish the standards, they essentially coordinate the speed of efficiency improvements in the industry – and competition policy needs to watch very carefully whether this on balance increases the ambition.

2.8. Summary

The examples described illustrate that the transition will profoundly change the allocative outcomes of market competition. In most cases, neither direct public management nor full laissez-faire competition will lead to satisfactory results.

To ensure efficient resource allocation, policy must, early on, re-adjust the institutional framework. The optimal points of intervention will differ case-by-case, and interventions might need to adjust dynamically over time. Relatively light-handed intervention to protect virtuous competition can be done by adjusting competition authority toolkits.

For example, market definitions can be revised when investigating declining brown sectors, rules should be clarified on the evaluation of green efficiencies to prevent green-washing, and state-of-the-art market monitoring (eg. in certificate markets) should be put in place. These adjustments would go a long way to prevent abuses of market power that threaten efficient resource allocation.

The politically but also technically most challenging intervention is designing efficient markets. Well- designed markets with robust regulatory oversight will often be the only realistic option for benefiting from the efficiencies of markets, without falling for the inefficiencies from rising market power, especially in network/platform sectors.

This is not made easier by the fact that market design is a continuous process that is at constant risk of being taken over by incumbents, and that suffers from different preferences in different EU countries.

Finally, the costs and benefits of direct state control in essential pieces of infrastructure need to be evaluated on a case-by-case basis. It might be that the benefits of being able to design a functioning market around directly state-controlled infrastructure exceed the inefficiencies of public-sector management of the infrastructure segment of the value chain.

This shows that it will be impossible to develop one single institutional framework to facilitate efficient resource allocation in a dynamic transition process. Quite the reverse: a complex mix of institutions and instruments will be needed to approach the efficiency frontier.

3. Competition can make the transition more efficient

The transition can be defined as a recombination of production factors into products and services that increase utility for consumers, while generating much less or no greenhouse gases.

Market mechanisms are well placed to play a significant role in determining efficient combinations quickly. In this section, we show with examples that competition will be important in allowing markets to pursue this role.

3.1. Competition pushes innovation which is crucial in the transition

Innovation is crucial for efficient decarbonisation. Previous cost-degressions for wind and solar power generation facilitated more aggressive global decarbonisation targets – such as the carbon-neutrality pledge in the Paris Agreement.

Future innovations are already priced-in in the large-scale economic models that underpin European climate targets. The cost of offshore wind turbines, for example, is expected to fall by one third by 2050 according to the assumptions used for the European Commission's impact assessment that justified EU climate neutrality by 2050.

While basic research into completely new technologies such as nuclear fusion is almost entirely provided by governments, much of the resources that go into translating this research into new products are provided by companies[18].

Competition is thus a strong incentive for innovation activity. Having better production processes, products or services is a mayor way for a company under pressure of competition to maintain extraordinary profits. By investing in innovation, companies can achieve/defend this ability.

Competition creates a positive incentive to innovate while punishing companies that do not innovate, as successful innovation by a competitor will have adverse impacts on the non-innovative companies' ability to charge high margins.

Finally, the competitive success of companies depends on their targeting of resources to innovation activities in the commercially most promising areas, and on their ability to take resources away from innovation activities that cease

to look promising. In the transition, shifting resources from a multitude of 'brown' to green innovation projects will be crucial.

But the literature indicates that market structure impacts innovation in a complex way[19]. While more competition increases the incentives for innovation, it can also reduce the means to do so.

One major finding that there is less innovation in sectors with an extreme intensity of competition is possibly explained by the argument that neck-and-neck competition decreases the free cash flow of companies to fund innovation activities (Aghion *et al* 2005).

In sectors that do not easily support multiple providers, such as electricity transmission and distribution, railroads or logistics, incumbents do very little R&D (Popp *et al* 2020). But innovation might still occur in the non-oligopolistic segments of the value chain, and contestability through more modular technologies (wind and solar versus large complex power plants) can be related to more innovation.

The structure of competition impacts both the speed and direction of innovation. While larger incumbents are suited to developing incremental innovations, small new firms are better at developing radical innovation (D'Estea *et al* 2011; Christensen and Bower, 1996; Hamilton and Singh, 1992; Henderson, 1993).

In the absence of market incentives for innovation, regulation or public ownership can try to mimic them[20]. But while this is an improvement over purely cost-based regulation (without any innovation incentives), it might often result in incumbents optimising to meet the demands of the regulator/mechanism, rather than meeting the future needs of consumers.

As innovation is so crucial for an efficient transition, policymakers, including competition authorities, should put a high value on protecting and encouraging competition in green sectors in the many cases where it is good for innovation.

The European Commission has demonstrated such encouragement. In the 2018 merger between Bayer and Monsanto[21], the Commission found significant R&D overlaps, including in green products. The Commission cleared the merger on the condition that the parties divested certain activities to ensure adequate continuation of R&D in these activities.

3.2. Competition for 'green quality' contributes to the transition

Consumers often care about purchasing sustainably, and are willing to pay for it (Volpin, 2020)[22]. Consuming more sustainable products thus increases consumer welfare.

An overwhelming majority of Europeans (94 percent) say that protecting the environment is important to them personally, and a third believe that changing consumption patterns is the most effective way of tackling environmental problems (Eurobarometer, 2017).

Other studies confirm that consumers' attitudes and beliefs reflect an intention to consume more sustainable products (see Annex for a discussion on the literature on consumer preference for green products). This is a strong motivation for companies to distinguish themselves from competitors by offering more sustainable products.

Competition for sustainability is hence a driver for innovation and a speedier transition, and policy should encourage it.

Under current competition policy practices, environmental protection is not treated as a standalone non-economic goal to be defended in the way that, say, market integration is[23]. Nor has environmental protection justified derogation from competition rules[24].

Where the European Commission has taken environmental concerns into account, it has been as an element of consumer welfare[25] and, more specifically, as a mark of the 'quality' of products. 'Quality' is a key aspect of competition under EU law. When firms compete on quality, any agreement or behaviour that artificially weakens quality may be subject to a prohibition.

In the context of mergers, for example, the European Commission (2013) states that *"competitive harm caused by a reduction of quality [is] on an equal footing with an increase of prices, or a reduction of output, choice of goods and services."*

In 2017, the Commission blocked the proposed takeover of Aer Lingus by the low-cost airline Ryanair on the basis that the merged entity would impose lower service quality at equal prices[26].

Agreements or behaviour that undermine sustainability to the detriment of consumers may be deemed anti-competitive and treated with the same severity as those that raise prices. If sustainability is a quality that consumers care about, then a merger that would allow the phasing out of a sustainable line or product could be blocked for this reason.

Similarly, competition authorities may prohibit or punish agreements between companies or conduct by dominant firms that limit green quality (under Articles 101(1) and 102 of the Treaty on the Functioning of the EU, respectively).

The Commission is in fact at time of writing investigating an agreement under which car manufacturers allegedly colluded to limit the development and roll-out of technology to reduce pollutants in emissions from cars[27].

So undercutting of sustainability as a result of mergers, acquisitions and abuse of market dominance can already be sanctioned by competition authorities by referring to the negative impact on 'green quality'.

But it becomes very difficult for competition authorities if lower sustainability needs to be balanced against potential cost benefits for consumers in the same case. Moreover, competition policy is focused on the impacts on current and possibly potential consumers, but not on externalities cases have on all living (let alone future) citizens.

3.3. Competition between institutions helps identify more efficient and resilient solutions

Virtuous competition can emerge not only between companies, but also between technology systems, regulatory systems, countries and institutions (Petersmann and Steinbach, 2020). Particularly in the European context, allowing some differentiation between member state approaches might enable a faster and more resilient transition, if differentiation is not used to protect suboptimal solutions.

Different energy mixes in EU countries enhance mutation and selection of the best technologies based on geographical and pre-settled conditions. Having a wide energy portfolio fosters competition and permits complementarity among technologies, lowering the price of energy and increasing supply resilience.

A high degree of freedom in technology adoption by EU countries has resulted in a very diverse assortment of energy technologies in the EU, which was complemented by the emergence of a bandwagon effect by pioneer countries dragging others to adopt effective technologies.

For example, the successful early adoption of solar photovoltaics in Germany was a strong market signal for southern countries such as Italy and Spain to invest in the technology. Italy is now the second producer of solar energy (after Germany) with 20.5 gigawatts of installed capacity, amounting to about 8 percent of its electricity production, while Spain was both the EU's and Europe's largest solar market in 2019, after adding an estimated 4.7 GW in a single year (Schmela *et al* 2019).

Therefore, the French government's commitment to spend €1 billion on small modular reactors, known as SMRs, and other technologies such as atomic waste recycling, might increase the portfolio of available low-emission technologies[28].

Similarly, the German National Hydrogen Strategy[29], and its required network of international partnerships to guarantee supply of green hydrogen, represents an opportunity to assess the real potential of the technology for the foreseeable future.

Having EU countries bet on distinct technologies could turn out to be a winning strategy. It could lead to a more resilient portfolio of sometimes complementary solutions, and might allow the EU to maintain its technological advantage in low-carbon energy sources.

Competition might emerge not only between technological solutions for the transition, but also between the policies and rules to bring about the transition. Different regulatory/policy approaches among EU countries have improved the common understanding and selection of the most effective policies for the roll out of low-carbon technologies.

Table 1. Share of first (green) and second (yellow) most important source of zero carbon electricity consumption in the five most populous EU countries 2021

	Nuclear	Solar	Wind	Hydro
Germany	12%	9%	21%	3%
France	47%	7%	2%	1%
Poland		2%	10%	1%
Italy		10%	8%	15%
Spain	22%	10%	24%	13%

Source: Entso-E.

For instance, regulatory convergence is now emerging around the auctioning of feed-in premiums as the most common policy framework for incentivising the adoption of renewable energy sources. This is the standard price-setting mechanism in Czechia, Denmark, Germany, Italy, the Netherlands, Estonia, Finland, Slovenia, Slovakia and Spain[30].

Given the massive uncertainty and complexity of the choices, trying different technologies, systems and regulations might be more likely to result in the emergence of efficient solutions.

But, at some point, eliminating ineffective solutions will increase overall efficiency. Unleashing the power of the internal market by removing regulatory and infrastructure bottlenecks and cancelling support for inferior solutions can speed up this process[31].

For example, a more integrated energy market at the EU level would not only increase the degree of competition energy providers are exposed to, but would also guarantee greater benefits from investments in successful technologies.

