TECH FOR NET ZERO ALLIANZ

Investing in Net Zero

Assessing Germany's venture capital potential in climate tech until 2030

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Summary and Key Messages

Scaling new and existing climate technologies will be indispensable for the transition to a net-zero economy. Most of the reductions in CO_2 emissions needed to achieve the 2030 climate targets will come from technologies readily available today.[1] However, rapid deployment requires investments in a wave of new companies that will bring much needed climate technologies to market. In addition, achieving global net zero by 2050 will require huge leaps in innovation, as almost half the reductions involve technologies in the demonstration or prototype phase according to the International Energy Agency. Climate tech innovation needs acceleration on all levels of technology maturity – some technologies still require further development, while others are ready for the demonstration phase, and some are already preparing for a widespread market deployment.

Decarbonizing the entire economy is an enormous opportunity for new climate tech start-ups and venture capital investments, which will be critical to help shoulder the risk of breakthrough technologies. Start-up and growth finance can help shorten the technology maturity cycle of new climate tech companies from the usual 25 to about 10 years.[2] Such acceleration is needed to deliver a positive climate impact already by 2030, while holding a promise of high earnings for long-term successful climate tech start-ups. The aim of the investment is to foster technology improvements to drive down costs, accelerate the scale up of climate tech solutions and capitalize on their potential for economic and jobs growth.

As Europe's largest economy and technology powerhouse, Germany has a special role to play in making a climate-neutral future a reality. On the one hand, Germany continues to be the largest source of GHG emissions in Europe, even despite a 35 percent reduction between 1990 and 2019[3].

[1] International Energy Agency, 2021: "Net Zero by 2050 – A Roadmap for the Global Energy Sector".
[2] Moore, 2014: Crossing the Chasm, published by Collins Business Essentials.
[3] GHGs declined from 1,249 million tons of CO_2e in 1990 to 810 million tons in 2019.

On the other hand, given its technology research prowess, the country is well-positioned to lead the development and commercialization of many of the breakthroughs that are needed to fulfil the objectives of the Paris Agreement.[4] The German government aims to achieve climate neutrality by 2045, ahead of many other industrialized nations. The ambitious deployment of climate protection technologies allows Germany to become a lead market and exporter of these technologies.[5]

This report quantifies the investment opportunities for this decade until 2030 to build new start-ups delivering impactful climate technologies across all economic sectors in Germany. The analysis builds on detailed market forecasts to determine the opportunity for climate tech entrepreneurs and venture capital funds. Climate technologies have significantly evolved since the first clean-tech investment wave in the early 2000s. Today, the investment landscape is powered by a broad base of investors who are managing billions of euros to tackle the world's most important global threat and opportunity: climate change. The new wave of climate tech has been bolstered by a staggering rise in extreme weather such as floods and wildfires, an international push for net-zero emission targets and further technology breakthroughs.

The climate tech financing opportunity for venture capital investments in Germany is estimated at an average €22.7 billion per year until 2030. These investments will be needed to build and grow new climate tech start-ups to a scale where they can deliver on decarbonising the economy. Until 2030, new climate tech solutions will require annual investments of €5.9 billion in the energy sector, €6.3 billion in the industry sector; €3.1 billion in the building sector; €4.5 billion in the transport sector; and €3 billion in the agriculture and food sector. These technologies present significant market opportunities, potentially allowing private and public venture capital investors to benefit from the rapidly expanding and highly innovative climate tech market.

[4] https://www.statista.com/statistics/257152/ranking-of-the-20-countries-with-the-most-patent-grants/.
[5] Agora Energiewende, 2021: "Klimaneutrales Deutschland 2045".

Although the trend is increasing, currently less than 5 percent of the required investment volume estimated by this report is flowing into climate tech start-ups based in Germany.[6] The immense investment gap shows the opportunity for new founders and investors, while highlighting the public policy challenge to set effective incentives and establish smart regulatory frameworks for the deployment of decarbonisation technologies. In addition, it will be essential to leverage the massive influx of funding for decarbonisation efforts from the EU Recovery and Resilience Fund and the German Corona recovery fund for the large-scale construction of the infrastructure required by climate technologies.[7] These include investments in the transmission of renewable energy, new pipelines to transport captured CO_2, as well as supplying industrial zones with hydrogen.

Table 1: Germany: Venture capital investment need by sector, annual until 2030

Economic Sector	Annual investment need in billion euros
Energy	5,9
Industry	6,3
Buildings	3,1
Transport	4,5
Agriculture & Food	3,0
Total	22,7

Source: Own calculations based on Capgemini data

[6] Own calculations based on investments reported by PwC, 2020: The State of Climate Tech 2020: The next frontier for venture capital.

[7] Germany will receive €25.6 bn from the Recovery and Resilience Fund, of which €12.5 bn are earmarked for "Decarbonization using renewable hydrogen in particular," "Climate-friendly mobility" and "Climate-friendly renovation and construction."

Background

As greenhouse gas emissions continue to build up in the atmosphere at historic levels, the push to decarbonise the planet is intensifying. Companies and governments are making meaningful commitments to achieve ambitious net-zero targets to meet the growing demands of consumers, investors, and citizens, all of whom want to see progress on climate change. This global effort is creating a renewed push for a variety of climate tech solutions, ranging from energy, to industry, transport and buildings to agriculture and food.

Climate tech innovations are critical to tackle the challenge of decarbonising the global economy and to reach net zero emissions before 2050. The need for post-carbon solutions has grown particularly acute in areas that have had few viable alternatives, such as commercial vehicle fleets, maritime shipping and energy-intensive industry applications like steel and cement production. As alternative renewable energy sources become available, they will have applications across other sectors as well. In steel production, hydrogen and electricity-to-heat processes are available for direct reductions, which enables the decarbonisation of the blast furnace. Every new energy source, from synthetic fuels to green hydrogen, adds to the potential to reduce emissions more broadly, not just in transport but also in other traditionally carbon-dependent industries. Besides financing emission reductions, capital investment into Carbon Dioxide Removal (CDR) technology is vital to achieving the Paris goals and are urgently needed in sectors where emissions are impossible to abate.

Climate tech innovations will affect a wide range of markets in varying depth. The technologies required to achieve the Paris climate goals will include many incremental innovations that improve existing processes, e.g. the use of hydrogen instead of coal in steel manufacturing. In addition, a net zero world requires breakthrough innovations through new products and processes with a substantial competitive edge, e.g. carbon-neutral cement. Overall, this study builds on scenarios that focus on the fast transformation using largely existing technologies. Technical feasibility and market deployment and scaling are the foundation of the analysis,

with an emphasis on climate technologies with low-to-medium technical and business risks, where feasible.

