Digital Economy and Society Index (DESI) 2021

DESI methodological note

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1 DESI methodological note

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 progress towards 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.

With the DESI, four main types of analysis are possible:

- A general performance assessment: to obtain a general characterisation of the performance of individual Member States by observing their overall index score and the scores of the main dimensions of the index.
- Zooming-in: to pinpoint the areas where Member State performance could be improved by analysing the scores of the index's sub-dimensions and individual indicators.
- Follow-up: to assess whether there is progress over time.
- Comparative analysis: to cluster Member States according to their index scores, comparing countries in similar stages of digital development in order to flag up the need for improvement in relevant policy areas.

The DESI was developed according to the guidelines and recommendations in the OECD's 'Handbook on constructing composite indicators: methodology and user guide'[1]. The data included in the index were mostly collected from the relevant authorities of the Member States by the European Commission (Directorate-General for Communications Networks, Content and Technology as well as Eurostat) and from ad hoc studies launched by the Commission.

[1] http://www.oecd.org/els/soc/handbookonconstructingcompositeindicatorsmethodologyanduserguide.htm

1.1 Structure of the DESI

The DESI has a three-level structure as depicted in the three columns in the below table.

Table 1. DESI structure

Dimension	Sub-dimension	Indicator
1 Human capital	1a Internet user skills	1a1 At least basic digital skills
		1a2 Above basic digital skills
		1a3 At least basic software skills
	1b Advanced skills and development	1b1 ICT specialists
		1b2 Female ICT specialists
		1b3 Enterprises providing ICT training
		1b4 ICT graduates
2 Connectivity	2a Fixed broadband take-up	2a1 Overall fixed broadband take-up
		2a2 At least 100 Mbps fixed broadband take-up
		2a3 At least 1 Gbps take-up
	2b Fixed broadband coverage	2b1 Fast broadband (NGA) coverage
		2b2 Fixed Very High Capacity Network (VHCN) coverage
	2c Mobile broadband	2c1 4G coverage
		2c2 5G readiness
		2c3 5G coverage
		2c4 Mobile broadband take-up
	2d Broadband prices	2d1 Broadband price index
3 Integration of digital technology	3a Digital intensity	3a1 SMEs with at least a basic level of digital intensity
	3b Digital technologies for businesses	3b1 Electronic information sharing
		3b2 Social media
		3b3 Big data
		3b4 Cloud
		3b5 AI
		3b6 ICT for environmental sustainability
		3b7 e-Invoices
	3c e-Commerce	3c1 SMEs selling online
		3c2 e-Commerce turnover
		3c3 Selling online cross-border
4 Digital public services	4a e-Government	4a1 e-Government users
		4a2 Pre-filled forms
		4a3 Digital public services for citizens
		4a4 Digital public services for businesses
		4a5 Open data

At the dimension level, DESI now addresses the four principal policy areas of the 2030 Digital Compass. These are not isolated areas that contribute separately to digital development but in fact interconnected areas. As such, developments in the digital economy and society cannot be achieved through isolated improvements in particular areas but through concerted improvement in all areas. The following sections present the list of indicators in DESI 2021.

1.1.1 Human capital dimension

Table 2. Human capital dimension

Indicator	Description	Unit	Source
1a1 At least basic digital skills	Individuals with 'basic' or 'above basic' digital skills in each of the following four dimensions: information, communication, problem solving and software for content creation (as measured by the number of activities carried out during the previous 3 months).	% individuals	Eurostat - European Union survey on ICT usage in Households and by Individuals
1a2 Above basic digital skills	Individuals with 'above basic' digital skills in each of the following four dimensions: information, communication, problem solving and software for content creation (as measured by the number of activities carried out during the previous 3 months).	% individuals	Eurostat - European Union survey on ICT usage in Households and by Individuals
1a3 At least basic software skills	Individuals who, in addition to having used basic software features such as word processing, have used advanced spreadsheet functions, created a presentation or document integrating text, pictures and tables or charts, or written code in a programming language.	% individuals	Eurostat - European Union survey on ICT usage in Households and by Individuals
1b1 ICT specialists	Employed ICT specialists. Broad definition based on the ISCO-08 classification and including jobs like ICT service managers, ICT professionals, ICT technicians, ICT installers and servicers.	% individuals in employment aged 15-74	Eurostat - Labour force survey (isoc_sks_itspt)
1b2 Female ICT specialists	Employed female ICT specialists. Broad definition based on the ISCO-08 classification and including jobs like ICT service managers, ICT professionals, ICT technicians, ICT installers and servicers.	% ICT specialists	Eurostat - Labour force survey (isoc_sks_itsps)
1b3 Enterprises providing ICT training	Enterprises who provided training in ICT to their personnel	% enterprises	Eurostat - European Union survey on ICT usage and eCommerce in Enterprises (E_ITT2)
1b4 ICT graduates	Individuals with a degree in ICT	% graduates	Eurostat (table educ_uoe_grad03, using selection ISCED11=ED5-8) and and ISCEDF_13 [F06] Information and Communication Technologies