In fact, increasing the potential customer base of energy companies makes risk-taking more appealing because the returns on fruitful investments will be higher. This is particularly important in a sector with high upfront costs in R&D and subsequently in infrastructure.

Therefore, a broad conclusion could be that allowing heterogeneity in emerging regulations/systems can be very helpful in developing a resilient portfolio of solutions. However, at some point these solutions need to be exposed to competition with each other to determine the most efficient role for each.

In the European context, this approach bring two risks: to avoid costly mistakes in terms of backing ultimately unsuccessful approaches, countries might 1) prefer to wait and see and try to converge on the most conventional approach, and 2) they might try to protect their suboptimal solutions from true competition.

This might be rectified partly by engineering some risk-pooling between countries in order to allow them to take on the risk that mistakes will be made.

3.4. Testing disruptive ideas can require exemptions from regulations that discriminate against new entrants

An efficient transition will require not only massive investments in available low-carbon alternatives, but also the emergence of new business models and new technologies. This might allow new market players with different backgrounds to bring new ideas and different capabilities to old sectors that are dominated by incumbents. Start-ups might contribute disruptive ideas that enable more efficient transition pathways.

Economic activities in mature sectors are regulated by a complex web of rules to address a wide array of societal concerns (including privacy concerns, environmental protection, construction safety, social protection and energy security).

The rules were co-created between societal actors and incumbents. In many cases, the arrangements imply that incumbents address some externality in return for protection against too much competition. For example, the complexity and bureaucracy of some regulations are a de-facto barrier to entry into specific business activities.

For an efficient transition, the challenge will be to find the right balance between protecting legitimate societal concerns and allowing new dynamism in mature sectors. The emphasis should thus be on finding ways to remove barriers that discriminate needlessly against new entrants which are testing disruptive ideas and contesting incumbents.

4. Areas where a too-narrow focus on competition needs to be discussed

Focusing solely on defending competition might, in the presence of strong market failures, aggravate misallocations. In this section, we discuss cases in which public intervention in competition might improve resource allocation during the transition.

4.1. Some green innovation might justify temporary competition derogations

Because innovation is so crucial in the transition, the wider competition framework should be calibrated to make good use of the entrepreneurial innovation machine. But prioritising more and better innovation over lower mark-ups in competition policy is easier said than done[32].

This is best illustrated by the century-old academic debate on whether patents are a good tool to balance competition and innovation. While economists have learnt a lot about the dimensions and drivers of the trade-off in terms of the cost of patent protection and impact on innovation[33], there is still no consensus on an efficient toolbox (Scotchmer, 1991, 2004; OECD, 2004; Dosi *et al* 2006; Boldrin and Levine, 2008; Henry and Stigliz, 2010; Haskel and Westlake, 2018).

A more recent question relates to the innovation-competition trade-off when assessing the desirability of acquisitions of small innovators by incumbents. In some cases, these might be 'killer acquisitions' that destroy potential innovative disruptors.

In other cases, it might be the best way to quickly scale up a new solution or to encourage entrepreneurs to innovate in the first place. Hence, if acquisition by an incumbent helps to scale-up green solutions rapidly, the environmental benefits might be worth safeguarding.

Another example of the competition/green-innovation trade-off is innovation cooperation between companies. The incentives to invest in innovation might be sub-optimal for companies in complex value chains.

It is much easier for a company to justify investment in a marginal improvement to its current contribution to the existing system (say a combustion engine cylinder) than in a more sustainable new system (electromobility).

In the transition, such cases are not unimportant. As noted by IEA (2020), *"low-carbon electricity systems are characterized by increasingly complex interactions of different technologies with different functions in order to ensure reliable supply at all times,"* placing a premium on collaborative research between different partners, stretching well beyond partners in the energy field.

While there is scant evidence on the role of collaborative research in the energy sector, the work that does exist suggests government intervention can facilitate collaboration[34].

EU initiatives such as the Fuel Cells and Hydrogen Joint Undertaking or the Battery Alliance offer the participating companies some shield against competition authorities' claims of anticompetitive collusion.

These examples show that the competition/innovation trade-off is particularly complex and getting it right is particularly rewarding. In fact, there is little discussion in the academic literature about whether it is possible and desirable to discriminate in the innovation-competition trade-off between societally useful ('green') and detrimental ('brown') innovation.

Nevertheless, it is clear that an over-strong focus on static efficiency is suboptimal. Competition policymakers should in general emphasise dynamic effects more – which depending on the case can imply either a more permissive or more restrictive stance.

4.2. Investment in new systems might require cooperation between potential competitors

The transition will require the quick deployment of new productive systems, in the circular economy or multimodal transport, for example. Coordination by companies to develop new sustainable systems will be necessary in the innovation stage, and also when coordinating investments in emerging systems to overcome chicken-and-egg problems.

Current coordination structures might go a long way in allowing the coordination/synchronisation of significant capital investment, but it should not be excluded that in specific cases more exclusive forms of cooperation will be required to enable investments in new systems.

One illustrative example of the high capital-specificity of new system investments is the complementarity of a hydrogen-based steel-plant, a hydrogen transmission system, and electrolysers. None of the three elements are useful without the others.

Each player in one part of the value chain might have an incentive to look for more economic partners once the system is established, but no partner would invest if it were worried that the other partners might switch once the system is running.

Hence, the investment might only go ahead if partners sign watertight long-term exclusive cooperation agreements, or even form an exclusive joint venture. Sector regulation and competition policy need to provide a framework to encourage such systems to emerge, with the proviso that they are eventually opened up to competition after companies manage to recover their capital costs.

In this, and other cases of investment in new systems, temporary exemptions should be considered to rules that were developed to protect competition in mature sectors.

4.3. Some 'green efficiencies' might trump competition concerns

Competition policy already has tools to protect 'green competition', by treating green as a quality (see section 3). But consumers do not always demand sustainable products[35].

In such cases, competition does not drive green progress – firms have little incentive to invest in costly clean-ups. Worse still, in markets where consumers care primarily about prices, firms may have little choice but to adopt the dirtiest production processes.

There might thus be cases when reducing competition (eg. through mergers and acquisitions) might have positive environmental effects. For example, a merger of an emerging company with a clean technology and an incumbent with a dirty technology could allow the clean technology company to develop faster based on the incumbent company's infrastructure.

Competition authorities might therefore have to rule on behaviours that are good for the environment but otherwise anti-competitive[36]. EU competition policy is asymmetric in its analysis of harmful and beneficial effects.

Beneficial effects, or 'efficiencies', are typically only considered in the second stage of a two-step process, while harmful effects are considered in the first step. In the first step, the European Commission assesses whether the agreement, merger or behaviour restrains competition.

If the action raises competition concerns then, in a second step, the Commission examines potential efficiencies. The burden of proof is on the companies to show that the improvements offset the anti-competitive restrictions – the so-called efficiency defence.

In practice however, efficiency arguments are largely ignored, the Commission having set demanding requirements which are rarely met in practice.

Competition authorities must identify if a merger between and clean-tech company and an incumbent 'dirty' tech company is a killer acquisition to destroy a new green competitor, an acquisition that primarily aims to consolidate market shares, or an acquisition that will serve the faster deployment of the environmental technologies developed by the emerging company.

As the future business model of the merged company (brown or green) is unknown to the competition authority, this might be resolved partly by attaching conditions and obligations to such an acquisition. In our example, this might be a specified share of clean technology sales in the overall sales of the new company.

4.4. Global market imperfections might require protection for European companies

Some countries, notably China and Russia, seek to ensure that in some sectors their companies do not compete or do even collaborate on foreign markets (Monopolkommission, 2020, p.18). They also do not give foreign companies full access to their markets (Monopolkommission, 2020, p.15).

Moreover, countries like China provide implicit or explicit subsidies to certain companies in international competition (Monopolkommission, 2020).

This can lead to foreign companies operating in Europe securing larger markets, greater scale efficiencies, higher profits and hence more funds for further expansion. This might result in European companies facing an unfair disadvantage in sectors that are crucial for the transition.

And as the transition will alter the determinants of competitiveness in many industries (eg increasing demand for specific skills, capital or low cost renewables), countries that manage to establish agglomeration effects in new industries most effectively might benefit from such industrial policy for a long time.

A much quoted, but also disputed example is the active Chinese support for its photovoltaic panel industry (Goron, 2018). It has been argued that the subsidised Chinese industry has killed off its European competitors through dumping.

As a remedy, there are calls for national champions to be supported in the EU to level the playing field. Most prominently, the creation of Airbus and the proposed Alstom/Siemens merger were justified on the basis that they would strengthen European companies in international competition for aviation/rail-technology[37].

In fact, Motta and Peitz (2019) pointed out that EU merger control can allow the formation of European champions if companies can show that efficiency gains (synergies and complementarities) outweigh anti-competitive effects in terms of higher prices and less choice in the short term, and less investment, innovation and quality in the long term.

"But in the Siemens/Alstom case, there is no public information that points to such synergies, and the European Commission stated that the parties have not substantiated any such efficiency claims", Motta and Peitz (2019) added.

But how should the EU then react to unfair market practices by foreign companies? In crossborder trade, European undertakings are already protected by anti-dumping and anti-subsidy instruments.

However, such measures – as in the case of Chinese solar panels – are complicated by internal divisions inside the EU, the threat of retaliation and their focus on narrow product categories (Goron, 2018). The first-best approach would be for EU's competition authorities to continue to build partnerships with foreign antitrust institutions, preferably in the context of trade agreements, which have chapters on competition policy[38].

But this long-term approach will be continuously challenged by incentives to deviate. As an alternative to solving unfair global competition challenges by resorting to the inefficiencies of national champions, Motta and Peitz (2019) proposed *"preventive intervention – such as excluding from tenders non-EU firms suspected of engaging in such behaviour – or with having to resort to anti-dumping provisions."*

The sustainability dimension will further complicate the already almost insoluble issue of ensuring a sufficiently level playing field between companies from different economic systems.

4.5. Resolving uncertainty about competition law treatment might promote investment

An efficient transition will likely be characterised by the development of new business models and new company ecosystems with new networks of contractual regulations between companies (see section 3.4).

Regulatory and competition agencies will require time and experience to identify which of those are helpful or innocent, and which might substantially reduce competition. This might create substantial uncertainty on the part of companies and hence might delay the transition.

In principle, temporary and targeted deviations from rules that protect competition in mature sectors should be allowed if those rules would have unduly complicated the emergence of new systems. Such regulatory holidays could act as innovation incentives similar to patents and could be compatible with later regulation, thereby preventing long-run monopolistic exploitation (Choi, 2011).

