June 2023

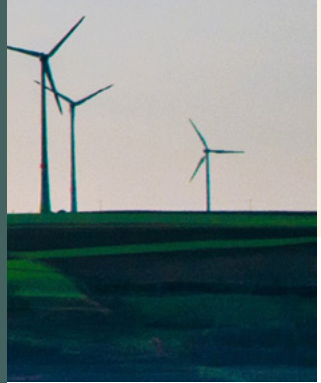
IMPLEMENT
CONSULTING GROUP_

Summary report

# DIGITAL DECARBONISATION

## Accelerating Germany's climate protection with efficient digital solutions

An Implement Consulting Group study
commissioned by Google




THE
BUZZ

This report builds on the European perspective in our Digital Decarbonisation report published October 2022 and follows the publication of Digital Decarbonisation Sweden April 2023 This version looks closer at the German situation and identifies case studies of German firms from various sectors enabling and accelerating the green transition across the economy and society.

Like the previous reports, this report focuses on the role of digital technology in relation to climate protection. It also presents progress to date towards a carbon-free and environmentally sustainable tech sector.

The report reviews German climate policies and digital transformation efforts and highlights the importance of a close partnership between the tech sector and policy makers for solving key environmental challenges while strengthening German competitiveness.

The report invites a conversation around how digital technologies can accelerate the green transformation in Europe and thereby contribute to key short-term and long-term policy objectives.

**Commissioned by**

Google

# **Digital technologies** are key to driving decarbonisation in Germany and Europe

The digital sector is supporting all major sectors of the economy to decarbonise.

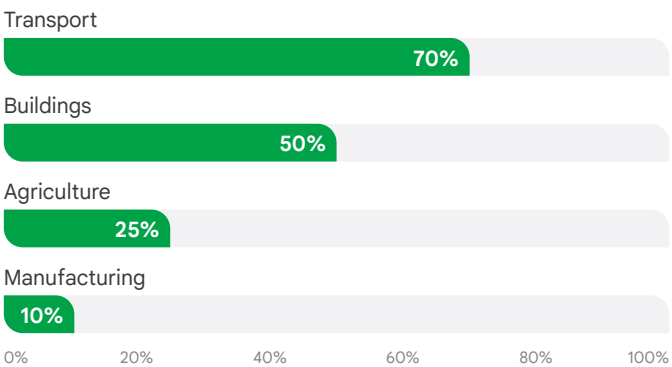
## 20-25%

of the **greenhouse gas (GHG) reductions** needed to reach net-zero in Germany will require **digital solutions**. This is 150-180 $MtCO_2e$ which is equivalent to Germany's manufacturing emissions.

Four sectors – transport, buildings, agriculture and manufacturing - make up two-thirds of Germany's GHG emissions.

**Digital technologies** will play a key role in **decarbonising all of them**.

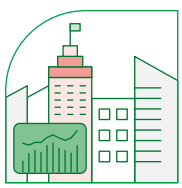
**Digital contribution - Share of pathway to net-zero in each sector enabled by digital technology**



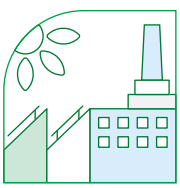

## Examples of how digital can help reduce emissions

**Transport**
Video conferencing reduces the need to travel.

**Agriculture**
Sensors and satellite data help increase the efficiency of crops.



**Buildings**
Artificial intelligence uses real-time data to shrink energy use.



**Manufacturing**
Energy savings through digital-driven process optimisation.

Implement Consulting Group study commissioned by Google.
"Digital decarbonisation: Accelerating Germany's climate protection with efficient digital solutions", 2023.

# **The digital sector** continues to innovate on reducing its own emissions

The digital sector is leading the zero-carbon transition and data centres help enable more reductions than they emit.

