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Working Paper

Developing the EU's 'competitive sustainability'

for a resilient recovery and dynamic growth

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Executive summary

A new concept, **'competitive sustainability'**, lies at the heart of the European Green Deal and the EU's growth strategy, which has itself now been convincingly re-confirmed by EU institutions as the framework for the Covid-19 Recovery and Resilience Plans (RRPs) and a new Industrial Strategy for Europe.

With an **international context very recently transformed** by other major economies such as China, Japan and South Korea also now publicly committing to targeting climate neutrality by mid-century, and a new administration in the US with a similar agenda, the need for the EU to focus on this new approach to competitiveness has very quickly become urgent, so that immediate and upcoming investment and policy decisions, such as those on the Recovery and Resilience Plans and new Industrial Strategy, can also reflect this.

Despite this apparent significance, the term currently lacks a clear definition or an operational effect on analysis or policy. This paper therefore seeks to give ideas to help address that gap and to:

- better define 'competitive sustainability' with a view to enabling analysis and operational policymaking to advance it
- offer an initial synthesis of recent evidence assessing the EU's performance and potential for competitive sustainability
- provide some research and policy recommendations that could help enhance EU performance, in particular in so far as that relates to the responsibilities of the Competitiveness Council.

From this initial work, we conclude that a clear and operational definition of 'competitive sustainability', with climate neutrality at its core, is both important and readily available based on previous work by the EU (e.g. Eurostat and Joint Research Centre (JRC))[1]. This extends the related notion of 'sustainable competitiveness' but with mission-oriented, innovation-led (and often digital) growth at its heart. An initial typology of the dimensions of competitive sustainability differentiates between micro, meso and macro-economic innovation-related investment aims, and a preliminary definition could be:

Competitive sustainability is the ability of an economy, its companies and industrial ecosystems to excel relative to international competitors in their transition to sustainable development (with climate neutrality at its core) through investment in the necessary innovation. Success in this can be measured in relevant and fully aligned:

- **enterprise-level technology and business model leadership in global growth markets**
- **infrastructure development enabling cross-sectoral productivity and economy-wide gross domestic product (GDP) growth**
- **strength of domestic industrial ecosystems in generating increased and high-quality employment and additional value-added as a proportion of their global value chains.**

We use these parameters and the EU taxonomy as a guide to assessing potential competitive advantage in the transition to climate neutrality based on an initial review of analysis that allows us to make some preliminary observations about the EU's current situation.

1. The EU's policy leadership positions it well

From the limited research available (see below), we see that in leading the global policy agenda and enabling the necessary industrial system transformation, the EU is already starting to prove that it stands to perform well and benefit significantly across the three identified dimensions of competitive sustainability, and integrating its climate neutral, smart and circular economy goals. For example:

- **Areas of current or potential European technology or business model leadership with high global market shares** include wind energy, heat pumps, demand-side power grid management, buildings and domestic appliance efficiency, aviation biofuels, shared mobility solutions, industrial process efficiency, and material recycling and management.
- Significant investment and **productivity improvements necessary for European GDP growth** are promised by smart electricity grid inter-connections, e-charging and hydrogen infrastructure.
- Significant **employment and EU value-added offering enhanced resilience through domestic industrial ecosystems and segments of global value chains** are available from buildings renovations, district heating, materials processing and management, and batteries.

The EU has success stories and much potential in this area. It also has strong collaborative instincts, networks and endeavours to ensure that international frameworks enable collaboration as well as competition, too. This combination can enable it to support global public investments on key early stage research, and also to align and allow market-based solutions to thrive as a result.

2. The EU should not be complacent about its strengths – or those of its competitors

But with international competition rapidly increasing, **the EU would be complacent to assume its position is uniformly strong or leading**. In fact, in many areas across these three dimensions of competitive sustainability, other economies are clearly very strong and well positioned to secure advantage, as they have on occasion done before. Heavy and aviation transport electrification, solar and carbon capture and storage (CCS) may all be areas in which international competition places competitors at an advantage. With regard to hydrogen, the EU's own strategy contains goals that other countries are already meeting – suggesting its significant investment push in this area needs to be understood in dimensions other than global technology or business model leadership, rather in relation to productivity and GDP growth or the resilience of its industrial ecosystem.

3. The EU lacks a full picture of its competitive sustainability

This initial study finds **that evidence on competitive sustainability is, however, far from complete, and what does exist is hard to compare or aggregate**. This is likely a consequence of the rapid pace of recent economic change, the implications of the new strategic focus on the climate neutrality goal as a growth strategy, and new analytical approaches developed to underpin EU industrial strategy (such as the focus on industrial ecosystems linking geographical clusters of assets and activities with more circular value chains). As a result, **the EU lacks a sufficiently clear overall picture and shared understanding of where it is leading or lagging internationally, has high or low potential, or has new or unmet strategic needs**.

4. Further analysis needs to feed into immediate policy and investment decisions

The EU, and the European Commission in particular, **should develop a fuller analysis of competitive sustainability. With this, it can apply its logic to its economic strategy and policies across the full range of the European Semester process, including its Recovery and Resilience Plans and new Industrial Strategy** in order to make the best decisions between alternatives for its enabling framework and direct investment. Further work will be **necessary to identify and develop the most relevant key indicators for competitive sustainability that can be used to both assess current recovery plans and policy programmes, and to measure progress over time in each of these areas in order to maximise its chances of success**. Conversely, without further reflection, research and insight relevant to policymaking in this area, the EU risks making some decisions on Recovery and Resilience Plan projects and other programmes that do not maximise its competitive sustainability performance and potential.

Introduction

This thought-starter paper has been prepared with a view to sharing some initial ideas with EU policymakers involved in the design and implementation of the Covid-19 Recovery and Resilience Plans (RRPs), the EU's Annual Sustainable Growth Strategy, the EU Industrial Strategy for Europe and EU Research and Innovation (R&I), in particular through a focus on a new notion at the heart of the European Green Deal's growth strategy: 'competitive sustainability'.[2,3]

When the work on this thought-starter began, the EU was alone among the major economies at having committed to targeting net zero emissions by 2050. But recently, a string of announcements by major economic players such as China, Japan and South Korea, that they are also targeting climate neutrality by mid-century for their economies, has changed that context. Assuming the US also confirms similar commitments under its new administration and seeks to re-join the Paris Agreement, economies representing approximately two-thirds of greenhouse gas (GHG) emissions and global GDP are now aligned in pursuit of the same goal at a similarly rapid pace. There is also a very clear momentum from global businesses under the We Mean Business coalition[i] umbrella, which is especially active in Europe but also in other geographies. The race to secure the most advantage from the enormous transition involved in this effort has immediately become more competitive.

Strategic partners and competitors in the world economy are not just aligning around the same climate neutrality goal, they are also demonstrating national economic and political self-interest when implementing measures. The EU is well aware of this from a trade perspective, and the need to protect its own interests while continuing to promote a rules-based international open trading system, especially in the wake of Covid-19. Both the economic opportunities and risks of losing out in the transition to a climate neutral, 'smart green' economy are also increasing, as is the case for Europe's strategic autonomy, along with the need to ensure the best recovery-related investments and associated policy decisions are made by the EU.

The extent of possible future divergence between EU and other economies' policy approaches, and associated potential trade distortions, may have diminished somewhat as a result of this dynamic alignment targeting climate neutrality by mid-century. However, the scale of investment in technological and business model innovation, and the modernised infrastructure and industrial ecosystems necessary for success, has not. The competition for the private capital necessary to finance the investment will be ever more intense. The need to understand what is meant by competitive sustainability, how well the EU is positioned in this respect with regard to other economies, strategic partners and competitors alike, has also assumed a new importance and the need to define, operationalise and win competitive sustainability has become urgent.

With this context and goal in mind, the paper therefore aims to:

1. Clarify **understanding of 'competitive sustainability'** by explaining its genesis and offering a working definition of it, such that assessment of performance and potential is facilitated and further analysis and policy support to drive it can be developed.

[i] We Mean Business coalition: https://www.wemeanbusinesscoalition.org/

2. Use this to synthesise and assess recent available **evidence of the EU's performance and potential** in key technologies and business models, value chains and cross-sectoral infrastructure projects currently being addressed as part of the European Green Deal, Recovery and Resilience Plans and new Industrial Strategy, in particular those which would qualify as aligned with climate neutrality according to the Technical expert group on sustainable finance (TEG) recommendation on the taxonomy. For example:
   - power, large-scale electrification and hydrogen
   - the buildings 'renovation wave', including heating, cooling and materials
   - the mobility value chain and energy storage, including batteries and electric vehicle (EV) charging
   - the bio-economy, including ecosystem services, materials management and food.

3. Draw conclusions, including on further analytical work necessary to have the best-informed approach to selecting projects under the Recovery and Resilience Plans, and informing policies including the Annual Sustainable Growth Strategy and its implementation in the European Semester process, the new European Industrial Strategy or specific initiatives such as Important Projects of Common European Interest (IPCEI).