Gans and King (2003) set out conditions under which access holidays can increase investment incentives for innovative infrastructure. Simulations by Nitsche and Wiethaus (2011) confirmed increased investment incentives.

However, there are two commitment issues for regulatory holidays: first, that regulation will actually come at the stipulated date (or incident); second, that regulation will not come before that date. However, breaking the latter commitment and installing regulation may itself take time, meaning the commitment period is implicitly assured.

This potentially long lag will have to be traded off against the danger that the firm building the new market may gain a long-lasting first-mover advantage (Briglauer, 2014).

5. Making competition fruitful for the transition

We have provided examples of how the transition will affect the ability of markets to allocate resources efficiently, and how competition policy can help but also obstruct efficient resource allocation in the transition.

From this, it should be quite clear that policy frameworks will need to be adjusted to ensure economic actors have the right incentives to efficiently reallocate resources in line with the transition. It is most important to address the environmental externality directly and effectively through carbon pricing.

But the multitude of overlapping market and government failures implies that a carbon price alone will not be enough for an efficient transition.

In the following we discuss which shifts in policy frameworks would be effective in guiding resource allocation in the transition, from the least intrusive to the most intrusive.

5.1. Adjusting competition rules and enforcement

Competition rules are devised primarily to address the strategic behaviour of companies with market power that results in inefficient allocation of resources.

The EU Treaty gives EU competition authorities[39] the power to prohibit cartels, to punish or prevent abusive practices by powerful firms, and to block mergers that threaten to significantly reduce competition[40]. But competition policy tools interact with other externalities.

In the course of their work, competition authorities may find that some ostensibly anti-competitive practices have environmental benefits. An industry-wide agreement to phase out energy-intensive washing-machines may restrict competition, for example, but lead to reduced carbon emissions.

Conversely, competition authorities may find some industrial actions acceptable on pure competition grounds, but alarming for environmental reasons. They could, for instance, be called to rule on an acquisition by a dirty incumbent that wants to delay greening its production process by eliminating a competitor that exerts little competitive pressure but has green potential.

A common misconception is that the EU competition framework is directed solely towards maximising the welfare of consumers defined in terms of allocative efficiency41 and measured through prices.

According to this understanding, competition enforcers would be bound to making the decision that secures the lowest price (or highest quantity) for consumers, regardless of non-price concerns such as the environment[42].

But as the EU Court of Justice has made clear that *"the competition rules were aimed at protecting not only the interests of competitors or of consumers, but also the structure of the market and, in so doing, competition as such."*[43].

Non-economic factors may and have been relevant to competition decisions, most notably the integration of national markets into a single European market[44].

More generally, and as noted by the legal scholar Giorgio Monti (2007), *"to date no competition authority has deployed competition law in accordance with one unchanging set of aims – the goals of antitrust vary over time; even at the same time, the law can be pursuing different, even mutually contradictory, goals."*

Issues of law are at the sole discretion of the EU courts (the General Court and the EU Court of Justice), which enjoy full judicial review (Ibáñez Colomo, 2018).

So where does environmental protection stand? Can EU competition enforcers pursue sustainability as one of their legitimate aims? As Kingston (2012) and others[45] have argued, from a legal standpoint the answer is yes.

The Treaty on the Functioning of the European Union (TFEU) states: *"the Union shall ensure consistency between its policies and activities, taking all of its objectives into account"* (Article 7 TFEU).

Environmental protection has featured prominently among the EU's policies since long before the European Green Deal. Article 11 TFEU says that *"environmental protection requirements must be integrated into the definition and implementation of the Union's policies and activities, in particular with a view to promoting sustainable development."*

The question therefore is not so much whether but how competition policy can serve the EU's environmental goals.

Protect competition

The main task of competition policy is to protect competition in both green and non-green sectors. In general, this will remain the most important task for competition policy, which will help make best use of the resources needed for a socially viable transition.

Sharpen existing tools to take into account sustainability in competition decisions

As we have argued, competition enforcement and sustainability are not opposing aims, but they interact strongly on a case-by-case basis, sometimes in a complementary way, sometimes not.

Considering the environmental performance of products and services as a quality and assessing whether a

competition case might lead to reduced quality will mean taking into account sustainability concerns.

Accepting 'efficiency defence' arguments in competition cases, in particular when there are clear benefits in terms of resource use, is another element of a sustainability-friendly competition policy.

But marginal sustainability gains should not provide carte blanche for companies to engage in anticompetitive behaviour at the detriment of all-economy resource allocation. Hence, the assessment will remain an exercise in the weighting of the arguments – with more visibility of the sustainability effects.

On other important elements of competition policy enforcement, such as market definition[46] (eg. are green acquisition targets in the same sector as the brown acquirer?) or the test applied for the anticompetitive effects of mergers (eg. in complex emerging value chains), the effects in terms of efficient resource allocation in the transition should be assessed and monitored.

But before competition authorities are asked to consider such effects in their decisions, a better theoretical understanding is needed.

Legal certainty

As the transition must be fast, waiting for legal clarity on new business models and corporations might take too much time. Existing law provides various instruments at European and national level to ensure legal certainty in cases of uncertainty over new arrangements.

At European level, these instruments include:

- 'No infringement' decisions pursuant to Article 10 of Council Regulation (EC) No 1/2003, by which the European Commission can decide that Article 101 TFEU and/ or Article 102 TFEU does not apply to certain commercial practices if the *"Community public interest […] so requires"*, and

- Informal guidance letters that the European Commission can publish in the case of novel questions in individual cases.

Competition authorities should consider using these tools more for cases in which some tight coordination is needed for a limited period of time and a credible vision of a competitive market after this phase is provided.

Sector inquiry on new sectors

Some sectors that are extremely relevant for the transition, including electricity, circular economy sectors and shared mobility, are developing or changing fast and developing new forms of interaction between companies. This is much needed, but also carries risk in terms of monopolisation that might become a problem at later stages of the transition. To provide guidance (some metrics for critical concentration levels or undue practices) but also comfort to innocent developments, sector inquiries and/or benchmarking analysis should be conducted as per Article 17 of Regulation (EC) No 1/2003.

Improve competition authority capacity

The expected changes in economic organisation during the transition – in particular the increasing role of networks, systems and platforms – will require substantial legal and economics expertise in order to reach robust and speedy analysis and decisions. Accordingly, it will be important to strengthen the capacity of competition authorities in these complex areas[47].

5.2. Designing markets

Many of the sectors relevant for the transition have characteristics (network effects, scale and scope economies, platform effects, high capital specificity) that imply that unregulated markets either under-invest in socially desirable capital (eg. back-up capacities) or that market concentration makes resource allocation inefficient.

To produce efficient results, market rules need to be put in place that give market actors incentives that are aligned with maximising citizens' welfare. This is easier said than done, as the decade-long series of reforms of the electricity market design has shown. But there is no way to benefit from the power of competition in the internal market in these sectors other than designing robust markets.

As each network/platform technology creates different challenges to be addressed by regulators and competition authorities, and each industry presents specific problems, this is not the place to provide specific recommendations. Some more generic recommendations can be given however to illustrate some of the trade-offs:

1) New vs. old sectors: It might make sense to discriminate between emerging sectors where chicken-and-egg issues require strong coordination of investments, and more mature sectors. But again, any exemption to infrastructure access or unbundling rules[48] should be subject to clear sunset dates and a plan for how competition will be eventually protected.

2) National vs. European market designs: There is a trade-off between using the efficiency of the internal market and enabling effective national climate policies. This will remain a tension throughout the transition. This trade-off is better addressed through well-balanced initial policy design than by leaving it to state aid rules and their interpretation[49]. One solution is policies that tolerate periods of national support whilst pushing convergence to the first-best outcome of European integration.

3) Regulating access to new networks or not: Network and platform rules are important elements for new smart solutions in energy and mobility. Opening new networks to competitors might discourage investments, while not opening them might prevent virtuous competition. It is crucial that rules do not allow an incontestable position to emerge. For network rules, the UK's Furman Review (Furman *et al* 2019) recommended measures including inter-operability[50] and data openness as part of a regulatory framework that shapes the market.

4) System vs. company competition: In industries with competing networks (electric vs. hydrogen vehicles; district vs. individual electric heating; ride-sharing vs. public transport), having several systems compete (some even government driven) while trying to ensure that this system competition is based on merit rather than incumbent market power, might initially be enough competition. When one system prevails, however, it might become relevant to determine access conditions/interfaces, and to require unbundling.

5) Policy experimentation[51]: temporarily giving differentiated permissive rules in specific geographical areas (eg. not enforcing unbundling of hydrogen networks in Catalonia), when this serves to test a credible hypothesis on why this could be a useful approach, and closely monitoring the effects, might be a way to learn more quickly what works and what does not.

This illustrates how multifaceted and complex, but also path-prescribing, market design questions will be. But unregulated/unmonitored self-organisation risks running into problems, and companies might hence in anticipated obedience not try promising ideas at all.

Accordingly, EU countries and the EU will need to invest political capital in determining the playing field for competition in these sectors, which are so crucial for decarbonisation.

5.3. Direct state control

The economics in some sectors make it very difficult to engineer virtuous competition between companies, even with sophisticated market rules. Moreover, it is difficult to design markets so they produce the distributional results and resource allocation that are desired politically.

As the assessment on the balance of imperfections of markets, trust in indirect tools to address them and the imperfections of direct public management differ between countries and change over time, there are very different levels in EU countries of state ownership in some sectors, and also clear ups and downs in these shares over time.

Different developments in the energy sector, which remained state- controlled in France and went from liberalisation in the 1990s in Germany to some re-nationalisation in the 2010s, is a striking example.

And state control in specific sectors is not binary. It can range from (i) very light touch provision of company coordinating services, such as EU industrial alliances, that actually even shield companies against certain policies, (ii) via medium-level interventions such as strong regulation of the activities of private companies through specific agencies, public-private partnerships and minority shareholdings, to (iii) very heavy-handed direct control through majority shareholding in essential companies (eg. platforms or network providers), or even complete value chains (electricity and rail sectors in several EU countries).

Again, the optimal balance will be case-specific as countries and sectors differ markedly – and this is not the place to provide a comprehensive list of specific recommendations. However, a few selected considerations illustrate the complexity of the trade-offs:

- Public-body coordination: One approach would be to allow governments to take some temporary coordination role (as for example tried with EU industrial alliances) – but very often those protect incumbents.