Much of the needed technology is ready to be scaled up by 2030.[8] Achieving Germany's 2030 targets is possible, since more than 80 percent of required technology is already at the market stage and can be scaled now. The remainder is early-stage technologies under development (14.9 percent) and behaviour change by consumers (3.3 percent), such as lower meat consumption. However, in several high-emission sectors, such as heavy industry and long-distance transport, the dependence on early-stage technologies that are still under development is the highest.

Table 2: Source of Emission Reductions by climate tech maturity, in percent

Source of Emission Reductions	2030	2050
Technologies at market stage	81.8	49.8
Technologies at development stage	14.9	45.9
Behaviour changes	3.3	4.3
Total	100.0	100.0

Source: IEA 2021, Net Zero by 2050

A new wave of climate tech start-ups is beginning to tackle some of the sectors lagging in decarbonisation, for which viable business models are starting to emerge. Climate tech has experienced rapid growth in investment between 2013-2019, rising nearly 40-fold in only seven years.[9] In 2020, investment in climate tech start-ups climbed to $14 billion in the U.S., about 6 percent of the total VC market.[10] During the first half of 2021 investments grew to new heights, as climate tech start-ups have secured more than $16 billion in funding in the U.S. – more than any other sector.[11] This impressive growth has been driven by a combination of factors, including growing corporate and consumer demand, an increasing number of founders entering the space, rising investment levels and investor attention, falling infrastructure and technology costs (increasing cost-competitiveness), and more

[8] International Energy Agency, 2021: "Net Zero by 2050 – A Roadmap for the Global Energy Sector"
[9] PwC, 2020: The State of Climate Tech.
[10] Climate Tech VC, 2020: Summary Report.
[11] Climate Tech VC, 2021: Mid-year investment action report.

stringent environmental policy, including carbon pricing and other regulatory incentive mechanisms. However, despite this impressive growth in the U.S, the climate tech landscape in Germany displays lower levels of maturity and, overall, is far from the scale society needs to make the overarching goal of a net-zero-emissions economy a reality by 2050.

To scale the necessary innovations in the field of climate technology as quickly as possible, significant financing is needed in the early stages and during the growth stage of climate tech companies. Market financing is required once basic development has been completed (post-R&D) and ranges from pre-seed financing to early-stage and all the way to growth financing. It comes in parallel to infratech finance for specific projects, which can help in de-risking the commercial operation of transformative technologies. Decarbonising the economy is a multi-billion-euro market and offers one of the greatest investment opportunities of this decade.[12] In addition to finance, several factors affect the overall success rate and resource needs of climate tech start-ups. These include carbon pricing[13], which have a large effect on the performance of brown assets[14]; the availability of de-risking instruments to accelerate the development phase and bridge the valley of death; R&D and related improvements in technological efficiency; project finance to fast-track the needed industrial transformation; green public procurement to activate markets, public incentives, rules and regulation; green standards and labels enabling markets, as well as trade policies, such as carbon border adjustments.

To better understand the overall investment opportunity presented by scaling climate tech start-ups, this report seeks to quantify the investment opportunity across the German economy until 2030. The objective is to show the financing opportunity for venture capital in the climate tech space and thus to inform investors. By quantifying the market potential, investors are better able to gauge the overall upswing of a transformational change of the overall economy.

[12] Carbon 180, 2018: Carbontech report.
[13] https://www.unepfi.org/publications/discussion-paper-on-governmental-carbon-pricing/.
[14] De Haas, R, R Martin, M Muûls and H Schweiger, 2021: Barriers to net-zero: How firms can make or break the green transition, VoxEU.org.

Germany aims to become greenhouse-gas neutral by 2045, with the hardest part of the journey still ahead. The government has set itself the target of cutting emissions by at least 65 percent by 2030 compared to 1990 levels, and by 88 percent by 2040.[15] These targets are set in line with the European greenhouse gas emission reduction plans. Missing these targets would come with enormous costs to advanced economies such as Germany, not only in fines to the European Union, but in damage to its ecosystem, economy, and asset stock.[16] At the same time, decarbonising the economy is a huge opportunity, as EU recovery funds are going to build the infrastructure and enabling conditions for many of these start-ups to scale – from EV charging, to hydrogen, etc. In essence, now is the time to invest in climate tech in Germany.

[15] Bundesregierung, 2021: Generationenvertrag für das Klima, https://www.bundesregierung.de/breg-de/themen/klimaschutz/klimaschutzgesetz-2021-1913672.

[16] https://www.cleanenergywire.org/news/missing-climate-targets-transport-could-cost-germany-billions-euros-report.

Methodology

This report dives deep into the German start-up landscape and climate technologies to estimate of climate tech investment opportunities for Germany until 2030. The analysis leverages the methodological approach and quantitative estimates of the Capgemini 2020 Fit for Net Zero report.[17] The Capgemini data is very rich and is based on comprehensive in-depth market research, which includes hundreds of interviews with technical experts and sector specialists. A detailed description of the methodology can be found in Annex 1. Building on detailed technology and market developments across Europe, the analysis highlights exemplary technologies and areas of applications and estimates overall capital needs.

In view of anticipated market developments, market size and structure, as well as the technological readiness of the most important climate technologies, the current analysis attempts the forecasting of investment needs. For each sector, the top three start-up challenges are ranked by their GHG reduction potential measured in mega-tons avoided CO_2e until 2030 based on the Capgemini data. Subsequently, the total start-up equity investment opportunity is forecast annually until 2030. The analysis builds on the overall project investment gap, the expected market size and the projected average debt-to-equity ratios.

The technology investment gap indicates the difference between the total size of a product market and the expected turnover for the respective product, both by 2030. The market growth until 2030 represents the annual expected size of the market by 2030.[18] Scaled to the German market, the total financing needs for fully developing and deploying each technology are derived.[19] Subsequently the required financing for climate tech start-ups is calculated using the assumed debt-to-equity ratio of the respective technology, which in turn is based on the market-structure and accounts for the expected investment volumes to come from venture capital investors, rather than being financed through debt by existing firms. In addition to the three most

[17] Capgemini, URL: https://www.capgemini.com/resources/investments-in-next-generation-clean-technologies/.
[18] The market forecasts developed by Capgemini are largely in line with the IEA climate scenarios and account for policy shifts towards achieving the 2030 climate targets.
[19] Where applicable, the Capgemini data accounts for interdependent performance of climate tech solutions in different sectors.

important technologies per sector, hydrogen is considered as a single category because of its cross-cutting nature covering several technology categories.