## 7.8 $MtCO_2e$

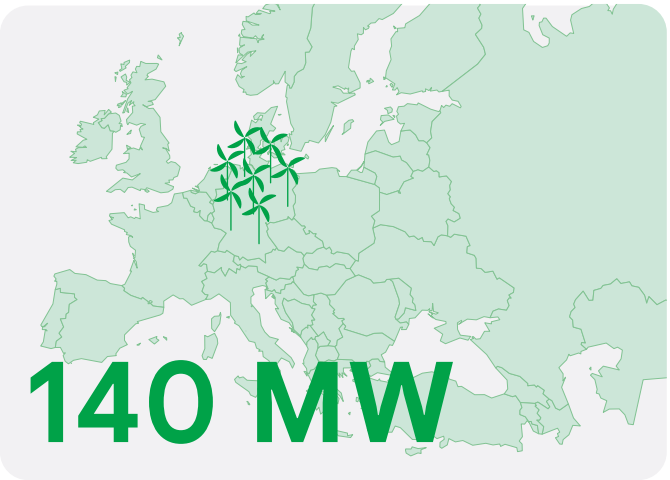
Estimated GHG emissions from **data centres** in Germany using a location-based approach.

Source: BitKom/Borderstep (2023), German Data Center Update.

## 1.3 $MtCO_2e$

**GHG emissions** from German **data centres if all followed the best practices of leading operators.**

Not all digital sector emissions come from data centres, but they are one area where tech companies have **direct control** to minimise their environmental impact.




Google has signed an advanced 24/7 power purchase agreement (PPA) with ENGIE in Germany.

Google aims to run all of its facilities on **24/7 carbon-free energy** by 2030.

The carbon free energy (CFE) score for Google's data centres in Germany is expected to be approximately 80% in 2022.

Note: CFE numbers for 2022 will be published in Google's Environmental Report later this year.

**2 out of 6** of Google's European data centres including Denmark and Finland already operated at around **90% carbon-free energy in 2021**.

The next step for the digital sector is to **achieve net-zero emissions across the entire supply chain,** which Google has committed to by 2030 in addition to its operations.

Implement Consulting Group study commissioned by Google.
"Digital decarbonisation: Accelerating Germany's climate protection with efficient digital solutions", 2023.

# EXECUTIVE SUMMARY

## Digital solutions are important enablers of European competitiveness and the green and energy transitions.

Digital solutions such as cloud, AI and machine learning are critical enablers of the green transition and the potential is vast. Digital technology is a general purpose technology, and we are already seeing innovative solutions being applied across many sectors and these technologies have the potential to further accelerate the green transitions.

### The findings

Overall this report proposes two equally important priorities as a win-win approach to competitiveness and the green energy transition in Europe:

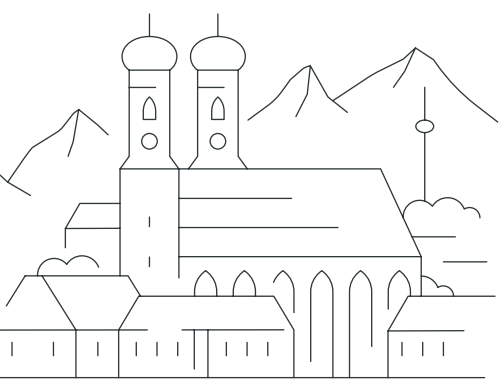
- **DIGITAL DECARBONISATION:** Maximising the enabling role of digital technologies by accelerating existing digital solutions at scale within four key sectors of the EU economy.
- **DECARBONISING DIGITAL:** Minimising carbon emissions across the entire digital value chain by decarbonising all operational electricity emissions, and addressing the emissions related to devices as well as servers, buildings and other inputs.

### The findings for Germany

The digital transformation offers a great opportunity for Germany, as new digital applications and solutions simplify and improve private lives as well as businesses and the public sector.

Digital technology is already making major contributions to achieving sustainability goals, including decarbonising our economies. Digital processes and new technologies are helping us to:

- save energy and use it more efficiently
- use resources more sustainably
- reduce travel by using video conferencing instead of air travel or to work from home
- increase our use of renewable electricity with intelligent power grids



For Germany, the report finds that existing digital solutions can help enable important steps on the journey towards Germany's net-zero goal in 2045. The report also presents German digital use cases which illustrate the potential of the German tech sector towards important sustainability goals.

The German report finds:

- **Four main sectors**, which account for two-thirds of Germany's total greenhouse gas (GHG) emissions, **hold significant potential for digitally enabled climate mitigation and energy savings**. These are: domestic transport, buildings, manufacturing and agriculture.

