Digital Economy and Society Index (DESI) 2021

Germany

About the DESI

The European Commission has monitored Member States' progress on digital and published annual Digital Economy and Society Index (DESI) reports since 2014. Each year, the reports include country profiles, which help Member States identify areas for priority action, and thematic chapters providing an EU-level analysis in the key digital policy areas.

In 2021, the Commission adjusted DESI to reflect the two major policy initiatives that will have an impact on digital transformation in the EU over the coming years: the Recovery and Resilience Facility and the Digital Decade Compass.

To align DESI with the four cardinal points and the targets under the Digital Compass, to improve the methodology and take account of the latest technological and policy developments, the Commission made a number of changes to the 2021 edition of the DESI. The indicators are now structured around the four main areas in the Digital Compass, replacing the previous five-dimension structure. 11 of the DESI 2021 indicators measure targets set in the Digital Compass. In future, the DESI will be aligned even more closely with the Digital Compass to ensure that all targets are discussed in the reports.

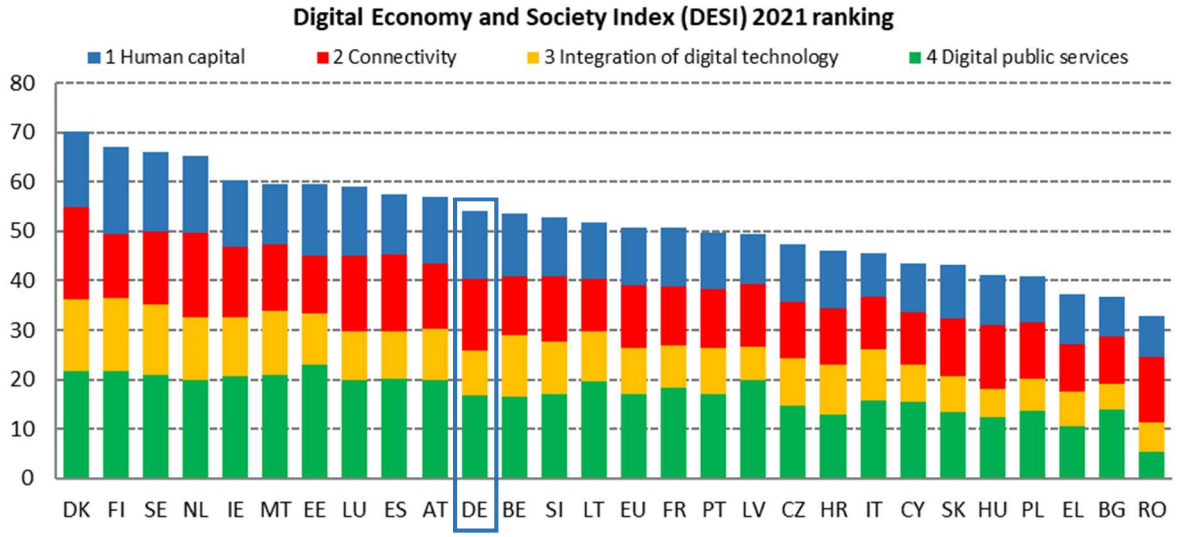
In addition, DESI now includes an indicator measuring the level of support that adopted ICT technologies provided companies in taking more environmentally-friendly measures (ICT for environmental sustainability) and the take up of gigabit services, plus the percentage of companies offering ICT training and using e-invoicing.

The DESI scores and rankings of previous years were re-calculated for all countries to reflect the changes in the choice of indicators and corrections made to the underlying data.

For further information, see the DESI website: https://digital-strategy.ec.europa.eu/en/policies/desi.

Overview

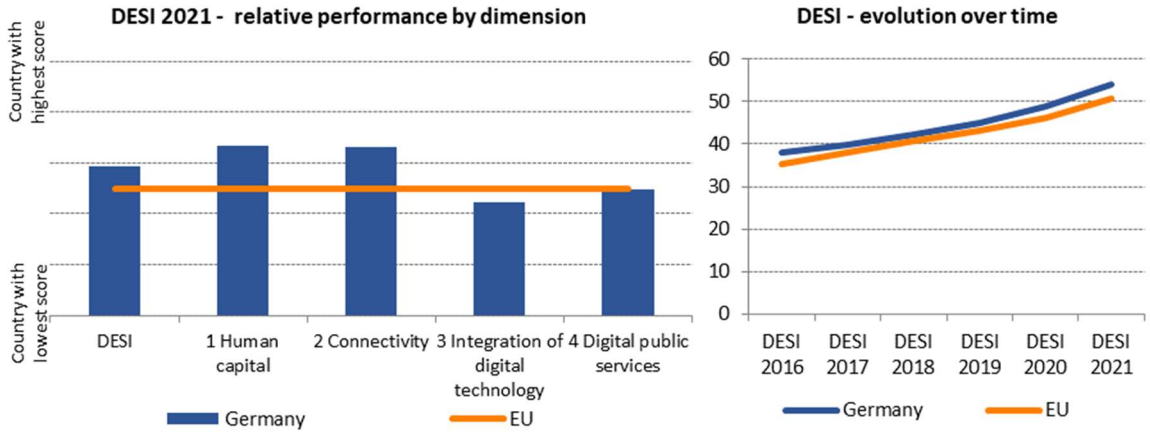
	Germany		EU
	rank	score	score
DESI 2021	**11**	**54.1**	**50.7**



