Ecodesign preparatory study on mobile phones, smartphones and tablets

Final Task 2 Report

Markets

Written by Fraunhofer IZM, Fraunhofer ISI, VITO
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Authors:

Karsten Schischke (Fraunhofer IZM)
Christian Clemm (Fraunhofer IZM)
Anton Berwald (Fraunhofer IZM)
Marina Proske (Fraunhofer IZM)
Gergana Dimitrova (Fraunhofer IZM)
Julia Reinhold (Fraunhofer IZM)
Carolin Prewitz (Fraunhofer IZM)

Contributors:

Antoine Durand (Quality control, Fraunhofer ISI)
Clemens Rohde (Quality control, Fraunhofer ISI)
Simon Hirzel (Quality control, Fraunhofer ISI)
Mihaela Thuring (Quality control, contract management, VITO)

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Contact: Davide Polverini

E-mail: davide.polverini@ec.europa.eu

European Commission
B-1049 Brussels

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1. GLOSSARY

Term	Definition
5G	5th Generation
AASP	Apple Authorized Service Provider
BAT	Best Available Technologies
BNAT	Best Not yet Available Technologies
CAGR	Compound Annual Growth Rate
CES	Consumer Electronics Show
COVID-19	Corona Virus Disease 2019
DECT	Digital Enhanced Cordless Telecommunications
EMEA	Europe, Middle East, Africa
eSIM	embedded Subscriber Identity Module
ETNO	European Telecommunications Network Operators
EU	European Union
EUR	Euro
EXPQNT	Exported Quantity
EXPVAL	Value Exports
GB	Gigabyte
ICT	Information and Communications Technology
IDC	International Data Corporation
IMPQNT	Imported Quantity
IMPVAL	Value Imports
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISI	Institut für System- und Innovationsforschung
ITU	International Telecommunication Union
IZM	Institut für Zuverlässigkeit und Mikrointegration
LCC	Life Cycle Cost
LCD	Liquid Crystal Display
LCS	Labour Cost Survey
LLCC	Least Life Cycle Cost
LTE	Long Term Evolution
MB	Megabyte
MC	Manufacturing Costs
MeErP	Methodology for the Ecodesign of Energy-related Products
MM	Manufacturing Margins
MNO	Mobile Network Operators
MP3	MPEG Audio Layer 3
MVNO	Mobile Virtual Network Operators
MWC	Mobile World Congress
n.a.	not available
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne
OEM	Original Equipment Manufacturer
OLED	Organic Light Emitting Diode
OS	Operating System
PC	Personal Computer

PCB	Printed Circuit Board
PP	Purchase Price
PRODCOM	Production Communautaire
PRODQNT	Produced Quantity
PRODVAL	Value Produced Goods
RAM	Random-Access Memory
RF	Radio Frequency
RM	Aggregated Sale Margin
SIM	Subscriber Identity Module
SMS	Short Message Service
SoC	System-on-Chip
TV	Television
US	United States
USD	US-Dollar
VAT	Value Added Tax
VITO	Vlaamse Instelling voor Technologisch Onderzoek
VoIP	Voice over IP
WEEE	Waste Electrical and Electronic Equipment
WiFi	Wireless Fidelity
WLL	Wireless Local Loop

2. INTRODUCTION

Preparatory studies aim to assess and specify generic or specific ecodesign measures for improving the environmental performance of a defined product group, sometimes in combination with energy label criteria. The ecodesign preparatory studies therefore provide the scientific foundation for defining these generic and/or specific ecodesign requirements as well as energy labelling criteria. The overall objective is to clearly define the product scope, analyse the current environmental impacts of these products and related systems (extended product scope) and assess the existing improvement potential of any measures. The central element of the MEErP (Kemna 2011; Mudgal et al. 2013), being the underlying assessment methodology, is to prioritise today's possible improvement options from a Least Life Cycle Cost (LLCC) perspective. Identification of the improvement options are based on possible design innovations, Best Available Technologies (BAT) for the short term and Best Not yet Available Technologies (BNAT) for long term, that can help in mitigating the impacts of these products. Policy options are assessed through a scenario analysis and the different outcomes have to be evaluated from the perspective of the EU targets, taking into account potential impacts on the competitiveness of enterprises in the EU and on the consumers.

Objective: The purpose of this task 2 is to assess trade and sales volumes, product stock on the market, growth and replacement rate forecasts for the defined products within the EU-27. It will include insights in the latest market trends so as to indicate the place of possible ecodesign requirements in the context of the market structures and ongoing trends in product design. A current data set of prices and rates to be used in a Life Cycle Cost (LCC) calculation is provided.

This market analysis uses the term "EU 27" whenever the group of member states of the European Union after the Brexit is meant, and "Europe" when data, typically from third parties, refers to Europe as a geographic region.

3. SUBTASK 2.1 - GENERIC ECONOMIC DATA

Generic economic data refers to production and trade data, including imports and exports.

3.1. Mobile phones

Most recent annual PRODCOM data for the product categories covered by this study refer to 2018. 2019 data is not yet available.

NACE code 26302200 - Telephones for cellular networks or for other wireless networks covers smartphones and other mobile phones for cellular networks[1]. Table 1 lists the corresponding 2018 data extracted from PRODCOM. EU 27 data covers exports from any EU 27 country to non-EU 27 countries, and imports from outside the EU 27 into any EU 27 countries. Data on a national level is available through PRODCOM but not included in Table 1. The export figures likely include also re-exports, which are as such irrelanvant for the ecodesign directive or the energy label regulation.

[1] for market shares smartphones vs. feature phones see 5.2

Table 1 : EU 27 PRODCOM original data for NACE 26302200 - Telephones for cellular networks or for other wireless networks, 2018

	Exported quantity (units) EXPQNT	Value exports (Euros) EXPVAL	Imported quantity (units) IMPQNT	Value imports (units) IMPVAL	Produced quantity (units) PRODQNT	Value produced goods (Euros) PRODVAL
EU 27	26.651.118	6.657.002.700	178.866.893	38.977.885.600	2.000.000	231.677.403

Table 2 lists derived values for the average value of exported, imported and produced mobile phones. These values do not necessarily reflect end user prices. Furthermore, this table lists the apparent consumption within the EU 27, which is the calculated domestic production and imports minus exports.

Table 2 : EU 27 PRODCOM derived data for NACE 26302200 - Telephones for cellular networks or for other wireless networks, 2018

	Average value of exported units (in Euros/unit) EXPVAL/EXPQNT	Average value of imported units (in Euros/unit) IMPVAL/IMPQNT	Average value of produced units (in Euros/unit) PRODVAL/PRODQNT	apparent consumption (PRODQNT+IMPQNT-EXPQNT)
EU 27	249,78	217,92	115,84	154.215.775

Data on member state level for 2018 are listed in Table 3. Imported quantity is exceptionally high for the Netherlands. As also exports from the Netherlands are much higher than from any other country, this indicates that imports to the EU to a significant extend go through the Netherlands. Reported imports to Slovakia are the second highest in the EU 27, and this has been also the case in 2017, but not in the years before. Exports are significantly lower, leaving Slovakia with an apparent consumption of 17 million units in 2018 – compared to a population of 5,44 million.

Table 3 : EU 27 PRODCOM original data for NACE 26302200 - Telephones for cellular networks or for other wireless networks, member states, 2018

	Exported quantity (units) EXPQNT	Value exports (Euros) EXPVAL	Imported quantity (units) IMPQNT	Value imports (units) IMPVAL	Produced quantity (units) PRODQNT	Value produced goods (Euros) PRODVAL
France	13.054.067	838.835.850	34.533.470	5.726.656.480	:	:
Netherlands	47.440.708	16.131.671.060	55.604.106	16.964.326.760	:	:
Germany	14.625.940	4.516.124.810	36.672.007	10.922.004.560	:	:
Italy	4.508.126	1.490.234.960	23.729.825	4.629.715.810	939	149.000
Ireland	471.471	77.829.690	1.914.035	502.435.700	0	0
Denmark	632.662	140.102.350	2.929.882	867.112.590	61	34.348
Greece	429.923	85.737.780	3.969.559	432.962.460	0	0
Portugal	548.498	78.674.580	3.893.877	621.071.020	8.000	3.400.848
Spain	2.106.225	334.669.300	19.000.884	3.412.457.290	:	:
Belgium	2.675.894	490.905.910	6.027.772	1.470.875.780	0	0
Luxemburg	1.078.881	309.045.890	1.336.251	388.945.700	0	0
Sweden	5.049.599	1.761.453.330	8.239.916	3.076.676.200	:	:
Finland	448.313	97.485.310	3.530.213	693.666.360	:	:
Austria	22.570.307	4.085.703.880	25.774.511	5.019.804.140	0	0
Malta	13.742	8.212.110	92.167	24.512.590	0	0
Estonia	917.398	113.243.930	1.423.123	177.129.290	0	0
Latvia	1.079.642	338.619.110	1.548.816	412.563.520	0	0
Lithuania	509.176	202.573.850	1.320.888	414.248.410	0	0

	Exported quantity (units) EXPQNT	Value exports (Euros) EXPVAL	Imported quantity (units) IMPQNT	Value imports (units) IMPVAL	Produced quantity (units) PRODQNT	Value produced goods (Euros) PRODVAL
Poland	4.225.667	589.875.900	14.892.387	2.324.411.200	0	0
Czech Republic	18.784.584	5.494.708.250	19.962.246	6.064.011.300	0	0
Slovakia	25.912.733	3.982.686.760	43.176.236	4.731.555.620	0	0
Hungary	1.923.988	500.683.600	5.121.026	873.210.990	228.565	24.514.077
Romania	1.195.985	123.005.580	6.408.258	946.431.940	0	0
Bulgaria	618.527	87.295.370	2.140.224	335.859.180	0	0
Slovenia	732.354	119.500.980	1.414.339	283.100.160	0	0
Croatia	202.675	30.044.170	1.629.866	259.113.410	0	0
Cyprus	138.722	88.162.180	283.528	78.074.580	0	0
EU27 TOTALS	26.651.118	6.657.002.700	178.866.893	38.977.885.600	2.000.000	231.677.403

Derived data on member states level shows some gaps due to confidential or otherwise not reported production data, but overall PRODCOM data provides an almost complete picture on the member state level. Sales of mobile phones are highest in Germany (22 million units), France (21,5 million units) and Italy (19,2 million units).

Table 4 : EU 27 PRODCOM derived data for NACE 26302200 - Telephones for cellular networks or for other wireless networks, member states, 2018

	Average value of exported units (in Euros/unit) EXPVAL/EXPQNT	Average value of imported units (in Euros/unit) IMPVAL/IMPQNT	Average value of produced units (in Euros/unit) PRODVAL/PRODQNT	apparent consumption (PRODQNT+IMPQNT-EXPQNT)
France	64,26	165,83	n.a.	21.479.403
Netherlands	340,04	305,09	n.a.	8.163.398
Germany	308,78	297,83	n.a.	22.046.067
Italy	330,57	195,10	158,68	19.221.699
Ireland	165,08	262,50	0	1.442.564
Denmark	221,45	295,95	563,08	2.297.220
Greece	199,43	109,07	0	3.539.636
Portugal	143,44	159,50	425,11	3.345.379
Spain	158,90	179,59	n.a.	16.894.659
Belgium	183,45	244,02	0	3.351.878
Luxemburg	286,45	291,07	0	257.370
Sweden	348,83	373,39	n.a.	3.190.317
Finland	217,45	196,49	n.a.	3.081.900
Austria	181,02	194,76	0	3.204.204
Malta	597,59	265,96	0	78.425
Estonia	123,44	124,47	0	505.725
Latvia	313,64	266,37	0	469.174
Lithuania	397,85	313,61	0	811.712
Poland	139,59	156,08	0	10.666.720
Czech Republic	292,51	303,77	0	1.177.662
Slovakia	153,70	109,59	0	17.263.503
Hungary	260,23	170,51	107,25	3.197.038

	Average value of exported units (in Euros/unit) EXPVAL/EXPQNT	Average value of imported units (in Euros/unit) IMPVAL/IMPQNT	Average value of produced units (in Euros/unit) PRODVAL/PRODQNT	apparent consumption (PRODQNT+IMPQNT-EXPQNT)
Romania	102,85	147,69	0	5.212.273
Bulgaria	141,13	156,93	0	1.521.697
Slovenia	163,17	200,16	0	681.985
Croatia	148,24	158,98	0	1.427.191
Cyprus	635,53	275,37	0	144.806
EU27 TOTALS	249,78	217,92	115,84	152.215.775

Overall, PRODCOM data on mobile phones is plausible[2] and seems to give a correct impression of the overall EU 27 market – which is not the case for many other product groups.

3.2. Cordless landline phones

NACE code 26302100 - Line telephone sets with cordless handsets covers cordless phones, including base stations. To our understanding packages of a base or charging station with a handset is reported as one unit. If individual packages of several handsets and several charging stations are reported according to the number of handsets or as "one system" is speculative.

Table 5 : EU 27 PRODCOM original data for NACE 26302100 - Line telephone sets with cordless handsets, 2018

	Exported quantity (units) EXPQNT	Value exports (Euros) EXPVAL	Imported quantity (units) IMPQNT	Value imports (units) IMPVAL	Produced quantity (units) PRODQNT	Value produced goods (Euros) PRODVAL
EU 27	1.704.713	65.525.100	9.478.019	190.827.820	6.000.000	300.000.000

For comparison, data for NACE code 26302330 – Telephone sets (excluding line telephone sets with cordless handsets and telephones for cellular networks or for other wireless networks); videophones, which is out of scope of this study but is assumed to share the telephone set market for landline telecommunication with cordless phones, is provided Table 6. This data suggests that in monetary terms cordless phones have a market share of 45% in EU 27. In terms of units this share is likely to be lower, given the lower value of wired phones.

Table 6 : EU 27 PRODCOM original data for NACE 26302330 – Telephone sets (excluding line telephone sets with cordless handsets and telephones for cellular networks or for other wireless networks); videophones, 2018

	Exported quantity (units) EXPQNT	Value exports (Euros) EXPVAL	Imported quantity (units) IMPQNT	Value imports (units) IMPVAL	Produced quantity (units) PRODQNT	Value produced goods (Euros) PRODVAL
EU 27	:	505.787.590	:	839.040.960	4.890.423	176.042.731

[2] Except for the data reported for Slovakia

Table 7 lists derived data for the average value of exported, imported and produced cordless phones. These values do not necessarily reflect end user prices. Furthermore, this table lists the apparent consumption within the EU 27 in 2018, which is the calculated domestic production and imports minus exports.

Table 7 : EU 27 PRODCOM derived data for NACE 26302100 - Line telephone sets with cordless handsets, 2018

	Average value of exported units (in Euros/unit) EXPVAL/EXPQNT	Average value of imported units (in Euros/unit) IMPVAL/IMPQNT	Average value of produced units (in Euros/unit) PRODVAL/PRODQNT	apparent consumption (PRODQNT+IMPQNT-EXPQNT)
EU 27	38,44	20,13	50,00	13.773.306

Combined with the figures for wired landline phones we estimate a market size of roughly 40 million landline phones in EU 27 per year.

Data on member state level for 2018 are listed in Table 8. Germany is a net exporter of cordless phones. As no production data for Germany is disclosed by Eurostat, the calculated apparent consumption is negative (Table 8). Total production in EU 27 is rounded by Eurostat to 6 million units, which apparently refers to production in those countries, for which no production data has been disclosed: France, Netherlands, Germany, and Spain. All other member state no production.

Table 8 : EU 27 PRODCOM original data for NACE 26302100 - Line telephone sets with cordless handsets, member states, 2018

	Exported quantity (units) EXPQNT	Value exports (Euros) EXPVAL	Imported quantity (units) IMPQNT	Value imports (units) IMPVAL	Produced quantity (units) PRODQNT	Value produced goods (Euros) PRODVAL
France	258.729	7.878.360	3.775.035	94.552.920	:	:
Netherlands	1.159.999	42.906.270	2.380.517	64.170.560	:	:
Germany	5.701.105	130.554.690	3.300.931	95.892.650	:	:
Italy	161.022	5.092.360	1.899.125	28.151.900	0	0
Ireland	9.239	399.890	118.127	4.017.090	0	0
Denmark	399.402	17.707.740	75.528	7.610.850	0	0
Greece	13.594	1.262.970	1.004.597	9.880.070	0	0
Portugal	7.036	471.850	323.895	5.144.360	0	0
Spain	347.312	33.996.160	1.969.829	69.701.740	:	:
Belgium	169.980	5.797.530	473.512	15.276.520	0	0
Luxemburg	1.601	388.690	25.086	2.833.850	0	0
Sweden	179.579	5.945.370	184.444	3.509.510	0	0
Finland	912	86.880	3.486	250.560	0	0
Austria	38.136	5.185.930	211.317	13.532.940	0	0
Malta	0	0	6.056	95.590	0	0
Estonia	186	12.580	25.502	1.172.970	0	0
Latvia	192	7.040	1.514	45.020	0	0
Lithuania	3.780	138.170	13.418	332.290	0	0
Poland	44.109	1.917.400	622.783	8.727.100	0	0
Czech Republic	54.498	2.031.210	98.637	3.150.350	0	0
Slovakia	14.481	3.397.850	37.122	4.387.590	0	0
Hungary	11.789	656.360	155.590	3.828.850	0	0
Romania	1.745	149.070	103.042	3.275.960	0	0
Bulgaria	186.353	4.189.920	197.272	4.162.230	0	0

	Exported quantity (units) EXPQNT	Value exports (Euros) EXPVAL	Imported quantity (units) IMPQNT	Value imports (units) IMPVAL	Produced quantity (units) PRODQNT	Value produced goods (Euros) PRODVAL
Slovenia	5.204	619.880	25.614	909.520	0	0
Croatia	6.325	101.470	132.614	2.008.260	0	0
Cyprus	6	2.830	14.159	278.670	0	0
EU 27 TOTALS	**1.704.713**	**65.525.100**	**9.478.019**	**190.827.820**	**6.000.000**	**300.000.000**

Exports from Denmark are higher than imports to Denmark although production volume is stated to be zero. This was also the case in years 2014 to 2017. It is not known which statistical effect or reporting error might be the reason.

Table 9 : EU 27 PRODCOM derived data for NACE 26302100 - Line telephone sets with cordless handsets, member states, 2018

	Average value of exported units (in Euros/unit) EXPVAL/EXPQNT	Average value of imported units (in Euros/unit) IMPVAL/IMPQNT	Average value of produced units (in Euros/unit) PRODVAL/PRODQNT	apparent consumption (PRODQNT+IMPQNT-EXPQNT)
France	30,45	25,05	n.a.	3.516.306*
Netherlands	36,99	26,96	n.a.	1.220.518*
Germany	22,90	29,05	n.a.	(-2.400.174)
Italy	31,63	14,82	0	1.738.103
Ireland	43,28	34,01	0	108.888
Denmark	44,34	100,77	0	-323.874
Greece	92,91	9,83	0	991.003
Portugal	67,06	15,88	0	316.859
Spain	97,88	35,38	n.a.	1.622.517*
Belgium	34,11	32,26	0	303.532
Luxemburg	242,78	112,97	0	23.485
Sweden	33,11	19,03	0	4.865
Finland	95,26	71,88	0	2.574
Austria	135,99	64,04	0	173.181
Malta	0	15,78	0	6.056
Estonia	67,63	46,00	0	25.316
Latvia	36,67	29,74	0	1.322
Lithuania	36,55	24,76	0	9.638
Poland	43,47	14,01	0	578.674
Czech Republic	37,27	31,94	0	44.139
Slovakia	234,64	118,19	0	22.641
Hungary	55,68	24,61	0	143.801
Romania	85,43	31,79	0	101.297
Bulgaria	22,48	21,10	0	10.919
Slovenia	119,12	35,51	0	20.410
Croatia	16,04	15,14	0	126.289
Cyprus	471,67	19,68	0	14.153
EU27 TOTALS	**38,44**	**20,13**	**50,00**	**13.773.306**

(*) confidential domestic production to be added

3.3. Tablets

PRODCOM statistics from Eurostat do not differentiate laptop / notebook computers, slates and tablets.

Table 10 below covers NACE code 26201100 - Laptop PCs and palm-top organisers, which includes tablet computers, but also the large laptop / notebook market. Total apparent consumption in the EU 27 is 51 million units in 2018. Another 14 million units are sold in the United Kingdom, i.e. 21% of the EU 28 market at that time.

Table 10 : EU 27 and EU 28 PRODCOM derived data for NACE 26201100 - Laptop PCs and palm-top organisers, member states, 2018

	Average value of exported units (in Euros/unit) EXPVAL/EXPQNT	Average value of imported units (in Euros/unit) IMPVAL/IMPQNT	Average value of produced units (in Euros/unit) PRODVAL/PRODQNT	apparent consumption (PRODQNT+IMPQNT-EXPQNT)
France	186,20	340,16	741,47	9.724.446
Netherlands	514,28	494,12	n.a.	4.572.684
Germany	467,75	448,09	827,09	10.887.018
Italy	306,38	338,77	189,91	4.076.202
Ireland	429,20	307,72	n.a.	813.874
Denmark	344,62	402,19	1183,85	1.366.555
Greece	354,24	282,20	0	769.887
Portugal	285,32	353,29	147,49	893.959
Spain	166,21	294,04	n.a.	4.719.050
Belgium	341,47	449,09	0	1.500.666
Luxemburg	296,38	428,69	0	97.893
Sweden	348,11	472,89	n.a.	1.795.288
Finland	283,72	504,78	139,97	958.539
Austria	212,31	324,77	n.a.	974.046
Malta	613,70	517,92	0	32.413
Estonia	141,81	455,65	320,57	90.516
Latvia	242,96	335,69	0	127.480
Lithuania	350,88	372,74	0	156.717
Poland	191,81	307,53	n.a.	2.604.048
Czech Republic	489,02	465,23	n.a.	1.098.946
Slovakia	172,57	195,93	0	441.849
Hungary	353,67	320,64	0	947.294
Romania	80,64	350,31	0	578.178
Bulgaria	155,54	211,70	n.a.	438.948
Slovenia	185,28	313,03	n.a.	154.921
Croatia	320,61	289,17	3067,00	290.382
Cyprus	415,05	331,14	0	73.083
EU27 TOTALS	**403,31**	**391,35**	**362,97**	**51.007.767**
United Kingdom	240,09	347,09	498,92	13.945.589
EU28 TOTALS	340,79	382,01	384,08	64.665.200

The Computer Review Study in 2017 estimated the sales volume for the EU (EU 28 at that time) based on Statista global sales data[3], and applying a 20% EU share value. "It should be noted that it was not possible to identify the size of products that were covered under the market research company data. Assuming that this Statista category also covers portable all-in-ones (often seen as very large tablet computers) and for the purposes of this project, sales of portable all-in-ones have been deducted from the total tablet and slate computer sales." (Maya-Drysdale et al. 2017)

Deducting from these figures the share of the United Kingdom leads to corrected tablet data for EU 27 – under the assumption that UK's market share of 21% for "Laptop PCs and palm-top organisers" applies also to the sub-segment of tablets.

Table 11 : EU, tablet sales, Computer Review Study (EU 28) and approximation for EU 27, 2010-2030

	Sales, million units				
	2010	**2015**	**2020**	**2025**	**2030**
Tablets/slates as defined in (EU) 617/2013, EU 28	3,65	40,79	38,38	38,47	38,56
Tablets/slates as defined in (EU) 617/2013, EU 27	2,88	32,22	30,32	30,39	30,46

Market intelligence company IDC forecasted earlier this year a total global market of 126,1 million tablets, correcting earlier forecasts already by taking effects of the COVID-19 pandemic into account. This forecast might need to be corrected once more in the course of 2020.

The EMEA market (Europe, Middle East, Africa) is in terms of units approximately 30% of the global market, and Western Europe (including the United Kingdom) 20% of the global market – or 65% of the EMEA market.

In the first quarter of 2020 the overall tablet market in EMEA reached 8,8 million units, declining 9.6% compared to the first quarter of 2019. International Data Corporation (IDC) reports an increase in the commercial segment sustained by the demand for mobile solutions to address the needs of working and schooling from home, but this was not enough to offset the weakness in the consumer segment, which is a consequence of the lockdown in European countries and supply chain issues due to factory shutdowns in China. (IDC 2020)

Table 12 : Global tablet unit shipments 1Q20 (IDC 2020)

Vendor	1Q20 Unit Shipments (millions)	1Q20 Market Share	1Q19 Unit Shipments (millions)	1Q19 Market Share	Year-Over-Year Growth
Apple	6.9	28.0%	9.9	32.9%	-30.4%
Samsung	5.0	20.2%	4.8	15.9%	3.9%
Huawei	3.0	12.0%	3.2	10.7%	-8.3%
Lenovo	1.6	6.4%	1.6	5.2%	1.9%
Amazon.com	1.4	5.8%	1.9	6.3%	-24.5%
Others	6.8	27.5%	8.7	29.0%	-22.2%
Total	**24.6**	**100.0%**	**30.1**	**100.0%**	**-18.2%**

[3] http://www.statista.com/statistics/272595/global-shipments-forecast-for-tablets-laptops-and-desktop-pcs/

Under these conditions the data in the Computer Review study of 2017 seems to be too optimistic in terms of sold units on the EU 27, then EU 28, market. The EU 27 market being a share of roughly 20% of the global market of tablets seems to be accurate, but instead of 38 million sold units a figure of 25 million units or less for 2020 and in the mid-term future is more plausible.

4. SUBTASK 2.2 - MARKET AND STOCK DATA

4.1. Mobile phones

4.1.1. Historic data and forecasts

NACE code 26302200 - Telephones for cellular networks or for other wireless networks covers smartphones and other mobile phones for cellular networks exists since 2007 in European PRODCOM statistics. Table 13 lists the corresponding data extracted from PRODCOM for the years since 2007. Production of mobile phones in the European Union went down over the years. Until approximately 2011 the market share of EU production was still significant. With the ever increasing share of smartphones vs. feature phones imports took over almost completely. In recent years 2-3% of all mobile phones sold in the EU are manufactured in the EU.

Table 13 : EU 27 PRODCOM original data for NACE 26302200 - Telephones for cellular networks or for other wireless networks, 2006 - 2018

	Exported quantity (units) EXPQNT	Value exports (Euros) EXPVAL	Imported quantity (units) IMPQNT	Value imports (units) IMPVAL	Produced quantity (units) PRODQNT	Value produced goods (Euros) PRODVAL
until 2006	:	:	:	:	:	:
2007	142.031.071	13.431.601.840	200.604.133	14.013.027.090	206.603.384	8.000.000.000
2008	112.971.424	11.683.827.100	207.133.807	14.561.853.600	155.085.306	13.390.103.770
2009	84.976.593	8.553.165.480	192.507.335	13.508.306.190	115.338.415	7.766.482.271
2010	91.496.311	11.611.201.220	202.341.350	15.885.495.780	112.245.240	8.926.055.468
2011	85.315.970	12.832.032.470	195.168.462	18.303.801.270	73.385.375	6.611.341.215
2012	65.358.127	12.898.289.650	210.235.610	25.008.431.230	34.000.000	2.800.000.000
2013	58.740.685	11.328.004.680	218.076.212	26.806.773.490	16.412.003	1.604.027.035
2014	42.286.516	8.514.321.990	210.390.948	25.216.518.000	4.000.000	689.458.769
2015	42.336.200	10.496.302.140	212.622.071	37.940.030.910	894.138	170.402.369
2016	34.741.511	7.799.206.480	196.320.079	35.216.757.330	1.506.998	210.276.276
2017	33.037.434	8.427.316.850	193.497.190	38.760.748.670	2.587.176	221.141.072
2018	26.651.118	6.657.002.700	178.866.893	38.977.885.600	2.000.000	231.677.403

Table 14 lists derived values for the average value of exported, imported and produced mobile phones. This table lists the apparent consumption within the EU 27, which is the calculated domestic production and imports minus exports, since 2007. Statistically calculated value of exported units is steadily increasing from 95 Euros in 2007 to about 250 Euros in more recent years. Presumably the export figures also include export of used smartphones. The rather high average value for exported units however indicates that among reported figures under this NACE code second hand units do not seem to play a major role. Imported mobiles are of lower value, but also steadily increasing from 70 to 218 Euros in 2018. Value of produced units has been below 100 Euros until 2013,

and fluctuated thereafter, which obviously is also a statistical effect of the very low number of produced units.

Table 14 : EU 27 PRODCOM derived data for NACE 26302200 - Telephones for cellular networks or for other wireless networks

	Average value of exported units (in Euros/unit) EXPVAL/EXPQNT	Average value of imported units (in Euros/unit) IMPVAL/IMPQNT	Average value of produced units (in Euros/unit) PRODVAL/PRODQNT	apparent consumption (PRODQNT+IMPQNT-EXPQNT)
until 2006	n.a.	n.a.	n.a.	n.a.
2007	94,57	69,85	38,72	265.176.446
2008	103,42	70,30	86,34	249.247.689
2009	100,65	70,17	67,34	222.869.157
2010	126,90	78,51	79,52	223.090.279
2011	150,41	93,78	90,09	183.237.867
2012	197,35	118,95	82,35	178.877.483
2013	192,85	122,92	97,73	175.747.530
2014	201,35	119,86	172,36	172.104.432
2015	247,93	178,44	190,58	171.180.009
2016	224,49	179,38	139,53	163.085.566
2017	255,08	200,32	85,48	163.046.932
2018	249,78	217,92	115,84	154.215.775

Overall, PRODCOM data on mobile phones for recent years is plausible and seems to give a correct impression of the overall EU 27 market – which is not the case for many other product groups. Figures for 2007-2010 are however exceptionally high and do not correspond with other market statistics. 250 million units per year would have meant more than half a phone for every EU 27 citizen. These historic figures have to be used with caution.

Statista publishes similar statistical data on the mobile phone retail market, based on own in-depth analytics and for some country algorithm based calculations (statista 2020). Table 15 summarises this data, including historical data from 2012 until now and an outlook until 2023. Data is provided for the largest European markets – and Slovakia. Compared to the apparent consumption calculated with PRODCOM data (see above), the figures stated here are much more plausible. Sales in Slovakia are stated to be 1,3 million units in 2017 and 2018.

Calculations based on statista's individual data for all EU member states result in total sales within the EU 27 of 147,84 million units in 2018, compared to 154,22 million units apparent consumption based on PRODCOM data. Although also statista's data is partly based on official national statistics, just as PRODCOM, a figure of approximately 150 million sold units in the EU 27 per year can be considered a reliable figure.

Table 15 : EU 27 mobile phone sales, member states and EU totals, 2012-2023 (compiled by Fraunhofer IZM, based on data by statista)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
France	28,0	28,2	28,3	28,5	28,6	28,7	28,8	28,9	26,9	27,9	28,4	28,8
Netherlands	6,5	6,7	6,9	7,0	7,2	7,3	7,3	7,4	7,1	7,2	7,3	7,4
Germany	24,1	25,6	26,4	25,6	24,2	23,1	22,5	22,3	19,3	20,6	21,3	21,9
Italy	23,5	23,8	24,1	24,4	24,7	24,9	25,1	25,2	23,6	24,5	24,9	25,2
Spain	12,6	12,7	12,8	12,9	13,0	13,0	13,1	13,1	11,0	12,0	12,5	13,0
Poland	9,4	9,5	9,6	9,7	9,8	9,8	9,9	9,9	9,6	9,8	9,9	10,0
Slovakia	1,0	1,1	1,1	1,2	1,2	1,3	1,3	1,3	1,2	1,3	1,3	1,4
other member states	36,3	37,0	37,8	38,5	39,1	39,5	39,9	40,2	35,9	38,1	39,5	40,4
EU 27	**141,5**	**144,5**	**146,9**	**147,7**	**147,6**	**147,5**	**147,8**	**148,2**	**134,6**	**141,3**	**145,2**	**147,9**

Data by statista clearly shows a COVID-19 impact on the mobile phone market in 2020: The market is predicted to drop this year by 9,2% in EU 27, although this effect is more apparent in some countries – such as Denmark with -29% and Portugal with -25% - than in others, where only a very minor downwards trend is forecasted for this year, such as Austria and Belgium. Reasons for these differences among the EU member states are not evident. The outlook until 2023 indicates a recovery of the market, returning within 3 years almost to the 2019 level (Figure 1).