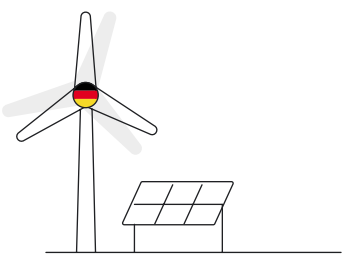
- In total, **20-25% of the GHG reductions needed for a net-zero German economy will require some degree of digital enablement** to happen at scale and at an acceptable social cost. This equates to GHG reductions in Germany of 150–180 $MtCO_2e$.

  - Germany's **domestic transport sector** emitted 146 $MtCO_2e$ in 2020 and around 70% of these emissions will be reduced by a switch to electric cars and trucks which will require smart charging apps, digitally integrated networks of charging stations, a smart grid solution to provide demand flexibility – i.e., a large degree of digital enablement to happen at scale and affordable cost. Video conferencing can avoid over 90% of the carbon emissions from a typical physical international conference.

  - Germany's **building sector** emitted 122 $MtCO_2e$ in 2020. Around 50% of these emissions will be reduced by replacing gas and oil boilers with electric heat pumps in homes and large buildings. The heating of our homes and buildings is already being transformed by new building management systems using AI and machine learning. These are already providing cost-effective energy savings and enabling the switch to carbon-free energy. Smart apps are helping consumers to more climate-conscious heating behaviour in private homes. Large buildings are digitally connected to power platforms to provide demand flexibility. The ongoing transformation of Germany's buildings is already being decarbonised with the help of digital solutions.

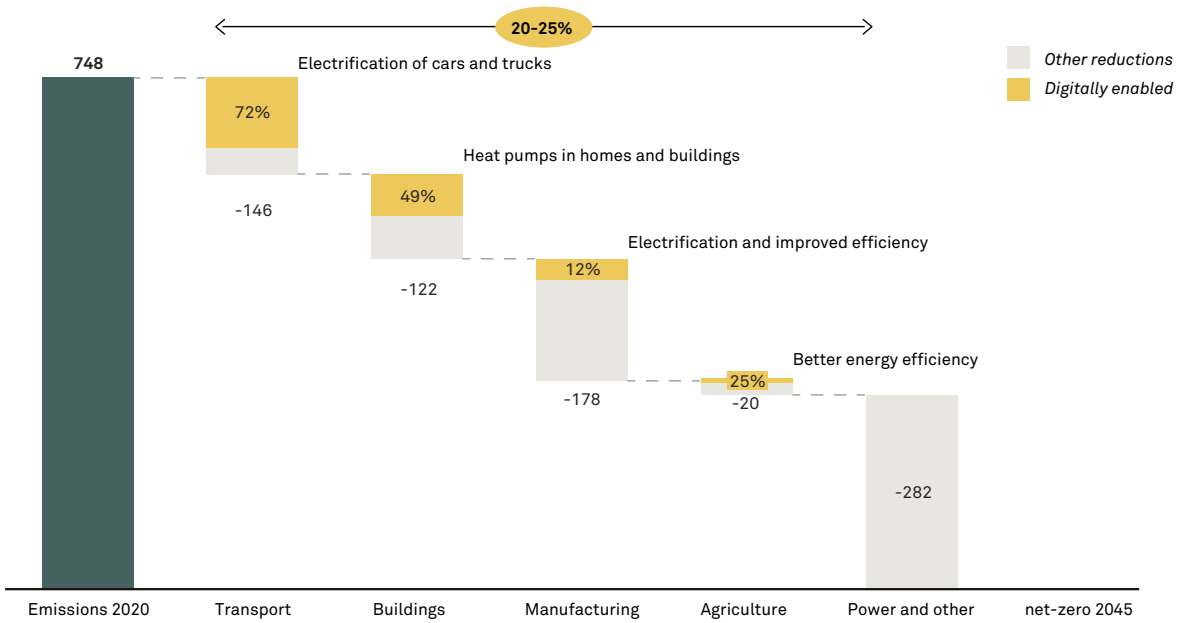
  - Germany's **manufacturing sector** emitted 178 $MtCO_2e$ in 2020 and at least 10-15% of these emissions are to be reduced by electrifying lighter industrial processes and from improved energy efficiency. As found in several studies and demonstrated by the digital use cases, digital solutions in Germany's manufacturing sector are key, not only to its competitiveness, but also to its decarbonisation pathway to net-zero.

