Cleantech *for* Europe

Cleantech Group

Seizing the EU's man on the moon moment

MAKE **FIT FOR 55** A GREEN DEMAND SHOCK TO SCALE EU CLEANTECH

With the support of

Breakthrough Energy

The EU's upcoming "Fit for 55 package", to be enacted later this year, is a major revamp of the EU's climate and energy legislation. The revisions of key policies will translate the European Green Deal's vision into legal obligation and drive the implementation of the raised 2030 target of 55% net emissions reduction compared to 1990 levels. It is a unique opportunity to set the course for climate neutrality and deliver increased competitiveness.

> **"We do not have all the answers yet. But this is Europe's man on the moon moment."**
>
> **— Ursula von der Leyen**
> President of the European Commission,
> announcing the European Green Deal,
> December 2019

Acknowledgements

This report was researched and written by Cleantech Group, with the support of Breakthrough Energy.

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Cleantech can power the EU's climate leadership, but needs a demand shock

The EU's climate future is at a crossroads. As momentum grows for a green recovery, there is an increasing realisation that meeting ambitious targets of 55% reduction in CO_2 emissions by 2030 and net zero by 2050 will take extraordinary efforts. The time to act is now: in sectors such as steel, cement and aviation, reaching low emissions levels by 2050 means making significant investments in innovation in 2021-22.

The EU's upcoming "Fit for 55" package is a major revamp of the EU's climate and energy legislation to translate the European Green Deal's vision and the new 55% emissions reduction target into law. It offers a unique opportunity to set the EU up for decarbonisation and competitiveness, by scaling the technologies needed to get to net zero, and creating industrial leadership, high-quality jobs and a better life for its citizens. However, Fit for 55 also presents a risk: of focusing on the 2030 target by investing in incremental change, without preparing for the harder, longer-term 2050 goals.

To seize its "man on the moon moment", the EU has at its disposal an extraordinary supply of cleantech innovation. Over the past 10 years, a vibrant ecosystem of innovators and investors has emerged. It attracted more than €5 billion in venture capital funding in 2020 and is developing most of the technology we need to get to net zero. However, this ecosystem is lacking the investment and policy support it needs to scale. By creating a demand shock, and focusing on lead markets for green products, the EU could boost these innovators to reach continental scale.

There has traditionally been a disconnect between the cleantech community and EU policymakers. This gap needs to be bridged now, if the two communities are to work together towards the EU's climate leadership. With this goal in mind, our hope is that the Cleantech for Europe initiative will first bridge the knowledge gap, by providing a common understanding of the state of EU cleantech and its potential in the race to net zero. Beyond this paper, we will create quarterly briefings and gatherings to bridge the connectivity gap.

Developed with the contribution of the leading cleantech innovators, investors and thinkers in Europe, and the support of Breakthrough Energy, this paper draws the current EU cleantech landscape, and outlines how the EU can leverage upcoming policy changes to lead the global clean transformation, starting with clear demand signals in five key sectors.

We hope this report inspires you to invest in Cleantech for Europe, and look forward to taking action together.

Jules Besnainou
Director, Cleantech Group

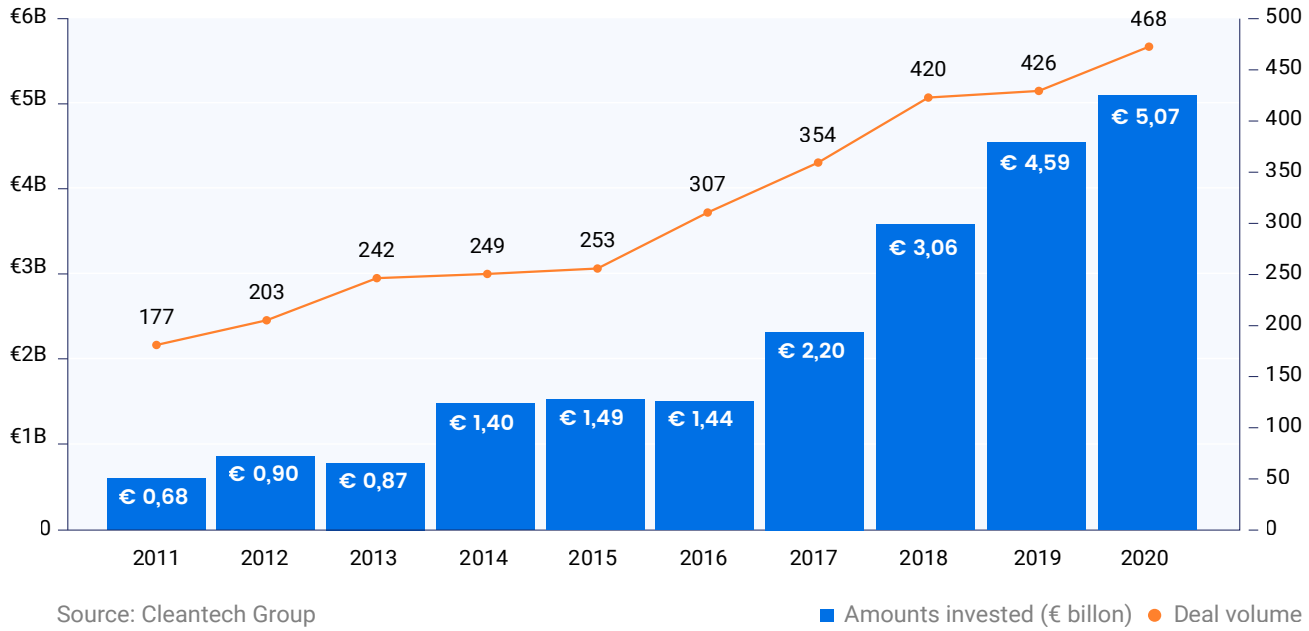
Executive Summary

01

The European Union (EU) is setting increasingly ambitious climate targets, with emissions reductions of 55% by 2030 and climate neutrality by 2050. **Cleantech innovation is essential for achieving these targets and securing continued competitiveness.** The International Energy Agency estimates that almost 50% of the technologies we need to get to net zero by 2050 have not reached the market yet[1]. Deploying mature technologies like solar and wind is crucial but will not be enough. We need to scale up the next generation of cleantech to decarbonise sectors such as steel, cement and aviation. This is harder, and demands that leaders take bold action now.

02

The **EU already has at its disposal a large and high-quality supply of cleantech innovation** waiting to be scaled across all sectors of the economy. Amounts invested have grown by a factor of 7.5x over the last decade, driven by extraordinary progress in seed funding for early-stage cleantech innovation.



Source: Cleantech Group

EU27 Cleantech Seed, Venture and Growth investments, 2011–20

[1] Net zero by 2050 plan for energy sector is coming, Dr. Fatih Birol, International Energy Agency, 2021

Yet while great at building young companies, the **EU is severely lacking scale-up capital and support – meaning that these companies cannot reach the demonstration or commercialisation stages of their technologies.** EU cleantech scale-ups only attract 6.9% of global cleantech growth capital (compared to 32% for Asia, 54% for North America, and 4.8% for the UK alone). This situation is preventing the EU from reaping the climate and competitiveness benefits of our innovation and **condemning promising ventures to move to North America or Asia to reach scale.**

Proportion of Global Cleantech VC going to EU Companies by Stage - 2020

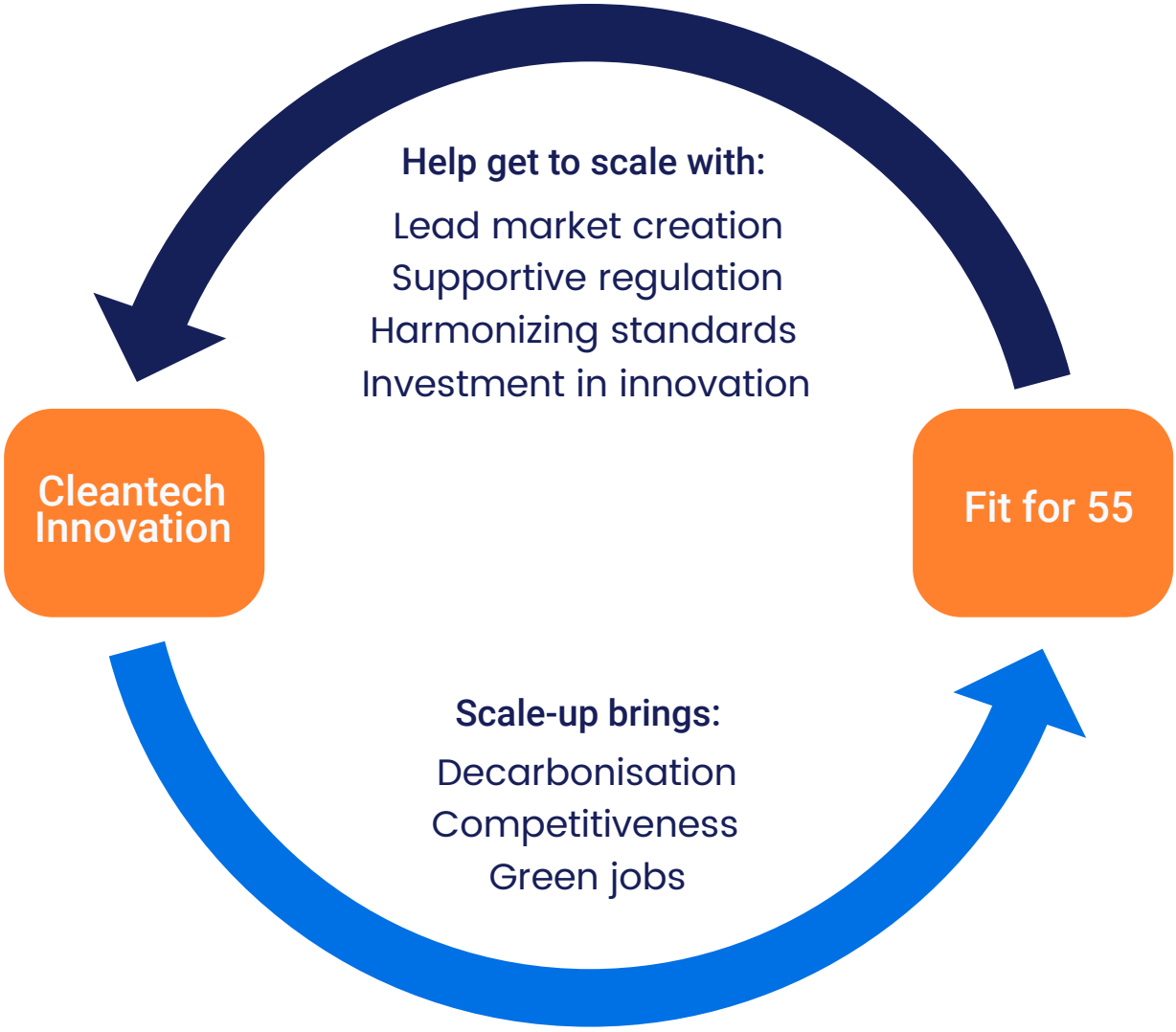
This lack of scale-up capital is a consequence of a **demand-side challenge** for EU cleantech innovation: there are not enough EU-wide demand signals for adoption of green products and solutions. Markets are fragmented with divergent regulation in key sectors like energy.

> **"Europeans tend to be cleantech pioneers, but not always cleantech leaders. We are good at inventing, but not so good at scaling. Regulation is very fragmented in Europe. Scaling from one country to the other tends to be difficult for start-ups unless they find the right partners."**
>
> **— Yann Lagalaye**
> Demeter IM and Partner, Green European Tech Fund

03

If the EU wants to lead the global race to net zero, it needs to set a decisive policy agenda and take risks. President von der Leyen's "Man on the Moon moment" analogy is justified. **Fit for 55 is a crucial opportunity to create a demand shock and scale the EU clean technologies we need to get to that moon,** by focusing on lead market creation, rewarding green products, phasing out more polluting alternatives, and implementing innovation-friendly policy. The regulator's role is vital for succes. Bold policy actions will translate into climate and competitiveness benefits.

> **"Europe must ask itself: Are we ready to take the helm and become the global model for sustainability? If yes, we need more progressive legislation and a central drive."**
>
> **— Ernst-Jan Stitger**
> CEO, Land Life Company



Source: Cleantech Group

04

Our project outlines **five initial sectors in which the EU could take global leadership**, by adopting a value chain approach and with the help of strong demand signals and market-shaping policies from the Fit for 55 package. The key to success in these value chains lies in reducing the green premium, the cost differential between a clean technology and its GHG-emitting competitors:

Green Hydrogen at scale is essential to reach the net zero target, providing the most feasible decarbonisation route for industries like steel, chemicals and heavy-duty transport. The EU has strong potential to lead in green hydrogen, thanks to a strong base in electrolyser production and the presence of hydrogen innovators across the value chain, as well as continental scale demonstration projects. Barriers to scale include the absence of a clear hydrogen classification and incentive system based on carbon intensity, and slow construction and permitting processes. To achieve value chain leadership, the EU needs to send a decisive policy signal to catalyse investment, ensure sufficient renewable energy supply to produce hydrogen at scale, support the scale-up of next-generation production technologies for continued cost reduction and invest in enabling infrastructure to transport hydrogen.