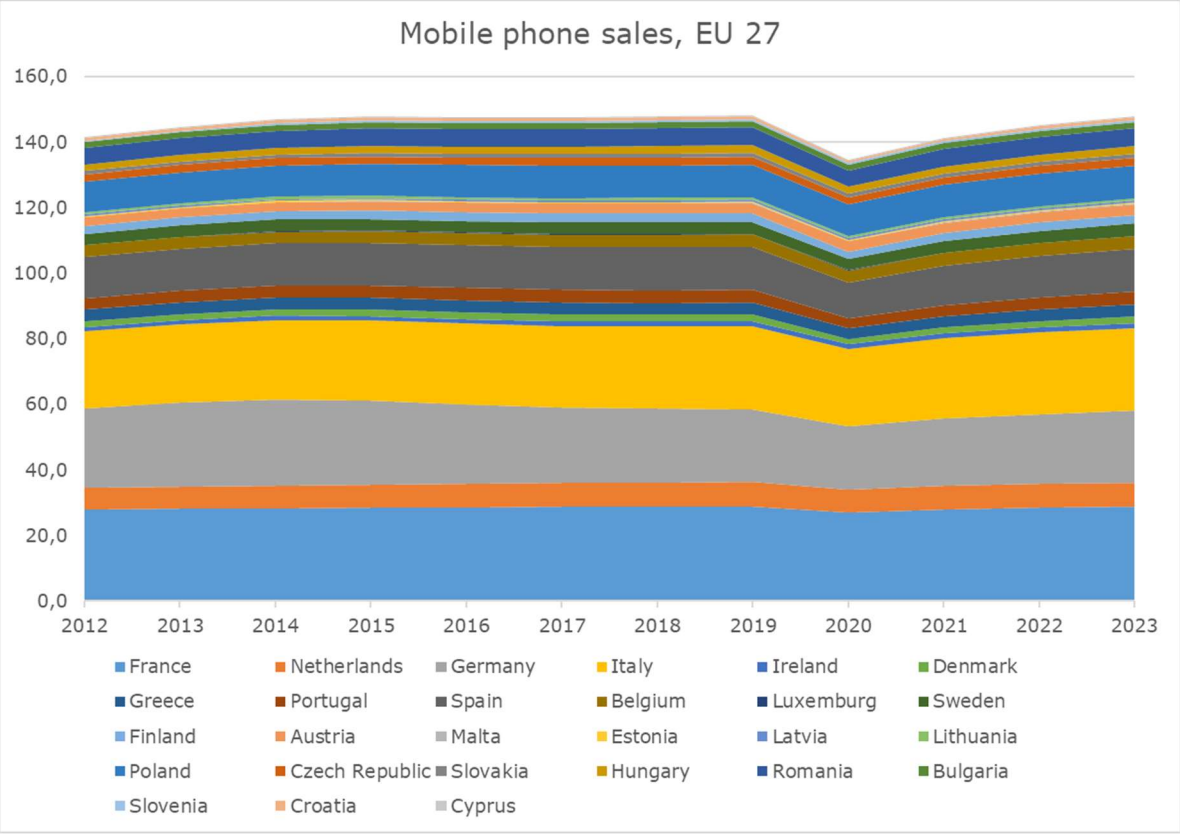


Figure 1: EU 27 mobile phone sales, member states and EU totals, 2012-2023 (compiled by Fraunhofer IZM, based on data by statista)

Figure 2 depicts the exports, imports, sold production and resulting apparent consumption for EU 27 for mobile phones from 2007 – the first year the corresponding NACE code 26302200 is reflected in Eurostat data – to 2018. The apparent consumption shows a steady downwards trend reaching 154 million sold units in the EU 27 in 2018,

compared to 265 million units back in 2007. At that time there still was a significant domestic production of smartphones within EU 27 countries (more conventional mobile phones, feature phones). With the advent of smartphones this domestic EU production largely vanished.

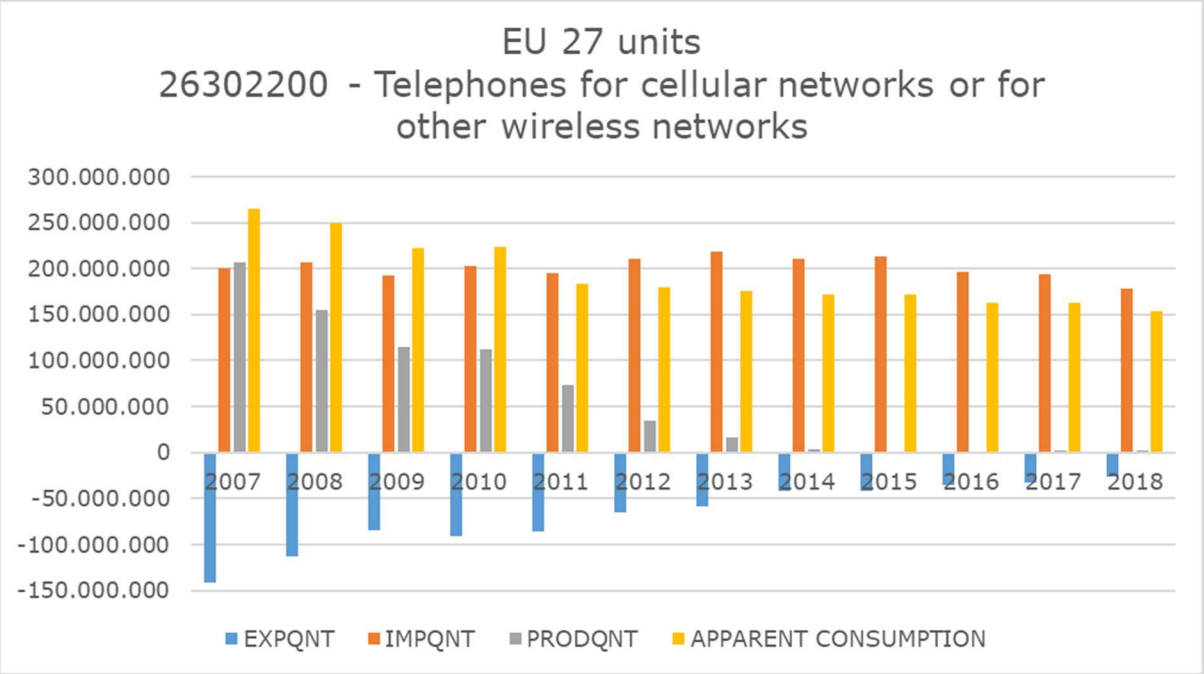


Figure 2 : EU 27 PRODCOM units data for NACE 26302200 - Telephones for cellular networks or for other wireless networks

4.1.2. Products in use and lifespan

4.1.2.1. Active use

There is no explicit data on mobile phones / smartphones in active use in EU-27, but stock data can be derived indirectly from various sources.

Eurostat provides data on smartphone use, based on surveys and national statistics. Table 16 lists data on smartphone use for private purposes throughout the EU-27 member states[4]. As per setting of this survey, the share of individuals using a smartphone for private purposes does not reflect business use only, if an individual uses multiple smartphones or if individuals share devices. As a proxy for the number of smartphones in active use this is considered appropriate.

[4] Data are collected annually by the National Statistical Institutes and are based on Eurostat's annual model questionnaires on ICT (Information and Communication Technologies) usage in households and by individuals

Table 16 : EU 27 Eurostat data on smartphone use for private purposes (2018, percentages)

	Individuals use a smartphone for private purposes	Individuals, 16 to 24 years old	Individuals, 25 to 34 years old	Individuals, 35 to 44 years old	Individuals, 45 to 54 years old	Individuals, 55 to 64 years old	Individuals, 65 to 74 years old	Individuals, 75 years old or more
	individuals (%)							
European Union - 27	**73**	**93**	**91**	**86**	**75**	**56**	**35**	**:**
Belgium	71	88	88	83	73	57	32	:
Bulgaria	55	83	78	71	58	34	11	:
Czech Republic	68	95	92	86	73	42	19	:
Denmark	91	98	97	97	94	88	72	:
Germany	77	96	95	92	79	58	38	:
Estonia	72	97	94	88	75	50	25	:
Ireland	75	94	95	95	79	59	25	:
Greece	59	95	86	77	57	33	12	:
Spain	84	95	97	94	89	74	48	15
France	69	91	89	81	67	50	35	:
Croatia	60	87	90	76	64	36	16	:
Italy	76	94	91	87	81	66	39	11
Cyprus	81	98	96	93	85	61	33	:
Latvia	65	94	92	81	64	40	16	:
Lithuania	68	97	95	85	66	45	20	:
Luxembourg	85	91	94	92	80	76	62	:
Hungary	65	90	88	83	68	42	18	:
Malta	75	100	96	93	73	52	22	:
Netherlands	87	95	96	94	90	83	65	:
Austria	82	98	97	93	85	67	41	:
Poland	67	95	91	83	63	39	20	:
Portugal	58	89	86	79	57	31	17	:
Romania	57	78	74	68	60	39	19	:
Slovenia	71	93	93	90	74	44	31	:
Slovakia	59	85	82	75	56	33	12	:
Finland	86	99	97	96	90	79	57	:
Sweden	86	95	90	91	90	84	67	:

The survey above does not include smartphone users below 16 years of age and only in two cases users above 74 years of age. Among all others 73% of individuals use a smartphone for private purposes. In Denmark this share is highest (91%), in Bulgaria it is lowest (55%). Smartphone use is much more popular among individuals up to 44 years of age, than among older individuals. Across the EU-27 93% in the age of 16 to 24 use a smartphone, among individuals 55 to 64 years of age this share is at 35%, and in those two countries which report data for individuals 75 years of age and older this share is 15% in Spain, and 11% in Italy respectively.

With this data private smartphone use among EU individuals can be quantified. For those below 16 years of age and above 74 years an estimate has to be made. Assuming a low rate among elderly people, similar to Spain and Italy, and that smartphone use (including smartphone ownership) starts at 10 – 12 years of age, we take 15% as a proxy for those age groups not covered by the EU survey data. Based on these figures the number of EU 27 individuals using a smartphone for private purposes is **260 million**.

Table 17: EU 27 estimation on total number of smartphone users for private purposes (2018)

	total population	population 16 to 74 years old	individuals, 16 - 74 years old, use a smartphone for private purposes	estimation individuals use a smartphone for private purposes, total population (15% for all individuals below 16 and above 74 years old)
	individuals (persons)			
European Union - 27	**446.098.424**	**330.848.595**	**241.519.474**	**258.806.949**
Belgium	11.398.589	8.330.257	5.914.483	6.374.732
Bulgaria	7.050.034	5.369.045	2.952.975	3.205.123
Czech Republic	10.610.055	8.060.964	5.481.456	5.863.819
Denmark	5.781.190	4.283.082	3.897.605	4.122.321
Germany	82.792.351	61.418.371	47.292.145	50.498.242
Estonia	1.319.133	964.698	694.583	747.748
Ireland	4.830.392	3.482.817	2.612.113	2.814.249
Greece	10.741.165	7.893.993	4.657.456	5.084.532
Spain	46.658.447	34.800.395	29.232.332	31.011.039
France	66.918.941	47.752.276	32.949.071	35.824.070
Croatia	4.105.493	3.083.592	1.850.155	2.003.441
Italy	60.483.973	44.836.669	34.075.869	36.422.964
Cyprus	864.236	656.682	531.912	563.045
Latvia	1.934.379	1.419.150	922.448	999.732
Lithuania	2.808.901	2.081.548	1.415.453	1.524.556
Luxembourg	602.005	458.427	389.663	411.200
Hungary	9.778.371	7.472.273	4.856.977	5.202.892
Malta	475.701	371.050	278.288	293.985
Netherlands	17.181.084	12.841.200	11.171.844	11.822.826
Austria	8.822.267	6.641.216	5.445.797	5.772.955
Poland	37.976.687	29.099.461	19.496.639	20.828.223
Portugal	10.291.027	7.684.064	4.456.757	4.847.801
Romania	19.530.631	14.695.450	8.376.406	9.101.683
Slovenia	2.066.880	1.550.756	1.101.036	1.178.455
Slovakia	5.443.120	4.212.137	2.485.161	2.669.808
Finland	5.513.130	4.061.695	3.493.058	3.710.773
Sweden	10.120.242	7.327.327	6.301.502	6.720.439

Being asked how often phone calls are made over a mobile phone, figures in EU are significantly higher than what is indicated above: In 2017 92% stated to make or receive

phone calls over a mobile phone at least occasionally (Figure 3). This apparently includes not only smartphones as above, but also feature phones, includes business use – and still excludes those few, who have a smartphone, but do not use it for phone calls. In Latvia only 1% stated never to use a mobile phone, in Croatia this share is highest with 12%.

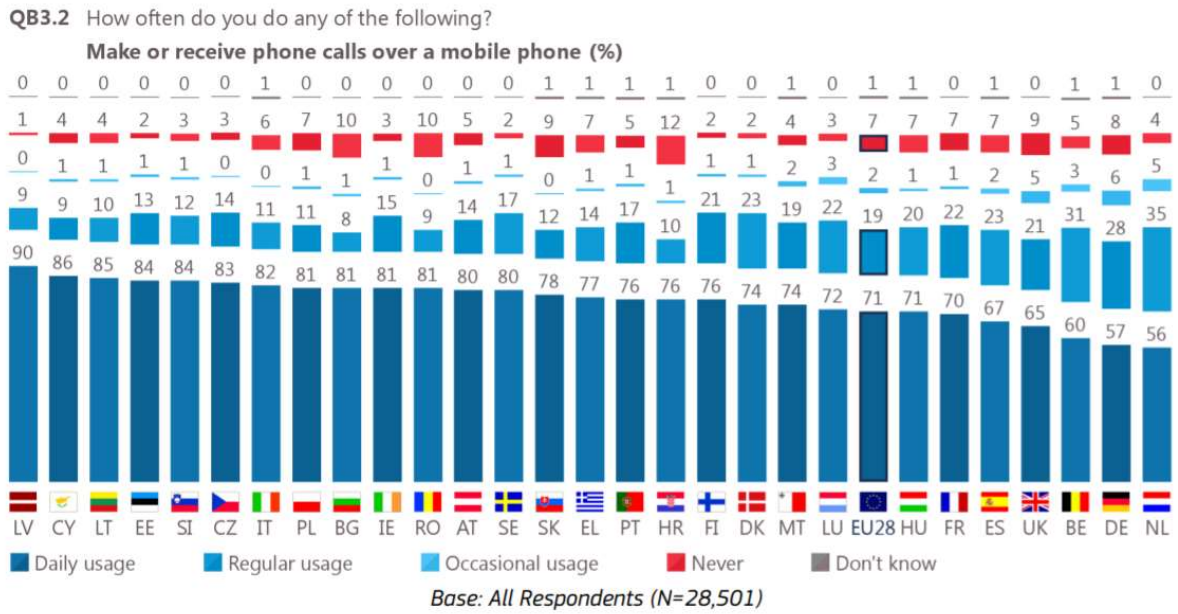


Figure 3: EU 28, Use of mobile phones, 2017 (European Commission 2018)

Whereas Eurostat data focusses on smartphones, data by ITU states the proportion of individuals using a mobile phone. Data is provided for some EU 27 member states only. As mobile phones is understood to be the broader term, including smartphones, a higher usage rate for mobile phones can be expected and is actually the case for Belgium, Czech Republic, Spain, Italy, Romania and Slovenia, , but lower for Denmark and Sweden, which is not plausible. The age range for both statistics is stated to be the same (16 – 74 years).

Table 18 : EU 27 Eurostat data on smartphone use for private purposes (2018, percentages) compared with ITU data on using a mobile cellular telephone (most recent data)

	Individuals use a smartphone for private purposes in % (Eurostat)	Proportion of individuals using a mobile cellular telephone in % (ITU)
European Union - 27	**73**	**n.a.**
Belgium	71	97,3 (2017)
Bulgaria	55	n.a.
Czech Republic	68	96,0 (2018)
Denmark	91	88,5 (2018)
Germany	77	n.a.
Estonia	72	n.a.
Ireland	75	n.a.
Greece	59	n.a.
Spain	84	96,9 (2019)
France	69	n.a.
Croatia	60	n.a.
Italy	76	91,5 (2017)

	Individuals use a smartphone for private purposes in % (Eurostat)	Proportion of individuals using a mobile cellular telephone in % (ITU)
Cyprus	81	n.a.
Latvia	65	n.a.
Lithuania	68	n.a.
Luxembourg	85	n.a.
Hungary	65	n.a.
Malta	75	n.a.
Netherlands	87	n.a.
Austria	82	n.a.
Poland	67	n.a.
Portugal	58	n.a.
Romania	57	60,8 (2018)
Slovenia	71	96,2 (2018)
Slovakia	59	n.a.
Finland	86	n.a.
Sweden	86	83,6 (2017)

ITU reports the number of mobile cellular subscriptions worldwide. Subscriptions are an indication for the number of units in active use. A single mobile phone might be operated on more than one mobile subscription (Dual SIM or user swaps SIM cards), and there are also applications, which run on mobile subscriptions, but do not require a mobile phone, such as sensors, which are equipped with a SIM card to send data through a telecommunications network. Furthermore, also tablets and laptops frequently feature mobile connectivity and the user might subscribe to a mobile cellular service for these devices individually.

The number of mobile cellular subscriptions grew steadily from 1995 to 2008, and remains on a plateau since then. In total there are close to 550 million active[5] subscriptions to mobile cellular services in the EU 27 (Figure 4).

[5] postpaid subscriptions and active prepaid avccounts (i.e. that have been used during the last three months)

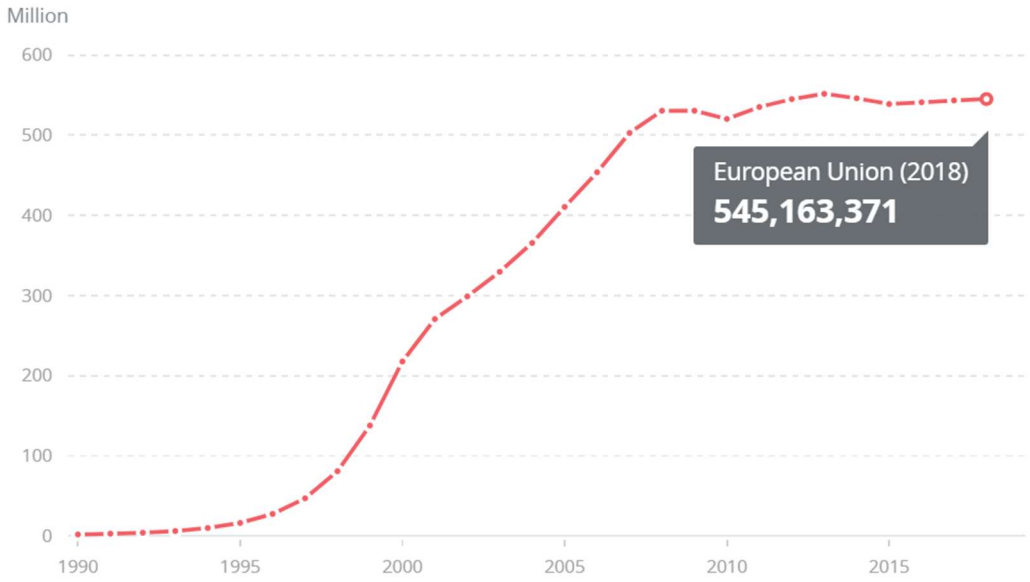


Figure 4 : EU 27 Mobile cellular subscriptions, 1990-2018 (ITU, License : CC BY-4.0)

In all EU 27 member states there is statistically at least 1 mobile cellular subscription per inhabitant (Belgium) and up to 1,64 subscriptions per inhabitant (Lithuania). ITU reports the share of household with a mobile cellular telephone for Denmark, Spain and Italy, but no distinction is made of how many phones are in use per household.

Table 19 : EU 27 Mobile cellular subscriptions, EU 27 and per country (2018), and proportion of households with mobile phones

	total subscriptions (Eurostat)	subscriptions per inhabitant[6] (Eurostat)	proportion of households with mobile-cellular telephone[7] (ITU)
European Union - 27	**545.163.371**	**1,23**	**n.a.**
Belgium	11.447.351	1,00	n.a.
Bulgaria	8.387.160	1,19	n.a.
Czech Republic	12.704.262	1,19	n.a.
Denmark	7.197.000	1,25	94,2 % (2018)
Germany	107.500.000	1,29	n.a.
Estonia	1.924.034	1,45	n.a.
Ireland	4.971.493	1,03	n.a.
Greece	12.170.757	1,16	n.a.
Spain	54.161.014	1,16	98,5 % (2019)
France	70.422.000	1,08	n.a.
Croatia	4.388.476	1,06	n.a.
Italy	83.342.486	1,37	95,0 % (2017)
Cyprus	1.200.378	1,39	n.a.
Latvia	2.070.180	1,07	n.a.

[6] https://data.worldbank.org/indicator/IT.CEL.SETS.P2?end=2018&locations=EU&start=1990&view=chart

[7] https://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2019/CoreHouseholdIndicators.xlsx

	total subscriptions (Eurostat)	subscriptions per inhabitant[6] (Eurostat)	proportion of households with mobile-cellular telephone[7] (ITU)
Lithuania	4.590.441	1,64	n.a.
Luxembourg	798.600	1,32	n.a.
Hungary	10.041.939	1,03	n.a.
Malta	615.843	1,40	n.a.
Netherlands	21.108.000	1,24	n.a.
Austria	10.984.000	1,24	n.a.
Poland	51.098.747	1,35	n.a.
Portugal	11.859.548	1,16	n.a.
Romania	22.675.000	1,16	n.a.
Slovenia	2.465.857	1,19	n.a.
Slovakia	7.241,702	1,33	n.a.
Finland	7.150.000	1,29	n.a.
Sweden	12.647.103	1,27	n.a.

The fact, that there are more mobile subscriptions in the EU 27 than inhabitants is plausible, given the 2017 Eurobarometer survey (European Commission 2018): In 64% of all households in the EU the number of mobile phones[8] equals the number of household members, but in 11% the number of mobile phones is higher than number of household members. In 25% of all households there is less than 1 mobile phone per household member.

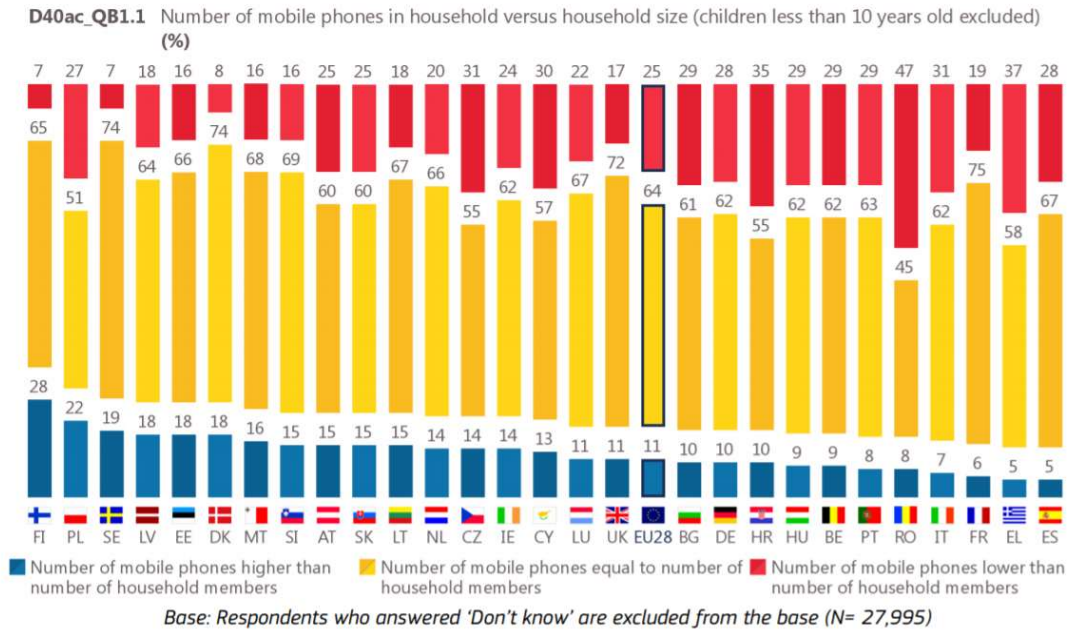


Figure 5: EU 28, Number of mobile phones in households, 2017 (European Commission 2018)

There are no similarly detailed figures for **satellite phones**, as one sub-segment of mobile phones. As the market for satellite phones and related services is dominated by

[8] As the question precisely is on « mobile telephones with access to the telephone network » this apparantly includes devices in active use, but not those in hibernation (see 4.1.4)

very few companies only (Table 20), subscriptions for satellite based voice and data services published by these companies is a rough indication of devices in active use (Iridium Communications Inc. 2020; Globalstar, Inc.; Henry 2018). Further data points are number of users stated in a 2015 market overview (Beam Communications 2015). Based on these figures a rough estimate is a global stock of 1.000.000 satellite phones. Most service providers state the U.S. as their dominating market with more than 50% market share. Satellite phones in operation in Europe might be in the range of 100.000-200.000 units roughly.

Table 20 : Major satellite communication providers – subscriptions and users

Company	subscriptions	scope	users (all services, 2015)
Iridium	363.000	”commercial” voice and data services, global, 2019	751.000
	57.000	“government“ voice and data services, global, 2019	
Globalstar	56.856	all services, two-way voice communication and data transmissions using mobile or fixed devices, global, 2019	
Inmarsat	166.000	“Land” services , including through satellite phones, 2013	866.000
Thuraya	300.000	active subscribers for voice and data services, 2018	220.000

Compared to mobile cellular phones the market share of mobile satellite phones is below 0.1% in terms of units.

4.1.2.2. Lifetime

Lifetime of devices is important to calculate the stock of devices in use, and to analyse ecodesign measures with an impact on product lifetime. Several terms are relevant in this respect. Various references mention relevant data points, but it is important to understand how this data point is defined. Figure 6 illustrates the relevant terms: “Replacement cycle” refers to to the time after which a user upgrades to a new model and the old one is at the end of its first use. Such data points are occassionally misinterpreted as end of life. In particular mobile phones are reused, either by giving them to relatives or friends, or by selling them to a recommerce platform or through a second hand channel. The “active use lifetime” including these potential further uses is what is of main interest for this study. This active use lifetime comes to an end when the mobile phone is not further used – and frequently enters an after life in hibernation. The “average age of devices in use” is not the same as the lifetime as it is mathematically derived from devices which just entered the market to those coming to end of life, so this value is expected to be much lower than the active use lifetime.

The active use lifetime is typically linked to the use of a SIM card or eSIM, and to frequent charging of the device. Without an active SIM card or eSIM the use intensity almost instantly is assumed to be zero or very close to zero.

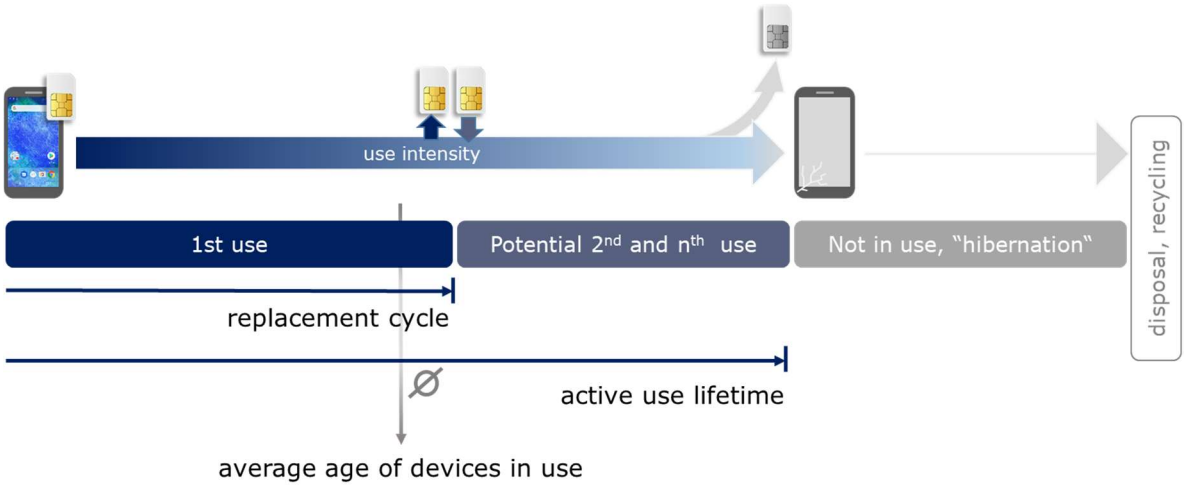


Figure 6 : Mobile phones – Lifetime terms

Average age of devices in use

Data on the age of smartphones in active use can be approximated from an analysis of the age of smartphone batteries in active use carried out in 2016 (Clemm et al. 2016), which is limited to iPhones though, and does not cover all mobile phones on the market. The battery age data is based on data globally collected by coconutBattery[9] on a total of ten different Apple iPhone models, which entered the market between the years 2010 and 2016. The vast majority of the device batteries in the database are less than two years old (66 % of the total), while only 15 % of the datasets are from batteries older than 3 years. It may be assumed that in the majority of cases the age of the battery is coherent with the age of the smartphone. However, some batteries may have been replaced during the lifetime the smartphone, possibly overestimating the share of the lower age groups when the age structure of the smartphone pool in active use is approximated from these data. These data suggest an average age of smartphones in active use (not lifetime!) is **1,7 years**.

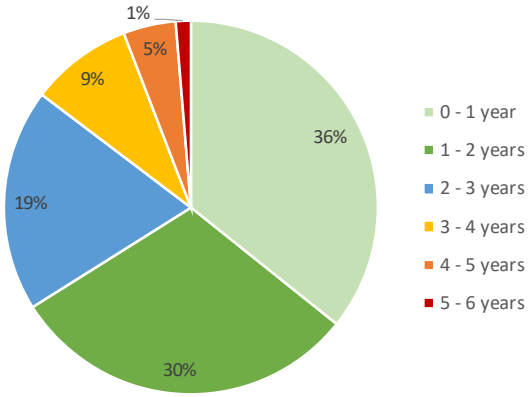


Figure 7 : Age structure of active smartphone batteries in 2016 as an approximation for the age structure of smartphones in active use (Clemm et al. 2016)

[9] https://www.coconut-flavour.com/coconutbattery/

Replacement cycle

In 2017 Counterpoint Research stated an average replacement cycle for smartphone users in Germany of 21 months (**1,75 years**) – and exactly the same value for global replacement cycles, with deviations for other countries (Lu 2017).