  - Germany's **agriculture sector** emitted 64 $MtCO_2e$ in 2020 and is foreseen to reduce emissions by 20 $MtCO_2e$, of which at least around 20-25% will require a degree of digital enablement. Solar-powered robots with AI replacing emitting machines for weeding fields is one example of a digitally enabled solution to a more sustainable agriculture sector.



The above estimates and examples are not exhaustive and there are ample other ways in which digital solutions are already enabling Germany's decarbonisation journey.

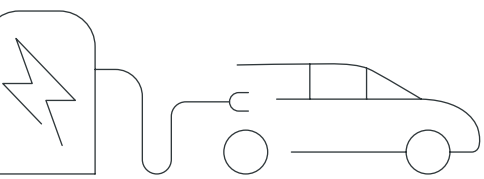
## Germany's greenhouse gas emissions
$MtCO_2e$




## German businesses make digital decarbonisation happen

Germany's tech sector is Europe's largest, and leading German innovators and tech start-ups are already deploying digital use cases for Europe's decarbonisation journey.

In this report we show a range of leading German digital solutions enabling carbon reductions across all parts of the economy.



## German digital use cases for climate change mitigation in main sectors

| | Transport | Buildings | Manufacturing | Agriculture and forestry | Cross sectoral |
|---|---|---|---|---|---|
| **Do different**<br>Digital technologies enabling transition to non-polluting alternatives | **Kiwigrid** smart charging systems for EV at workplaces | **Kiwigrid** IoT service platform to monitor all energy devices | | **Dahlia Robotics** autonomous robots for weeding powered by solar panels | **sonnen** smart solar storage system enhances households solar energy utilisation |
| | **Deutsche Bahn** enhancing customer experience with AI and digitalisation | **Enpal** provides solar systems for climate climate-neutral homes | | | **BLOK-Z** blockchain-based software makes 24/7 renewable energy matching possible |
| | **Berliner Verkehrsbetriebe** easy tickets and real-time traffic information | | | | |
| **Use less**<br>Digital technologies enable the reduction in use of resources through human action or automatically | **Hamburg** use AI tools to keep traffic flowing efficiently | **tado°** smart heating management for buildings | **alcemy** AI-software enables low-carbon cement and concrete production | **Plantix** transforms smartphones into mobile crop doctors | |
| | | **aedifion** AI-powered platform helps reduce building's carbon footprint | **SAP** digital twin technology optimise product and production processes | **constellr** uses satellite data to increase crop efficiency | |
| | | | | **Climate Farmers** helps farmers towards climate-smart agriculture | |
| | | | | **Bayer** enables digital farming through innovative solutions | |
| | | | | **mineral** increases farmland productivity through digital solutions | |

*Note: Implement illustration.*

## Digital decarbonisation at European scale

At the EU level, the report aims to identify digital solutions that are already in use in areas with the highest potential for near-term impact on emission reductions and energy savings.

The report finds:

- **Europe has similar challenges and opportunities as Germany.** The potential for digitally enabled climate mitigation and energy savings is concentrated in the same four sectors, namely transport, buildings, manufacturing and agriculture.

- At the EU-level, **20-25% of the GHG reductions needed for a net-zero EU economy will require some degree of digital enablement.** This equates to GHG reductions in the EU of 700-900 $MtCO_2e$ corresponding to the total emissions of Germany.

  - *Electrification* is the key decarbonisation pathway, and GHG reductions in the EU of around 350–450 $MtCO_2e$ across various sectors depend on a degree of digital enablement. This corresponds to France's combined emissions in 2020. Several digital solutions are already in use in this context, but the uptake is well below the potential.