Our top policy recommendations are:

1. Classify hydrogen production methods and set targets based on lifecycle carbon intensity in the revision of the Renewable Energy Directive **(RED III)** ; streamline the permitting process for hydrogen generation projects and renewable electricity generation projects

2. Implement an EU-wide carbon floor price which is high and predictable enough to encourage investments in green hydrogen in the revision of the Emissions Trading System **(ETS)** in conjunction with a Carbon Border Adjustment Mechanism **(CBAM)** to avoid imports of carbon-intensive hydrogen

3. Mandate hydrogen refuelling infrastructure for heavy-duty road transport in the Directive on Alternative Fuels Infrastructure **(DAFI)**

Green Hydrogen

Green Steel has the potential to reduce up to 95% of current emissions from steelmaking, one of the highest GHG-emitting sectors globally[2]. The EU is leading in low-carbon steel production innovation and demonstration projects. The green premium, currently between 30% and 80% based on production methods[3], is a powerful barrier to adoption in an industry with insufficient investment capacity. To achieve leadership in this sector, the EU should continue to support research and innovation, work on stimulating demand, and support investment in large projects that match green steel production with committed off-takers.

[2]Ambitious EU climate law must show how EU climate policy can lead global emissions reduction efforts, EUROFER press release, 2020
[3]Cleantech Group interview with Arcelor Mittal, 2021

Green Steel

Our top policy recommendations are:

1. Phase out free carbon allowances, which give an advantage to emissions-intensive production methods, and implement a carbon floor price which is high and predictable enough to encourage investments in in green steel in the revision of the **ETS**

2. Compensate for the phase-out of ETS allowances by pricing imports according to emissions footprint in the Carbon Border Adjustment Mechanism **(CBAM)**, to avoid environmental dumping and provide a level playing field for green products

3. Create lead markets for green steel with **Green Public Procurement**, by mandating upper limits for emissions intensity of products used in public buildings and vehicle fleets

Low-carbon Construction Materials: emissions associated with construction and construction materials (excluding steel) are responsible for around 7% of EU emissions[4]. Moreover, materials need to be chosen in the context of minimising overall lifetime building emissions. The EU has a strong base of early-stage innovators across the value chain, but needs more incentives and industry buy-in to scale up green production of materials like cement and concrete and reduce the green premium. The main barrier to adoption is industry fragmentation and inertia: developers prefer products they already know and choose materials without considering their impact on the building as a whole. Moreover, standards and regulations designed for conventional products, such as cement, may rule out green alternatives even when their performance is equivalent or better. For value chain leadership the EU should implement a holistic building approach to minimise overall lifetime emissions of buildings.

Construction Materials

Our top policy recommendations are:

1. Introduce emissions-based performance standards, a building information modelling (BIM) requirement and an environmental product declaration (EPD) requirement with embodied carbon limits for all construction projects over a certain size, and mandate that new construction should be lifecycle zero emissions by the late 2020s in the Energy Performance of Buildings Directive **(EPBD)**

2. Mandate the use of low-carbon refurbishment materials and make construction/ demolition companies responsible for end-of-life provisions for materials removed from construction sites in the **Renovation Wave**

3. Include stricter materials performance and emissions footprint specifications for both renovations and new build in the Energy Efficiency Directive **(EED)**

4. Create lead markets for green cement, concrete and other construction materials with **Green Public Procurement**, by mandating upper limits for emissions intensity of products used in public buildings

[4] European Environment Agency emissions data, 2018

Sustainable Aviation: Aviation was responsible for 4.1% of EU emissions in 2018[5] and the EU aviation industry has committed to net-zero emissions by 2050[6]. The EU has strong industrial expertise in the sector, and a track record in sustainable aviation innovation. Technologies are at different readiness levels: bio-based fuels are ready to be scaled up while focusing on sustainable feedstocks, synthetic fuels need to come down in price to be viable, and electric aviation shows promise to decarbonise regional air transport. Hydrogen-based fleets also face technical hurdles which must be solved by innovation. All the while, aircrafts need to continue to become more fuel-efficient. For value chain leadership in sustainable aviation, the EU should invest further in R&D to advance battery technology for regional electric aviation, lightweight electrical motors, fuel cells and hydrogen systems, efficient hydrogen refuelling technologies and lowest-carbon fuels. Alternative fuels need innovative financial and ecosystem support to compensate for gaps in financing options.

[5] European Environment Agency emissions data, 2018
[6] Destination 2050: A route to net-zero European Aviation, 2021

Our top policy recommendations are:

1. Reintegrate international aviation into the EU **ETS** and phase out free allowances to the aviation industry to accelerate uptake of low-carbon fuels, implement a carbon floor price which is high and predictable enough to encourage investments in sustainable aviation

2. Mandate sub-targets for fuels based on their carbon-intensity in the Renewable Energy Directive **(RED III)**

3. Link taxation to the emissions footprint of each fuel (including a tax on kerosene) in the Energy Taxation Directive **(ETD)** to ensure a level playing field for green products

Sustainable Aviation

Soil Carbon: Agriculture, together with changes in carbon stock stored in agricultural land, accounts for around 15% GHG emissions in the EU and over 30% in some member states[7]. Europe's land mass has the second highest potential in the world for carbon sequestration by volume. EU-funded projects promoting soil health and carbon sequestration are in place, but a lack of adequate monitoring, reporting and verification (MRV) infrastructure is slowing the adoption of new agricultural practices. Innovation is needed across the value chain to lead in this sector. In particular, automated testing and monitoring to reduce costs, and standardisation of monitoring frameworks are key.

[7] Net-zero agriculture in 2050: How to get there, Institute for European Environmental Policy, 2019

Soil Carbon

Our top policy recommendations are:

1. Increase the targets for **GHG emissions and removals of land use, land use change and forestry (LULUCF)**, create an EU-wide standard for monitoring, reporting and verification (MRV) and create a mechanism to compensate farmers who implement sustainable farming practices to sequester more carbon

2. Use **LULUCF** to make it harder to urbanise agricultural land to avoid decreasing the EU's carbon sink capacities

3. The Comet Farm Tool in the USA is a greenhouse gas accounting system for farms. The EU Soil Observatory could be expanded to fulfil this role, providing tailored recommendations to farmers on how to reduce emissions

05

While creating EU-wide strong demand signals is the most important step to scaling up cleantech innovation, improving scale-up finance conditions in the EU will help accelerate the process. We recommend funding **more EU cleantech growth equity funds**, encouraging the creation of more cross-border funds, **attracting pension funds** to cleantech, improving access to **public markets**, and drastically increasing **blended finance** allocations.

> **"If we allowed pension funds to allocate even a tenth of what US ones do to venture capital, our fundraising bottlenecks would be eased dramatically."**
>
> **— Christian Reitberger**
> **Partner, btov**

Fit for 55 cannot be achieved without cleantech innovation.

1

Mature technologies can only take us halfway

The EU's upcoming Fit for 55 package was first announced in September 2020, with the goal of raising the 2030 target for greenhouse gas emission reductions to 55% of 1990 levels, up from 40% previously[8]. Analysis carried out during 2020 concluded that the previous 40% reduction target for 2030 would not put the EU on a trajectory to net zero by 2050. It also showed that the current policy framework was insufficient to meet a 55% reduction target.

To create the legislation which will facilitate the 55% target, a comprehensive review of climate policy across twelve regulations, directives and other instruments will take place during 2021 and 2022. The package will review important EU policies and push for deeper decarbonisation across all sectors of the EU economy, including energy, buildings, transport, heavy industry and agriculture. This is a unique opportunity to set the EU on a course to climate neutrality and competitiveness.

Innovation is critical to reach this ambitious target. The IEA estimates[9] that almost 50% of the emissions reductions needed to get on a path to net zero by 2050 may come from technologies that are not on the market yet, and are still at the research, demonstration, or pilot phase.

[8] European Parliament, Legislative Train Schedule, Fit for 55 Package
[9] Net zero by 2050 plan for energy sector is coming, Dr. Fatih Birol, International Energy Agency, 2021

This means that accelerating the pace of deployment of mature technologies is necessary, but not sufficient, to achieve climate targets. The EU should continue to create the conditions for large deployment of mature technologies such as wind and solar power, which will provide significant decarbonisation by replacing fossil fuel generation. But it should also **focus on the technologies which will deliver the second half of decarbonisation objectives**. These technologies are **already demonstrated at a small scale, but need to be scaled up now to have a material impact by 2030.** They include long-duration energy storage, green hydrogen production and storage, the use of hydrogen in heavy industry, low-carbon fuels for transport, and carbon capture. As we scale these technologies up, their cost will decrease, making it easier to deploy them at continental scale.

The EU has understood the value of early-stage innovation bets, as evidenced by the recent **increase of the Horizon Europe budget**, despite the UK's departure. **By focusing Fit for 55 on the scale-up of demonstrated technologies, the EU can create the conditions for these bets to pay off in this decade.**

Two examples of sectors where this scale-up opportunity is playing out are cement production and aviation.

Example 1: Cement Production

Traditional cement making using clinker emits high levels of process emissions and requires a significant amount of heat, currently provided mainly by fossil fuel sources. Emissions from cement production are forecast to remain flat[10] for the next ten years, an unacceptable outcome when we need to reach minus 55% for the EU as a whole. Scaling existing incremental innovations such as cement alternatives, clinker substitution and process optimisation, we estimate an additional 20-30% of decarbonisation could be achieved by 2030.

[10] Decarbonisation Pathways for the EU Cement Sector, New Climate Institute, 2020

According to our research, to get to 55% and eventually climate neutrality, we need to develop a portfolio of earlier-stage innovations and push them to rapid adoption, including:

- **Digital design and 3D-printed concrete to use less material**
- **Raw materials for cement and concrete derived from recycled demolition waste**
- **Increased use of Supplementary Cementing Materials (SCM)**
- **Electrification, green hydrogen or alternative fuels as the energy source for heat**
- **New concrete methods, radical cement formulations and new clinker substitutes**
- **Sequestering carbon from cement production for 'last mile' abatement**

Example 2: Aviation

Aviation is a fast-rising emitter. The industry was responsible for 144 million tonnes of GHG emissions in the EU in 2018[11], more than double its 1990 level. Air traffic has been impacted by the pandemic, but the industry expects flight numbers to continue on an upward trend once passenger levels have recovered to 2019 levels[12]. To decarbonise the industry, one option is to reduce fuel demand, but with currently available techniques, efficiency gains from improved engine and aircraft design have been almost fully exploited . Existing bio-based fuels are another opportunity for carbon savings, but this also has a limited impact and raises questions on the sustainability of feedstock.

In February 2021 the European aviation industry published an ambitious plan to reduce net CO_2 emissions by 45% by 2030 for all flights within and departing from the EU, and to reach net zero CO_2 emissions by 2050[14]. Industry initiatives such as the Clean Skies for Tomorrow coalition[15] are steps in the right direction.

[11] European Environment Agency emissions data, 2018
[12] Destination 2050: A route to net-zero European Aviation, 2021
[13] Roadmap to decarbonising European aviation, Transport & Environment, 2018
[14] Destination 2050: A route to net-zero European Aviation, 2021
[15] Clean Skies for Tomorrow Coalition, World Economic Forum

According to our research, to meet this challenging target, the EU will need to invest in innovation, by promoting:

- **Electric aviation for regional service and short haul. Technologies are already being tested at a small scale and could be widely deployed by 2030**
- **Synthetic fuel, or e-fuel, for long-haul aviation. This still faces substantial barriers to scale, including cost of production and renewable energy capacity, but could be scaled with the appropriate demand signals**
- **A portfolio of longer-term technology options, including hydrogen fuel cell systems, new gas turbines for direct combustion, and innovative aircraft designs such as blended wing body**

For both cement and aviation, going beyond incremental improvement will require investment in R&D and scale-up funding, demand stimulation for green products, the development of supporting infrastructure and changes in EU policy and regulation. Fit for 55 is a unique opportunity for the EU to take this bold path: given the time it takes to scale up technologies and deploy them, a strong policy direction is needed this year if we want to achieve emissions reduction targets. In section III, we make a number of recommendations for how the Fit for 55 package can achieve this vision in aviation, construction materials and other sectors with potential for significant emissions reductions.