From 2016 to 2018, in five European countries tracked by Kantar Worldpanel — France, Germany, Great Britain, Italy and Spain — the replacement cycle of a smartphone was extended by nearly three months, from 23,4 to 26,2 months (**2,18 years**). Users in Great Britain logged the longest average of 27,7 months (2,31 years) in 2018. (Ng 2019)

Market research experts identified multiple reasons for this trend towards extended replacement cycles:

- advancements in technology,
- increasing prices of phones,
- maturity of the market,
- users with a decade long history of various brands and models having figured out their preferred model by now, rating high the model they own,
- not much further improvements in features and experience expected,
- longer support for older smartphone models, in particular by Apple,
- consumers increasingly moving away from mobile contracts with telecommunications carriers and related handset upgrade cycles offered by these mobile service providers

are all reasons explaining longer product lifetimes. (Ng 2019; Triggs 2018)

For comparison, in the United States in 2019 average expected life span (replacement cycle length) of smartphones in the consumer segment is estimated to be 2,87 years, according to data published by statista[10]. For 2018 Kantar Worldpanel stated a significantly lower value of 24,7 months (2,06 years) replacement cycle for smartphones in the United States, but with a clear trend towards longer replacement cycles compared to years before, just as for other regions. (Ng 2019)

Morgan Stanley estimated the worldwide average replacement cycle rising from 2,1 years in 2013 to **2,6 years** in 2016 and projected in 2017 a further increase to **2,8 years** by 2020 (Morgan Stanley Research 2017).

All these figures do not account for a second use of mobile phones.

Active use lifetime

In 2015 a non-representative survey in Portugal came to the conclusion, that the average lifetime of smartphones is **2,7 years** (Martinho et al. 2017).

Data from surveys in Belgium and France indicate a use lifetime of smartphones of **4,3 years** and **3 years** respectively (FNAC DARTY, harris interactive, ADEME 2019).

By the end of 2018 Apple reported an active base of iPhones of more than 900 million units (Maestri 1/29/2019). This is equal to all iPhones sold since Q4 2014 (Statista Research Department 2020b). Statistically this means an average lifetime of iPhones of **4,1 years**.

[10] https://www.statista.com/statistics/619788/average-smartphone-life/

545 million mobile subscriptions in the EU 27 (2018, see Table 19) at sales figures of 147 million mobile phones in recent years (Table 15) rather point at mobile phone use lifetimes of **3,7 years** across the EU 27[11].

For the stock model we calculate with a mobile phone lifetime of **3 years**.

4.1.3. Reuse market

The reuse market comprises numerous players, including professional refurbishers and recommerce companies, but also individuals giving used devices to relatives and friends, which can result in a kind of "family cascade reuse". A recent survey in Germany found out, that 50% of all mobile phone users ever giving away a mobile phone sold it to an individual, another 9% sold it to a commercial reseller, and 25% gave away the phone to others for free[12] (Bitkom e.V. 2020). These figures indicate, that the reuse market is dominated by selling between individuals, followed by giving devices away for free, and commercial resellers being the smallest reuse market channel – but still significant.

The following is an exemplary analysis of reuse channelled through eBay. This does not mean, that this is the only way mobile phones make it into secondary use.

In Europe, approximately 1.500 used mobile phones are sold on eBay alone per day (sample 2nd half of May 2020). As the covered period neither includes major release dates, when traditionally trade with used devices is going up, nor the Christmas season, it is reasonable to assume, that more than 600.000 second-hand mobile phones are traded on eBay in Europe annually.

Used mobile phones sold on eBay per brand are shown in Figure 8. This includes the most recent trades in Europe, i.e. end of February through end of May 2020. In total 127.602 used mobile phones have been traded in this time, in total more than 1.000 different models. For 82.959 units the model has been listed properly on eBay, and only those units are covered by the statistics below. "Used" also includes exhibited samples from stores. The largest market share is with iPhones (39,1%), followed by mobile phones from Samsung (31,4%). Huawei phones contribute another 9,5% of the reuse market on eBay. In total 21 different brands where sold in numbers above 50 units in the analysed period.

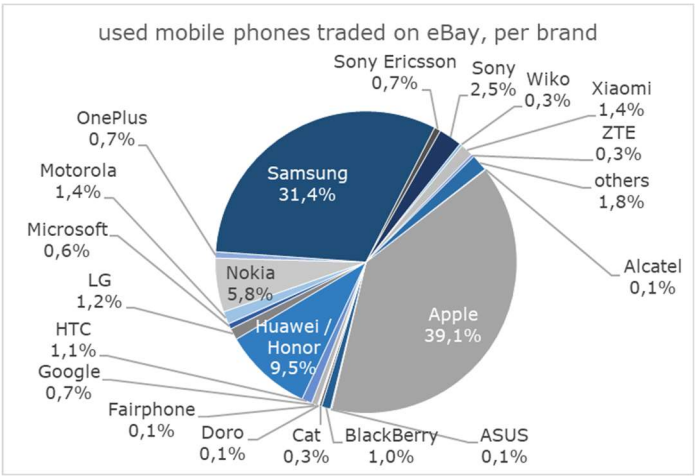


Figure 8: Market share of used mobile phones, per brand, traded on eBay in Europe (n = 82.959)

[11] Not taking into account Dual-SIM users, inactive subscriptions etc.

[12] another 5% donated a phone, 41% disposed it at a collection point, 17% gave it back to vendor or retailer (figures do not add up to 100% as the survey allowed for multiple replies)

In terms of memory capacity 64 GB configurations lead the market followed by 32, 16, and 128 GB (Figure 9).

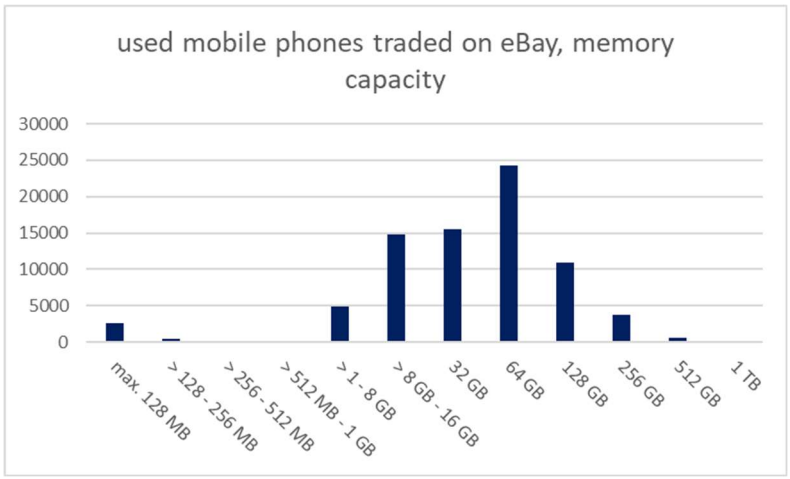


Figure 9: Market share of used mobile phones, per memory capacity, traded on eBay in Europe (n = 78.255)

When having a closer look at individual model generations there is a wave of traded mobile phones, with an obvious delay after the release dates. For iPhones the current peak of traded used phones – on eBay – is with the iPhone 7 (launched September 2016), followed by the iPhone 6s (launched September 2015), iPhone 6 (launched September 2014) and iPhone 8 (launched September 2018).

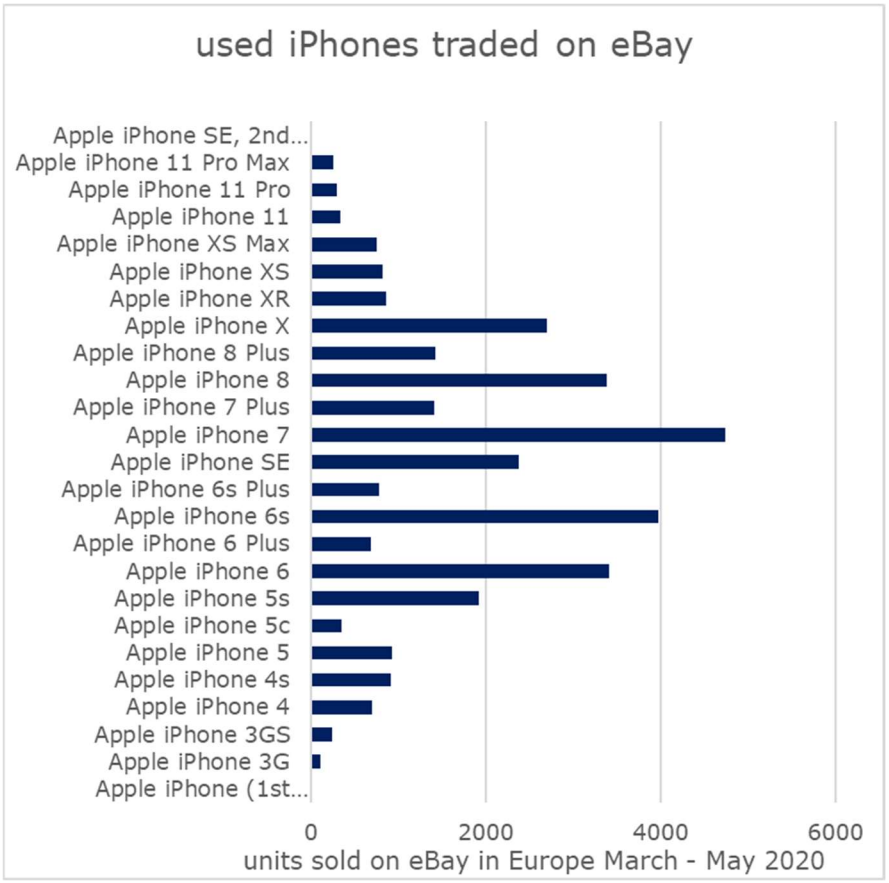


Figure 10: Used iPhones traded on eBay (February - May 2020, n = 33.369)

A similar wave can be observed for Samsung's Galaxy S series (Figure 11). The most sold used Galaxy phone on eBay in Europe in recent months was the S8 (launched April 2017), followed by S9 (launched March 2018) and S7 (launched March 2016).

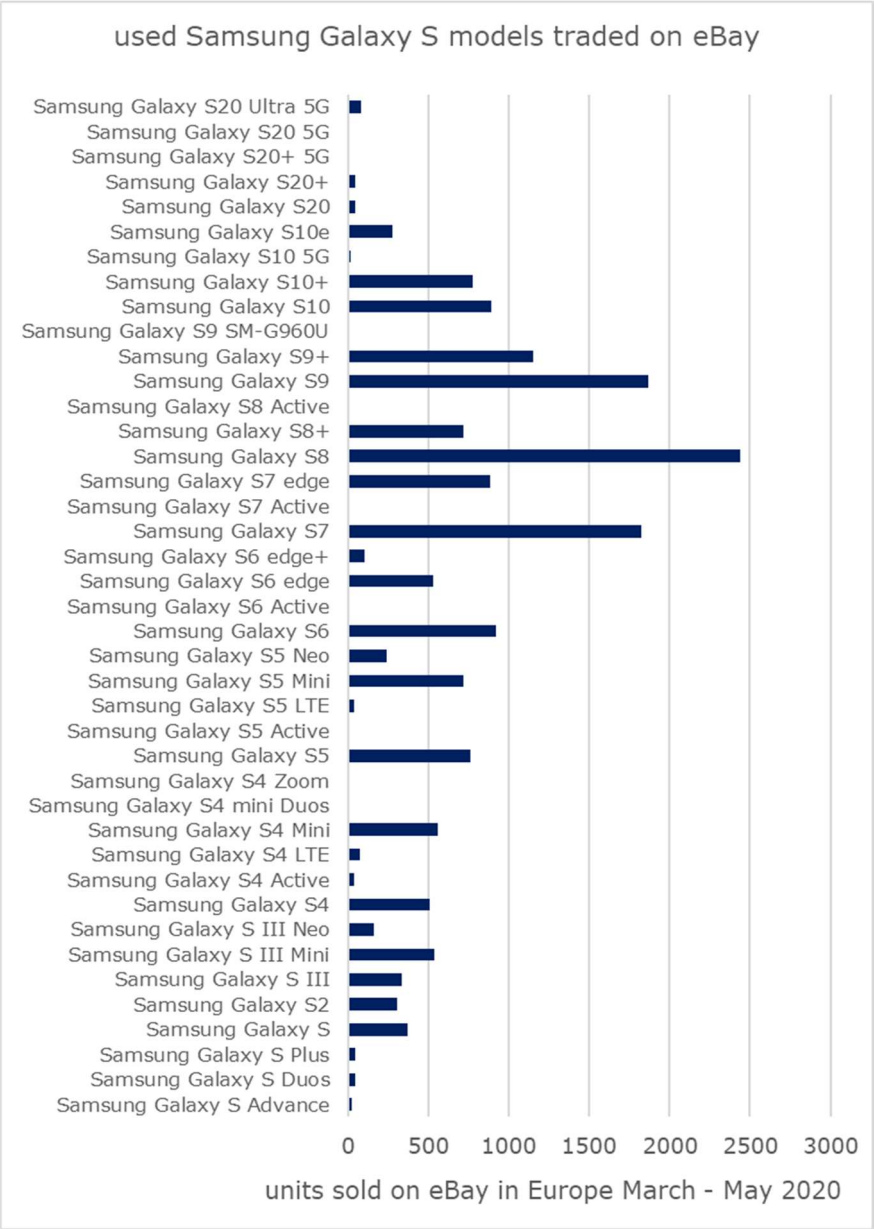


Figure 11: Used Galaxy S phones traded on eBay (February - May 2020, n = 17.368)

It has to be noted that this analysis, based on several 10.000 units, covers only a very minor share of all mobile phones sold on the market (trades of used mobile phones on eBay are roughly 0.5% the size of the market for new mobile phones), but some relevant trends can be observed: There is still a significant demand for mobile phones, which are 3 – 4 years old. Some much older models are still sold and bought in significant numbers. Even if these older models are bought only for spare parts cannibalism, at least one other phone is apparently repaired with these spare parts.

4.1.4. Devices in hibernation

A study conducted in 2019 analysing the market and stock data of mobile phones in France concluded that 54-113 million old devices are hibernating in French households, of which more than 2/3 are still functioning (Sofies 2019). The functioning fraction of the phones is mainly kept as a back-up solution for occasional needs (replacement phone for oneself or

relatives/friends). The non-functioning part is mainly retained for data safety reasons, because an easy access to the recycling sector is not available or since people forget about the old device due to the small size. According to the study, 13-25.1 million phones are put in hibernation every year in France, which represents more than 50% of the devices put on the market.

According to a survey by Bitkom Research (Bitkom e.V. 2020) in Germany the number of old mobile phones kept at home but not being used anymore grew rapidly in recent years: Currently[13] there are 199,3 million mobile phones in hibernation in Germany, compared to 123,9 million in 2018. Being asked how many old mobile phones are kept at home, 51% of all respondents stated a figure of 3 or more phones. Only 4% stated not to have a hibernating phone – and another 10% stated to have no mobile phone at all. These figures indicate, that a major share of the mobile phones sold in the past decade are still hibernating at home.

4.1.5. Stock model

Taking the accessible market data and current market dynamics as a basis and calculating with a product lifetime of 3 years leads to the stock model provided in Table 21. This stock refers to devices in active use. There is an additional stock of devices in "hibernation".

Table 21 : EU 27, stock model mobile phones, 2010 - 2030

year	sales (million units)	assumption	CAGR	Stock (3 years lifetime)
2010	140,0	proxy		420,0
2011	140,0	proxy	0%	420,0
2012	141,5	statista	1%	421,5
2013	144,5	statista	2%	426,0
2014	146,9	statista	2%	432,9
2015	147,7	statista	1%	439,1
2016	147,6	statista	0%	442,2
2017	147,5	statista	0%	442,8
2018	147,8	statista	0%	442,9
2019	148,2	statista	0%	443,5
2020	134,6	statista	-9%	430,6
2021	141,3	statista, 5G phones	5%	424,1
2022	145,2	statista, 5G phones	3%	421,1
2023	147,9	statista	2%	434,4
2024	147,9	stable market	0%	441,0
2025	147,9	stable market	0%	443,7
2026	147,9	stable market	0%	443,7
2027	147,9	stable market	0%	443,7
2028	147,9	stable market	0%	443,7
2029	147,9	stable market	0%	443,7
2030	147,9	stable market	0%	443,7

[13] survey period January – February 2020

On top of these devices in active use there is a hibernating stock of devices not in use anymore, which is rapidly growing according to Bitkom data for Germany (see above), and which is likely to exceed the stock of active devices.

Figure 12 depicts the stock model for active devices with hardly any changes in the stock, given that the market for mobile phones is saturated. The COVID-19 gap in the sales figures results in this stock model also in a temporary decline of the stock. It might rather be, that use lifetimes of devices is longer to bridge this gap. With close to 450 million devices in active use now and until 2030 every EU 27 citizen is and will be in average equipped with a mobile phone. This figure depends largely on the correct assumption of the average lifetime, which might be shorter – or longer, as various sources indicate.

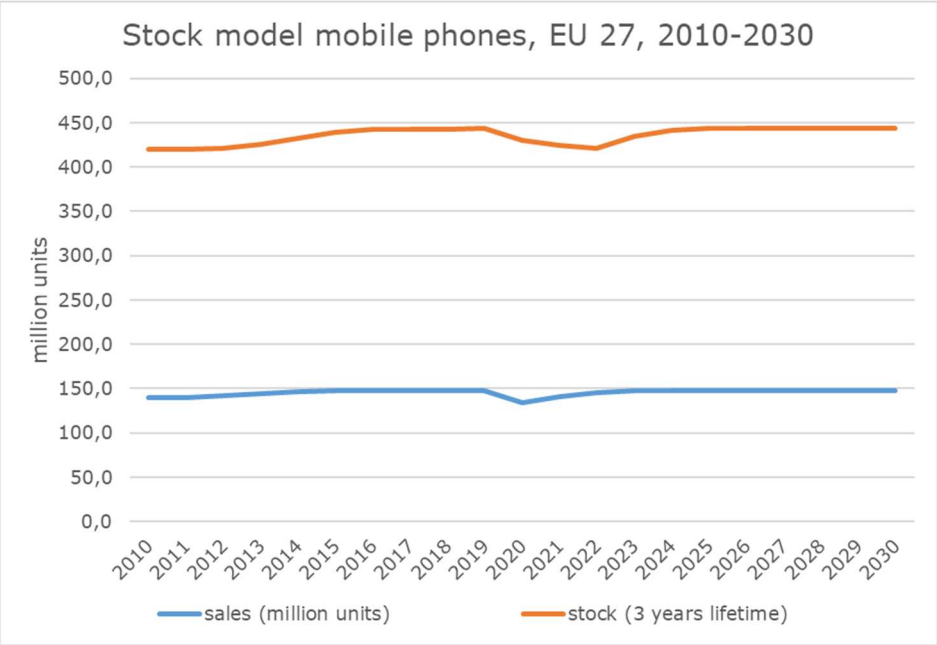


Figure 12 : EU 27, stock model mobile phones, 2010 - 2030

4.2. Cordless landline phones

4.2.1. Historic data and forecasts

NACE code 26302100 - Line telephone sets with cordless handsets covers cordless phones, including base stations exists since 2008 in European PRODCOM statistics. Table 22 lists the corresponding data for the years 2008 to 2018 extracted from PRODCOM.

Table 22 : EU 27 PRODCOM original data for NACE 26302100 - Line telephone sets with cordless handsets

	Exported quantity (units) EXPQNT	Value exports (Euros) EXPVAL	Imported quantity (units) IMPQNT	Value imports (units) IMPVAL	Produced quantity (units) PRODQNT	Value produced goods (Euros) PRODVAL
until 2006	:	:	:	:	:	:
2007	:	:	:	:	:	:
2008	4.826.841	162.039.200	25.970.545	485.571.250	17.281.634	533.162.639
2009	4.993.063	128.033.670	20.108.746	372.221.810	18.000.000	600.000.000
2010	4.481.556	142.627.030	21.405.017	360.127.510	12.000.000	400.000.000

	Exported quantity (units) EXPQNT	Value exports (Euros) EXPVAL	Imported quantity (units) IMPQNT	Value imports (units) IMPVAL	Produced quantity (units) PRODQNT	Value produced goods (Euros) PRODVAL
2011	4.045.696	113.111.580	19.891.084	313.837.420	14.119.670	300.000.000
2012	4.113.298	115.754.490	16.980.144	283.173.710	16.000.000	400.000.000
2013	3.230.904	95.086.280	15.399.162	277.383.840	7.000.000	399.199.303
2014	2.546.556	80.850.130	13.643.838	229.736.260	12.000.000	240.000.000
2015	2.382.003	95.011.920	13.232.256	225.871.800	6.000.000	320.000.000
2016	2.794.636	71.083.900	11.828.446	211.839.820	5.000.000	280.000.000
2017	2.424.320	65.251.250	10.749.225	193.690.190	10.000.000	300.000.000
2018	1.704.713	65.525.100	9.478.019	190.827.820	6.000.000	300.000.000

Table 7 lists derived data for the average value of exported, imported and produced cordless phones for the years 2008 to 2018. Statistically calculated value of exported units is fluctuating between 25 and 40 Euros. Imported cordless phones are of lower value, in the range of almost 16 to slightly over 20 Euros. Value of produced units shows major fluctuations over the years, which likely indicates some reporting issues with PRODCOM data, as this hardly can be explained by observed market trends over past years.

Table 23 : EU 27 PRODCOM derived data for NACE 26302100 - Line telephone sets with cordless handsets

	Average value of exported units (in Euros/unit) EXPVAL/EXPQNT	Average value of imported units (in Euros/unit) IMPVAL/IMPQNT	Average value of produced units (in Euros/unit) PRODVAL/PRODQNT	apparent consumption (PRODQNT+IMPQNT-EXPQNT)
until 2006	:	:	:	:
2007	:	:	:	:
2008	33,57	18,70	30,85	38.425.338
2009	25,64	18,51	33,33	33.115.683
2010	31,83	16,82	33,33	28.923.461
2011	27,96	15,78	21,25	29.965.058
2012	28,14	16,68	25,00	28.866.846
2013	29,43	18,01	57,03	19.168.258
2014	31,75	16,84	20,00	23.097.282
2015	39,89	17,07	53,33	16.850.253
2016	25,44	17,91	56,00	14.033.810
2017	26,92	18,02	30,00	18.324.905
2018	38,44	20,13	50,00	13.773.306

Figure 13 depicts the exports, imports, sold production and resulting apparent consumption for EU 27 for cordless phones from 2008 – the first year the corresponding NACE code 26302100 is reflected in Eurostat data – to 2018. The apparent consumption shows a steady downwards trend reaching 14 million sold units in the EU 27 in 2018, compared to 38 million units back in 2008. There is still a significant domestic production of cordless phones within EU 27 countries, but also with a downwards trend.

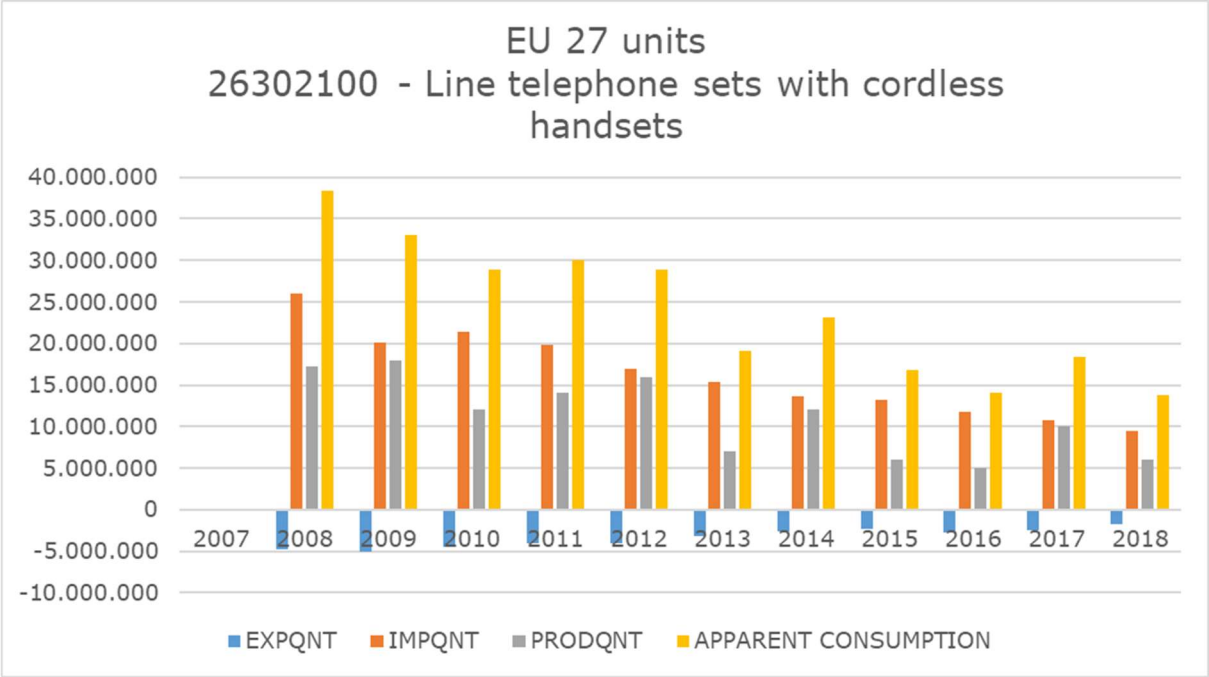


Figure 13 : EU 27 PRODCOM units data for NACE 26302100 - Line telephone sets with cordless handsets

The downwards trend in cordless phones sales continued in 2019 with -11% in terms of sold units in some of the largest European markets (Germany, Italy, Spain, France, Netherlands, United Kingdom) (Gigaset 2020).

The market for cordless phones is significantly smaller than that for mobile phones. Currently apparent consumption of cordless phones within the EU 27 is roughly 1/10 of the mobile phones market size – in terms of units.

4.2.2. Products in use and lifespan

4.2.2.1. Active use

ITU reports the number of fixed telephone subscriptions worldwide. Fixed telephone subscriptions refers to the sum of active number of analogue fixed telephone lines, voice-over-IP (VoIP) subscriptions, fixed wireless local loop (WLL) subscriptions, ISDN voice-channel equivalents and fixed public payphones. Landline telephony with cordless phones is included in these figures, but as the definition of this statistical reference indicates, there are also other types of telephones included.

In the EU 27 the number of fixed telephone subscriptions grew steadily from 1995 until 2002, reaching 208 million fixed telephone subscriptions. Since then the number of subscriptions is decreasing, dropping to 171 million subscriptions in 2018 (Figure 14). This indicates a shift in the overall telecommunications market from landline telephony towards mobile telephony.

Figure 14 : EU 27 Fixed telephone subscriptions, 1990-2018 (ITU, License : CC BY-4.0)

As of 2018 there are statistically 39 fixed telephone subscriptions in the EU 27 for each 100 inhabitants – with a downwards trend similar to total subscriptions. Across the EU 27 member states the spread is huge: The number of fixed telephone subscriptions is lowest in Finland (6 per 100 inhabitants, although it has been on a similar high level as in most other EU countries 20 years ago) and highest in France (59 per 100 inhabitants). The trend towards less fixed telephone subscriptions is observed in almost all countries – except Portugal where the subscription numbers are still increasing, on an already high level of 49 subscriptions per 100 inhabitants. Some other countries never had such high penetration rates for fixed telephone subscription, such as Lithuania and Estonia, but now are leading in terms of mobile subscriptions instead (see above).

Table 24 : EU 27 Fixed telephone subscriptions EU 27 and per country (2018)

	total subscriptions	subscriptions per inhabitant[14]
European Union - 27	**171.143.136**	**0,39**
Belgium	4.105.557	0,36
Bulgaria	1.120.392	0,16
Czech Republic	1.511.942	0,14
Denmark	1.131.064	0,20
Germany	42.500.000	0,51
Estonia	345.690	0,26
Ireland	1.829.166	0,38
Greece	5.078.083	0,48
Spain	19.484.361	0,42
France	38.620.000	0,59
Croatia	1.355.662	0,33
Italy	20.396.603	0,34
Cyprus	311.559	0,36

[14] https://data.worldbank.org/indicator/IT.CEL.SETS.P2?end=2018&locations=EU&start=1990&view=chart

	total subscriptions	subscriptions per inhabitant[14]
Latvia	266.214	0,14
Lithuania	427.066	0,15
Luxembourg	273.530	0,45
Hungary	3.016.878	0,31
Malta	255.437	0,58
Netherlands	5.900.000	0,35
Austria	3.772.429	0,42
Poland	5.073.458	0,17
Portugal	5.073.458	0,49
Romania	3.660.000	0,19
Slovenia	694.709	0,33
Slovakia	722.704	0,13
Finland	323.000	0,06
Sweden	2.392.386	0,24

For Germany, the stock of fixed phones in households and in offices has been estimated and forecasted (Stobbe et al. 2015).

Table 25 : Germany, fixed telephone stock forecast, 2010 - 2025

	2010	2015	2020	2025
Households (mainly cordless, i.e. DECT)	49,3	44,2	35,4	30,6
Workplace (mainly wired)	24,0	24,0	24,0	24,0

In the years 2000 – 2009, when mobile phones became increasingly popular, there was an obvious shift towards mobile-phone only households, indicating indirectly a declining marked for landline phones (Mohorko et al. 2013): In 2009 Finland had a mobile-phone-only population of 74%. The other countries with a mobile phone only rate higher than 50 % at that time are Slovakia (51%), Latvia (54%), Lithuania (59%), and the Czech Republic (74%). These figures reflect two different trends: in some Western European countries people abandon their landline connection in favor of a mobile phone, while in some former Eastern European countries no-phone households opt for a mobile phone instead of a landline phone.

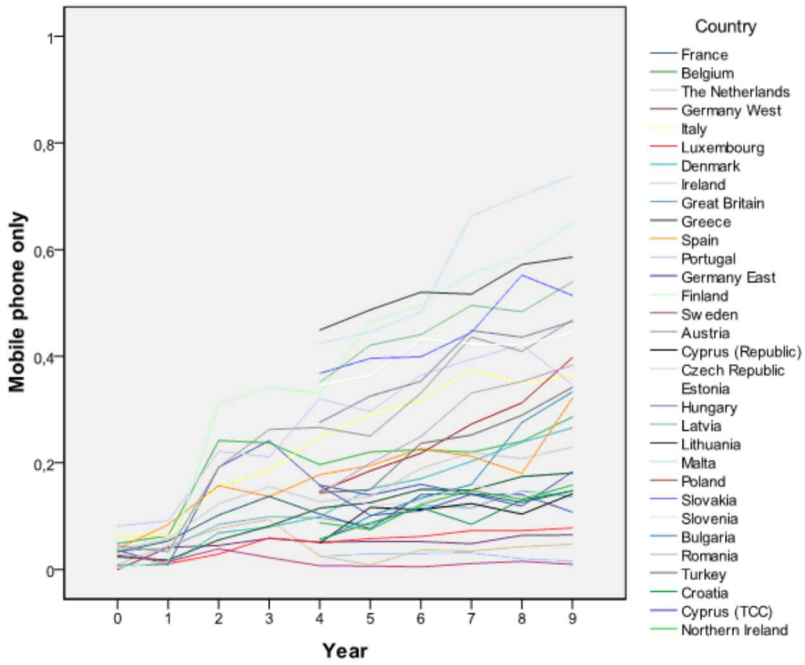


Figure 15: Europe, Share of mobile-phone-only households, 2000 – 2009 (Mohorko et al. 2013), (CC BY-NC-ND 3.0)

The upwards trend of households with mobile phone access only is confirmed by a 2017 Eurobarometers survey (European Commission 2018): As of 2017 the EU 28 share of mobile-phone-only households reached 37%, significantly going up year over year. 61% of all households have fixed telephone access, but thereof 54% with access to both, landline and mobile. This share of 54% with kind of redundant access to voice-based telecommunication services might phase out landline access in the mid- to long-term future.