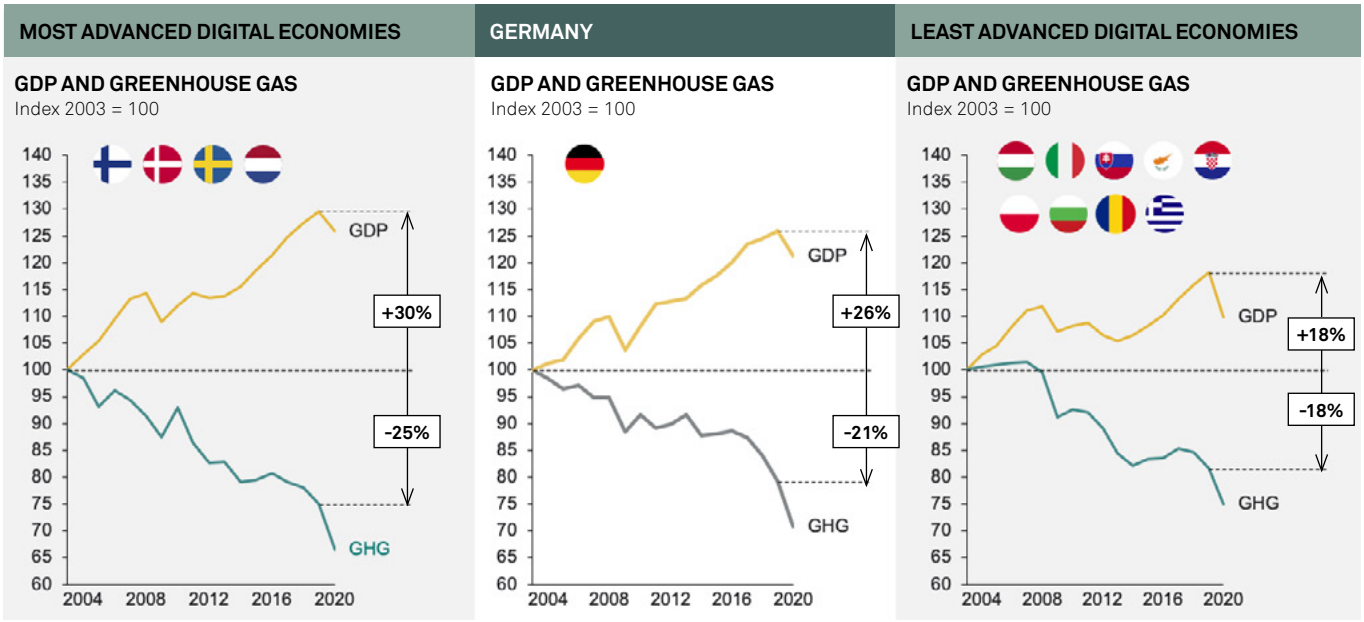
  - *Energy efficiency* is the second decarbonisation pathway and GHG reductions of in the EU around 250–300 $MtCO_2e$ across sectors depend on a degree of digital enablement or equivalent to the emissions of Spain in 2020. A number of digital solutions are already increasing efficiency, but uptake is in the early phase.

  - *Digital displacement* is the third but less potent decarbonisation pathway. A smaller amount of GHG reductions can be enabled by digital solutions replacing less sustainable activities, for example when video conferencing replaces the need for business flights.

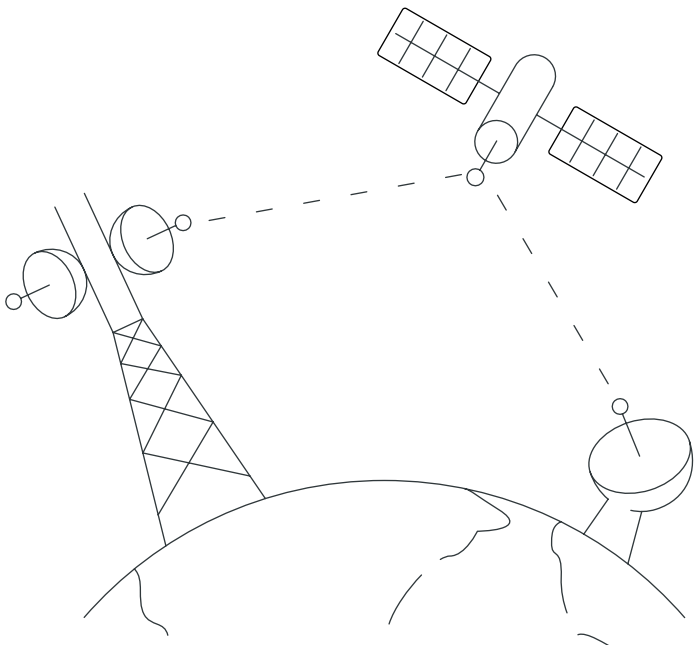
  - *Energy security measures* to reduce the EU's imports of fossil fuels also depend on digital solutions. Around 40% of the pathway to the desired level of EU gas demand will require a degree of digital enablement.