Germany ranks 11th out of 27 EU Member States in the Digital Economy and Society Index (DESI) 2021. Germany performs relatively well in broadband connectivity, although deployment is affected by a shortage of planning and building capacities, and an urban-rural digital divide persists. It is a leader in 5G readiness and is second in the EU in overall fixed broadband take-up. However, although its performance in fixed very high-capacity network coverage improved (from 33% to 55.9%), it remains below the EU average (59.3%). On Human capital, Germany scores above average on almost all indicators (except the share of female ICT specialists). At least basic digital skills and at least basic software skills are widespread in the country, but a lack of ICT specialists still persists. This shortage also affects the Integration of digital technology by businesses. Less than a third of enterprises (29%) share information electronically and only 18% of SMEs issue e-Invoices. In both indicators, the country has not improved much over recent years. As for Digital public services, there is an overall improvement in performance. However, continuous efforts, e.g. to ensure the interoperability of the services provided, are necessary. In November 2018, the Federal Government published its implementation strategy 'Shaping Digitalisation'. As Germany is shifting its focus to implementation of the strategy, the progress achieved is monitored in the digital dashboard 'digital-made-in.de.' A closely coordinated, targeted approach focused on implementation efficiency could further increase the impact of the numerous digitalisation measures. In addition to that, in January 2021, the Federal Government adopted its first Data Strategy. With over 240 measures, the Data Strategy aims to improve the innovative use of data and data sharing and covers, for example, data infrastructure, use of data and data competency.

With the Corona Recovery Plan 'Fighting Corona Consequences, Securing Prosperity, Strengthening Future Capability', which was adopted in June 2020, the German Federal Government is investing EUR 130 billion in a wide variety of measures to deal with the economic effects of the COVID

pandemic. Several measures were dedicated to digitalisation in the following areas: public administration, culture, forestry, learning, mobility (such as shipping), artificial intelligence, quantum technologies, 5G, fibre roll-out, smart cities, digital sovereignty, and modernisation of hospitals. Some of these measures were taken up in the Recovery and Resilience Plan that Germany submitted to the European Commission on 28 April 2021.



Digital in Germany's Recovery and Resilience Plan

With a total budget of up to EUR 26.5 billion[1] (Germany receives EUR 25.6 billion under the Recovery and Resilience Facility, with the difference financed by national funds), Germany's Recovery and Resilience Plan is going to further support the economic recovery, including through significant investments in digitalisation (the 20% digital target[2] is largely exceeded, as the contribution to digital objectives accounts for more than 50% of the planned allocation), decarbonisation of industry and climate-friendly mobility.

The plan includes two important multi-country projects on digitalisation: the Important Project of Common European Interest (IPCEI) Microelectronics and Communication Technologies, and the IPCEI Next Generation Cloud Infrastructure and Services (IPCEI-CIS).

Germany aims to address its main digital-related challenges with the Plan.

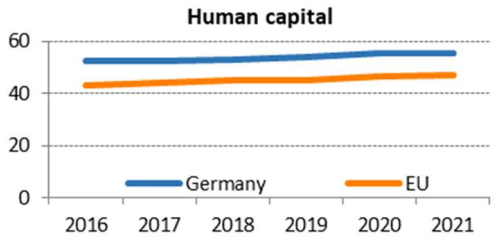
- Digital skills are addressed in the Component Digitalisation of education by investments in teacher terminal equipment, an education platform, education competence centres, and modernisation of the educational institutions of the Federal Armed Forces.
- Digitalisation of businesses and the development and integration of advanced digital technologies are addressed in part by the Component Digitalisation of the economy, with a significant focus on the automotive industry: the vehicle manufacturer/supplier investment programme, and measures on Building continuing education and training networks and the Centre for Digitalisation and Technology Research for defence. Additionally, the Component Data as a raw material of the future includes a measure on innovative data policy and the two IPCEIs.
- Digitalisation of public services, which makes up more than half of the investments on

[1] This is the net amount excluding value-added tax.
[2] At least 20% of the total spending under the national RRPs should be digital.

digital in the Plan, is supported by measures in the Component Modern public administration, with projects on European identity ecosystem, implementation of the Online Access Act and modernisation of registers. Moreover, the Component Strengthening social participation includes a measure improving the access to information about pension rights for citizens through a digital platform. The Component Digitalisation of the economy includes a measure supporting the digitalisation of the rail. The Component Strengthening a pandemic-resilient health system includes two relevant measures: the digital and technical strengthening of the public health service and the Future Hospital Programme. In addition, the Component Reducing barriers to investment contains reforms aimed at facilitating and speeding up public investments.