- Regulation: Since a regulatory agency can never be completely independent of political influences, its mandate can shift from providing a solution to market failures to becoming an instrument for the protection of incumbents.

  Regulation can thus become a barrier against technological change and can create inefficient path dependence and reduce dynamic competition. Moreover, domestic regulatory initiatives in a context in which services are often supra-national in scope, are unlikely to lead to efficient outcomes.

- Public financing: providing public financing especially thorough public banks in ways that enable additional efficient investments in sustainable projects, requires this financing to be used to overcome well-defined market failures. Hence public finance might be less useful in reasonably competitive segments with limited externalities (eg mature renewables).

- State control: Direct control over decisions ('build X nuclear power plants by 20XX!') can be an advantage in speeding up the transition, but public companies' incentives are often less-well aligned with minimising resource misallocation.

- Fiscal rules: If public budgets are credit-constrained by fiscal rules, direct forms of state control (through public companies) might be more difficult.

The balance of the advantages and disadvantages of different forms of state control is a never-ending policy discussion. But the role of competition in the transition cannot be discussed without noting that the need for an efficient transition will require a reassessment of arguments. This discussion has clearly started in practice in specific cases (eg. re-nationalisation of energy networks in Germany), but it requires a more comprehensive framework.

6. Conclusion

Competition and carbon pricing remain key for an efficient transition

Markets will play a central role in the EU's transition to carbon neutrality. Efficiency of resource allocation between sectors is crucial to chart a least-cost route to net zero.

Products, services and underlying sectors will undergo abrupt and significant reshaping. The challenge for policy is to adapt dynamically to evolving circumstances, creating the framework to ensure effective allocation of labour and capital.

On balance, the urgency of the climate transition does not alter the broad principle that free markets are good for achieving efficient resource allocation. Competition must continue to be supported, particularly with the goal of spurring innovation.

This should take place within an underlying framework of progressively more ambitious carbon pricing, which remains the most effective tool for addressing the principal market failure – that of mispriced carbon emissions.

Efficient allocation in the transition will require well-designed markets

However, carbon pricing alone will not efficiently allocate resources because of a number of further externalities, or market failures. There are therefore compelling cases for public intervention to improve resource allocation.

The main challenge will be designing markets for new network industries, including hydrogen, smart grids, the circular economy and multi-modal transport. In all these areas there are efficiency gains to be had from economies of scale and/or scope.

A careful balance needs to be struck between allowing coordination of competitors in a sector in order to develop new integrated systems, and potentially even permitting a certain degree of market power to encourage them to make initial investments, while proving longer-term robust protection against abuse of this power.

Policy framework should focus on enabling innovation

As Europe peers over the precipice of rapid energy-system change, it is not clear whether all member states will move in the same direction in terms of technology and policy choices.

Moving together would provide valuable efficiency gains, but diverging paths would permit greater adherence to national political preferences and, importantly, could offer valuable experimentation on what technologies and policies work well, and which don't.

In this and other cases there are trade-offs between pushing for innovation outcomes and sacrificing short-term (sometimes green) gains. The benefits of providing innovative green solutions to the rest of the world means we take the view that in cases of conflict, policy should err on the side of innovation.

Running through the veins of policy must remain the mantra of 'allowing failure'. A large body of literature in the Schumpeterian tradition finds empirical evidence for positive effects of exit or firm turnover on growth (Comin and Mulani, 2005; Aghion and Howitt, 2006; Fogel *et al* 2006).

While companies are very good at stopping failing projects, politicians are less so. Failure should not only be tolerated but expected.

A discussion is needed on how to ensure efficient resource allocation in the transition

Economic models that assume perfect market outcomes and flawless government decisions already demonstrate that the low-carbon transition implies substantial challenges for jobs, growth and welfare.

If on top of this, an inappropriate institutional framework leads to very inefficient resource allocation, the corresponding cost might make the transition politically unmanageable.

As the EU and its members are now committed to ambitious climate targets and the necessary changes in production and consumption become clearer, it is high time to discuss which fundamental reforms are needed to ensure that the institutional framework that guides resource allocation in the transition is up to challenge.

There are no easy answers on how to organise sectors so that they use the benefits from competition, while minimising detrimental rent-seeking behaviour. But, an efficient transition will, depending on the sector require revised competition rules, redesigned markets and recalibrated roles for the state and the private sector. ■

Georg Zachmann is a Senior Fellow at Bruegel

Endnotes

1. Throughout, the term 'transition' refers to the process of transition to a climate-neutral economy.

2. Benchmarking is very difficult because it is very hard to control for all the idiosyncrasies of different systems. In the energy sector, with its quickly changing regulatory and market conditions, there are abundant examples of projects that completely failed: eg. German coal plants (Moorburg, Datteln) that were built but never entered into operation; the Montalto di Castro, Stendal and other nuclear power plant projects that were abandoned. Moreover, some large energy projects turn out to be unprofitable, such as the big third generation reactor projects in Finland and Flamanville, which had huge cost overruns.

3. This environmental externality is not restricted to greenhouse gases. Concepts such as 'natural capital' try to introduce environmental factors better into economic analysis. See for example https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/naturalcapital

4. Desruelle et al (1996) argued that the complementarities between different components of systems lead to a form of network effects.

5. For a comprehensive analysis see https://ec.europa.eu/competition-policy/system/files/2021-06/kd0521173enn_EEAG_revision_2021_0.pdf

6. For an estimate, see PACE (2021).

7. This would be competition for ownership of the infrastructure ('for the market' competition), rather than actually between competing construction projects ('in the market' competition).

8. If using heat-pumps is cheaper for affluent households than connecting to district heating, similar effects might also arise there.

9 See https://voxeu.org/article/us-firms-market-power-has-declined-due-import-competition

10. See https://ec.europa.eu/commission/presscorner/detail/en/IP_21_3541

11. "Average emission intensity of the 10 per cent worst performing EU installations for that type of goods" https://ec.europa.eu/info/sites/default/files/carbon_border_adjustment_mechanism_0.pdf p.67

12. European Commission (2016, p.156) showed how concentrated markets in steel, cement and refineries in the EU are.
13. On the other hand, if CBAM is used to reduce the free allocation of allowances, the corresponding distortions of international competition might make the international division of labour more efficient.
14. To minimise this risk, the EU wants to set up a CBAM system that is compatible with the rules of the World Trade Organisation.
15. This is often forgotten in modelling exercises that expect efficient government policies.
16. They, for example, make unavoidable mistakes, such as supporting the development of technologies that do not perform, like companies, but they are often worse at stopping them.
17. This depends on the ability of companies to pass through the carbon cost to product prices, which is relatively high in ETS sectors.
18. Measuring private R&D is difficult. According to the IEA, three quarters of clean energy R&D is done by business while one quarter by governments (IEA, 2020).
19. The relationship between market power and innovation is a deep research topic with diverse theoretical and empirical results. See for example Schumpeter (1942), Arrow (1962), Gilbert and Newbery (1984), Cohen (2010), Aghion et al (2021), Ding (2020), Gilbert (2020).
20. An example is the innovation components in state-of-the-art revenue regulation models, such as RIIO in the UK electricity distribution industry. See https://www.ofgem.gov.uk/energy-policy-and-regulation/policy-and-regulatory-programmes/network-price-controls-2013-2023-riio-1/network-price-controls-2013-2023-riio-1-riio-1-network-innovation-funding
21. Bayer/Monsanto (2018, M.8084).
22. This section was co-written by Julia Anderson.
23. In other words, subject to what OECD (2020) calls "abstract balancing", or balancing that occurs outside of the economic framework of competition policymaking.

24. For example, using the 'public interest clauses', that allow member states to overrule European Commission merger clearances (Article 21 of the EU Merger Regulation). See Dunne (2020).
25. Environmental consideration may also be indirectly considered as contributing to cost savings. This was the case, for instance, the CECED case where the Commission cleared an agreement to phase out the least energy-efficient washing machines that resulted in electricity cost savings for individual purchasers (2000/475/EC). In these cases, environmental considerations do not enter the (price-based) analysis.
26. Ryanair/Aer Lingus I (2017, M.4439).
27. For new diesel and petrol passenger cars. Open case AT.40178. Press release available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_19_2008
28. See https://www.bloomberg.com/news/articles/2021-10-12/france-to-build-small-nuclear-reactors-by-2030-in-export-push
29. See the German National Hydrogen Strategy available at https://www.bmbf.de/bmbf/de/forschung/energiewende-und-nachhaltiges-wirtschaften/nationale-wasserstoffstrategie/nationale-wasserstoffstrategie_node.html
30. https://energypedia.info/wiki/Feed-in_Premiums_(FIP)
31 Two important caveats apply: first, some technological choices might create path dependencies (ie. moving out of an unsuccessful bet will be difficult); second, competition might only come up with efficient technology choices when (public) infrastructure choices are optimal.
32. Caveneile et al (2021) estimated in a general equilibrium model that the dynamic welfare effects of antitrust are an order of magnitude larger than the static allocative efficiencies, but that "the complex interactions … exhibit how daunting a challenge optimal antitrust policy design can be in practice".
33. In principle, allowing companies that successfully bring societally useful innovation to the market to temporarily enjoy extraordinary returns is a very powerful incentive for said innovation.
34. This research primarily focuses on flows of knowledge across borders (eg Haščič et al 2012; Conti et al 2018) or across institutions. For alternative energy technologies, scientific articles and patents with authors from multiple types of

institutions (eg. university and corporations) are cited.
35. For the rest of this paper, the term 'sustainable' refers to environmental sustainability.
36. Or consumers do not yet benefit from or perceive the 'green quality' improvement.
37. Patrick Rey and Jean Tirole questioned whether Airbus and the Alstom-Siemens merger were analogues: "Whereas Airbus was a new challenger to Boeing, which had a near-monopoly in the commercial-aviation market at the time, the Alstom- Siemens merger would have reduced the number of players in the European rail industry". See https://www.project-syndicate.org/commentary/alstom-siemens-rejected-merger-european-competition-policy-by-patrick-rey-and-jean-tirole-2019-03
38. See https://www.bruegel.org/wp-content/uploads/2021/11/Strategische_Au_enwirtschaftspolitikStudie_AA_2.pdf p.105
39. 'EU competition authorities' is used to refer to the whole EU institutional infrastructure of competition policy as enshrined in case law, official publications, and administrative practices. DG COMP, the European Commission department responsible for competition matters, is as the administrative authority, and acts as both investigator and decision-maker.
40. This paper does not cover state aid. Note that the new Guidelines on State aid for climate, environmental protection and energy (CEEAG) of the European Commission entered into force in January 2022.
41. Allocative efficiency is a state at which goods and services are optimally distributed according to consumers' preferences.
42. This is a version of the Chicago school approach, according to which the goal of competition policy is to maximise total welfare, defined as the sum of consumer welfare and producer welfare. The European Commission's 2004 move towards a "more economic approach" has been interpreted as a shift towards a Chicago school approach to EU competition law (see Daskalova, 2015).
43. Case C-501/06 P GlaxoSmithKline Services Unlimited v Commission and Others [2009] ECR I-9291, para 63.
44. Based on case law and official publications, Ezrachi (2018) identified seven objectives of EU competition law:

consumer welfare, fairness, market integration, plurality and economic freedom, consumer well-being, efficiency and innovation, and effective competitive structures.