- At the macro level, we find that **decarbonisation happens faster in the most digitalised economies.** The most digitalised economies have achieved a strong decoupling of greenhouse gas emissions (-25% since 2003) from economic activity (+30%). Germany is in the mid-field of Europe's digital economies and has seen slightly slower growth (+26%) and slightly slower decarbonisation (-21%). Germany's digitalisation and carbon efficiency would need to accelerate to be among the frontrunners in Europe to experience robust growth aligned with increased decarbonisation.

## The most digitalised economies have achieved much stronger decoupling of greenhouse gas emissions from economic growth




*Note: GDP shown at constant prices and greenhouse gas emission based on absolute emissions. Level of digitalisation is determined by the DESI index measuring digital economy and society on a range of parameters such as skills, connectivity and uptake of digital technology. ICG analysis based on Eurostat data.*



## Decarbonising Europe's digital value chain

- **The potential for digitally enabled decarbonization is significant in comparison with the emissions from the digital value chain.** Data centres in the EU are estimated to account for 15–20 $MtCO_2e$ in 2020 through their operational emissions. It is important to also address the emissions across the whole value chain, including those related to data networks and the end-user devices, as well as embedded emissions.

  – A recent report estimates that data centres in Germany are associated with nearly 8 $MtCO_2e$ in 2022 using a so-called location-based approach assuming grid average emissions.

  – Leading data centre operators such as Microsoft, Iron Mountain and Google are aiming to run on 24/7 carbon-free electricity by 2030, meaning they will match their consumption hour-by-hour with carbon-free energy from the grid where they operate.

  – Three of Google's six European data centres already operated at more than 80% carbon-free electricity in 2021 (namely in Finland, Denmark and Belgium) and two (Finland and Denmark) operated at around 90% carbon-free electricity in 2021. This means that these locations are well-advanced towards the 24/7 carbon-free target.

  – The carbon-free energy (CFE) score for Google's data centres in Germany is expected to be approximately 80% in 2022.*

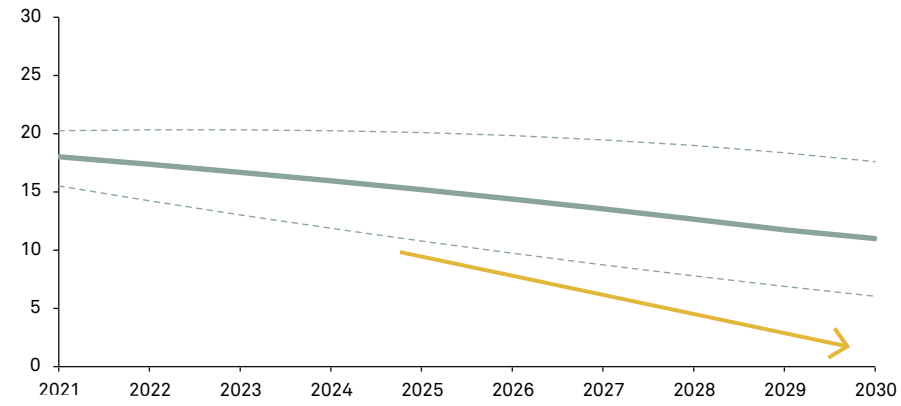
  – If all data centres in Germany pursued the best practices of the leading operators in terms energy efficiency and green power purchases, then emissions from German data centres could be around 1 $MtCO_2e$, when factoring in CFE purchases as above.