1 Human capital

1 Human capital	Germany		EU
	rank	score	score
DESI 2021	7	55.2	47.1



	Germany			EU
	DESI 2019	DESI 2020	DESI 2021	DESI 2021
1a1 At least basic digital skills % individuals	**68%** 2017	**70%** 2019	**70%** 2019	**56%** 2019
1a2 Above basic digital skills % individuals	**37%** 2017	**39%** 2019	**39%** 2019	**31%** 2019
1a3 At least basic software skills % individuals	**70%** 2017	**72%** 2019	**72%** 2019	**58%** 2019
1b1 ICT specialists % individuals in employment aged 15-74	**3.9%** 2018	**4.0%** 2019	**4.7%** 2020	**4.3%** 2020
1b2 Female ICT specialists % ICT specialists	**17%** 2018	**17%** 2019	**18%** 2020	**19%** 2020
1b3 Enterprises providing ICT training % enterprises	**30%** 2018	**32%** 2019	**24%** 2020	**20%** 2020
1b4 ICT graduates % graduates	**4.7%** 2017	**4.9%** 2018	**4.5%** 2019	**3.9%** 2019

For Human capital, Germany ranks 7th out of 27 EU countries and is thus above the EU average. Levels for both at least basic digital skills and at least basic software skills are well above the EU average, and Germany ranks fourth on these two indicators. Almost a quarter (24%) of enterprises provide ICT training to their employees. Female ICT specialists account for 18% of ICT specialists, slightly below the EU average. In Germany, 4.5% of all graduates are ICT graduates, much higher than the EU average of 3.9%. The proportion of ICT specialists in the workforce is above the EU average (4.7% versus 4.3%). Nevertheless, in some fields of ICT, Germany has a clear shortage of skilled workers. 66.1% of enterprises report hard-to-fill vacancies for jobs requiring ICT specialist skills (EU average 55.4%). Currently, the mismatch is particularly high regarding experts for informatics, software development and implementation, and IT specialists[3].

In 2019, Germany adopted a National Skills Strategy[4] under the leadership of the Federal Ministry of Labour and Social Affairs (BMAS) and the Federal Ministry of Education and Research (BMBF), and with the participation of 15 other partners, including social partners. The main aim of the National Skills Strategy is to improve continuing education and training and skills development. The recently published National Skills Strategy implementation report (June 2021)[5] notes that a large number of the measures have been implemented. The creation of networks for continuing education and

[3] https://statistik.arbeitsagentur.de/SiteGlobals/Forms/Suche/Einzelheftsuche_Formular.html?nn=27096&topic_f=fachkraefte-engpassanalyse
[4] https://www.bmbf.de/de/nationale-weiterbildungsstrategie-8853.html
[5] https://www.bmas.de/DE/Service/Publikationen/a805-umsetzungsbericht-nationale-weiterbildungsstrategie.html

training is one example of the strategy's concrete measures. The networks support companies, especially SMEs, with training needs. Digital skills and competence in artificial intelligence (AI) are part of the programme. Another example is the innovation competition INVITE (digital platform for professional development) that the BMBF launched in April 2020. The selected projects support continuing education via digital platforms and content.

Digital skills development also plays an important role in other digital strategies, such as: the Shaping Digitalisation[6] strategy, the Artificial Intelligence Strategy[7], the BMBF's digital strategy 'Digital future: Learning. Researchers. Knowledge.'[8] and the MINT action plan[9]. Additionally, in order to address the lack of ICT specialists, the Skilled Immigration Act (*Fachkräfteeinwandungsgesetz (FEG)*, March 2020) introduces a work visa for IT specialists with significant work experience.

In 2020, as part of the AI strategy, the BMAS started the programme 'AI Hubs of Tomorrow'. One objective of the programme is to help employees to gain application-oriented competence in AI. For example, centres can provide consulting and analytical services on training needs or deploy learning concepts for the workforce of companies that want to use artificial intelligence.

In 2016, the BMBF launched the Special Programme on Digitalisation to help inter-company training centres modernise their training programmes. The programme, which was extended until the end of 2023, has a budget of EUR 224 million to provide state-of-the-art training.

In order to improve the digital infrastructure in schools, the funding programme DigitalPact School entered into force in 2019. In 2020, to address the challenges schools faced due to the COVID pandemic, the Federal Government increased its initial budget of EUR 5 billion by EUR 1.5 billion. With the additional budget, the scope of the initiative was expanded to also finance staff supporting technical services in schools and terminal equipment for pupils and teachers. In 2020, projects amounting to EUR 735 million were approved under DigitalPact School, and a tripling is expected in 2021.

Germany does not have a national digital skills and jobs coalition. The country participated actively in the 2020 EU Code Week, organising 966 events involving nearly 20,000 participants, of which female participation reached 45%[10].

Germany is focusing on digital skills in several strategies and has made significant investments in digitalisation of the education system. An increase in the share of ICT specialists shows that the efforts are showing some first results. However, it is important that Germany continues to focus on the lack of digital experts as there is a high unmet demand from industry.