What is competitive sustainability?

In its Annual Sustainable Growth Strategy 2020, the European Commission states that "the European Green Deal is our new growth strategy. It puts sustainability – in all of its senses – and the wellbeing of citizens at the centre of our action. This requires bringing together four dimensions: environment, productivity, stability and fairness". Furthermore, "at the core of this will be an industrial strategy with strong foundations in the Single Market that enables our businesses to innovate and to develop new technologies while boosting circularity and creating new markets." Developed prior to the Covid-19 pandemic and associated shocks to the economy and society that followed, this has nonetheless proved a resilient approach, with the European Green Deal remaining Europe's strategic framework, even if the new European Industrial Strategy is being reviewed to better take account of the need for resilience that has resulted from the Covid-19 shock.

The European Green Deal, with its central goal of achieving climate neutrality by 2050, and the accompanying industrial and digital transition agenda, is now firmly accepted by all EU institutions as the EU's economic growth strategy and acts as the compass for its recovery from the Covid-19 shock, for both policy and financial measures. The climate and digitally focused design and size of the combined multiannual financial framework (MFF) and recovery package budget (€1.855 trillion), its linkages with national recovery plans, and their overall potential to leverage much more substantial private capital and investment, are significant demonstrations of EU commitment to this agenda, and solidarity in that endeavour, as long as they are also effectively implemented.

The economic rationale for the EU to align recovery from Covid-19 with the rapid transition to both climate neutrality and wider sustainable development, and leading ambitious global action, is very strong. But an overall benefit for the economy's growth, and the associated employment generation, does not necessarily translate into a uniformly distributed opportunity or comparative advantage for its economy, or for the industries and companies across and throughout the value chains in which they operate. And this is where the notion of competitive sustainability in a global context becomes important. Identifying the areas in which the competitive opportunities for its economy, the companies and industrial ecosystems in it are greatest, the return on investments is highest, and growth and employment impact is most significant is important, as are the strategic choices made which should reflect this.

In other words, as a recent Presidency discussion paper for the Competitiveness Council notes, there is a strong case to ensure that the EU also seeks competitive advantage from these investments because: "a successful transformation of industry towards a green and digital future will lay the foundation for Europe's long-term competitiveness. Of the wide range of projects that are intended to help attain the climate targets of the European Green Deal (EGD), it makes sense to identify those which are also capable of strengthening Europe's competitiveness".[4] So, how should the EU assess which projects and programmes can do this? In other words, what exactly we do mean when we talk about 'competitive sustainability'?

Thus far, it has only been defined by the European Commission in broad, if strategic, terms. For example, in its Annual Sustainable Growth Strategy 2020, the European Commission proposes a new paradigm to address interrelated key challenges and states that:

"Competitive sustainability has always been at the heart of Europe's social market economy and should remain its guiding principle for the future. Moving towards a sustainable economic model, enabled by digital and clean technologies, can make Europe a transformational frontrunner. Leadership on environmental protection and a strong, innovative industrial base must be seen as two sides of the same coin, giving the EU a competitive first-mover advantage". This is a strong starting point, but still only a general definition.

From sustainable competitiveness to competitive sustainability?

Always a somewhat contested and even imprecise notion,[5] understanding of competitiveness has been evolving as the challenge of sustainability has itself become more urgent and prominent. Without considering sustainable development, typical definitions of competitiveness emphasise economic productivity and increased market share, but differ depending on whether they apply to companies, sectors or whole economies, i.e. at micro, meso or macro levels. The European Investment Bank,[6] for example, defined it as follows:

"Competitiveness is the ability of firms to mobilise and efficiently employ the productive resources required to successfully offer their goods and services in a global economic environment. The competitiveness of EU economies depends on the capacity of firms and industries to drive and adapt to change through innovation, raising productivity and achieving a presence in key strategic sectors. To sustain high income levels, Europe needs to excel in high value-added activities within globalised systems of production. This capacity depends in turn upon certain enabling factors: long-term investments in human capital and strategic infrastructure, the capacity of the financial sector to support innovation, and an appropriate framework of competitive markets and institutions."

Following the agreement of the UN Sustainable Development Goals (SDGs) in 2015, the notion of sustainable competitiveness has developed, based on the idea that competitiveness today should be reached without compromising the possibility of competitiveness tomorrow. In their work on a statistical reference framework on competitiveness the year after the SDGs were agreed, experts from Eurostat and the Joint Research Centre (JRC)[1] define 'competitiveness' as "a broad concept which encompasses a large set of factors related to production, consumption, trade, globalisation, the environment and socio-institutional factors". The JRC[7] defines 'sustainable competitiveness' as "the set of institutions, policies and factors that make a nation productive over the longer term, while ensuring social and environmental sustainability", and it includes elements of high-quality growth, resource management, social equality, human development and well-being – all elements that go beyond the EIB's definition above.

If competitiveness is generally now considered a dynamic concept able to provide better quality of life based on adaptation to a change and technology development offering productivity gains, at its heart certainly lies innovation – evident in all the above definitions. The influence of recent thinking on mission-oriented, innovation-led growth[7] is very clear in an EU context, not just in core R&I policy, but also its extension into industrial strategy, the European Semester process and related goals, including those on sustainable development. Indeed, the centrality of the goal (mission) of climate neutrality by 2050 to the new growth strategy gives it perhaps its clearest and most significant expression at a strategic economic level – the implications of which in fact are made evident by the very notion of competitive sustainability.[8, 9, 10]

'Competitive sustainability' as referenced in the European Commission's recently released Strategic Foresight Report for 2020 puts strong emphasis on the standards and regulations in the Single Market as being key to this: "The EU's regulatory power, notably in the environmental field, can lead to the highest standards being used to underpin competitive sustainability. In recent decades EU action has significantly improved not only the quality of Europe's environment, but also the lives of its citizens. In many areas, EU environmental standards have been emulated by other countries. The EU was the first global region to pass binding legislation to enshrine climate and energy targets and become a highly energy-efficient climate neutral economy. The EU is a global leader in the shift towards a clean and circular economy."

Other recent reports[9, 10] on the implementation of the European Green Deal propose redefining competitiveness so that it is based on resource and energy productivity (as much as labour) and highlight using digitalisation to couple competitiveness considerations with strengthening resilience and strategic autonomy of the economy, while promoting new local jobs, education and training programmes.

Recognising the lack of clear and agreed methodology to evaluate competitiveness in the context of sustainable development in a multidimensional and internationally agreed framework, it is nonetheless possible to offer a preliminary definition of 'competitive sustainability' that builds on the European Commission's own expressions of it, the different levels (from macro to meso and micro-economic) at which it is relevant, and the key role of mission-oriented innovation in achieving it.

A clear and operational definition of 'competitive sustainability', with climate neutrality innovation related investment aims at its core, and key indicators of success related to these, could therefore be:

Competitive sustainability is the ability of an economy, its companies and industrial ecosystems to excel relative to international competitors in their transition to sustainable development (with climate neutrality at its core) through investment in the necessary innovation. Success in this can be measured in fully aligned:

1. Enterprise-level technology and business model leadership in global growth markets which enables a disproportionate benefit to accrue to its companies as they develop market share both in their home market and internationally. Key indicators of success would be value-added from exports and 'champions' in these markets.
2. Infrastructure development enabling cross-sectoral and economy-wide productivity and GDP growth. The companies involved may not necessarily be domestic nor, if they are, have a prospect of global market leadership, but the investment would stimulate short-term supply and longer-term demand growth in the domestic market (i.e. the EU Single Market) that is higher than other economies without such infrastructure development.
3. The strength and resilience of domestic industrial ecosystems (through clusters and the value chain) in bringing all relevant stakeholders together in communities at relevant stages of the innovation cycle. Key indicators of success would be employment generated and the amount of domestic value-added of global value chains.

Taking a similar exercise carried out by the Joint Research Centre and Eurostat[1], when seeking to build a typology for the earlier concept of sustainable competitiveness, it is possible to build up an initial typology of relevant dimensions, linking key aims and outcomes to possible indicators of success; see Table 1 below. The outcomes and indicators should be viewed within the overall perspective of the ability of the economy, its companies and industrial ecosystems to excel relative to international competitors in their transition to sustainable development (with climate neutrality at its core) through investment in the necessary innovation.