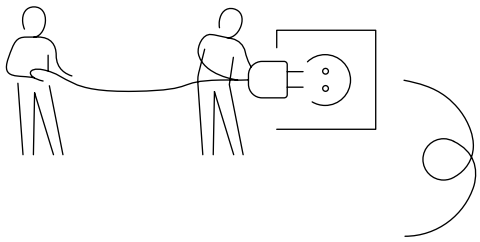
  – The hardest part of the decarbonisation journey is ahead of us, and a lot of effort is still needed before the digital value chain is fully carbon-free.

**Note: CFE numbers for 2022 will be published in Google's Environmental Report later this year.*

## Projected $CO_2$ emissions from European data centres

$MtCO_2e$



**PROJECTED EMISSIONS USING THE GRID**

... with high increase in electricity use (+100%)

... with trend increase in electricity use (+30%)

... with decline in electricity use (-30%)

**TRAJECTORY IF ALL EU DATA CENTRES MEET 24/7 CARBON-FREE ENERGY GOALS SUCH AS THOSE SET BY PIONEERS**

*Source: Implement analysis based on data from the EEA and Montevecchi et al. (2020).*

## The recommendations

The twin digital and green transformation is already high on the European policy agenda. The EU Council conclusions of December 2020 on *Digitalisation for the benefit of the environment* emphasised that the digital component will be key in reaching the ambitions of the European Green Deal and the Sustainable Development Goals (SDGs) as set out in the EU digital strategy.

The German government's modernisation package also acknowledges the need to make greater use of the advantages and opportunities of digitalisation for the energy transition. The electricity system requires modernisation and digitalisation to integrate even more renewable energy and the demand side will require more flexible consumption (e.g., smart charging apps for electric vehicles). This will require further developments both in the legal framework and standards.

The European Commission's 2022 Strategic Foresight Report also recommends accelerating the digital and green transitions. Several underpinning initiatives are ongoing, including the European Green Digital Coalition which is a collaboration among digital companies led by the Commission.

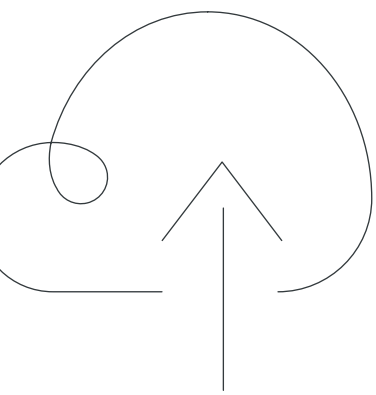
Based on the findings, we see two equally important priorities as the win-win approach to competitiveness and the green energy transition in Europe:

- **DIGITAL DECARBONISATION:** Maximising the enabling role of digital technologies by accelerating already available digital solutions at scale within four key sectors of the EU economy.

- **DECARBONISING DIGITAL:** Minimising the carbon emissions across the entire digital value chain by decarbonising all operational electricity emissions, and addressing the emissions related to devices as well as servers and buildings etc.

The **digital decarbonisation** priority is about accelerating the uptake of digital solutions enabling climate change mitigation. This will require an enabling policy framework.