45. For example, Holmes (2020), Dolmans (2020), Nowag (2019).

46. One challenge is that classic tools such as the SSNIP test, which seeks to identify the smallest market within which a hypothetical monopolist could impose a Small Significant Non-transitory Increase in Price, do not work for changes in quality (there is no 'SSNIQ' test).

47. Between 2010 and 2018 the number of posts in DG COMP was reduced slightly from 830 to 804, while the 2015 inquiry into e-commerce alone already required a team of around 15 full-time equivalents over a period of 18-24 months.

48. Opponents of required vertical unbundling point to benefits of vertical integration such as achieving operating efficiencies and avoiding double marginalisation. But in our view the most important aspect is de-risking in the build-up phase.

49. For example, several EU countries and the European Commission are currently considering commercialisation contracts ('carbon contracts for difference'). These contracts provide support to low-carbon industrial installations based on the prevailing carbon price. The most efficient solution is to allocate such support via transparent competition at European level (McWilliams and Zachmann, 2021).

50. Besen and Farrell (1994) stated that firms operating in network markets face a core strategic decision concerning whether to make products that are compatible with those of rival firms (pursue competition within standards) or make products that are incompatible (pursue competition between standards).

51. One problem with many of the currently proposed 'Reallabore' – a German initiative to create a regulatory sandbox to try new technologies – is that they just extrapolate existing business models.

52. The three groups are named the 'climato-natifs', the 'ecolo-equitables' and the 'ecolo-hipsters'. In these three groups, between 62 percent and 90 percent declare that environmental considerations are important or very important factors in their consumption decisions and between 71 percent and 88 percent declare that these same considerations are important or very important factors in their lifestyle choices.

53. Climate Neutral Group, 2Ons koopgedrag en klimaat, 2018.
54. Wageningen Economic Research, Monitor Duurzaam Voedsel 2019, 2020.
55. Sustainability in this survey encompasses environmental harm as well as respect to human rights and provision of good working and employment conditions.
56. 'Fully agree' or 'don't agree at all' with the statement "I am willing to spend more on a product if it is environmentally friendly" (IFAK; Ipsos; GfK Media and Communication Research, 2020).
57. Climate Neutral Group, 2Ons koopgedrag en klimaat, 2018.
58. 'Fully agree' or 'don't agree at all' with the statement "I am willing to spend more on a product if it is environmentally friendly" (IFAK; Ipsos; GfK Media and Communication Research, 2020).

References

ACM (2013) ACM analysis of closing down 5 coal power plants as part of SER Energieakkoord, available at https://www.acm.nl/sites/default/files/old_publication/publicaties/12082_acm-analysis-of-closing-down-5-coal-power-plants-as-part-of-ser-energieakkoord.pdf
ACM (2020) Draft guidelines - Sustainability Agreements, https://www.acm.nl/sites/default/files/documents/2020-07/sustainability-agreements%5B1%5D.pdf
Abrell, J, S Rausch and C Streitberger, C (2021) 'The Economic and Climate Value of Flexibility in Green Energy Markets', USAEE Working Paper No. 21-506
Aghion, P, R Bénabou, R Martin and A Roulet (2021) 'Is Market Competition Clean or Dirty?' American Economic Review: Insights, forthcoming
Arrow, K (1962) 'Economic Welfare and the Allocation of Resources for Invention', Volume Title: The Rate and Direction of Inventive Activity: Economic and Social Factors (pp609 - 626), Princeton University Press

Baccianti, C and O Schenker (2022) 'Cournot, Pigou, and Ricardo walk in a bar – Unilateral environmental policy and leakage with market power and firm heterogeneity', Journal of the Association of Environmental and Resource Economists, forthcoming
Besen, S and J Farrell (1994) 'Choosing How to Compete: Strategies and Tactics in Standardization' Journal of Economic Perspectives, vol 8, no 2, pp117-131
Briglauer, W (2014) 'The impact of regulation and competition on the adoption of fiber-based broadband services: Recent evidence from the European union member states', Journal of Regulatory Economics 46.10.1007/s11149-013-9237-4
Cavenaile L, M Alp Celik and X Tian (2021) 'The Dynamic Effects of Antitrust Policy on Growth and Welfare', Journal of Monetary Economics 121, pp42-59
Choi, S, S Lee and C Williams (2011) 'Ownership and firm innovation in a transition economy: Evidence from China', Research Policy, vol 40, no 3, pp 441-452, available at https://doi.org/10.1016/j.respol.2011.01.004
Christensen, CM and JL Bower (1996) 'Customer power, strategic investment and the failure of leading firms', Strategic Management Journal 17, pp197–218
Climate Neutral group (2018) Ons koopgedrag en het klimaat, available at https://www.climateneutralgroup.com/whitepaper-ons-koopgedrag-en-het-klimaat/
Cohen, W (2010) 'Fifty Years of Empirical Studies of Innovative Activity and Performance', Handbook of the Economics of Innovation, pp129-213, available at https://doi.org/10.1016/S0169-7218(10)01004-X
Conti, A (2018) 'Entrepreneurial Finance and the Effects of Restrictions on Government R&D Subsidies', Organization Science, vol 29, no 1, pp 134-153, available at https://doi.org/10.1287/orsc.2017.1168
D'Estea, P, S Iammarino, M Savonac and N von Tunzelmann (2011) 'What hampers innovation? Revealed barriers versus deterring barriers', Research Policy, available at https://iris.luiss.it/retrieve/handle/11385/197495/101980/Research%20Policy
Daskalova, VI (2015) 'Consumer Welfare in EU Competition Law: What is It (Not) About?' The Competition Law Review, vol 11, no 1, pp131- 160, available at https://ssrn.com/abstract=2605777

Desruelle, D, G Gaudet and Y Richelle (1996) 'Complementarity, coordination and compatibility: The role of fixed costs in the economics of systems', International Journal of Industrial Organization, vol 14, no6, pp747-768, Elsevier
Dolmans M (2020) 'Sustainable Competition Policy', Competition Law and Policy Debate, vol 5, no 4 and vol 6 no 1, available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3608023
Dunne N (2020) 'Public Interest and EU Competition Law', The Antitrust Bulletin, vol 65, no2, pp256- 281, available at doi:10.1177/0003603X20912883
Eurobarometer (2017) 'Eurobarometer survey – Protecting the Environment', https://ec.europa.eu/commission/presscorner/detail/en/QANDA_20_330
European Commission (2013) 'The Role and Measurement of Quality in Competition Analysis - submission by the European Union', submission to the OECD
European Commission (2016) Ex-post investigation of cost pass-through in the EU ETS, available at https://ec.europa.eu/clima/system/files/2016-11/cost_pass_through_en.pdf
European Commission (2018) 'Non-price Effects of Mergers - Note by the European Union', submission to the OECD
European Commission (2021) 'European Green Deal: Commission proposes transformation of EU economy and society to meet climate ambitions', available at https://ec.europa.eu/commission/presscorner/detail/en/IP_21_3541
Ezrachi, A (2018) 'EU Competition Law Goals and the Digital Economy', Oxford Legal Studies Research Paper No. 17/2018, available at SSRN: https://ssrn.com/abstract=3191766
Furman, J, D Coyle, A Fletcher, P Marsden and D McAuley (2019) Unlocking digital competition, Report of the Digital Competition Expert Panel, HM Treasury, available at https://doi.org/10.17639/wjcs-jc14
Gans, J and SP King (2003) 'Access holidays for network infrastructure investment', Agenda: A Journal of Policy Analysis and Reform, vol 10, no 2, pp163 - 178
Gilbert, RJ and D Newbery (1984) 'Preemptive Patenting and the Persistence of Monopoly: Reply', The American Economic Review, vol 74, no1, pp251–253, available at http://www.jstor.org/stable/1803330
Gilbert, RJ (2020) Innovation Matters - Competition Policy for the High-Technology Economy, MIT Press

Goron, C (2018) 'Fighting against climate change and for fair trade: finding the EU's interest in the solar panels dispute with China', China-EU Law Journal 6, pp103–125
Hamilton, W and H Singh (1992) 'The evolution of corporate capabilities in emerging technologies', Interfaces, vol22, no 4, pp13–23
Hascic, I, N Johnstone and M Kalamova (2012) 'Implications of Policy Uncertainty for Innovation in Environmental Technologies: The Case of Public R&D Budgets', in V Costantini and M Mazzanti (eds) The Dynamics of Environmental and Economic Systems, Springer, Dordrecht, available at https://doi.org/10.1007/978-94-007-5089-0_6
Haskel, J and S Westlake (2018) Capitalism without Capital: The Rise of the Intangible Economy, Princeton University Press
Henderson, R (1993) 'Under investment and incompetence as responses to radical innovation: evidence from the photolithographic alignment equipment industry', Rand Journal of Economics 24, pp248–270
Holmes, S (2020a) 'Climate Change and Competition Law – Note by Simon Holmes', submission to the OECD hearing on Sustainability and Competition
Holmes, S (2020b) 'Climate Change, sustainability, and competition law', Journal of Antitrust Enforcement, vol. 8, no 2, pp354-405, available at https://doi.org/10.1093/jaenfo/jnaa006
Ibáñez Colomo, P (2018) The Shaping of EU Competition Law, Cambridge University Press, Cambridge, available at doi:10.1017/9781108378505
IEA (2020) Clean Energy Innovation, International Energy Agency, Paris, available at https://www.iea.org/reports/clean-energy-innovation
International Trade Centre (2019) 'The European Union Market for Sustainable Products. The retail perspective on sourcing policies and consumer demand', ITC, Geneva
IRENA (2020) 'Green Hydrogen Cost Reduction: Scaling up Electrolysers to Meet the 1.5^{0}C Climate Goal', International Renewable Energy Agency, available at https://irena.org/-/media/Files/IRENA/Agency/Publication/2020/Dec/IRENA_Green_hydrogen_cost_2020.pdf

iVox, (2019) 'Enquête verantwoorde consumptive', Trade for Development Centre, available at https://www.tdc-enabel.be/2019/09/19/enquete-verantwoorde-consumptie/

