Housekeeping Rules

- the meeting will be recorded to ease compiling the minutes
- if you face technical issues during the meeting contact Gergana Dimitrova through the chat, not to all
- In the meeting mute yourself and switch off video
- After each agenda item we will have few minutes for Q&A
- If you have questions or comments, note them down during or after each presentation slot in the chat and we will answer them one-by-one at the end of each agenda item. In case your question or comment requires your oral intervention type in the topic AND #
- Limit your oral interventions to maximum 2 minutes, please.
- In case we run out of time, we need to cut-off Q&A and will reply to remaining questions with the minutes

Meeting kicks off at 9:00 a.m.

Welcome, Introduction of Agenda

Agenda

9.00 – 9.10	Welcome, Introduction of Agenda – Fraunhofer IZM
9.10 – 9.20	Introduction - DG GROW
9.20 – 9.40	Task 1 – Updates since 1st stakeholder meeting
9.40 – 10.00	Task 2 – Updates since 1st stakeholder meeting
10.00 – 10.30	Task 3 – User
10.30 – 11.00	Task 4 – Technologies
11.00 – 11.15	Break
11.15 – 12.15	Task 5 – Base Cases: 3 presentations with Q&A each
12.15 – 13.00	Lunch Break
13.00 – 14.30	Task 6 – Design Options: 4 presentations with Q&A each
14.30 – 14.45	Break
14.45 – 16.00	Task 7 – Policy Scenarios: 3 presentations with Q&A each
16.00 – 16.15	AOB
16.15 – 16.30	Next Steps, Closing Remarks

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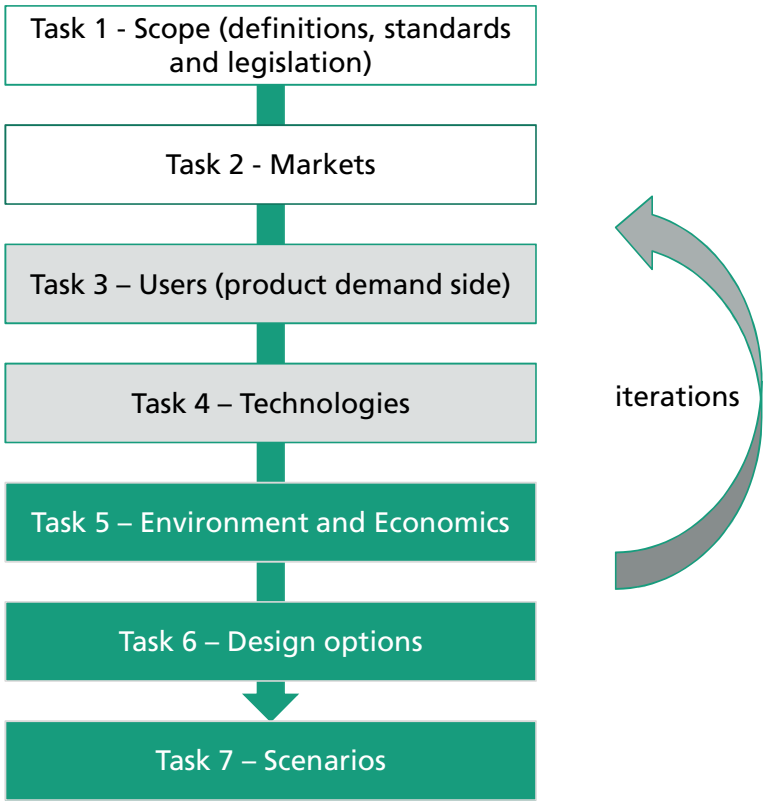
Welcome, Introduction of Agenda
Published Documents

- Draft Task 1 Report
- Draft Task 2 Report
- Draft Task 3 Report
- Draft Task 4 Report
- Draft Task 5 Report
- Draft Task 6 Report
- Draft Task 7 Report



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Task 1 – Updates since 1st stakeholder meeting

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Task 1 – Scope definition for the study
Product definition - clarification

A **mobile phone** is a cordless handheld electronic device designed for long-range communication over either a cellular telecommunications network or a satellite based telecommunications network, requiring a SIM card, eSIM or similar means to identify the connected parties *[to exclude other types of two-way radios, such as "walkie-talkies"]*, or over a landline telecommunications network *[to include DECT and other cordless landline phones]*. It is designed for battery mode usage, and connection to mains via an external power supply is mainly for battery charging purposes. A **smartphone** is furthermore characterised by an operating system, WiFi connectivity, mobile use of internet services, and the ability to accept original and third-party software applications. A smartphone has an integrated touch screen display with a diagonal size between 4 and 7 inches. Devices with more than one and/or foldable displays are characterized as smartphones if at least one of the displays falls into the size range in either opened or closed mode.

...

Major comments and study team response

Task	Comment	Study team response
1	**Definitions of product scope via display size:** Smartphone definition via display size of max. 7 inches may not include foldables; those may end up in the scope of the tablets definition. Same for tablets: using upper and lower display size limits may exclude some products from the scope.	New definition: • Foldables: smartphones if display size in either opened or closed mode falls within the given range of
1	**Terminology tablets / slates:** We recommend that consistent terminology is used across regulations, therefore the term "tablets" when referring to products in scope should be replaced by "slates" in the smartphone regulation to avoid any confusion. A gap/overlap between potential regulation following this study and the computer regulation need to be avoided.	Tablets in the scope of this study are all devices falling into the provided definition without keyboard or attachable (optional) keyboard. Devices with attached keyboard are not in scope of this study. In case of a regulation following this study, this will indeed require alignment with the revision of the regulation EU 617/2013.
1	Within the scope of the computer regulation (617/2013) tablets (with permanently attached keyboard) and slates (without) are considered under the notebook category, and therefore covered by **notebook requirements on energy efficiency**. If slates are to be shifted to a smartphone regulation, it will be important that these aspects continue to be addressed, but tightened to improve on the 2013 regulation requirements.	Energy efficiency is addressed via the design option pertaining to battery endurance per cycle
1	**Wearables** should be explicitly excluded from the scope. // Smart watches should be in scope of this study as „accessory" to smartphones.	This study does not consider smartwatches to be accessories to smartphones. In fact the product definition states "The scope includes accessories shipped with the device, such as external power supply, a charging cradle, a base station for cordless landline phones, a headset, a detachable keyboard, cables." Smartwatches are not commonly shipped with smartphones and are considered a separate product group.
1	It is important that the introduction of a **common charger** is taken into account in the modelling of impacts of potential Ecodesign measures.	This study does not go into depth regarding technical specifications of universal external power supplies and cables. However, the effects of unbundling of devices and chargers/cables is addressed in Task 6.

Task 1 – Updates since 1st stakeholder meeting

Q&A

short comments or questions: chat

complex comments or questions: topic -> chat AND #

Task 2 – Updates since 1st stakeholder meeting

Electricity prices

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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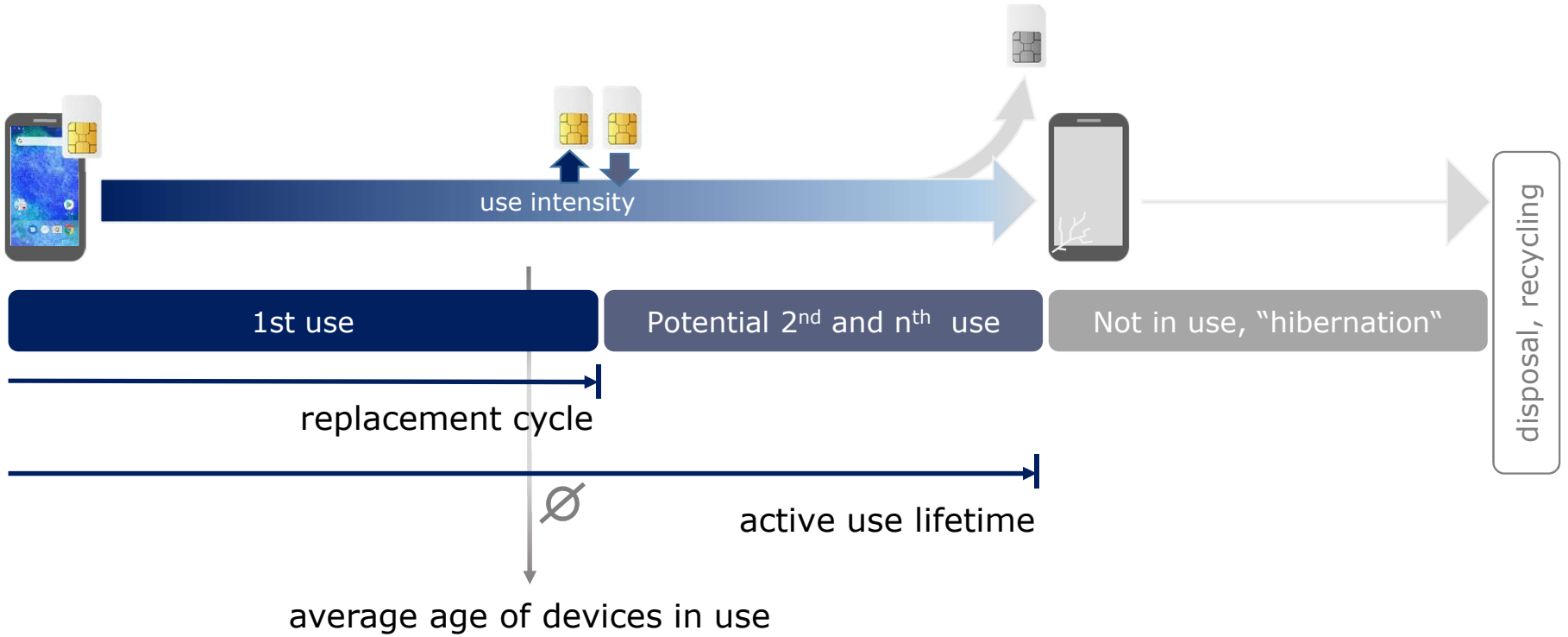
Task 2 – Market and Stock Data: Mobile Phones

Lifetime terms – no update



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Task 2 – Updates since 1st stakeholder meeting

Q&A

short comments or questions: chat

complex comments or questions: topic -> chat AND #

Task 3 – User
Overview

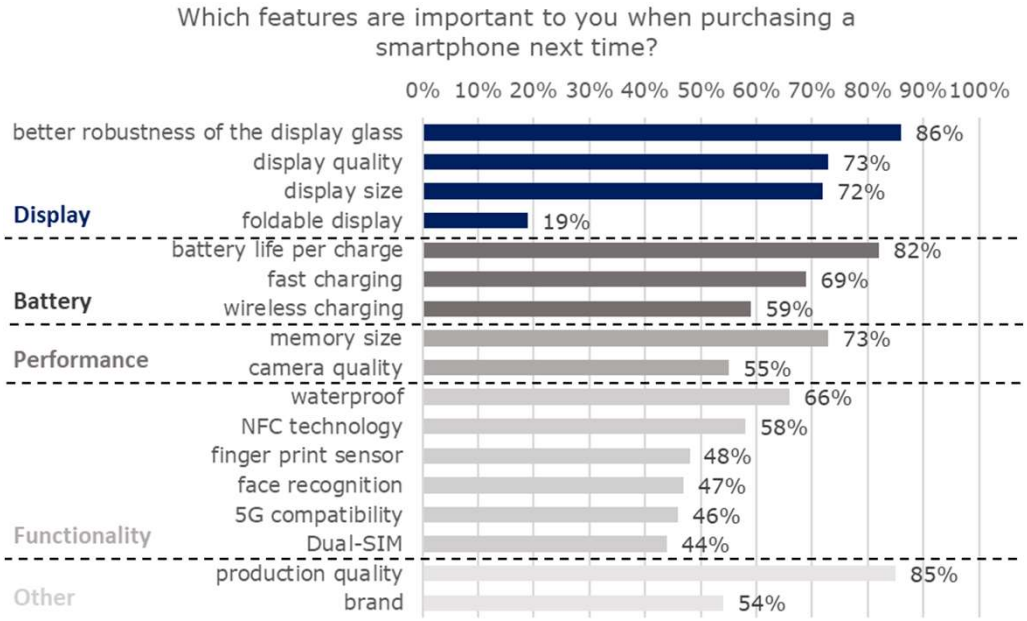
- **Subtask 3.1 – Systems aspects of the use phase for ErPs with direct impact**
  - **Purchase decisions**
  - **Active use lifetime (actual and expected)**
  - **General device use**
  - **Battery charging patterns**
  - **Defects and repairs**
- Subtask 3.2 – Systems aspects of the use phase for ErPs with indirect impact
  - Affected energy systems
  - Energy consumptions of the affected system
  - Interaction between the products covered by the study and the energy system
  - The energy use and the energy-related resources & environmental impacts
- **Subtask 3.3 – End-of-Life behaviour**
  - **Incentivising reuse**
  - **Upgrade to new device**
  - **Disposal and recycling**
- Subtask 3.4 – Local infrastructure

Task 3 – User
Purchase decisions

- Important features
  - Robustness and battery life are key
  - Quality criteria score high

- Reasons for purchase of a new smartphone (Eurobarometer 2020)
  - 37% old device broke
  - 30% the performance of the old device had significantly deteriorated
  - 19% certain applications or software stopped working on the old device.