Table 1: Dimensions of competitive sustainability – aims, outcomes and possible indicators

AIM	OUTCOMES	INDICATORS
Global enterprise technology or business model leadership	Global market share Exports and 'champions' "Winning the race"	% of global patents in given market % of total exports in given market % of growth enterprises (using OECD reference) % of global foreign direct investment in given market
Modernised enabling infrastructure	Investment Productivity and growth "Building for success"	Gross value-added in EU % of total EU investment Labour productivity Energy productivity
Strong industrial ecosystems in Europe	Resilience Jobs and communities "Reaping local benefits"	Employment generation in key clusters or value chains Cluster strengths (e.g. in patents) % of EU value-added from global value chain total Resource productivity (or degree of circularity)

These dimensions are inter-related if distinct and requiring an integrated overall approach in order to capture any synergies and maximise the potential advantage from a European perspective. Integrated approaches in other respects are also clearly of great importance. For example:

- the intertwined relevance of combining energy efficiency and renewable energy approaches; with most energy efficiency technologies being digital, they thus both contribute to smartening of infrastructure and increasing productivity and further innovation potential
- the relationship between (renovation of) buildings and (electrification of) transport.[11]

Different projects or programmes may satisfy more than one dimension – but it is also possible to identify key policies that would be of most importance for each area and which are considered in the concluding section of this paper. Before doing that, however, we consider this typology as a framework to synthesise evidence that has been identified as relevant to an initial assessment of the EU's performance and potential in each area.

Assessing the EU's competitive sustainability performance and potential

Identifying the areas in which the EU's competitive sustainability performance and potential opportunities are greatest, and conversely where they are not, requires an overview and comparison of the different technologies and business models, infrastructure and value chains where investment for innovation is relevant. Given the focus on climate neutrality, we focus here on those areas of the economy that are the source of GHG emissions – energy, transport, buildings, industry and agriculture/land use[ii] and consider the role of digital technology innovation, as well as business/financial model and social innovation, as relevant throughout. These areas of the economy cover over 90 per cent of all EU GHG emissions but less than one-third of total EU value-added and employment.[12] This suggests that the scope for economic growth in them may be significant as these areas transform and the EU can lead global market development, but also that the risk of any transitional negative economic competitiveness impact more widely from the pursuit of climate neutrality is relatively limited, given the extent of GDP that lies elsewhere in the economy.

Climate neutrality – moving from competitive risk to competitive opportunity for the EU?

Before considering evidence identified that enables comparison of the different investment choices in relation to competitive sustainability, we first put the goal of increasing EU competitiveness into recent historical context. The emphasis on sustainability, climate neutrality by 2050, and digitalisation as the core of the new EU growth strategy follows many years of concern about declining European economic, and in particular industrial competitiveness, as measured using the more narrowly focused productivity-centric approach. Many reports were produced on this, but by way of example the European Investment Bank's[6] report *Restoring EU Competitiveness* notes that:

"While Europe has many strengths and EU industry remains strong in many sectors, it is weak in others and risks being further squeezed out of key future markets. EU productivity growth has fallen behind that in the US since the mid-1990s. The economic and financial crisis exposed this weakness and has aggravated it, contributing to the loss of income and jobs in many sectors and regions. Restoring competitiveness is at the heart of ensuring long-term, sustainable economic recovery throughout the EU."

More specifically, in its Science for Policy Brief, entitled *EU losing share in global manufacturing value chains*,[13] the Joint Research Centre observes that the EU declined from 27 per cent in 2000 to 16 per cent in 2014, of which 40 per cent is attributed to a loss of competitiveness and 60 per cent to lower EU demand growth compared to the rest of the world. In other words, the increasing presence of foreign value-added in the output of EU firms was not compensated by the concomitant rise of EU participation in value chains serving final demand in the rest of the world.

As a result of this concern, the challenge of decarbonisation has often been seen as necessary but without obvious overall or manufacturing industry competitive advantage – avoiding further decline being an

[ii] We also recognise that these should ultimately be addressed in a whole-economy model that captures material value chains becoming more circular, often through digital technology innovation. The principal value chains identified by recent studies (such as Material Economics)[15] with the highest GDP associated as well as significant GHG emissions profiles are mobility (transport), construction (buildings) and food (agriculture). Energy and the bio-economy are cross-cutting, the latter also providing valuable ecosystem services.

over-riding goal. For example, as recently as 2019, in the report of the Strategic Forum for Important Projects of Common European Interest,[14] it is concluded that "strong collaborative efforts within the EU are needed to empower industry to make its technologies and processes climate neutral, while maintaining its competitiveness". This seems to assume that the process of transition to climate neutrality is at best neutral from a competitiveness perspective, and not one that offers significant potential advantage. This explains the tendency to focus on the possible disadvantages of first-mover or leading action, and the need for measures to address any unfair trade-related competitive distortions, and less emphasis on the potential gains overall or the competitive challenge in new growth markets.

There are continuing and genuine concerns about the immediate international competitiveness of parts of EU processing and manufacturing industry, should their investments in cleaner production processes mean producers outside of Europe gain a short-term cost advantage if they do not invest likewise. As difficult as it is to develop such a mechanism, a carbon border adjustment (CBA) mechanism has been proposed as a solution to this eventuality. The measure could be targeted, for example, at specific goods where trade exposure and carbon content disparity are both high. In the context of a new approach to competitive sustainability, these considerations should also be placed in the context of industrial ecosystems, infrastructure and growth market dynamics and goals, where the wider set of opportunities and potential are sought, too. Indeed, measures that can directly incentivise clean innovation can also level the playing field for industries at risk of investment leakage. Examples include standards for low carbon and climate neutral materials and products, as well as those enabling necessary infrastructure, clustered industrial ecosystem development and access to the most cost-competitive renewable energy and power. This approach is in line with recent studies from a variety of organisations looking at European industrial decarbonisation in particular.[15, 16, 17]

While there may be a need for some transitional measures against unfair competition and an ongoing challenge to attract sufficient private investment for the transition, the bigger picture suggests there is much more to gain than to lose from an EU perspective. In fact, from a strategic innovation perspective, the High-Level Panel on Long-Term Decarbonisation Pathways Initiative[18] notes that:

"Europe is well-positioned to address this challenge. Europe's competitiveness almost entirely relies on cognitive capacities, which today must be put to the task of decarbonisation and greatly enhancing resource productivity. Europe has many comparative advantages compared with other regions in the world, for instance in terms of human capital, cultural heritage, media independence, soil fertility and moderate climate conditions. Europe possesses expertise and manufacturing capacity in some of the world's leading technologies in a large number of sectors. However, it strongly depends on the import of raw materials from all corners of the planet and is challenged by high labour and production costs. Many of these weaknesses could be overcome by promoting innovation, fully exploiting Europe's domestic renewable energy resources, and closing materials loops within a more circular economy."

It is against this background that the European Commission's recently presented new Industrial Strategy for Europe states that the EU's global competitive advantage is seen as deriving strategically from high value-added, high environmental and social standards, a large and wealthy domestic market, and a high innovative capacity. Importantly, the same strategy proposes an approach which not only targets climate neutrality, but also integrates an emphasis on much greater circularity and digitisation, with all that this entails for materials and manufacturing industry in terms of process and business model innovation, including greater 'servitisation'. And it proposes to focus interventions through innovations in value chains and industrial ecosystems rather than sectors as typically measured in economic statistics.

Evidence comparing the competitive opportunities across the economy

Despite the EU's strong interest in competitiveness, in studies that seek to consider the economy as a whole or the transition to climate neutrality in the key areas identified (energy, transport, buildings, industry and agriculture), it is typically assumed that a benefit in terms of jobs and growth will equate to an improvement in competitiveness, but often without assessment of where the EU has particular strengths or weaknesses in comparison to international competitors. These benefits are increasingly clear and certainly important – but they do not tell us in which areas the EU will potentially excel or underperform.

Where there are real risks that investments will in fact fail to align with the climate neutrality goal at all, this remains important. An immediately relevant example is whether the selection of projects or recipients for Recovery and Resilience Plan funding meet the climate-related conditions and generate other economic and social value. Recent studies[19] indicate that there is a readily identifiable pipeline of €200 billion worth of public and private investment opportunities across all EU-27 countries, which would generate over 2 million new and resilient jobs. Moreover, these are estimated to be only a fraction of the total number of investable projects available, which with €1 trillion of investment could return all and more of the 12 million full-time jobs that have been lost due to the Covid-19 shock. These investments would spur more rapid emissions reduction, jobs and economic growth in alignment with the European Green Deal. These findings are in line with other recent studies showing that a green recovery would boost income, employment and GDP better than 'return to normal' stimulus measures.[20]

The findings are also consistent with the European Commission's assessment for its 2050 climate strategy, 'A Clean Planet for All'.[21] It notes that economic growth, quality employment and emissions reduction can be achieved together, and indeed are mutually reinforcing. Much attention has been given by many international and European policymakers, think-tanks, academics and non-governmental organisations (NGOs) to the urgent environmental need and the associated macro-economic case for ambitious climate action by Europe, which also supports the rationale for the EU's globally leading policy position internationally in this regard. This also underpins the plans to increase the EU's 2030 emissions reduction goals from 40 per cent to at least 55 per cent, where the impact assessment indicates that the higher level of ambition increases economic growth and benefits.[22]

Among these studies, however, it is striking how few there are that address the relative merits of different transition options from a competitiveness perspective, even where they embed the new approach of the European Green Deal and implications of climate neutrality as the central strategic goal of economic policy. Only a very few explicitly consider relative EU competitive advantage from different technologies, business models, infrastructure or value chain development, even if this is not their primary objective. The most relevant of these is a ground-breaking and influential study[23] that examines 58 'pathways' (technology and business models in power, transport, buildings, industry and agriculture/land use) necessary for the EU to support its climate goals. This study, on which we draw extensively below, is one of the very few which addresses the relative competitive advantages of different the options available and which are also drawn from a specific set which align those options to the EU's climate neutrality goal. It considers in each case not just the degree of innovation needed but also the potential for EU competitive advantage in the global marketplace as it develops. This study explicitly recognises that there is not always a direct correlation between innovation needs and competitive advantage for the EU. This means the choices about levels and types of policy and investment support for them might differ

if those with the greatest potential for competitive advantage are to be enabled with regard to international competition. There are some pathways identified where the EU is not likely to gain competitive advantage in the international market (one dimension of competitive sustainability) itself, but where a high innovation and investment need would benefit the whole economy and enable it to retain, if not enhance, competitiveness through productivity gain and overall GDP growth (a different dimension of competitive sustainability). The study suggests that all solutions in the buildings area offer EU value chain competitive advantage globally, as does mobility as a service, demand-side energy management, batteries and other energy storage, and off-shore wind, for example.