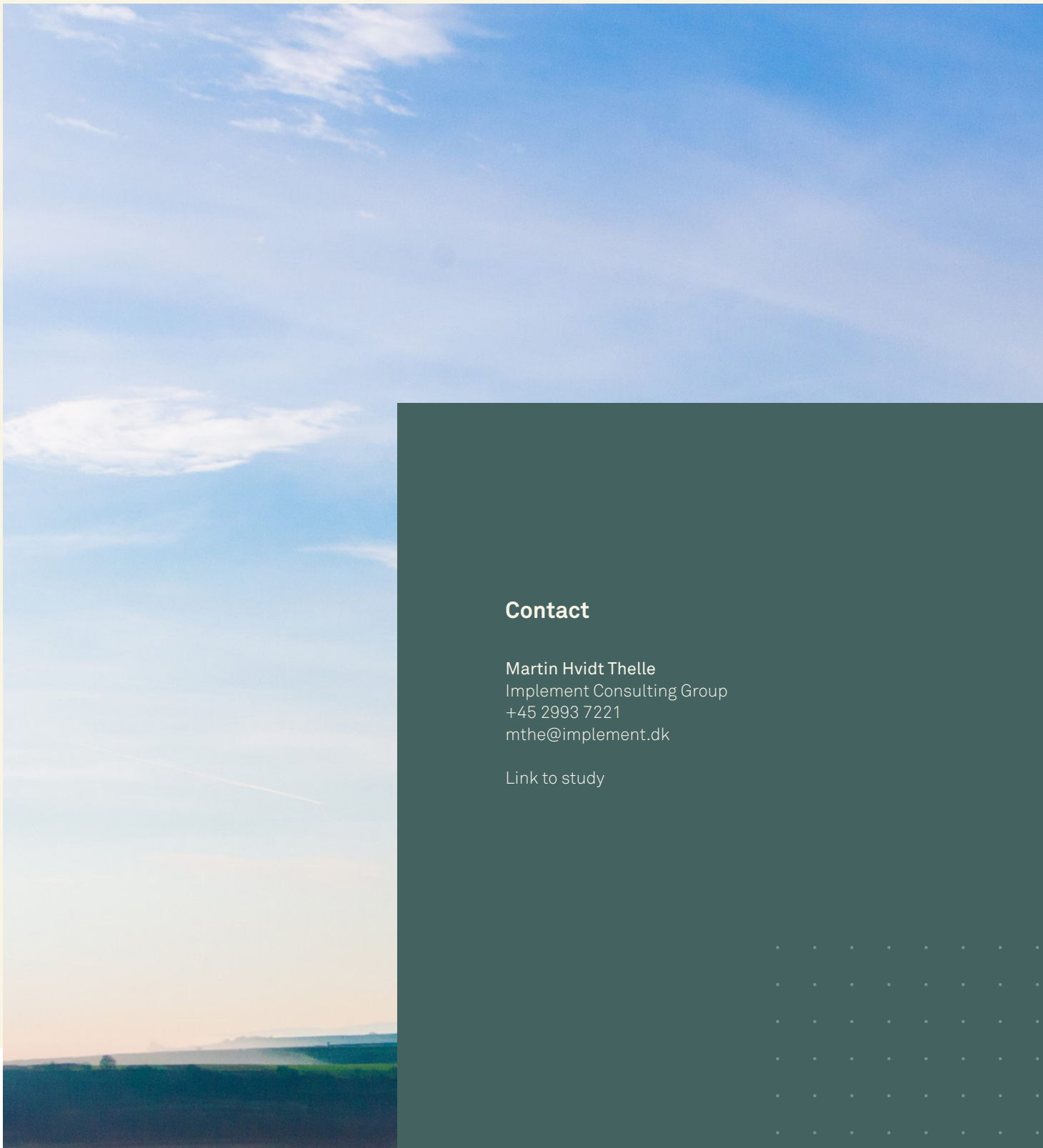
German businesses have more than doubled their use of cloud solutions over the last five years according to Eurostat data and are demanding green digital solutions to drive their business and growth, but an unfinished policy framework means lost opportunities for financing the development and deployment of green digital solutions. It also means a risk of increasing internal market obstacles and difficulties in procurement of green digital technology solutions. This works against the ambition of accelerating the green and energy transitions.



The EU policy framework should be strengthened in the short term to provide incentives to invest in cost-effective digital climate solutions and ensure efficient movement of capital within the internal market into the most effective digital climate solutions. This will require:

- An alignment at EU level across the various policy initiatives on the definition of sustainable activities and activities enabling a significant contribution to climate change mitigation. The efforts of the European Green Digital Coalition towards this objective are important.
- Coherence between EU and national policy initiatives towards sustainable digital solutions to avoid barriers to the internal market for technologies enabling substantial contribution to environmental objectives.
- An external EU trade policy which also supports these objectives by promoting trade in digital services with positive enabling effects for the environment.

The report also recommends that the ongoing efforts to decarbonise digital should be accelerated by encouraging a shift toward a 24/7 carbon-free energy approach to addressing operational electricity emissions, as this will most effectively drive decarbonisation in electricity consuming industries. This will among other things require an alignment across EU and national policies around the approach for decarbonising the digital value chain.



## Contact

**Martin Hvidt Thelle**
Implement Consulting Group
+45 2993 7221
mthe@implement.dk

Link to study