Other surveys come to similar results.



Source: Bitkom, 02/2020

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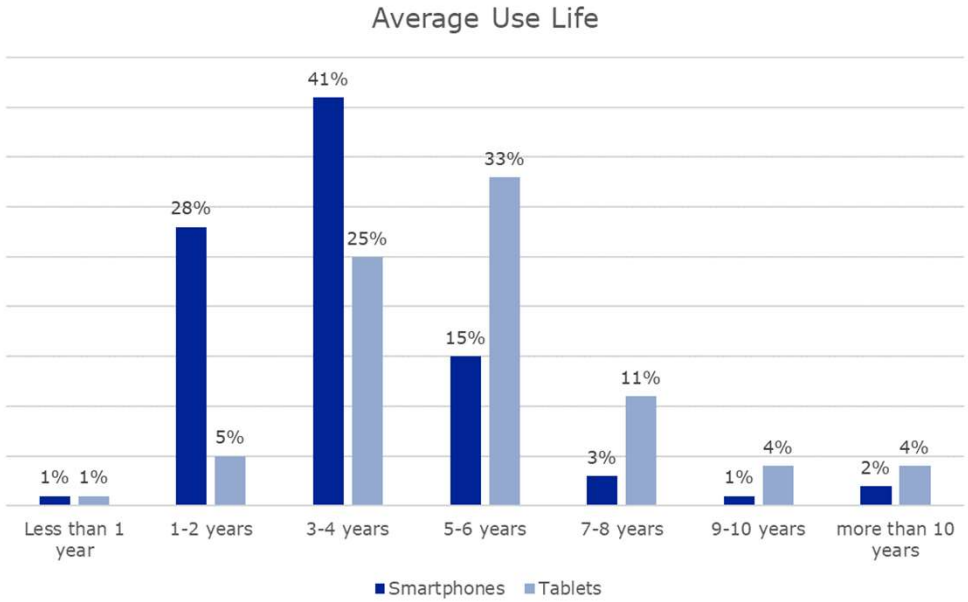
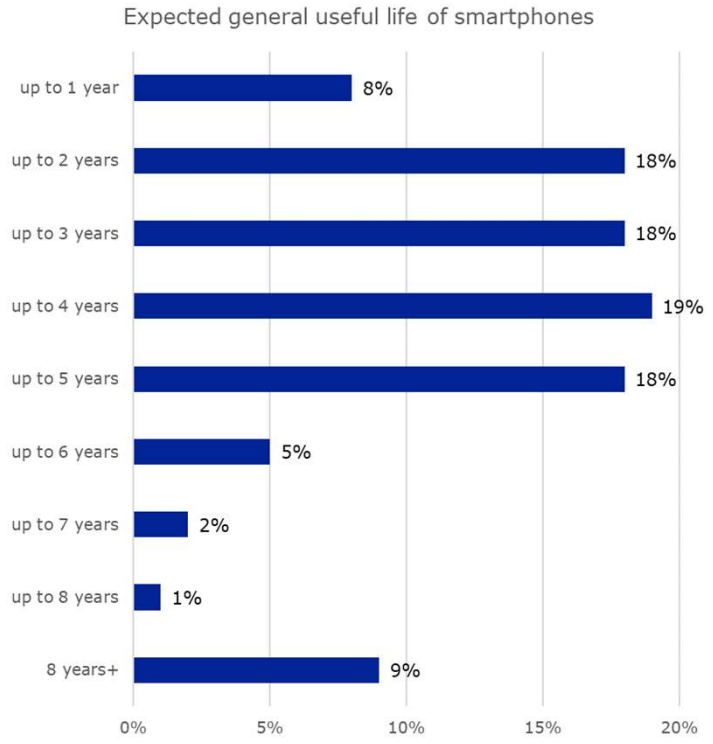
Task 3 – User

Actual and expected device use



Source : YouGov Research, 2020



Source : Jaeger-Erben and Hipp, 2018

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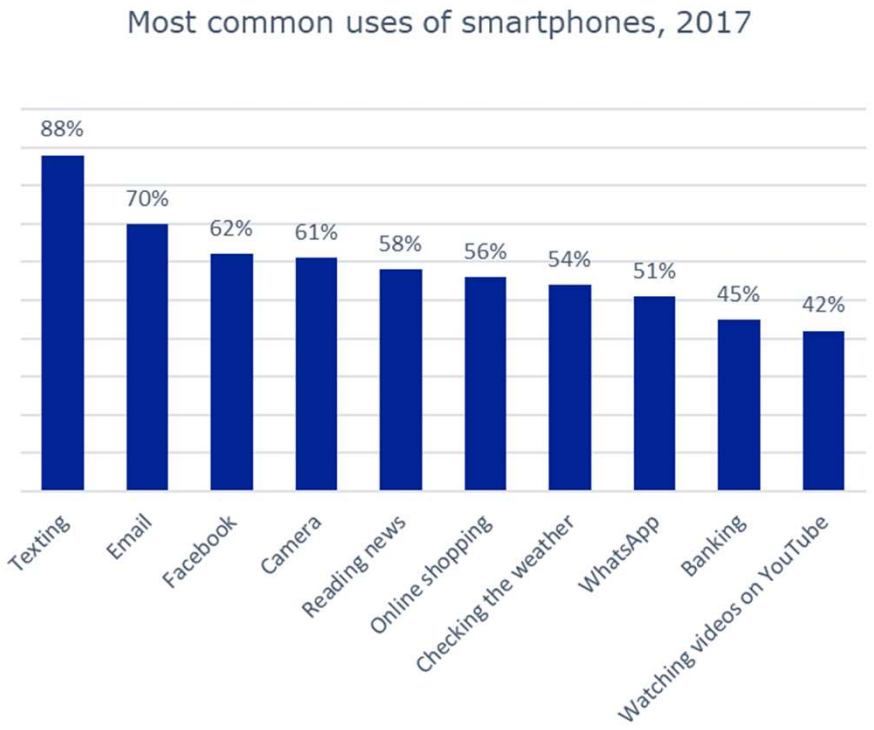
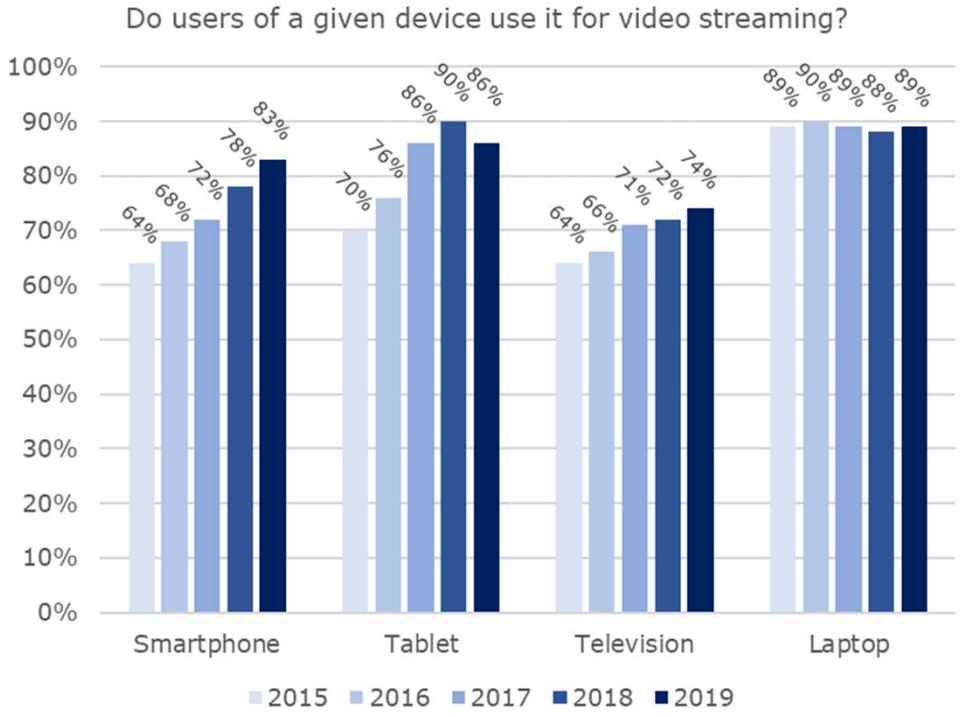
Task 3 – User
General device use



Source: Mobiles.co.uk, 2019



Source: Bitkom, 2019

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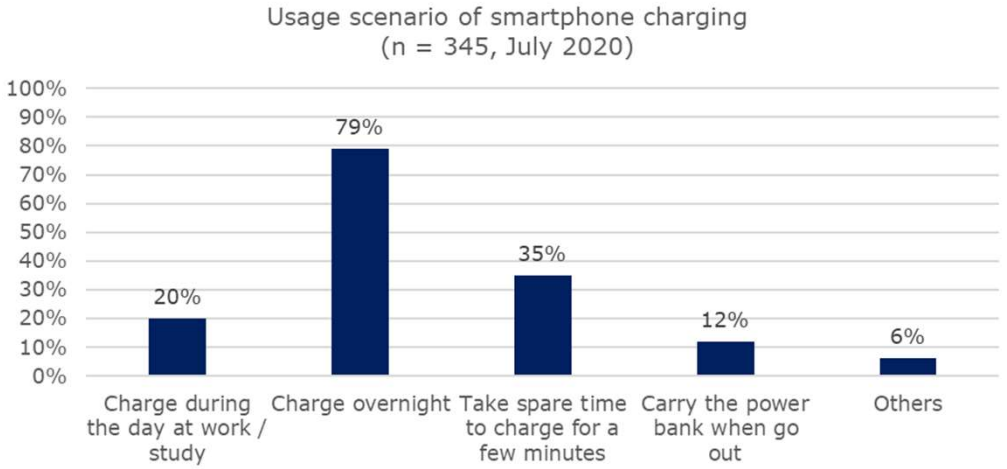
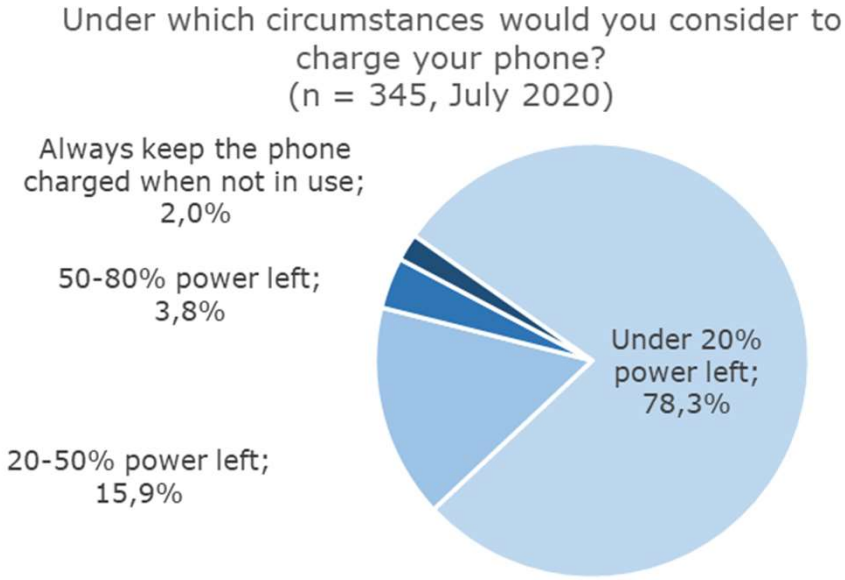
Task 3 – User
Battery charging patterns