In addition to reaching GHG emissions targets, investing in innovation provides a path for the EU to increase its competitiveness, and create highly qualified jobs in the process. Recent research led by CapGemini has identified 55 technology quests that, if scaled, would enable the EU to achieve its climate ambitions, while creating or transforming 12.7 million high-quality jobs[16]. A study of Spanish companies found that jobs created by innovative companies are more persistent over time than jobs in companies which are not innovative[17]. More broadly, jobs created in sustainable industries should last longer in the years to come, due to the gradual phase-out of non-sustainable businesses.

[16] Fit for Net-Zero, 55 Tech Quests to accelerate Europe's recovery and pave the way to climate neutrality, CapGemini, 2020
[17] Innovation and Job Creation: A sustainable relation? Joint Research Centre, 2013

Lilium: an example of how scaling EU innovation can bring decarbonisation and high-quality jobs

Lilium was founded in 2015 in Germany with the mission of revolutionising regional transport, by creating electric vertical take-off aircraft that can fly up to 300 kilometres, carry 5 people and operate with low noise. Given the large capital expenditure needed to develop the aircraft, early European investors such as Atomico were soon joined by foreign ones such as Tencent and Obvious Ventures. With relatively inexpensive infrastructure (€8 million for a "vertiport" that can welcome 1 to 2 million passengers a year), Lilium could compete with (and decarbonise) traditional short-haul regional aviation, which is responsible for 10 to 15% of aviation emissions, and some car trips. After raising more than $375 million, Lilium now employs 700 people and plans to operate in multiple markets by 2025.

Lilium's electric aircraft is an example of EU innovation that can yield significant carbon savings by 2030

"We believe we can have a significant impact on short -haul regional aviation- less than 500km- by 2030. Beyond that, as battery technology evolves and our network of vertiports densifies, we could start to replace longer flights and more importantly, long car journeys."

— Dr. Remo Gerber
COO, Lilium

1. Fit for 55 cannot be achieved without cleantech innovation

Cleantech Innovation takes time and support to grow

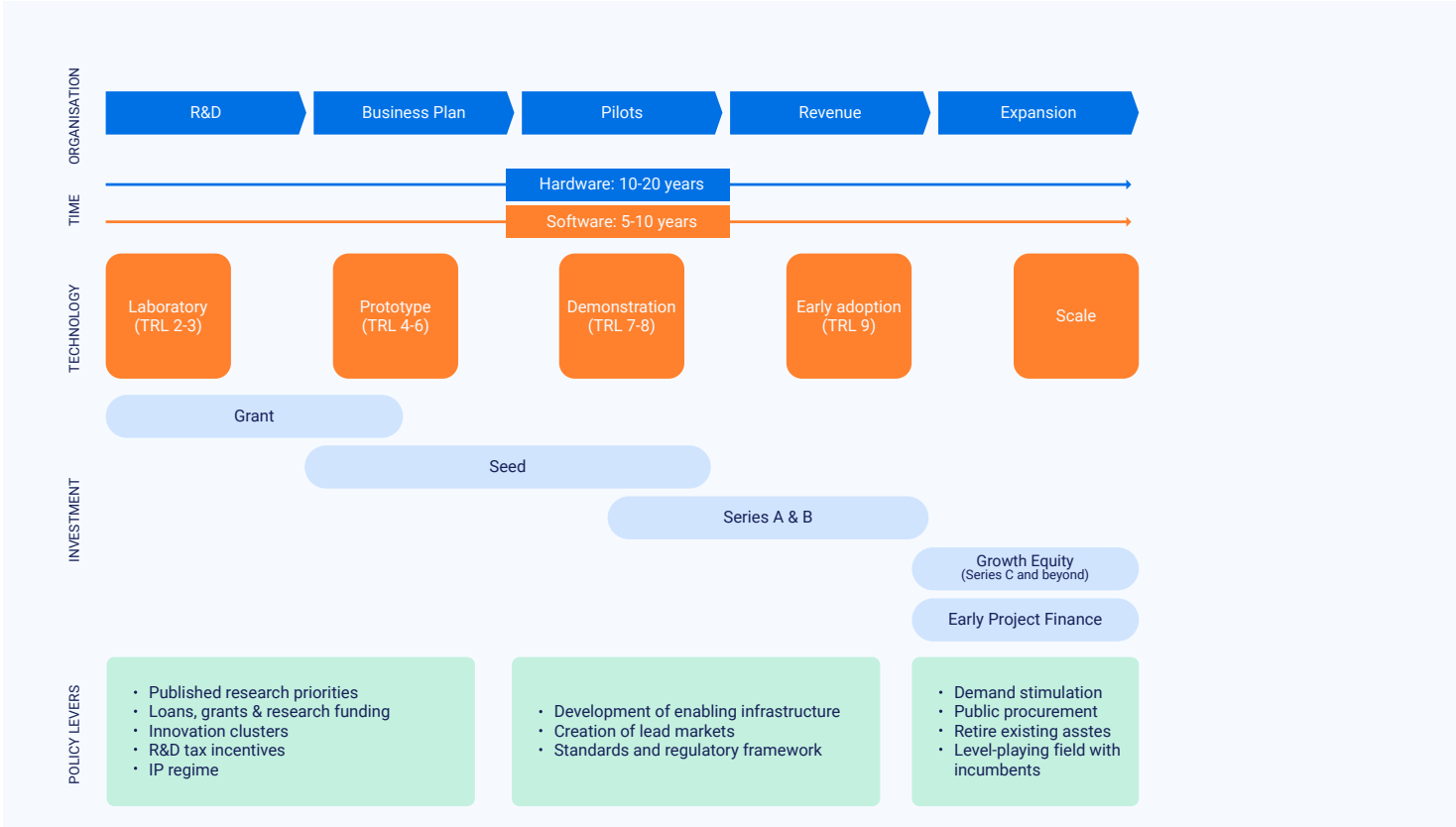
Before a new technology is ready to make a significant impact on decarbonisation, it must go through a number of development stages, from research & development to scale-up. This innovation cycle is important to keep in mind when making policy decisions, as the most effective support mechanisms will be different according to the level of maturity of each innovation. **A strong innovation support ecosystem increases both likelihood of successful commercialisation and speed to market.**

The IEA calculates a minimum lead time of ten years for clean technologies to get from laboratory or small prototype stage (TRL 4) to commercialisation[18]. Innovations that require a large capital expenditure may take longer because of the difficulty of raising the required investment, while products with low capital expenditure – especially those that can be mass-produced – are typically quicker to commercialise. New business model demonstrations for technologies which are approaching maturity (TRL 7 and above) can take five years before the market gains enough confidence to adopt the innovation. Only then can a new innovation start to make an impactful contribution to decarbonisation.

[18] Energy Technology Perspectives 2020, International Energy Agency, 2020

Once cleantech innovations have proved technical viability, the following policy levers can create the right market conditions to scale them up:

- **Demand stimulation: creating lead markets for green products, sending signals of phase-out of polluting alternatives, leveraging public procurement**
- **Level-playing field with incumbents: no subsidies for polluting industries, adequate pricing of negative environmental externalities**
- **Clear targets for transition, and sub-targets by carbon intensity of products**
- **Harmonised standards and measurement methodologies across the region**
- **Development of enabling infrastructure**
- **Mechanisms for retiring existing assets, especially in industries where investment cycles are long**
- **Financial mechanisms to support scale-up: blended finance, increased allocation of public funds to scale-up capital, redirection of institutional capital with incentives**



Innovation takes time and requires policy support to thrive
Source: Cleantech Group analysis

1. Fit for 55 cannot be achieved without cleantech innovation

EU cleantech innovation is ready for scale.

2

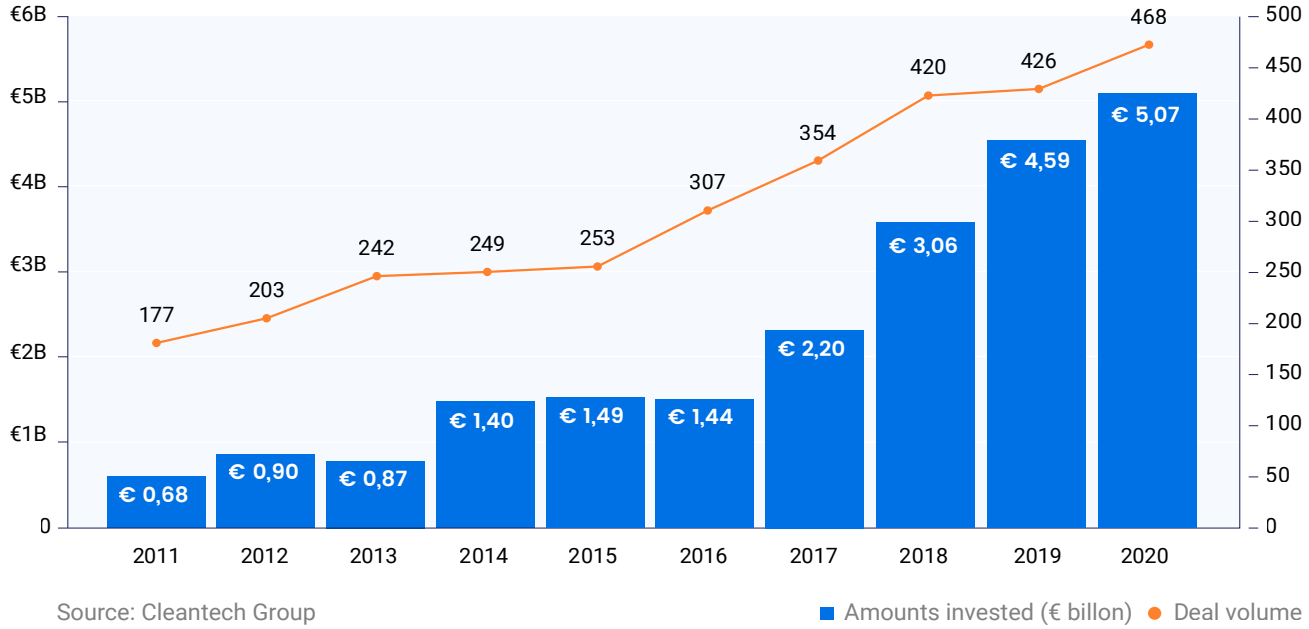
A short history of EU cleantech: from niche to industry transformation

The EU cleantech ecosystem is 20 years old. In the early 2000s, while solar, wind and biomass innovators were sprouting up in Silicon Valley, European venture capital investors took notice. Some of the best-known names in EU cleantech investing, such as Demeter IM in France or Munich Venture Partners in Germany set up shop between 2004 and 2005, closely followed by SET Ventures in the Netherlands, Capricorn Partners' cleantech fund in Belgium and others. At the time, the innovative companies they financed were developing technologies in solar, wind and geothermal power generation, home energy efficiency, recycling and wastewater treatment. Some were already looking at the early market for electric vehicles. A few hundreds of millions of dollars were invested each year. Public subsidies in Europe favoured biomass, wind, hydro and solar investments[19].

After a peak in 2008, the "cleantech 1.0" ecosystem was hit by a downturn. High-profile bankruptcies of cleantech innovators led to a common observation of the misfit between the venture capital model and cleantech innovation, which requires significant patient capital and time to reach market. Strong competition and dumping from China decimated solar producers in the EU and North America. Yet, **this first wave of innovation was instrumental in the global rise of affordable solar and wind power, as well as electric vehicles.** We are still reaping the benefits of the efforts invested by these cleantech pioneers.

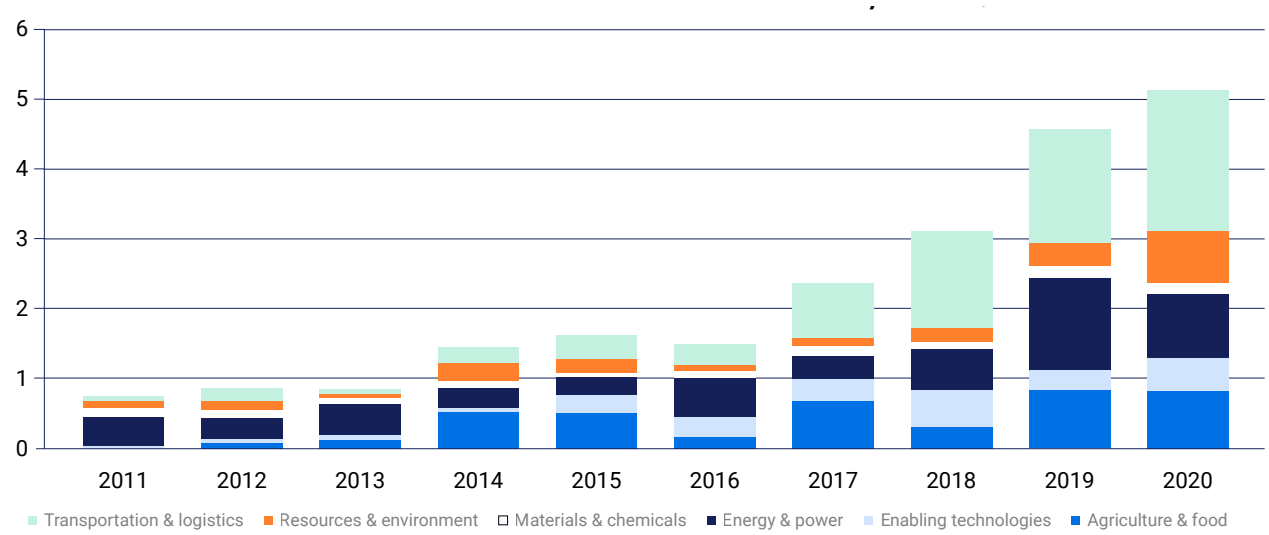
[19] Subsidies and costs of EU energy, Ecofys for the European Commission, 2014

EU27 Cleantech Seed, Venture and Growth investments, 2011-20



Around 2014-15, a second generation of cleantech innovators started up, with more emphasis on software and capital-light technology that could be more easily financed by the venture capital model, relying heavily on developments in enabling technologies such as sensors, connectivity, big data management and machine learning. This second wave proved more successful than the first, and produced a few exits that demonstrated successful venture capital was possible in cleantech.