1. Energy

Germany's energy industries are responsible for the largest share and contribute to about a third of the country's greenhouse gas emissions (32 percent, 258 $MtCO_2$ in 2019), above the global average of 27 percent.[20] At the same time, energy related emissions have been cut in half over the past 30 years.[21] Germany aims to further reduce emissions in the energy sector by a total of 61 percent until 2030[22], leading reductions of at least 175$MtCO_2$ equivalents per year compared to 1990.[23]

A successful transition to a net-zero economy will end Germany's dependence on cheap fossil fuels. To change gear, renewable energy supply and sustainable fuels need to be scaled more extensively, including offshore wind. Breakthrough developments of next-generation solar and wind energy are expected to lead to further cost degressions. Challenges such as available space, faster planning and implementation need to be overcome. In addition, technical issues such as energy intermittency will require energy storage solutions and technological solutions for more flexible demand patterns.

In the energy sector, a lot of new regulation at EU and national level in combination with a rising CO_2 price expected to enable the growth of renewables, while putting fossil energy sources out of business.[24] The varied portfolio of available and newly

[20] https://www.breakthroughenergy.org/our-challenge/the-grand-challenges.
[21] UBA, 2021: https://www.umweltbundesamt.de/themen/klima-energie/treibhausgas-emissionen.
[22] https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/klimaschutzplan_2050_bf.pdf.
[23] BMU, 2021: Emissionsdaten. URL: https://www.bmu.de/pressemitteilung/treibhausgasemissionen-sinken-2020-um-87-prozent/.
[24] Regulation includes the Renewable Energy Directive III (RED3); Erneuerbare Energien Gesetz (EEG); Energiewirtschaftsgesetz (EnWG).

emerging technologies will need to be complemented by smart power grids that connect consumers with a variety of energy sources.

Table 2: Climate tech opportunities in energy

Energy	Yearly investment need in billion euros
Biomethane	0.55
Floating off-shore wind	1.20
Solar giga-factories	0.06
Other[25]	4.11
Total	5.9

Source: Own calculations based on Capgemini data

Top 3: Climate tech opportunities in energy

i. Biomethane: €545m p.a. start-up finance

Building on existing research, the largest climate impact in decarbonising the energy sector is expected to come from breakthrough developments in the biomethane industry, with potential reductions of 27.6 $MtCO_2e$ in Germany per year.[26] While the total production volume of biogas is still relatively small, demand is already outpacing supply, turning biogas into a very attractive investment space.[27] At the same time, biogas is somewhat controversial in terms of biodiversity and food supply considerations, and innovations will need to focus on securing feedstock for biogas plants that won't endanger ecosystems and food chains, e.g. organic waste.

Climate tech start-ups are expected to lead the development of new technology applications for increasing biodigester efficiency, while also playing a significant role in biomethanisation infrastructure technology, as well as scaling different technologies for biogas production, and providing marketplaces for upstream feedstock and downstream energy products. New climate tech breakthroughs are expected to lead to large-scale industrialisation based on reduced production costs

[25] Includes energy storage technologies, direct air capture, and new energy infrastructure.
[26] Capgemini, 2020; emission reductions estimated for Germany based on its respective share in European estimates.
[27] In addition, power-to-methane technologies could become a bridge between renewable hydrogen, carbon capture and utilisingising the existing natural gas infrastructure (sector coupling).

of biomethane by at least 30 percent by 2025, which in turn will develop the biogas value chain.

The technical maturity of industrial biomethane is medium, thus expected to accelerate and scale-up until 2030. Given the high investment costs and infrastructure challenges, the debt-to-equity ratio for scaling this technology is expected to be high until 2030. To further reduce high investment costs, the creation of large-scale R&D and competitiveness hubs is expected that would create favorable unit costs in initially protected markets. Overall, the start-up financing need is estimated to reach €545 million per year.[28]

ii. Offshore wind technology: €1.2 bn p.a. start-up finance

The second largest climate impact in decarbonising the energy sector is likely to come from floating offshore wind farms, with potential reductions of at least 15.3 $MtCO_2e$ in Germany per year.[29] Overall, floating wind structures can unlock up to 80 percent of Europe's offshore wind potential through rapid scale-up of new floating wind structures in deeper waters. Most importantly, while the further expansion of onshore wind energy is facing growing political resistance, offshore wind holds the key for fully decarbonising Germany's energy sector, while also generating renewable energy to produce much needed green hydrogen and synthetic fuels.

The largest untapped wind resource potential is located in sea water more than 60 m deep – too deep for conventional offshore wind installations. Models predict a rapid growth across Europe to reach 99 GW of offshore wind installations by 2030, and some 450 GW by 2050.[30] Projects will need to be deployed in seas in the north of Europe where both deep waters and high wind speeds are abundant. Countries around the North Sea such as Germany are part of a strong knowledge cluster, with most offshore wind capacity installed and several floating wind projects either commissioned or under construction.

[28] Calculations based on available Capgemini data and market assessments.
[29] Capgemini 2020; emission reductions based on European estimates.
[30] WindEurope High Scenario 99 GW by 2030; 1.5TECH EU scenario: 450 GW by 2050.

The market is just starting and will grow by more than 20-fold from current trends by 2030 across Europe.[31] More cost-efficient floating technology, erosion-resistant materials and larger offshore volumes will be crucial in driving down costs by 70-80 percent by 2030.[32] Overall, the offshore wind energy market is expected to see more climate tech start-ups raising funds for up to 1.2 bn annually by 2030.

The technical maturity level of offshore floating wind technology is medium, thus expected to accelerate and scale-up until 2030. Given the concentrated market structure with large players, high capital intensity and difficult permitting processes the debt-to-equity ratio for scaling this technology is expected to be low until 2030. Overall, the start-up financing need is estimated to reach €1.2 billion per year.[33]

iii. Next generation solar cells and PV modules: €60m p.a. start-up finance

The potential climate impact of new solar cells and PV modules in terms of emission reductions is up to 12 $MtCO_2e$ in Germany per year.[34] While solar energy has already experienced cost reduction of more than 80 percent in the past two decades, new advances in photovoltaic technology will allow new climate tech start-ups to establish themselves in a mature solar market. German engineering can play a major role in developing the technology for large-scale manufacturing plants for producing multi-junction cells that have been shown to push yields by yet another 30 percent compared to the existing technology.[35] They will eventually be mounted as bifacial modules to further boost panel yields. In addition, improved technology will be needed to reduce the carbon footprint of producing solar panels.