Jacobsson, S and A Johnson (2000) 'The Diffusion of Renewable Energy Technology: An Analytical Framework and Key Issues for Research', Energy Policy, 28, 2000, pp 625-640

Kingston, S (2012) Greening EU Competition Law and Policy, Cambridge University Press, Cambridge

Lianos, I (2018) 'Polycentric Competition Law', Current Legal Problems, vol. 71, no 1, pp.161–213, available at https://doi.org/10.1093/clp/cuy008

McWilliams, B and G Zachmann (2021) 'Commercialisation contracts: European support for low-carbon technology deployment', Policy Contribution 15/2021, Bruegel, available at https://www.bruegel.org/2021/07/commercialisation-contracts-european-support-for-low-carbon-technology-deployment/

McWilliams, B and G Zachmann (2021) 'A new economic geography of decarbonisation?' Bruegel Blog, 8 November, available at https://www.bruegel.org/2021/11/a-new-economic-geography-of-decarbonisation/

Midttun, A and K Gautesen (2007) 'Feed in or certificates, competition or complementarity? Combining a static efficiency and a dynamic innovation perspective on the greening of the energy industry', Energy Policy 35, pp1419–1422, available at https://www.sciencedirect.com/science/article/pii/S0301421506001856

Monti, G (2007) 'Competition law: Policy perspectives', in EC Competition Law (Law in Context, pp. 1-19), Cambridge University Press, Cambridge, available at doi:10.1017/CBO9780511805523.002

Motta, M and M Peitz (2019) 'Competition policy and European firms' competitiveness', VoxEU, available at https://voxeu.org/content/competition-policy-and-european-firms-competitiveness

Nitsche, R and L Wiethaus (2011) 'Access regulation and investment in next generation networks -- A ranking of regulatory regimes', International Journal of Industrial Organization, vol. 29, no 2, pp263- 272, Elsevier

Nowag, J (2019) 'Competition Law's Sustainability Gap? Tools for an Examination and a Brief Overview', Lund University Legal Research Paper Series, October, available at https://ssrn.com/abstract=3484964

ObSoCo (2019) l'Observatoire des perspectives utopique - Les Perspective utopiques des Français, available at https://lobsoco.com/wp-content/uploads/2020/09/LObSoCo_ADEME-I-LObservatoire-des-perspectives-utopiques-Vague-2-I-Rapport-danalyse-I-Juin-2020.pdf

OECD (2004) Patents and Innovation: Trends And Policy Challenges, Organisation for Economic Co-operation and Development, available at https://www.oecd.org/science/inno/24508541.pdf

OECD (2012) 'Roundtable on the Role of Efficiency Claims in Antitrust Proceedings - Note by the European Union', Organisation for Economic Co-operation and Development

OECD (2020a) 'Sustainability and Competition', OECD Competition Committee Discussion Paper, Organisation for Economic Co-operation and Development, available at http://www.oecd.org/daf/competition/sustainability-and-competition-2020.pdf

OECD (2020b) 'Sustainability and Competition – Summary of Contributions', OECD Competition Committee Discussion Paper, Organisation for Economic Co-operation and Development, available at http://www.oecd.org/daf/competition/sustainability-and-competition-2020.pdf

Petersmann, E and A Steinbach (2020) Neo-Liberal, State-Capitalist and Ordo-Liberal Conceptions of Multilevel Trade Regulation, Robert Schuman Centre for Advanced Studies, available at https://cadmus.eui.eu/bitstream/handle/1814/68877/RSCAS%202020_74.pdf

Popp, D, J Pless, I Hascic and N Johnstone (2020) 'Innovation and entrepreneurship in the energy sector', in The Role of Innovation and Entrepreneurship in Economic Growth, University of Chicago Press

Schumpeter, JA (1942) 'Capitalism, Socialism, and Democracy', University of Illinois at Urbana- Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship, available at https://ssrn.com/abstract=1496200

Verdolini, E and M Galeotti (2011) 'At home and abroad: An empirical analysis of innovation and diffusion in energy technologies', Journal of Environmental Economics and Management, available at https://www.sciencedirect.com/science/article/pii/S0095069610001233

Volpin, C (2020) 'Sustainability as a Quality Dimension of Competition: Protecting Our Future (Selves)', CPI Antitrust Chronicle, pp9-18
Wenzhi, D, L Ross, L Chen and X Wensi (2020) 'Competition Laws, Norms and Corporate Social Responsibility', available at http://dx.doi.org/10.2139/ssrn.3605990
YouGov Italy (2019) 'L'ascesa della moda etica in Europa', available at https://it.yougov.com/news/2019/11/19/lascesa-della-moda-etica-europa/

An earlier version of this paper was co-written with Julia Anderson, providing excellent input on the legal basics and a deep dive into green efficiency that has been used in this paper. Based on this, and many comments (special thanks to Marie Le Mouel), the paper developed into a very broad take on the role of competition in decarbonisation. Research assistance from Ben McWilliams and Giovanni Sgaravatti is gratefully acknowledged. This paper benefited from a high-level closed-door workshop and bilateral meetings. We are grateful for the input of participants. This article is based on Bruegel Working Paper 11/2022 and was first published on Bruegel.

Annex. Consumer preference for green

For competition authorities, actual consumption behaviour matters more than intentions. Analyses (and most notably market definitions), are based largely on past consumption data, ie. revealed preferences.

This includes data from the market under study, or, if such data does not exist (for instance because the market does not exist), econometric techniques can help estimate consumers' preferences based on information gleaned from other markets (eg. the travel cost method).

When revealed preferences can neither be observed nor estimated, competition authorities conduct surveys to gauge consumers' intended behaviour in hypothetical markets, ie. their stated preferences. But even there, survey questions and choice situations are designed to elicit consumption decisions as if they were in real markets (Lianos, 2018).

So, are consumers' green intentions reflected in their actual purchase choices? On aggregate, yes. A French study estimated that 44 percent of consumers are "significantly engaged" in sustainable consumption (l'ObSoCo, 2020). This group of consumers is composed of three sociological types for whom environmental considerations largely guide consumption and lifestyle choices[52].

Overall, French consumers give themselves 6.7 out of 10 when asked to grade the extent to which they consider the environmental impact of their shopping choices (l'ObSoCo, 2020). Climate Neutral Group (2018) found that 50% of respondents to a Dutch survey indicated that they purchase climate-neutral products[53]. In Italy, 26 percent of families purchase at least one organic product (which is generally less carbon-intensive) per week (ITC, 2019).

The trend is also positive. In the Netherlands, sustainable food accounted for 14 percent of all food purchases in 2019, up from 6 percent in 2013[54]. In 2018, 21.5 million Italian families (81 percent) purchased at least one organic product, a 5 percent increase from just a year before.

A survey of retailers in the five largest EU markets finds that 85 percent increased their sales of sustainable products in the five years leading up to 2019 (ITC, 2019)[55]. The great majority (92 percent) of these surveyed retailers expected sales of sustainable products to increase in the next five years, with around three-quarters of these companies expecting the growth to exceed 10 percent (ITC, 2019). French young adults are much more environmentally conscious than previous generations (l'ObSoCo, 2020).

There are however signs of polarisation, and of possible entrenchment. The share of Germans that declare themselves fully willing to pay more for green products has increased in the last five years, from 6 percent to 8 percent. But so has the share declaring themselves not at all willing to pay more for green products (from 14 percent to 15 percent)[56].

The l'ObSoCo study found that in France, values and political affiliation are the most important predictor of sustainable consumption; not classic demographic characteristics (eg income, education, location). Given the tendency of people to cluster around values, those that care more about sustainability will find themselves comforted by their choices, while those uninterested in sustainability will be subject to little pressure to change.

Such polarisation gives a political dimension to competition decisions that prioritise one group over another, raising questions of legitimacy on the part of unelected competition officials (see section 4).

And while most consumers care about sustainability, they care even more about price. The l'ObSoCo study found that sustainability considerations do not ultimately drive purchase decisions. Price is much more important.

Sustainability trails behind price and other features that directly benefit consumers such as taste, performance and aesthetic quality. Price is one of the three most important factors when choosing which food products to buy for 62 percent of respondents.

Environmental consideration makes it to the top three for only 29 percent of those surveyed. The different is even more significant for non-food products (71 percent and 25 percent).

Similarly, in the Netherlands, a survey found that environmental impact is a deciding purchasing factor for only 6 percent of respondents[57]. Only 8 percent of surveyed Germans declared themselves fully willing to pay more for green products[58].

No evidence of a climate crisis

Allan MacRae considers climate change and finds that the empirical observations show very gentle warming and no evidence of a climate crisis

In his annual State of the Climate report published on April 14, 2022, Dr Ole Humlum, Emeritus Professor at the University of Oslo, examined detailed patterns in temperature changes in the atmosphere and oceans together with trends in climate impacts. Many of these show no significant trends and suggest that poorly understood natural cycles are involved. And while the report finds gentle warming, there is no evidence of dramatic changes, with snow cover stable, sea ice levels recovering, and no change in storm activity.

Professor Humlum said:

> *"A year ago, I warned that there was great risk in using computer modelling and immature science to make extraordinary claims. The empirical observations I have reviewed show very gentle warming and no evidence of a climate crisis."*

Dr Benny Peiser, Director of the UK-based Global Warming Policy Foundation, responded:

> *"It's extraordinary that anyone should think there is a climate crisis. Year after year our annual assessment of climate trends document just how little has been changing over the last 30 years. The habitual climate alarmism is mainly driven by scientists' computer modelling, rather than observational evidence."*

In reality a carbon tax, a tax on carbon dioxide (CO_2) emissions, has never been justified either scientifically or economically. Climate sensitivity to atmospheric CO_2 is very small, so there is no real fossil-fuel-caused climate crisis.

For decades, alarmists have ignored that reality, squandering trillions of dollars and millions of lives with their false climate crisis. In fact, the only measurable impact of more CO_2 is hugely beneficial – improved crop yields to feed the world.