Although its methodology is qualitative for its assessment of EU advantage in basing its conclusions on an expert survey – something which itself begs for further work of a more quantitative nature – its conclusions are that the EU can build competitive advantages[iii] in many of the decarbonisation pathways, but not all. Experts see opportunities for Europe to build global competitive advantages through R&I investment in all of the five climate-relevant sectors, however this opportunity is not evenly spread and some of the 58 decarbonisation component strategies offer greater potential competitive advantages than others. Leading competitive strategies focus on demand-side, distributed and technology-enhanced decarbonisation supported by innovative business models. The study considers primarily the first dimension of competitive sustainability in particular – technology or business model leadership in a global market – but has relevance to the two other dimensions insofar as they are inter-connected and have related investment needs and aims.

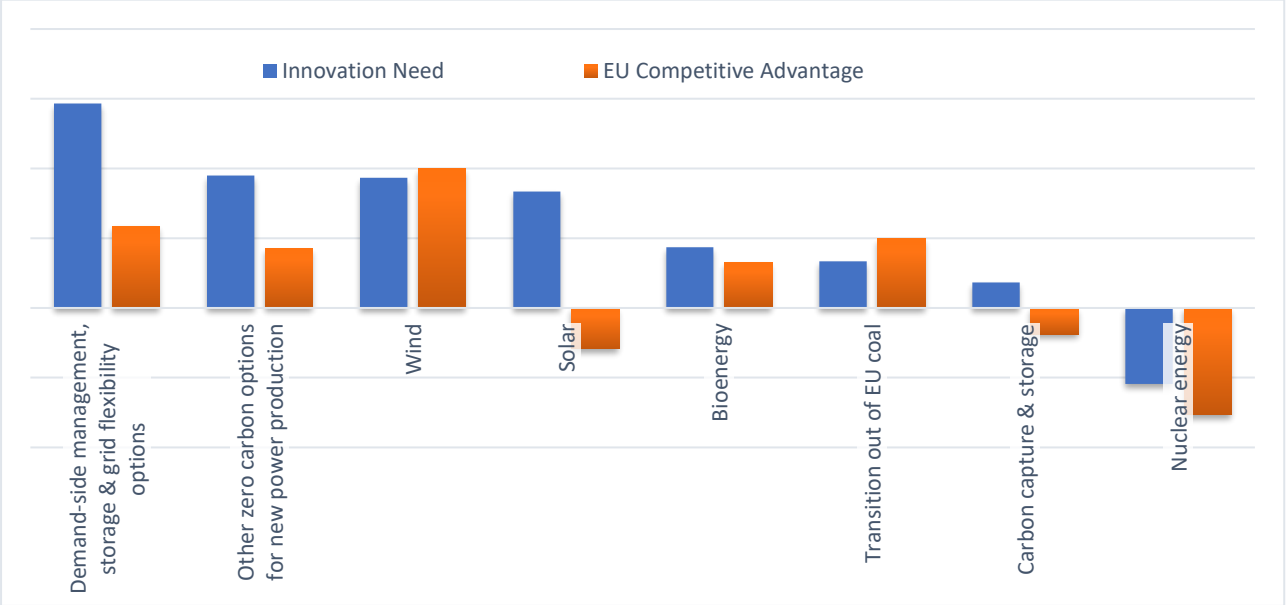
The following section is a synthesis of the specific sectoral findings from Climate Strategy study *Funding Innovation to Deliver EU Competitive Climate Leadership*:[23]

[iii] These are in relation to the first dimension of competitive sustainability we have identified – namely where EU companies may have a technology or business model that has potential for global leadership and advantage as the market develops internationally. The experts ranked potential EU competitive advantage among the 58 on a scale of 1 to 5, with answers above 2.5 being considered as net positive (offering leadership advantage) and below being net negative (not offering leadership advantage).

Power

Except in solar, experts see a reasonable correlation between the innovation opportunity and the potential to build, or build upon, a European competitive advantage in the respective component strategies required to decarbonise the power sector as shown below.

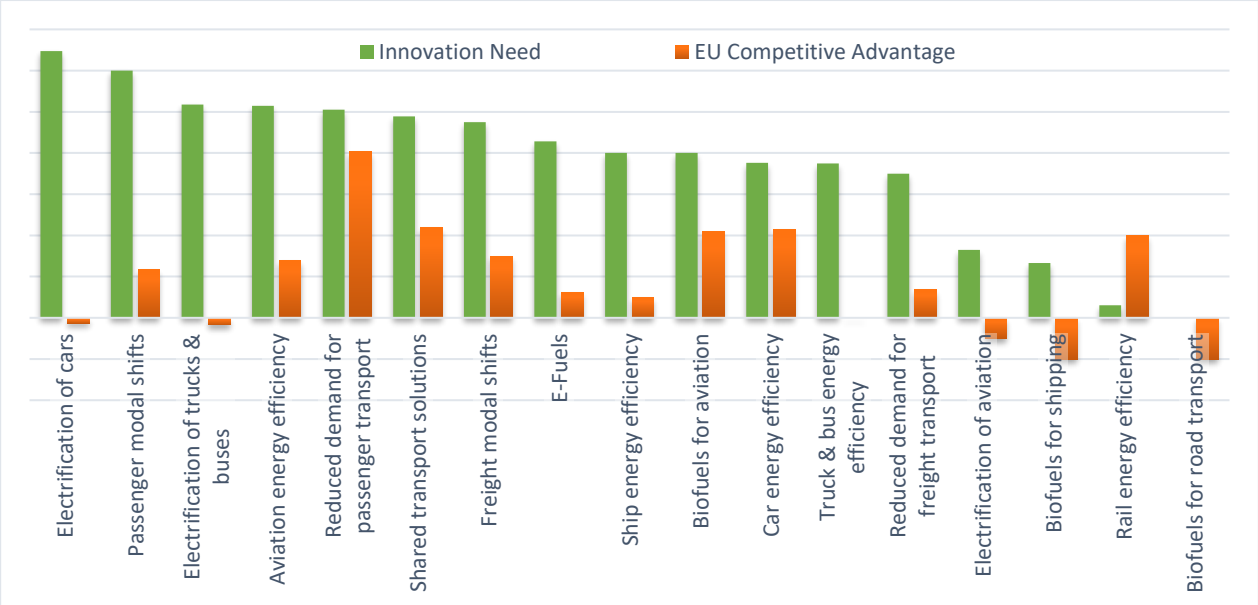
Figure 1: Innovation needs to decarbonise the power sector and their correlation with an EU competitive advantage



Transport

The innovation investment needs and opportunities in the transport sector are highly relevant for Europe. Experts point to a wide range of decarbonisation solutions, with car electrification and modal shifts clearly in the lead. The potential for EU competitive advantage in transport is less well correlated with innovation need than in power or in buildings. For example, experts see stronger EU competitive advantage on the demand side (with the delivery of mobility as a service and shared mobility services) than for pure vehicle electrification. On the other hand, transport energy efficiency from the motor or fuel used (car, truck, bus, ship and aviation) is seen as both clearly needing innovation investment and potentially also delivering an EU competitive advantage. The only innovation potential and possible competitive advantage that experts see in relation to biofuels in Europe is for aviation (recognising that the bio-economy is relevant for other reasons beyond transport, including in materials and land-use terms, where its benefit and opportunities may be very significant from a European perspective, as other charts indicate).