With ever better unit economics, demand for solar cells is expected to grow at 10-15 percent per year across Europe. Germany has the technical know-how, deep R&D and specialised manufacturers to seize the market. Germany has world-class solar research clusters, which will likely be a source of new climate tech start-ups for these

[31] At current trends only 4-5 GW are expected to be installed by 2030. By 2050 we require a 25-fold increase in offshore wind: https://windeurope.org/intelligence-platform/product/a-2030-vision-for-european-offshore-wind-ports-future-trends-and-opportunities/.
[32] Cost reductions are expected from around €200/MWh to €40-60/MWh by 2030.
[33] Calculations based on available Capgemini data and market assessments.
[34] Emission reductions based on European estimates (Capgemini 2020).
[35] Solar panel generation III-V and/or perovskites on silicon yield 40% efficiency in the lab compared to the current maximum of 30% with existing technology (Capgemini 2020).

technologies in 2022-2025. Overall, the solar panel market is expected to see more funding rounds up to 60m annually, with the remainder of the required growth capital likely coming from debt financing.

The technical maturity level of solar technology is mature and expected to grow fast until 2030. Given the highly commoditized product, the market structure is very homogeneous involving a huge number of players. The debt-to-equity ratio for scaling this technology is expected to be medium until 2030. Overall, the start-up financing need is estimated to reach €60 million per year.[36]

2. Industry

The industrial sector is the second-largest source of carbon emissions in Germany and accounts for 23 percent of total emissions (187 $MtCO_2e$ in 2019), significantly below the global average of 31 percent.[37] Germany aims to reduce industry emissions by 49 percent until 2030, leading to annual emission reductions of at least 140 million tons of CO_2 equivalents.[38] During the production process, most emissions are generated from the use of energy use needed to obtain high-grade and low-grade heat. In addition, direct emissions from production processes, e.g. chemical reactions including plastics, are another large source of CO_2. By industry, cement and steel production are the top emitters, where hydrogen and electrification could help cut emissions. Regulatory pressure and incentives are growing quickly to decarbonise industry, creating large markets for new climate tech applications.[39]

[36] Calculations based on available Capgemini data and market assessments.
[37] https://www.breakthroughenergy.org/our-challenge/the-grand-challenges.
[38] Klimaschutzplan 2050. URL: https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/klimaschutzplan_2050_bf.pdf.

[39] Regulation includes the European Emission Trading Scheme (ETS 1 und 2); Energy Taxation Directive; Energy Efficiency Directive; Alternative Fuels Infrastructure Directive (AFID); Carbon Border Adjustment Mechanism (CBAM).

For Germany to achieve net-zero greenhouse gas emissions, carbon dioxide removal (CDR) is needed. The climate scenario modelling of the IPCC for the 1.5°C path as well as the European Commission scenarios for reaching net-zero target by 2050 include extensive use carbon capture utilisation and storage (CCUS).[40] A recent study modelling net-zero pathways for Germany arrives at 63 million tons of CO_2 equivalent residual emissions annually that need to be neutralised using permanent CDR.[41] While carbon capture technology is developing quickly, carbon storage is currently not possible in Germany due to outdated regulation.[42] Financing and scaling carbon capture infrastructure in Germany can achieve important synergies with other CDR approaches and emission reductions, especially in the transport sector. Sustainable CO_2 sourced from direct air capture can play a key role as feedstock for synthetic sustainable aviation fuels in achieving clean transport.

Table 3: Climate tech opportunities in Industry

Industry	Yearly investment need in billion euros
Heat Supply	0.23
Refrigerants	0.05
Cement	0.93
Other[43]	5.09
Total	6.3

Source: Own calculations based on Capgemini data

Top 3: Climate tech opportunities in industry

i. Industrial Heat: €230m p.a. start-up finance

Building on existing research, the largest climate impact in decarbonising the industry sector is expected to come from breakthrough developments in industrial

[40] IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C; EUU Climate Strategy, URL: https://ec.europa.eu/clima/policies/strategies/2050_en.
[41] Agora Energiewende, 2021: Klimaneutrales Deutschland 2045, URL: https://static.agora-energiewende.de/fileadmin/Projekte/2021/2021_01_DE_KNDE2045/KNDE2045_Langfassung.pdf.
[42] Kohlendioxidspeicherungsgesetz (KDSG).
[43] Includes hydrogen in heavy industry, plastics and circular economy, energy efficiency, and carbon capture technologies.

heat, with potential annual reductions of 24.5 $MtCO_2e$ in Germany.[44] Industry process heat, both at high (300-1000°C) and low levels (up to 300°C), is currently mostly produced from fossil-fuels.

High-temperature heat generation (>300°) poses a challenge as it is typically produced using fossil fuels as electrical resistors are not able to generate enough heat. Hydrogen could help once available at a lower cost. For lower temperatures and cooling, industrial heat could be largely decarbonised by geothermal energy and biogas, especially where it can replace coal and gas in industrial low- and medium temperature heat generation.[45]

Renewable energy sources such as geothermal energy, biomass, waste, hydrogen and green electricity are expected to grow as feedstock for generating industrial heat. New technologies are under development for high-temperature heat, in addition to industrial applications of geothermic heating pumps for low-temperature heat needs. In addition, the market for retrofitting to enable symbiosis and circular reuse of wasted high-temperature heat through heat networks within large industrial clusters and ports is likely to play a major role in reducing overall industry emissions.

The overall technical maturity of process heat is at a high level and expected to grow fast until 2030. Given the semi-concentrated market structure, the debt-to-equity ratio for scaling this technology is expected to be medium until 2030. Overall, the start-up financing need is estimated to reach €230 million per year.[46]

ii. Sustainable Refrigerants: €55 million p.a. start-up finance

The second largest climate impact in decarbonising the industry sector is likely to come from reducing the emissions from refrigerants, with potential reductions of at least 22.2 $MtCO_2e$ in Germany per year.[47]

The global warming power of many refrigerants is about 2,000 times greater than that of CO_2, and their lifetime in the atmosphere exceeds 13 years. At the same time, HFC emissions due to refrigerants has been increasing since 1990 by 10 to 15 percent

[44] Capgemini, 2020; emission reductions based on European estimates.
[45] BCG, 2020: Climate Paths for Germany.
[46] Calculations based on available Capgemini data and market assessments.
[47] Capgemini, 2020; emission reductions based on European estimates.

annually. While some of the most dangerous refrigerants have been phased out with the Montreal Protocol in 1987[48], a newer generation of refrigerants called HFC are still a powerful driver of climate change.[49] The EU agreed in 2015 to phase out HFCs by 2030 for all refrigerants use. The phase-out is starting to make progress, allowing the market for ultra-low-GHG solutions to grow. Scaling the use of low-emission refrigerants across sectors and developing of alternative refrigerants will provide additional opportunities for climate tech start-ups.