Fast forward to today, and cleantech has gone from a niche category to a key investment focus. I**n 2020, more than €5 billion was invested in EU-based cleantech start-ups, representing a 7.5x increase on 2011**. A third generation of entrepreneurs and investors is emerging, with more appetite to tackle capital-intensive bets with strong decarbonisation potential.



Source: Cleantech Group

EU Cleantech Venture and Growth investments by sector, 2011-20

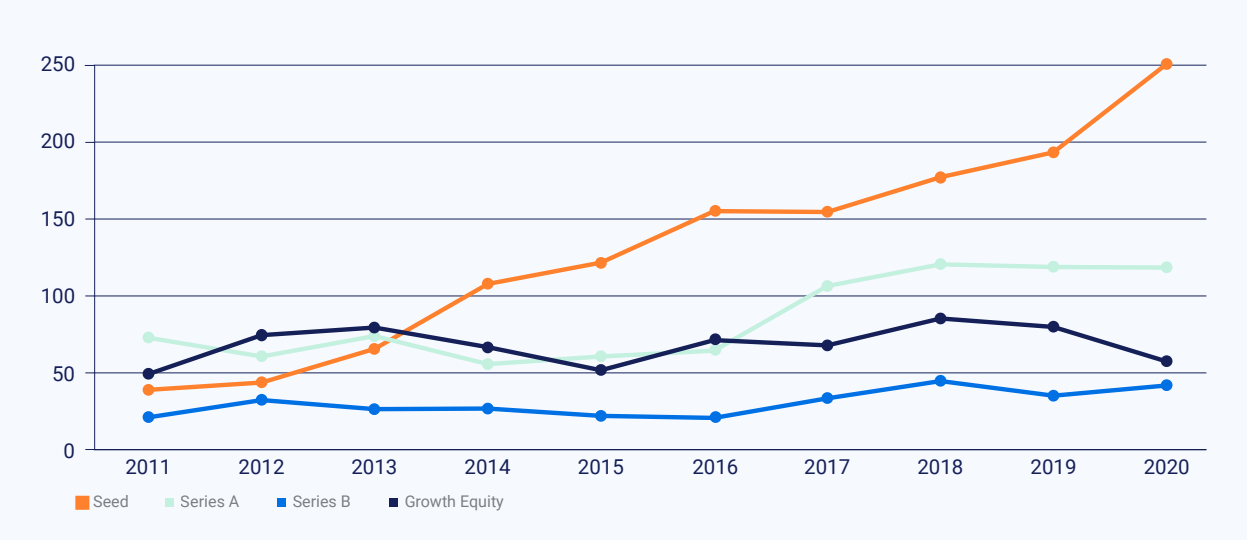
EU cleantech has diversified to help all major industries decarbonise. While energy is still an important innovation area, with the development of energy storage, hydrogen and efficiency optimisation, sectors like clean transportation and sustainable agriculture were responsible for the majority of the growth in investment in the last five years, and waste and carbon management are increasing areas of focus as well.

The EU is a leader in early-stage cleantech innovation supply

Breaking down the evolution of cleantech VC deal volumes in the EU over the past decade, it is clear that **seed-stage[20] investments are responsible for the lion's share of overall growth in deal volumes**, increasing by 6.4x over the period.

This is thanks to government-sponsored innovation investors across the EU, such as EIT InnoEnergy and High-Tech Gründerfonds, as well as private accelerators such as Rockstart and venture capitalists like Demeter IM playing earlier in the value chain. These venture capital investments were enabled by fund of fund programs that were set up notably in France and Germany, as well as at the European level with the role of the European Investment Fund.

[20] Seed funding refers to the first round of investment that a start-up raises, and is typically used to prove its concept.



EU27 Cleantech deal volume by stage - 2011-20

Source: Cleantech Group

The result is that the EU is now an early-stage cleantech innovation powerhouse, with close to 23% of all global cleantech seed money flowing into EU-based start-ups. In short, **there is no shortage of cleantech innovation supply in the EU.**

> **"Finding the money for early-stage companies is less and less of a problem. What is more challenging is helping start-ups design a business that can be scaled within Europe, choose the right entry markets and land there successfully."**

— Feerk Bisschop
Managing Partner, Rockstart Energy

Once companies pass the seed phase, they enter the early revenue / product-market testing phase, and go on to raise series A and B rounds. For this phase, they can rely on a small but experienced ecosystem of private cleantech funders, such as Munich Venture Partners, btov or eCapital in Germany, SET Ventures in the Netherlands, Idinvest or Demeter in France, Capricorn Venture Partners in Belgium or Emerald Technology Ventures in Switzerland.

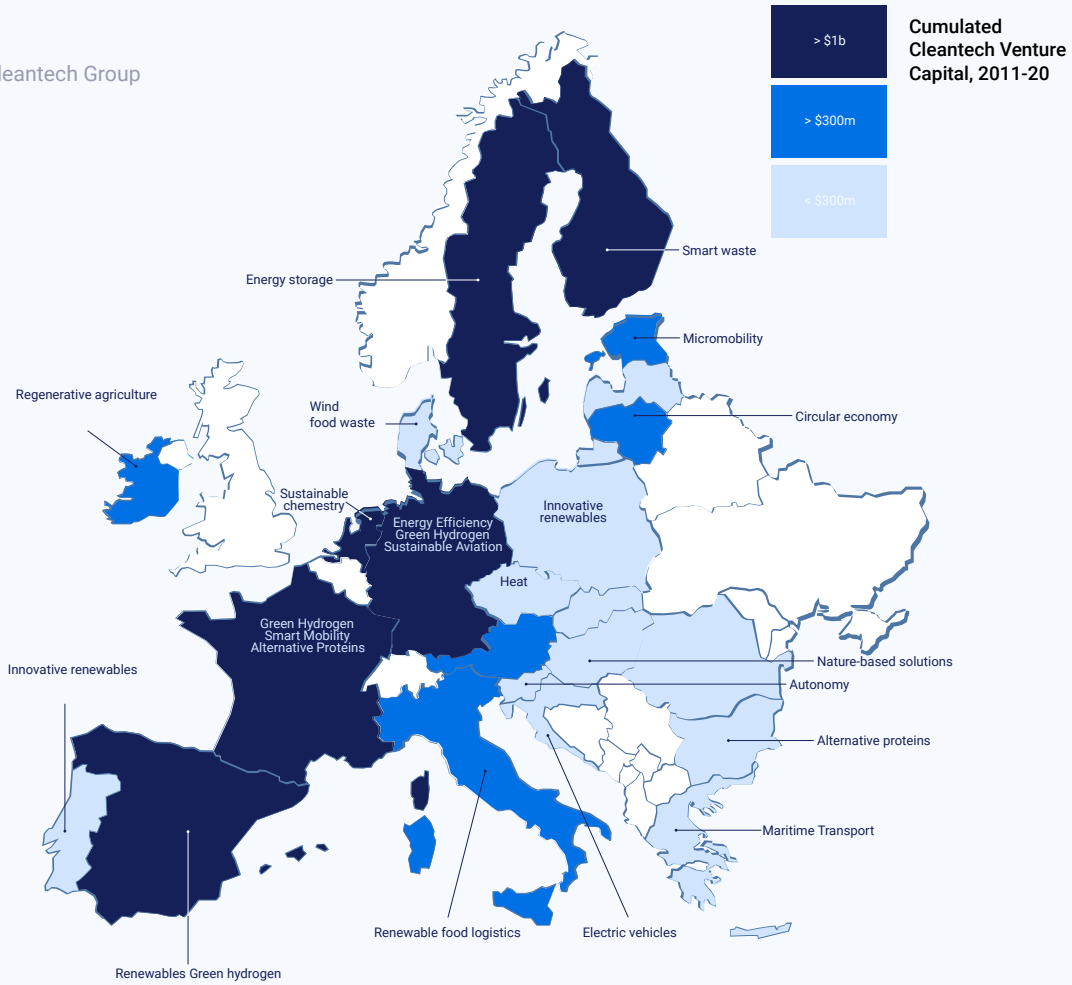
Most of these investors have been operating for 15 years and have remained steady in their focus on sustainable innovation. In the last couple of years, this category has grown to welcome a few new players such as Daphni in France or Telos Impact in Belgium, and has welcomed back generalist investors looking to get exposed to climate solutions.

Public funds are very active at this stage as well, with the examples of BPIFrance, High-Tech Gründerfonds, Innoenergy, Almi Invest and Enterprise Ireland.

Large corporates have also played a role over the last decade, setting up corporate venturing units that have co-invested with financial venture capitalists and increased access to capital. The most active corporate venturing units over the last decade include Robert Bosch Venture Capital, Engie New Ventures, Total Carbon Neutrality Ventures, Shell Ventures and EnBW New Ventures. Interestingly, the corporate with most investments into EU cleantech companies is Intel Capital, the venturing unit of US technology giant Intel.

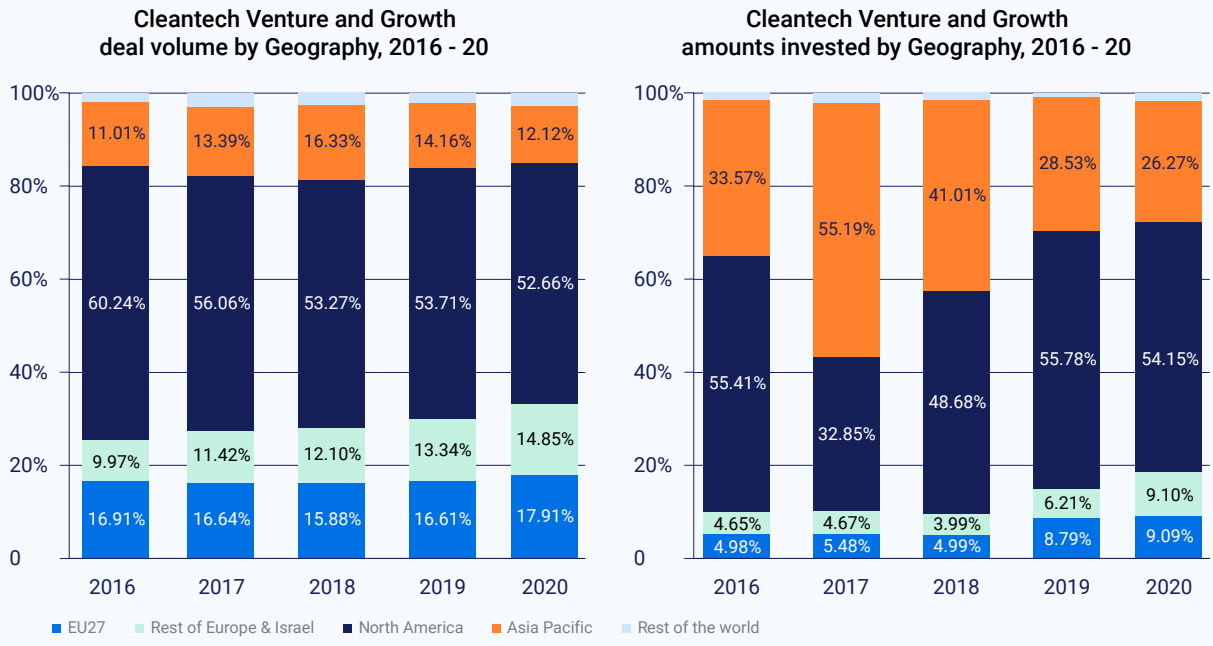
Innovation supply has increased in all quarters of the EU, making cleantech a true EU27 opportunity. In the following map, we show some of the most interesting players, and national strengths.