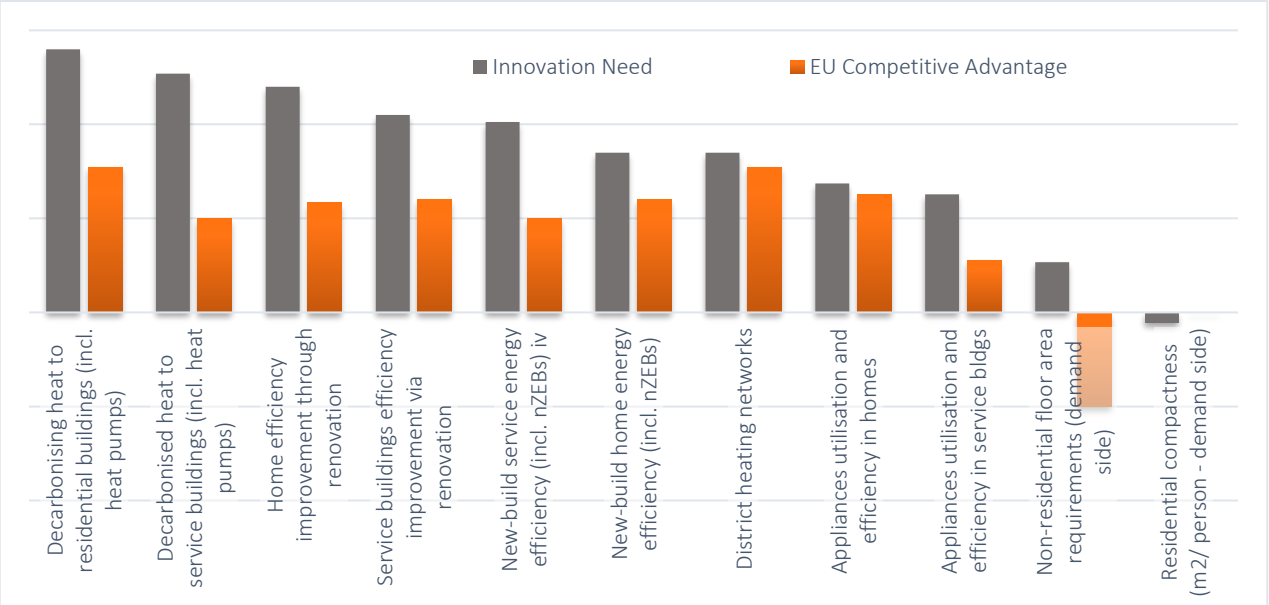
Figure 2: Innovation needs to decarbonise the buildings sector and their correlation with an EU competitive advantage



Buildings

Decarbonising heat for residential and service buildings together with energy efficiency upgrades are seen by experts as the leading areas for R&I investment for the full decarbonisation of Europe's buildings, accompanied by near-zero energy new buildings and district heating. The innovation investment needs and opportunities for the EU to seize a competitive advantage through such investments are probably best correlated in the buildings sector, as shown below.

Figure 3: Innovation needs to decarbonise the buildings sector and their correlation with an EU competitive advantage

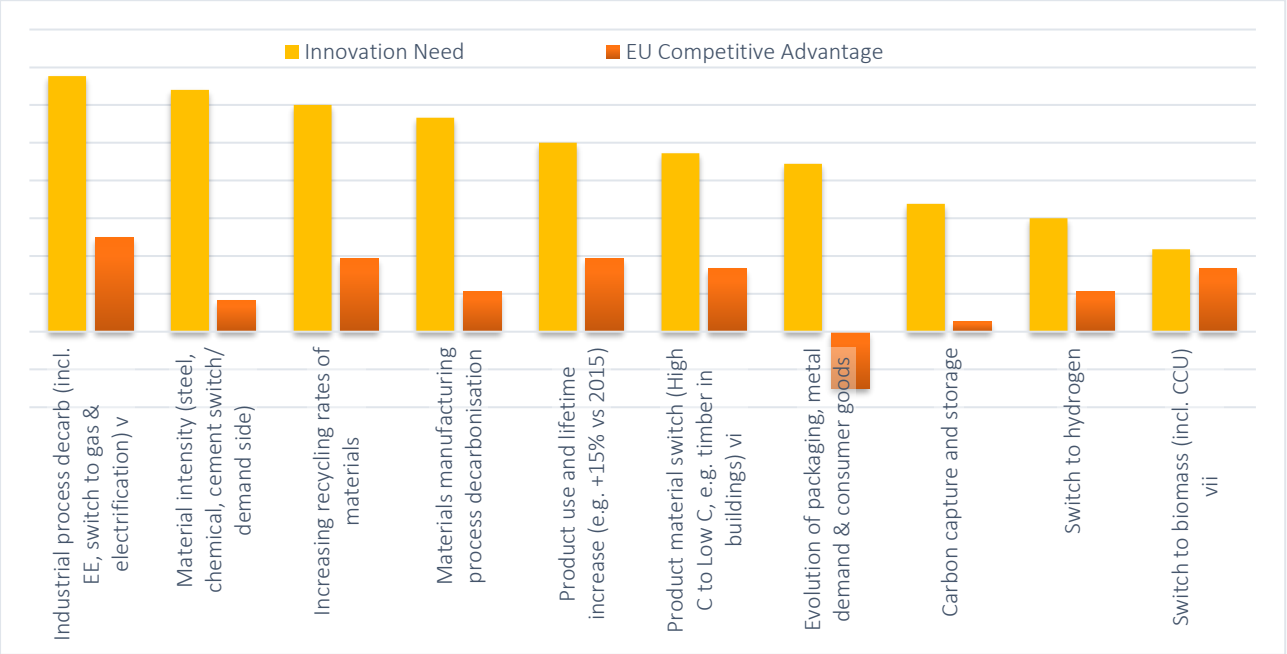


[i] nZEBs: Net Zero Emissions Buildings

Industry

Experts noticed a very strong need for innovation across the net zero modelled strategies for industrial decarbonisation, especially in process efficiency, decarbonising materials and increased recycling rates. This is shown where experts ranked these components. However, while experts do see the potential to develop EU competitive advantages through pursuing these decarbonisation pathways, there is a weaker correlation evident between innovation need and potential competitive advantage than in other sectors. Experts saw application for mainly technology innovation in carbon capture and storage/use, and the switch to hydrogen, but they were ranked below other options in the short term.

Figure 4: Innovation needs to decarbonise industry and their correlation with an EU competitive advantage

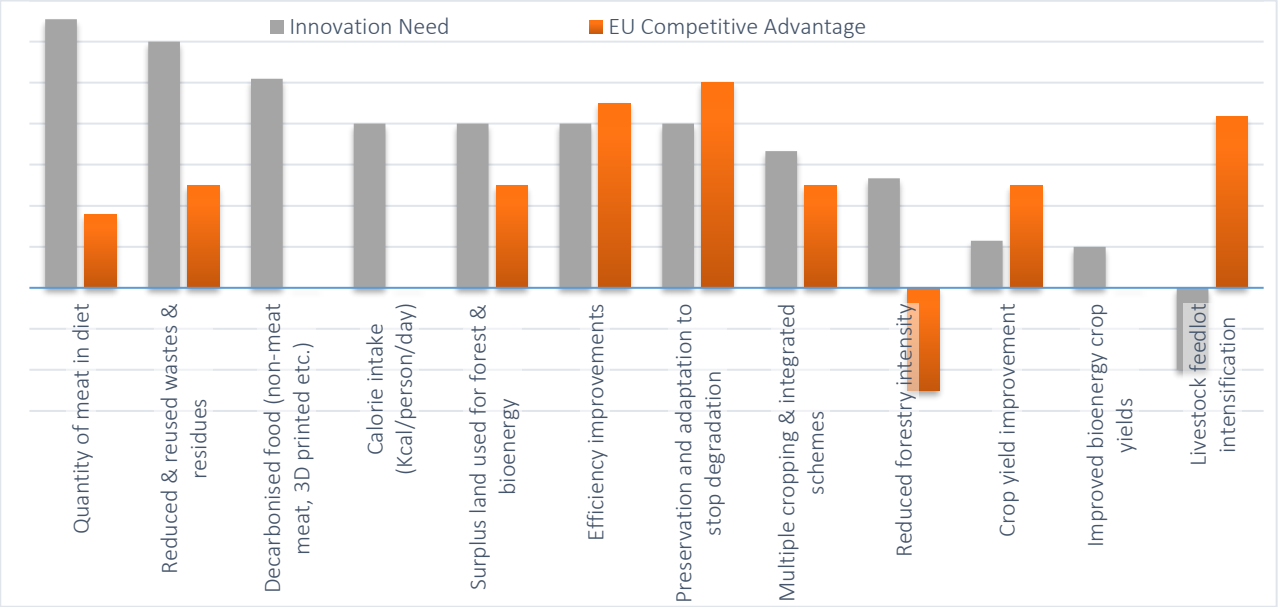


[v] EE: Energy efficiency
[vi] C: Carbon
[vii] CCU: Carbon capture and utilisation

Agriculture, land use and forestry

There are clear needs for new and innovative approaches to decarbonise the European agriculture, forestry and other land use (AFOLU) sectors, as well as addressing the European diet and opportunities for carbon sequestration. In the survey, experts articulated three main levers for which innovation is deemed critical to enable a net zero emissions economy by 2050: reducing meat consumption, reduced and reused waste, and the decarbonisation of food production. Experts also saw very strong EU competitive advantages to be gained in pursuing specific innovation needs, including reduced absolute calorie intake, reforestation of surplus land, efficiency and the prevention of land degradation, as well as food waste recycling, as shown below.