The overall technical maturity of process heat is at a relatively advanced level and is expected to grow fast until 2030. Given the semi-concentrated market structure, the debt-to-equity ratio for scaling this technology is expected to be medium until 2030. Overall, the start-up financing need is estimated to reach €55 million per year.[50]

iii. Decarbonising cement production: €930 million p.a. start-up finance

Cement production accounts for about 2 percent of CO_2 emissions, and clinker production alone generates two thirds of those emissions. 16,5 $MtCO_2e$ can be saved each year by decarbonising cement production in Germany.

Replacing clinker with substitutes would allow using less clinker per unit of cement and could cut emissions by 18 percent according to existing climate forecasts. The development of alternative clinkers that replace classic Portland clinker altogether could achieve an additional 17 percent cut in CO_2 emissions. In addition, scaling up carbon capture at cement kilns at an industrial scale could help to reduce a further 14 percent of cement-based emissions by 2030. Captured CO_2 can be partly reused with recycled concrete granulates to increase material strength. Several other technologies such as oxyfuels allow reducing emissions from cement production, which demand growing rapidly as the cement industry is renewing itself.

The overall technical maturity of sustainable cement production is at a medium level and expected to accelerate and scale-up until 2030. Given the highly concentrated, oligopolistic market structure, the debt-to-equity ratio for scaling this technology is

[48] Reduction of 97% of chlorofluorocarbons.
[49] Hexafluorocarbons.
[50] Calculations based on available Capgemini data and market assessments.

expected to be high until 2030. Overall, the start-up financing need is estimated to reach €930 million per year.[51]

3. Buildings

The building sector is the fourth largest source of carbon emission in Germany, accounting for 15 percent (123 $MtCO_2e$ in 2019), more than double the global average of 7 percent.[52] Germany aims to reduce emissions from buildings by 61 percentage points until 2030[53], leading to emission reductions of at least 70 $MtCO_2$ equivalents per year. These emissions stem from the energy used to heat and cool buildings, warm water, and the direct use of electricity.

The main challenge in decarbonising the building sector lies in retrofitting the existing housing stock, especially in cities where insulations and deep renovations are very complex. On average, three-quarters of all buildings are residential across Europe, with more than 40 percent constructed before 1960, when energy efficiency and other regulations were very limited. Crucially, three-quarters of today's buildings will continue to exist in 2050. Thus, renovating the existing building stock is a top priority for a near-zero emission status.

New regulation at EU and national level in combination with sizable public funds is paving the way for eliminating emissions in the building sector.[54] To this end, several new technologies will need to be installed in most buildings, including energy efficiency measures (insulation), on-site energy production facilities (PV and geothermal systems), or electrification (heat pumps) including smart sensors and

[51] Calculations based on available Capgemini data and market assessments.
[52] https://www.breakthroughenergy.org/our-challenge/the-grand-challenges.
[53] BMU, 2021: Emissionsdaten. URL: https://www.bmu.de/pressemitteilung/treibhausgasemissionen-sinken-2020-um-87-prozent/.
[54] Regulation includes the European Emission Trading Scheme (ETS 1 und 2); Brennstoffemissionshandelgesetz (BEHG); Gebäudeenergiegesetz (GEG).

metres. The annual renovation rate will increase to at least 3 percent to achieve the government's climate objectives.

To ensure renovations are taking place, a growing set of rules and regulations are creating fast growing markets in the buildings space. Public funding through grants and special financing for homeowners provide opportunities for new climate tech companies to contribute to the race for net zero. Accordingly, the market for heat pumps, new insulation materials and deep renovations is starting to grow rapidly. In addition, future materials will need to be largely recyclable to reduce their lifetime carbon footprint.

Table 4: Climate tech opportunities in Buildings

Buildings	Yearly investment need in billion euros
Green energy in buildings	1.31
Deep renovations	0.93
New building processes	0.82
Total	3.1

Source: Own calculations based on Capgemini data

Top 3: Climate tech opportunities in buildings

i. Warm water and heating: €1.31 bn p.a. start-up finance

Based on existing research, the largest climate impact in decarbonising the building sector is expected to come from breakthrough developments from heat pumps, with potential reductions of 6.5 $MtCO_2e$ in Germany per year.[55] The electrification of heating and cooling equipment is necessary to reach near-zero emissions for buildings. According to the IEA, heat pumps can save 50 percent of emissions in the building sector, as well as 5 percent of emissions in industry. In addition, with heat waves becoming the norm in many regions, the demand for cooling technologies is forecast to grow.

On the demand side, up-front investment requirements are still relatively high compared to oil or gas equipment, allowing new climate tech start-ups to focus on

[55] Capgemini, 2020; emission reductions based on European estimates.

improved efficiency, better technology, and leaner production to seize shares in a growing market. The market covers three sectors: residential, commercial buildings and industry applications. In addition, small heat pumps will be required for heating and cooling in electric cars creating potential synergies. Commercial buildings account for about 40 percent of demand which is forecast to grow exponentially in the coming years, including cooling equipment.[56]

The overall technical maturity of warm water, and heating and cooling technology is already at an advanced level with the market expected to quickly expand until 2030. Given the mass-market structure, the debt-to-equity ratio for scaling this technology is expected to be medium until 2030. Overall, the start-up financing need is estimated to reach €1.31 billion per year.[57]

ii. Deep renovation: €930 million p.a. start-up finance

The second largest climate impact in decarbonising the building sector is bound to come from reducing heat related emissions by enabling deep renovation, with potential reductions of at least 2.8 $MtCO_2e$ in Germany per year.[58] Governments are under pressure to increase the rate of renovations of the European building stock in Germany and across the European Union, as private and public buildings account for around 40 percent of EU energy use. New regulations and funding schemes are creating ever larger demand for affordable renovations in a market that is forecast to exceed €110 bn by 2030 across Europe.

Deep renovations will require new technologies to apply next-generation insulation materials, smarter heating and cooling using building surfaces, as well as alternatives to traditional cost-intense processes such as scaffolding, roof tiling, etc. New technologies will need to focus on reducing cost by shortening month-long building insulation projects. The use of industrialised components will play a critical role in deep renovations, all in an effort to reduce cost per m^2. In addition, coordinated renovation programs and the use of digital tools can help to further standardize and industrialise the renovation process. These technologies are expected to lead to faster and more efficient processes as well as lower unit costs.

[56] Capgemini, 2020.
[57] Calculations based on available Capgemini data and market assessments.
[58] Capgemini, 2020; emission reductions based on European estimates.