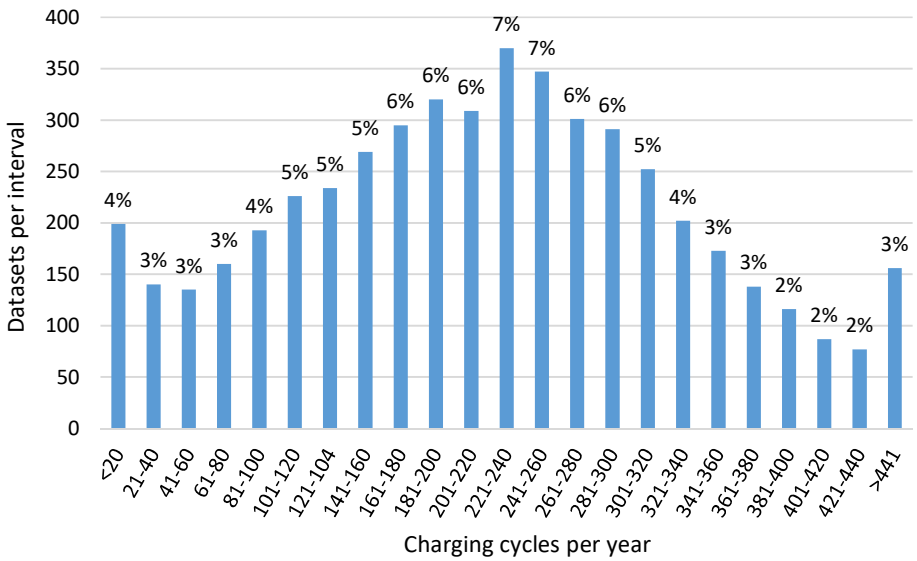
Source: Smartphone OEM (anonymous)



Source: Smartphone OEM (anonymous)

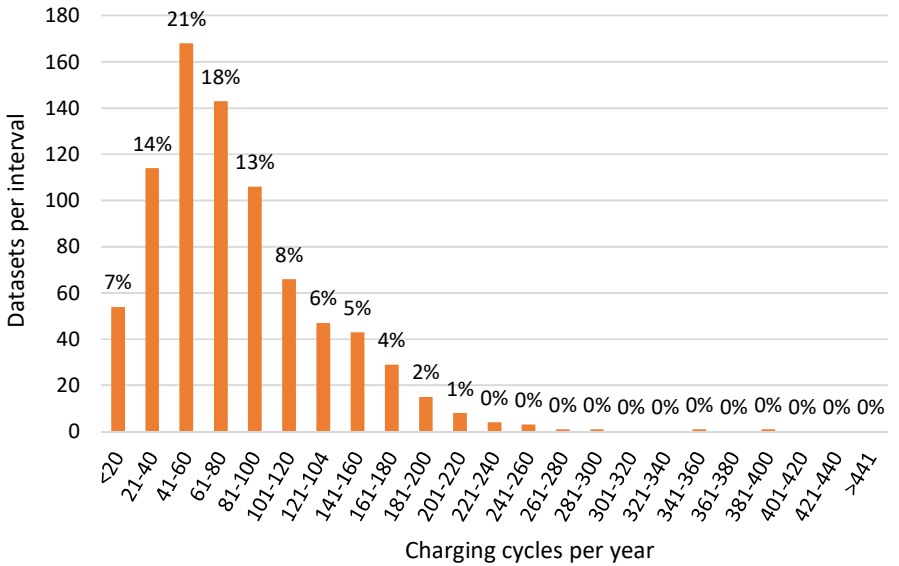
Task 3 – User
Battery charging patterns

Smartphones



Source: Clemm et al. 2016

Tablets



Source: Clemm et al. 2016

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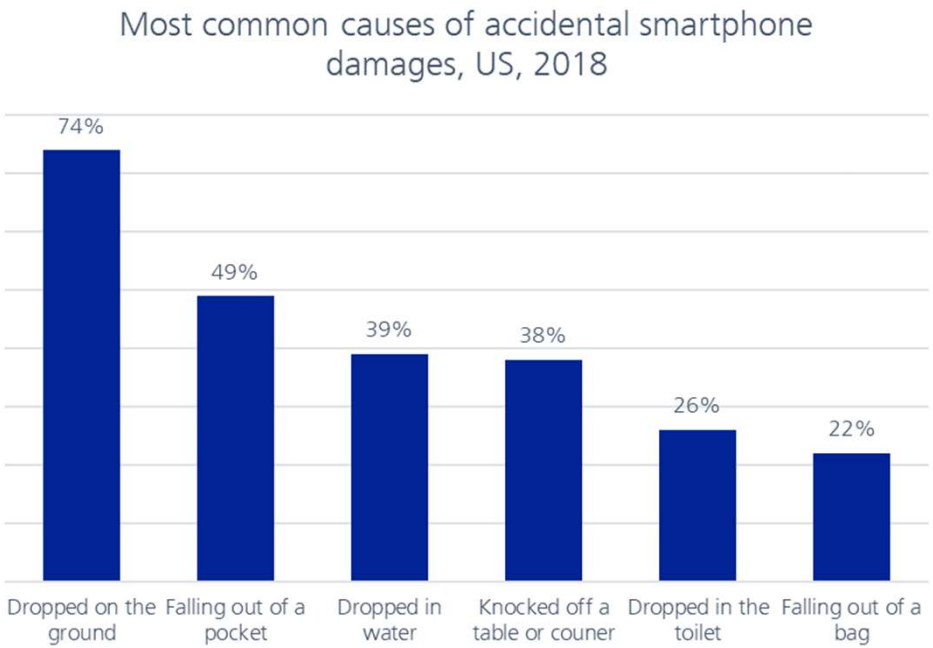
Task 3 – User
Defects and repairs

Defects in smartphones (Germany, 2019)	Share (%)
Display	67,4%
Casing	50,0%
Battery	33,9%
Connectors	16,1%
Camera	7,9%

Damages of dropped tablets (Germany, 2018)	Share (%)
Display	64.1%
Casing	47.1%
Camera	18.1%
Blemish to the appearance	17.5%
Ports	13.6%



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Sources: clickrepair, 2019 / Wertgarantie, 2018

Source: Statista

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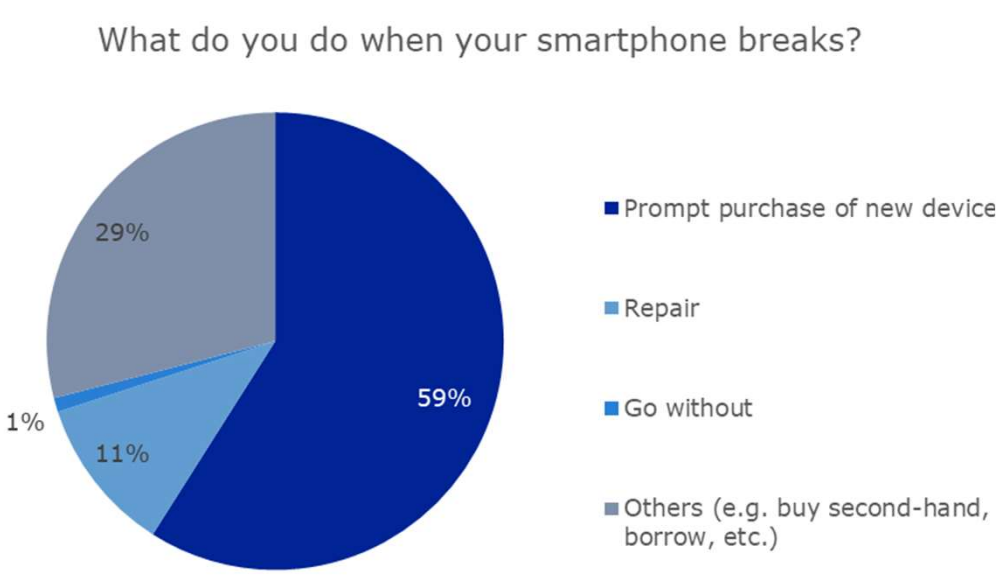
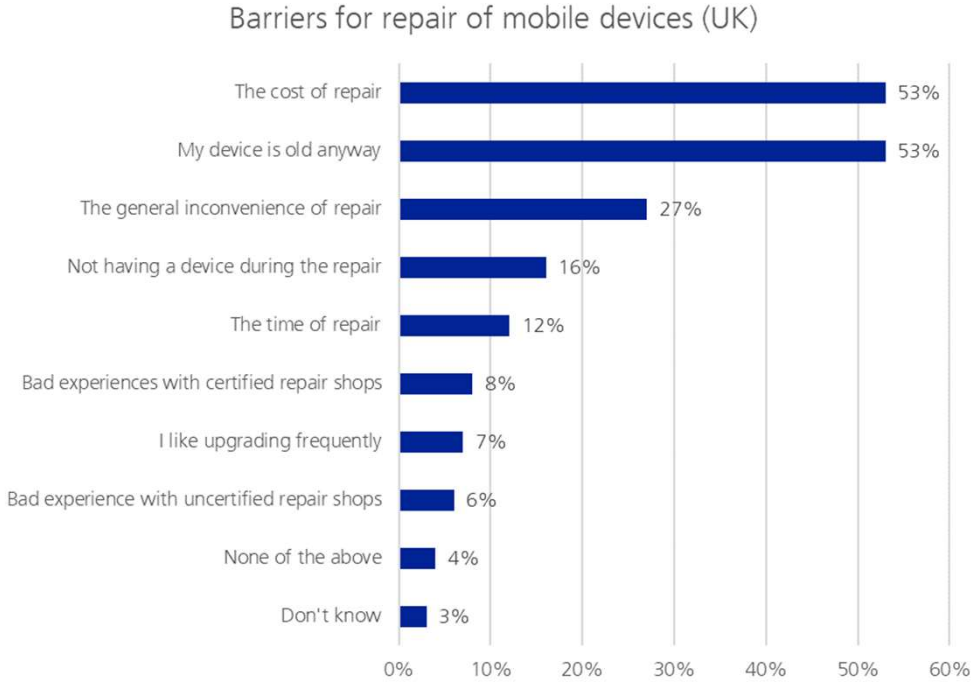
Task 3 – User
Defects and repairs

Part	Main failures	Failure mechanism
Screen	Black screen, broken/dead pixels (spots, stripes or similar), no background light	Accidental drops or other mechanical stresses (shocks, vibrations)
Back cover	Breakage	
Battery	Loss of performance in terms of duration of battery cycles	Aging of the battery due to quality issues or use under stress conditions or regular long-term use
	Battery not charging	EPS / battery connection failure
	Overheating	
Connectors	Disconnected connector assemblies	Mechanical stress, particle ingress
Operating System	Malfunctioning/ loss of security and performance (e.g. device not switching on, error codes, apps crashes)	OS and/or security updates not provided by the manufacturer
Whole Product	Short circuits, disconnection of main parts (including buttons and connectors)	Stress conditions (e.g. exposure dust and water, shocks, vibration).