[6] https://www.bundesregierung.de/resource/blob/975292/1605342/284988700922725d63a0fb95db824024/digitalsierung-gestalten-englisch-download-bpa-data.pdf?download=1
[7] https://www.ki-strategie-deutschland.de/home.html
[8] https://www.bildung-forschung.digital/de/die-digitalstrategie-des-bmbf-2479.html
[9] https://www.bildung-forschung.digital/de/mint-aktionsplan-3416.html
[10] https://digital-strategy.ec.europa.eu/en/news/eu-code-week-organisers-register-over-72000-activities-second-year-row

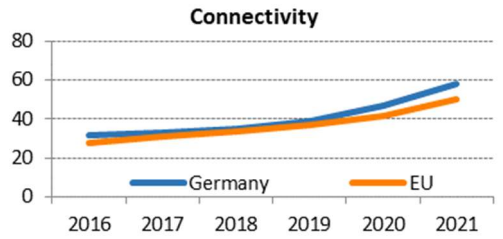
Human capital in Germany's Recovery and Resilience Plan

The German Recovery and Resilience Plan includes six measures that are entirely or partially linked to digital skills. They have a total digital budget of about EUR 1.8 billion. The measures mainly address challenges linked to education and some cover (further) training. Some of these measures are listed below:

- Teacher devices: the measure finances terminal equipment for teachers (net budget EUR 420.2 million, part of the DigitalPact School mentioned above).
- Education platform: the measure establishes an education platform of online trainings and courses giving access to people in education and training (e.g. pupils, students, teachers, apprentices) (net budget EUR 529.4 million).
- Education competence centres: the measure establishes competence centres for teachers to improve their knowledge and skills on digital technologies and digital learning concepts e.g. for remote teaching (net budget EUR 172.3 million).
- Modernisation of the educational institutions of the Federal Armed Forces: the measure focuses on modernisation of the technical infrastructure of the educational institutions of the Federal Armed Forces, e.g. to enable remote teaching and working (net budget EUR 84 million).
- Building continuing education and training networks: the measure finances the establishment of training networks that support companies – especially SMEs – to develop trainings in relevant areas (e.g. digital competence) for their staff (net digital budget EUR 12.8 million).
- Support for apprentices: the measure aims at stabilising and increasing the number of apprenticeships, which decreased due to COVID-19. The measure also includes apprenticeships related to digital areas and apprenticeships that take place remotely and use digital technologies (digital budget EUR 290 million).

2 Connectivity

2 Connectivity	Germany		EU
	rank	score	score
DESI 2021	6	58.0	50.2



	Germany			EU
	DESI 2019	DESI 2020	DESI 2021	DESI 2021
2a1 Overall fixed broadband take-up % households	**87%** 2018	**88%** 2019	**92%** 2020	**77%** 2020
2a2 At least 100 Mbps fixed broadband take-up % households	**15%** 2018	**21%** 2019	**27%** 2020	**34%** 2020
2a3 At least 1 Gbps take-up % households	**NA**	**0.15%** 2019	**1.12%** 2020	**1.3%** 2020
2b1 Fast broadband (NGA) coverage % households	**88%** 2018	**92%** 2019	**95%** 2020	**87%** 2020
2b2 Fixed Very High Capacity Network (VHCN) coverage % households	**9%** 2018	**33%** 2019	**56%** 2020	**59%** 2020
2c1 4G coverage % populated areas	**97.5%** 2018	**98.6%** 2019	**99.7%** 2020	**99.7%** 2020
2c2 5G readiness Assigned spectrum as a % of total harmonised 5G spectrum	**33%** 2019	**67%** 2020	**100%** 2021	**51%** 2021
2c3 5G coverage % populated areas	**NA**	**NA**	**18%** 2020	**14%** 2020
2c4 Mobile broadband take-up % individuals	**79%** 2018	**75%** 2019	**75%** 2019	**71%** 2019
2d1 Broadband price index Score (0-100)	**NA**	**75** 2019	**75** 2020	**69** 2020

In 2020, Germany made progress on most connectivity indicators, ranking 6th in the composite overall indicator for connectivity. The speed of available broadband connections is increasing. From the perspective of a citizen coping with confinement under the COVID-related health crisis since March 2020, this is the most important trend. Germany has 95% coverage of fast broadband, providing a solid base for social and economic participation in society by digital means. Although rural coverage has significantly improved since 2019, from 75% to 81%, and is well above the EU average of 60%, Germany still has a clear digital divide between urban and rural areas. Compared with other Member States, Germany performs particularly well on 5G readiness, overall fixed broadband take-up and broadband prices. As to future trends towards, and preparedness for, the gigabit society, fixed VHCN coverage is at 56%, slightly below the EU average of 59%; it nevertheless increased substantially last year, mainly due to the one-off effect of upgrading legacy cable networks. In parallel, take-up of at least 100 Mbps fixed broadband had also increased significantly, without however fully matching the acceleration in VHCN roll-out. At the end of 2020, Germany had approximately 1.9 million fibre to the building/home (FttB/H) subscriptions up and running (up from

1.5 million at the end of 2019)[11] and 1.1% of German households subscribe to fixed broadband with a minimum capacity of 1Gbps. In the broadband pricing index (based on representative baskets of fixed, mobile and converged offers, adjusted for national household income levels), Germany ranks 8th in the EU.

Germany has almost reached the EU 2020 targets on Next Generation Networks: in June 2020, 94.8% of households had access to 30 Mbps or more. Cable operators are investing in DOCSIS 3.1, while the incumbent, Telekom Deutschland GmbH (TDG) has switched its focus to fibre roll-out. Germany is at the forefront in 5G, scoring 100% in the 5G readiness indicator, and has a 5G coverage of 18% of populated areas, above the EU average of 14%. 4G coverage[12] stands at 99.7%, which is the EU average.