Figure 5: Innovation needs to decarbonise agriculture, forestry and other land use (AFOLU) and diet, and their correlation with an EU competitive advantage



Other studies that specifically address areas of potential competitive advantage include Bruegel's study on 'areas of low carbon growth'.[24] This considers only four energy technologies (wind turbines, solar photovoltaics (PVs), batteries and electric vehicles) but its findings are very consistent with those of the Climate Strategy study,[23] highlighting the success and continued potential in wind turbines and by way of contrast, the limited potential for solar PVs. In considering the role of clustering of industrial and innovation activity, it also highlights the importance of 'ecosystems' to competitive sustainability, and notes the potential for battery development to concentrate in certain geographical regions, especially linked to the enabling of electric vehicle value chain activities in the EU. This illustrates how competitive advantage is always dynamic and changes over time, and how strategic choices can create the conditions for future advantage, as several clusters of battery and electric vehicle development are now evident in the EU.

The Bruegel study also highlights the way in which clusters of relevant industrial stakeholders – 'ecosystems' as the European Commission now describes them, including not just industry but academia and skilled employees, investors, policymakers and end-users – are key to success. But in that regard, there are clear indicators of why the EU should not be complacent about any of this challenge.[25] It notes that while the EU has many high-performing clusters for exporting industries, there are three industries that host only 'medium' and 'basic performing' clusters – construction products and services, electric power generation and transmission, and environmental services – which are all important for competitive sustainability.

The enabling role of key infrastructures or accelerators is relevant both for the other dimensions of competitive sustainability beyond enterprise leadership in global markets, and also its importance to domestic employment and the resilience of the value chain and economy around it. A recent Capgemini report,[26] which addresses an almost identical set of technology and business model innovations as the climate strategy report above, confirms its overall assessment without looking in detail at the competitiveness dimension. It expects by 2030 that €13 trillion of European market opportunities (investment and turnover combined) and 12 million new or improved jobs would be generated. It also identifies six 'acceleration pathways' that are largely infrastructural enablers of the other possibilities, and would fall into the second category of competitive sustainability we have identified.

One of these would be energy storage 'giga-factories'. As the Strategic Forum for Important Projects of Common European Interest report[14] observes with regard to batteries, they are important not because of their export potential or leadership internationally but because: "European produced batteries are expected to be a key driver for the EU's industrial competitiveness in a key industry for the future, supporting jobs and economic growth in enabling the transition towards a circular economy in Europe".

By way of contrast, but still with enormous potential, for hydrogen, the European Commission itself notes the potential for exports into global markets as much as domestic benefit:[27] investment in hydrogen will foster sustainable growth and jobs, which will be critical in the context of recovery from the Covid-19 crisis. The Commission's recovery plan highlights the need to unlock investment in key clean technologies and value chains. It stresses clean hydrogen as one of the essential areas to address in the context of the energy transition and mentions a number of possible avenues to support it. Moreover, Europe is highly competitive in clean hydrogen technologies manufacturing and is well positioned to benefit from a global development of clean hydrogen as an energy carrier. Cumulative investments in renewable hydrogen in Europe could be €180–470 billion by 2050, and in the range of €3–18 billion for low carbon fossil-based hydrogen. Combined with the EU's leadership in renewables technologies, the emergence of a hydrogen

value chain serving a multitude of industrial sectors and other end uses could employ up to one million people, directly or indirectly. Analysts estimate that clean hydrogen could meet 24 per cent of world energy demand by 2050, with annual sales in the region of €630 billion. The question is how this compares to other economies, some of which have invested very significantly in hydrogen technology and infrastructure already, notably in Asia.

To take this one area as an example, there are clearly other economies, their companies or industrial ecosystems with strengths and potential relative to the EU, against which a full benchmarking exercise would be useful, to be able to assess both current performance as well as potential from different investments and policies in the area. The EU Hydrogen Strategy wants to drive electrolysers "from €900/kW to € 450/kW or less in the period after 2030". However, according to one recently highly reputed study,[28] leading Chinese manufacturers are already supplying equipment at $200/kW, so apparently have a clear edge already. Similar examples may be found in other technologies or value chains, where countries have established leadership positions – but which are not necessarily taken into explicit account in the analysis of EU potential advantage in the new, growing markets they are in.

The challenge from an analytical and policy perspective is to be able to compare this to other opportunities and assess the merits in relative as well as absolute terms – which is where other studies also face difficulties, if they address competitiveness at all.

Outcomes and challenges in comparing studies from a competitive sustainability perspective

Not only is there actually very little analytical work available that seeks to compare the relative merits of different approaches from a competitive sustainability perspective, where work undertaken to date does make a reference to competitiveness it is not easy to compare it to other studies. The studies considered in this paper broadly fall into three categories:

- whole economy projections with assessments of overall GDP and jobs impacts, but little or no disaggregation into where EU competitive potential would result in specific advantages in particular value chains – examples of this include those referenced in the first section
- individual value chain or technology assessments – such as those on hydrogen and fuel cells, lithium ion batteries, CCS and renewable energies overall or on digital opportunities[29, 30, 31, 32, 33, 34, 35, 36, 37] – where conclusions may be positive but are not easily compared to other value chains, so a relative judgement on competitive advantage and investment merits overall is difficult
- sectoral industry assessments – often by the relevant trade associations for chemicals, steel and cement, for example – which do not provide a whole-economy perspective, but tend to focus on supply rather than demand-side solutions and, understandably, faced with a significant innovation challenge to their current activities, identify investment needs as much as market opportunities.[15]

In the context of the new approach to industrial strategy, which stresses the role of the Single Market in creating demand for new climate neutral markets, value chains and industrial ecosystems as the most relevant targets for policy, these studies are therefore often difficult to compare and combine, can overlap and inevitably do not consider all relevant value-adding activities in the EU. This can make it difficult to assess whether the best areas for investment and policy support have always been chosen from a competitiveness perspective, or which dimensions of competitiveness they seek to enhance.

However, using the initial framework definition proposed for competitive sustainability, and reflecting both the most relevant recent studies and also those that consider the issue partially, we can ascertain the following. In a rapidly growing and increasingly competitive global market where the EU can achieve significant GDP growth, employment gains and market-leading enterprises, there is considerable potential competitive advantage for the EU in many technology and business models, infrastructure development and segments and value chains. This is, however, not the case for all. Some of these where the EU is not identified by Sweatman[23] as having a competitive advantage recently include solar, heavy transport and aviation electrification and CCS, for example. An overall picture of strengths and weaknesses, opportunities and threats from a sustainable competitiveness perspective is both important and lacking. Determining how clusters of connected industries can deliver on all three dimensions of competitive sustainability will be important to maximise returns on investment.

Using these parameters as a guide to assessing potential competitive advantage in the transition to climate neutrality, we see from the limited research available (notably that from Capgemini[26] and Climate Strategy[23]) addressing this that in leading the global policy agenda and enabling the necessary industrial system transformation, the EU is already starting to prove that it stands to benefit significantly in and across the three identified dimensions of competitive sustainability. For example:

- Areas of current or potential European technology or business model leadership with high global market shares include wind energy, heat pumps, demand-side grid management, buildings and domestic appliance efficiency, aviation biofuels, shared mobility solutions, industrial process efficiency, and material recycling and management.
- Significant investment and productivity improvements necessary for European GDP growth are promised by smart electricity grid inter-connections, e-charging and hydrogen infrastructure.
- Significant employment and EU value-added through domestic value chains offering enhanced resilience or strategic autonomy are available from buildings renovations, district heating, materials processing and management, and batteries.

Conclusions and next steps for analysis and policy

This study confirms that there is a strong macro-economic analysis of the benefits and risks of leading the transition. This in turn confirms the clear strategy behind the European Green Deal and the growth strategy that the needs and opportunities involved in targeting climate neutrality clearly outweigh the risks for the EU. However, it also finds that there is a less clear identification of the risks and opportunities of choices between different pathways compatible with the Green Deal goals as far as competitiveness is concerned. This gap needs filling.

From a policy perspective, with enormous and rapid structural changes envisaged and even accelerated by the consequences of Covid-19, there is a very strong case for public investment and policy to combine clear strategic choices with a calculated mix of high-risk and high-return options and lower-risk, lower-return ones – and this is particularly important in the context of the Recovery and Resilience Plans under consideration right now. There is a strong correlation between the overall areas that the EU is promoting for investment – such as the innovation wave, hydrogen and batteries, for example. However, better understanding of where there are specific types of competitive advantage to be accrued, potentially, from them, would now also be important, especially given the amount of public funding involved and the likelihood that the size of the investment opportunity at present will not recur in the short term. Equally, there are very strong signs that the EU's major economic competitors are now fully engaging in this, which means that any first-mover advantage that the EU has currently may be under strong challenge.