Source: Cleantech Group



A severe scale-up investment gap

The extraordinary rise of early-stage EU cleantech shows we can turn things around in the space of a decade. However, it hides a deeper challenge and should be considered in a global context. **While the EU represented close to 18% of cleantech venture capital deal volume worldwide in 2020, it only accounted for 9% of amounts invested**. This means that on average, an investment round in an EU-based company was half the amount of a round for a similar company in North America, and a quarter of the amount of a round for a similar company in Asia Pacific.
In effect, **despite hosting a vibrant and growing innovation ecosystem, the EU severely lags North America and Asia Pacific in the amounts invested in cleantech innovation.**

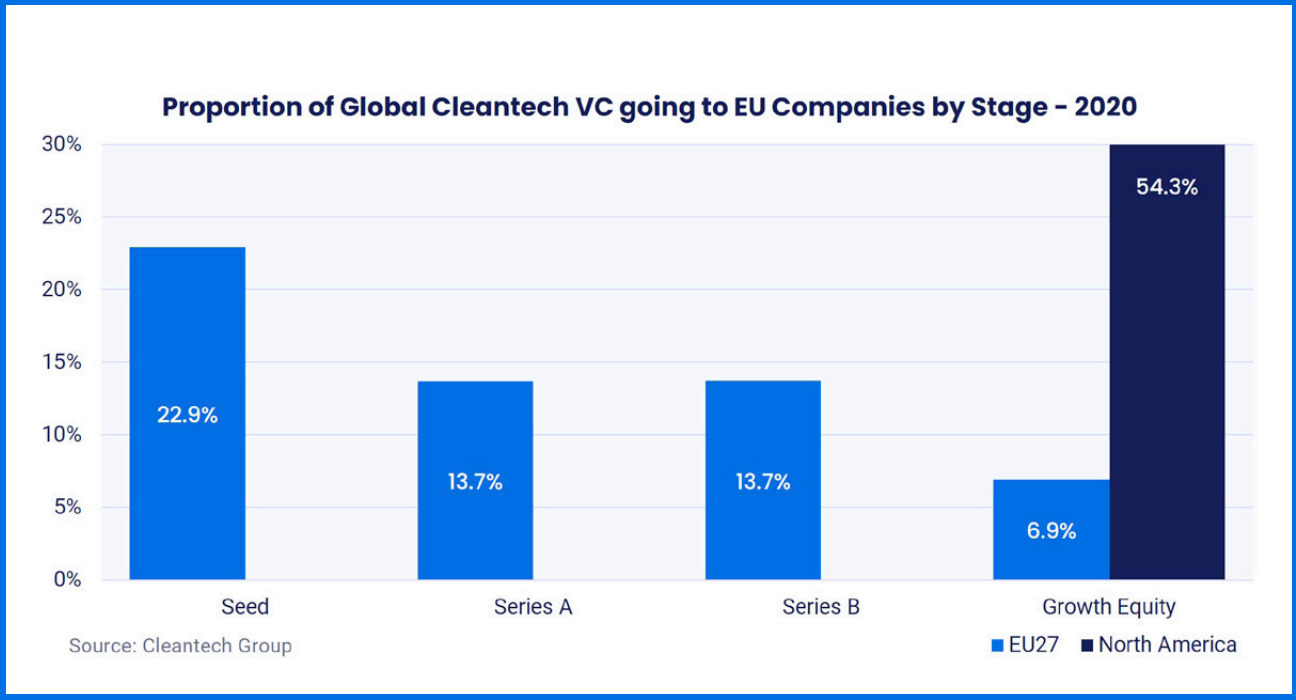


Breaking down the amounts invested by stage, it becomes clear that this investment gap is concentrated on the revenue and expansion stages of the start-up lifecycle. While EU-based seed-stage companies receive 23% of global seed funding, they only attract 7% of global growth equity – the investment needed to take their innovation from early revenue to continental scale.

This compares poorly with North America, which attracts 54% of global growth equity investment, and Asia Pacific, which attracts 32%. The United Kingdom alone boasts 4.8% of the same pie, which is more than Germany, France, Spain and the Netherlands combined.

We are producing a number of highly-promising ventures that will not scale up to become EU-wide champions – because of a lack of demand, translating in a lack of growth capital.

EU Cleantech Venture and Growth investments by sector, 2011-20



The consequences of this investment gap could be significant in terms of global competition. As we saw in China with the boom of solar power and equipment, massive funding at the scaling stage, along with a value chain leadership approach created a clear global leader in the space, and all but killed European and North American competition. If the EU does not capitalise on its current innovation in energy storage, hydrogen and industrial tech, the same fate awaits these new technologies. Today, **many EU cleantech scale-up are relocating to North America to find better funding and scale-up conditions.**

> **"To build a nature-based wastewater plant in Europe, you will need 3-4 years between initial contact and contract signature. In Asia, that time is reduced by half, and you can scale 10x at each new project, compared to 3-4x in Europe. So we chose to scale in Asia first."**
>
> **— Attila Bodnar**
> **Co-founder, Organica Water**

The following EU cleantech ecosystem map, which includes local and foreign investors most active in EU investment, reflects this strong group of seed and venture investors, but relative weakness of growth / scale-up players:

EU Cleantech Ecosystem

The EU and North America have comparable GDP and population, meaning the addressable market for companies in a scale-up phase should be broadly similar. We believe this investment gap is the result of a demand-side shortcoming in the EU, with three key causes:

Not enough clear EU-wide demand signals for green products: while we are starting to see some local and national commitments to green products emerge, such as bans on sale of new combustion engine cars by the mid 2030s, there is no continent-wide, systematic phase-in of green products in industries like construction, automotive, chemicals or aviation. Instead, the EU is relying on large corporates to make voluntary commitments and pledges. This is not sufficient to create the demand needed to get green industries off the ground. In section 3, we explore how this can be remedied in the context of Fit for 55.

Not enough penalties for high-polluting products: conversely, highly polluting products are not penalised enough in the EU. For instance, steel plants are given free allocations of emissions under the Emissions Trading Scheme, and there is no tax on kerosene. This is harming greener, more innovative alternatives and skewing competition.

Fragmented market: With 27 different jurisdictions and multiple languages, it is hard for start-ups to grow continentally. What should be a market of c. 450 million people ends up much more fragmented, especially in fields like energy where the national regulation and market structure have very different characteristics from one country to the next. Because of this fragmentation, some companies will start, say, in Germany, expand to Austria and maybe Italy, but then move straight to the US, without trying to scale in France, the Nordics, Eastern Europe, etc.

In other cases, we will find four or five scale-ups developing the same innovation in multiple EU countries, and becoming national champions, instead of building EU-wide champions. As a consequence, these companies don't develop the economies of scale needed compete with non-EU counterparts and become entrenched in their home markets.

And two aggravating factors:

01

Lack of growth equity funders: North America's venture capital industry is 50 years old and has evolved to a high level of granularity. As a consequence, it has a number of specialized growth equity funds which can invest the €20-50 million a scale-up needs to deploy commercially. The EU's Venture Capital industry is only 20-25 years old and has not developed the same granularity. While some growth funds exist, very few of them invest in cleantech. Rare examples like Energy Impact Partners' Europe fund are crucial players, but not enough to help the entire ecosystem scale. This gap is being filled by a few infrastructure players sliding down the maturity chain, some foreign growth investors such as Princeville Capital, and large corporates, who ultimately have an interest in acquiring companies instead of letting them scale independently.

> **"When growing a successful hardware cleantech business, you need to finance a large working capital. You won't find that kind of money from EU VCs or banks. Your options are go abroad, or go with large corporates"**
>
> **— Christoph Ostermann**
> **former CEO, Sonnen**

02

Poor exit routes: Our analysis shows that EU innovators attracted 20% of global cleantech M&A events in the last ten years, in line with its share of the global cleantech venture capital investment. However, EU cleantech only attracted 7% of amounts raised via public markets over the last ten years. This means that public markets are not a serious exit option for EU cleantech scale-ups. As a consequence, most turn to acquisitions by large corporates. However, large corporates are negotiating from a position of strength, knowing there are no other options on the table.

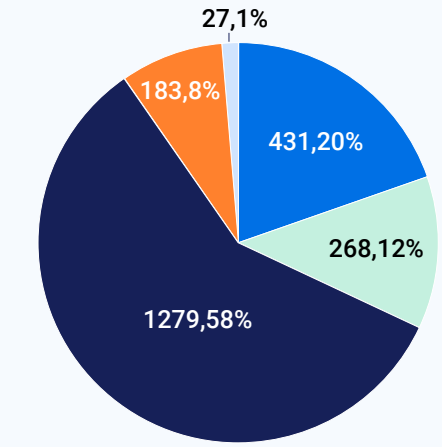
This results in a significant discount on M&A exits, which in turn limits the possible scale-up investments, as investors know they may not get the right reward for their risk. More broadly, corporate acquisitions present the risk of slowing the scale-up of disruptive technologies, as once acquired, innovative companies tend to focus on quarterly financial performance, and diminishing their risk profile instead of prioritising growth. The rise of Special Acquisition Companies (SPACs[21]) could help European scale-ups gain better access to public markets, but current evidence suggests most SPACs are focusing on the North American market.

"The lack of a good IPO route for EU cleantech businesses is an ongoing nuisance. That's reason 1, 2 and 3 why we can't get more exit tension to our later stage investments."

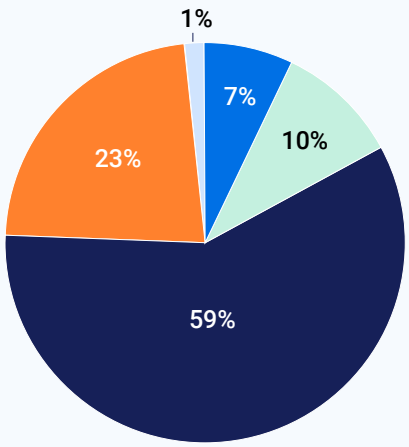
— Christian Reitberger
btov

[21] SPACs are blank-check companies listed on stock exchanges with the purpose of acquiring private companies and make them public.

Cleantech M&A events by geography, 2011-20



Amounts raised in Cleantech IPOs by geography, 2011-20 ($ billions)



EU27 Rest of Europe & Israel North America Asia Pacific Rest of the world

Source: Cleantech Group

Fit for 55 is the opportunity to create a green demand shock.

3

If the EU wants to lead the global race to net zero, it needs to set a decisive policy agenda, develop clear rules and regulations that work for the clean technologies we need for decarbonisation, and be prepared to take risks. Fit for 55 is a unique opportunity to create strong demand signals and scale the most promising EU cleantech ideas, by focusing on lead market creation, rewarding green products, phasing out more polluting alternatives, and implementing innovation-friendly policy. The regulator's role in success is crucial: bold and clear policy actions will translate into climate and competitiveness benefits.

Policy-makers can and should create green markets

Regulators have a long history of building and shaping markets, especially when early-stage innovation is at a disadvantage. **An effective regulatory framework creates the conditions for innovations to make the leap from the lab to the market** by mobilising investment, creating supportive policies and standards and, most importantly, creating the lead markets for these technologies to scale. In the EU, policy intervention in markets has been key in deploying renewable power generation, and is creating a similar movement in short-duration energy storage.

> **"The regulatory framework is critical for success in cleantech. Without political effort, you cannot make the change. It has to be the first step. We see it in hydrogen and electric mobility: strong policy moves result in market uptake."**
>
> **— Ivo Nemejc**
> **Inven Capital**

Once a promising clean technology has been proven, we need to create market demand for the new product or service. An example is solar photovoltaic electricity generation, which was first demonstrated in the 1950s but remained uncompetitive in comparison to conventional generation until well into the 2000s. Innovators were able to scale the technology thanks to demand stimulation from EU member states. This was done by identifying applications in successive niche markets, starting with the highest value ones. Each wave of market expansion resulted in a cost decrease, which catalysed technical innovation, leading to further cost improvements.

Feed-in tariff programmes in Germany, Italy and Spain were particularly effective in providing market stability, allowing the whole value chain to invest in scaling capacity. Yet while the EU was initially a leader in solar technology innovation, it was outcompeted by China, which combined a cheaper labour force with economies of scale. It is important the EU does not repeat the same scenario in green hydrogen, energy storage and other key sectors. Setting a high sustainability standard for products is a good way to do so, with the example of the requirement of green batteries in automotive. There are complementary ways, such as border adjustment and a sufficiently high carbon price, which we detail below.

Left to their own devices, **markets reward incremental technological developments and other cost-reducing innovations, but tend to undervalue disruptive innovation.** This is due to a significant green premium – the additional cost of choosing a clean technology over one that emits a greater amount of greenhouse gases[22]– for truly sustainable products, which exists until they reach continental scale, and to the fact that large incumbents have an incentive to focus on improving their existing profitable portfolio rather than investing for the long-term. If the EU wants to achieve significant climate targets, it will have to create a demand shock and create the lead markets that will drive down the green premium as clean technologies scale.