Task 3 – User
Defects and repairs



Source: OHA (Obsoleszenz als Herausforderung für Nachhaltigkeit), 2019



Source: Survey by YouGov, 2020

Task 3 – User

Enhancing the purchase intention of refurbished smartphones (1:low - 7:high)

Incentive	Category	Consumer group						Total
		1	2	3	4	5	6	
		Casual supporter	Sustainability enthusiast	Conservative critic	Susceptible follower	Proud power-user	Expert techie	
Upgraded battery	Product	6,65	6,00	5,97	6,33	6,55	6,70	6,44
Guaranteed software updates	Product	6,37	6,16	5,62	6,07	6,57	6,36	6,25
Upgraded performance	Product	5,91	5,32	5,31	5,84	6,43	6,00	5,91
Classification system	Information	5,76	5,28	5,52	5,58	6,07	5,60	5,69
Info on refurbishing process	Information	5,76	5,56	5,1	5,84	5,81	5,53	5,65
Quality certification	Information	5,46	5,52	5,07	5,47	5,76	5,51	5,5
Upgraded internal storage	Product	5,41	4,52	4,79	5,33	5,79	5,77	5,39
Upgraded screen	Product	5,33	4,2	5,03	5,29	5,86	5,55	5,34
Unbiased testimonials	Information	5,37	4,76	4,79	4,98	5,52	5,13	5,16
Upgraded camera	Product	5,04	3,84	4,83	5,27	5,74	5,21	5,13
Extendable protection period	Service	4,85	4,52	4,72	4,93	5,24	5,28	4,99
More innovative features	Product	4,50	4,20	4,07	4,96	5,48	5,06	4,84
Extended trial period	Service	4,89	4,00	4,03	4,36	4,86	4,72	4,57
Extendable protection coverage	Service	4,20	3,80	3,97	4,29	4,64	4,26	4,26
Updated appearance	Product	3,48	3,20	3,83	4,42	4,47	3,85	3,96
Leasing option	Service	3,96	3,56	3,55	4,00	3,69	3,00	3,64

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Source: Mugge et al., 2017

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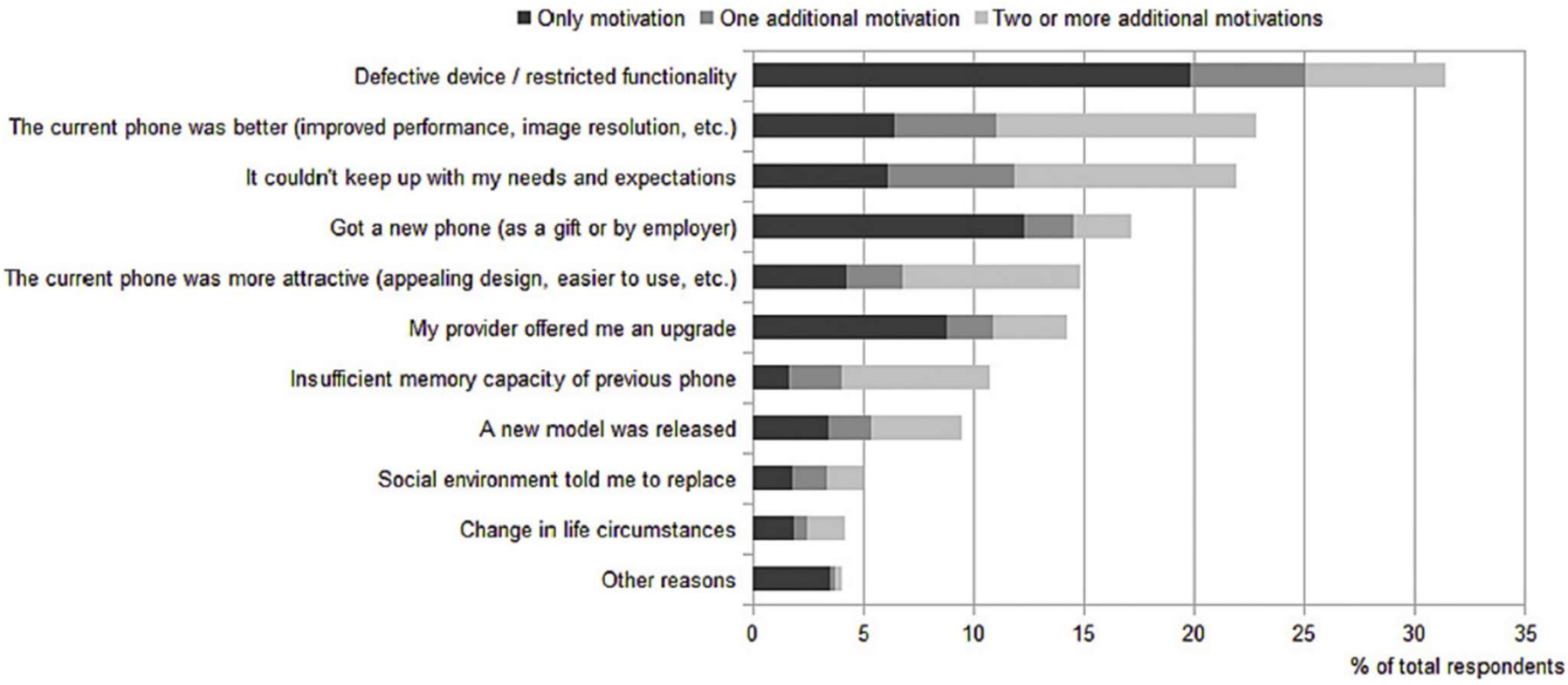
Task 3 – User
Upgrade to new device



Source : Wieser and Tröger, 2018

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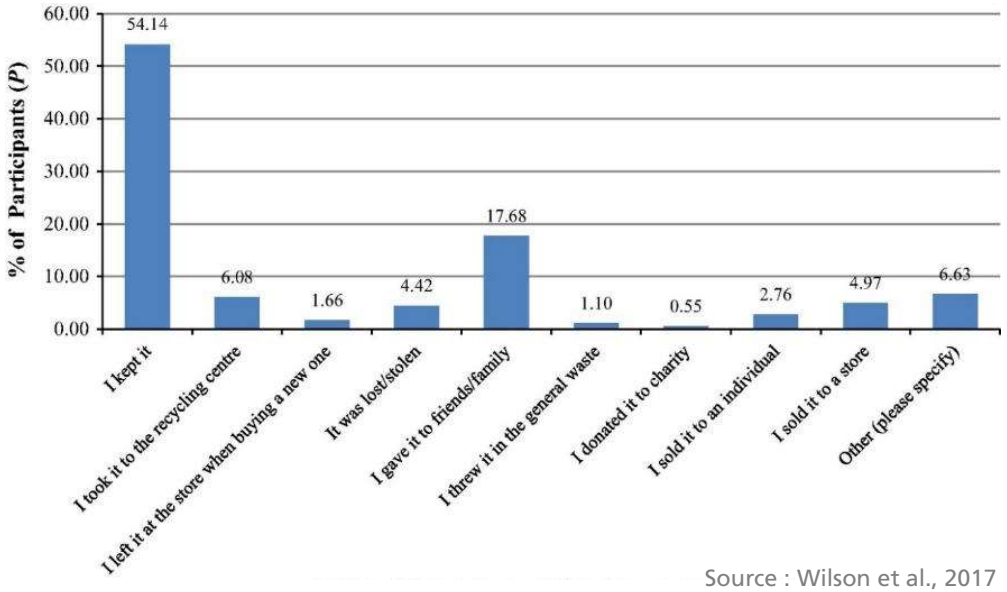
Task 3 – User
Disposal and Recycling

- Although collection programmes for mobile devices are in place in many countries, consumers often store their phones after use, leading to a hibernating stock of old devices (see Task 2).
- Collection programmes need to propose interesting alternatives for users to mitigate expected risks, such as:
  - Data deletion certificate
  - Financial incentives
  - Nudging (Tokyo 2021 Olympic and Paralympic medals are made from recycled electronic waste)

Action with previous mobile phone once replaced among students in the UK (2015)



Source : Wilson et al., 2017

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Task 3 – User

Q&A

Short comments or questions: chat

Complex comments or questions: topic -> chat AND #

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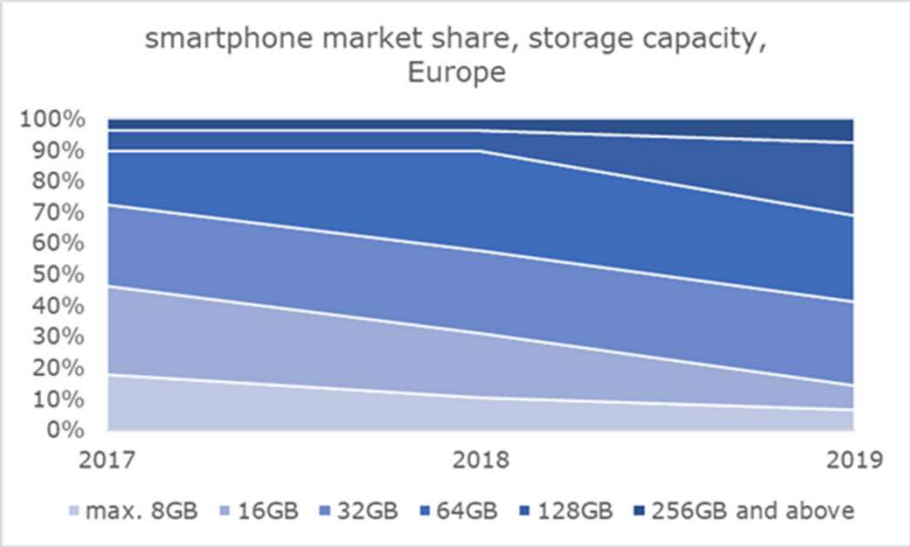
Task 4 – Technologies

- Goal: Getting the technical characterisation of the product group right
- Selected technology aspects and trends with high relevance for later assessments

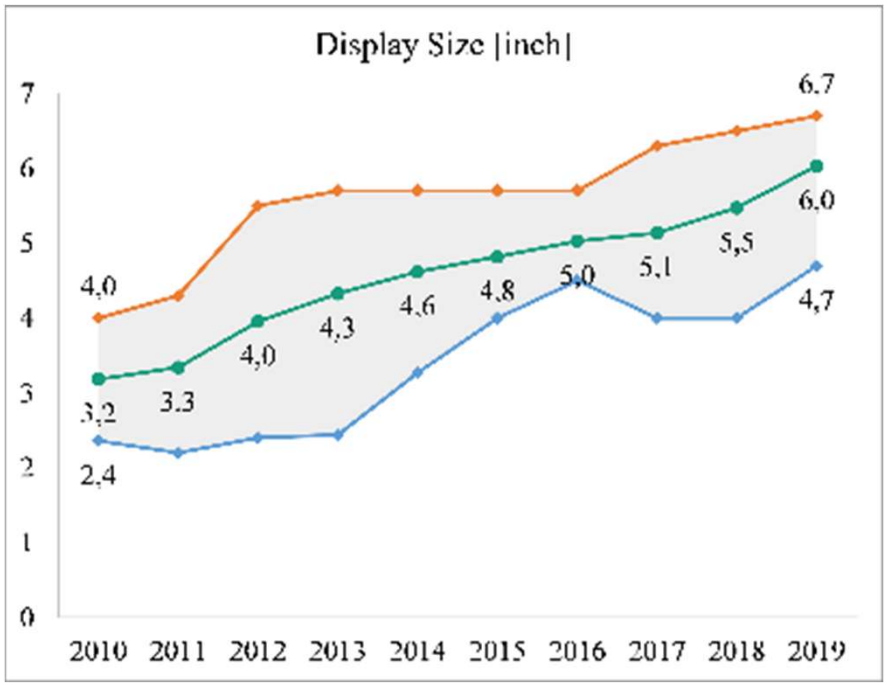
Task 4 – Technologies

- Smartphones: Storage capacity



Task 4 – Technologies

- Smartphones: Display size



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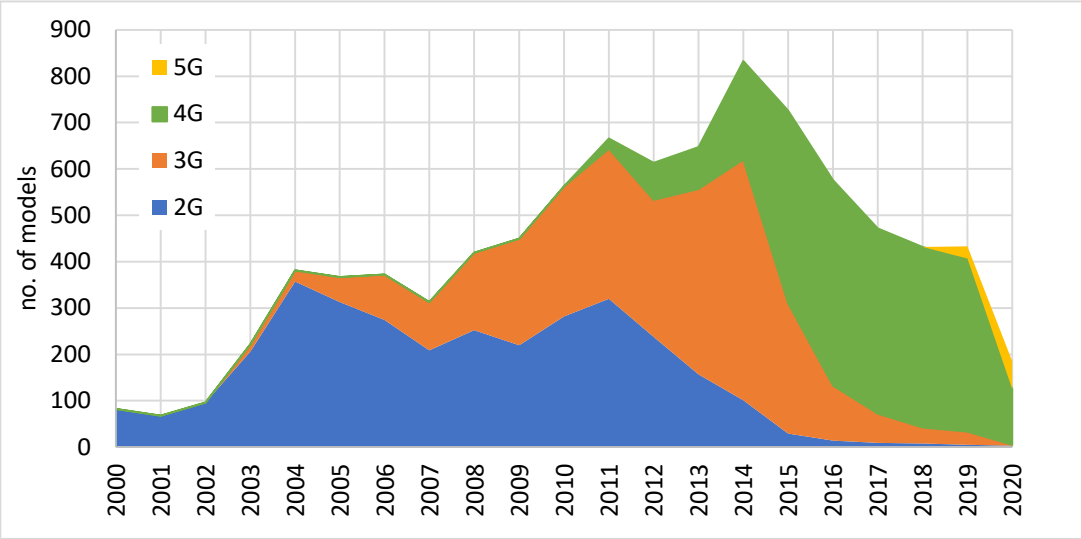
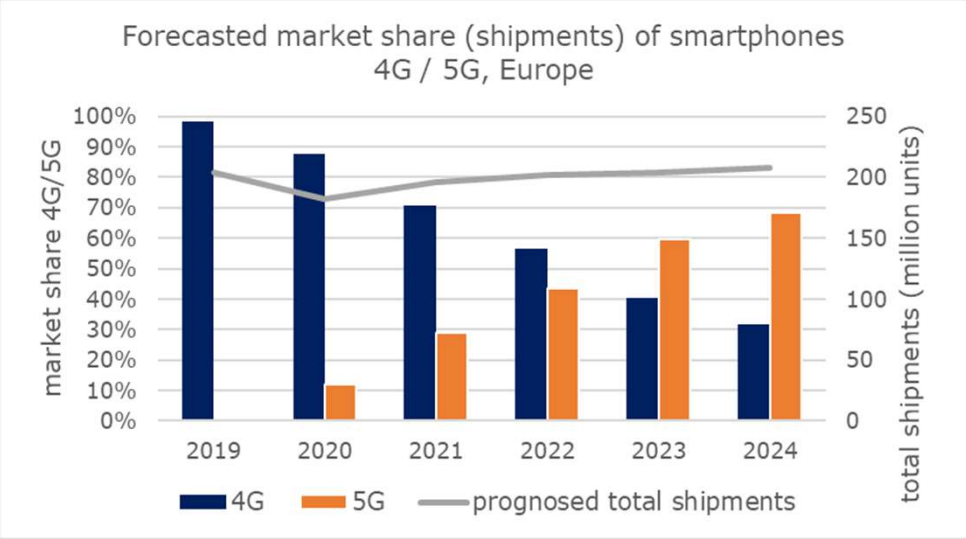
Task 4 – Technologies