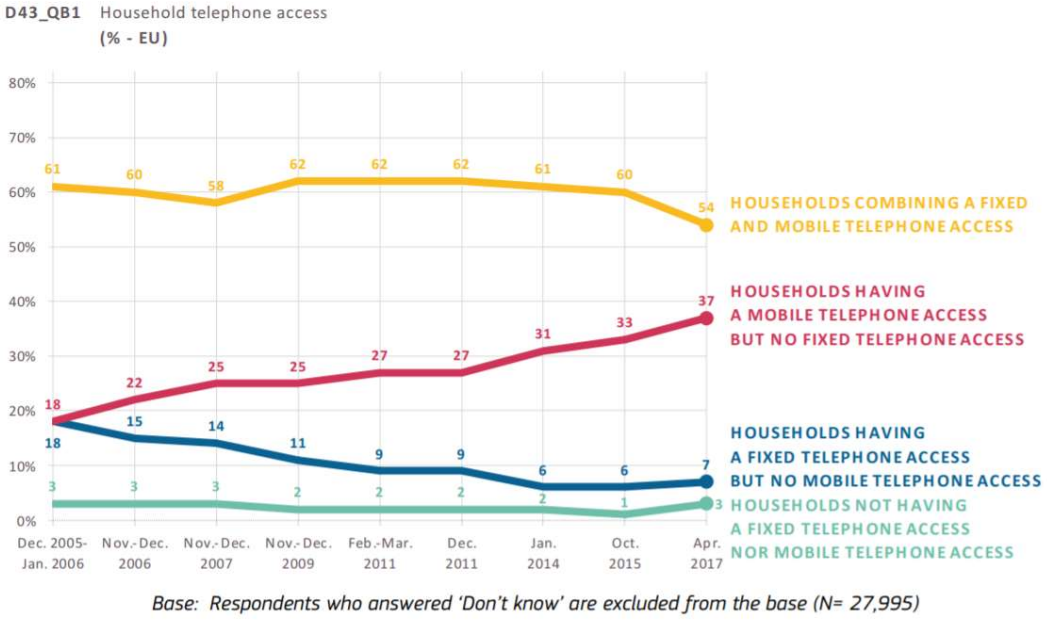


Figure 16: EU 28, Access to mobile and fixed phones, 2005 - 2017 (European Commission 2018)

Differences regarding use of landline phones are huge within the EU (European Commission 2018): In Finland 84% of the population never make or receive calls over a landline phone – so apparently do not own one. Landline use, thus landline phone access, is much more popular in Greece (12% never use a landline phone), Malta (10%), and Germany (12%).

The EU 28 average[15] is: 36% never make or receive phone calls over a landline phone, 63% use a landline phone daily, regularly or at least occasionally.

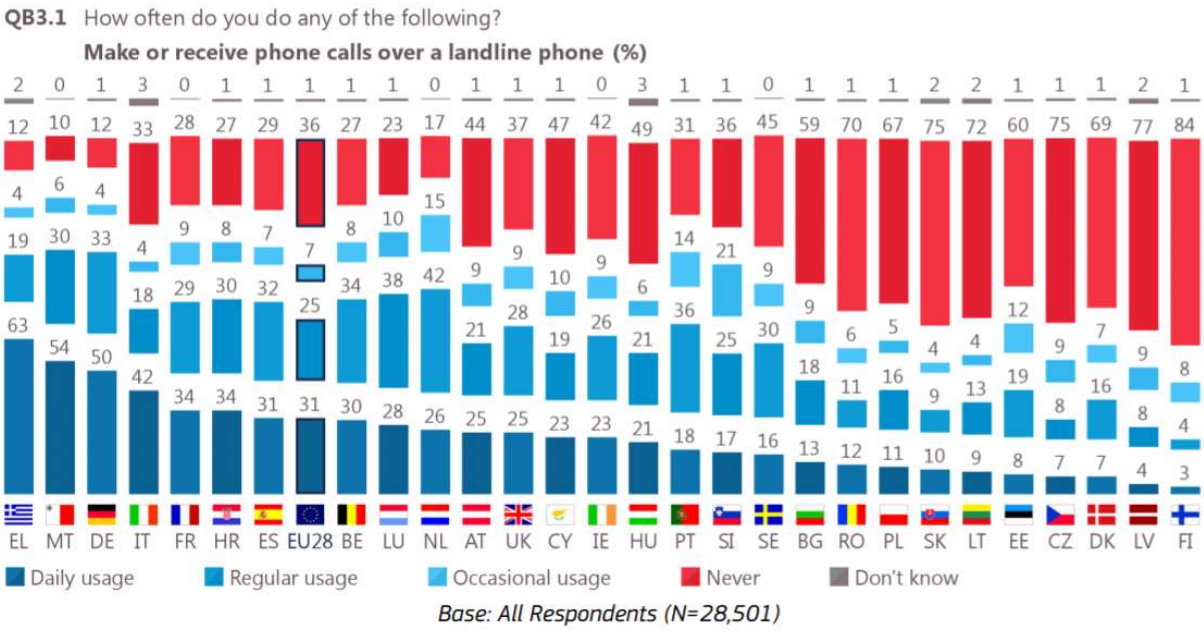


Figure 17: EU 28, Use of landline phones, 2017 (European Commission 2018)

For Germany as a member state with a rather high share of landline phones the trend over past years is depicted in Figure 18: In 2019, roughly 86,4% of German households owned at least one landline phone, an increase compared to the previous year, at 84,9% (Koptyug 2019). The years before this share has been in the range of 90% and above. Mobile phone penetration rates at the same time increased significantly and reached 97% in 2019.

[15] Applies roughly also to EU 27 as UK almost meets the EU 28 average, thus Brexit does not affect these shares

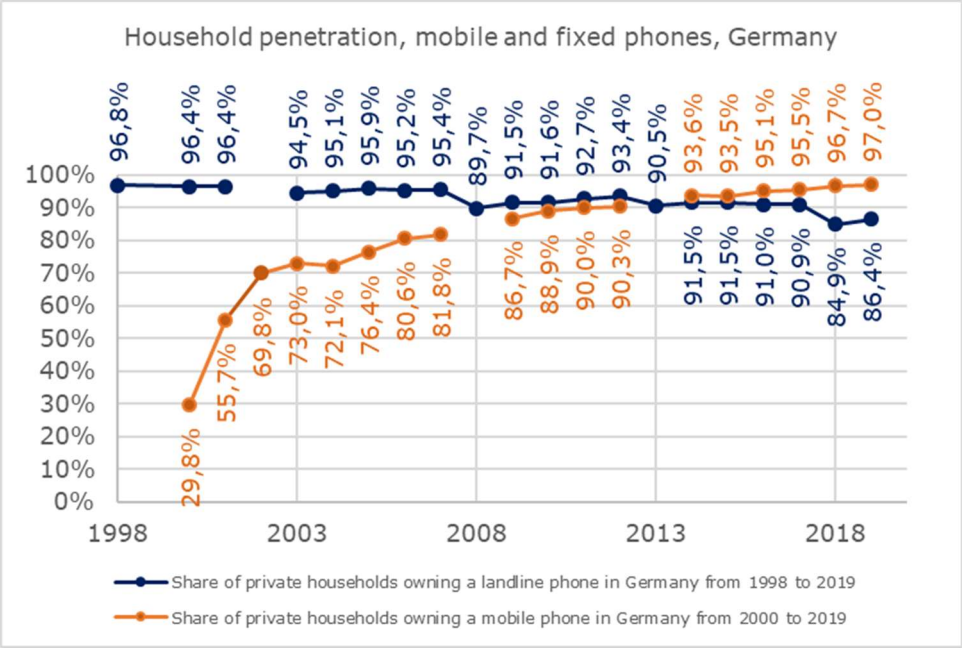


Figure 18: Germany, Household penetration mobile and landline phones, 1998 – 2019 (based on data by statista)

4.2.2.2. Lifetime

Figure 19 illustrates the relevant terms related to the lifetime of cordless phones: "Replacement cycle" refers to to the time after which a user upgrades to a new model and the old one is at the end of its first use. Such data points are occassionally misinterpreted as end of life. This active use lifetime comes to an end when the mobile phone is not further used – and might enter an after life in hibernation. The "average age of devices in use" is not the same as the lifetime as it is mathematically derived from devices which just entered the market to those coming to end of life, so this value is expected to be much lower than the active use lifetime.

The active use lifetime is typically linked to being connected to a landline telecommunications network, and to sitting on the powered charging cradle most of the time, ready to receive calls.

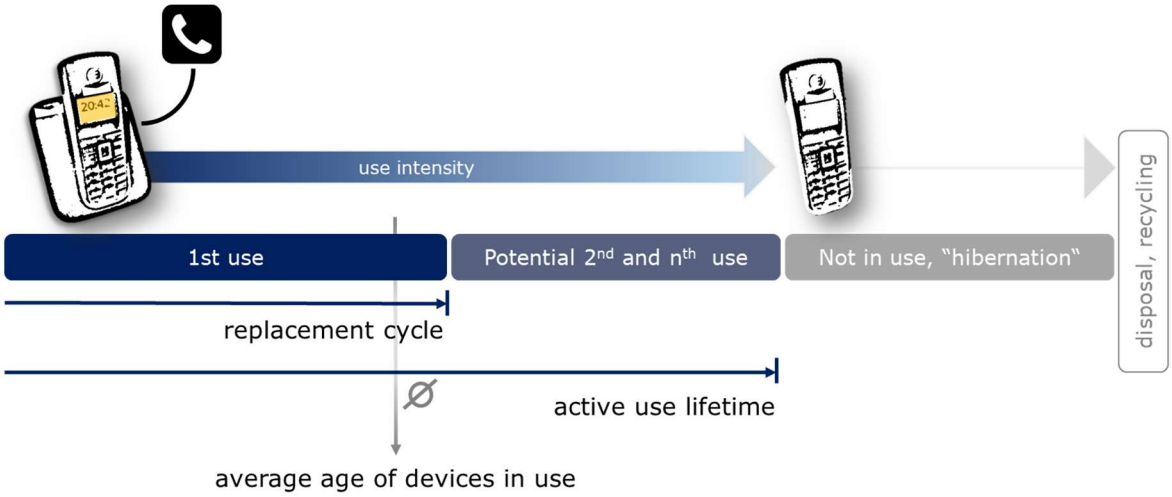


Figure 19 : Cordless landline phones – Lifetime terms

Average age of devices in use

No data available.

Replacement cycle

20 years ago Hurley and Keller stated a replacement cycle of **10 years** for cordless phones (Hurley and Keller 1999).

System provider Placetel states a typical replacement cycle of **3 to 5 years**[16].

Comparing the number of fixed telephone subscriptions with the estimated total market size (40 million phones sold per year, see 3.2) indicates a replacement cycle of **4 – 4.5 years** - for landline phones in general.

Active use lifetime

The estimated typical lifetime of cordless phones is **8 years** in a calculated forecast on ICT power consumption in Germany (Stobbe et al. 2015).

Given that cordless phone technology did not progress as much as, e.g., smartphone technology, there is much less interest to upgrade an existing model. A mature technology, a certain level of robustness and typically in-door use are all factors, which rather indicate towards longer replacement cycles. For this reason we assume an active product lifetime of **5 years** for the stock model.

4.2.3. Stock model

Taking the accessible market data and current market dynamics as a basis and calculating with a product lifetime of 5 years leads to the stock model provided in Table 29. Longer product lifetimes do not match with the PRODCOM figures as this would lead to a non-plausible stock in past years. The steady decline of the market – and there is no indication that this decline will flatten: Latest when smartphone owners move, they frequently terminate landline subscriptions. Finland defines the role model for a country with a minimum number of fixed phones.

Table 26 : EU 27, stock model cordless landline phones, 2010 - 2030

year	sales (million units)	assumption	CAGR	Stock (5 years lifetime)
2010	28,9	PRODCOM apparent consumption	-12,7%	160,0
2011	30,0	PRODCOM apparent consumption	3,6%	160,0
2012	28,9	PRODCOM apparent consumption	-3,7%	159,3
2013	19,2	PRODCOM apparent consumption	-33,6%	140,0
2014	23,1	PRODCOM apparent consumption	20,5%	130,0
2015	16,9	PRODCOM apparent consumption	-27,0%	117,9
2016	14,0	PRODCOM apparent consumption	-16,7%	102,0
2017	15,4	Average 2016 – 2018 PRODCOM apparent consumption as starting point for forecast to rule out large fluctuations in PRODCOM data	30,6%	88,5
2018	14,8	decline corresponding to average CAGR 2014 - 2018	-24,8%	84,2

[16] https://www.placetel.de/ratgeber/wlan-telefon

year	sales (million units)	assumption	CAGR	Stock (5 years lifetime)
2019	14,3		-3,5%	75,4
2020	13,8		-3,5%	72,4
2021	13,3		-3,5%	71,7
2022	12,9		-3,5%	69,2
2023	12,4		-3,5%	66,8
2024	12,0		-3,5%	64,4
2025	11,6		-3,5%	62,2
2026	11,2		-3,5%	60,0
2027	10,8		-3,5%	57,9
2028	10,4		-3,5%	55,8
2029	10,0		-3,5%	53,9
2030	9,7		-3,5%	52,0

Figure 20 depicts the stock model and clearly shows the decline until today – which is likely to continue, resulting in 2030 in a stock of 52 million units in the EU 27.

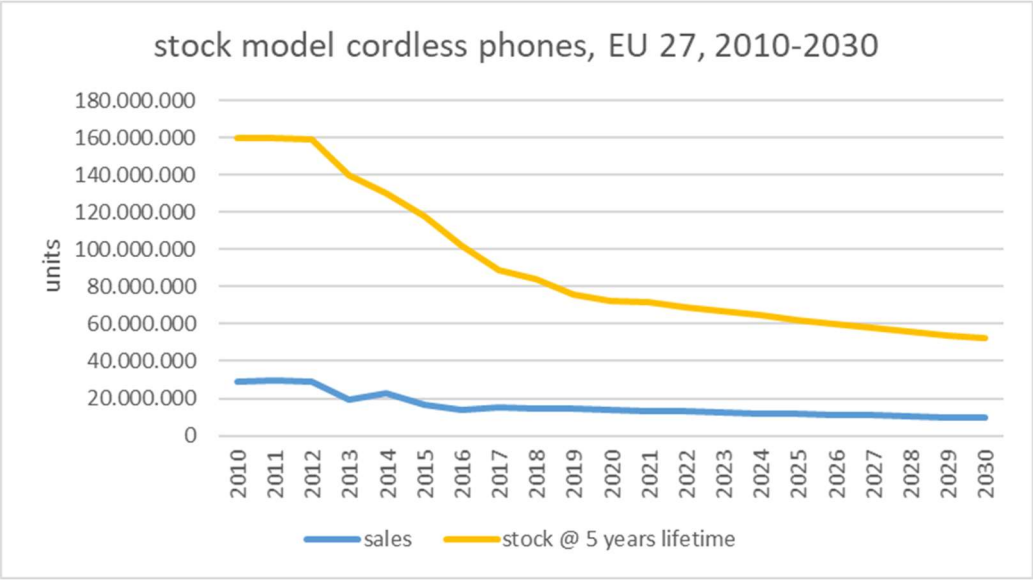


Figure 20 : EU 27, stock model cordless landline phones, 2010 - 2030

4.3. Tablets

4.3.1. Historic data and forecasts

The Computer Review Study in 2017 calculated future development of the EU tablet market as follows: "Since there is no consistent forecast after 2016, it is assumed that sales will follow population growth up to 2030." (Maya-Drysdale et al. 2017)

However, since the publication of the Computer Review Study in 2017 tablet sales continued to drop in sales and based on data by IDC this trend is likely to continue.

Historic IDC data on tablets[17] shows a global peak in 2014 when the worldwide tablet market reached 230,1 million units. Since then the market is declining, flattening at 145 million units in 2018 / 2019 – then the effect of the COVID-19 pandemic kicked in, and IDC forecasted a drop to 126,1 million units. Contrary to the forecasts for the mobile phone market IDC forecasts do not suggest a full recovery of the tablet market.

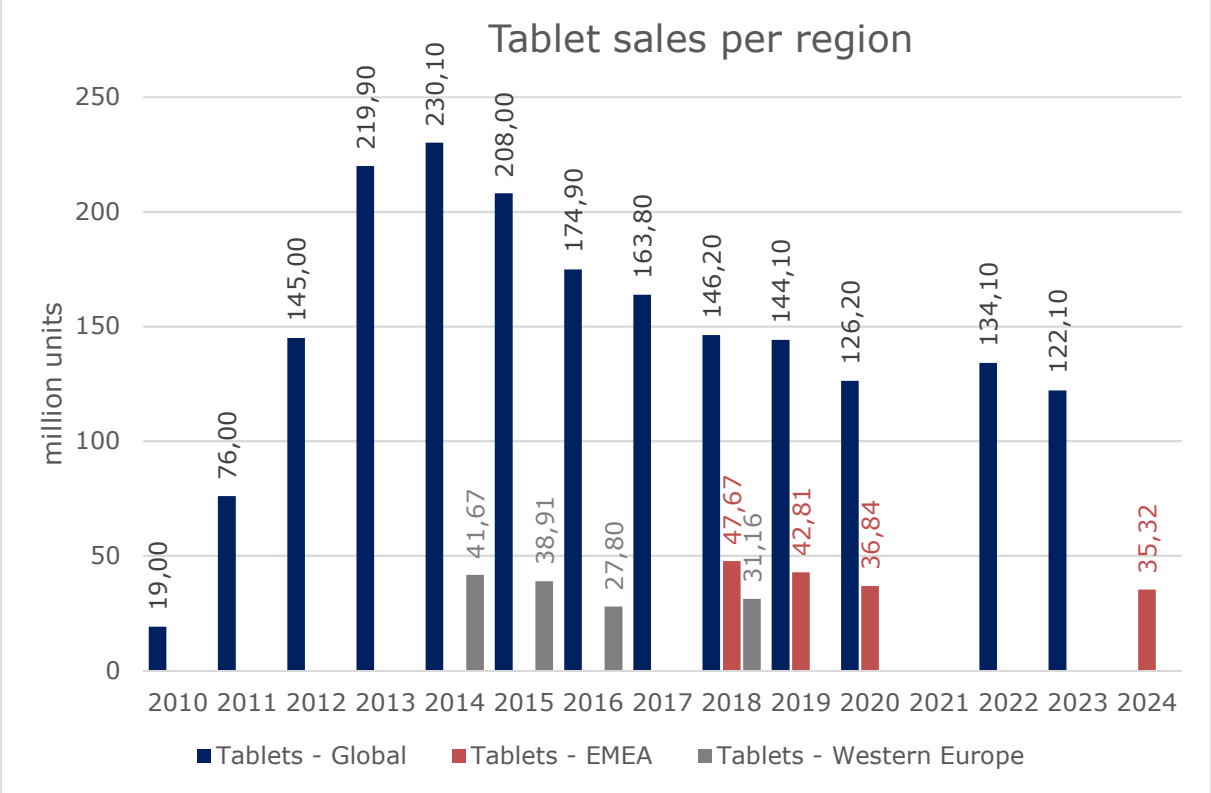


Figure 21 : Global, EMEA, Western Europe Tablet sales (data by IDC, data points derived from various press releases)

It has to be noted that IDC data refers to detachable tablets and slate tablets. The market split among these two sub-categories is depicted in Figure 22. Just above 75% of sold tablets are slate devices. Detachable tablets are expected to grow in numbers over the coming years, compensating partly the declining sales of slate tablets.

[17] definition of tablets covered by IDC market data : Tablets are portable, battery-powered computing devices inclusive of both slate and detachable form factors. Tablets may use LCDs or OLED displays (epaper-based ereaders are not included here). Tablets are both slate and detachable keyboard form factor devices with color displays equal to or larger than 7in. and smaller than 16in. Tablets with detachable keyboards are those, which are sold with keyboards explicitly made for the model it is sold with.

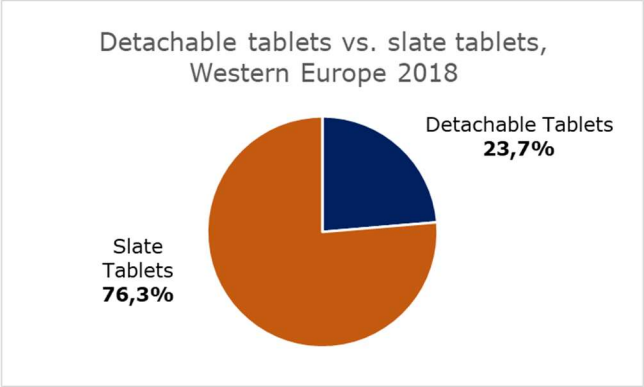


Figure 22 : Western Europe, Market share of detachable tablets and slate tablets, 2018 (data by IDC)

Total sold tablets in EU member states have to be derived from third party statistics as PRODCOM only provides aggregated data for "notebook computers", which includes tablet computers: The number of tablets sold to private consumers in Germany peaked in 2014 at 6,64 million devices and dropped by 2019 to just over 4 million units (Koptyug 2020a) , although other sources indicate sales of 6,3 million tablets in Germany in 2019 (Research by Markets 2020a). In France unit sales in the years 2011 to 2016 were similar to those in Germany, also with a peak in 2014 with 6,2 milion units (Statista Research Department 2019b). Sales in Italy are at 4,9 million units in 2019 (Research by Markets 2020b) and in Spain at 2,8 million units (Research by Markets 2020c).

Table 27 : Various EU member states, tablet sales (2010-2019)

sales (million)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Germany (source: statista)	0,44	1,43	3,33	5,55	6,64	6,15	4,81	4,1	4,06	4,05
Germany (source: Research by Markets)										6,3
France		1,15	3,61	6,11	6,20	5,33	4,3			
Italy										4,9
Spain										2,8

4.3.2. Products in use and lifespan

4.3.2.1. Active use

For 2016 eMarketer reported a total figure of **133,6 million tablet users** for most of the larger EU 27 member states[18] (eMarketer 2016b, 2016a).

Table 28 : Various EU member states, tablet users (2014-2017)

Tablet users (million)	2014	2015	2016	2017
Germany	27,7	31,0	34,3	36,9
France	21,8	24,3	26,6	28,6
Italy	15,6	17,9	19,8	21,6
Spain	15,1	17,1	19,8	21,0
Netherlands	8,4	9,1	9,7	10,2

[18] covering 78% of the EU 27 population

Tablet users (million)	2014	2015	2016	2017
Sweden	4,3	4,8	5,1	5,5
Denmark	2,6	2,8	3,0	4,2
Finland	1,8	2,1	2,4	2,6
Ireland	2,0	2,2	2,4	2,6
Poland	6,7	7,4	8,1	8,8
Czech Republic	1,9	2,2	2,4	2,6
Total	**107,9**	**120,9**	**133,6**	**144,6**

In 2020, roughly 58% of Germans used a tablet PC at least from time to time (Koptyug 2020b). Compared with the accumulated sales of tablets in Germany (2010-2019: 40,6 million units) and given a population in Germany of 82 million, this indicates that a major share of all tablets ever sold in Germany is still in use (Figure 23). However, use does not mean ownership and shared use in households can be expected, but even if we assume, that two users share one tablet, this corresponds to the aggregate sales of approximately the last **5 years**.

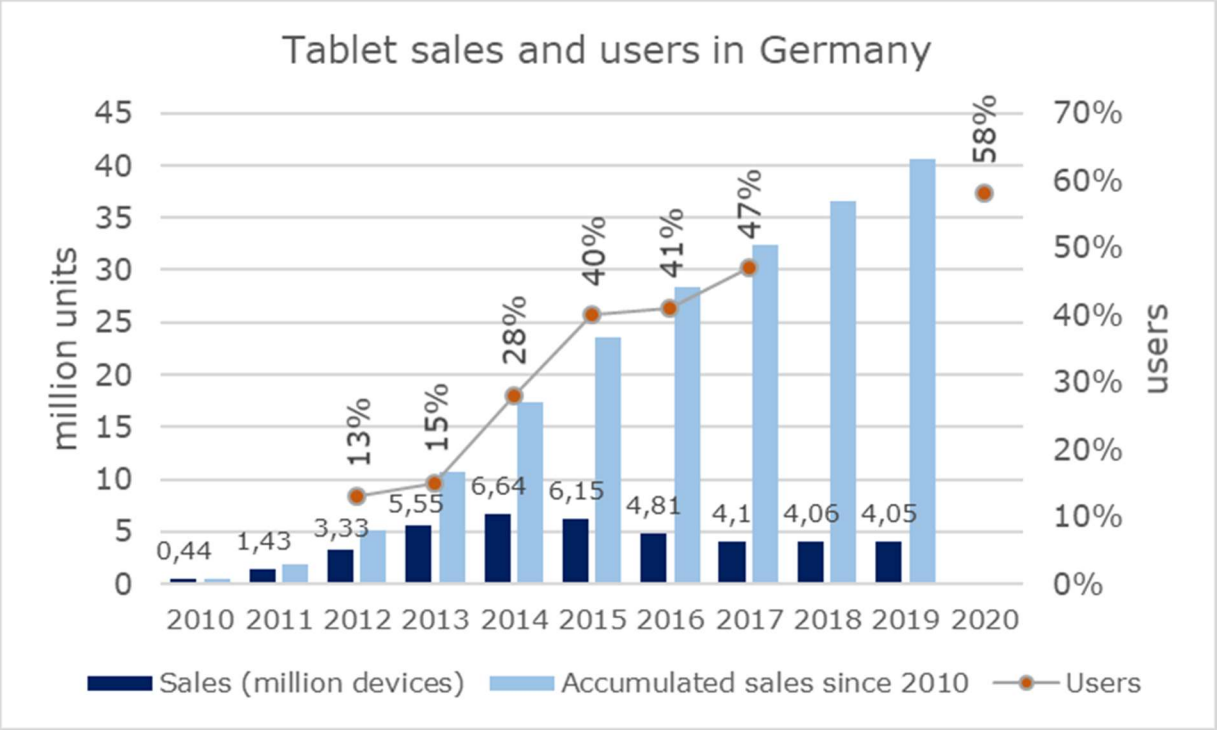


Figure 23: Germany, tablet computer sales and use, 2010 – 2020 (based on data by statista and own calculations)

eMarketer states a sligtly higher "household penetration" for tablets in Germany (62% in 2020), and similarly high values are also reported for other countries. (eMarketer 2020; Statista Research Department 2020a; O'Dea 2020)

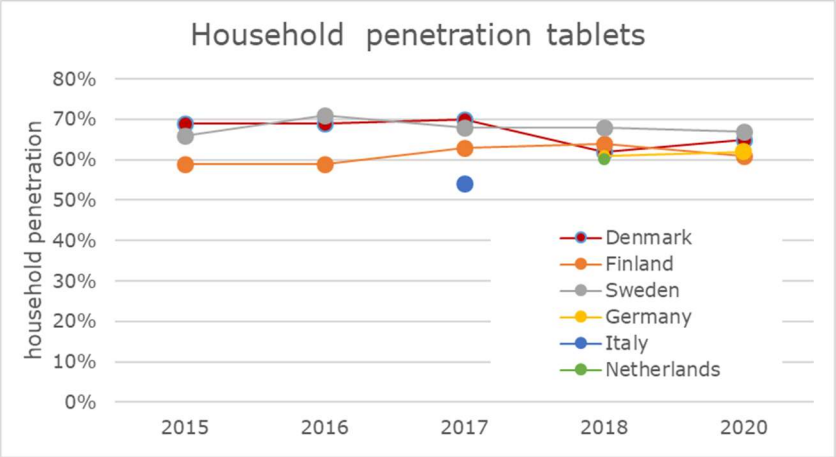


Figure 24: Denmark, Finland, Sweden, Germany, Italy, Netherlands, tablet household penetration, 2015 – 2020 (based on data by statista and eMarketer)

The usage penetration of several information and communication technology devices in France is shown in Figure 25. In 2017 44% had access to a tablet, 41% one year later. (Statista Research Department 2019a)

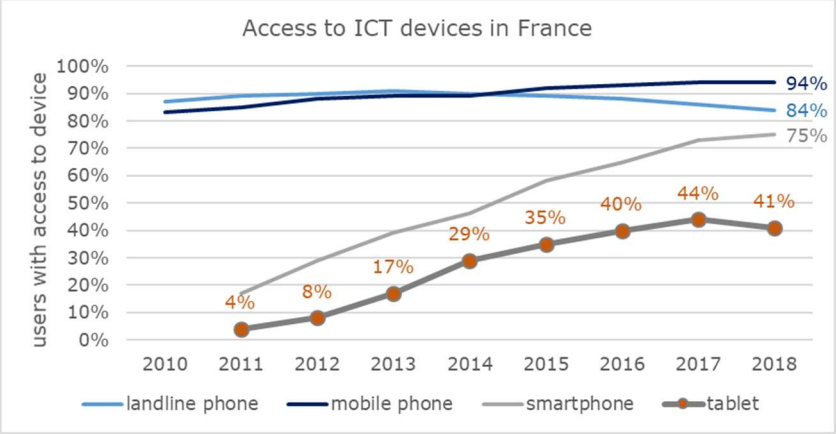


Figure 25: France, tablet computer use, compared to other ICT products, 2010 – 2018 (based on data by statista)

4.3.2.1. Lifetime

Figure 26 illustrates the relevant lifetime related terms for tablets: "Replacement cycle" refers to to the time after which a user upgrades to a new model and the old one is at the end of its first use. Such data points are occassionally misinterpreted as end of life. Tablets are reused, either by giving them to relatives or friends, or by selling them to a recommerce platform or through a second hand channel. The "active use lifetime" including these potential further uses is what is of main interest for this study. This active use lifetime comes to an end when the tablet is not further used – and frequently enters an after life in hibernation. Whereas mobile phones are assumed to end active use life with a well defined event – decoupling the SIM from the device -, this is much less evident for tablet computers: Use intensity is assumed to decrease over time (unless there is a fatal incident) towards a state of hibernation.

The "average age of devices in use" is not the same as the lifetime as it is mathematically derived from devices which just entered the market to those coming to end of life, so this value is expected to be much lower than the active use lifetime.

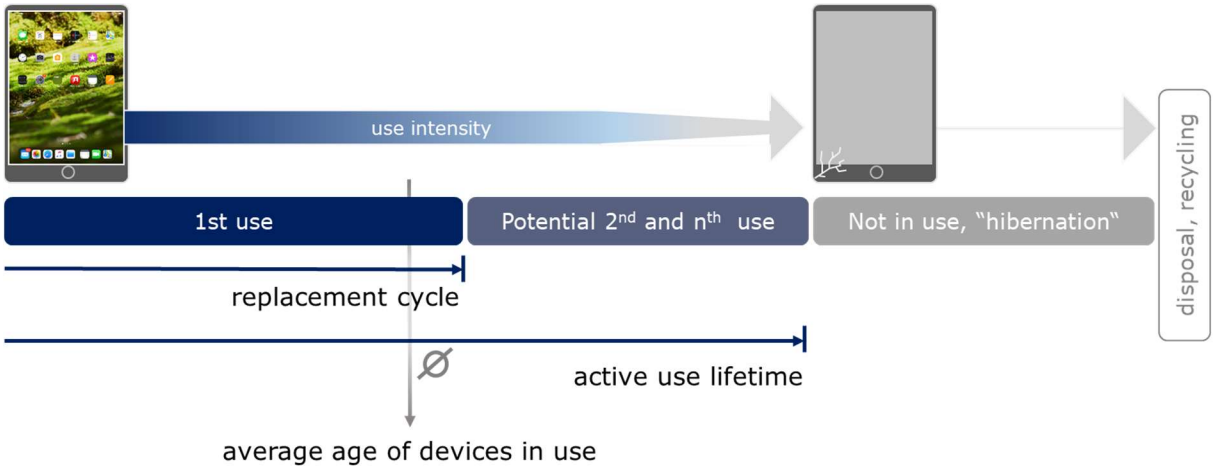


Figure 26 : Tablets – Lifetime terms

Average age of devices in use

Analogous to iPhones, data on the age of tablets (iPads) in active use can be approximated from an analysis of the age of device batteries in active use carried out in 2016 (Clemm et al. 2016). The battery age data is based on data collected by coconutBattery on a total of nine different Apple iPad models, which entered the market between the years 2010 and 2016. In contrast to iPhones, only 26 % of the active device batteries are less than two years old, while close to 50 % are between two and four years old, with the remaining 26 % being older than 4 years. Again, it is assumed that in the majority of cases the age of the battery is coherent with the age of the tablet device. However, some batteries may have been replaced during the lifetime of the tablet, possibly overestimating the share of the lower age groups. It should be noted, that at the time of this analysis (2016) the market launch of the first iPad was 6 years ago, so analysed battery data could not indicate anything older than 6 years. Therefore it can be assumed that tablets remain active in the field considerably longer than smartphones.