[22] The Green Premium, Understanding where to innovate first, Breakthrough Energy

Lithium-ion batteries: an EU market-creation example

In 2015, China, Japan and Korea together accounted for 88% of global Lithium-ion battery manufacturing capacity, while only 3.5% was located in the EU[23]. Today, the EU is back on the map, with committed investments in production which may serve between 7 and 28% of global demand by 2028[24], thanks to active market creation, both on the demand and supply sides.

On the supply side, this result was helped by a series of successful policy interventions, starting in 2016, when the European Commission and Member States published a Declaration of Intent, setting out cost and manufacturing targets up to 2030 on batteries for e-mobility and stationary storage applications. In 2017 the European Battery Alliance was created, identifying an opportunity for EU countries to create a €250bn battery market by 2025 and emphasising the need for immediate action to allow the EU to compete globally. This was followed in May 2018 by the Strategic Action Plan on Batteries, which laid out measures for coordinated regulatory and financial support along all parts of the battery value chain, from R&D and access to raw materials, to battery manufacturing, recycling and business model innovations.

On the demand side, two key policy initiatives are driving the uptake in Europe batteries. In 2017, the commission unveiled a plan to reduce the emissions from car fleets by 30% by 2030. After negotiations with the European Parliament and the Council, the target was raised to 37.5% and passed in 2019[25]. This was a strong signal to automakers to accelerate the electrification of their vehicle range, and created a demand shock for batteries, which currently represent up to 40% of the value of an electric vehicle. While global sales of electric vehicles decreased in 2020, EU markets remained strong; **nine of the top ten markets for EVs globally are now in the EU[26]**. The second demand signal came in December 2020, when the European Commission announced new green battery standards, giving EU producers a potential competitive edge.

[23] Automotive Lithium-ion Battery Supply Chain and U.S. Competitiveness Considerations, NREL, 2015

[24] Batteries for Europe, Strategic Research Agenda for batteries, European Technology and Innovation Platform, 2020

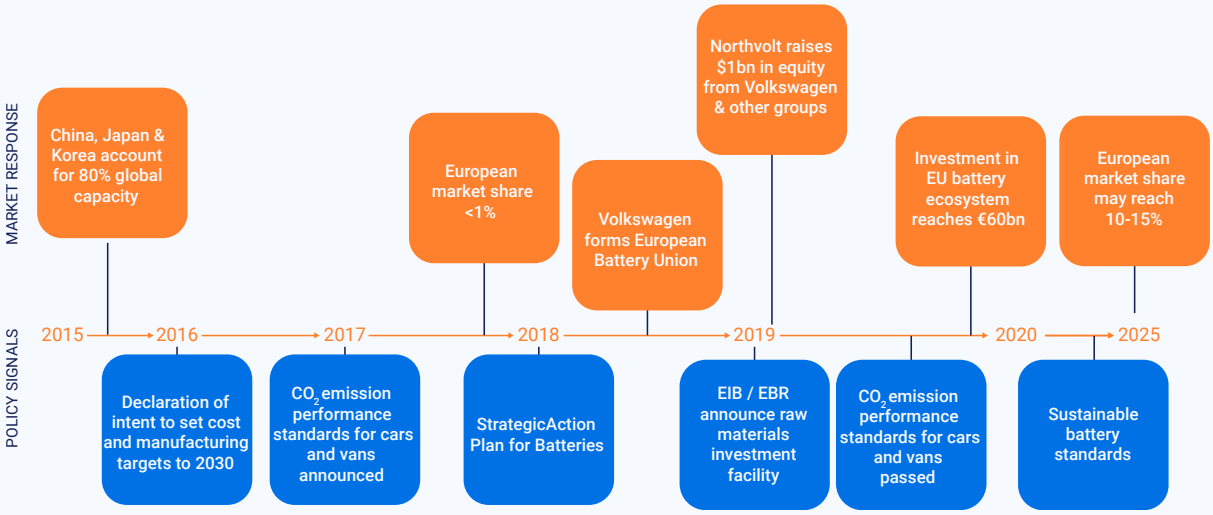
[25] CO_2 emission performance standards for cars and vans (2020 onwards), European Commission

[26] Electric Vehicle Index: Europe cushions a global plunge in EV sales, McKinsey & Company, 2020

According to the plan, industrial batteries sold in the EU must disclose their carbon footprint from 2024, and comply with a CO_2 emissions limit from 2027. If these new standards are implemented, they will provide a strong demand signal that will encourage automakers to source batteries from EU innovators such as Northvolt, whose batteries are significantly less CO_2 -intensive than those of foreign competitors.

The combination of supply and demand policy signals has had remarkable results. Over 500 GWh of planned European production capacity has now been announced by more than 20 different companies. The number of EU-registered patents in battery technology has also risen sharply since 2017[27]. In late 2020, European Commission Vice-President Maroš Šefčovič announced that investment in the EU battery ecosystem had reached €60 billion, three times larger than China's investment. From a market share of less than 1% in early 2018, EU market share may reach 10-15% by 2025.

[27] Innovation in batteries and electricity storage, European Patent Office and International Energy Agency, 2020



Policy Signals and Market Response in EU Li-battery manufacturing

Northvolt: a model for scaling up EU innovation

Northvolt was founded in 2016 in Sweden by former Tesla executives, with the goal of building the world's greenest batteries, and keeping the value, knowledge and jobs of the automotive supply chain in Europe. A co-founder of the European Battery Alliance, the company enrolled the support of the European Commission, the European Investment Bank and automakers such as Volkswagen and BMW as off-takers. In 2019 and 2020, it was able to raise more than €3 billion to build Gigafactories in Northern Sweden and Germany, and grow to 1,200 people. Northvolt will rely on automation and economies of scale to offer price-competitive green batteries to European automakers.

> **"We live in extraordinary times and need extraordinary efforts to succeed. The EU has an opportunity to put more focus and speed on financing green scale-ups, accelerating permitting and training the talent we need to reach continental scale."**
>
> **— Alexander Hartman**
> **CFO, Northvolt**

Northvolt Ett, a battery Gigafactory being built in Northern Sweden

Fit for 55 offers unparalleled opportunities for green demand signals

The Fit for 55 package is a comprehensive review of climate and energy policy across twelve regulations, directives and other instruments which will take place during 2021 and 2022. In the figure below, we show that each of the twelve revisions impacts clean technologies and innovations.

For this initial research, we have identified five priority innovation areas based on their decarbonisation potential and existing technology leadership in the EU, and assessed how each legislative revision within the Fit for 55 package would impact the speed, scale and success of the EU in these sectors.

The five priority areas are:

- **Green Hydrogen**
- **Green Steel**
- **Low-carbon Construction Materials**
- **Sustainable Aviation**
- **Soil Carbon**

The innovation areas that should be scaled-up in Fit for 55

Revision of the EU Emissions Trading System (ETS)	Carbon Border Adjustment Mechanism	Effort Sharing Regulation	Amendment to the Renewable Energy Directive	Amendment to the Energy Efficiency Directive	GHG emissions and removal of land use & forestry
Sustainable Aviation **Green Steel** **Low-carbon Construction materials** Decarbonizing Maritime Transport Industrial Efficiency CCUS	**Green Steel** **Low-carbon Construction materials** Carbon Tracking & Accounting	Heating & Cooling for buildings Electric Vehicles & Drivetrains Industrial heat Cleaner Livestock Cleaner Crops	**Green Hydrogen** **Sustainable Aviation** Heating & Cooling for buildings Industrial heat Innovative Renewables	**Low-carbon Construction materials** Building Management Automation	**Soil carbon** **Low-carbon Construction materials** Reforestation and Sustainable Forestry Bio-based materials Cleaner Crops Biodiversity credits
Revision methane emissions in the energy sector	**Revision of the Energy Tax Directive**	**Directive on alternative fuels infrastructure**	**CO2 standards for new cars and light commercial vehicles**	**Energy performance of Building Directive**	**Revision of Third Energy Package for gas**
Methane leak detection	**Green Hydrogen** **Sustainable Aviation** Decarbonizing Maritime Transport	**Green Hydrogen** **Sustainable Aviation** EV charging Vehicle-to-Grid	**Green Hydrogen** **Green Steel** Electric Vehicles & Drivetrains EV charging	**Low-carbon Construction materials** Heating & Cooling for buildings Net-zero buildings Building Management Automation	**Green Hydrogen** Biogas

Green Hydrogen

Why this technology matters

Green hydrogen, which is produced using electrolysis powered by renewable energy sources, or by non-electrolysis methods from biogenic sources such as waste or biogas, is **the method of hydrogen production with the lowest carbon intensity**. Scaling green hydrogen is essential to meeting climate objectives: it offers the most feasible route to decarbonisation in industries such as steel, cement, fertiliser and heavy-duty transport. Hydrogen could account for up to 24% of final energy consumed in 2050, reducing GHG emissions by around 560 million tonnes annually[28].

[28] Hydrogen Roadmap Europe, Fuel Cells and Hydrogen Joint Undertaking, 2019

EU potential

The EU has the potential to become the global leader in green hydrogen production: over 50% of hydrogen start-ups globally are located in Europe[29] and the continent hosts a strong selection of demonstration projects which aim to validate commercial viability. Most of the projects announced in the EU involve collaboration across several countries and companies, and across the value chain – from renewable energy production to end-use hydrogen consumption, showing that hydrogen has the potential to become an integrated sector across the EU.

[29] Mainstreaming Green Hydrogen in Europe, Material Economics, 2020

Green Hydrogen

Sunfire's headquarters in Dresden, Germany

Barriers to scale

The most important barrier for EU green hydrogen is the lack of a clear **signal of prioritisation over the rest of the hydrogen spectrum**, which discourages long term planning and investment. **The absence of a CO_2-based hydrogen production classification** undervalues the environmental advantage of green hydrogen (which entails lower lifetime emissions than other forms of production) and brings the risk of investment being diverted to blue hydrogen projects, delaying green hydrogen's journey down the cost curve.

The EU also lacks the enabling **infrastructure** to transport hydrogen continentally.

Cross-border projects and internationalisation efforts by innovators are hindered by **fragmented permitting** and **regulation which differs between member states**. Another barrier is the availability of the renewable energy needed for electrolysis. Simplifying permitting processes for renewable energy projects would accelerate the green hydrogen scale-up

> **"There is no clarity on how electrolysers can source renewable electricity via the power grid. The Renewable Energy Directive needs to set clear rules for the purchase of renewable electricity via the grid."**
>
> **— Nils Aldag**
> **CEO, Sunfire**

Recommendations to reach value chain leadership

Competitiveness in green hydrogen will come from integration and cost reductions across the whole value chain, which should favour the EU's approach, provided more efforts are invested in under-developed parts of the value chain. In particular, **enabling infrastructure** for hydrogen transportation needs to scale with the market. Current **renewable generation** is not enough to power the projected hydrogen demand; this also needs to scale. Innovative generation methods such as floating offshore will be needed to overcome land availability constraints. In hydrogen **production technologies**, more ecosystem support is needed to commercialise and scale next-generation production technologies currently at prototype or pilot stage. Further improvements in electrolyser cost and efficiency will come from competition. **Lead markets** such as ammonia, trucking heavy-duty road transport, green steel, refining, shipping and off-grid power should be identified and prioritised according to price of best available alternative.

Green Hydrogen

Green Hydrogen

Fit for 55 Recomendations

Policy file	Recommendation
Renewable Energy Directive (RED III)	RED III is the opportunity to remove the main barriers to hydrogen project development. We recommend the following amendments: • Set targets for electrolyser deployment and market demand incentives such as contracts for difference and guarantees of origin • Classify hydrogen production methods according to lifecycle carbon intensity, and corresponding incentives for the lowest carbon methods • Consider hydrogen produced with renewable grid energy as transport fuel • Simplify permitting procedures for renewable energy projects and for hydrogen generation projects, remove steps (for example emissions footprint calculation) which do not apply to renewable generation, and add cost and time to the process
Emission Trading System (EU ETS)	• Implement an EU-wide carbon floor price with a gradual increase over time (e.g. €30 in 2022, €70 in 2025 and €120 in 2030) and some revenue redistribution to EU carbon-intensive countries for decarbonisation investments through the Modernisation Fund. While not enough to compensate the current green premium, these prices would bring forward green hydrogen's break-even point with grey to between 2025 and 2030, and should provide the predictability necessary to encourage investments in green hydrogen
Carbon Border Adjustment Mechanism (CBAM)	• Deploy at the same time as carbon floor price, to avoid imports of carbon-intensive hydrogen
Energy Tax Directive (ETD)	• Remove tariffs on electricity consumed by electrolysers to avoid double taxation

Green Hydrogen

Policy file	Recommendation
Directive on Alternative Fuels Infrastructure (DAFI)	• Provide the enabling infrastructure needed to implement the hydrogen strategy by mandating hydrogen refuelling infrastructure for heavy-duty road transport • Develop common specifications for refuelling stations, including a refuelling protocol for heavy-duty vehicles
Instruments and initiatives outside Fit for 55	• Renewable energy supply is a key enabler which could constrain growth. We recommend an upwards revision of the renewable energy target. • Green bonds and sustainability-linked bonds can encourage the private investment necessary to create the new hydrogen infrastructure • InvestEU can support by investing in scale-up projects for electrolysis, demonstration projects for hydrogen-based heavy-duty transport along with associated refuelling infrastructure, and demonstration projects for newer hydrogen production technologies

Green Steel

Why this technology matters

Steelmaking is one of the highest GHG-emitting sectors. The EU iron and steel industry emitted around 152 million tonnes of GHG emissions in 2018[30], or 4.3% of EU emissions. The potential decarbonisation solutions – Carbon Direct Avoidance via Direct Reduced Iron (DRI), electrowinning or Electric-Arc Furnaces, or the use of carbon capture and increased process efficiency – have the potential to reduce 80-95% of current emissions[31]. Further innovation is needed to reduce abatement cost of these solutions.