This initial study finds, however, that evidence on competitive sustainability is far from complete, and what does exist is hard to compare or aggregate. This is likely a consequence of the rapid pace of recent economic change, the profound implications of the new strategic focus on climate neutrality goals as a growth strategy, and new analytical approaches developed to underpin EU industrial strategy (such as the focus on industrial ecosystems linking geographical clusters of assets and activities with more circular value chains). As a result, the EU lacks a sufficiently clear overall picture and shared understanding of where it is leading or lagging internationally, has high or low potential, or has new or unmet strategic needs.

In light of the new thinking that has developed as a result of the European Green Deal and the significance of competitive sustainability to its approach and success, as well as the new approach to industrial strategy with its focus on industrial ecosystems, there is a strong case for a more comprehensive set of analyses to be undertaken by the Commission and others to aid implementation and further work on strategy. This is very much in line with the recommendations of the High-Level Panel of the European Decarbonisation Pathways Initiative,[18] which also proposes that: "efforts should be focused in particular on improving the representation of European industrial policy, financing mechanisms and the increased competitiveness that should arise from successful low-carbon innovation and deployment."

These should follow an approach consistent with its new thinking, capturing the key value chains, clusters and industrial ecosystems necessary from a whole economy perspective, at national and EU levels. They should also build on the work of the EU taxonomy in doing this, as it itself also further advances, to integrate not only the goal of climate neutrality, but also the other dimensions of environmental and social activities that it will define and measure progress on.

There is also a need for clearer and more consistent use of the relevant terminology as this agenda develops. As a basis for further discussion, the dimensions of competitive sustainability that have been identified in this study could also be extended to help identify ways to measure progress towards them, and which policies might be the most important ones to focus on when seeking this. This is shown in Table 2 below, which builds on a similar exercise carried out by the European Central Bank and Eurostat when seeking to build a typology for the earlier concept of sustainable competitiveness.

Table 2: Dimensions of competitive sustainability – aims, outcomes, indicators and key policies

AIM	OUTCOMES	INDICATORS	KEY POLICIES
Global enterprise technology or business model leadership	Global market share Exports and 'champions' "Winning the race"	% global patents % exports % of growth enterprises % of global foreign direct investment (FDI)	Innovation + Lead market standards R&D Business environment Trade
Modernised enabling infrastructure	Investment Productivity and growth "Building for success"	Gross value-added in EU % of total EU investment Labour productivity Energy productivity	Innovation + Trans-European networks/ Important Projects of Common European Interest Sustainable finance competition Economy-wide emissions, RES and EE[viii] targets
Strong (segments of) value chains in Europe	Resilience Jobs and communities "Reaping local benefits"	Employment generation Cluster specialisation in patents % of EU value-added from global value chain total Resource productivity (or degree of circularity)	Innovation + Skills and knowledge Regional development/ Just Transition Fund Industrial policy Sectoral emissions targets

For policy and investment to be optimally targeted, there should be a clear set of publicly available, comparable and comprehensive analyses and assessments of the competitiveness dimension of the transition being undertaken in the Green Deal, along with explicit assumptions about alternative options.

Building on the European Commission's initial focus for competitive sustainability, there is clearly a very significant role for new and climate neutral aligned regulatory standards in the Single Market to drive the development of lead markets in Europe. These in turn stimulate the industrial ecosystem in Europe to develop solutions to this, which may be internationally leading and ultimately exportable as the standards themselves become references elsewhere. They also focus attention on the pan-European infrastructure necessary for the standards to be achieved in practice, so also help drive investment, public and private, into that dimension of competitive sustainability. Maximising the EU's international impact will be key for success here – and that is as relevant for sustainable financial standards such as the taxonomy and associated regulations, where the EU has a unique leadership position at present that offers much potential as the efforts globalise rapidly.

[viii] RES: Renewable energy
EE: Energy efficiency

With international competition rapidly increasing, the EU would be complacent to assume its position is uniformly strong or leading. In fact, in many areas across these three dimensions of competitive sustainability, other economies are clearly very strong and well positioned to secure advantage. The EU therefore needs to urgently apply the logic of competitive sustainability to its economic strategy and policies across the full range of those relevant to the European Semester process, including its Recovery and Resilience Plans and new Industrial Strategy.

Further work will be necessary to identify and develop the most relevant key indicators for competitive sustainability that can be used to both assess current recovery plans and policy programmes, and to measure progress over time in each of these areas in order to maximise its chances of success. Conversely, without further reflection, research and insight relevant to policymaking in this area, the EU risks making some decisions on Recovery and Resilience Plan projects and other programmes that do not maximise its competitive sustainability performance and potential.

Taken together, the four key conclusions from this initial study on competitive sustainability are therefore summarised as follows:

1. The EU's policy leadership positions it well

From the limited research available, we see that in leading the global policy agenda and enabling the necessary industrial system transformation, **the EU is already starting to prove that it stands to perform well and benefit significantly across the three identified dimensions of competitive sustainability**, and integrating its climate neutral, smart and circular economy goals. **The EU has success stories and much potential** in this area. It also has strong collaborative instincts, networks and endeavours to ensure that international frameworks enable collaboration as well as competition, too. This combination can enable it to support global public investments on key early stage research, and also to align and allow market-based solutions to thrive as a result.

2. The EU should not be complacent about its strengths – or those of its competitors

But with international competition rapidly increasing, **the EU would be complacent to assume its position is uniformly strong or leading**. In fact, in many areas across these three dimensions of competitive sustainability, other economies are clearly very strong and well positioned to secure advantage, as they have on occasion done before. Heavy and aviation transport electrification, solar and CCS may all be areas in which international competition places competitors at an advantage. With regard to hydrogen, the EU's own strategy contains goals that other countries are already meeting – suggesting its significant investment push in this area needs to be understood in dimensions other than global technology or business model leadership, rather in relation to productivity and GDP growth or the resilience of its industrial ecosystem.

3. The EU lacks a full picture of its competitive sustainability

This initial study finds **that evidence on competitive sustainability is, however, far from complete, and what does exist is hard to compare or aggregate**. This is likely a consequence of the rapid pace of recent economic change, the implications of the new strategic focus on the climate neutrality goal as a growth strategy, and new analytical approaches developed to underpin EU industrial strategy (such as the focus on industrial ecosystems linking geographical clusters of assets and activities with more circular value chains). As a result, **the EU lacks a sufficiently clear overall picture and shared understanding of where it is leading or lagging internationally, has high or low potential, or has new or unmet strategic needs**.

4. Further analysis needs to feed into immediate policy and investment decisions

The EU, and the European Commission in particular, **should develop a fuller analysis of competitive sustainability. With this, it can apply its logic to its economic strategy and policies across the full range of the European Semester process, including its Recovery and Resilience Plans and new Industrial Strategy** in order to make the best decisions between alternatives for its enabling framework and direct investment. Further work will be **necessary to identify and develop the most relevant key indicators for competitive sustainability that can be used to both assess current recovery plans and policy programmes, and to measure progress over time in each of these areas in order to maximise its chances of success**. Conversely, without further reflection, research and insight relevant to policymaking in this area, the EU risks making some decisions on Recovery and Resilience Plan projects and other programmes that do not maximise its competitive sustainability performance and potential.

References

[1] Joint Research Centre (JRC), & Eurostat. (2016, April). The EU Wheel of Competitiveness: The European Statistical Reference Framework on Competitiveness. Presentation to the ECB, Prague, April 21–22, 2016. Retrieved from: https://www.ecb.europa.eu/home/pdf/research/compnet/20160421/20160421-13-Montinari_European_Wheel.pdf

[2] European Commission. (2020). *2020 Strategic Foresight Report, Charting a Course Towards a more Resilient Europe*. Retrieved from: https://ec.europa.eu/info/sites/info/files/strategic_foresight_report_2020_1.pdf

[3] European Commission. (2019, December). *Annual Sustainable Growth Strategy 2020*. Retrieved from: https://ec.europa.eu/info/publications/2020-european-semester-annual-sustainable-growth-strategy_en

[4] Council of the European Union, German Presidency. (2020, October). *Resilience and recovery: Strengthening international competitiveness of European industry.* Preparation of the Competitiveness Council on 18 September 2020. Retrieved from: https://data.consilium.europa.eu/doc/document/ST-10364-2020-INIT/en/pdf

[5] Andreoni, V., & Miola. A. (2016). *Competitiveness and Sustainable Development Goals*. Joint Research Centre (JRC) Technical Report. Retrieved from: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC103576/lb-na-28316-en-n.pdf

[6] European Investment Bank (EIB). (2016, January). Restoring EU competitiveness. European Investment Bank. Retrieved from: https://www.eib.org/attachments/efs/restoring_eu_competitiveness_en.pdf