The Human capital dimension assesses both internet user skills of citizens and advanced skills of specialists. At least basic skills, ICT specialists and Female ICT specialists measure targets of the Digital Decade Compass.

1.1.2 Connectivity dimension

Table 3. Connectivity dimension

Indicator	Description	Unit	Source
2a1 Overall fixed broadband take-up	% of households subscribing to fixed broadband	% households	Eurostat - European Union survey on ICT usage in Households and by Individuals [H_BBFIX]
2a2 At least 100 Mbps fixed broadband take-up	% of households subscribing to fixed broadband of at least 100 Mbps, calculated as overall fixed broadband take-up (source: Eurostat) multiplied with the percentage of fixed broadband lines of at least 100 Mbps (source: COCOM)	% households	European Commission, through the Communications Committee (COCOM) and Eurostat - European Union survey on ICT usage in Households and by Individuals
2a3 At least 1 Gbps take-up	% of households subscribing to fixed broadband of at least 1 Gbps, calculated as overall fixed broadband take-up (source: Eurostat) multiplied with the percentage of fixed broadband lines of at least 1 Gbps (source: COCOM)	% households	European Commission, through the Communications Committee (COCOM) and Eurostat - European Union survey on ICT usage in Households and by Individuals
2b1 Fast broadband (NGA) coverage	% of households covered by fixed broadband of at least 30 Mbps download. The technologies considered are FTTH, FTTB, Cable Docsis 3.0 and VDSL	% households	Broadband coverage in Europe studies for the European Commission by IHS Markit, Omdia and Point Topic
2b2 Fixed Very High Capacity Network (VHCN) coverage	% of households covered by any fixed VHCN. The technologies considered are FTTH and FTTB for 2015-2018 and FTTH, FTTB and Cable Docsis 3.1 for 2019 onwards	% households	Broadband coverage in Europe studies for the European Commission by IHS Markit, Omdia and Point Topic
2c1 4G coverage	% of populated areas with coverage by 4G	% populated areas	Broadband coverage in Europe studies for the European Commission by IHS Markit, Omdia and Point Topic
2c2 5G readiness	The amount of spectrum assigned and ready for 5G use within the so-called 5G pioneer bands. These bands are 700 MHz (703-733 MHz and 758-788 MHz), 3.6 GHz (3400-3800 MHz) and 26 GHz (1000 MHz within 24250-27500 MHz). All three spectrum bands have an equal weight	Assigned spectrum as a % of total harmonised 5G spectrum	European Commission services, through the Communications Committee (COCOM)
2c3 5G coverage	% of populated areas with coverage by 5G	% populated areas	Broadband coverage in Europe studies for the European Commission by IHS Markit, Omdia and Point Topic
2c4 Mobile broadband take-up	Individuals who used a mobile phone (or smart phone) to access the internet	% individuals	Eurostat - European Union survey on ICT usage in Households and by Individuals [I_IUMP]
2d1 Broadband price index	The broadband price index measures the prices of representative baskets of fixed, mobile and converged broadband offers	Score (0-100)	Broadband retail prices study, annual studies for the European Commission realised by Empirica

Under Connectivity, both fixed and mobile broadband are analysed with indicators measuring the supply and the demand side as wells as retail prices. Fixed VHCN and 5G coverage measure targets of the Digital Decade Compass.