The building sector is fragmented, which allows relatively easy market access for new technologies. The overall technical maturity of deep renovation technologies is at a mature level and expected to grow fast until 2030. Given the highly dispersed mass-market structure, the debt-to-equity ratio for scaling this technology is expected to be medium until 2030. Overall, the start-up financing need is estimated to reach up to €930 million per year.[59]

iii. New building processes: €816 million p.a. start-up finance

The third largest climate impact in decarbonising the building sector is likely to come from new building processes, with potential reductions of at least 2.2 $MtCO_2e$ in Germany per year.[60]

Digital tools have strong potential to improve building sustainability and lower the environmental impacts. New climate tech start-ups enabling the use of building information modelling through drone scans, 6D-features to integrate lifecycle information, building sensors to improve energy and indoor performance, digital building passes, etc. can play a major role in cutting costs and emissions. In addition, construction techniques such as prefabricated or modular components, 3D printing of building materials and additive manufacturing can deliver further streamlining.

Promising new insulation technologies such as phase-change materials and heat recovery devices are bound to meet rapidly growing demand as they can optimize heating and cooling management. In dense urban areas thin insulation materials are required for space conservation and to maintaining asset value. In cities, the deployment of vertical photovoltaic systems integrated to the windows or walls is forecast to rise significantly to harvest enough solar energy.

The overall technical maturity of new building processes is at medium level, thus expected to accelerate and scale-up until 2030. Given the highly dispersed mass-market structure in the building sector, the debt-to-equity ratio for scaling this

[59] Calculations based on available Capgemini data and market assessments.
[60] Capgemini, 2020; emission reductions based on European estimates.

technology is expected to be medium until 2030. Overall, the start-up financing need is estimated to reach €816 million per year.[61]

4. Transport

The transport sector accounts for more than one fifth of Germany's greenhouse gas emissions (20.2 percent; 164 $MtCO_2e$ in 2019), above the global average of 16 percent.[62] Most of these greenhouse gases are emitted on roads. Liquid fossil fuels, that power most of transport, are dense in energy and thus not easy to replace with new, clean alternatives which require building new infrastructure.

New regulation and financing at EU and national level is paving the way for decarbonising emissions in the transport.[63] They include support for electric vehicles, charging stations, trains, urban transport, and new mobility solutions. The renewed push is meant to counter the stagnating trend, where emissions reduced in all other sectors in the past 30 years, while transport related GHGs have stagnated and even slightly increased. Under its current legislation, Germany's aims to reduce emissions from transport by 40 percent until 2030[64], leading to reductions of at least 70 $MtCO_2e$ per year.

[61] Calculations based on available Capgemini data and market assessments.
[62] https://www.breakthroughenergy.org/our-challenge/the-grand-challenges.
[63] Regulation includes the ReFuel Aviation and ReFuel Maritime Directives; Brennstoffemissionshandelgesetz (BEHG).
[64] BMU, 2021: Emissionsdaten. URL: https://www.bmu.de/pressemitteilung/treibhausgasemissionen-sinken-2020-um-87-prozent/.

Table 5: Climate tech opportunities in Transport

Transport	Yearly investment need in billion euros
EV Charging	0.73
E-fuels	0.32
Electrified heavy-duty transport and urban bussing	0.64
Other[65]	2.80
Total	4.5

Source: Own calculations based on Capgemini data

Top 3: Climate tech opportunities in transport

i. Electric Vehicle Charging Infrastructure: €730 million p.a. start-up finance

The largest climate impact in decarbonising the transport sector is expected to come from breakthrough developments from electric vehicle (EV) charging stations, with potential reductions of 1.83 $MtCO_2e$ in Germany per year.[66]

The German EV market is expected to reach 2 to 2.5 million units per year by 2030, with most net-zero scenarios assuming 80 percent of passenger cars to be electric by 2050. This necessitates a tremendous expansion in private and public charging infrastructure as well as access to vast quantities of latest-generation batteries. This implies a business opportunity of massively deploying charging points at private homes and offices to ease adoption and use of e-mobility. With declining prices of EVs, increasing variety of EV models and growing driving ranges, the main bottleneck for the growth in the EV market will soon be access to charging infrastructure. Climate tech start-ups can help close the gap by deploying additional charging infrastructure at home and in offices to accelerate EV market penetration.

In the light of the persisting heterogeneity of available charging companies, progress in standardisation and technology have recently boosted the charging infrastructure. This is good news as EV uptake closely follows the deployment of chargers. Already today, more than 90 percent of charging installations in Europe are private charging

[65] Includes hydrogen-based fuels for aviation, shipping, heavy duty trucking and regional trains; EV batteries; etc.
[66] Capgemini, 2020; emission reductions based on European estimates.

points. Growing demand and regulatory pressure to add charging stations into new residential buildings will lead to a sustained market.

The overall technical maturity of EV charging infrastructure is already relatively high and the drive to market targets nearly 14 million EVs in Germany by 2030.[67] In Germany, where almost two-thirds of households have a garage or parking space, installations of private charging stations are particularly attractive. Given relatively easy market entry and a high debt-to-equity ratio for scaling this infrastructure technology, the start-up financing need is estimated to reach €730 million per year for this upcoming decade.

ii. Synthetic fuels for aviation and shipping: €320 million p.a. start-up finance

The second largest climate impact in decarbonising the transport sector is likely to come from reducing the emissions from aviation and shipping, with potential reductions of at least 0,99 $MtCO_2e$ in Germany per year.[68]

Liquified Natural Gas (LNG) continues to be the cleanest shipping fuel on the market for now, despite its substantial climate footprint. However, biofuels could eventually substitute LNG, yet biofuels depend on further cost reductions through scaling production. Alternatively, clean e-fuels for aviation and shipping such as synthetic methanol, could soon develop into cost-competitive alternatives. As Germany moves towards net-zero, the CO_2 feedstock needed to produce e-fuels will increasingly come from sustainable sources of CO_2, such as directly from the air, presenting relevant synergies for the scale up of carbon capture technologies.

Given Germany's large seaports, German climate tech start-ups are bound to become leading players in the field of sustainable fuels. Hamburg is already trying to position itself as major entry port for synthetic shipping fuels, while aiming at producing 1 million tons of e-fuel for its cargo-ships. This would require about 170,000 tons of hydrogen[69], which could ideally be supplied by nearby offshore wind and solar power plants. These e-fuels would help reduce the significant carbon footprint of cargo shipping, which exceeds global aviation emissions.

[67] https://www.bloomberg.com/news/articles/2021-07-13/germany-sees-14-million-electric-vehicles-on-its-roads-by-2030.
[68] Capgemini, 2020; emission reductions based on European estimates.
[69] Capgemini, 2020.