The CAGW hypothesis ASSUMES that the future is causing the past. False!

The Catastrophic Anthropogenic Global Warming ('CAGW') hypothesis is based on a false premise – it assumes that atmospheric CO2 changes drive temperature changes, which is incorrect. If CO2 was a significant driver of global temperature, CO2 changes would LEAD temperature changes, but they do NOT.

Atmospheric CO_2 changes LAG temperature changes at all measured time scales, as proved by MacRae 2008, and Humlum *et al* (2013). Kuo *et al* (1990) made similar observations in the journal *Nature* that were ignored for decades.

The CAGW hypothesis ASSUMES that the future is causing the past. The CAGW hypothesis is disproved.

The ability to correctly predict is the best objective measure of scientific and technical competence

In fact, the CAGW hypothesis has also been proved false in many other ways, but as Albert Einstein famously stated, *"One would be enough."*

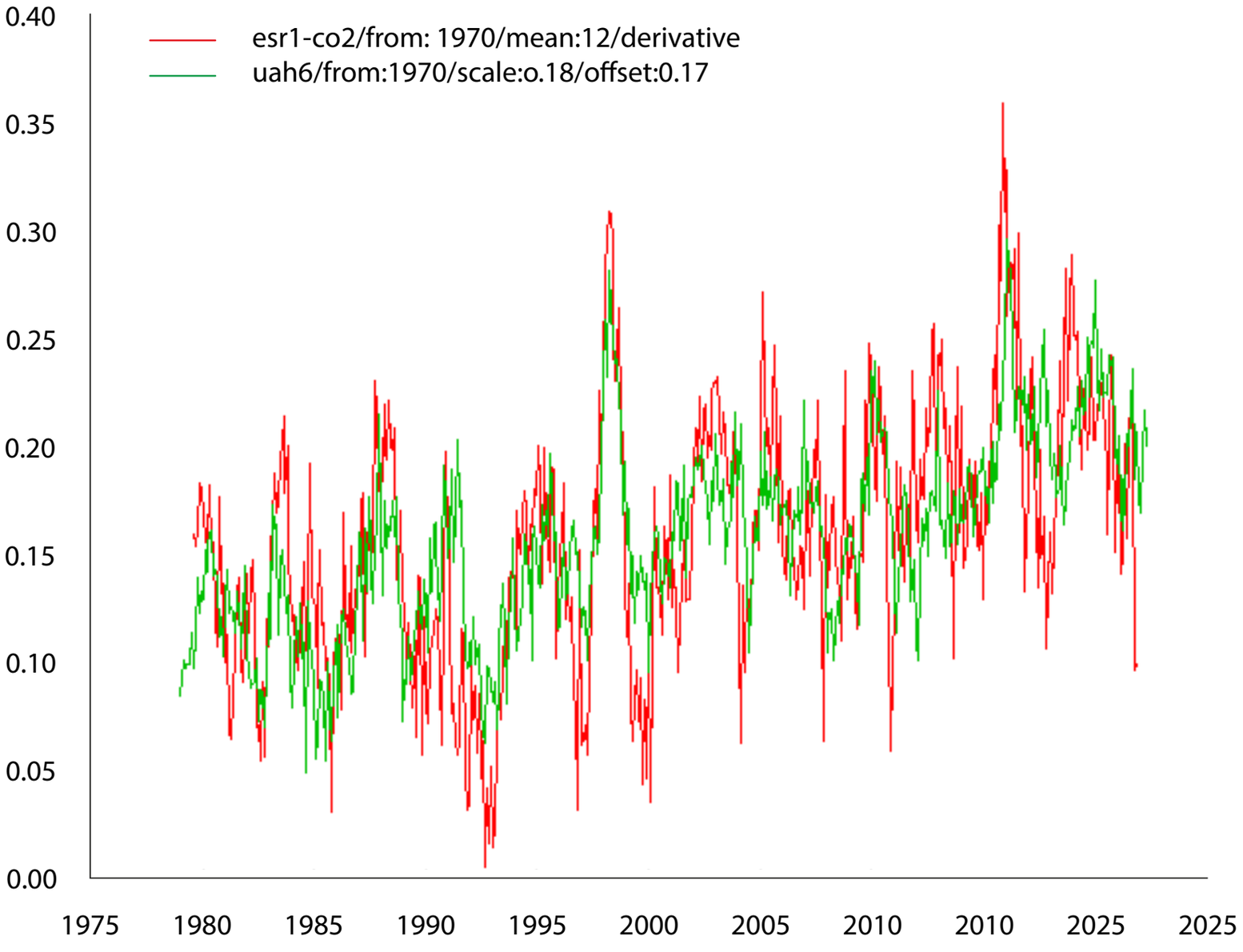
Solar-driven global cooling is happening now, just as we predicted in 2002 – another disproof of the false global warming climate crisis. Crop failures, food shortages and price inflation are happening, and famine is increasingly probable, caused primarily by cold and wet weather.

The lag of atmospheric CO_2 changes after temperature changes is confirmed in my 2008 paper, which shows the close correlation of the rate-of-change dCO_2/dt vs Lower Tropospheric air temperature. The integral of dCO_2/dt is CO_2 change, which lags temperature change by approximately 9 months in modern data.

Our scientific predictions on climate are infinitely more accurate than the mainstream narratives, which have been false and baselessly alarmist to-date. In 2002 and again in 2013, we published the earliest and most accurate predictions of climate and energy, as follows:

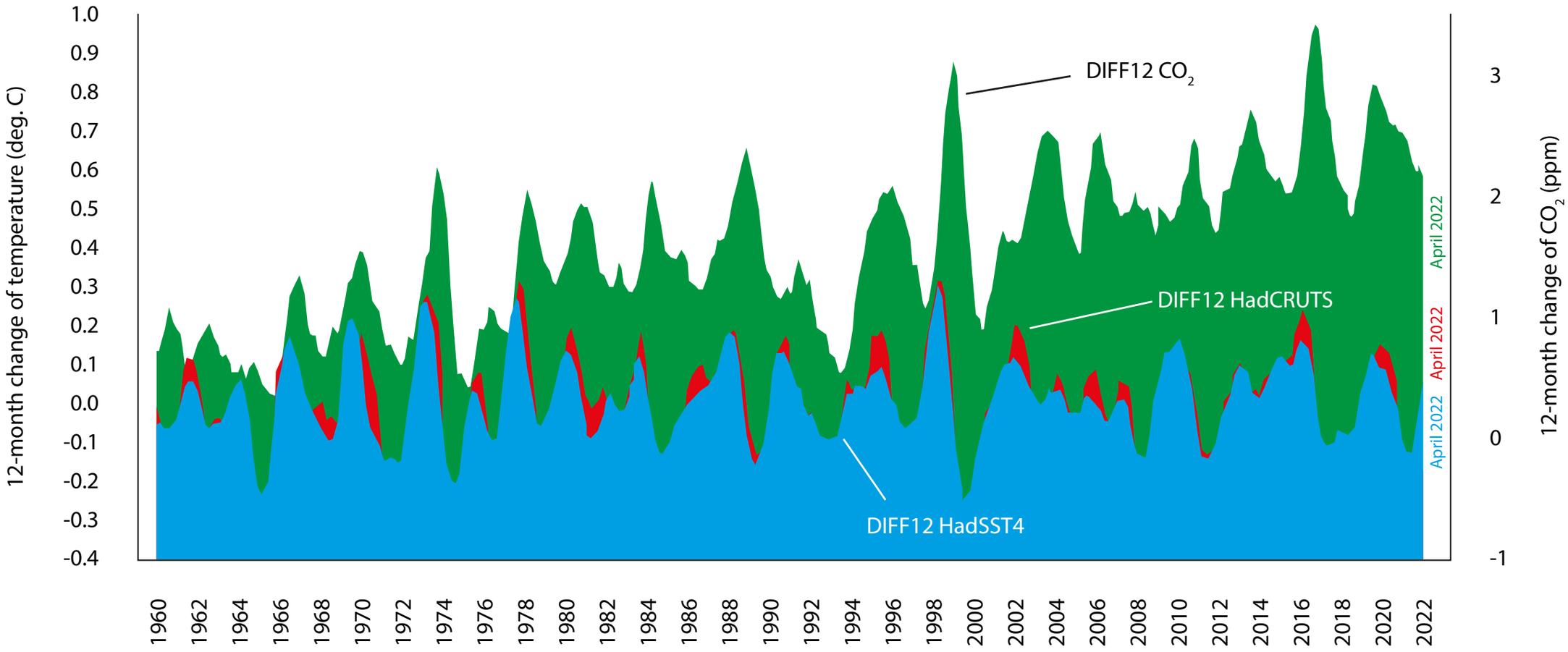
- There is no real global warming crisis.
- Green energy is not green and produces little useful (dispatchable) energy.
- Climate is insensitive to increasing atmospheric CO_2 and the burning of fossil fuels.
- Climate at the century-scale IS sensitive to small changes on solar activity.

Figure 1. Correlation of the rate-of-change dCO2/dt vs Lower Tropospheric air temperature



Source: MacRae (2008)

Figure 2. Correlation of carbon dioxide concentrations and temperature records



Red: change of global surface air temperature (HadCRUT5; last 12 months minus previous 12 months)
Blue: change of global sea surface temperature (HadSST4; last 12 months minus previous 12 months)
Green: change of atmospheric CO_2 (Last 12 months minus previous 12 months)

Source: Humlum et al (2013 and annual updates)

- Earth will start natural solar-driven cooling by ~2020 or sooner.

- Grid-connected green (wind and solar) energy will prove a huge failure by ~2020.

Contrast the abysmal failure of the global warming alarmists' predictive track record. Rode and Fischbeck of Carnegie Mellon University, collected 79 predictions of climate-caused apocalypse going back to the first Earth Day in 1970. With the passage of time, many of these forecasts have since expired; the dates have come and gone uneventfully. In fact, 48 (61%) of the predictions have already expired as of the end of 2020.

For 60:40 predictions, the odds of being this wrong are 1 in 13 quintillion; for 70:30 predictions, the odds are 1 in 13 septillion. It's not just climate scientists being randomly mistaken - they must have known they were not telling the truth.

To conclude, the alleged fossil-fuel-caused global warming crisis does not exist in reality. The only real, measurable impact of increasing atmospheric CO_2 concentrations is improved crop yields – which are hugely beneficial. Trillions of dollars and millions of lives have been squandered due to the false climate crisis.