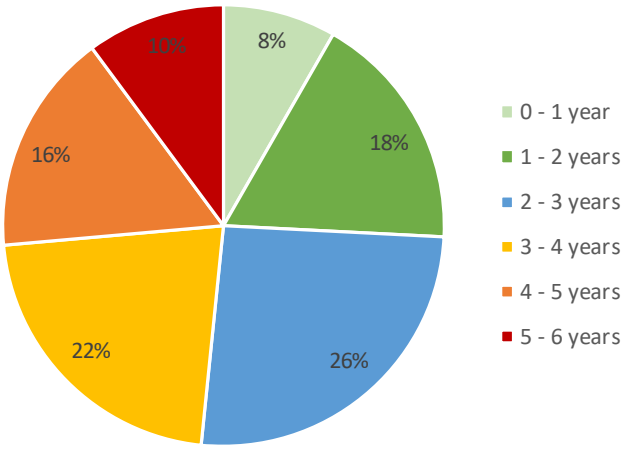


Figure 27 : Age structure of active tablet batteries in 2016 as an approximation for the age structure of tablets in active use (Clemm et al. 2016)

Replacement cycle

In the United States the average lifespan of consumer tablets is projected to be **7,01 years** in 2024.[19]

Active use lifetime

In 2015 a non-representative survey in Portugal came to the conclusion, that the lifetime of tablets is **3 years** (Martinho et al. 2017). The ICT Impact Study for DG ENER calculates with a lifetime of **3 years** for tablets/slates (Kemna et al. 2020), but all of the above data indicates, that this significantly underestimates the use lifetime of tablet computers.

In our stock model we apply a use lifetime of **5 years**.

4.3.3. Reuse market

In Europe, approximately 160 used tablets are sold on eBay alone per day (sample March - May 2020). This figure indicates a total turnover of tablets of more than 60.000 tablets traded second hand on eBay in Europe annually, which is roughly 1/10 the second-hand mobile phone trade volume on eBay.

Used tablets sold on eBay per brand are shown in Figure 8. This includes the most recent trades in Europe, i.e. March to May 2020. In total 12.038 used tablets have been traded in this time, in total more than 180 different models. The largest market share is with Apple (56,0%), followed by tablets from Samsung (20,3%). All others play a minor role. In total tablets of 100 different brands where sold in the analysed period.

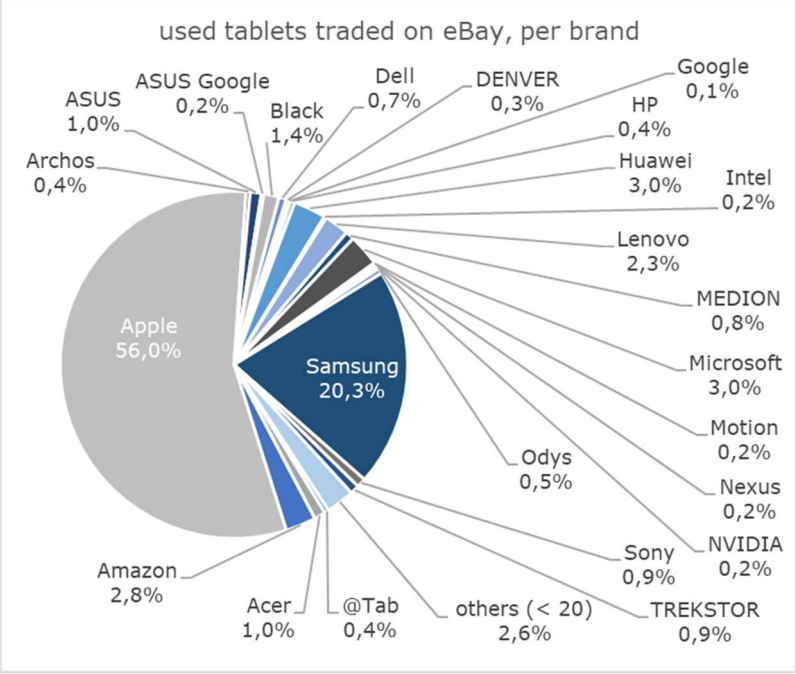


Figure 28: Market share of used tablets, per brand, traded on eBay in Europe (n = 12.017)

When having a closer look at individual model generations there is a wave of traded tablets, with an obvious delay after the release dates. For the various types of iPads this

[19] https://www.statista.com/statistics/267473/average-tablet-life/

is shown in Figure 29. There is no clear trend, except that older generations still see significant second-hand sales on eBay. It is worthwhile to mention, that the iPad 2, which was sold by Apple from 2011 to 2014 is still the most traded used iPad on eBay, although the OS is not supported anymore.

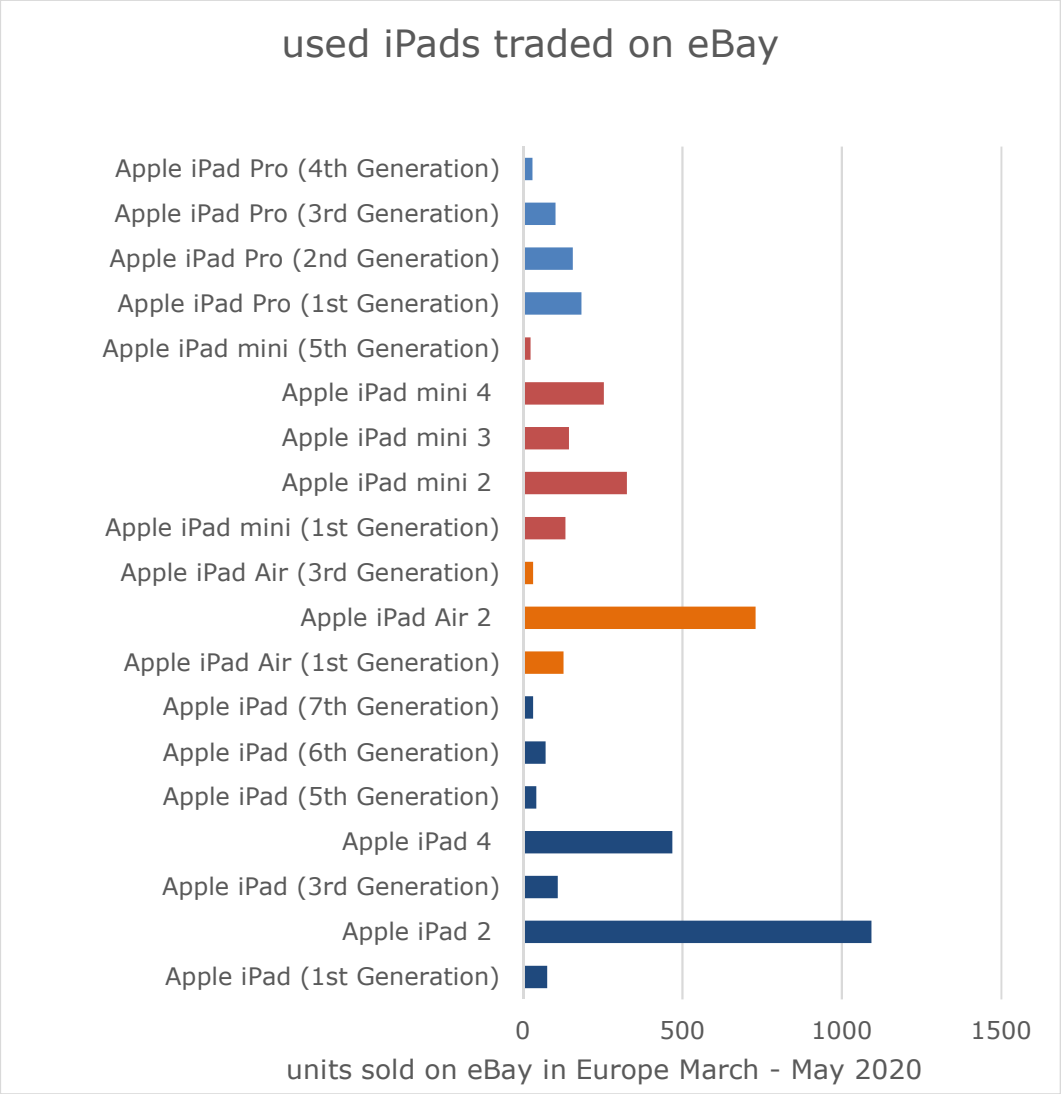


Figure 29: Used iPads traded on eBay (March - May 2020, n = 4.131)

A similar trend can be observed for Samsung's tablets from the various product series (Figure 30): Some of Samsung's first tablet models are still traded in significant numbers on eBay. The highest number of trades currently is with the Galaxy Tab A, which has been on the market since 2016.

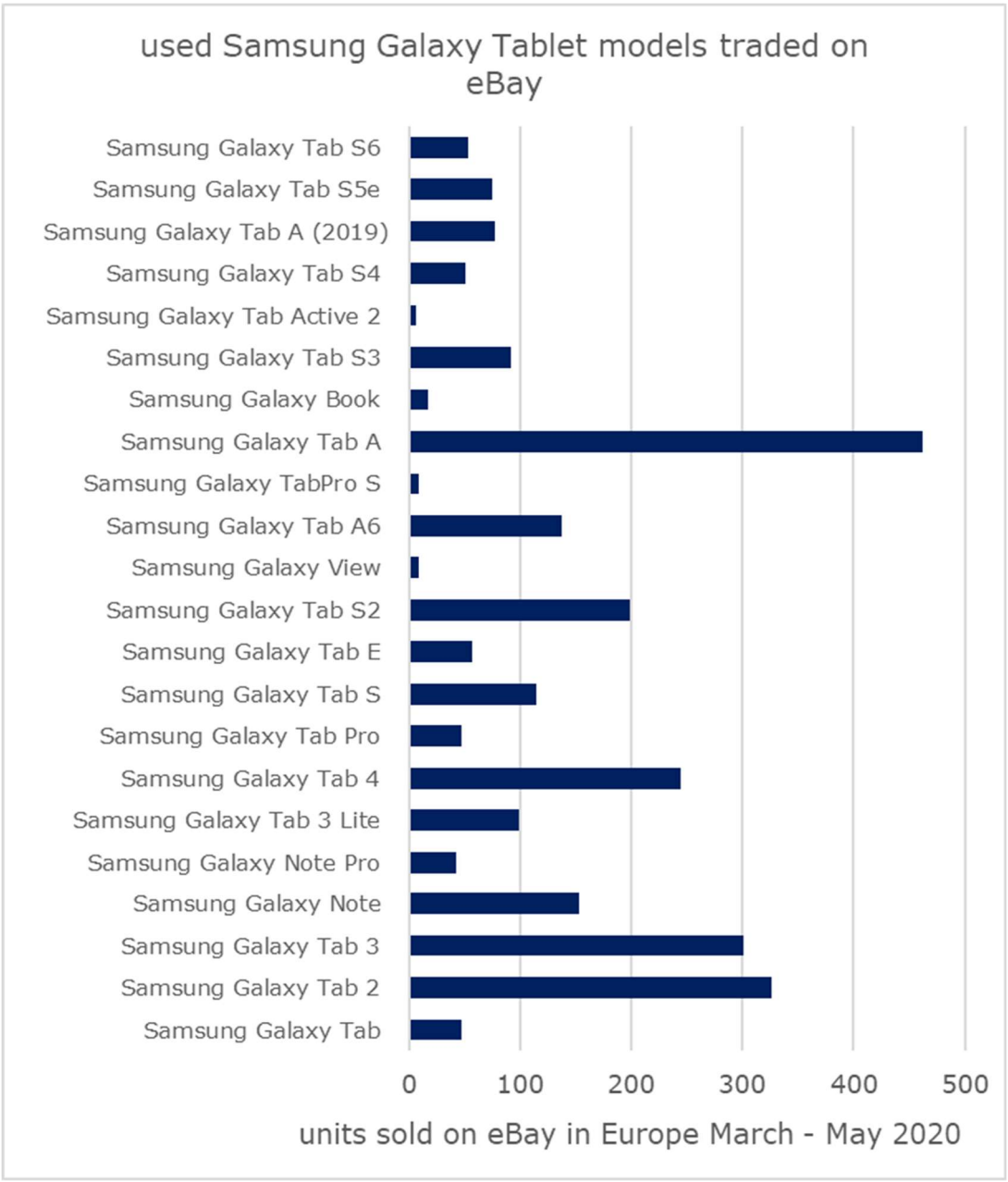


Figure 30: Used Galaxy tablets traded on eBay (March - May 2020, n = 2.615)

This analysis, similar to the analysis of the mobile phone market on eBay, covers only a very minor share of all tablets sold on the market.

4.3.4. Devices in hibernation

There is no similar research as for mobile phones accessible, but it can be assumed that a similar hibernation effect occurs as with mobile phones: They are like to be kept at home even after the service life. This delays the availability of used devices for a second hand market (or disqualifies the devices for reuse at all) and for recycling

4.3.5. Stock model

Taking the accessible market data and forecasts as a basis, assuming a stable market beyond 2024 and calculating with a product lifetime of 5 years leads to the stock model provided in Table 29.

Table 29 : EU 27, stock model tablets, 2010 - 2030

year	sales (million units)	assumption	CAGR	Stock (5 years lifetime)
2010	3,7	Computer Review Study (2017)		3,7
2011	14,8	Computer Review Study (2017)	306%	18,5
2012	28,5	Computer Review Study (2017)	92%	46,9
2013	44,7	Computer Review Study (2017)	57%	91,7
2014	45,2	Computer Review Study (2017)	1%	136,9
2015	41,6	20% of global market (IDC data)	-8%	174,8
2016	35,0	20% of global market (IDC data)	-16%	195,0
2017	32,8	20% of global market (IDC data)	-6%	199,3
2018	31,0	65% of EMEA (IDC data)	-5%	185,5
2019	27,8	65% of EMEA (IDC data)	-10%	168,2
2020	23,9	65% of EMEA (IDC data)	-14%	150,5
2021	23,6	recession, further slow decline	-1%	139,1
2022	23,4	recession, further slow decline	-1%	129,8
2023	23,2	further slow decline	-1%	122,0
2024	23,0	65% of EMEA (IDC forecast)	-1%	117,1
2025	23,0	stable market	0%	116,1
2026	23,0	stable market	0%	115,5
2027	23,0	stable market	0%	115,0
2028	23,0	stable market	0%	114,8
2029	23,0	stable market	0%	114,8
2030	23,0	stable market	0%	114,8

This stock model indicates a decline in tablets in use since 2017 onwards, which is actually not observed in the market as the share of tablet users remains on a very high level. Declining sales and a stable household penetration above 50% is only feasible, if product lifetime is going up over time – which actually is plausible for a mature product category. Two alternative scenarios are provided in Table 30:

- Shorter lifetime of 4 years and a recovery of the market from 2021 onwards to 2018 level (in contradiction to the IDC forecast, but similar to the forecast for mobile phones)
- 5 years lifetime until 2017, then gradually increasing to 6,5 years in 2023

Table 30 : EU 27, stock model tablets, alternative scenarios, 2010 - 2030

	stock	
year	scenario: 4 years lifetime, recovery of the market from 2021 onwards to 2018 level	scenario: 5 years lifetime until 2017, then gradually increasing to 6,5 years in 2023
2010	3,7	3,7
2015	160,0	174,8
2019	126,6	190,8
2020	115,5	181,7
2025	123,9	154,0
2030	123,9	149,2

The graph below shows the effect of the current market decline for tablet computers on the number of units in stock, i.e. in active use: From almost 200 million units in use the

stock is forecasted to go down to 115 million units in 2026 and remaining on this level until 2030.

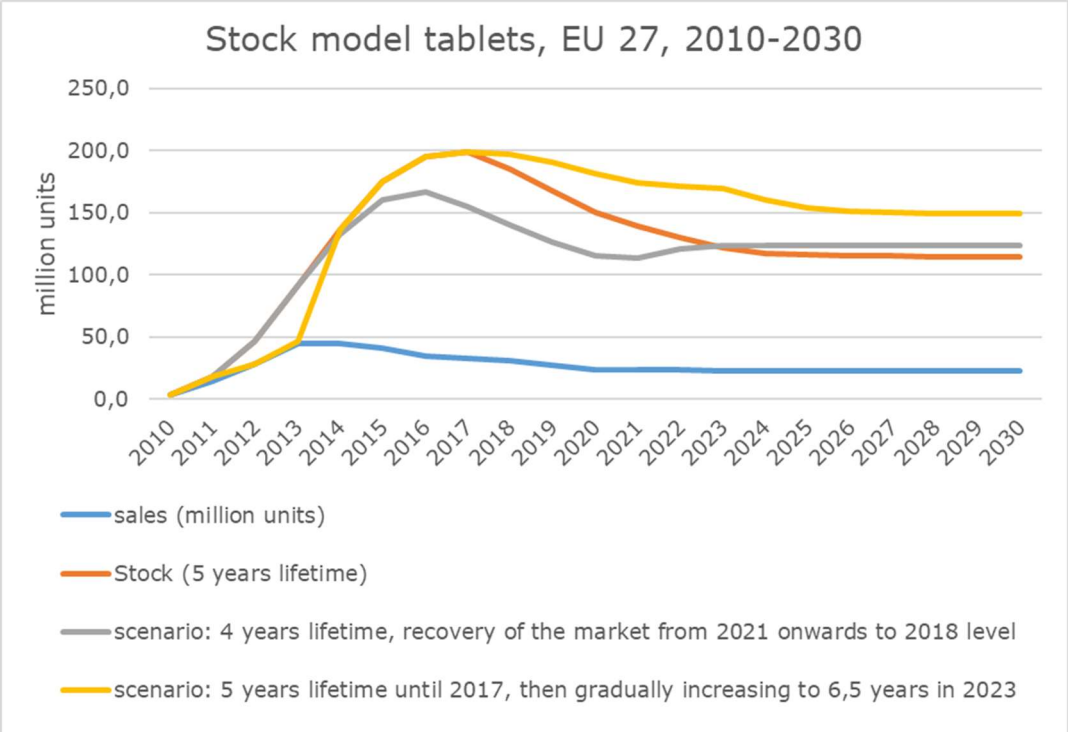


Figure 31 : EU 27, stock model tablets, all scenarios, 2010 - 2030

5. SUBTASK 2.3 - MARKET TRENDS

The objective of this subtask is basically twofold. The first task is the description of the market structure. This includes the identification of the leading product and component manufacturers, the main production locations, typical distribution channels, product related services, and other aspects of the value chain. The second task is the identification of product trends which have to be considered in later stages of the study.

5.1. Voice and data traffic

Although rapidly growing, mobile data usage is not the main driver for overall data usage, which is generally driven by connected TVs. Households with connected TVs generally consume around 300GB per month (European Telecommunications Network Operators' Association 2020).

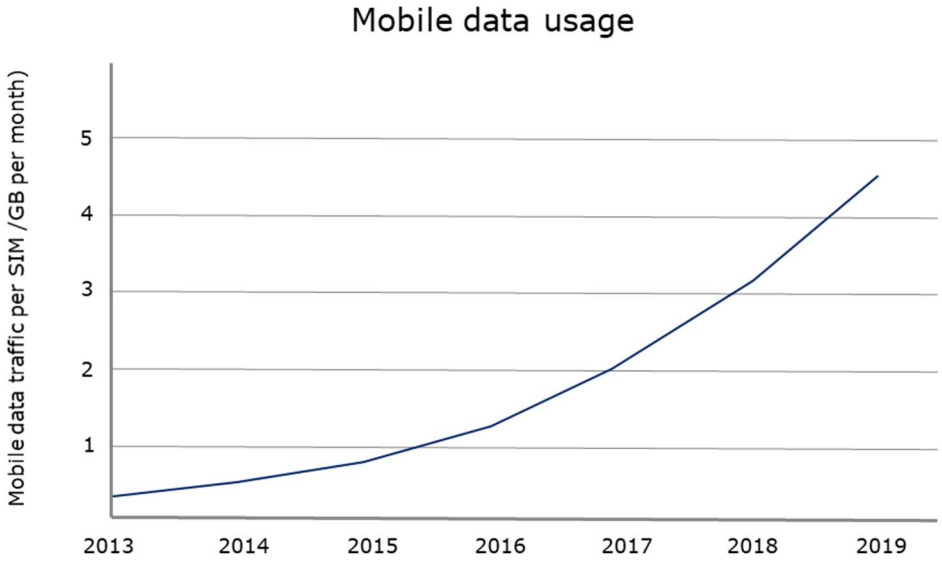


Figure 32 : Mobile data usage per SIM, per month, Europe (data by ETNO)

Total voice traffic goes down continously in Europe, from 1,7 billion minutes in 2011 to 1,596 billion minutes in 2019 (Figure 33). Mobile voice traffic is growing, but this growth went down from 6% per year in 2014 to a rate of 2% in 2019. This growth does not compensate the steady decline of fixed voice traffic (partly attributable to the use of cordless phones).

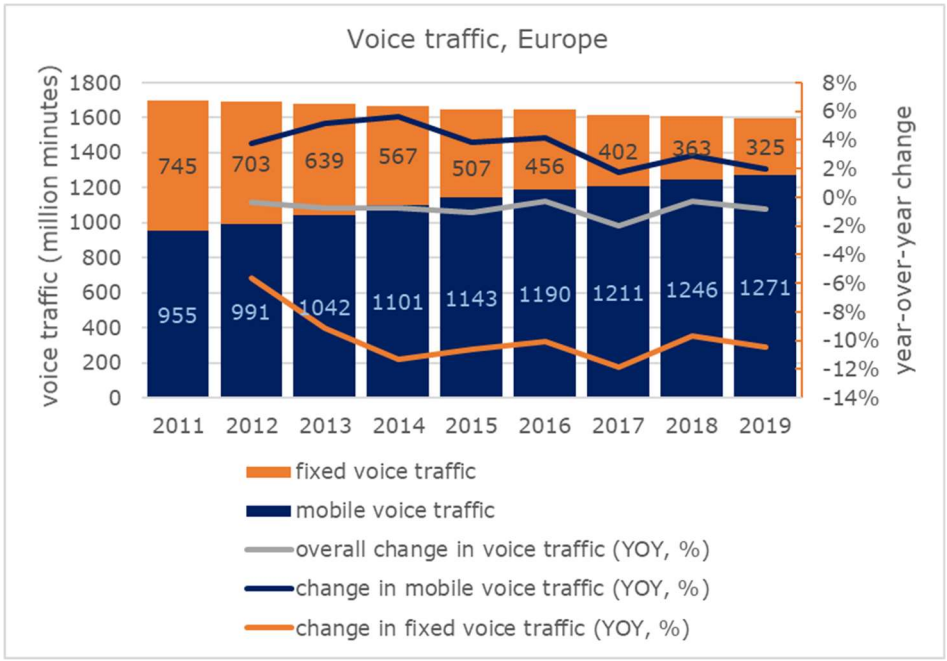


Figure 33 : Mobile and fixed voice traffic, per year, Europe (data by ETNO)

5.2. Mobile phones

The first smartphones came on the market already in the late 1990s. However, it was with the introduction of the iPhone in 2007 that they gained significant market share. As of 2019 smartphones make up 90% of the mobile phones sold in Europe (see Figure below, Share of smartphones sold among total handsets – Source: Counterpoint).

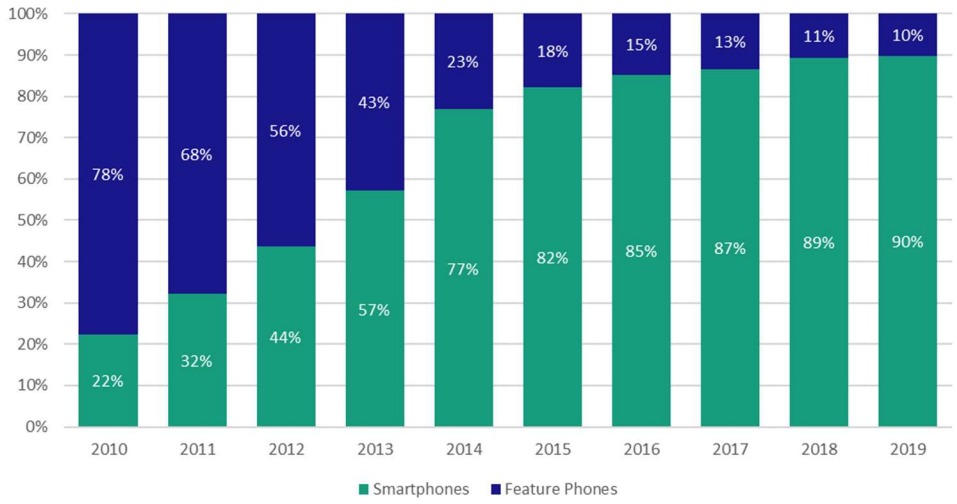


Figure 34: Market share of smartphones and feature phones in Europe (2010-2019)

The smartphone market is relatively concentrated, since three main brands (Samsung, Huawei and Apple) are responsible for more than 50% of total shipments by the end of 2019.

In Europe, just as globally, the smartphone market is dominated by Samsung and Apple, followed by Huawei. Xiaomi gained market shares recently, and all other brands are below 2% of the market each (Figure 35).

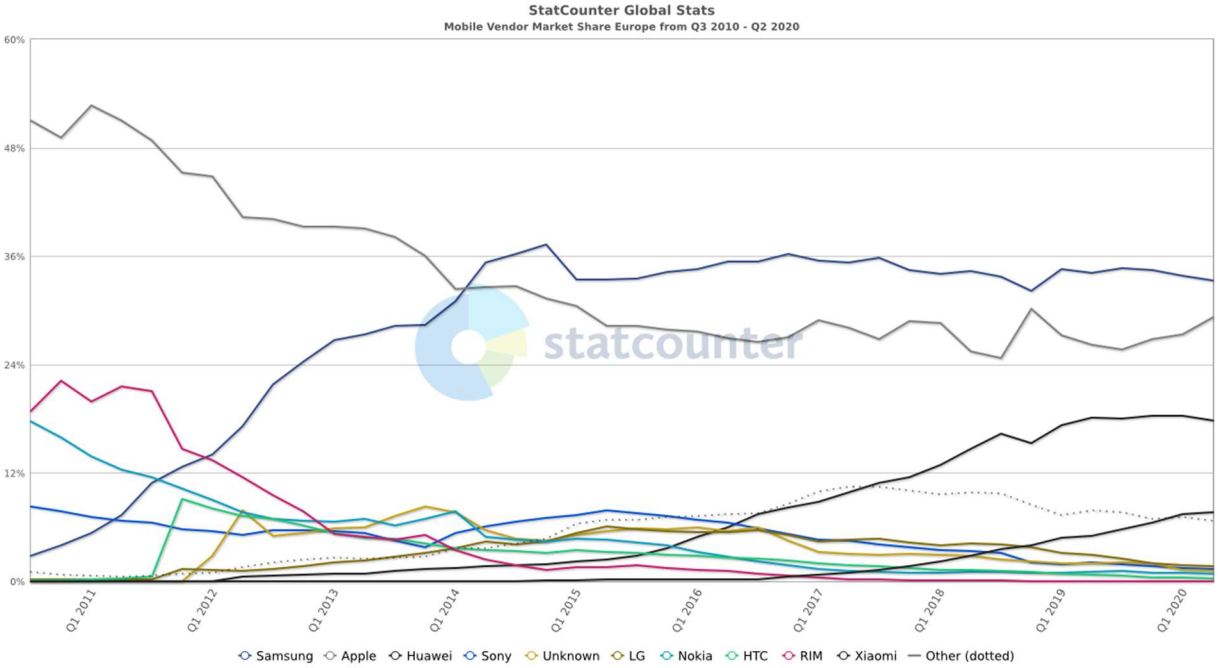


Figure 35: Smartphone vendor market share Europe from Q1 2010 – Q2 2020 (source : statcounter[20])

[20] work by Statcounter is licensed under a Creative Commons Attribution-Share Alike 3.0 Unported License

Among the EU member states market shares of smartphone brands differs, according to statcounter[21]. Samsung is leading the market in most of the EU member states, in others iPhones are more popular. Some brands do not show up at all, although they are definitely sold and also available on the reuse market (see Table 31), such as Google, ZTE and Alcatel.

Table 31 : Smartphone vendor market shares Q3 2019, EU member states (devices in use, in %, compiled by Fraunhofer IZM, based on data by statcounter)

Country	Samsung	Apple	Huawei	LG	Xiaomi	Sony	Lenovo	Motorola	Unknown	Google	OnePlus	HTC	Nokia	Oppo	Asus	Mobicel	Wiko	bq	ZTE	Alcatel
Austria	37,9	29,3	21,1	1,3	1,9	1,6	0,0	0,0	2,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Belgium	36,6	34,9	15,5	0,0	1,7	0,0	0,0	1,9	1,4	0,0	2,1	0,0	1,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Bulgaria	35,8	14,0	24,3	1,6	5,8	1,8	5,1	2,0	1,8	0,0	0,0	0,0	4,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Croatia	43,2	14,1	23,1	2,7	4,5	1,8	1,7	0,0	2,4	0,0	0,0	1,1	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Cyprus	43,3	22,1	14,6	3,9	5,8	1,0	1,5	0,0	1,2	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0
Czech Republic	28,7	18,4	22,3	1,4	12,3	1,8	5,2	0,0	2,3	0,0	0,0	0,0	1,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Denmark	21,3	51,6	15,0	0,0	0,0	1,6	0,0	0,0	0,0	0,0	4,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Estonia	31,6	32,1	16,5	1,2	4,9	3,8	1,2	0,0	1,2	0,0	3,4	0,0	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Finland	26,2	26,7	24,3	0,0	1,6	2,5	1,3	0,0	1,8	0,0	7,6	0,0	4,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0
France	37,5	25,6	14,2	0,0	5,2	2,0	0,0	0,0	3,8	0,0	0,0	0,0	0,0	2,2	1,4	1,3	1,1	0,0	0,0	0,0
Germany	44,0	26,6	15,0	1,3	2,0	1,8	0,0	1,1	2,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Greece	35,5	13,4	16,3	1,6	17,4	1,6	3,2	1,6	2,8	0,0	0,0	0,0	1,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Hungary	34,0	19,5	28,1	2,2	6,3	1,7	1,6	0,0	1,8	0,0	0,0	0,0	1,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Ireland	32,8	41,6	12,6	0,0	2,2	1,7	0,0	0,0	1,3	0,0	1,9	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Italy	34,9	24,7	25,0	2,1	3,9	0,0	0,0	0,0	1,6	0,0	0,0	0,0	0,0	0,0	1,7	0,0	1,1	0,0	0,0	0,0
Latvia	37,5	24,9	18,7	1,7	5,4	2,2	1,4	0,0	1,6	0,0	0,0	0,0	2,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Lithuania	39,3	20,0	21,4	2,4	6,3	1,9	1,4	0,0	2,0	0,0	0,0	0,0	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Luxembourg	40,0	34,6	11,5	1,6	2,4	1,0	0,0	0,0	2,9	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Malta	42,1	25,8	9,4	0,0	6,3	0,0	1,4	0,0	1,6	0,0	7,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Netherlands	39,0	35,4	10,3	1,1	2,3	1,2	0,0	1,7	2,5	0,0	1,4	0,0	1,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Poland	32,2	2,8	32,7	8,9	7,7	2,9	2,1	2,7	1,3	0,0	0,0	1,5	1,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Portugal	28,2	24,2	23,9	0,0	8,2	0,0	0,0	0,0	2,1	0,0	1,5	0,0	1,4	0,0	2,3	0,0	1,1	0,0	0,0	0,0
Romania	50,0	18,0	17,7	1,3	2,1	0,0	1,2	0,0	2,0	0,0	0,0	0,0	1,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Slovakia	28,3	18,8	25,8	2,0	8,3	2,0	5,8	3,6	1,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Slovenia	39,8	17,0	26,6	3,7	2,9	1,7	1,3	0,0	2,0	0,0	0,0	0,0	1,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Spain	27,6	21,2	20,0	2,6	15,5	1,4	0,0	1,4	1,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,4	0,0	0,0
Sweden	29,8	50,1	8,9	0,0	0,0	2,9	0,0	1,1	0,0	0,0	1,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

Figure 36 illustrates some of the major trends affecting mobile communication products, reflecting topics most prominently featured in conjunction with the Consumer Electronics Show (CES) and the Mobile World Congress (MWC): 5G is at the center of upcoming developments, being related to connectivity and streaming, potentially also livestreaming. 5G requires new antenna technologies, and beamforming will enhance reception and

[21] https://gs.statcounter.com/vendor-market-share/mobile/europe#quarterly-201903-201903-map Statistics from statcounter are based on analytical tools monitoring the way websites are accessed.

reduce power consumption potentially. 5G is relevant for numerous applications, including autonomous driving and industrial applications, and consumer 5G is only part of the current hype around 5G. Financial technologies ("fintech"), such as smartphone payments, and health technologies are two domains, which will influence overall functionality of mobile devices. Increased connectivity calls for enhanced privacy protection and security measures. Fast charging and wireless charging are product related trends, which merge to fast wireless charging. Multiple cameras are a feature stressed by OEMs to define latest smartphone technology and several OEMs launched foldable phones or presented prototypes, testing out the market for such product concepts.