- Mobile phones / Smartphones: Network generations



Mobile network generation technology in mobile phones between 2000 and 2020 (Proske et al. 2020a)



Smartphones - 5G market penetration forecast (data provided by an anonymous OEM)

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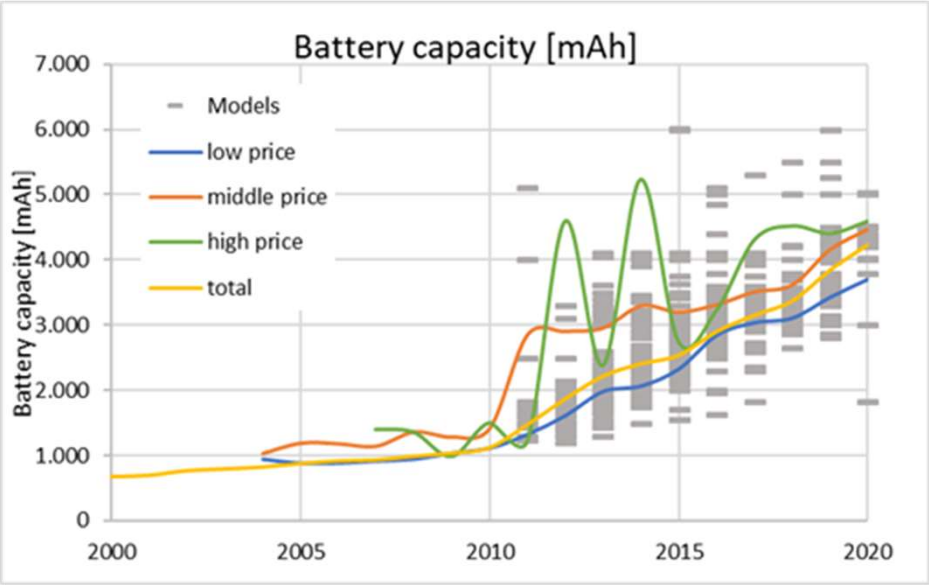
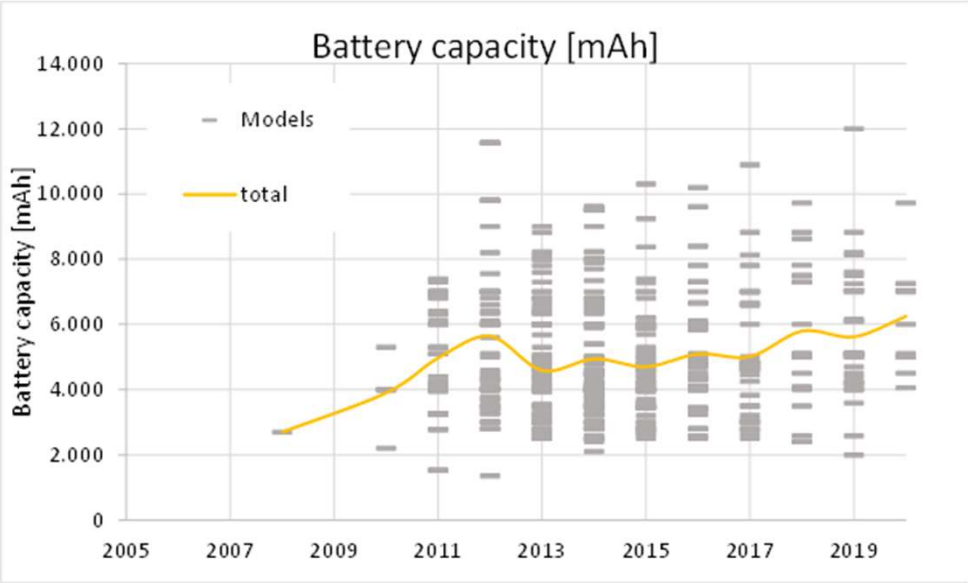
Task 4 – Technologies

- Smartphones / tablets: Battery capacity



mobile phones between 2000 and 2020 per price segment (Proske et al. 2020a)



tablets between 2008 and 2020

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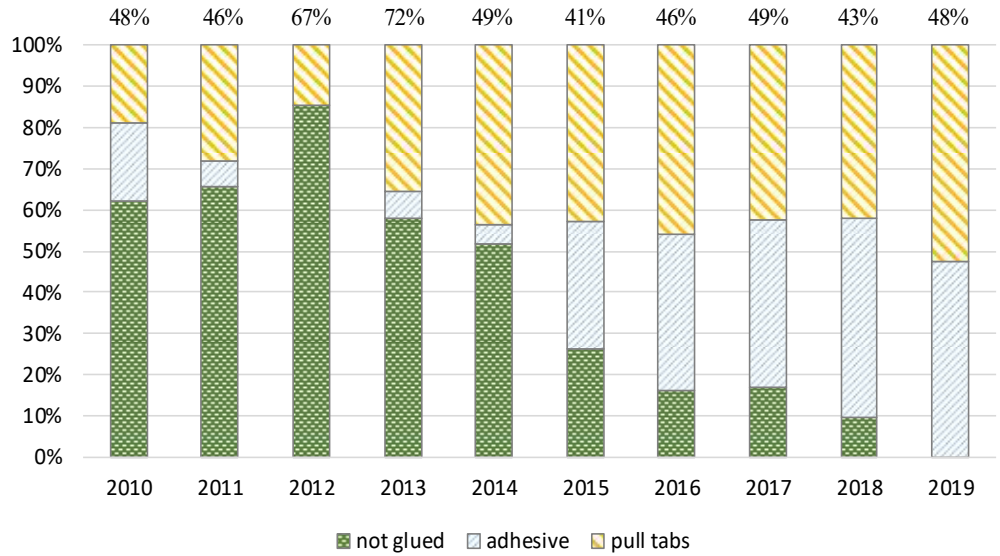
Task 4 – Technologies

- Smartphones: Battery integration



Trend towards the use of adhesives to fix the battery within smartphones among the best-selling smartphones in Europe (based on market data from Counterpoint Research; market coverage denoted on top of data columns)

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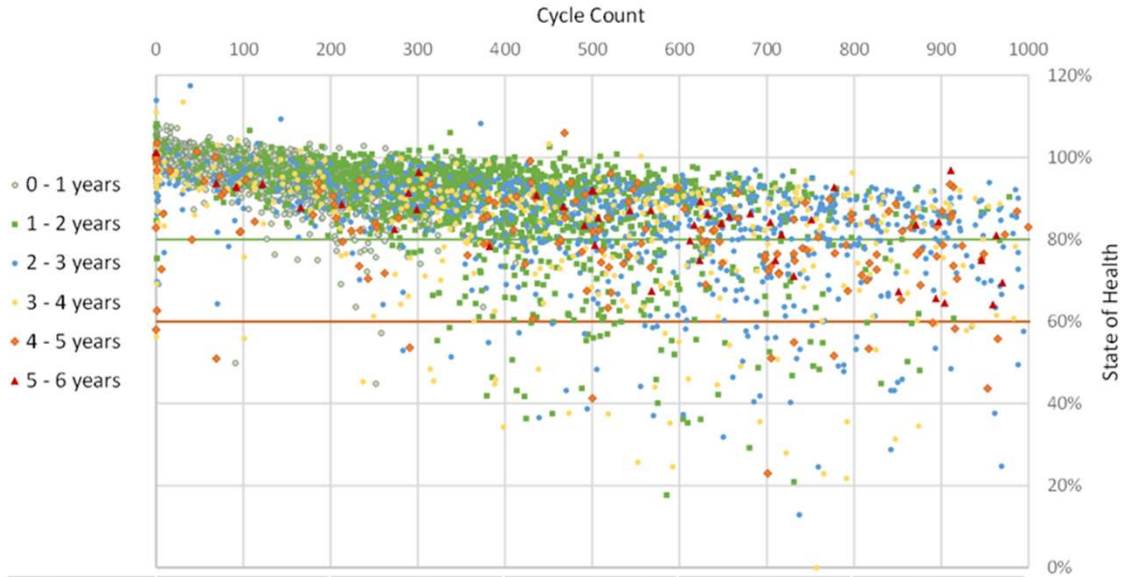
Task 4 – Technologies

- Smartphones: Battery health



Cycles	0 - 200	201 - 400	401 - 600	601 - 800	801 - 1000
Datasets (n)	1824	1174	887	504	247
SoH > 80 %	99%	92%	75%	64%	55%
SoH > 60 %	100%	99%	95%	90%	88%
SoH < 60 %	0,3%	1,4%	4,8%	10%	12%

State of health (SOH) of smartphone batteries, clustered into intervals of battery age in years, over the course of 1.000 charging cycles (Clemm et al. 2016b)

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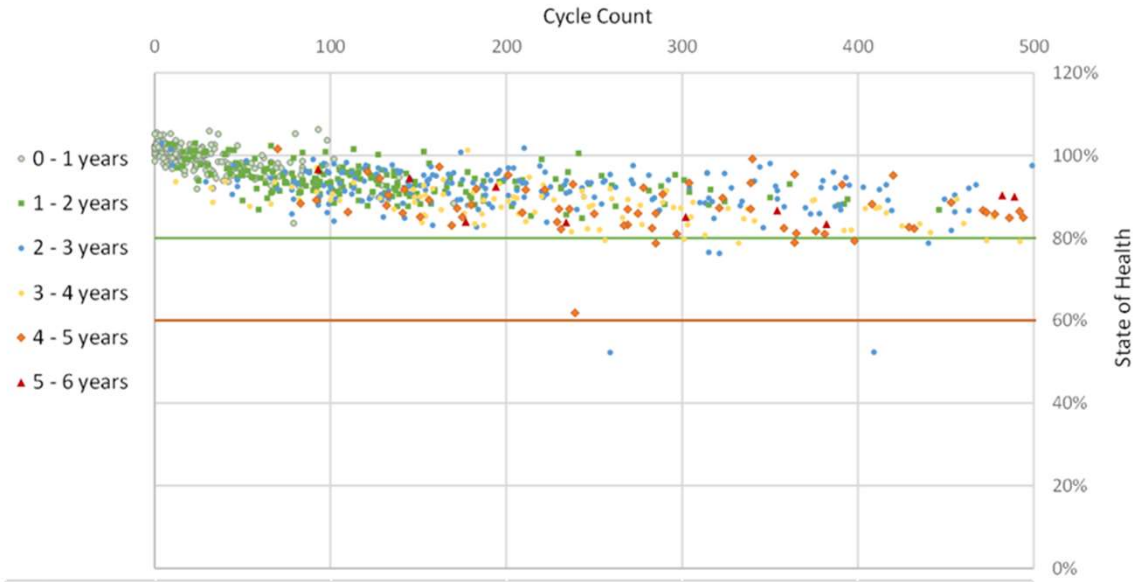
Task 4 – Technologies

- Tablets: Battery health



Cycles	0-100	101-200	201-300	301-400	401-500
Datasets (n)	308	208	189	76	42
SoH > 80 %	100%	100%	95%	92%	90%
SoH > 60 %	100%	100%	99%	100%	98%
SoH < 60 %	0,0%	0,0%	0,5%	0%	2%

State of health (SOH) of tablet batteries, clustered into intervals of battery age in years, over the course of 500 charging cycles. The statistics below present the share of data points in each interval that have retained at least 80 % and 60 % SOH (Clemm et al. 2016b)