[30] European Environment Agency emissions data, 2018
[31] Ambitious EU climate law must show how EU climate policy can lead global emissions reduction efforts, EUROFER press release, 2020

EU potential

The EU is home to some of the world's leading steel producers. EU steel production is already efficient due to a high presence of Electric-Arc Furnaces. The EU is leading the world in green steel innovation and demonstration projects. While the EU has some promising AI/optimisation software innovators who are attracting investment, the USA has invested more in hardware solutions and has produced more operations-focussed innovators.

Barriers to scale

The **green premium** remains the greatest barrier to wider adoption of green steel production. Low-carbon steelmaking costs 30-80% more than conventional production[32], whose environmental damage is not reflected in the price. The carbon price is currently not high enough to compensate, and free allowances under the Emissions Trading System further distort the market.

While there is good support for AI and software solutions, **hardware innovators do not receive enough support** in terms of investment and ecosystem services. Potential **low-carbon steel substitutes are at a double disadvantage**: they have high costs due to early development stage of the technology and they compete against traditional steelmaking which is effectively subsidised by free ETS emissions allowances. A long regulatory approval process delays time to market, further impacting potential price reductions.

[32] Cleantech Group interview with Arcelor Mittal, 2021

Recommendations to reach value chain leadership

More investment in innovation is needed across the whole value chain to have an impact at scale.

At the start of the value chain, renewable energy and alternative fuel sources are not currently available at the scale needed to support green steel production. In production, Electrowinning and molten-oxide electrolysis technology needs more attention in the EU. Finally, digital solutions can support the transition to new, more efficient technologies by measuring impact and enabling more precision in production processes. At the end of the value chain, market demand must be developed by procurement requirements, a combination of higher carbon price and carbon border adjustment, as well as certification of green steel to create consumer awareness and pull.

Green Steel

Green Steel

Fit for 55 Recomendations

Policy file	Recommendation
Emission Trading System (EU ETS)	• Implement an EU-wide carbon floor price with a gradual increase over time (e.g. €30 in 2022, €70 in 2025 and €120 in 2030) and some revenue redistribution to EU carbon-intensive countries for decarbonisation investments through the Modernisation Fund. Price should be high and predictable enough to encourage investments in green steel and alternatives • Phase out free allowances to steelmakers, which provide a cost advantage to emissions-intensive production methods
Carbon Border Adjustment Mechanism (CBAM)	• It is crucial to deploy a CBAM at the same time as phasing out free ETS allowances, to avoid environmental dumping and provide a level playing field for green products • Price imports of steel according to emissions footprint. The calculation for the mechanism should rely on average carbon intensity in the country of origin
CO_2 Standards for New Cars and Light Commercial Vehicles	• Create market demand for green steel by embedding a requirement for EU standard Environmental Product Declarations requirement for new cars and car components
Energy Performance of Buildings Directive (EPDB)	• Incentivise or mandate the use of green steel in new build • Embed a requirement for EU standard Environmental Product Declarations for all components in the construction process

Green Steel

Policy file	Recommendation
Instruments and initiatives outside Fit for 55	• Mandate upper limits for carbon intensity of steel used for public buildings and cars with **Green Public Procurement,** awarding higher points in tenders to greener products using EU-standard EPDs as inputs • An EPD labelling system could educate the public and create consumer pull for green steel; alternatively, a consumer tax based on carbon intensity of end products could be effective in switching demand from cheaper, more polluting products. A key enabler to this would be a common EU standard EPD information database recording lifetime carbon intensity of products, which could be developed under the **Circular Economy Action Plan**. EU-wide materials efficiency standards (for example a Clean Product Standard) could then be introduced, with a voluntary phase-in period • On the production side, establish a plan for the phase-out of existing assets, together with support mechanisms for deep decarbonisation technologies, via **Carbon Contracts for Differences**, the EU ETS Innovation Fund or public funding options • Adapt the **CCS directive** for energy-intensive industry, while incorporating the flexibility to plan multiple decarbonisation strategies. Define standards, a streamlined permitting process, and a more flexible process for the storage of captured carbon to accelerate deep decarbonisation technologies such as CCS/ CCU for the steel sector

Low-carbon Construction Materials

Why this technology matters

Buildings account for around 36% of EU emissions[33]. Emissions associated with construction and construction materials (excluding steel) were responsible for a further 191 million tonnes of GHG emissions in 2018[34], or 5.5% of EU emissions. As well as reducing the production emissions associated with the highest-emitting materials such as cement and concrete, decisions need to be taken in the context of minimising overall lifetime building emissions.

[33] European Environment Agency emissions data, 2018
[34] European Environment Agency emissions data, 2018

EU potential

The EU has a good base of innovation across the value chain, from materials and construction products to innovative construction techniques, digital optimisation solutions and end of life solutions which are capable of reclaiming high quality raw materials from demolition waste. Early-stage financing and ecosystem support from incubators and accelerators has also increased over the last five years, although the amount of funds raised remains small when compared to similar start-ups in the USA and Asia. The upcoming **Renovation Wave** is an opportunity to incorporate best practices and low-carbon materials into existing buildings, but must also be managed to ensure demolition waste is directed back into the construction cycle instead of ending up in landfill.

Low-carbon Construction Materials

Barriers to scale

The construction industry is highly fragmented with many small, local players and low margins. Regulations and standards tend to be conservative. There is little coordination between different industry players and materials choices are usually made independently by actors in different parts of the value chain. Often contractors will choose the cheapest material available, without considering its impact either in terms of embodied carbon or on the operational emissions of the building.

> **"Either subsidies or regulation are needed for the construction sector, otherwise buyers tend to nearly always opt for the solution with the cheapest upfront cost."**
>
> **— Felix Rau**
> **VA-Q-Tec**

Prescriptive regulations and standards and costly approval processes disadvantage green materials, especially those developed by smaller innovators with limited resources. We also found evidence of a lack of growth funding for scale-ups. Innovators who wish to remain independent are opting for equipment sales or licensing rather than as-a-service models which would enable them to grow faster and more profitably.

Recommendations to reach value chain leadership

Low-carbon Construction Materials

With a very fragmented industry, construction materials are in need of a **more holistic value chain approach** in the EU. Our research shows that digitalisation has a key role to play here, by coordinating materials choices for the best outcome. Using **building information modelling software (BIM)** when planning a project can optimise the trade-off between different materials, balancing the construction and operational phases to minimise total lifetime emissions. To reduce the green premium, use of **low carbon materials** – including cement, concrete and concrete alternatives - needs to be incentivised or mandated to create strong demand signals, and Circular Economy practices need to be extended to enable waste processing into raw materials and redirect them back into the construction cycle.

Construction Materials

Fit for 55 Recomendations

Policy file	Recommendation
Energy Performance of Buildings Directive (EPBD)	This is the key policy tool impacting construction materials and cement, which mandates emission-based performance standards for new buildings. To influence better materials choices the revised directive can: • Introduce emissions-based performance standards for new and existing buildings • Mandate that new construction over a certain size should be lifecycle zero-emissions by the late 2020s by promoting third party-verified Environmental Product Declarations (EPDs) according to European Standard EN 15804 • Include a BIM (building information modelling) requirement and an EN 15804 Environmental Product Declaration calculation requirement for all construction projects of a certain size • Define an accelerated, simplified certification process for Green construction materials; to avoid delays in the market availability of new products and challenge incumbents • Harmonise and share building performance data among member states to disseminate best practice; encourage extension of emissions calculations to the whole building envelope • Incentivise the use of sustainably sourced timber in new build The revision is also an essential part of the renovation wave strategy and can support its objectives through the following measures: • Target approach to improve the worst-performing buildings to a minimum standard through mandatory minimum energy performance standards • Incentivise the use of low-carbon refurbishment materials • Make construction/demolition companies responsible for end-of-life provisions for material they remove from building sites, modelled on the WEEE Directive, to avoid a steep rise in landfilled materials caused by the Renovation Wave

Construction Materials

Policy file	Recommendation
Effort Sharing Regulation (ESR)	• Increase target reduction by 2030 to support uptake of building renovation and other building related emissions not covered by the ETS
Renewable Energy Directive (RED III)	• Introduce quotas or incentives for hydrogen as an energy source in manufacturing of construction materials
Emissions Trading System (EU ETS)	• Implement an EU-wide carbon floor price with a gradual increase over time (e.g. €30 in 2022, €70 in 2025 and €120 in 2030) and some revenue redistribution to carbon-intensive countries for decarbonisation investments through the Modernisation Fund. Price should be high and predictable enough to encourage investments in low-carbon cement and concrete, glass and metal production Phase out free allowances to cement producers, which provide a cost advantage to emissions-intensive production methods
Carbon Border Adjustment Mechanism (CBAM)	• Introduce at the same time as ETS allowance reductions to avoid environmental dumping and provide a level playing field for green products
Energy Efficiency Directive (EED)	• Include stricter materials performance and emissions footprint specifications for both renovations and new build Embed a requirement for EU standard Environmental Product Declarations for all components in the construction and renovation process

Construction Materials

Policy file	Recommendation
Instruments and initiatives outside Fit for 55	Circular Economy Action Plan: • An EU-wide product information database enabling embodied carbon comparisons between different materials using third party-verified Environmental Product Disclosure (EPDs) according to European Standard EN 15804 • Set minimum materials efficiency standards, with a voluntary phase-in period • Set minimum percentages of waste-derived raw material inclusion for cement and concrete producers • Clarify regulation on recycled construction materials so that recyclers know what specifications they need to achieve Waste Framework Directive: • Assess materials by emissions footprint (embodied carbon) instead of weight, using third party-verified Environmental Product Disclosure (EPDs) according to European Standard EN 15804

Sustainable Aviation

Why this technology matters

Aviation was responsible for 144 million tonnes of GHG emissions in the EU in 2018[35], or 4.1% of EU emissions. Air traffic has been impacted by the Covid pandemic, but the industry expects flight numbers (and therefore emissions) to continue on an upward trend once passenger levels have recovered to March 2019 levels[36]. Pre-covid projections estimated a 21% increase in CO_2 emissions and 16% increase in NOx emissions by 2040[37]. Innovation is needed to advance sustainable propulsion technologies, and bring costs down to competitive levels.

[35] European Environment Agency emissions data, 2018
[36] Destination 2050: A route to net-zero European Aviation, 2021
[37] European Aviation Environmental Report, European Environment Agency, 2019

EU potential

The EU benefits from a combination of a strong aviation industrial expertise and leadership in sustainable aviation innovation, with demonstration projects for different technologies including sustainable fuels, hydrogen production and infrastructure, electric charging infrastructure, hydrogen-powered and electric aircrafts. By setting clear targets for the phase out of jet fuel, the EU could create a global industrial leadership while achieving decarbonisation targets.

Barriers to scale

Aircraft: Technical challenges in several areas still need to be resolved. Innovation is needed in batteries, motors, optimisation of fuel cells and balance of plant for different types of aircraft. Once the technologies are ready for commercialisation long fleet lifetimes will slow uptake, especially if new technologies are not ready in time to catch the next wave of investment. EU venture capital is more risk-averse for such hardware bets, which limits funding options.

Low-carbon fuels: bio-based and electricity-based fuels are at different stages of technological readiness, with the lowest-carbon fuels not yet ready for commercialisation. Cost improvements in Direct Air Capture and waste to biofuel processes are needed to make these fuels commercially viable. For those lower-carbon fuels which are already at demonstration stage, current incentives are not strong enough to drive demand. Sustainable Aviation Fuels also encounter financing difficulties because payback periods are too long. Additionally, regulations need to be adapted for different categories of alternative fuels (for example blending requirements for aviation fuels do not yet include e-fuels).