Figure 36: Mobile communication trends (compilation by Fraunhofer IZM)

Smartphones evolved to potentially replace a range of other devices (e.g. digital cameras, MP3 players, etc.) or physical documents (e.g. maps, transport tickets, etc.). On average phones have become thinner, but larger to allow for increasing display sizes. The display size has increased from 4 inches or less in 2010 to just 6 inches and above in 2019, while the form factor of devices has not increased as much due to decreasing bezel sizes. Nowadays, many devices integrate a fingerprint sensor and in the display and feature hole-punch front-facing cameras. Foldable smartphones have been a recent trend, in which flexible OLED technology is used to allow for clamshell designs. These types of phones, as well as some traditionally designed smartphones, have started incorporating two battery cells rather than the common single-cell designs. Although foldable smartphones are a minor niche right now, there is apparently a relevant market demand: A recent study indicates that 35% of all Germans would consider buying a foldable smartphone (Bitkom Research GmbH 2019). In terms of housing materials, high-end smartphones have moved from metals (commonly aluminium) to using glass for the back cover, while using metals for the frame. Glass has the advantage to be relatively scratch-resistant, it is very transmissible for RF signals (LTE, WiFi, Bluetooth, etc.) and it enables wireless charging (as opposed to metals). The main disadvantage is the inherent fragility of the material. Lower-end devices generally tend to use plastics for housing materials, commonly polycarbonate, as well as polycarbonate blends with Acrylonitrile-Butadiene-Styrene (ABS). Generally speaking there has been a trends towards using adhesives to seal smartphone housing. This allows for more and more devices to feature ingress protection from water and dust (IP ratings), while also hampering repair. The first smartphones using the new 5G standard are on their way. At the end of 2019, 14 European telecommunication companies had launched 20 5G networks in 9 European countries. By the end of 2020 there will be over 80 networks in operation across Europe (European Telecommunications Network Operators' Association 2020).

The ongoing trend towards streaming leads to a shift in data storage: More and more data is stored in the cloud, less on mobile and other end-devices (Bitkom Research GmbH 2019).

In terms of technical specifications, the smartphone market has steadily moved towards higher performance in every regard. System-on-chip (SoC) solutions have moved towards multi-core designs using the latest process node (currently 7 nm). RAM has increased from 0.5 GB or less in 2010 to up to 12 GB in 2019. Internal storage has increased to feature up to 512 GB in high-end devices in 2019. Battery capacity has increased in the same time frame to 4000 mAh to keep up with increasing performance.

A more in-depth analysis of technological trends will be presented in the Task 4 report.

5.3. Tablets

In Europe the tablet market is dominated by Apple, followed by Samsung. All other brands play a minor role (Figure 37). Market share of Apple is stated to be 56 % in Q2 2020, and 25 % for Samsung, according to statcounter.

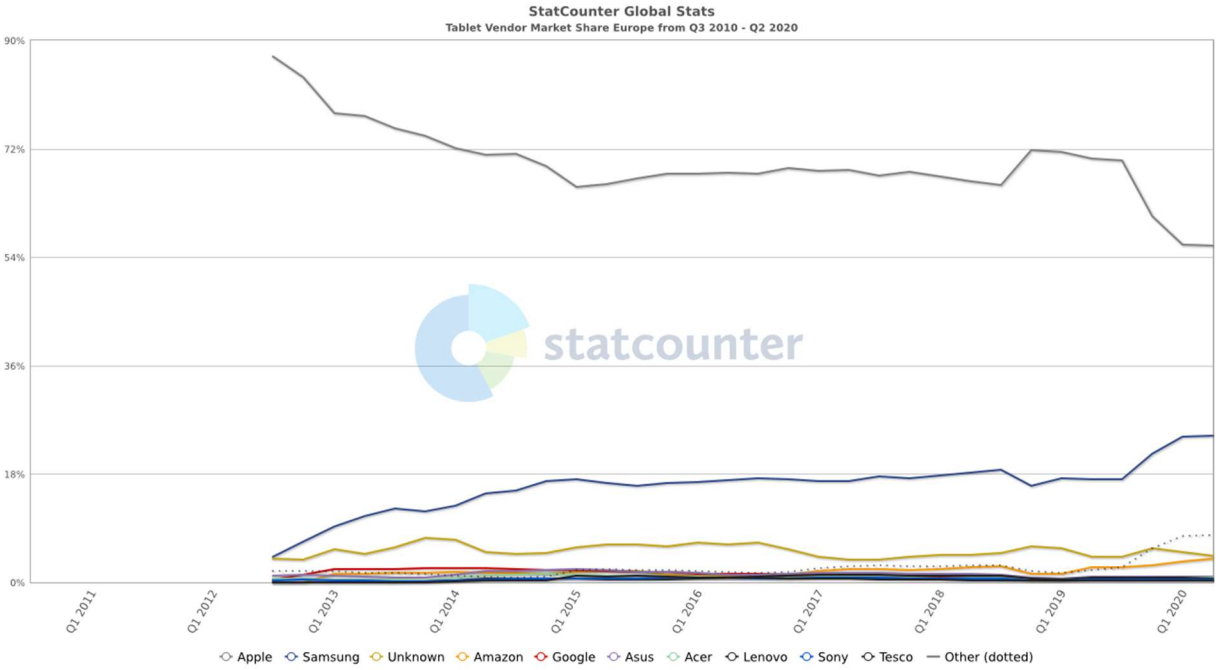


Figure 37 : Tablet vendor market share Europe from Q3 2012 – Q2 2020 (source : statcounter[22])

According to statcounter there are some differences among the EU member states with respect to market shares of individual brands for tablets (devices in use). In almost all countries Apple devices lead the market. Denmark is an extreme case with 92,2 % market share for Apple tablets. In Poland there are more Samsung tablets in use than Apple tablets. Lenovo tablets are more popular in Poland than in any other EU member state. Data suggests Alcatel tablets are popular in Bulgaria.

[22] work by Statcounter is licensed under a Creative Commons Attribution-Share Alike 3.0 Unported License

Table 32: Tablet vendor market shares Q3 2019, EU member states (devices in use, in %, compiled by Fraunhofer IZM, based on data by statcounter)

Country	Apple	Samsung	Amazon	Acer	Medion	Asus	bq	Prestigio	Lenovo	Vodafone	MLS	Huawei	Sony	Alcatel	Google	AlcateI	Unknown
Austria	67,9	20,6	2,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,6
Belgium	75,7	18,6	0,0	0,0	0,0	1,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,3
Bulgaria	37,6	19,2	1,3	3,3	0,0	3,8	0,0	0,0	4,1	0,0	0,0	2,6	0,0	4,6	0,0	10,6	9,4
Croatia	52,2	27,9	1,0	3,0	0,0	1,2	0,0	0,0	1,0	0,0	0,0	1,3	0,0	4,2	0,0	0,0	6,0
Cyprus	64,3	25,5	1,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,2
Czech Republic	60,8	15,4	0,0	2,8	0,0	3,4	0,0	0,0	3,6	1,8	0,0	1,2	0,0	0,0	1,1	0,0	5,6
Denmark	92,2	5,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Estonia	64,9	21,8	0,0	0,0	0,0	2,9	0,0	0,0	1,5	0,0	0,0	0,0	2,4	0,0	0,0	0,0	4,5
Finland	73,4	20,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,1	0,0	0,0	0,0	2,1
France	62,0	28,2	0,0	1,5	0,0	2,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,0
Germany	62,5	23,5	2,4	1,1	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,4
Greece	47,0	23,1	0,0	0,0	0,0	0,0	0,0	3,0	2,9	1,6	1,6	1,2	0,0	0,0	0,0	0,0	15,9
Hungary	54,6	22,8	0,0	0,0	0,0	1,8	0,0	0,0	2,3	1,8	0,0	2,6	0,0	0,0	0,0	0,0	10,1
Ireland	76,9	14,3	2,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,1
Italy	68,8	22,2	0,0	0,0	0,0	2,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,5
Latvia	56,2	30,1	0,0	0,0	0,0	2,4	0,0	0,0	1,4	0,0	0,0	1,9	1,2	0,0	0,0	0,0	3,7
Lithuania	49,7	35,4	0,0	0,0	0,0	4,7	0,0	0,0	1,2	0,0	0,0	1,1	1,3	0,0	0,0	0,0	4,0
Luxembourg	79,1	15,8	0,0	0,0	0,0	1,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,4
Malta	62,6	29,6	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,8
Netherlands	81,2	15,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,2
Poland	28,9	38,2	0,0	0,0	0,0	1,1	0,0	0,0	12,2	0,0	0,0	5,8	0,0	2,0	0,0	0,0	7,6
Portugal	66,0	18,7	0,0	2,6	0,0	4,2	0,0	0,0	0,0	1,7	0,0	0,0	0,0	0,0	0,0	0,0	2,9
Romania	47,1	34,0	0,0	0,0	0,0	3,1	0,0	0,0	1,8	2,8	0,0	1,1	0,0	0,0	0,0	0,0	5,5
Slovakia	54,5	20,4	0,0	2,1	0,0	3,8	0,0	1,4	2,6	0,0	0,0	3,3	0,0	0,0	0,0	0,0	9,0
Slovenia	56,9	29,2	0,0	0,0	0,0	2,4	0,0	0,0	1,4	0,0	0,0	1,7	0,0	0,0	0,0	0,0	4,1
Spain	65,6	22,7	0,0	0,0	0,0	0,0	4,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,6
Sweden	87,2	9,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

5.4. Operating Systems

Similar to other regions on the globe tablets and smartphones either run on iOS or Android and hardly any other operating system. Since 2009 Android gained significant market share, covering more than 75% of the market within global sales to end users, followed by iOS. This is not fully the case for Europe, where Android holds a market share (devices in use) of 70,3% among smartphones. The – smaller - tablet market is the other way round: iOS devices in use represent 70,4% of the market according to statcounter data (Table 33).

Table 33 : OS market shares for tablets and smartphones Q3 2019, EU member states (in %, compiled by Fraunhofer IZM, based on data by statcounter)

	Tablets		Smartphones		
Country (Q3 2019)	iOS	Android	Android	iOS	Others
Austria	67,9	31,8	69,9	29,3	0,0
Belgium	75,7	24,1	64,6	34,9	0,0
Bulgaria	37,6	62,2	85,4	14,0	0,0
Croatia	52,2	47,7	85,1	14,1	0,0
Cyprus	64,3	35,1	77,5	22,1	0,0
Czech Republic	60,8	39,0	80,6	18,4	0,0
Denmark	92,2	7,7	48,2	51,6	0,0
Estonia	64,9	35,0	67,6	32,1	0,0
Finland	73,4	26,5	72,5	26,7	0,0
France	62,0	37,4	74,0	25,6	0,0
Germany	62,5	37,2	72,5	26,6	0,0
Greece	47,0	53,0	83,1	13,4	2,8
Hungary	54,6	45,2	78,0	19,5	1,8
Ireland	76,9	23,0	58,0	41,6	0,0
Italy	68,8	31,0	74,6	24,7	0,0
Latvia	56,2	43,6	74,5	24,9	0,0
Lithuania	49,7	50,1	79,4	20,0	0,0
Luxembourg	79,1	20,6	65,1	34,6	0,0
Malta	62,6	37,3	73,6	25,8	0,0
Netherlands	81,2	18,7	63,9	35,4	0,0
Poland	28,9	70,9	96,0	2,8	0,0
Portugal	66,0	33,4	75,3	24,2	0,0
Romania	47,1	52,7	81,2	18,0	0,0
Slovakia	54,5	45,4	79,5	18,8	1,3
Slovenia	56,9	43,0	82,6	17,0	0,0
Spain	65,6	34,2	78,5	21,2	0,0
Sweden	87,2	12,8	49,6	50,1	0,0
Europe (April 2020)	**70,4**	**29,2**	**70,3**	**29,2**	**0,4**

Table 34 provides statistical evidence on the Android versions running on tablets and smartphones in use (as of Q3 2019).

Table 34 : Android version market shares Q3 2019, EU member states (in %, compiled by Fraunhofer IZM, based on data by statcounter)

version	9.0 Pie	6.0 Marshmallow	8.1 Oreo	8.0 Oreo	7.0 Nougat	5.1 Lollipop	4.4 KitKat	7.1 Nougat	5.0 Lollipop	4.2 Jelly Bean	2.3 Gingerbread	4.1 Jelly Bean
Release date	*Aug 2018*	*Oct 2015*	*Dec 2017*	*Aug 2017*	*Aug 2016*	*Mar 2015*	*Oct 2013*	*Oct 2016*	*Nov 2014*	*Nov 2012*	*Dec 2010*	*Jun 2012*
Poland	24,3	13,3	11,9	18,0	12,4	8,2	3,2	4,6	2,0	0,0	0,0	0,0
Germany	37,7	10,6	7,6	18,5	11,4	4,2	3,1	3,3	2,5	0,0	0,0	0,0
Spain	38,9	9,3	12,3	13,6	10,1	4,5	2,1	7,1	1,5	0,0	0,0	0,0
France	34,0	9,8	11,6	16,6	10,8	6,8	2,9	4,7	2,1	0,0	0,0	0,0
Italy	33,6	10,1	9,1	18,4	12,8	6,3	2,9	3,7	2,2	0,0	0,0	0,0
Netherlands	42,5	8,0	8,7	18,2	10,1	4,2	2,3	3,5	1,8	0,0	0,0	0,0
Romania	38,2	8,9	9,7	17,6	9,7	6,9	2,4	4,2	1,6	0,0	0,0	0,0

version	9.0 Pie	6.0 Marshmallow	8.1 Oreo	8.0 Oreo	7.0 Nougat	5.1 Lollipop	4.4 KitKat	7.1 Nougat	5.0 Lollipop	4.2 Jelly Bean	2.3 Gingerbread	4.1 Jelly Bean
Release date	*Aug 2018*	*Oct 2015*	*Dec 2017*	*Aug 2017*	*Aug 2016*	*Mar 2015*	*Oct 2013*	*Oct 2016*	*Nov 2014*	*Nov 2012*	*Dec 2010*	*Jun 2012*
Hungary	38,9	8,4	8,0	17,9	10,7	6,0	2,4	4,9	1,9	0,0	0,0	0,0
Greece	26,4	11,0	12,7	12,5	10,6	8,7	5,7	8,4	2,1	1,4	0,0	0,0
Sweden	52,1	5,9	5,0	19,3	8,8	2,0	1,3	3,5	1,5	0,0	0,0	0,0
Bulgaria	33,3	11,3	10,0	15,3	10,5	6,7	4,8	4,5	2,3	0,0	0,0	0,0
Ireland	41,5	7,6	7,0	21,1	10,3	5,9	1,8	3,2	1,2	0,0	0,0	0,0
Belgium	41,9	6,6	9,1	18,6	10,9	4,3	2,3	3,7	1,3	0,0	0,0	0,0
Austria	41,4	7,2	7,6	21,0	11,6	3,5	2,5	2,8	1,7	0,0	0,0	0,0
Portugal	39,2	9,8	9,9	16,0	10,2	5,2	2,7	4,4	1,8	0,0	0,0	0,0
Croatia	36,9	9,1	8,0	19,5	11,7	6,1	2,6	3,8	1,7	0,0	0,0	0,0
Denmark	53,0	6,6	5,8	17,2	8,9	2,3	1,4	3,0	1,5	0,0	0,0	0,0
Finland	45,5	7,3	7,3	15,8	13,5	2,5	1,7	4,2	1,8	0,0	0,0	0,0
Czech Republic	28,9	11,8	10,8	14,6	12,1	7,2	4,2	6,4	2,5	0,0	0,0	0,0
Slovakia	33,3	10,2	8,8	16,3	12,3	6,3	4,0	5,2	2,1	0,0	0,0	0,0
Lithuania	38,9	9,3	7,8	16,2	12,2	5,0	2,6	3,7	2,4	0,0	0,0	0,0
Slovenia	42,2	9,0	9,0	18,0	10,6	4,1	1,9	2,6	1,9	0,0	0,0	0,0
Cyprus	38,8	9,8	12,0	15,1	8,2	5,9	3,4	4,5	1,5	0,0	0,0	0,0
Latvia	40,8	9,0	8,1	16,9	10,1	4,0	3,1	3,6	2,7	0,0	0,0	0,0
Estonia	44,1	8,0	7,0	18,9	9,5	3,5	1,5	4,1	2,4	0,0	0,0	0,0
Malta	42,2	8,8	12,4	12,3	8,7	4,8	3,3	5,4	1,7	0,0	0,0	0,0
Luxembourg	35,3	11,4	10,2	14,9	11,4	6,3	2,7	3,3	3,6	0,0	0,0	0,0

As of April 2020 statcounter reports significantly changed market shares of Android versions for Europe, but not yet giving details on the country level (Table 35).

Table 35 : Android version market shares April 2020, Europe (in %, compiled by Fraunhofer IZM, based on data by statcounter)

version	9.0 Pie	10.0 10	8.0 Oreo	7.0 Nougat	8.1 Oreo	6.0 Marshmallow
Release dates	*Aug 2018*	*Sep 2019*	*Aug 2017*	*Aug 2016*	*Dec 2017*	*Oct 2015*
Europe	39,8	21,3	10,2	7,0	6,1	5,5

Similar dynamics in Android version market shares can be observ[23]ed when analysing version distribution according to Android Market/Play Store usage, as seen in Figure 38. At any time since mid 2015 there are at least seven Android versions in active use in significant market shares.

[23] i.e., referring to devices in active use

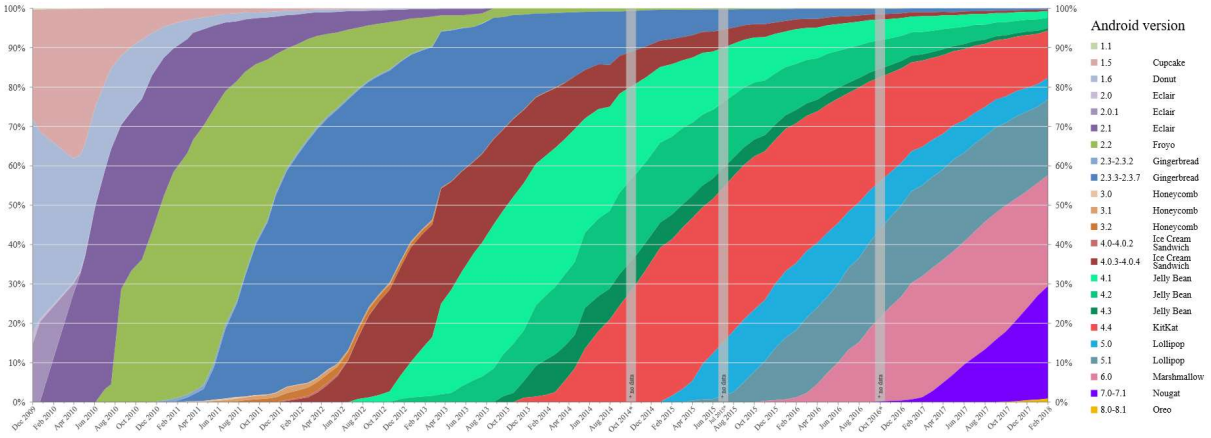


Figure 38: Global market share of Android versions, Dec 2009 – Feb 2018 (source: Erkrespo, Creative Commons Attribution-Share Alike 3.0 Unported)

Figure 39 : iOS version market shares Q3 2019, EU member states (in %, compiled by Fraunhofer IZM, based on data by statcounter)

version	iOS 13.1	iOS 13.0	iOS 12.4	iOS 12.3	iOS 12.2	iOS 12.1	iOS 12.0	iOS 11.4	iOS 11.3	iOS 11.2	iOS 10.3	iOS 9.3	iOS 9.1	iOS 7.1	iOS 7.0	iOS 6.1	iOS 5.1	iOS 5.0
Release dates	*Sep 2019*	*Sep 2019*	*Jul 2019*	*May 2019*	*Mar 2019*	*Oct 2018*	*Sep 2018*	*May 2018*	*Mar 2018*	*Dec 2017*	*Mar 2017*	*Mar 2016*	*Oct 2015*	*Mar 2014*	*Sep 2013*	*Jan 2013*	*Mar 2012*	*Oct 2011*
Germany	1,3	1,9	36,8	38,4	3,8	4,4	0,0	2,3	0,0	0,0	3,1	2,7	0,0	0,0	0,0	0,0	0,0	0,0
France	0,0	1,4	31,9	38,1	4,6	5,8	1,0	3,1	1,1	1,4	4,2	2,8	0,0	0,0	0,0	0,0	0,0	0,0
Spain	0,0	1,5	36,5	39,0	4,4	4,8	0,0	2,5	0,0	1,0	2,8	2,5	0,0	0,0	0,0	0,0	0,0	0,0
Netherlands	1,1	1,6	35,7	41,1	4,0	4,5	0,0	2,2	0,0	0,0	3,1	2,7	0,0	0,0	0,0	0,0	0,0	0,0
Sweden	0,0	0,0	33,0	41,9	5,3	5,8	0,0	3,0	1,4	1,4	2,5	1,4	0,0	0,0	0,0	0,0	0,0	0,0
Italy	1,2	2,1	32,7	37,5	4,3	5,3	1,1	2,8	1,2	1,4	3,4	2,9	0,0	0,0	0,0	0,0	0,0	0,0
Ireland	0,0	0,0	33,4	38,8	5,0	6,0	0,0	3,7	1,0	1,5	2,9	2,5	0,0	0,0	0,0	0,0	0,0	0,0
Norway	0,0	1,6	36,1	40,3	5,0	4,6	0,0	2,4	0,0	0,0	2,3	1,8	0,0	0,0	0,0	0,0	0,0	0,0
Belgium	0,0	1,2	33,0	40,7	4,5	5,2	0,0	2,7	0,0	1,0	3,5	2,7	0,0	0,0	0,0	0,0	0,0	0,0
Denmark	0,0	0,0	34,2	41,4	4,3	4,7	0,0	2,9	1,0	1,1	3,5	2,3	0,0	0,0	0,0	0,0	0,0	0,0
Hungary	1,3	2,3	34,0	41,6	4,4	4,9	1,0	2,2	0,0	1,1	2,2	1,7	0,0	0,0	0,0	0,0	0,0	0,0
Romania	1,1	1,8	32,6	38,9	5,3	6,5	1,2	3,3	1,1	1,4	2,6	1,6	0,0	0,0	0,0	0,0	0,0	0,0
Greece	0,0	0,0	28,4	35,8	4,1	4,2	0,0	2,9	0,0	1,2	4,1	5,5	0,0	1,1	1,9	1,1	1,5	1,9
Poland	1,5	2,6	33,2	36,8	5,3	6,1	1,1	2,8	0,0	1,4	2,4	2,3	0,0	0,0	0,0	0,0	0,0	0,0
Austria	1,0	1,6	34,3	40,1	4,5	5,0	0,0	2,4	0,0	1,4	2,8	2,6	0,0	0,0	0,0	0,0	0,0	0,0
Portugal	1,2	2,0	34,2	40,5	3,8	5,0	0,0	2,3	0,0	0,0	2,9	3,7	0,0	0,0	0,0	0,0	0,0	0,0
Bulgaria	0,0	1,3	32,3	41,1	4,7	5,5	1,1	3,1	0,0	1,1	3,1	1,8	0,0	0,0	0,0	0,0	0,0	0,0
Finland	0,0	1,2	29,5	38,5	5,6	7,6	1,1	2,8	1,3	1,4	3,4	2,3	1,2	0,0	0,0	0,0	0,0	0,0
Czech Republic	1,3	2,1	32,3	42,1	4,5	4,7	0,0	2,2	0,0	1,2	2,5	2,7	0,0	0,0	0,0	0,0	0,0	0,0
Croatia	0,0	0,0	30,2	43,5	4,4	5,6	1,0	2,8	0,0	1,2	3,5	2,7	0,0	0,0	0,0	0,0	0,0	0,0
Slovakia	1,1	2,0	34,0	42,6	4,5	4,6	0,0	2,1	0,0	0,0	2,1	2,0	0,0	0,0	0,0	0,0	0,0	0,0
Lithuania	0,0	1,5	31,6	41,1	5,0	6,2	1,1	3,0	0,0	1,0	3,0	1,2	0,0	0,0	0,0	0,0	0,0	0,0
Cyprus	0,0	1,0	33,4	41,4	4,2	4,2	0,0	2,8	0,0	0,0	3,4	3,0	0,0	0,0	0,0	0,0	0,0	0,0
Slovenia	1,1	1,5	31,5	42,4	5,9	5,0	0,0	2,5	0,0	1,5	2,1	2,3	0,0	0,0	0,0	0,0	0,0	0,0
Latvia	1,2	2,3	30,2	39,1	5,8	6,4	1,2	2,3	0,0	1,1	2,4	3,7	0,0	0,0	0,0	0,0	0,0	0,0
Luxembourg	0,0	1,4	36,4	40,4	4,1	4,2	0,0	2,4	1,1	0,0	2,5	2,1	0,0	0,0	0,0	0,0	0,0	0,0
Estonia	0,0	1,7	33,8	41,3	4,6	5,6	1,3	2,3	0,0	1,2	2,3	2,1	0,0	0,0	0,0	0,0	0,0	0,0
Malta	1,0	1,6	34,1	38,5	4,4	5,1	0,0	2,6	0,0	0,0	4,3	2,8	0,0	0,0	0,0	0,0	0,0	0,0

As of April 2020 statcounter reports significantly changed market shares of iOS versions for Europe, but not yet giving details on the country level (Table 36).

Table 36 : iOS version market shares April 2020, Europe (in %, compiled by Fraunhofer IZM, based on data by statcounter)

version	iOS 13.4	iOS 13.3	iOS 13.1	iOS 12.4	iOS 10.3	iOS 9.3
Release dates	*Mar 2020*	*Dec 2019*	*Sep 2019*	*Jul 2019*	*Mar 2017*	*Mar 2016*
Europe	10,3	66,5	2,0	9,1	2,2	2,1

5.5. Key actors

Different actors play an important role in the smartphone business and as such have significant influence on material and energy efficiency aspects and related impacts.

5.5.1. Suppliers, Manufacturers

The landscape of producers is characterised by large companies serving the global market, such as Apple, Samsung, and Huawei. Few mid-size companies are active in the market, such as Gigaset in Germany, producing smartphones for a few years now and being also the largest European manufacturer of cordless phones. The product portfolio of Philips also includes cordless phones. In general there is very little overlap of manufacturers of smartphones and cordless DECT phones. French based companies Wiko designs and develops smartphones, which are available in some European countries. Archos, another French company, and BQ from Spain supply smartphones and tablets. Some small companies, such as Fairphone and Shift, put particular emphasize on sustainability aspects, although their market share is quite small. Several former European brands, such as Nokia and Alcatel, are now owned by high-tech companies from outside Europe.

Final production of mobile phones, smartphones and tablets is mostly located in East Asia and particularly in China. The main components such as radio interfaces (baseband chip), processors, flash memory, computer network interfaces, displays, batteries, cameras and audio components come from various regions including Asia, North America and to a small extent Europe. Printed Circuit Boards for these products are typically manufactured in Asia, but Austrian based AT&S is a relevant player in this PCB segment. The value chain is considerable large and underlies constant changes. Some market consolidation trends are noticeable.

As an indication of the location of manufacturing sites in the consumer ICT business Table 37 lists the number of manufacturing sites per country for Apple's top 200 suppliers (Apple 2019). Most of the manufacturing takes place in Asia, particularly in China. Only few manufacturers are located in the EU 27, and among these the semiconductor fabs represent the majority of the sites, followed by some material suppliers. Although Apple's portfolio does not only include smartphones and tablets, this split can be assumed to apply to this product group.

Table 37 : Manufacturing locations for Apple's top 200 suppliers, number of manufacturing sites per country (based on Apple's 2019 list of suppliers)

Manufacturing sites					
Asia		***Americas***		***EU***	
China	378	USA	59	Germany	8
Japan	128	Brazil	4	Netherlands	4
Taiwan	56	Mexico	3	France	4
South Korea	45	Costa Rica	1	Austria	3
Philippines	19			Czech Republic	3
Vietnam	18			Belgium	3
Malaysia	17			Italy	1
Thailand	16			Ireland	1
Singapore	13			Malta	1
India	8			*Europe: non-EU*	
Indonesia	4			United Kingdom	4
Cambodia	1			Norway	1
Israel	1				

5.5.2. Software suppliers

Software suppliers include those providing the operating system (in case of smartphones and tablets), which might (Apple: iOS, Google: Android) or might not be (most others) the device manufacturer. Manufacturers of Android devices usually provide versions of Android adapted to the device. For the lifetime of smartphones and tablets it is cruicial for how long devices are supported with an up-to-date operating system and with security updates.

Third party application developers provide software for smartphones and tablets, which are typically provided through the App Store (for iOS devices) or Google Play (for Android devices). These apps have significant influence on the usability of the hardware, in particular hardware compatibility is an issue but also required resources in terms of memory.

For feature phones and cordless phones the providers of the firmware for these devices are typically the manufacturers, thus having good control over the interplay of software and hardware.