The Federal Government aims at achieving nationwide gigabit connectivity by 2025. In April 2021, a funding programme started for the roll-out of 2.8 million fibre connections in ('grey') areas with connections of less than 100 Mbps (download). This is targeted at households and socio-economic drivers, more precisely schools, hospitals, SMEs, commercial districts, local administration and traffic hubs. Swedish investment company EQT and Canadian investment fund Omers took over 'Deutsche Glasfaser' and merged it with Inexio, which is expected to invest heavily in rural FttH roll-out. Private investors perceive the construction process in Germany as being slower and more expensive than in other Member States. There are efforts at the administration levels involved to accelerate the permit granting process and conditions. However, there is a persistent lack of available sites where massive infrastructure and towers can be built, and scarcity in civil works planning and building capacities limit further expansion of private and public investment.

Operators implemented dynamic spectrum sharing, a combination of LTE and 5G in selected spectrum bands, allowing fast roll-out and wide population coverage. Standalone 5G network introduction started in 2021, allowing for gigabit speeds and low latency. Bundesnetzagentur (BNetzA), the national regulatory authority, identified the 6 GHz and 40 GHz bands that might be made available in the coming years for electronic communications services. By May 2021, BNetzA had granted rights of spectrum use in the 3.7-3.8 GHz band for 5G campus and industrial networks to about 120 entities and in the 24.25-27.5 GHz band to five entities. A EUR 1.1 billion federal funding programme has been established aiming at ('white') spots with no or only 2G coverage, addressing the profitability gap of new mobile sites in sparsely populated areas. In addition, some federal states provide funding.

Main market & regulatory developments

In 2020, the revenue of the telecommunications market stood at EUR 57 billion and decreased by slightly less than 1% compared with 2019; at the same time, there was a 7% increase in investment in telecommunications infrastructure, which stood at EUR 10.5 billion in 2020[13]. In addition, there might be a long-term tendency towards consolidation of the fixed retail market, even if there are still many smaller players on the retail market. Since November 2020, Telefónica has wholesale access to Vodafone's cable network and provides fixed broadband

[11] https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2021/20210519_Jahresbericht.htm
[12] BNetzA publishes an interactive map with actual 2G/3G/4G coverage per mobile network operator.
[13] https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2021/20210519_Jahresbericht.htm

subscriptions to end users also via this network. This was part of Vodafone's commitments in the clearance procedure by the European Commission of its 2019 merger with Unitymedia.

In 2020, 5G services were launched commercially. All three established operators provide 5G services, at least in the biggest cities. The new mobile network operator (MNO) 1&1 AG finalised a national roaming agreement with Telefónica in May 2021. Tower companies play an increasingly important role. MNOs have mainly shifted their mobile site business to affiliated companies. In addition, independent companies are entering the market, most of them operating nationwide. Further newcomers (some from the energy sector) are expected. All MNOs have announced a 3G switch-off for summer/end 2021. With the 3G switch-off, the subscriptions of all remaining 3G customers will be transferred to 4G without additional costs. Only a few customers without a 4G compatible phone will have to change their hardware if they intend to continue using their phones for common data purposes. 2G is still available, so there are no problems expected for calls or SMS.

On 4 February 2021, the Commission opened infringement procedures against 24 Member States for failing to enact new EU telecom rules, more specifically the European Electronic Communications Code (EECC). The Commission sent a letter of formal notice to Germany. The 'Telecommunications Modernization Act' (*Telekommunikationsmodernisierungsgesetz (TKMoG)*) will implement the EECC. It was formally adopted in June 2021 and will enter into force on 1 December 2021. Among other things, the new law will strengthen end user rights for universal service[14] and increase the standards to be achieved by coverage obligations for MNOs. The possibility for landlords to charge for TV and broadband subscriptions as part of the rental contract will be gradually phased out.

In July 2020, BNetzA decided on the contractual conditions and obligations for access to TDG's local loops and fixed the one-off charges in September 2020. In December 2020, BNetzA mandated a standard offer for (layer 3) bitstream access to TDG's network. In June 2020, BNetzA approved TDG's prices for native Ethernet leased lines. In August 2020, BNetzA found that established MNOs had not fully complied with their coverage obligations of at least 50 Mbps per antenna sector for 98% of households. BNetzA set a deadline of end 2020 to achieve full compliance. By the end of 2022, at least 100 Mbps per antenna sector will have to be achieved. Coverage will have to include 98% of households, motorways, major highways and railway lines. A range of other traffic lines will have to be covered by end 2024. A new market analysis established the (continued) existence of significant market power of mobile operators on their respective network-wide wholesale markets for call termination and the existing obligations (interconnection, non-discrimination, transparency and licensing obligations) had been retained. Price regulation will be revoked upon applicability of the Commission delegated act.

In its roadmap[15] to implement the Connectivity Toolbox[16], Germany referred, among other things, to activities assessing mobile network technologies and roll-out strategies as to their

[14] In 2020, there were 1 100 cases of end users submitting enquiries to BNetzA relating to different legal and practical aspects of basic telecommunications services.

[15] https://digital-strategy.ec.europa.eu/en/library/connectivity-toolbox-member-states-develop-and-share-roadmaps-toolbox-implementation

environmental impact, to a nationwide electromagnetic fields (EMF) measuring campaign, and to the new public company MIG[17] that supports access to physical infrastructure.