1.1.3 Integration of digital technology dimension

Table 4. Integration of digital technology dimension

Indicator	Description	Unit	Source
3a1 SMEs with at least a basic level of digital intensity	The digital intensity score is based on counting how many out of 12 selected technologies are used by enterprises. A basic level requires usage of at least 4 technologies.	% SMEs	Eurostat - European Union survey on ICT usage and eCommerce in Enterprises
3b1 Electronic information sharing	Enterprises who have in use an ERP (enterprise resource planning) software package to share information between different functional areas (e.g. accounting, planning, production, marketing)	% enterprises	Eurostat - European Union survey on ICT usage and eCommerce in Enterprises (E_ERP1)
3b2 Social media	Enterprises using two or more of the following social media: social networks, enterprise's blog or microblog, multimedia content sharing websites, wiki-based knowledge sharing tools. Using social media means that the enterprise has a user profile, an account or a user license depending on the requirements and the type of the social media.	% enterprises	Eurostat - European Union survey on ICT usage and eCommerce in Enterprises (E_SM1_GE2)
3b3 Big data	Enterprises analysing big data from any data source	% enterprises	Eurostat - European Union survey on ICT usage and eCommerce in Enterprises (E_BDA)
3b4 Cloud	Enterprises purchasing at least one of the following cloud computing services: hosting of the enterprise's database, accounting software applications, CRM software, computing power	% enterprises	Eurostat - European Union survey on ICT usage and eCommerce in Enterprises (E_CC_GE_ME)
3b5 AI	Enterprises using at least 2 AI technologies	% enterprises	European enterprise survey on the use of technologies based on artificial intelligence by Ipsos and iCite
3b6 ICT for environmental sustainability	The indicator measures the level of support that adopted ICT technologies offered to enterprises to engage in more environmentally-friendly actions. The level of intensity is measured based on the number of environmental actions (maximum 10) reported by enterprises to have been facilitated by the use of ICT. The following categorisation was achieved: low intensity (0 to 4 actions), medium intensity (5 to 7 actions) and high intensity (8 to 10 actions).	% enterprises having medium/high intensity of green action through ICT	Survey of businesses on the use of digital technologies by Ipsos and iCite
3b7 e-Invoices	Enterprises sending e-invoices, suitable for automated processing	% enterprises	Eurostat - European Union survey on ICT usage and eCommerce in Enterprises (E_INV4S_AP)
3c1 SMEs selling online	SMEs selling online (at least 1% of turnover)	% SMEs	Eurostat - European Union survey on ICT usage and eCommerce in Enterprises (E_ESELL)
3c2 e-Commerce turnover	SMEs' total turnover from e-commerce	% SME turnover	Eurostat - European Union survey on ICT usage and eCommerce in Enterprises (E_ETURN)
3c3 Selling online cross-border	SMEs that carried out electronic sales to other EU countries	% SMEs	Eurostat - European Union survey on ICT usage and eCommerce in Enterprises (E_AESEU)

The Integration of digital technology dimension is made up of 3 sub-dimensions: digital intensity, take-up of selected technologies by enterprises and e-commerce. SMEs with at least a basic level of digital intensity, take-up of Big data, Cloud and AI are targets of the Digital Decade Compass.

1.1.4 Digital public services dimension

Table 5. Digital public services dimension

Indicator	Description	Unit	Source
4a1 e-Government users	Individuals who used the Internet, in the last 12 months, for interaction with public authorities	% internet users	Eurostat - European Union survey on ICT usage in Households and by Individuals (I_IUGOV12)
4a2 Pre-filled forms	Amount of data that is pre-filled in public service online forms	Score (0 to 100)	eGovernment Benchmark
4a3 Digital public services for citizens	The share of administrative steps that can be done online for major life events (birth of a child, new residence, etc.) for citizens	Score (0 to 100)	eGovernment Benchmark
4a4 Digital public services for businesses	The indicator broadly reflects the share of public services needed for starting a business and conducting regular business operations that are available online for domestic as well as foreign users. Services provided through a portal receive a higher score, services which provide only information (but have to be completed offline) receive a more limited score.	Score (0 to 100)	eGovernment Benchmark
4a5 Open data	This composite indicator measures to what extent countries have an open data policy in place (including the transposition of the revised PSI Directive), the estimated political, social and economic impact of open data and the characteristics (functionalities, data availability and usage) of the national data portal.	% maximum score	European data portal

The Digital public services dimension describes the demand and supply of e-government as well as open data policies. The Digital public services for citizens and businesses indicators assess targets of the Digital Decade Compass.

1.1.5 Data sources

Most of the data in the DESI have been collected directly by national authorities. The below table presents the data sources and the role of national authorities in data collection and validation.