5.5.3. Retailers

Retailers are among the biggest providers of mobile phones, which can influence customers towards certain business models, and which can enter 2nd-hand markets (Watson et al. 2017). Many EU countries also oblige retailers under specific conditions (e.g. size of shop) to provide a collection point for WEEE. For large retail chains of electronics and white goods, sales of mobile phones represent a minor element of total turnover; however, these sales are growing in importance. For more specialised retailers the share of turnover represented by phone sales can be as high as 80%, with the remaining 20% represented by repairs, tablets or accessories. (Cordella et al. 2020)

5.5.4. Network operators

Network service providers are large sellers/providers of mobile phones, which they sell via subscriptions of network services to attract and keep customers.

Besides mobile network operators (MNO) there are also mobile virtual network operators (MVNO), providing communications services but do not own the wireless network infrastructure over which it provides services to its customers. A MVNO enters into a cooperation agreement with one or more mobile network operators to obtain bulk access to telecommunications services at wholesale rates, then sets retail prices under its own brand independently. Frequently subsidiaries of MNOs act as MVNOs.

The market of mobile network operators in Europe is characterised by a large number of midsized players: As of Q2 2019 there were 47 operators with at least 500.000 subscribers each. In the US (7 operators), South Korea or Japan (3 operators each), the market is much more concentrated (European Telecommunications Network Operators' Association 2020).

Market leader among the MNOs in EU 27 is Vodafone. Deutsche Telekom, Orange and Telefónica are next, including subsidiaries where applicable. The market share of the MNOs in the EU 27 countries is depicted in Figure 40, which shows the large number of operators. MNOs with same majority owner are grouped together. Many companies are represented in several countries, partly with a regional focus.

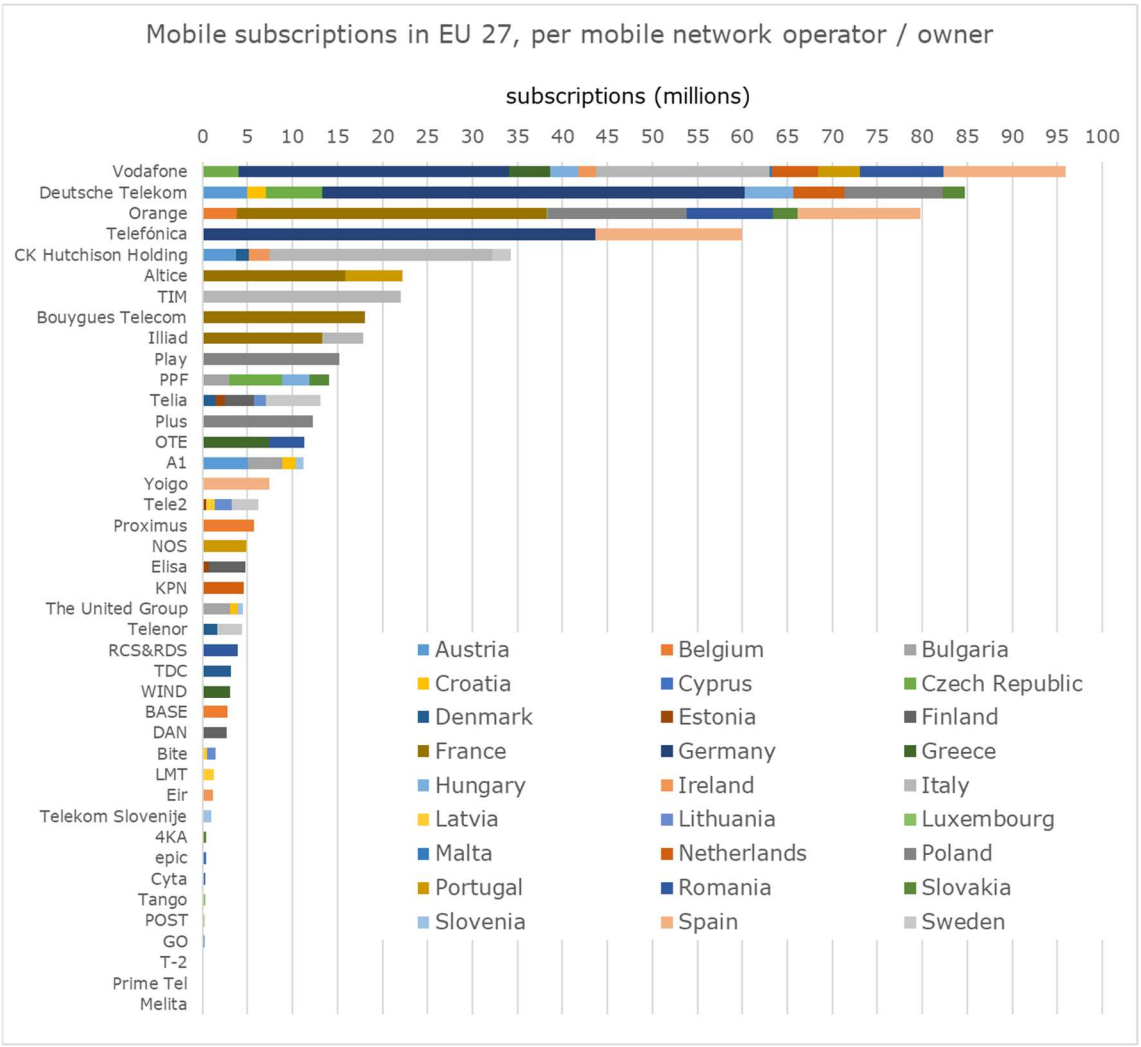


Figure 40 : Mobile network operators in EU 27, brands / majority owner, subscriptions

Mobile network operators have a strong influence over how often customers upgrade their telephones, but also have relevance to warranties, repair and refurbishment processes. The range of models via which network service providers are offering mobile phone upgrades have been diversifying rapidly over the past few years in global markets and now can include leasing and buy-back upgrades. Sales of phones do not directly generate profits for the service providers (some service providers even claim it is a cost). The providers' main turnover is via data and network services and subscriptions for these. (Cordella et al. 2020)

The (landline) telecom providers also play a major role for cordless phones as the providers are the dominating distribution channel for the end device and as these remain to be involved as service provider throughout the product lifecycle.

5.5.5. Repair shops

Repairers can be found frequently in cities and towns. Phone producers/electronics retailers increasingly demand that repair shops are certified in order to activate product warranties. There is also a wide range of professional and amateur repairers that are not official but independent. For repair companies, repair of mobile phones is in general a large part of their business (up to 95% of the total turnover). However, also selling accessories is becoming a relevant part of the business for repair companies (Cordella et al. 2020; Watson et al. 2017).

As an indication for the number of players, exemplary figures for Germany – with a population of just over 80 millions – there are 4.300 electrical and electronics repair shops, 1.200 specialised smartphone repair shops, and – to give a specific example for iPhones and iPads – approximately 140 authorised Apple Service Providers (AASP, as of 2018) and 15 Apple Stores which provide support.

5.5.6. Refurbishers

The market for refurbished mobile devices is growing and several refurbishment companies are active on a typically regional scale. Some refurbishers are specialised on business devices, which they collect from enterprises and institutions, selling refurbished devices primarily in the consumer market. Others buy used devices, at large scale on internet platforms, from consumers, test, repair, and refurbish these and sell devices with a warranty through online shops.

There is also an overlap between companies involved in repair and 2nd-hand sales.

6. SUBTASK 2.4 - CONSUMER EXPENDITURE BASE DATA

6.1. Purchase price and manufacturing costs

6.1.1. Smartphones

The purchase price (PP) of products is given by the manufacturing costs (MC) plus the margins added, which could be simplified as follows (Cordella et al. 2020):

$$PP = MC \times (1+MM) \times (1 + RM) \times (1+VAT)$$

Where:

MC = material costs, considered to include the cost of the phone's / tablet's parts

MM = manufacturing margins, considered to include additional costs (e.g. investment and operational costs associated with manufacturing, product design, software, Intellectual Property, certifications)

RM = aggregated sale margin

VAT = value-added tax (e.g. 21.6% as average in the EU in 2015)

PP of Fairphone 2, as an example, was reported to be about 1.5 times MC, and MM to be about 20% of MC (Fairphone 2015).

Manufacturing costs (MC) for high-end smartphones recently exceeded 500 USD for components (bill of materials) and final test and assembly. Several years ago, costs in the range of roughly 150 to 300 Euros or USD where more common. These estimates are made by TechInsights, not the OEMs.

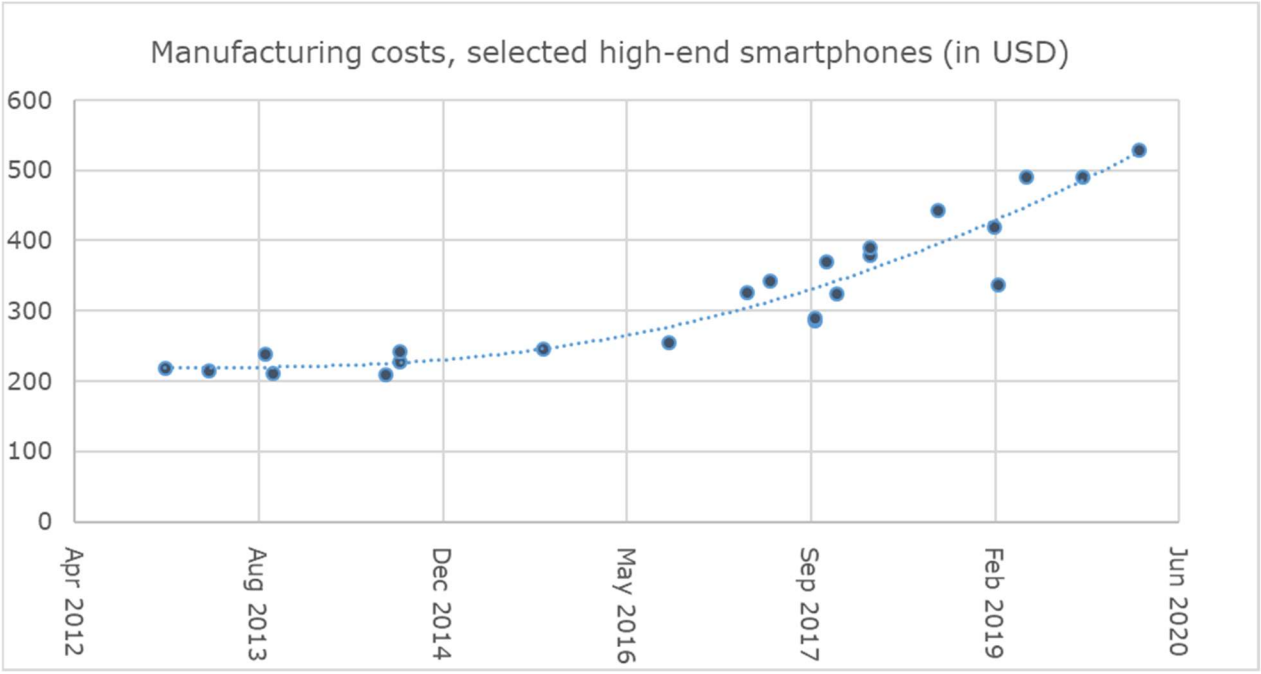


Figure 41 : Manufacturing costs of selected high-end smartphones in USD (compiled by Fraunhofer IZM based on TechInsights data)

As detailed data by TechInsights (Apple iPhone 11 Pro Max Teardown | TechInsights 2020; Cost Comparison – Apple iPhone X, Apple iPhone 8, Huawei Mate 10, Samsung Galaxy S8 2020; Cost Comparison – Samsung Galaxy S9+, Samsung Galaxy Note 8, Samsung Galaxy 8+, Apple iPhone 8+, Apple iPhone X 2020; Samsung Galaxy S10 5G Teardown | TechInsights 2020; Google Pixel 3 XL Teardown 2020; Samsung Galaxy S20 Ultra 5G Teardown Analysis | TechInsights 2020) shows, main cost drivers for high-end smartphones are

- **application and baseband processor** (19% in average for the 2017 – 2020 models listed in Table 38)
- **display / touchscreen** (17,5 % in average; prices for larger displays are not necessarily higher as can be seen, when comparing the regular size models with the larger "plus"-models)
- **camera assemblies** (costs increased massively for the latest models, being now in a same range as the application / baseband processor and the display / touchscreen: 12,5% in average, but 15% and above 20% respectively for the iPhone 11 Pro Max and the Samsung Galaxy S20 Ultra 5G).
- **RF components** (7% in average)

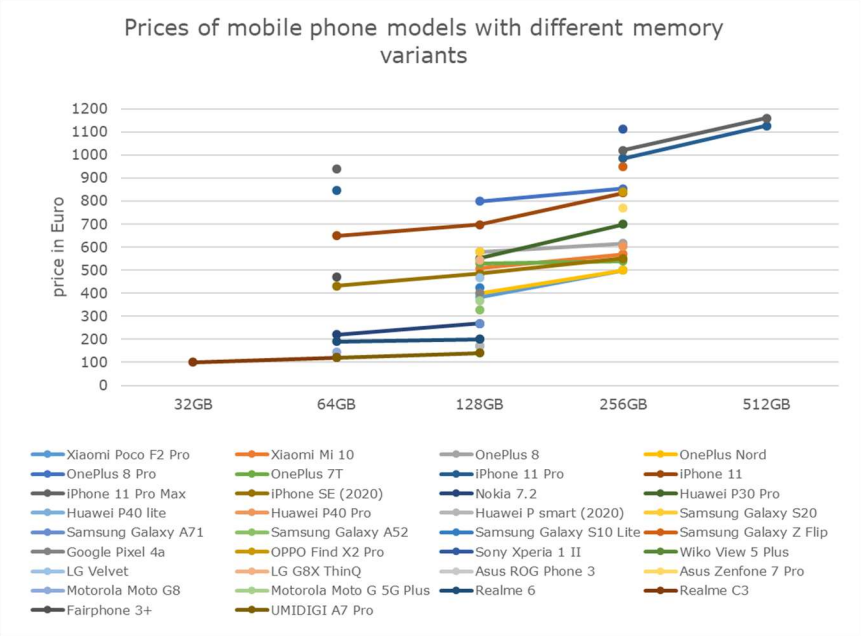
Costs for the batteries are estimated at 7,50 to 11,50 USD for most recent models, and 1,8 % in average for all listed models.

Table 38 : Component and assembly costs for selected high-end smartphones, in USD (compiled by Fraunhofer IZM based on TechInsights data)

Category	Samsung Galaxy S8 SM-G950F	Samsung Galaxy S8+ SM-G955F	Apple iPhone 8 A1905	Huawei Mate 10	Samsung Note 8 SM-N950F	Apple iPhone 8+ A1864	Samsung Galaxy S9+ SM-G965F/DS	Apple iPhone X A1865	Google Pixel 3 XL G013C	Samsung Galaxy S10+ SM-G975F	Samsung Galaxy S10 5G SM-G977N	Apple iPhone 11 Pro Max	Samsung Galaxy S20 Ultra 5G
	Apr 2017	*Jun 2017*	*Oct 2017*	*Oct 2017*	*Nov 2017*	*Dec 2017*	*Mar 2018*	*Mar 2018*	*Feb 2019*	*Feb 2019*	*May 2019*	*Oct 2019*	*Mar 2020*
Applications Processor	–	–	52,00	–	–	52,00	–	52,00		–	–	64,00	
Applications/Baseband Processor	71,00	71,00	–	52,50	68,50	–	68,00	–	64,17	70,50	70,50	–	81,00
Baseband Processor	–	–	14,50	–	–	12,50	–	12,50		0,00	32,08	25,50	26,50
Battery	4,00	4,00	4,00	6,00	4,00	4,50	5,50	6,50	10,33	10,50	11,50	10,50	7,50
Camera / Image	25,50	32,00	20,00	35,00	40,50	35,00	48,00	43,00	47,94	56,50	62,50	73,50	107,50
Connectivity	10,50	11,00	11,50	6,50	11,00	10,00	12,00	9,50	4,95	10,50	10,00	10,50	9,50
Display / Touchscreen	76,50	78,50	36,00	31,00	82,00	47,50	72,50	77,00	54,45	86,50	90,00	66,50	67,00
Memory: Non-Volatile	22,00	22,00	20,50	24,00	21,00	21,00	12,00	19,50	6,81	11,50	18,00	58,00	23,50
Memory: Volatile	18,00	18,00	16,50	31,50	36,00	26,50	39,00	25,50	21,81	39,00	37,50	11,50	44,00
Mixed Signal	–	–	–	0,50	–	–	–	–	2,40	0,50	0,50	1,50	0,50
Non-Electronics	21,50	26,50	21,50	17,00	23,50	28,00	29,00	46,00	21,79	29,00	32,50	61,00	30,50
Other	15,50	15,00	15,50	17,50	16,50	15,00	15,00	18,00	16,24	17,00	18,00	21,00	28,00
Power Management / Audio	8,50	8,50	12,00	10,50	7,00	12,00	8,50	14,50	10,39	7,00	10,00	10,50	9,50
RF Component	18,50	18,50	25,00	20,50	19,00	23,00	23,50	22,50	25,65	31,00	46,00	30,00	33,00
Sensor	4,50	4,00	4,00	5,50	4,00	4,00	5,00	5,50	6,15	3,50	2,50	1,50	11,00
Substrates	11,00	13,50	9,00	9,50	12,50	10,00	19,50	13,50	17,54	12,50	26,00	16,50	12,50
Supporting Materials	7,50	8,00	7,00	8,00	9,00	7,00	9,00	7,00	9,34	8,50	8,50	7,50	9,50
Final Assembly & Test	12,00	12,50	16,00	14,50	14,50	16,50	12,50	17,00	17,16	14,00	14,00	21,00	27,50
Total	**326,50**	**343,00**	**285,00**	**290,00**	**369,00**	**324,50**	**379,00**	**389,50**	**337,12**	**420,00**	**490,08**	**490,50**	**528,50**

A major cost factor for mobile phones is the memory capacity. An analysis of sales prices for same model with different memory configuration shows a clear price difference in almost all cases (Figure 42). Where mobile phones are available in a 64 GB and a 128 GB version the latter costs 5 to 22% more. Where devices are available with a 128 GB and 256 GB version, the latter is up to 30% more expensive, but in individual cases are also on almost the same price level. With few exceptions the statement con be made, that there is a strong incentive for the consumer to go for a rather lower memory capacity. This is important to understand when reflecting on memory capacity as a potential eco-design option: Here it is safe to say, that the market sets strong incentives to buy the device with the lower environmental footprint.

Figure 42 : Prices of mobile phone models with different memory variants (on September 21, 2020; compiled by Fraunhofer IZM based on www.idealo.de)



The average sales price for mobile phones is steadily increasing over the years: In 2012 mobile phones on the EU 27 market in average were sold for 290 Euros. At that time feature phones still had a significant market share whereas today the market is almost completely absorbed by smartphones (see 5.2). As of 2020 the average price is 395 Euros in EU 27, with a span from 322 Euros in Bulgaria up to 495 Euros in Belgium. This data is calculated based on statistics by statista for individual countries (statista 2020). Prices in Germany are 437 Euros for *mobile phones* according to statista data, compared

to 525 Euro stated for *smartphones* by Bitkom Research (Bitkom Research GmbH 2019). A reason for the difference in stated prices is the different scope (mobile phones vs. smartphones), but the market share of feature phones is so small, that this effect alone cannot justify the difference. Therefore also the statista data compiled and analysed in Table 39 might not be fully accurate, but is the best available price data for EU 27.

Table 39 : Average prices for mobile phones, EU member states and EU 27 totals, retail market (compiled by Fraunhofer IZM based on statista data)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
France	336	362	386	408	424	435	442	447	450	451	452	452
Netherlands	333	349	364	378	392	406	418	430	441	451	459	466
Germany	240	269	296	332	371	402	421	431	437	440	442	443
Italy	305	324	344	359	370	377	381	382	383	384	384	384
Ireland	362	371	379	386	394	401	408	415	420	426	430	434
Denmark	364	376	386	397	408	419	430	440	449	456	463	468
Greece	307	332	357	381	403	423	440	455	468	478	487	495
Portugal	345	350	354	357	360	361	362	363	363	363	363	363
Spain	329	337	346	353	359	363	365	366	367	367	367	367
Belgium	355	366	381	398	417	438	459	478	495	509	520	529
Luxemburg	315	333	351	369	385	400	412	422	430	436	441	445
Sweden	344	355	365	375	384	392	399	406	412	417	421	425
Finland	318	319	321	322	324	325	326	327	327	327	328	328
Austria	352	367	380	392	403	412	421	428	435	441	445	450
Malta	287	303	320	334	348	359	368	375	380	385	389	393
Estonia	287	303	318	333	347	362	375	387	398	407	414	421
Latvia	251	271	289	304	315	322	325	326	327	327	327	327
Lithuania	280	300	320	338	355	370	383	394	403	411	417	423
Poland	263	312	331	349	365	379	392	403	412	420	427	433
Czech Republic	291	305	320	333	346	358	369	379	388	396	403	408
Slovakia	255	290	320	346	366	381	392	399	405	409	412	414
Hungary	294	318	341	362	381	399	414	428	440	451	460	467
Romania	279	308	332	351	365	375	383	389	394	398	400	402
Bulgaria	270	277	283	290	297	305	311	317	322	326	328	331
Slovenia	215	237	258	277	294	309	322	333	343	352	359	366
Croatia	265	283	299	315	331	347	362	375	387	397	405	412
Cyprus	290	305	320	333	344	353	361	367	372	377	381	384
EU 27	**290**	**311**	**330**	**348**	**364**	**377**	**385**	**391**	**395**	**399**	**401**	**403**

Until 2023 statista predicts a slight further increase of the average sales price. For the EU 27 in average the price for mobile phones will increase from 395 Euros to 403 Euros.

6.1.2. Tablets

According to data from statista, the average tablet computer sold on the consumer market in Germany for 603 Euros in 2010 and was 337 Euros in 2019, indicating a trend towards more affordable lower-end devices in this market over the past decade.

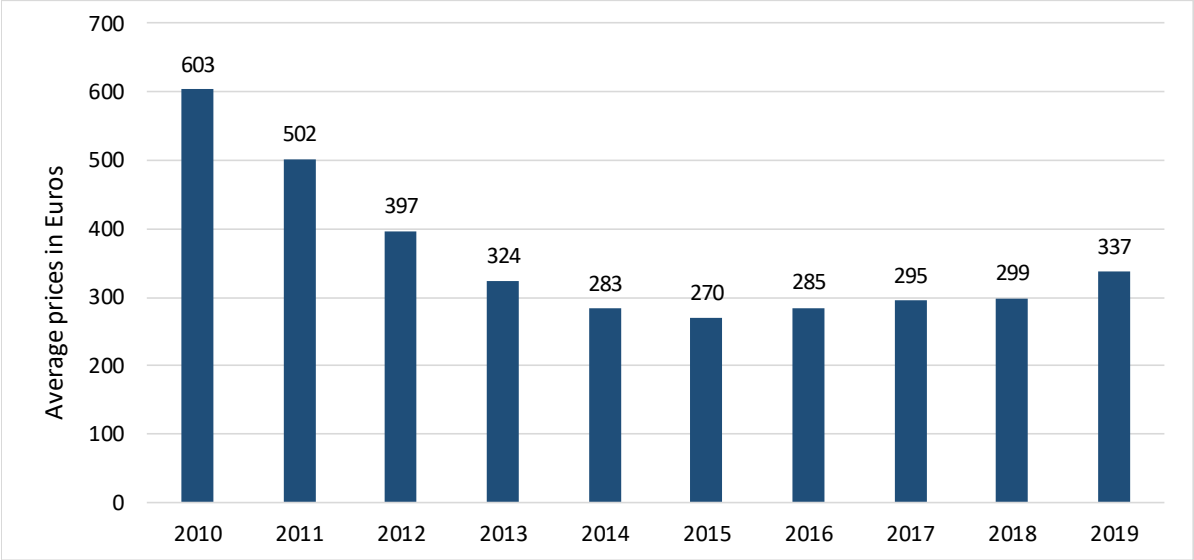


Figure 43 : Average price of tablet PCs sold on the consumer market in Germany from 2010 to 2019 (based on statista data)

A survey of the price comparison platform "idealo" revealed the number of tablet models offered in different price segments on the German market. Lower market devices with a price range between 80 and 200 Euros (n = 793) clearly dominate the offer side, followed by higher-end devices in the price range between 220 and 550 Euros (n = 464). These by far outnumber the bottom-end and high-end devices in the market.

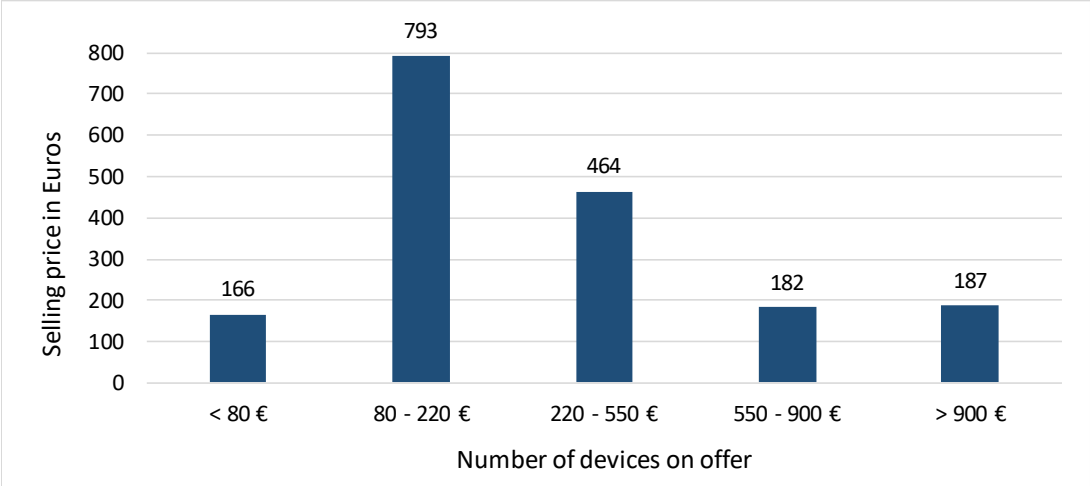


Figure 44 : Number of tablet models offered in different market segments on the German market (compiled by Fraunhofer IZM based on idealo data)

Data from statista on the market share of specific tablet models in Europe was complemented with the recommended retail price at launch to gain insights into the market share of different price segments. The source data provides market shares for several device models form the leading OEMs Apple and Samsung, which combined make up 59 % of the European market, while the remaining 41 % are not named (unknown manufacturer and device model). In the second quarter of 2018, low-end devices with a retail price below 200 € only accounted for 6 % market share. Medium-priced devices with retail prices in the range of 200 to 400 € accounted for 17 %, devices in the range of 400 to 800 € accounted for 11 %. High-end devices with a retail price above 800 € had a major market share with 25 %.

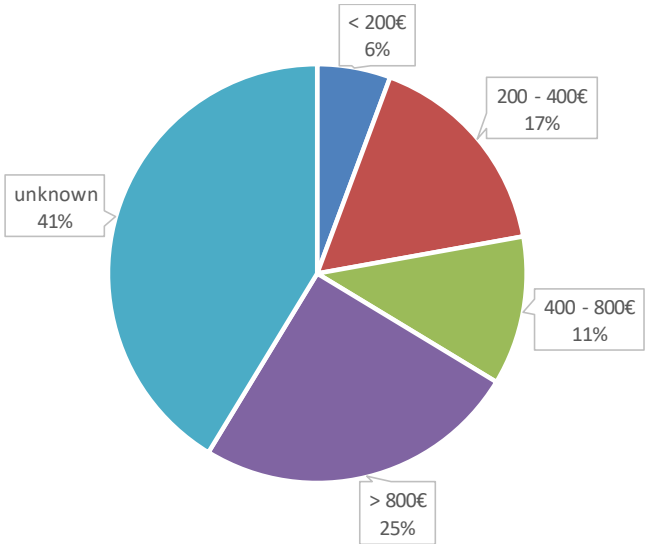


Figure 45 : Market share of tablets in different market segments in Europe in Q2 of 2018 (compiled by Fraunhofer IZM based on statista data)

As a breakdown of the cost of components in several tablets from the market leader Apple shows, the most cost-relevant components in tablets in 2012 and 2013 were

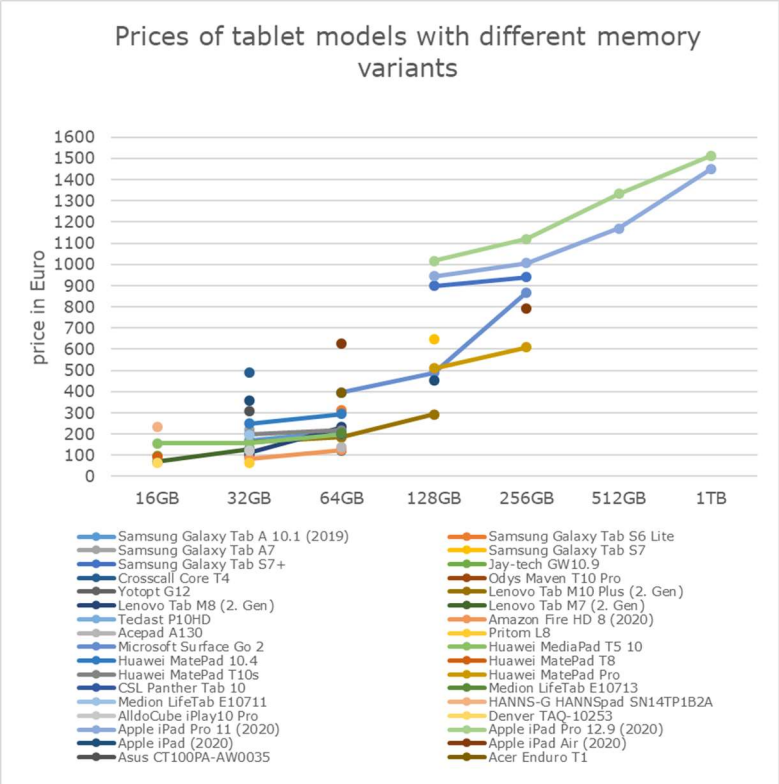
- **display / touch panel / glass** (up to 35 % of the total costs, price relatively lower for the "mini" device)
- **application and baseband processor** (up to 12% of total costs)
- **mass storage** (low cost for lower memory versions, but up to 22 % of total cost in case of higher memory version)

Category	Apple iPad 4 LTE A1459 (32GB)	Apple iPad mini LTE A1454 (32GB)	Apple iPad Air A1475 (32GB)	Apple iPad Air A1475 (128GB)
	Nov 2012	*Nov 2012*	*Nov 2013*	*Nov 2013*
Display / Touch Panel / Glass	111,91	61,07	106,00	106,00
Battery	20,27	9,10	17,50	17,50
Camera	16,31	13,82	15,50	15,50
Connectivity	10,54	9,79	9,00	9,00
NAND	15,15	16,32	15,15	84,00
SDRAM	4,84	2,54	5,50	5,50
Processor	39,54	19,49	36,40	36,40
BB+XCR	28,18	24,23	24,07	24,07
Power Mgmt/Audio	7,34	6,78	4,25	4,25
Non-Electric	17,75	11,69	17,75	17,75
Other	39,09	29,49	38,50	38,50
Supporting Materials	5,20	3,80	5,20	5,20
Final Assembly & Test	12,04	9,64	12,00	12,00
Total	**326,16**	**217,76**	**306,82**	**306,82**

Figure 46 : Component and assembly costs for selected high-end tablets, in USD (compiled by Fraunhofer IZM based on TechInsights data)

Similar to smartphones tablets sometimes are offered with varying memory configuration. An analysis of sales prices for same model with different memory configuration shows a clear price difference in almost all cases (Figure 47). Where tablets are available in a 32 GB and a 64 GB version the latter costs 10 to 25% more, except for one case with actually no price difference. Where devices are available with a 128 GB and 256 GB version, the latter is 6 to 77% more expensive. It can be stated, that there is a strong incentive for the consumer to buy a device with a rather lower memory capacity and thus also a lower environmental footprint.