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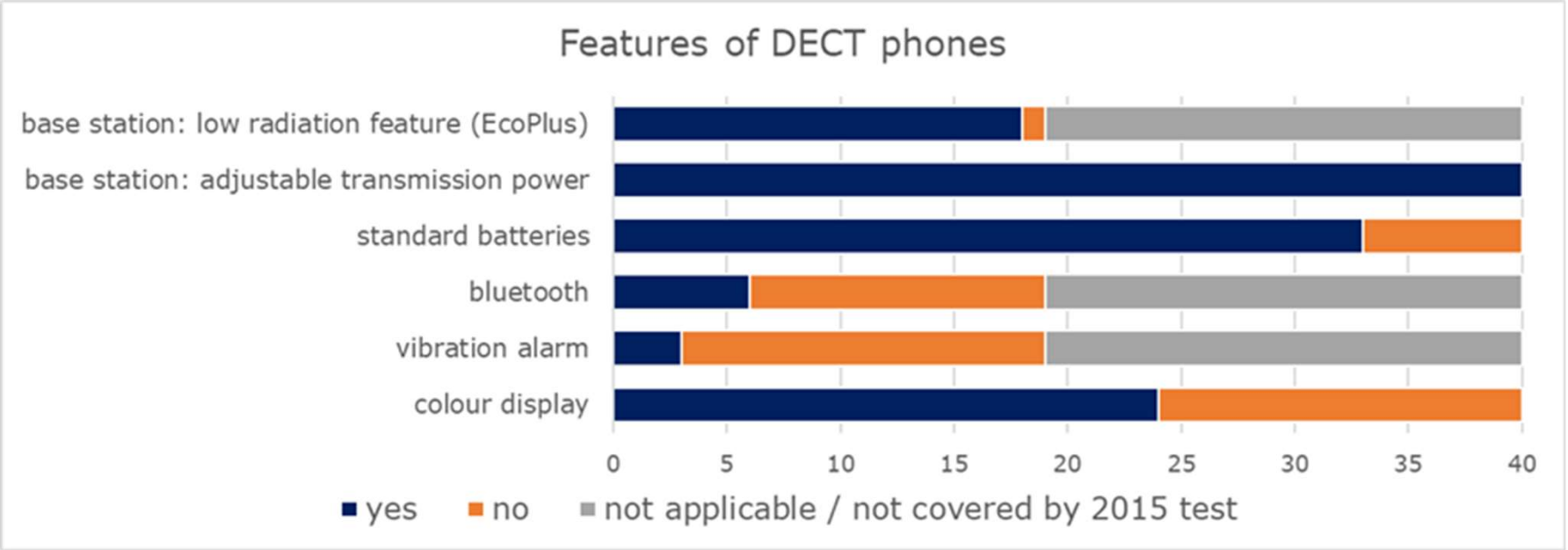
Task 4 – Technologies

- DECT phones: Features



Features DECT phones (data by Stiftung Warentest, compilation by Fraunhofer IZM)

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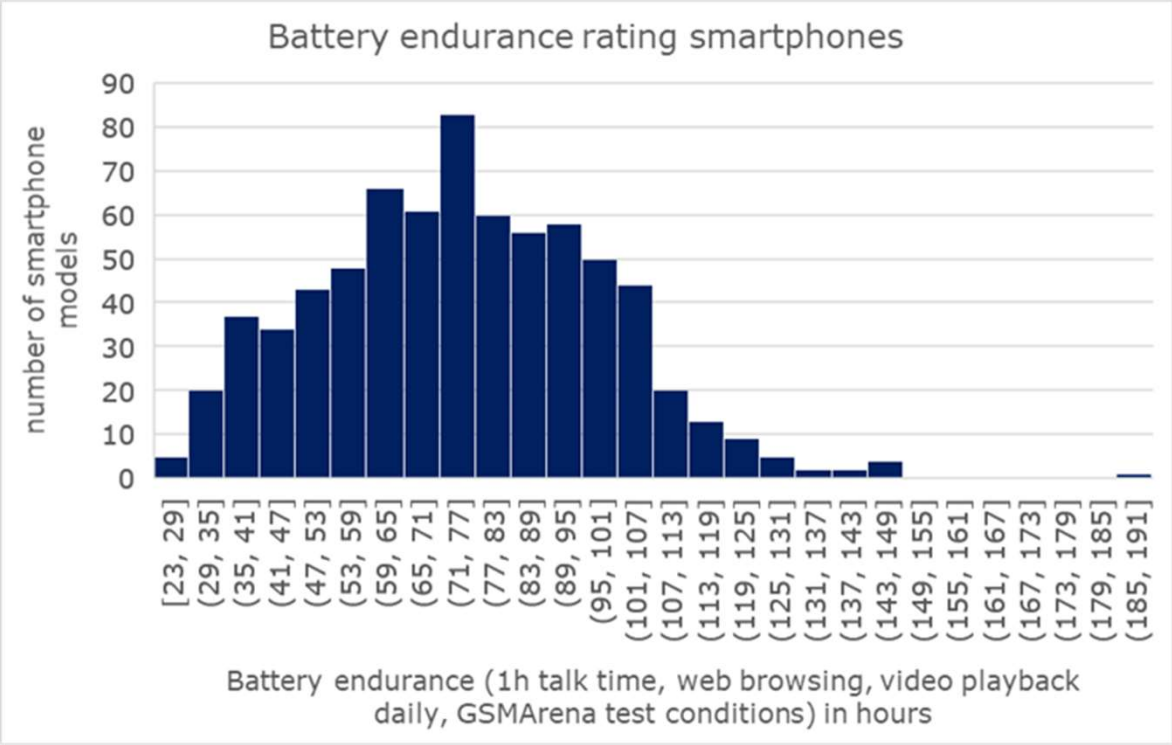
Task 4 – Technologies

- Smartphones:
  Battery endurance (per cycle)



Smartphones – Battery endurance testing results (GSMArena 2020)

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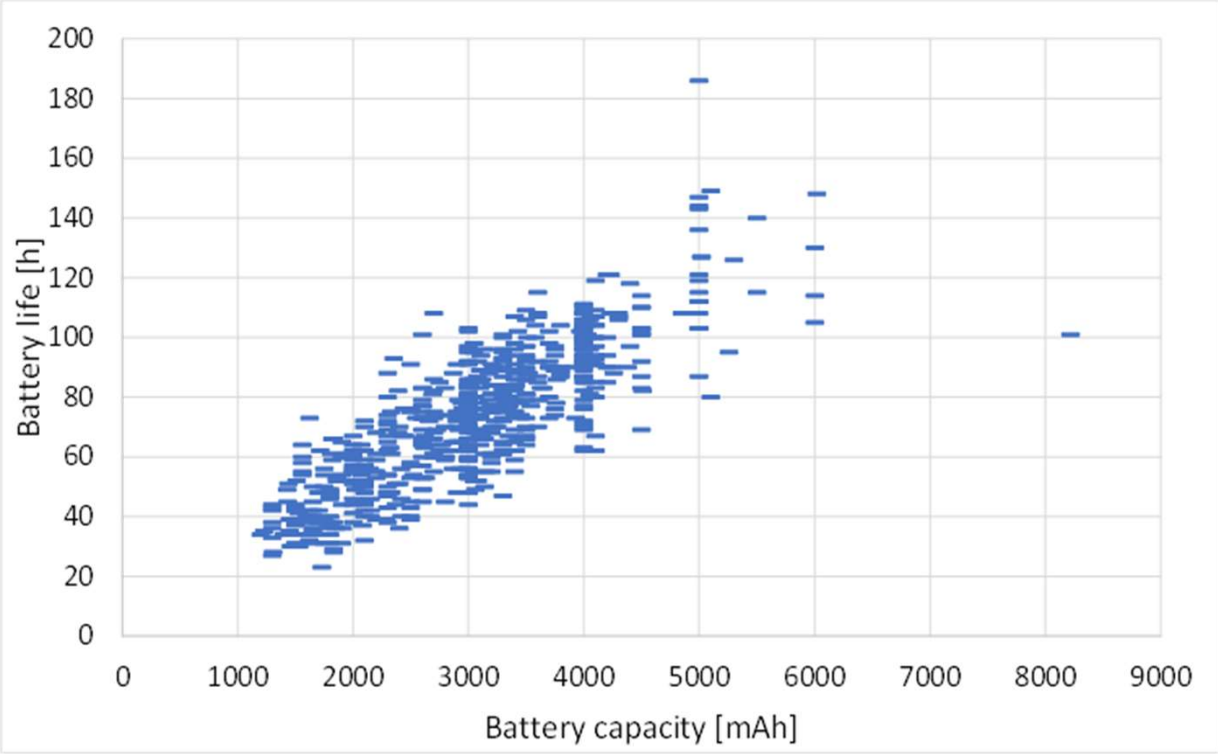
Task 4 – Technologies

- Smartphones:
  Battery endurance (per cycle)



Smartphones – Battery endurance correlated with battery capacity (GSMArena 2020)

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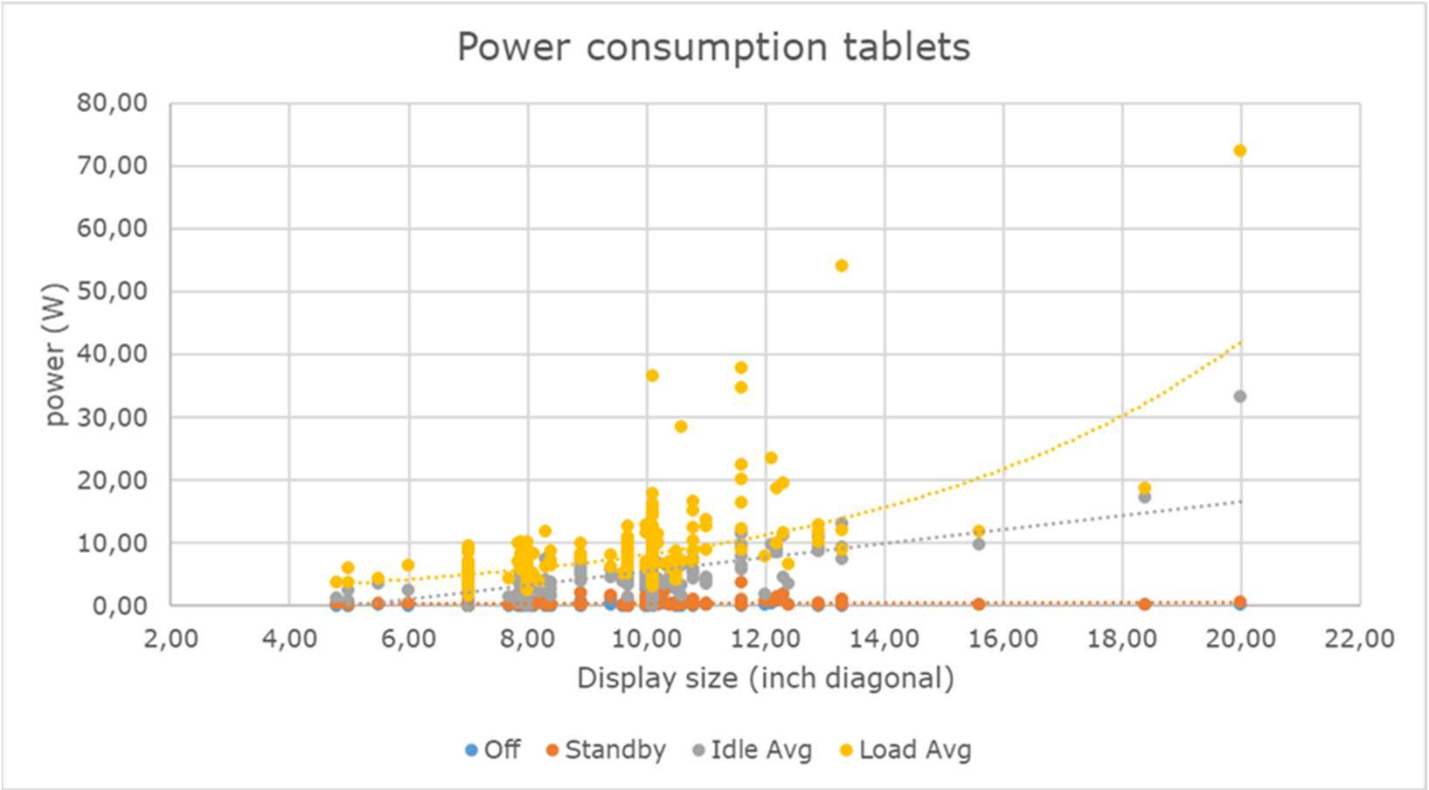
Task 4 – Technologies