Table 6. Data sources and the role of national authorities

Data source	Data collection process
Eurostat	Data collected and verified by the national statistical offices or by Eurostat.
Communications Committee (COCOM)	Data collected and verified by the national regulatory authorities (by data experts appointed by the members of the Communications Committee in every Member State).
Broadband coverage studies	Data collected by IHS Markit, Omdia and Point Topic and verified by the national regulatory authorities (by data experts appointed by the members of the Communications Committee in every Member State).
Retail broadband prices studies	Data collected by Empirica and verified by the national regulatory authorities (by data experts appointed by the members of the Communications Committee in every Member State).
e-Government benchmark	Data collected by Capgemini and verified by relevant ministries in every Member State.
Survey of businesses on the use of digital technologies	Data collected by Ipsos and iCite, survey results have been reviewed by the Digital Single Market Strategic Group.
European data portal	Data collected by Capgemini from representatives appointed by the relevant ministries in every Member State.

It is important to note that the Commission organises two technical workshops annually under the Digital Single Market Strategic Group to discuss the future evolution of data collections and the index. Changes made in DESI 2021 have been agreed with Member States in the Strategic Group.

1.1.6 Data flags

A limited number of data points include explanatory notes (data flags), which can be consulted directly on the website of Eurostat at https://ec.europa.eu/eurostat/web/digital-economy-and-society.

1.2 Methodological considerations

1.2.1 Indicator requirements

Indicators used in the DESI comply with the following requirements:

- *Must be collected on a regular basis*. In order to fulfil the monitoring function, the indicators used in the index must be collected ideally on a yearly basis (or at least with a pre-defined regularity).
- *Must be relevant for a policy area of interest*. All indicators in the index must be accepted as relevant metrics in their specific policy areas.
- *Must not be redundant*. The index should not contain redundant indicators, either statistically or in terms of interpretation.

1.2.2 Data updates and corrections

Updates and corrections are part of the lifecycle and nature of statistical data. It is typical that the values for one indicator suffer small amendments and only stabilise completely months or even years after the indicator was originally computed. This is the case for a significant number of indicators used in the construction of the DESI.

At each publication, historical data are also reviewed to accommodate such changes. The current report takes account of changes notified to the European Commission before 31 August 2021. Any modification made after this date will be included in the next report, which is expected in 2022.

1.2.3 Normalisation

In order to aggregate indicators expressed in different units into the sub-dimensions and dimensions of the DESI, those indicators were normalised. In DESI, normalisation was done using the *min-max* method, which consists in a linear projection of each indicator onto a scale between 0 and 1. For indicators with positive direction (i.e. where higher is better), the 0 value in the normalised scale was anchored to the minimum value in the indicator original scale, and the value 1 in the normalised scale was anchored to the maximum value in the indicator's scale.

To allow for inter-temporal comparisons of index scores, the minima and maxima for the normalisation of each indicator were fixed and will be used for normalisation in the future versions of the DESI. Table 7 presents the values that were chosen as the minimum and maximum of each indicator for normalisation purposes.

Due to the choice of normalisation minima and maxima that are fixed over time, the values of one or another indicator may surpass the indicator's normalisation maximum or fall below its minimum in the future. The score for such values will become higher than 1 or lower than 0 respectively. While this is not a major methodological concern, the choice of minima and maxima was performed carefully, taking into account the likely evolution of each indicator and the balance between indicators, in an attempt to minimise the occurrence of such events.

Table 7. Minima and maxima used in indicator normalisation

Indicator	Minima	Maxima
1a1 At least basic digital skills	0%	100%
1a2 Above basic digital skills	0%	66%
1a3 At least basic software skills	0%	100%
1b1 ICT specialists	0%	10%
1b2 Female ICT specialists	0%	50%
1b3 Enterprises providing ICT training	0%	50%
1b4 ICT graduates	0%	10%
2a1 Overall fixed broadband take-up	50%	100%
2a2 At least 100 Mbps fixed broadband take-up	0%	100%
2a3 At least 1 Gbps take-up	0%	50%
2b1 Fast broadband (NGA) coverage	25%	100%
2b2 Fixed Very High Capacity Network (VHCN) coverage	0%	100%
2c1 4G coverage	40%	100%
2c2 5G readiness	0%	100%
2c3 5G coverage	0%	100%
2c4 Mobile broadband take-up	0%	100%
2d1 Broadband price index	25	100
3a1 SMEs with at least a basic level of digital intensity	25%	100%
3b1 Electronic information sharing	0%	60%
3b2 Social media	0%	50%
3b3 Big data	0%	75%
3b4 Cloud	0%	75%
3b5 AI	0%	75%
3b6 ICT for environmental sustainability	30%	100%
3b7 e-Invoices	0%	100%
3c1 SMEs selling online	0%	50%
3c2 e-Commerce turnover	0%	33%
3c3 Selling online cross-border	0%	25%
4a1 e-Government users	0%	100%
4a2 Pre-filled forms	0	100
4a3 Digital public services for citizens	35	100
4a4 Digital public services for businesses	40	100
4a5 Open data	0%	100%