The first tech companies developing sustainable aviation fuels are emerging, however Germany and Europe are still a long way from large-scale market deployment, as demand only recently started to grow. Once technologically mature, fuel start-ups are expected to produce price-competitive alternative fuel for air travel which are expected to further grow within industrial clusters and transport hubs.

The overall technical maturity of aviation and shipping e-fuels is still at a relatively low-to-medium level and expected to accelerate and scale-up until 2030. Given the concentrated, oligopolistic market structure in both air and ship transport, the sector is ripe for disruption despite the difficulty to enter. Thus, the debt-to-equity ratio is assumed to be low. Overall, the start-up financing need for sustainable shipping and aviation fuels is estimated to reach about €320 million per year.[70]

iii. Electrifying heavy-duty transport and urban bussing: €635 million p.a. start-up finance

Climate impact: emission reductions of 0,423 $MtCO_2e$ in Germany per year can be achieved by new climate technologies to electrify short and medium distance trucks. Already today, car makers are offering small trucks with 16 tons capacity and a range of 300km. New climate tech start-ups can grow in this market by providing battery technology and solutions that extend the lifetime of EV trucks. Scaling up electric truck transport capabilities in Europe can be financed by leveraging public-private investment initiatives. For example, the European Investment Bank forecasts that up to 10 percent of truck fleets will be electric by 2030.[71]

Further, deploying electric vehicles for public transport, waste collection, and postal deliveries in urban areas has already been shown to be a promising and easy-to-enter market. Electrifying all municipal transport would not only avoid emissions but also reduce air and noise pollution otherwise caused on short distance transport trips.

The overall technical maturity of electrifying heavy transport and urban bussing is at the acceleration and scaling-up stage, yet only expected to expand slowly until 2030. As large construction machines and trucks for heavy loads and long-distance

[70] Calculations based on available Capgemini data and market assessments.
[71] Capgemini, 2020.

traveling will remain difficult to run on electric batteries, e-fuels will have the same role as in aviation and shipping. Given the market structure of truck and bus producers and the prevailing public procurement systems, the debt-to-equity ratio for scaling this technology is expected to be high. Overall, the start-up financing need is expected to reach €635 million per year. [72]

5. Agriculture and Food

The agriculture and food sector accounts for 9.6 percent of GHG emissions in Germany (164 $MtCO_2e$ in 2019), slightly above the global average of 7 percent.[73] Germany aims for emission reductions in agriculture and food by 61 percent until 2030[74], leading to emission reductions of at least 58 $MtCO_2$ equivalents.

Currently, the European agro-sector generates 430.5 MtCO2e, with 90 percent of emissions from soils nitrification and denitrification, enteric fermentation, and manure management. Only about 10 percent, that is 35.5 $MtCO_2e$ directly result from the food and beverage industry. However, the food and beverage industry generate more than a trillion Euro in annual turnover, of which about 20 percent are generated by the meat sector, which makes it an attractive market.

Reducing the environmental impact of the entire agricultural value chain from farm to fork is forecast to reduce emissions by 20 percent in 2030 and 50 percent in 2050. This can be achieved through new technologies, including creating alternative sources of proteins and synthetic meat to reduce the dependency on livestock production. In addition, expanding agriculture 4.0, and applying more sustainable practices, such as conservation agriculture and organic agriculture will help reduce emissions across the sector. New regulation in combination with financing through

[72] Calculations based on available Capgemini data and market assessments.
[73] https://www.breakthroughenergy.org/our-challenge/the-grand-challenges.
[74] BMU, 2021: Emissionsdaten. URL: https://www.bmu.de/pressemitteilung/treibhausgasemissionen-sinken-2020-um-87-prozent/.

the EU and national level is already paving the way for decarbonising emissions from agriculture and food.

Table 6: Climate tech opportunities in Agriculture and Food

Agriculture & Food	Yearly investment need in billion euros
Meat alternatives	1,01
Sustainable Farming	0,24
Agriculture 4.0	0,21
Other[75]	1,54
Total	3,0

Source: Own calculations based on Capgemini data

Top 3: Climate tech opportunities in agriculture and food

i. Alternatives to Meat and Dairy Products: €1.01 bn p.a. start-up finance

The market for plant-based and cell-based alternative meat products is expected to replace up to 20 percent of the meat consumption by 2030 across Europe. In addition, changing dietary habits will create a market for synthetic dairy products, requiring new milk technology development. The change in the diary market is estimated at 10 percent by 2030. Combined, alternative meats and synthetic dairy products could help save up to 51 $MtCO_2e$ per year.

So far there are only a few alternative plant-based meat products and almost no cell-based alternatives, providing ample opportunities for new climate tech start-ups. Market size is thus low, and until recently most alternative meat companies failed to successfully imitate original products. Effective research and technological development can break down these last barriers of go-to-market and unleash the acceleration of alternative meats and synthesized milk products. While plant-based meat alternatives are already available, quality and production need to be ramped-up across Europe. One such solution is cultured meat, which is a highly innovative solution but has economic barriers to overcome before becoming competitive.

[75] Includes solutions to reduce methane emissions from enteric fermentation; faster-growing feedstock crops; less-fertiliser dependent crops; etc.

The overall technical maturity of alternative meat and dairy products is still at a relatively low level requiring more development and certification. As a result, the overall market for alternative meats is expected to initially grow slow before speeding up by 2030. Given the dispersed market structure and state of development, the debt-to-equity ratio for scaling this technology is expected to be low. Overall, the start-up financing need for alternative meats and dairy products are estimated to reach €1.01 billion per year.[76]

ii. Sustainable Farming Techniques: €240 million p.a. start-up finance

The second largest climate impact in agriculture and food is likely to come from the broad field of sustainable farming techniques. It holds the key for potential reductions of at least 0,82 $MtCO_2e$ in Germany per year.[77] Agriculture is among the hardest sectors to decarbonise, as very few low-emission alternatives exist to date. Conservation agriculture and sustainable farming systems are likely going to play a critical role in cutting farming costs as well as emissions. While systemic approaches to lower GHG emissions from farms have proven efficient, they are currently still not widespread across European farms.

Until 2030, it is forecast that sustainable farming practices will be widely deployed through regulatory pressures and financial incentives and are expected to cut a fifth of all emissions in agriculture. A new generation of farming start-ups is needed to scaleup the latest research into new technologies. Specifically, tested methods of Conservation Agriculture as well as developing sustainable livestock farming systems that can help reduce emissions from meat and dairy industries offer opportunities to climate tech start-ups. An anticipated EU carbon credit program and other financial incentives are expected to create a viable market. The scale up of sustainable crop and livestock farming systems will encourage local farmers to adopt sustainable farming models.