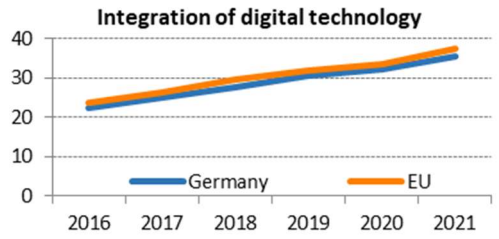
There has been a decrease in the number of consumer complaints compared with the previous year. Issues became increasingly complex, partly as a result of technological developments. Around a quarter of all end user concerns relate to switching, followed by contract issues, service provision, disruptions and moves, transparency information, internet performance of telecoms providers, and invoices. In January 2020, BNetzA lowered wholesale prices for mobile number portability and fixed maximum end user charges for switching. Under the TKMoG, BNetzA will have to ensure that end users are no longer directly charged.

There remains an urban-rural digital divide regarding fixed NGA coverage and a shortage of planning and building capacities. Challenges on the markets are addressed by increasing private investment and public funding of network roll-out, both fixed and mobile. The share of fibre connections is increasing but starting from a low level of coverage.

[16] https://digital-strategy.ec.europa.eu/en/news/connectivity-toolbox-member-states-agree-best-practices-boost-timely-deployment-5g-and-fibre-0
[17] https://netzda-mig.de/

3 Integration of digital technology

3 Integration of digital technology	Germany		EU
	rank	score	score
DESI 2021	18	35.5	37.6



	Germany			EU
	DESI 2019	DESI 2020	DESI 2021	DESI 2021
3a1 SMEs with at least a basic level of digital intensity % SMEs	NA	NA	62% 2020	60% 2020
3b1 Electronic information sharing % enterprises	NA 2017	29% 2019	29% 2019	36% 2019
3b2 Social media % enterprises	16% 2017	23% 2019	23% 2019	23% 2019
3b3 Big data % enterprises	15% 2018	15% 2018	18% 2020	14% 2020
3b4 Cloud % enterprises	12% 2018	12% 2018	20% 2020	26% 2020
3b5 AI % enterprises	NA	NA	28% 2020	25% 2020
3b6 ICT for environmental sustainability % enterprises having medium/high intensity of green action through ICT	NA	NA	57% 2021	66% 2021
3b7 e-Invoices % enterprises	17% 2018	17% 2018	18% 2020	32% 2020
3c1 SMEs selling online % SMEs	19% 2018	17% 2019	17% 2020	17% 2020
3c2 e-Commerce turnover % SME turnover	9% 2018	10% 2019	11% 2020	12% 2020
3c3 Selling online cross-border % SMEs	11% 2017	10% 2019	10% 2019	8% 2019

Germany ranks 18th in the EU on Integration of digital technology in business activities. 62% of SMEs have at least a basic level of digital intensity, slightly above the EU average of 60%. Under a third of enterprises (29%) share information electronically and 18% of SMEs issue e-Invoices. Both indicators are much below the EU average (36% and 32%, respectively). 23% of enterprises use social media (same as the EU average) and 20% use cloud services (below the EU average of 26%). 18% of German enterprises use big data analysis, above the EU average of 14%. As regards AI technologies, 28% of German enterprises make use of them, exceeding the EU average of 25%, and 57% have a medium/high intensity of green actions through ICT (compared with 66% in the EU as a whole).

As part of the national SME strategy (*Mittelstandsstrategie*[18]), the national regulatory authority (*Bundesnetzagentur*) set up the new unit 'Digitisation & networking in SMEs' to actively accompany the digitisation process in SMEs. Activities focus on monitoring developments in the SME digitalisation process and on collecting and disseminating relevant information to SMEs and other

[18] https://www.bmwi.de/Redaktion/DE/Publikationen/Mittelstand/mittelstandsstrategie.html

relevant stakeholders. Other activities include the provision of support to the ministry for the implementation of relevant digital funding programmes and acting as a central contact point for SMEs and foreign delegations.

Under the initiative SMEs Digital, a network of 26 Mittelstand 4.0 Centres of Excellence[19] has been rolled out across Germany. These Centres of Excellence have been established to support SMEs in all matters related to digitalisation, spanning the entire value chain. In 2020, more than 65,000 SMEs benefited from the offers made by the Mittelstand 4.0 Centres of Excellence. Additionally, the Digital Now (*Digital Jetzt*) support programme stimulates SME investments in digitisation and IT security, including the skills of their employees.

The Digital Hub Initiative[20] of the Federal Ministry for Economic Affairs and Energy supports the establishment of 12 digital hubs in Germany. The underlying idea is that cooperation between companies and business start-ups within a small area will boost innovation. The hubs support SMEs on any issues relating to digitisation. Some of these institutions or consortia are keen to contribute to the European Digital Innovation Hubs network and have been selected for the national shortlist.

In December 2020, the Federal Government updated its national Artificial Intelligence Strategy (adopted in November 2018) focusing on five key areas: research; minds and expertise; transfer and application; regulatory framework; and society. As part of the German economic stimulus programme, the planned investments in artificial intelligence for the period up to 2025 have been increased from EUR 3 billion to EUR 5 billion. Strengthening information and consulting services on artificial intelligence for enterprises, especially for SMEs, is part of the strategy.