- Tablets:
  Power consumption



Tablets – Power consumption in various modes (Notebookcheck 2020)

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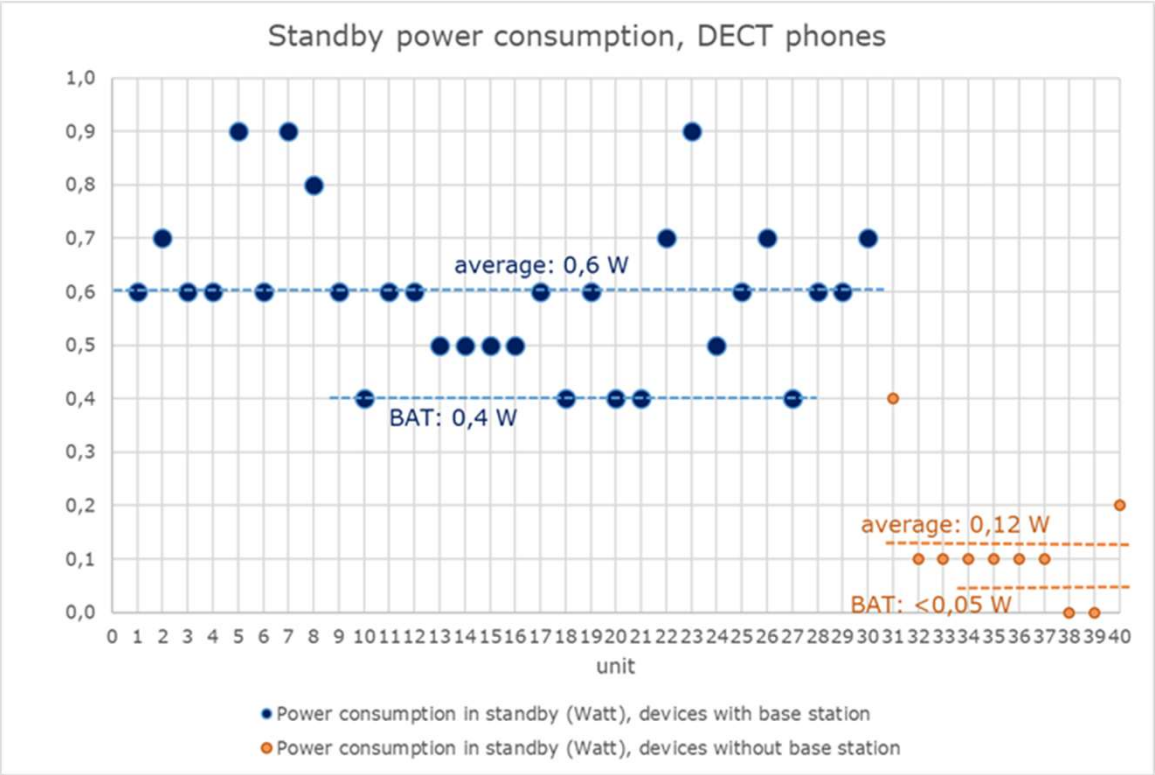
Task 4 – Technologies

- Cordless phones:
  Standby power consumption



Standby power consumption, DECT phones / charging cradle / base station (data by Stiftung Warentest, compilation by Fraunhofer IZM)

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Task 4 – Technologies

- Smartphones:
  OS security update support

Brand	Model	OS	Released	regular security update support (months, as of March 2019)	(expected) security update support (years, as of March 2019)
Apple	iPhone 5S	iOS	2013	66	6
Apple	iPhone 4S	iOS	2011	58	Ended
Apple	iPhone 5	iOS	2012	58	Ended
Nokia/Microsoft	Lumia 1520	Windows	2013	57	Ended
Nokia/Microsoft	Lumia Icon	Windows	2014	55	Ended
Apple	iPhone 6/6 Plus	iOS	2014	54	5+
Nokia/Microsoft	Lumia 530/630/930	Windows	2014	50	Ended
Apple	iPhone 4	iOS	2010	48	Ended
Nokia/Microsoft	Lumia 730/830	Windows	2014	47	Ended
Microsoft	Lumia 640/640 XL	Windows	2015	47	4
Apple	iPhone 5C	iOS	2013	46	Ended
Apple	iPhone 3GS	iOS	2009	45	Ended
Microsoft	Lumia 430/435/635	Windows	2015	42	Ended
Apple	iPhone 6S/6S Plus	iOS	2015	42	6+
Microsoft	Lumia 950/950 XL	Windows	2015	40	4
OnePlus	OnePlus X	Android	2015	12	Ended
OnePlus	OnePlus 3	Android	2016	11	3
Sony	Xperia Z5	Android	2015	<11	Ended
Huawei	P8	Android	2015	<11	Ended
Xiaomi	Redmi Note 3	Android	2016	<11	Ended
Huawei	P9	Android	2016	<11	Ended
Samsung	J3	Android	2016	<11	Ended
HTC	10	Android	2016	<11	Ended

Availability of Operating System security updates, adapted from (Mobile & SecurityLab 2019)

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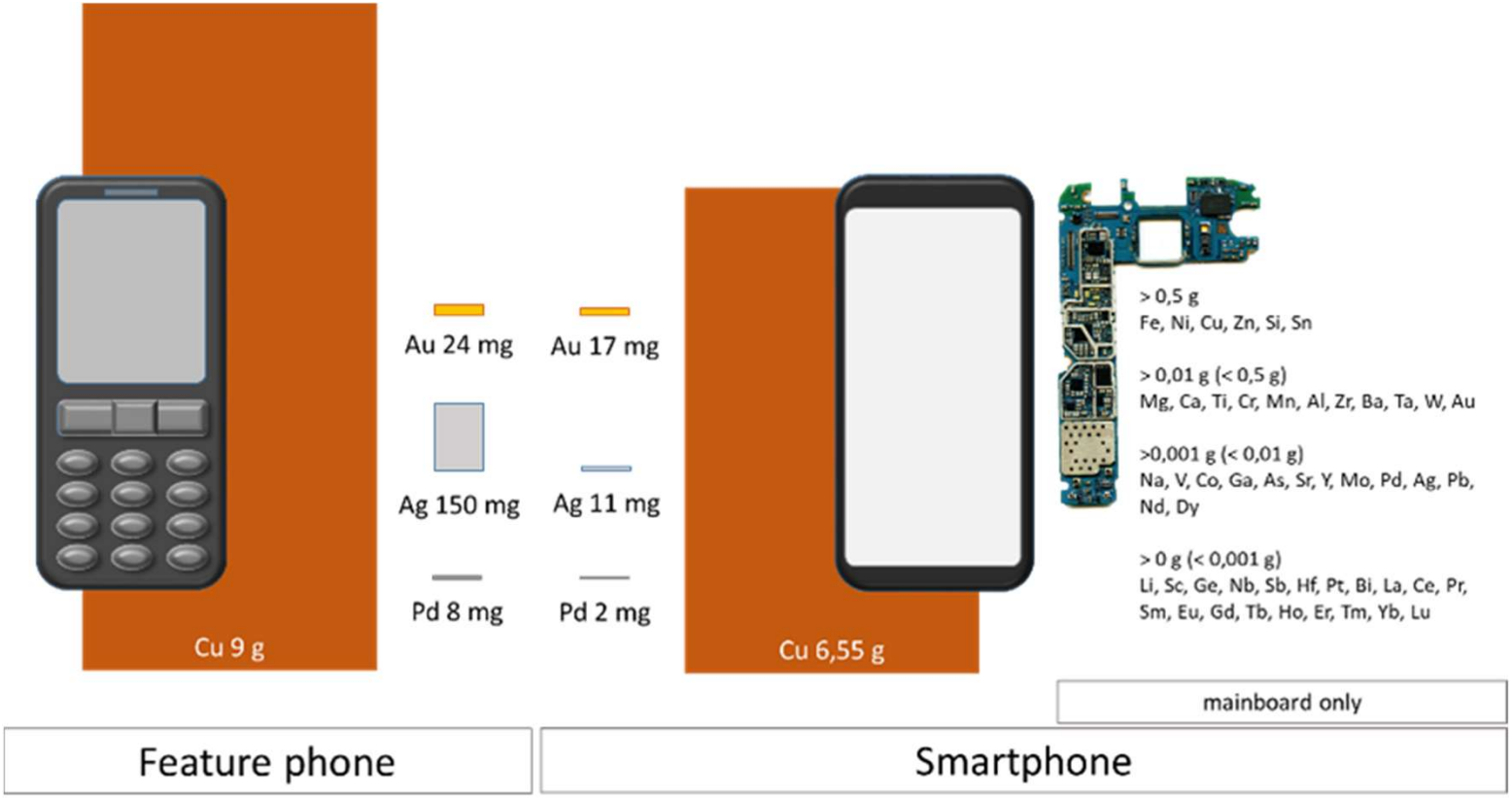
Task 4 – Technologies

- Material composition

Material content of selected metals in conventional mobile phones and smartphones (data source: Bookhagen et al.)



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Task 4 – Technologies

- Feature phone: Generic design

Task 4 – Technologies

- Cordless phone: Generic design

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Task 4 – Technologies

- Smartphones: Examples of recycled materials

Material	Recycled material rate	Application
Neodymium and possibly Dysprosium	100%, unknown if PIR or PCR	Taptic Engine of iPhone 11, iPhone 11 Pro, and iPhone 11 Pro Max
Rare earth elements	100%, unknown if PIR or PCR	all magnets in iPhone 12 (and MagSafe accessories)
Tin	100% PCR	solder on main logic boards of iPhone XR, iPhone 11, iPhone 11 Pro, iPhone 11 Pro Max, iPhone SE (2020)
Aluminum	unknown	aluminum enclosures for iPhones released 2019
Cobalt	Unknown share, PCR	Battery for "portable electronics"
Tungsten	50%, unknown if PIR or PCR	Vibration motor Fairphone 2
Plastics	35%, unknown if PIR or PCR	multiple components of iPhone 11 Pro Max
	35% PCR	iPhone XR speaker enclosure
	47% PCR	plastic mechanical parts of Google Pixel 4a
	20%, unknown if PIR or PCR	Power supply Galaxy Note 9
	40%, unknown if PIR or PCR	Plastic parts of Fairphone 3+
Polycarbonate	50% PCR	back covers and modules Fairphone 2

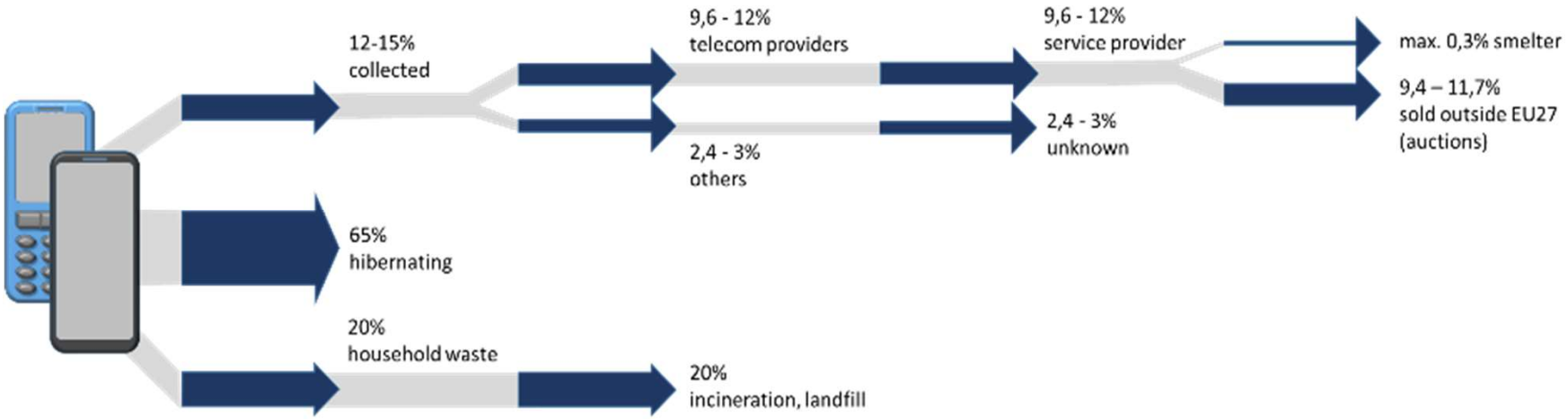
Task 4 – Technologies

- Mobile phones: End-of-Life

Device	Region	Year	Collection rate
Mobile phones	Germany	2012	1%
Smartphones	Germany	2012	1%
Tablet computers	Germany	2012	0%
Landline phones	Germany	2012	22%

Collection rates (Sander et al. 2019)

Mobile phones – end of life routes in Belgium (van der Voort 2013)



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Task 4 – Technologies - Update

- Smartphone featuring high IP classes and good reparability

- IP68 and conformance with many of the MIL-810G tests
- Battery: 4.050 mAh
- Thickness: 9,9 mm

https://youtu.be/QOiBytB9po0

Task 4 – Technologies

Q&A

short comments or questions: chat

complex comments or questions: topic -> chat AND #

Break until 11:15

(next: Task 5)

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Task 5 – Base Cases: definition

- base-cases are “conscious abstractions from reality”, especially in the sense that average “virtual” products/base-cases will be defined based on market share of the different underlying technologies.
- each base-case is comprehensively evaluated with regard to
  - environmental impact,
  - life-cycle costs for consumers and
  - EU totals.