The overall technical maturity of sustainable farming techniques is at medium level and expected to grow accelerate and scale-up until 2030. Given the highly dispersed

[76] Calculations based on available Capgemini data and market assessments.
[77] Capgemini 2020; emission reductions based on European estimates.

market structure the debt-to-equity ratio for scaling this technology is expected to be low. Overall, the start-up financing need is estimated to reach €240 million per year.[78]

iii. **Agriculture 4.0: €210 million p.a. start-up finance**

The third largest climate impact in agriculture and food is likely to come from the field of agriculture 4.0. It holds the key for potential reductions of at least 0,581 $MtCO_2e$ in Germany per year.[79]

Digital solutions to increase productivity while lowering GHG emissions need a boost, moving from the 5 percent front-runner farmers to broad application. Innovative instruments such as robotics, IOT, satellites, and AI offer great, yet under-exploited potential in the agricultural sector. Accelerating the deployment and uptake of these tools will help deliver more environmentally friendly practices. These will save vital inputs such as water, fertilisers, pesticide, and others, reduce farm-related CO_2 emissions, soil compaction, optimize yields and quality in agricultural production.

The overall technical maturity of agriculture 4.0 farming techniques is at a medium level and expected to grow, accelerate and scale-up until 2030. Given the highly dispersed market structure the debt-to-equity ratio for scaling this technology is expected to be low until 2030. Overall, the start-up financing need is estimated to reach €210 million per year.[80]

[78] Calculations based on available Capgemini data and market assessments.
[79] Capgemini 2020; emission reductions based on European estimates.
[80] Calculations based on available Capgemini data and market assessments.

6. Hydrogen

€660 million p.a. start-up finance

As an energy carrier, hydrogen is cross-cutting in nature and spans several technological categories, including energy, industry, and transport. It is estimated that the total start-up equity investment opportunity for Germany is about €660 million per year. The associated reductions in annual emissions equate 1.8 $MtCO_2e$.

The hydrogen technologies covered by the analysis include the large-scale production of hydrogen, the hydrogen reduction of iron ore for basic oxygenated furnaces, green on-site hydrogen production in refineries, as well as the shift to hydrogen for short- and medium-distance ferries, heavy-duty road transport, trucking and high-speed inter-city trains.

Hydrogen is of particular relevance for decarbonising sectors such as steel production, which makes up 35 percent of European industrial emissions. The production of hydrogen in Germany and Europe will be mostly green, meaning entirely produced with renewable energy.[81] Small- and large-scale production is feasible and allows new climate tech start-ups to develop modular island solution for on-shore and off-shore production (e.g., from wind energy, waste, biogas, etc.). In addition, production of green hydrogen in large-scale refineries will be critical to fast-track the needed transition, and some early-stage pilot projects have already been successful.[82] Large production facilities of green hydrogen remain necessary to drive down costs.

Moreover, replacing fossil fuels with green hydrogen (or hydrogen-based e-fuels) for ferries, heavy-duty transport and high-speed trains either requires retrofitting existing vehicles, or increasing transport cost, which provides further opportunities for climate tech start-ups to shape a new and rapidly growing market. The production of hydrogen will mostly take place from huge industrial hubs, especially ports and airports along emerging freight hydrogen corridors, which are close to emerging new green hydrogen production facilities and renewable energy sources such as offshore

[81] Blue hydrogen is unlikely to be cost competitive, since it is based on fossil gas in combination with expensive carbon capture. Regulatory restrictions further complicate blue hydrogen, since carbon storage is effectively not permitted in Germany. See for example KPMG: https://home.kpmg/xx/en/home/insights/2020/11/the-hydrogen-trajectory.html.

[82] Capgemini 2020.

wind. For train transport, Germany is actually a forerunner in successfully launching hydrogen trains, which not only reduce emissions, but also local pollutants and noise.[83] At the same time, the growth potential for green hydrogen depends on the availability of renewable energy, in particular on the rapid expansion of offshore wind farms.

The overall technical maturity of hydrogen and its applications is at a medium level and expected to grow, accelerate and scale-up until 2030. Given the oligopolistic market structure, the debt-to-equity ratio for scaling this technology is expected to be high. Overall, the start-up financing need is estimated to reach €660 million per year.[84]

[83] Capgemini 2020.
[84] Calculations based on available Capgemini data and market assessments.

Annex: Methodology

For each sector, the top three start-up challenges are ranked by their carbon dioxide emission reduction potential measured in mega-tons avoided until 2030 within Europe. Subsequently, the total start-up equity investment opportunity is forecast on an annual level until 2030.

The analysis builds on the overall project investment gap and the expected market size by 2030. The project investment gap indicates the difference between the total size of a product market and the expected turnover for the respective product, both in 2030. The market growth until 2030 represents the annual expected size of the German market by 2030, which implicitly implies that the current market is assumed to be zero. We break these numbers down from the European level to the German market by multiplying it with the German export share in European trade of 37 percent. This results in the German Investment Need p.a. in billion Euro, thus the total financing that needs to be mobilised in order to fully develop and deploy a given product technology.

We then compute the debt-to-equity ratio based on the market structure in the respective technological category. When the market concentration is very high, companies tend to be mature and able to secure debt financing without requiring much equity, hence a high debt-to-equity ratio of 80 percent is assumed. This is the case for example for climate technologies in the cement-industry, which is typically the text-book example of a market oligopoly. For markets which only show a medium-amount of concentration a debt-to-equity ratio of 50 percent is applied, for example, for many solar cell technologies. Lastly, highly dispersed markets with a variety of stakeholders on the demand and supply sides allow new climate technologies to be developed and scaled through newly founded start-ups. In such a market structure the debt-to-equity ratio is assumed to be relatively low and is set at 20 percent, as most financing will be raised through equity. This is the case for some agricultural technologies.

Finally, the required financing for climate tech start-ups is calculated focusing on climate technologies in Germany until 2030. This is done by multiplying the debt-to-equity share of each of the top three climate technologies for each sector with the debt-to-equity ratio. This ultimately provides an estimate of the financing required to develop and scale climate tech start-ups until 2030. The final estimates provide an aggregate overview of the venture capital funding needs to incubate and grow successful climate tech ventures. Note that these are equity investments in companies, which differ from the previously estimated project finance required to finance individual technological enhancements within each category.

TECH FOR NET ZERO ALLIANZ

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The alliance is formed by the leading innovation stakeholders in Germany, who jointly demonstrate the potential of innovative technologies to achieve climate neutrality in Germany.. The alliance engages with political decision-makers to shows where action is needed to strengthen Germany's position as a technological leader, driver of the energy transition and innovation-friendly location for business.

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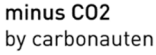
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