Since the adoption of the Blockchain Strategy in September 2019, almost 90% of the designated measures have been started and even partly completed. There are several important projects in the Federal Ministry for Economic Affairs and Energy (*BMWi*), such as the programme 'Showcase for Secure Digital Identities' (some EUR 85 million, until summer 2024) and the future-energy-lab that supports blockchain applications for energy. As part of its mFUND[21] research and innovation initiative, the Federal Ministry of Transport and Digital Infrastructure (*BMVI*) is funding several research and development projects on blockchain applications related to data-based innovation for Mobility 4.0.

The project GAIA-X entered its implementation phase and launched a funding programme on applications and data spaces in the GAIA-X ecosystem. The funded consortia will work on the development of data-driven business models and AI-based services by using the GAIA-X infrastructure.

In January 2020, the Federal Ministry of Education and Research (*BMBF*) launched 'Strategic Initiative Quantum Computing'. Under this initiative, R&D in quantum computing will be funded with up to EUR 300 million by 2025. The call 'Quantum processors and technologies for quantum computers' was published in April 2020. It addresses projects on next-generation quantum chips (some EUR 100 million). Additional calls focus on, for example, technology development, the exploration of potential use cases and the creation of research groups.

[19] https://www.bmwi.de/Redaktion/EN/Publikationen/Mittelstand/smes-digital-flyer.pdf?__blob=publicationFile&v=7
[20] https://www.de-hub.de/
[21] www.mfund.de

Regarding cybersecurity, the German security research programme 'Self-determined and secure in the digital world 2015-2020' brings together national security research activities. The follow-up security research programme 'Digital.Sicher.Souverän.' (*Digital. Secure. Sovereign.*) was published on 2 June 2021 and has a budget of about EUR 350 million up until 2026. Regarding implementation of the Cybersecurity Competence Centre and Network Regulation, the National Coordination Centre for Cybersecurity for Germany has officially been established in October 2021. The Federal Office for Information Security plays a key role in this.

The main barrier for digitalisation of enterprises in Germany is the need for investment. The lack of qualified personnel also contributes to this, because the training of employees has its costs. Although companies themselves are primarily responsible in this respect, the state can support this process by offering information and further training, especially for small and medium-sized enterprises, and by providing suitable framework conditions.

Integration of digital technology in Germany's Recovery and Resilience Plan

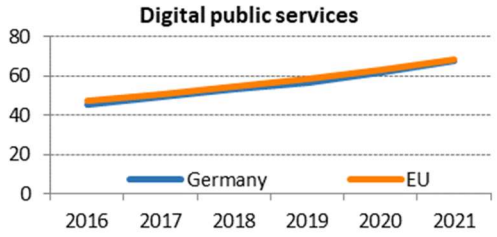
Germany's Recovery and Resilience Plan includes measures linked to the deployment of advanced technologies and R&D (EUR 3.36 billion) and to the digitalisation of businesses (EUR 1.17 billion) with a total budget of EUR 4.53 billion.

The relevant measures of the Plan are the following.

- The measure Vehicle Manufacturers/Supply Industry Investment programme under the Component Digitalisation of the Economy will contribute to the digitalisation of production and the development of new innovative products in vehicle manufacturing (digital budget about EUR 1.6 billion).
- The Centre for Digitalisation and Technology Research will carry out several research and development projects related to digital technologies (e.g. robotics, artificial intelligence and cybersecurity). The Centre supports and promotes research, innovation and technology to strive for digital sovereignty as a possibility for independent self-determination for the state and organisations, thus reducing dependence on non-European technologies and knowledge (budget EUR 588.2 million).
- Cutting-edge technologies will be enabled by the Component Data as raw material of the future. The two multi-country projects — the IPCEI on Microelectronics (EUR 1.5 billion) and the IPCEI on Cloud (EUR 750 million) — will especially contribute to the digital sovereignty of the EU. The measure on Innovative data policy for Germany contributes to this pillar with relevant strategies (relevant net budget EUR 129 million).

4 Digital public services

4 Digital public services	Germany		EU
	rank	score	score
DESI 2021	16	67.5	68.1



	Germany			EU
	DESI 2019	DESI 2020	DESI 2021	DESI 2021
4a1 e-Government users % internet users	**61%** 2018	**63%** 2019	**69%** 2020	**64%** 2020
4a2 Pre-filled forms Score (0 to 100)	**NA**	**NA**	**42** 2020	**63** 2020
4a3 Digital public services for citizens Score (0 to 100)	**NA**	**NA**	**72** 2020	**75** 2020
4a4 Digital public services for businesses Score (0 to 100)	**NA**	**NA**	**88** 2020	**84** 2020
4a5 Open data % maximum score	**NA**	**NA**	**88%** 2020	**78%** 2020

Germany ranks 16th in the EU on Digital public services. For this, Germany's performance is quite mixed. It performs well and above the EU average in digital public services for businesses (with a score of 88) and open data (88%), but considerably below average for pre-filled forms (with a score of 42) and slightly below average for digital public services for citizens (by scoring 72).