Recommendations to reach value chain leadership

R&D is needed in battery technology, lightweight electrical motors, fuel cells and hydrogen systems and efficient hydrogen refuelling technologies. Once these technologies are ready for market, financing and market creation support will be needed to drive adoption and incentivise airlines to switch fleets.

Early-stage innovation needs more specialist incubators, accelerators and investors to support development of commercialisation strategies. EU investment programs should compensate for the shortage in risk capital for development of alternative fuels by investing in early-stage companies, providing scale-up funding or guaranteed offtake mechanisms to encourage investment.

Sustainable Aviation

Sustainable Aviation

Fit for 55 Recomendations

Policy file	Recommendation
Emission Trading System (EU ETS)	• Reintegrate international aviation into EU ETS and phase out free allowances to airlines to accelerate uptake of low-carbon fuels • Implement an EU-wide carbon floor price with a gradual increase over time (e.g. €30 in 2022, €70 in 2025 and €120 in 2030) and some revenue redistribution to carbon-intensive countries for decarbonisation investments through the Modernisation Fund. Price should be high and predictable enough to encourage investments in sustainable aviation
Renewable Energy Directve (RED III)	• Implement a Clean Fuel Standard to reduce the emissions-intensity of fuels over time (including e-fuels), mandating targets for fuels based on their carbon intensity. Land-use change (LUC) emissions should be included in these calculations, to avoid incentivising fuels with high LUC emissions • Additional renewable energy projects are essential to increase production of e-fuels; facilitate these with streamlined and simplified permitting procedures
Energy Tax Directive (ETD)	• Correct the current unfair price advantage of fossil fuels by linking taxation to CO_2 footprint of each fuel. This should include a tax on kerosene • Ensure that plane tickets do not benefit from VAT exemption
Directive on Alternative Fuels Infrastructure	• Support the development of light infrastructure for electric regional aviation • Develop common specifications for refuelling stations and accelerate permitting for e-fuels refuelling infrastructure

Sustainable Aviation

Policy file	Recommendation
Instruments and initiatives outside Fit for 55	Long-term EU (and member state) contracts for low-carbon fuels would provide the stable revenue streams needed to obtain financing for projects: • Green bonds and sustainability-linked bonds can encourage the private investment necessary to create a commercial refuelling market • Market confidence could be further developed by InvestEU financing of demonstration projects into synthetic aviation fuel production associated with refuelling infrastructure • Specific Research & Innovation quests to develop alternatives to short, medium and long-haul air travel funded by public-partnerships

Soil Carbon

Why this technology matters

Agriculture, together with changes in carbon stock stored in agricultural land, account for around 15% GHG emissions in the EU and over 30% in some member states[38]. EU Soils hold the potential for carbon storage of up to 230 million tonnes per year[39] . Soil carbon sequestration is also a low-cost mitigation option. However, **farming methods which increase soil health** and carbon sequestration **are not currently rewarded**, nor are the costs of practices which harm biodiversity and increase soil-related emissions priced. Innovation is needed to ensure rapid adoption of sustainable farming practices, develop carbon sequestering soil additives and monitor results.

[38] Net-zero agriculture in 2050: How to get there, Institute for European Environmental Policy, 2019

[39] Global Sequestration Potential of Increased Organic Carbon in Cropland Soils, Bossio et al., Nature, 2017

EU potential

Europe's land mass has the second highest potential in the world for carbon sequestration (by volume)[40] and this could provide an **additional revenue stream for almost ten million farmers** while contributing to sustainable farming practices[41]. EU-funded projects promoting soil health and carbon sequestration are in place, there is a good base of innovators acting across the value chain, and European agricultural corporates see soil carbon as an integral part of their sustainability strategies as well as a growth sector for farm goods and services.

Barriers to scale

Soil Carbon

Monitoring, Reporting and Verification (MRV) infrastructure is needed to measure and document progress: at present there is no reliable and affordable solution for this in the EU. Low margins and trust issues slow adoption of new practices in this sector and there are not enough incentives for change at present. Lack of market coordination has also prevented the development of voluntary soil-based carbon markets.

There is little support to commercialise and scale the existing early-stage innovation, either in terms of specialist investment or agriculture-focussed incubators and accelerators.

[40] Global Sequestration Potential of Increased Organic Carbon in Cropland Soils, Bossio et al., Nature, 2017

[41] Farmers and the agricultural labour force – statistics, Eurostat, 2016

Recommendations to reach value chain leadership

Innovation is needed across the value chain to exploit the EU's potential to lead in this sector. Innovative financing, specialist investors and ecosystem services including incubators and accelerators will help emerging innovations throughout the value chain to commercialise and scale.

At the farm level, automated field monitoring which leverages robotics, satellite data and drone technology should be accelerated to render testing costs affordable to farmers. Innovation is also needed in developing Farm Management Systems which calculate returns on investments and business models, which could be based on ecosystem services (including soil carbon, water quality and retention and biodiversity). A framework is also needed for standardised calculation of sequestration potential as well as monitoring, reporting and verification. This should encourage adoption by allowing farms which adopt sustainable practices to monetise their carbon sequestration.

Soil Carbon

Public-private partnerships and results-linked loans could help farms to finance the investments needed, as could Green Bonds and Sustainability-linked Bonds.

A land restoration project by Netherlands-based Land Life Company

Soil Carbon

Fit for 55 Recomendations

Policy file	Recommendation
GHG emissions and removals of land use, land use change and forestry (LULUCF)	To incentivise farmers, foresters and land managers to implement sustainable farming practices, they should be compensated for sequestering more carbon. • Increase targets to reflect Fit for 55 goals • Create an EU-wide standard for monitoring, reporting and verification (MRV) to enable the certification of soil carbon sequestration credits • Create a carbon fund that would pay farmers for sequestering carbon. Australia pioneered this approach in 2013 with the Emissions Reduction Fund, and successfully kick-started a soil carbon market • Discourage urbanisation of agricultural or forested land by increased permitting requirements and costs, as any land that is urbanised takes away from the carbon sink potential
Renewable Energy Directive (RED III)	• Include land use change emissions in Clean Fuel Standard calculations to avoid incentivising high LUC fuel alternatives
Instruments and initiatives outside Fit for 55	• Align agricultural subsidies provided through the Common Agricultural Policy (CAP) with sustainable soil management. Soil carbon sequestration could also be built into member state National Energy and Climate Plans. • The Comet Farm Tool in the USA is a greenhouse gas accounting system for farms. The EU Soil Observatory could be expanded to fulfil this role, providing tailored recommendations to farmers on how to reduce emissions • Improved measurement and monitoring of the EU net carbon sink to create a national baseline below which all individual project credits are invalid for cross border trading, unless the sink is net positive in the year of crediting.

Looking beyond Fit for 55: fixing EU scale-up finance.

4

While creating strong demand signals from the EU is the most important step to scaling up cleantech innovation, improving scale-up finance conditions in Europe will help accelerate the process. We recommend taking the following steps to create continental-scale EU cleantech champions.

More EU cleantech growth funds

The easiest solution to create a culture of continental scale-ups is to back the creation of cleantech growth equity funds. This will happen organically anyway – as cleantech funds start to demonstrate success stories and exits, they are raising bigger and bigger funds, and will be able to raise €300-500 million funds in the next two fundraising cycles. However, we need to accelerate this timeline significantly, and back the creation of cleantech growth funds in 2021 and 2022. This means taking more risk than usual, and pushing VC firms to take bigger bets on cleantech. **It is the most capital-efficient approach** – EU cleantech VC funds already have the pipeline of companies to invest in, and the expertise in helping them scale.

> **"There just isn't enough money in the EU cleantech market. What's more, it is very hard for start-ups to scale beyond their national borders. This is why we are partnering with Demeter to create the GET fund, which will focus on growth funding for EU cross-border opportunities."**
>
> **— Martin Kröner**
> **Managing Partner, Munich Venture Partners**

4. Beyond Fit for 55: fixing EU scale-up finance.

More cross-border funds

To build more continental-scale cleantech champions, we need to get better at scaling promising companies beyond national borders. Currently, companies often get stuck in their own markets, or transfer straight to the US or Asia even before expanding to other EU countries. Here are a few levers to make that change:

Any opportunity to harmonise regulations and certification processes across the continent should be taken. Sonnen's experience is a key example here. Despite their home battery system being certified in Germany, they had to re-start the certification process from scratch for every new member state they entered. This points to larger deficiencies of the EU single market.

Creating cross-border VC funds will help promising companies scale in multiple EU locations. Initiatives such as Demeter IM and Munich Venture Partners' Green European Tech fund are welcome and should be emulated by others.

Attracting pension funds, including via infrastructure plays:

If we are to successfully scale European cleantech champions, a larger share of the European investment ecosystem must go to sustainable innovation. According to Atomico's 2020 State of European Tech[42], European pension funds invested 31.2x more money in buyout funds ($112.3 billion) from 2015 to 2019 than in venture capital funds ($3.6 billion). If some percentage of this money were to slide down to scale-up capital and focus on cleantech strategies, it could easily close the scale-up funding gap. While the current EU regulation of private pension funds sets a broad limit on alternative asset classes, and requires ESG reporting, it does not set clear targets or incentives for the contribution of pension funds to decarbonisation efforts.

[42] State of European Tech, Atomico, data from InvestEurope, 2020

> **"As yields come down in mature clean energy projects, infrastructure investors are setting eyes on emerging themes, such as EV charging stations or even hydrogen infrastructures, and increasingly considering Private Equity-like plays"**
>
> **— Witold Marais**
> **Investment Manager, Mirova**

As traditional investors of pension fund capital, infrastructure investors also have a role to play, by investing in earlier-stage technologies such as electrification of vehicles and the deployment of hydrogen.

Improving IPO and public market conditions:

Improving access to public markets for European cleantech scale-up is crucial to open pools of money that could fill in for the lack of growth equity and create exit routes that will increase investment throughout the lifecycle. Once a company lists, it can also attract funding from institutions and pension funds more easily.

To date, there have been few success stories of EU cleantech companies going public, but we are starting to see some interesting activity emerge, especially on the NASDAQ First North.

The rise of Special Acquisition Companies (SPACs) over the last year has mostly focused on North American targets in vehicle electrification and hydrogen. However, a few EU companies have recently listed via SPAC. While this is a welcome phenomenon, it mostly favours the North American cleantech ecosystem for now.

4. Beyond Fit for 55: fixing EU scale-up finance.

> **"We are in discussions with exchanges to foster more cleantech IPOs. A couple of success stories have shown that once listed, even young companies can receive investment from pension funds."**

— Matias Torrellas
Portfolio Manager, Innoenergy

More blended finance and non-dilutive instruments

Public investors have a key role to play in de-risking cleantech scale-up investments. Instruments like the Energy Demonstration Projects or the EFSI from the European Investment Bank have allowed many EU cleantech companies to finance their early industrialisation and prove they can reach profitability. Such instruments are an important bridge to project finance, which needs a track record to come into play.

Given the outsized role that it plays in Europe, it is crucial that we increase the European Investment Bank's funding for such instruments. It is also important that national and local development banks follow suit. In Northvolt's case, the combined force of the EIB and KfW was instrumental in raising the funds necessary to build the Gigafactory.

> **"The EIB has an important role to play in cleantech financing and advisory support given our mission as the EU Climate Bank and our extensive experience of long-term infrastructure financing."**

— Shiva Dustdar
Head of Division, Innovation Finance and Advisory, European Investment Bank

4. Beyond Fit for 55: fixing EU scale-up finance.

Presented by Cleantech Group

At Cleantech Group, we provide research, consulting and events to catalyse opportunities for sustainable growth powered by innovation. We bring clients access to the trends, companies and people shaping the future and the customized advice and support businesses need to engage external innovation. Industries are undergoing definitive transitions toward a more digitized, decarbonized and resource-efficient industrial future. At every stage from initial strategy to final deals, our services bring corporate change makers, investors, governments and stakeholders from across the ecosystem, the support they need to thrive in this fast-arriving and uncertain future.

The company was established in 2002 and is headquartered in San Francisco with people based in London, Paris and Boston.

With the support of Breakthrough Energy

Established in 2015 by Bill Gates and a coalition of private investors concerned about the impacts of accelerating climate change, Breakthrough Energy supports the innovations that will lead the world to net-zero emissions.

We are building on the proven model of public-private partnerships that Gates has already used to transform health, education, and public welfare around the world. Breakthrough Energy is a network of entities and initiatives, including investment funds, non-profit and philanthropic programs, and policy efforts linked by a common commitment to scale the technologies we need to achieve a path to net zero emissions by 2050. We are encouraging the development of new net-zero energy technologies, championing policies that speed innovation from lab to market, and bringing together governments, research institutions, private companies, and investors to expand and enhance clean-energy investment.

Thank you

Feel free to contact us with any questions you have

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