Figure 47: Prices of tablet models with different memory variants (on September 21, 2020 ; compiled by Fraunhofer IZM based on www.idealo.de)



6.2. Repair and refurbishment services

There are different levels of repair with different implications on costs for the user. Some manufacturers encourage repairs by the end-user ("do it yourself" repairs and facilitate this through a modular product design (examples: Fairphone, Shift). In these cases only spare parts costs and shipping costs are relevant. Labour costs as such do not apply in these cases, but potentially costs for tools and how the user values the time spent on repairs.

As soon as professional repair services are consulted, labour costs and the margin of the repair service has to be accounted for.

6.2.1. Professional repair services

Many manufacturers offer professional repair services in-house or through authorised independent repairers. As an example, it is possible to bring iPhones and iPads to Apple stores where they can be repaired. Samsung has launched a doorstep repair service where professional repairers come to the customer. Huawei also offers customer service centres where repairs are offered. Xiaomi has cooperated with most tier one Service Provider in most EU Countries, and those Authorized Service Provider can provide walk in and mail in service for end user, retailer distributor and operator. Most of the OEMs offer information on prices of spare parts on their websites.

It is important to note that the total cost of repair services can vary significantly from one country to another, since repair is a labour intensive activity subject to regional labour costs. The following Figure shows the average per hour labour costs (excluding apprentices) per employee in full-time equivalents for the repair of computers and personal and household goods in 2016 (NACE Code S95) in selected EU countries.

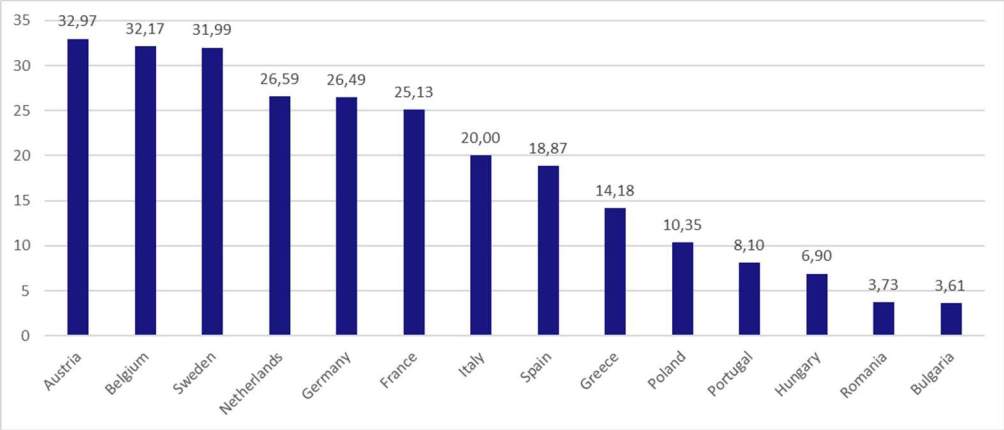


Figure 48: Average per hour labour costs for the repair of computers and personal household goods in selected countries (EUR, 2016)[24]

6.2.1.1. Smartphones

A data set of purchase prices, battery replacement costs as well as display replacement costs of 52 smartphones from seven different manufacturers was collected from OEM websites and price comparison portals (by Fraunhofer IZM). The analysis of the dataset shows an average sales price of 414.80 EUR for new devices, slightly above the average price shown in above Table 39. The average price for battery replacement amounts to 58.60 EUR (14% of the average purchase price) and for displays to 174.30 EUR (42% of the average purchase price). This relationship is summarised in the following Figure.

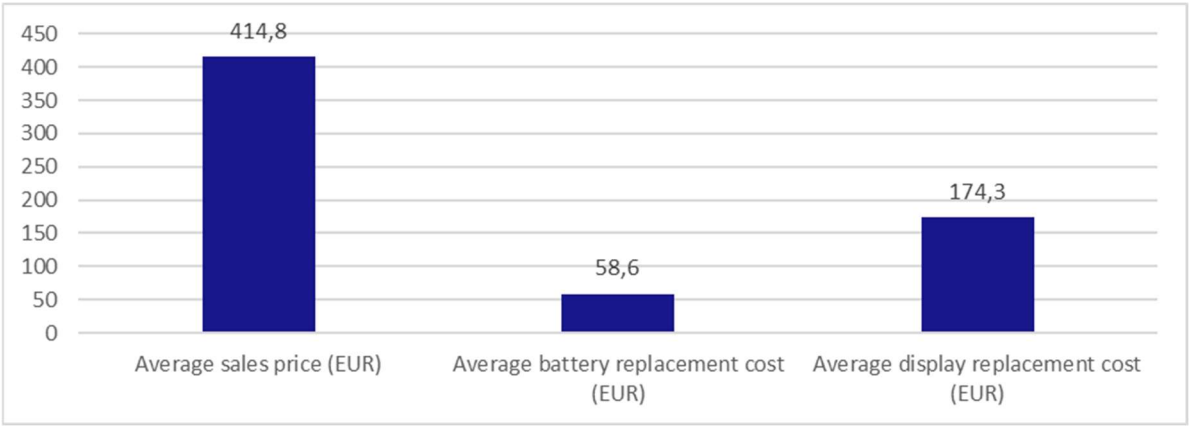


Figure 49: Average smartphone sales price and replacement costs of batteries and displays (EUR)

The purchase prices vary significantly between manufacturers and models and prices range from 73 EUR for older generation phones (e.g. iPhone5c) to >1400 EUR for new flagship devices (e.g. Samsung Galaxy Fold 5G). The cost for battery replacement can also vary to a large extent and range from 10 EUR to 78 EUR and for display replacement from 65 EUR to 579 EUR. A positive relationship can be observed between sales prices and replacement costs for both batteries and displays as can be observed in Figure 50 and Figure 51.

[24] Source: Eurostat: Labour cost, wages and salaries, direct remuneration by NACE Rev. 2 activity and NUTS 1 regions - LCS surveys 2008, 2012 and 2016

Figure 50: Smartphone battery replacement cost vs. purchase price of new device (EUR)

Figure 51: Smartphone display replacement cost vs. purchase price of new device (EUR)

6.2.1.2. Tablets

A similar investigation was performed by Fraunhofer IZM for tablets where data for 15 tablets from four manufacturers was collected from OEM websites and price comparison portals. The price range of the tablets analysed is between 159 EUR and 629 EUR. The average sales price of a new tablet was 420.80 EUR. According to the analysed dataset, the average price for battery replacement for tablets amounts to 89.90 EUR (21% of the

average purchase price) and for displays to 154.09 EUR (37% of the average purchase price). This relationship is summarised in the following Figure.

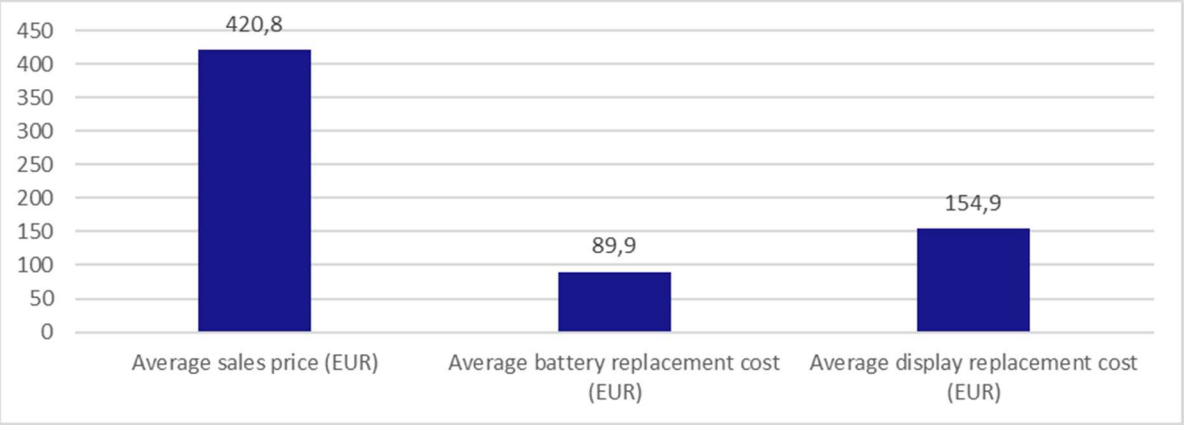


Figure 52: Average tablet sales price and replacement costs of batteries and displays (EUR)

The tablet purchase prices can differ considerably between manufacturers and models and prices range from 159 EUR to >600 EUR in the analysed dataset. The cost for battery replacement has less variation than for smartphones and lies between 76 EUR and 119 EUR. The cost for display replacement ranges between 89 EUR and 280 EUR. The relationships between purchase prises and replacement costs for batteries and displays are depicted in Figure 53 and Figure 54.

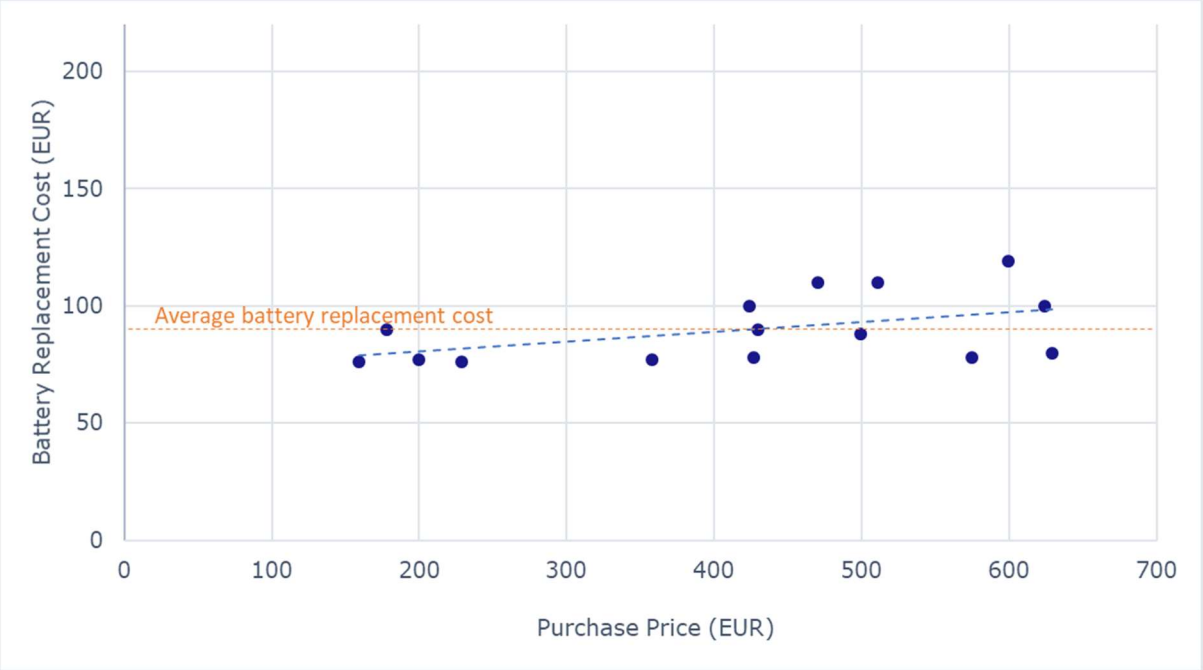


Figure 53: Tablet battery replacement cost vs. purchase price of new device (EUR)

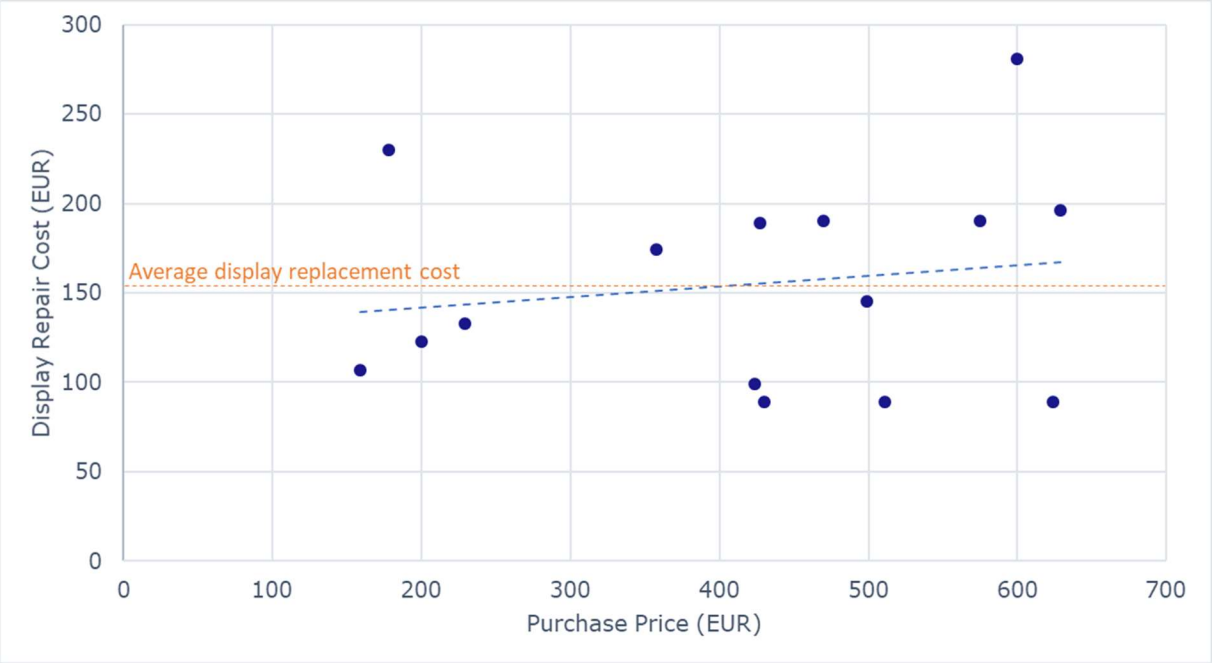


Figure 54: Tablet display replacement cost vs. purchase price of new device (EUR)

6.2.2. Self-repair services

6.2.2.1. Repair Cafés

The Repair Café concept was created in 2007 in the Netherlands by Martine Postma, a Dutch environmental activist. Today, there are more than 1,500 Repair Cafés worldwide[25]. Repair Cafes are locally organised non-profit workshops dedicated to repair of all kinds of products. The concept brings together volunteers who are skilled in a particular field (household appliances, electronics, bicycles, etc.) and people in need of such skills to repair an object they own. The repaired goods brought to the workshops for repair are very diverse and can be clothing, furniture, electrical and electronic appliances, bicycles, dishes, toys, etc. Large household appliances are generally not repaired in the workshops due to logistical challenges and in particular the size and weight of the products. Participation is free of charge, but a small compensation is usually provided through a donation. The meeting place is most of the time at a public location (e.g., a café, a banquet hall or an associative hall) and the tools provided by the volunteers are available to the participants. The main objectives of Repair Cafés are waste reduction, transmission of repair know-how and the strengthening of social cohesion between locals.

6.2.2.2. Other self-repair initiatives

Other self-repair initiative that are based on a for-profit business model have been developed by several private companies (e.g. SOSAV[26] or iFixit[27]). They usually offer a free remote diagnosis of the product (established online by detailed questionnaires), allowing the identification of the defect part. The required spare parts can then be directly purchased online. These replacement parts are compatible with the devices, but often not licensed or endorsed by the OEMs. The sales of spare parts and repair kits represent most of the time

[25] https://repaircafe.org/en/new-milestone-1500-repair-cafes-worldwide/

[26] https://www.sosav.com/

[27] https://www.ifixit.com/

the main income source of the companies. Free repair tutorials are available on the websites allowing the user to repair the device. Depending on the company, additional services are offered, e.g. specific tools. Furthermore, forums allow repair communities to exchange.

Price data for the replacement of batteries and displays was collected from the German iFixit website in May 2020 for both smartphones and tablets and compared between manufacturers. When available, the price of a single battery or display was chosen. For some devices, only repair sets were offered for purchase. The analysis depicts the cheapest spare part/set available.

On average, a replacement battery for smartphones can be purchased for 29 EUR and a replacement display for 92 EUR. While the price variation between manufacturers is relatively low for batteries, a significant difference can be observed for displays. A larger variation in display prices is linked to the fact that some displays are more integrated than others (e.g. containing camera and speaker). The following Figures show the differences between average prices for replacement batteries and displays.

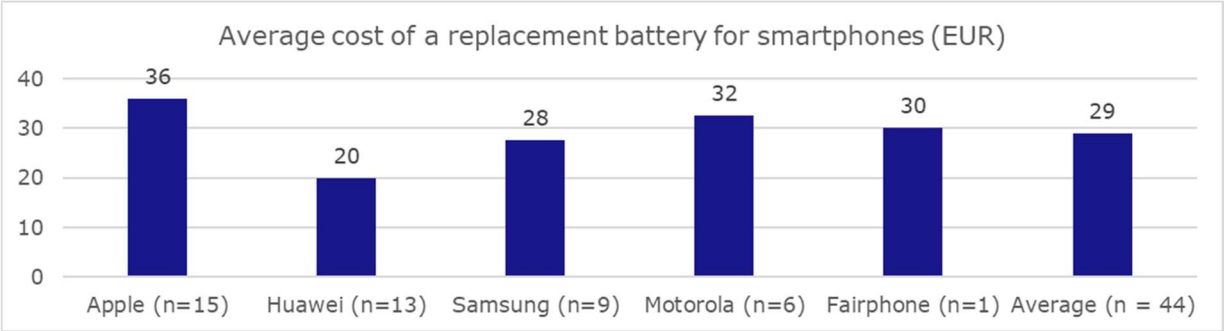


Figure 55: Average cost of a replacement battery for smartphones (EUR)

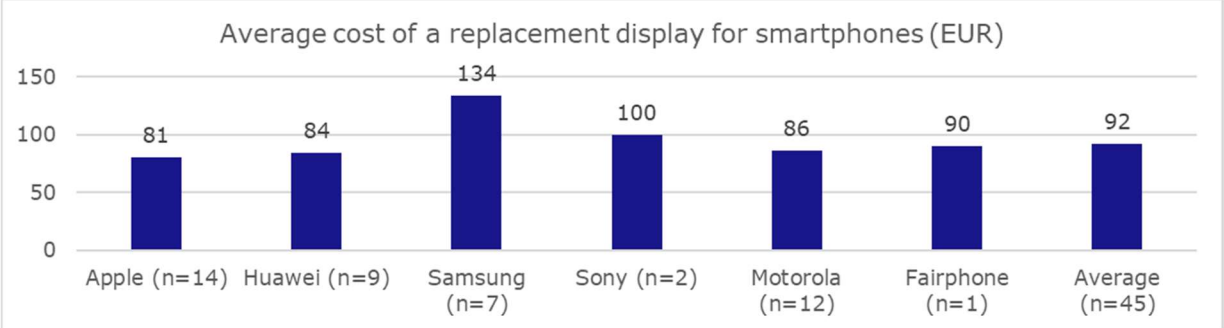


Figure 56: Average cost of a replacement display for smartphones (EUR)

When it comes to tablets, replacement batteries and displays were found only for nine iPads (Apple). The average replacement price of a battery was 37 EUR and for a display 109 EUR.

6.2.3. Refurbished devices

The major difference between "refurbished" and "used" devices is that refurbished products have to undergo test and verification processes before being sold to a new owner. Refurbished products can be used or unused customer returns and phones or tablets usually undergo data cleaning, change of components (if necessary) and external polishing before being sold. Some selected European online platforms selling refurbished devices are listed in following Table:

Table 40 : Selected online platforms selling refurbished devices in Europe

Company	Description
refurbed™	Refurbed was founded in Vienna in 2017 and is now one of the largest refurbishers in German-speaking countries. It is a platform for renewed smartphones, tablets, laptops, smartwatches, etc. with uniform standards in terms of quality, safety and guarantee. Products are renewed in up to 40 steps. A warranty of 12 months is offered for the refurbished products.
reBuy	Rebuy was founded in 2009 and operates an online platform for the purchase and sale of used electronics and media items. It is based in Berlin and has over five million customers. 84ebuy offers up to 36 months of warranty.
BackMarket	The French startup BackMarket, founded in 2014, has partners in France, Germany, Spain, Italy and Belgium. To be allowed to sell on the platform, each new seller has to answer a questionnaire about his operational and quality process. It offers up to 36 months of warranty.
Renewd	The Dutch company renewd was founded in 2015 and was the first brand for refurbished Apple products (e.g. iPhones, iPads, etc.) in Europe. All devices are authentic Apple products with 100% original Apple parts. A warranty of 24 months is offered for the refurbished devices.
Swappie	The Finnish company Swappie was founded in 2016 and is specialised on refurbishing iPhones. The company sells phones in most EU member states and offers a 12 months warranty on refurbished phones.

A price comparison between new phones (lowest price from the price comparison site idealo.de) and refurbished phones (refurbed, rebuy, BackMarket) was performed. While *refurbed* offers only one single state of the device: *refurbed*™, others offer a broader choice. At *reBuy*, the customer can choose between the conditions: *like new, very good, good and heavily used* and at *BackMarket* one has the choice between five conditions: *like new, very good, good, used and stallone* (clear signs of use such as scratches). For this comparison only phones with the best available condition (like new) were selected. The comparison in Table 41 illustrates, that prices of refurbished smartphones can vary significantly and are not always below the prices of new devices. The highest prices for the respective product models are highlighted in **bold** in the Table.

Table 41 : Price comparison of selected new and refurbished smartphones

Product		Price (EUR)[28]			
Brand	Model	Idealo (new)	Refurbed (like new)	Rebuy (like new)	BackMarket (like new)
Apple	iPhone 8 (64 GB)	**420.99**[29]	314.00[30]	356.99[31]	288.00[32]
	iPhone X (64 GB)	529.00[33]	499.00[34]	**570.99**[35]	534.00[36]

[28] Prices were collected from the different platforms on 31/05/2020.
[29] https://www.idealo.de/preisvergleich/ProductCategory/19116F1827447.html?q=iphone+&qd=iphone+
[30] https://www.refurbed.de/p/apple-iphone-8/
[31] https://www.rebuy.de/p/iphone-8/10727011
[32] https://www.backmarket.de/iphone-8-64-gb-silber-ohne-vertrag-gebraucht/36828.html#?l=4
[33] https://www.idealo.de/preisvergleich/ProductCategory/19116F1827447.html?q=iphone+&qd=iphone+
[34] https://www.refurbed.de/p/iphone-x/1090/
[35] https://www.rebuy.de/p/iphone-x/10727039
[36] https://www.backmarket.de/iphone-x-64-gb-space-grau-ohne-vertrag-gebraucht/36833.html#?l=3

	iPhone 11 (64 GB)	679.00[37]	669.99[38]	639.99[39]	**729.00**[40]
Samsung	Galaxy S10 (128 GB)	528.57[41]	509.99[42]	512.99[43]	**588.99**[44]
	Galaxy S9 (64 GB)	**449.00**[45]	389.99[46]	393.99[47]	375.99[48]

6.3. Telecommunication services

ITU monitors the affordability of ICT services by analysing and comparing price data for mobile-voice services, mobile data and fixed broadband globally. To allow for comparisons price baskets are defined, reflecting different user types and pricing models by service providers. Bundled services are "becoming increasingly widespread, as it enables converged telecommunication and media companies to take greater advantage of consumers' willingness-to-pay, thus increasing revenues. It is not yet clear whether, on balance, price bundling benefits consumers or helps to close gaps in access to broadband. For consumers, one main advantage of bundles is that they are often offered at a discount, whereas stand-alone services are not. It may nevertheless be detrimental to consumer welfare if price bundling limits choice and/or forces consumers to purchase services they do not value." (Schaaper and Biggs 2020) The price baskets applied to the 2019 statistical data are (values per months)[49]:

- mobile-data-and-voice basket (i.e. voice, SMS and mobile data combined) – low consumption (70 minutes, 20 SMSs and 500 MB);
- mobile-data-and-voice basket – high consumption (140 minutes, 70 SMSs and 1.5 GB);
- mobile-voice (including voice and SMS : 70 min + 20 SMS);
- mobile-data (1,5 GB);
- fixed-broadband (5 GB).

Prices in the individual member states show significant differences. ICT prices are highest in Ireland throughout all price baskets. Prices for fixed-broadband (5 GB) are only 12% in Croatia and Romania compared to Ireland. The price difference between Austria and Ireland for the mobile-cellular basket low usage is a factor of 10. Some price trends are also counter-intuitive: The service package 70 min phone calls + 20 SMS + 500 MB costs less in average than a package without data volume. "On average, mobile voice, mobile-data and fixed-broadband prices are falling steadily around the world" (Schaaper and Biggs 2020). In relation to incomes the most affordable prices are found in Europe.

Prices for EU 27 are a population-weighted average of the prices per EU member state. As ITU states prices in US-Dollar, prices have been recalculated with the IMF average 2019 exchange rate of 0,89 Euro / USD.

[37] https://www.idealo.de/preisvergleich/ProductCategory/19116F1827447.html?q=iphone+&qd=iphone+
[38] https://www.refurbed.de/p/iphone-11/
[39] https://www.rebuy.de/p/iphone-11/11168600
[40] https://www.backmarket.de/iphone-11-64-gb-rot-ohne-vertrag-gebraucht/290060.html#?l=1
[41] https://www.idealo.de/preisvergleich/OffersOfProduct/6461743_-galaxy-s10-samsung.html
[42] https://www.refurbed.de/p/samsung-galaxy-s10/
[43] https://www.rebuy.de/i,11077809/handy/samsung-g973f-galaxy-s10-dual-sim-128gb-prism-black
[44] https://www.backmarket.de/samsung-galaxy-s10-128-gb-schwarz-ohne-vertrag-gebraucht/235548.html#?l=3
[45] https://www.idealo.de/preisvergleich/OffersOfProduct/6027640_-galaxy-s9-samsung.html
[46] https://www.refurbed.de/p/samsung-galaxy-s9/
[47] https://www.rebuy.de/i,10917284/handy/samsung-g960f-galaxy-s9-64gb-midnight-black
[48] https://www.backmarket.de/samsung-galaxy-s9-64-gb-coral-blue-ohne-vertrag-gebraucht/154214.html#?l=4
[49] https://www.itu.int/en/ITU-D/Statistics/Pages/ICTprices/default.aspx#methodology

Table 42 : ICT service prices per price basket, EU 27 and member states, 2019 (ITU)

	Fixed-broadband basket 5GB	Mobile-cellular basket low usage (70 min + 20 SMS)	Low usage voice and data (70 min + 20 SMS + 500 MB)	Data-only mobile broadband 1,5 GB	High usage voice and data (140 min + 70 SMS + 1,5 GB)	Tax rate included (%)
	(1)	(2)	(3)	(4)	(5)	
	EUR	EUR	EUR	EUR	EUR	
EU 27	**29,84**	**18,03**	**16,48**	**11,20**	**22,76**	n.a.
Austria	29,33	3,78	9,54	10,51	14,80	20,0
Belgium	28,91	10,51	16,80	15,76	23,11	21,0 (1, 2, 4, 5) / n.a. (3)
Bulgaria	10,64	13,42	12,88	5,90	17,38	20,0 (1, 2, 4, 5) / n.a. (3)
Croatia	6,92	21,12	21,12	14,04	21,12	25,0
Cyprus	16,86	11,56	17,87	18,92	32,06	19,0
Czech Republic	20,43	21,66	21,66	8,15	32,73	21,0
Denmark	39,32	23,82	23,82	16,78	23,82	25,0
Estonia	16,82	5,25	5,25	12,61	12,61	20,0 (1, 2, 4, 5) / n.a. (3)
Finland	34,58	14,83	14,83	31,32	23,53	24,0 (1, 2, 4, 5) / n.a. (3)
France	24,16	8,40	17,85	10,50	28,36	20,0
Germany	36,73	36,77	19,75	13,13	30,79	19,0 (1, 2, 4, 5) / n.a. (3)
Greece	19,54	8,94	10,51	13,40	22,11	30,0 (1,2) / n.a. (3) / 24,0 (4, 5)
Hungary	18,44	11,17	11,33	13,15	35,87	5,0 (1, 4, 5) / 27,0 (2) / n.a. (3)
Ireland	55,70	36,78	36,78	36,78	36,78	23,0 (1, 2, 4, 5) / n.a. (3)
Italy	36,78	20,92	18,92	6,29	18,92	22,0 (1, 2, 4, 5) / n.a. (3)
Latvia	20,50	8,93	8,93	6,29	12,60	21,0 (1, 2, 4, 5) / n.a, (3)
Lithuania	12,15	8,30	11,45	10,40	11,45	21,0
Luxembourg	43,09	5,24	5,24	10,51	18,91	n.a.
Malta	21,01	10,51	21,02	15,76	31,53	18,0
Netherlands	44,67	16,82	22,07	31,53	22,07	n.a. (1, 2) / 21,0 (3, 4, 5)
Poland	17,25	9,61	9,61	2,47	11,09	23,0
Portugal	23,11	9,46	9,46	15,65	16,82	23,0
Romania	6,77	9,46	8,01	9,46	9,46	n.a. (1, 2) / 19,0 (3, 4, 5)
Slovakia	11,45	9,02	13,08	10,51	25,22	20,0
Slovenia	36,78	15,75	15,75	13,65	15,75	22,0
Spain	42,04	14,60	14,60	7,31	19,69	21,0 (1, 2, 4, 5) / n.a. (3)
Sweden	39,83	23,85	20,37	15,25	20,37	25,0

ETNO presents price data in a different way and states for Europe in 2018 as an average spend per gigabyte of mobile data used 3,94 Euro/GB at an average mobile data usage per capita of 4,3 GB/month (European Telecommunications Network Operators' Association 2020). Data usage shows a clear upwards trend (see Figure 33, p. 60).

6.4. Electricity prices

The only relevant energy cost for this product group are electricity prices. Prices including taxes, levies and VAT for household consumers are in average 0,2126 €/kWh as of first half of 2020 (Eurostat 2020), ranging from 0,0997 €/kWh in Bulgaria to 0,3043 €/kWh in Germany (Table 43).

Table 43 : Electricity prices for household consumers, EU 27, 2020

Data extracted on 02/11/2020 20:38:29 from [ESTAT]		
Dataset:	**Electricity prices for household consumers - bi-annual data (from 2007 onwards) [NRG_PC_204]**	
Last updated:	22/10/2020 23:00	
Time frequency	Half-yearly, semesterly	
Products	Electrical energy	
Consumption	Band DC : 2 500 kWh < Consumption < 5 000 kWh	
Unit of measure	Kilowatt-hour	
Taxes	All taxes and levies included	
Currency	Euro	
TIME	**2020-S1**	
GEO (Labels)	**€ / kWh**	
Bulgaria	0,0997	
Hungary	0,1031	
Estonia	0,1236	
Malta	0,1284	
Croatia	0,1301	
Latvia	0,142	
Lithuania	0,1426	
Netherlands	0,1427	
Slovenia	0,1448	
Romania	0,1459	
Poland	0,1475	
Greece	0,1681	
Slovakia	0,1686	
Finland	0,174	
Sweden	0,1826	estimated
Czechia	0,1841	
France	0,1899	
Luxembourg	0,1986	
Austria	0,2102	
Portugal	0,212	
European Union - 27 (from 2020)	**0,2126**	
Cyprus	0,2133	
Italy	0,2226	
Spain	0,2239	
Ireland	0,2413	
Belgium	0,2792	
Denmark	0,2833	
Germany	0,3043	

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