Cheap abundant reliable energy is the lifeblood of humanity. The failure of intermittent wind power electrical generation is causing the current disastrous electrical energy shortfalls in Britain and Germany. The climate-and-green-energy falsehoods are causing a global disaster.

The global warming and green energy issues that the green extremists fret about are not relevant – not even real. The alleged catastrophic global warming crisis carbon tax is a decades-old scientific fraud. It is pseudo-scientific nonsense – wolves stampeding the sheep.

The real issue now is natural solar-driven global cooling that started circa 2016-2020, causing energy and food price inflation and shortages, now exacerbated by the Ukraine War.

As my co-authors and I published twenty years ago, the global warming (climate) crisis does not exist. ■

Allan MacRae of Energy Experts International is an energy and climate expert based in Calgary

ABOUT THE AUTHOR

As Manager of Oilsands for an owner of Syncrude Canada Ltd and two other megaprojects, Allan initiated or co-initiated three of the four major changes that revitalized the Alberta oil sands industry. These four changes created 500,000 new jobs, made Canada the 4th largest oil producer in the world, the largest foreign supplier of oil to the USA and for more than a decade the strongest economy of the G8 countries.

This article was originally published by FCPP.

REPowerEU: will the EU really make it work?

Simone Tagliapietra believes acting together, the European Union can optimise its response to the energy crisis in all scenarios, but each country will have to make concessions

The European Commission on Wednesday 18 May published its plan setting out how the European Union can eliminate its dependency on Russian fossil fuels. A phase out of Russian coal imports by August 2022 has already been agreed within the fifth package of sanctions imposed by the EU on Russia in the wake of the war in Ukraine, and a gradual phase out of oil by end-2022 is currently been discussed in the context of the sixth package.

Consequently, the new plan, known as REPowerEU, focuses predominantly on how to underake an orderly and affordable phase out of Russian gas by 2027. REPowerEU also proposes EU-level backstop options in the face of the plausible risk of a sudden interruption of Russian gas supplies, particularly after the supply cuts to Poland and Bulgaria.

Main areas of action

The plan covers four main areas: energy efficiency and savings; energy supply diversification; clean-energy transition acceleration; investment and reform. If approved, this plan should see Europe end its reliance on Russian energy by 2027, while also accelerating its green transformation. And this would be economically beneficial for Europe.

The European Commission estimates that delivering REPowerEU objectives requires an additional investment of €210 billion between now and 2027, but this would save almost €100 billion per year in reduced fossil-fuel imports. In short, a reasonable investment to get a significant structural cost reduction.

However, it will be national capitals that determine the success of the plan. Most of the proposed measures require either national implementation or coordination between EU countries. The extent to which countries really engage is therefore going to be defining. Four key areas of the plan underline the complexities.

Energy savings

Simple energy saving actions could immediately reduce demand for gas and oil. But for this to happen, action needs to be undertaken at national level. Governments must actively promote awareness campaigns, adopt financial schemes to prompt households to save energy and introduce regulations mandating energy savings in public buildings.

At EU level, rules on energy efficiency, starting with buildings and transport, can be strengthened. The plan puts forward new proposals on this, additional to the EU's current Fit for 55 package, from strengthening energy requirements for new buildings, to the introduction of a range of regulatory measures to increase transport energy efficiency.

A fragmented response to the energy crisis would likely lead to suboptimal results domestically, both in terms of energy security and competitiveness

Since September 2021, countries including Germany, France, Italy and Spain have each spent €20 billion to €30 billion to artificially lower gas and electricity bills, as well as gas and diesel prices. A determining factor in the success of REPowerEU will be whether governments switch from universal energy subsidies to targeted measures for poor households and vulnerable small and medium companies, and if they have the courage to ask all others to consume less energy.

Energy supply diversification

REPowerEU mainly addresses this key item through the EU Energy Purchase Platform, an initiative under development since March that would pool demand to maximise Europe's leverage and attract reliable supplies from global markets at stable prices.

For now, the contours of this initiative remain unclear. Initially proposed by the European Commission as a joint purchasing scheme similar to what was done for COVID-19 vaccines, this has been turned – after discussion between EU countries – into a voluntary initiative aimed at coordinating ongoing EU initiatives with members, transmission system operators, associations and market players.

EU countries need to appreciate that the EU should be given an emergency tool to procure LNG for the 2022 storage refilling season and to coordinate gas distribution across Europe in case of a disruption of Russian gas supplies.

Accelerating renewable energy deployment

Third, unlocking renewable energy projects by accelerating permitting. REPowerEU emphasises the acceleration of green technologies, from solar photovoltaic to wind, and heat pumps to green hydrogen – and proposes to increase the EU's headline 2030 target for renewables from 40% to 45%.

The plan rightly focuses on faster permitting, with slow processes today represent a major obstacle to the deployment of wind and solar energy. Obtaining a permit can take nine years for wind projects, and four and a half years for solar projects in certain European countries.

National rules and capacities unnecessarily slow down permits, and the time to obtain a permit varies significantly between EU countries. REPowerEU seeks to overcome this issue by removing ambiguity in the application of EU legislation and setting out good practices in EU countries. Countries must fix long-lasting administrative inefficiencies and implement the necessary changes quickly.

Backstop solutions in case of a sudden interruption of Russian gas supplies

Fourth, REPowerEU includes two main contingency measures in case of a sudden interruption to Russian gas supplies. First, it proposes the creation of a coordinated European plan for the reduction of industry gas demand.

Should an EU-wide gas security shock occur, a reduction of gas demand in countries less affected by the interruption to allow redirection of gas to more affected countries should be considered, even in case such rationing is not foreseen in the national emergency plan. Such a plan would aim to minimise the overall impact on the European economy of emergency measures.

On the regulatory front, the plan suggests an EU gas price cap in case of an emergency situation, in order to put a limit on price rises for consumers, companies and essential service providers.

The fundamental question in this scenario is: will EU countries be able to agree a common European response in case of an abrupt interruption in Russian gas supplies, or will they react individually, closing their energy market borders?

A united Europe would be better off than a fragmented Europe

REPowerEU shows convincingly that by acting together, the EU could optimise its response to the energy crisis, in both 'muddling-through' and 'abrupt disruption' scenarios. But EU countries must decide to what extent to engage in this cooperation.

Each country will have to make concessions: for instance, Germany might need to overcome its reluctance on joint procurement of LNG through the EU Energy Purchase Platform to ensure EU energy security, while France might need to organise its gas infrastructure so other EU countries can tap into Spain's unused LNG import capacity.

A fragmented response to the energy crisis would likely lead to suboptimal results domestically, both in terms of energy security and competitiveness. This would likely spillover into foreign policy, with far-reaching consequences on the capability of the EU to maintain a firm stance on Russia. ■

Simone Tagliapietra is a Senior fellow at Bruegel

This article was first published on Bruegel.

Calling out the West

The Russian subject is a sensitive one. Vijay Jayaraj considers India's defence of the purchase of Russian oil amidst global energy volatility

The Russian subject is a sensitive one. The global consensus, including that of India, is that its invasion violated Ukraine's sovereignty. But when it comes to trade relations, the lines remain blurred despite the massive exodus of businesses from Russia.

For example, Europe had been buying Russian gas in large volumes even as it levied other forms of sanctions on Moscow. It was not until recently that European states decided to phase out their import of Russian gas. This in effect meant that more funds from Europe were flowing into Russia than into Ukraine during the war.

Likewise, India too is a trade partner of Russia. But unlike Europe, India has decided not to phase out Russian oil, but to increase its import. India's position irked politicians and media entities in the West.

Last week, India defended its decision as a matter of domestic energy requirements. It explained why it neither supports Russia nor is against the Western axis that supports Ukraine.

India's External Affairs Ministry clears the air on Russian oil

Speaking at the conference in Bratislava, the media questioned India's External Affairs Minister Jaishankar on Russian oil.

In a very raw response, the Minister explained why India's priority is to meet the energy needs of its people, who make up one-sixth of the world's population. 300 million among the 1.3 billion are still in poverty, and many more millions live in energy poverty, with little or no access to electricity.

He also dismissed the argument that India is funding the war by acting as Russia's oil customer. He asked the media if Europe's *"buying Russian gas is not funding the war?"*

"Today, Europe is buying oil and gas from Russia and new package of sanctions is designed in a way considering the welfare of the people while timelines have been set for reducing Russian energy imports with no immediate cuts…. People need to understand that if you can be considerate of yourself, surely you can be considerate of other people," he said referring to the welfare of Indian citizens.

In May 2022, Russia became India's second biggest supplier of oil. Iraq remains the top supplier, while Saudi Arabia fell below Russia.

For India and China, where millions die from poverty, the odds are in favour of buying cheap fuels from the international market—whatever their source

Russian oil accounted for 16.5% of all oil imported into the country in May, nine times the previous year. Forecasts for June indicate that the imports during June (1.05 million barrels per day) will raise Russian oil above 23% of total imports. There are even talks to increase the imports further.

China competes with India for Russian oil

AsiaFinancial reports that India's efforts to increase its import of Russian oil further may face challenges given that Russia has made new export agreements with China.

"China has also boosted its purchases from Russia. Rosneft has awarded 900,000 tonnes (6.66 million barrels) of ESPO Blend crude oil loading in June to Unipec, the trading arm of Asia's top refiner Sinopec," said a report by *AsiaFinancial*. The Beijing-based Sinopec is the world's largest oil refining, gas, and petrochemical conglomerate.

Some analysts now claim that the imported Russian oil in India may have even reached American soil. Earlier this month, the *Wall Street Journal* said that Indian refineries are exporting the refined products from Russian oil to Europe and US.

Indian journalists say that the claim refers to a particular, large refinery on India's West Coast which sent a consignment of refined oil to a US port. But this cannot be verified without official statement from the refiner.

It is remarkable that even a near-global embargo on Russian products did not stop India and China from relying on Russian oil. It is a testament to the reality of energy needs in both these economies, where fossil fuels play a key role. Their purchase of Russian oil is an attempt to maintain energy security, not a political move related to the war.

It is a whole different question whether India, China, and Europe have funded the war against Ukraine by buying Russian oil and gas. It boils down to weighing domestic energy security against trading with a country that is active at a war. For India and China, where millions die from poverty, the odds are in favour of buying cheap fuels from the international market—whatever their source. ■

Vijay Jayaraj is a Contributing Writer to the Cornwall Alliance for the Stewardship of Creation and a Research Associate for the CO2 Coalition