In August 2017, Germany's 'Online Access Act' (*Onlinezugangsgesetz (OZG)*) was adopted. This obliges all German federal and state governments to provide online, by the end of 2022, all services for citizens and companies via public administration portals. This encompasses 575 public services at the federal and state/municipal level, of which 315 were already available online, to varying degrees, in May 2021.

A user-friendly digital administrative service requires reliable, interlinked register data. In March 2021, therefore, an important step was taken for the harmonisation of registers in Germany with the adoption of the 'Register Modernisation Act' (*Registermodernisierungsgesetz*). The act stipulates that administrative data can be assigned to the right person in a secure and data-protection-compliant manner with the help of a classification feature, the tax ID number. The first stages to develop this digital architecture are underway in order to use the tax ID number for important administrative services under the Online Access Act (OZG).

Germany has established and uses the Federal Cloud (*Bundescloud*), which provides automated IT services for federal authorities. Germany is currently working on the 'German Strategy for Federated Cloud Solutions in Public Administration', which was approved in October 2020. The aim is to enable secure cross-cloud usage of (open-source) applications in line with the principle 'build once, run everywhere'. It also targets the development of common standards and open interfaces for different federal cloud solutions.

Digitalisation of the German health system is based on the telematics infrastructure, allowing a secure exchange of medical data. A key application is the electronic patient file provided by health insurance funds in several stages from 1 January 2021 onwards. People who are insured have access to their stored medical data not only in a medical practice, but also via a suitable mobile device (e.g. smartphone). Another important application is the e-prescription, which will be mandatory by 2022. For cross-border patient safety, the national e-health contact point will be established by mid-2023 so that insured people can also provide doctors in other EU countries with their health data in a secure and translated manner. Citizens in both metropolitan and rural areas have full access to telemedicine. The Digital Healthcare Act (2019) creates an obligation for statutory healthcare funds to promote digital health literacy.

In Germany, the Federal Academy of Public Administration (*BAköV*) is the central training institution for the federal administration. It organises training for all federal authorities. To improve digital skills training for federal staff, they will in future gather together all related training courses in a separate digital academy at BAköV.

The initiative Urban.Rural.Digital (*Stadt.Land.Digital*) of the Federal Ministry for Economic Affairs and Energy (*BMWi*) supports cities and regions in digitalising their services to make better use of new economic and social opportunities.

The Federal Government has taken several measures to advance the digitisation of public services and to make progress in implementing the OZG. These actions seem to translate into a first progress of the relevant indicators to the benefit of citizens and businesses. However, continuous efforts, e.g. to ensure the interoperability of the services provided, are necessary.

Highlight 2020-2021: Acceleration of the digitisation of health- and crisis-related services

Germany is currently implementing the Online Access Act (OZG), a programme responsible for digitising all administrative services. The Federal Ministry of the Interior manages the implementation. The aim is to make public administration digital, more efficient, user-friendly and safe to use. Due to COVID-19, from the beginning of April 2020, the digitisation of health- and crisis-related services was prioritised and their digitisation has been accelerated through a number of initiatives.

- Remote Express-Laboratory: online application for the reimbursement of loss of earnings due to quarantine or closing of schools/kindergarten because of COVID-19 (German Infection Protection Act), development and implementation in only 36 days: https://www.ifsg-online.de.
- Development of an online application for a 'COVID-19 bridging aid' for small and medium-sized businesses in only three weeks: https://www.ueberbrueckungshilfe-unternehmen.de/.
- Rapid digitisation of 'Unemployment Benefit II' for municipal job centres (the application is implemented in the portal of the respective municipalities).

Digital public services in Germany's Recovery and Resilience Plan

The German Recovery and Resilience Plan includes measures that support the digitalisation of public services with a total budget of about EUR 7.1 billion.

Seven measures in the Plan are entirely linked to digital public administration and services:

- The measure European Identity Ecosystem under the Component Modern public administration (net budget EUR 168.1 million) is designed to enable citizens to securely issue, transmit and deposit — and to transfer and use — proof of identity in a user-friendly and self-determined manner.
- Implementation of the Online Access Act, with a considerable net budget of EUR 2521 million, aims to digitalise the German administrative landscape. This is to enable a fully digital and user-oriented offer of public administrative services by the Federal Government, the Länder and municipalities.
- The measure 'Implementation of the modernisation of the register' (*Registermodernisierungsgesetz (RegMoG)*) (net budget EUR 231.1 million) aims at preventing citizens from having to resubmit their data and to submit evidence to different authorities by introducing a unique identification number.
- The digital pension overview under the Component Social participation (net budget EUR 28.8 million), aims to make it possible for all connected pension institutions to easily retrieve information about their own retirement provision, presenting the information in an understandable, reliable and comparable way.
- The measure 'Support for the digitalisation of rail' in the Component Digitalisation of the Economy aims at replacing conventional signposting and will boost the use of digital components in the railway sector (fast-track programme (*Schnelläuferprogramm (SLP)*) to speed up roll-out of 'Digital Rail Germany' (budget EUR 500 million).
- Two measures in the Component Strengthening a pandemic-resilient health system support the digitalisation of the health system: Strengthening the digital and technical resources of the public health service (net budget EUR 684 million) and Programme to future-proof hospitals (budget EUR 3 billion).

In addition, the Component Reducing barriers to investment contains reforms to accelerate public investments.