1.2.4 Imputation of missing observations

Some indicators presented missing observations for some countries. Values for those observations were estimated using different methodologies, such as:

- using available figures from the previous year,
- using available figures from the following year,
- using proxy indicators to identify trends to complete time series.

In DESI 2021, 0.2% of all observations were imputed.

1.2.5 Weights

The four dimensions of the Digital Compass are of equal importance, which is reflected in the equal weights of each dimension.

Table 8. Weights attributed to the DESI dimensions

Dimension	Weight
1 Human capital	25%
2 Connectivity	25%
4 Integration of digital technology	25%
5 Digital public services	25%

Weights were also assigned at the sub-dimension and individual indicator level. Compared to the previous edition of the report, Mobile broadband has a higher weight, as 5G coverage is now included in the index. For the Integration of digital technology dimension, a new sub-dimension has been added to report on the target on digital intensity. In addition, the weight of the Digital technologies for businesses sub-dimension has been increased, as this sub-dimension includes 3 indicators measuring targets of the Digital Decade Compass.

Table 9. Weights attributed to the DESI sub-dimensions

Sub-dimension		Weight
1 Human capital		
	1a Internet user skills	50%
	1b Advanced skills and development	50%
2 Connectivity		
	2a Fixed broadband take-up	25%
	2b Fixed broadband coverage	25%
	2c Mobile broadband	40%
	2d Broadband prices	10%
3 Integration of digital technology		
	3a Digital intensity	15%
	3b Digital technologies for businesses	70%
	3c e-Commerce	15%
4 Digital public services		
	4a e-Government	100%

The majority of individual indicators within each sub-dimension were considered of equal importance and therefore weighted equally within the respective sub-dimension. However, indicators measuring the targets of the 2030 Digital Compass were considered as having higher importance and they therefore have double weights within their sub-dimension. These indicators are presented in the below table.

Table 10. DESI indicators with double weights

1 Human capital	At least basic digital skills ICT specialists Female ICT specialists
2 Connectivity	Gigabit for everyone (Fixed very high capacity networks coverage) 5G coverage
3 Integration of digital technology	SMEs with a basic level of digital intensity AI Cloud Big data
4 Digital public services	Digital public services for citizens Digital public services for businesses

1.2.6 Method of aggregation

In DESI, the aggregation of indicators into sub-dimensions, of sub-dimensions into dimensions, and of dimensions into the overall index was performed from the bottom up using simple weighted arithmetic averages following the structure of the index (Table 1).

As an example, the top-level DESI score for country C was calculated using the formula:

*DESI(C) = Human_capital(C) * 0.25 + Connectivity(C) * 0.25 + Integration_of_Digital_Technology(C) * 0.25 + Digital_Public_Services(C) * 0.25*

Where $Connectivity(C)$ is the score obtained by country C in the Connectivity dimension.

Annex 1 Methodology for the Broadband price index indicator

Scope

The Broadband price index includes all the baskets identified in the Broadband retail prices study by Empirica. It covers 34 baskets altogether:

- 13 with fixed services only,
- 12 with mobile service only and
- 9 with converged fixed and mobile services.

Treatment of outliers

For the data series of each basket, the skewness and kurtosis tests are performed. When the absolute value of skewness is larger than 2 and kurtosis is larger than 3.5, the outliers are treated.

Normalisation

The min-max approach is used to normalise data for each basket separately. Minimum and maximum values were fixed based on the 2019 data and were computed as follows:

- Minimum: Actual minimum value in the basket multiplied by 0.75.
- Maximum: Actual maximum value in the basket multiplied by 1.25.

Minimum and maximum values have not been updated based on the 2020 data to avoid updating 2019 figures. All prices are normalised to a score between 0 and 100, where 100 is the best performance.

Aggregation and missing data

The Broadband price index score is calculated as the arithmetic average of the normalised scores for all baskets in each member state. When data is not available (as no such offers exist that meet the criteria of a given basket), missing data is not estimated, so the index score is calculated based on the available baskets.