[7] Mazzucato, M. (2018, February). *Mission-Oriented Research & Innovation in the European Union: A problem-solving approach to fuel innovation-led growth*. Retrieved from: https://ec.europa.eu/info/sites/info/files/mazzucato_report_2018.pdf

[8] Verhaar, H. (2018, January 18). *The age of Sustainalism: a new growth model for the 21st century*. UN Environment Programme. Retrieved from: https://www.unenvironment.org/news-and-stories/story/age-sustainalism-new-growth-model-21st-century

[9] SYSTEMIQ, & The Club of Rome. (2020, October). *A System Change Compass: Implementing the European Green Deal in a Time of Recovery*. SYSTEMIQ and The Club of Rome. Retrieved from: https://clubofrome.org/wp-content/uploads/2020/10/System-Change-Compass-Full-report-FINAL.pdf

[10] Hedberg, A., Sipka, S. (2020, July 13). *Towards a green, competitive and resilient EU economy: how can digitalisation help?* European Policy Centre. Retrieved from: https://www.epc.eu/en/publications/Towards-a-green-competitive-and-resilient-EU-economy-How-can-digital~35bfc4

[11] Egerter, A., Hopkins, G., Mandel, J., & Verhaar, H. (2018). *Energy Efficiency and Electric Vehicles: How Buildings Can Pave the Way for the Global EV Revolution*. Rocky Mountain Institute. Retrieved from: https://rmi.org/insight/energy-efficiency-and-electric-vehicles/

[12] Sweatman, P., & Hessenius, M. (2020, October 20), *"Applying the EU Taxonomy": Lessons from the Front Line*. Climate Strategy & Partners and Climate & Company. Retrieved from: https://wwfeu.awsassets.panda.org/downloads/applying_eu_taxonomy___lessons_from_the_front_line_final.pdf

[13] Joint Research Centre (JRC). (2018, June). *EU losing share in global manufacturing value chains*. Joint Research Centre (JRC) Science for Policy Brief, Retrieved from: https://ec.europa.eu/docsroom/documents/38642/attachments/3/translations/en/renditions/native

[14] Strategic Forum for Important Projects of Common European Interest. (2019). *Strengthening Strategic Value Chains for a future-ready EU Industry – Report of the Strategic Forum for Important Projects of Common European Interest*. Retrieved from: https://ec.europa.eu/docsroom/documents/37824/attachments/2/translations/en/renditions/native

[15] Material Economics. (2019). *Industrial Transformation 2050 – Pathways to Net-Zero Emissions from EU Heavy Industry*. Retrieved from: https://materialeconomics.com/publications/industrial-transformation-2050

[16] University of Cambridge Institute for Sustainability Leadership (CISL). (2020). *How the EU Industrial Strategy and Circular Economy Action Plan can support the decarbonisation of European industry*. Cambridge, UK: CLG Europe. Retrieved from: https://www.corporateleadersgroup.com/reports-evidence-and-insights/news-items/how-the-eu-industrial-strategy-and-ceap-can-support-the-decarbonisation-of-european-industry

[17] Giuli, M., Dhéret, C., Bjerkem, J., Pilati, M., & Sipka, S. (2019, November 7), *An Industry Action Plan for a more competitive, sustainable and strategic European Union*. Issue Paper, EPC. Retrieved from: https://www.epc.eu/en/Publications/An-Industry-Action-Plan-for-a-more-competitive-sustainable-and-strate~2c7ab8

[18] High-Level Panel on Long-Term Decarbonisation Pathways Initiative. (2018, November). *Final Report of the High-Level Panel of the European Decarbonisation Pathways Initiative*. Final report to the European Commission. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/226dea40-04d3-11e9-adde-01aa75ed71a1

[19] EY. (2020). *A Green Covid-19 Resilience and Recovery Plan for Europe*. Retrieved from: https://assets.ey.com/content/dam/ey-sites/ey-com/it_it/news/2020/ey-summary-report-green-recovery-v2.pdf

[20] University of Cambridge Institute for Sustainability Leadership (CISL). (2020). *Maximising the benefits: Economic, employment and emissions impacts of a Green Recovery Plan in Europe*. Technical Report. Cambridge, UK: CLG Europe. Retrieved from: https://www.corporateleadersgroup.com/reports-evidence-and-insights/maximising-the-benefits

[21] European Commission. (2018, November 11). *A Clean Planet for All: A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy*. COM (2018) 773 Final. Communication from the European Commission. Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0773&from=EN

[22] European Commission. (2020, September 17). *Stepping up Europe's 2030 climate ambition. Investing in a climate-neutral future for the benefit of our people*. COM (2020) 562 Final. Communication from the European Commission. Retrieved from: https://ec.europa.eu/knowledge4policy/publication/communication-com2020562-stepping-europe%E2%80%99s-2030-climate-ambition-investing-climate_en

[23] Sweatman, P. (2018, October). *Funding Innovation to Deliver EU Competitive Climate Leadership*. Climate Strategy. Retrieved from: https://www.climatestrategy.es/en/informe_5.php

[24] Zachmann, G., & Bruegel. (2016, September 27). *An approach to identify the sources of low-carbon growth for Europe.* Policy Contribution Issue n˚16 | 2016. Bruegel. Retrieved from: https://www.bruegel.org/2016/09/an-approach-to-identify-the-sources-of-low-carbon-growth-for-europe/

[25] Hollanders, H., & Merkelbach, I. (2020), *European Panorama of Clusters and Industrial Change, Performance of strong clusters across 51 sectors and the role of firm size in driving specialisation.* Retrieved from: https://ec.europa.eu/docsroom/documents/40524/attachments/1/translations/en/renditions/native

[26] Capgemini. (2020). *Fit for Net Zero: 55 Tech Quests to accelerate Europe's recovery and pave the way to climate neutrality*. Capgemini. Retrieved from: https://www.capgemini.com/wp-content/uploads/2020/10/Net-zero-main-report-2020.pdf

[27] European Commission (2020) *A Hydrogen Strategy for a Climate Neutral Europe*. Communication from the European Commission. Retrieved from: https://ec.europa.eu/knowledge4policy/publication/communication-com2020301-hydrogen-strategy-climate-neutral-europe_en

[28] Liebreich, M. (2020, October 8). *Separating Hype from Hydrogen – Part One: The Supply Side*. BloombergNEF. Retrieved from: https://about.bnef.com/blog/liebreich-separating-hype-from-hydrogen-part-one-the-supply-side/

[29] Cihlar, J., Lejarretta, A. V., Wang, A., Melgar, F., Jens, J., & Rio, P. (2020, July). *Hydrogen generation in Europe: Overview of costs and key benefits*. Study for the European Commission. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/7e4afa7d-d077-11ea-adf7-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=37085&WT.ria_f=3608&WT.ria_ev=search

[30] FCH 2 JU. (2019, September). *Value Added of the Hydrogen and Fuel Cell Sector in Europe – Supporting European Growth and Competitiveness, study on Value Chain and Manufacturing Competitiveness Analysis for Hydrogen and Fuel Cells Technologies*. Summary Report for the European Commission. Retrieved from: https://www.fch.europa.eu/sites/default/files/Value%20Chain%20study%20SummaryReport_v2.02%20%28ID%207505004%29%20%28ID%207893445%29%20%28002%29%20%28ID%207916853%29.pdf

[31] ECORYS. (2009, October 22). *Study on the Competitiveness of the EU eco-industry.* Study for DG Enterprise and Industry of the European Commission. Retrieved from: https://ec.europa.eu/growth/content/study-competitiveness-eu-eco-industry-0_en

[32] ICF International. (2014, July 31). *Study on the competitiveness of the EU Renewable Energy Industry (both products and processes).* Final Report for DG Enterprise and Industry, European Commission. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/465ccb9f-cc6c-456e-9d87-a0e948775804

[33] Steen, M., Lebedeva, N., Di Persio F., & Boon-Brett, L. (2017). *EU Competitiveness in Advanced Li-ion Batteries for E-Mobility and Stationary Storage Applications – Opportunities and Actions*. Joint Research Centre (JRC) Science for Policy Report. Retrieved from: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC108043/kjna28837enn.pdf

[34] Windisch, E., Neha Nagaraj, N., & Reinaud, J. (2017, October). *Driving Innovation in the Automotive Value Chain*. Ricardo Energy and Environment. Retrieved from: https://i2-4c.eu/wp-content/uploads/2016/10/SP_IP_Driving-innovation-in-the-automotive-value-chain_3.3_hyperlinked1.pdf

[36] Kuik, O., Branger, F., & Quirion, P. (2019, February). *Competitive advantage in the renewable energy industry: Evidence from a gravity model*. *Renewable Energy*, *131*, 472–481. Retrieved from: https://www.sciencedirect.com/science/article/pii/S0960148118308437

[37] Felice, S. (2019, August). *Competitiveness of the heating and cooling industry and services. Part 2 of the study on the competitiveness of the renewable energy sector.* Study for the European Commission. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/618d5369-c48f-11e9-9d01-01aa75ed71a1/language-en