  These base-cases serve as a point of reference to analyse technical design options in Task 6.

Task 5 – Base Cases: definition

- BC1: Smartphone, display 5”, low-end price segment
- BC2: Smartphone, display 6”, mid-range
- BC3: Smartphone, display 6,5”, high-end

} Each 1/3 of the EU27 smartphone stock

- BC4: Feature phone
- BC5: DECT cordless landline phone, with charging cradle / base station
- BC6: Tablet (no attached keyboard)

- Foldables not covered by an individual Base Case
- Tablets not further broken down into low-end / mid-range / high-end

Task 5 – Base Cases: Specification

Parameter	Value		
	BC1 – low-end / entry	BC2 – mid-range	BC3 – high-end
Weight	150 g	180 g	195 g
Display size	5” (16:9, 69cm²)	6” (18:9, 93cm²)	6,5” (20:9, 102cm²)
Display type	LCD	50% LCD, 50% OLED	OLED
Main housing material	plastics	aluminum, plastics	aluminum
backcover	plastics	aluminum, plastics	glass
RAM	2 GB	4 GB	8 GB
Flash memory	32 GB	64 GB	128 GB
Mainboard	6-layers, 75cm² (incl. cut-offs)	8-layers, 35cm² (incl. cut-offs)	10-layers, 43cm² (incl. cut-offs, stacked)
Other rigid boards	(mainboard covers all connectors / interfaces)	6-layers, 8cm²	8-layers, 6cm²
Flex PCBs	Very few, distances bridged by mainboard	Double-sided, 50 cm² (mainboard to sub-board flex, misc. other module flexes)	Double-sided, 50 cm² (mainboard to sub-board flex, misc. other module flexes)
Mobile network	up to 4G/LTE	up to 4G/LTE	up to 5G
Battery	2400 mAh	3330 mAh	4500 mAh
Battery design	Integrated, with adhesive	Integrated, with adhesive	Integrated, with pull strips
Cameras	1 + 1	1 + 1	4 + 1
IP class	none	none	IP 67 or 68
Wireless charging	no	no	yes
Price	200 €	500 €	1000 €

Task 5 – Base Cases: Specification

Parameter	Value
	BC6 - tablet
Weight	600 g
Display size	11” (337cm²)
Display type	LCD
Display design	traditional
Main housing material	plastics, aluminum
backcover	plastics, aluminum
CPU (SoC)	Typical: Quad-core, 1,8 GHz
GPU	SoC integrated
RAM	4 GB
Flash memory	64 GB
Mainboard	6-layers, 100cm² (incl. cut-offs)
Other rigid boards	6-layers, 8cm²
Flex PCBs	Double-sided, 60 cm² (mainboard to sub-board flex, misc. other module flexes)
Mobile network	none
Battery capacity	6000 mAh
Battery design	Integrated, with adhesive or screwed frame
Cameras	1 + 1
IP class	none
Wireless charging	no
Price	330 €

Task 4/5 – Base Cases: Lifetime

BC		Active product lifetime
1	Smartphone, 5”, low-end price segment	2,5 years (30 months)
2	Smartphone, 6”, mid-range	3 years (36 months)
3	Smartphone, 6,5”, high-end	3,5 years (42 months)
4	Feature phone	3 years (36 months)
5	DECT cordless landline phone, with charging cradle / base station	5 years (60 months)
6	Tablet	5 years (60 months)

(Task 4, Table 35)

Task 5 – Base Cases: Definition

Q&A

short comments or questions: chat

complex comments or questions: topic -> chat AND #

Task 5 – Base Cases: Charging scenarios

Base Case	Charge cycles / day	Daily time spent in		
		Active battery charge	Trickle charge	Power adapter no-load
BC1 Smartphone – low-end	1	2,5 h	9,5 h	12 h
BC2 Smartphone – mid-range	1	2,5 h	9,5 h	12 h
BC3 Smartphone – high-end	1	2,5 h	9,5 h	12 h
BC4 Feature phone	1	2,5 h	9,5 h	12 h
BC6 Tablet	0,5	2,5 h	9,5 h	12 h

Base Case	Call duration per day	Daily time spent in		
		Active	Active battery charge	Standby
BC5 DECT phone	10 min	0,16 h	0,075 h	23,765 h

Task 5 – Base Cases: Repair scenario

Base Case	New device costs	Repair costs			Defect devices over lifetime									
					Display / cover glass				Battery			Other		
		Display	Battery	Other		repaired	continued use	disposal / hibernation		repaired	disposal / hibernation		repaired	disposal / hibernation
1	200 €	120 €	55 €	55 €	16,7%	4,2%	4,2%	8,4%	12,5%	4,2%	8,4%	12,5%	4,2%	8,4%
2	500 €	200 €	60 €	60 €	20%	5%	5%	10%	15%	5%	10%	15%	5%	10%
3	1000 €	330 €	75 €	75 €	23,3%	5,8%	5,8%	11,6%	17,5%	5,8%	11,6%	17,5%	5,8%	11,6%
4	80 €	50 €	30 €	50 €	7,5%	2,5%	-	5%	15%	5%	10%	15%	5%	10%
5	50 €	-	7 €	-	-	-	-	-	65%	50%	15%	-	-	-
6	330 €	150 €	90 €	90 €	10%	5%	-	5%	15%	5%	10%	15%	5%	10%

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Task 5 – Base Cases: BOM modelling – BC 1 example

Nr	Base Case 1 - smartphone, 5", entry Products		Date 03.11.2020	Author Fraunhofer IZM	
Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
1	**Total handset (150g)**				
2	Battery (2420mAh)	37,79	8-Extra	109-LCO-Battery (Lithium-Cobalt-Oxid)	
3	Battery PCB	1,50	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
4	Display 5" (16:9, 69cm²), LCD	69,00	8-Extra	111-LCD display, smartphone, per cm²	
5	LED backlights	0,40	6-Electronics	49 -SMD/ LED's avg.	
6	Light guide panel	1,50	2-TecPlastics	14 -PMMA	
7	OLED	0,00	8-Extra	113-AMOLED panel per cm²	
8	Display PCB	3,00	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
9	Cover glass	18,00	8-Extra	114-Glass per g	
10	Backside glass	0,00	8-Extra	114-Glass per g	
11	Midframe (Mg)	0,00	4-Non-ferro	34 -MgZn5 cast	
12	Cover, housing	30,00	2-TecPlastics	13 -PC	No
13	Backcover, housing	0,00	4-Non-ferro	27 -Al sheet/extrusion	
14	Machining losses aluminum	0,00	4-Non-ferro	27 -Al sheet/extrusion	
15	Aluminum anodizing (plating as proxy)	0,00	5-Coating	41 -Cu/Ni/Cr plating	
16	Steel parts	10,00	3-Ferro	26 -Stainless 18/8 coil	
17	Ni plating steel parts	0,05	5-Coating	41 -Cu/Ni/Cr plating	
18	Copper foils and shields	4,00	4-Non-ferro	31 -Cu tube/sheet	
19	Rubber sealings	0,50	8-Extra	115-Silicone	
20	**Mainboard**				
21	PCB substrate, 6-layers, 75cm²	75,00	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
22	CPU SoC (1,5cm² package size, 0,5cm² die size)	0,50	8-Extra	117-IC, SoC per cm² die area	
23	RAM, 2GB (1,5cm² package size, 0,5cm² die size)	0,50	8-Extra	118-IC, DRAM (50% of SoC) per 1cm² die area	
24	NAND, 32GB (1,5cm² package size, 2cm² total die size)	2,00	8-Extra	119-IC, NAND (60% of SoC) per 1cm² die area	
25	SoC, RAM, NAND gold (entered as 3 mg)	3,00	5-Coating	42 -Au/Pt/Pd	
26	other ICs (1,5cm² total die size)	1,50	8-Extra	120-Generic IC per 1cm² die area	
27	other IC gold (entered as 0,4 mg)	0,40	5-Coating	42 -Au/Pt/Pd	
28	diodes	0,04	6-Electronics	48 -IC's avg., 1% Si	
29	passive components	0,60	6-Electronics	49 -SMD/ LED's avg.	
30	coils	1,00	3-Ferro	25 -Ferrite	
31	various connectors, incl. SIM card slot, Board-to-board connectors, USB	1,20	6-Electronics	46 -slots/ ext. ports	
32	additional gold connectors in mg	3,00	5-Coating	42 -Au/Pt/Pd	
33	steel sheets (EMI shields)	4,00	3-Ferro	26 -Stainless 18/8 coil	
34	solder	0,40	6-Electronics	53 -Solder SnAg4Cu0.5	
35	eSIM	0,00	8-Extra	120-Generic IC per 1cm² die area	
36	5G components (modem and antenna ICs)	0,00	8-Extra	120-Generic IC per 1cm² die area	
37	heat pipe	0,00	4-Non-ferro	31 -Cu tube/sheet	
38					
39					
40					

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
41	**Sub-boards (components included above)**				
42	PCB	0,00	8-Extra		
43	**Flex boards (5cm²)**	5,00	8-Extra	101-Flex PCB Ni/Au-Finish 1-layer, double-sided per c	
44	solder on flex	0,10	6-Electronics	53 -Solder SnAg4Cu0.5	
45	passive components on flex	0,01	6-Electronics	49 -SMD/ LED's avg.	
46	**speakers, microphone**				
47	Metal cover	1,00	3-Ferro	26 -Stainless 18/8 coil	
48	Plating	0,01	5-Coating	41 -Cu/Ni/Cr plating	
49	Plastic adhesive	0,01	2-TecPlastics	17 -Flex PUR	No
50	Plastic housing	0,80	2-TecPlastics	13 -PC	No
51	Membrane foil	0,01	1-BikPlastics	10 -PET	No
52	Copper coil	0,04	4-Non-ferro	29 -Cu winding wire	
53	Magnet	1,20	8-Extra	116-NdFeB magnet	
54	Rubber adhesive	0,02	8-Extra	115-Silicone	
55	**Vibration alert**				
56	Magnet	0,20	8-Extra	116-NdFeB magnet	
57	other mechancial parts, incl. Tungsten	1,20	4-Non-ferro	31 -Cu tube/sheet	
58	**Front camera (1x)**				
59	Sensor chip, 0,2cm²	0,20	8-Extra	120-Generic IC per 1cm² die area	
60	Gold bond wires (0,5mg)	0,50	5-Coating	42 -Au/Pt/Pd	
61	PCB, 6-layers; flex included above	0,30	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
62	aluminum	0,60	4-Non-ferro	27 -Al sheet/extrusion	
63	steel	0,20	3-Ferro	26 -Stainless 18/8 coil	
64	plating steel parts	0,01	5-Coating	41 -Cu/Ni/Cr plating	
65	copper	0,10	4-Non-ferro	29 -Cu winding wire	
66	magnets	0,10	8-Extra	116-NdFeB magnet	
67	cover	0,20	2-TecPlastics	14 -PMMA	No
68	glass	0,10	8-Extra	114-Glass per g	
69	**flash light**	0,10	6-Electronics	49 -SMD/ LED's avg.	
70	**Rear camera**				
71	Sensor chip, 0,2cm²	0,20	8-Extra	120-Generic IC per 1cm² die area	
72	Gold bond wires (0,5mg)	0,50	5-Coating	42 -Au/Pt/Pd	
73	flex included above	0,00			
74	aluminum	0,30	4-Non-ferro	27 -Al sheet/extrusion	
75	steel	0,10	3-Ferro	26 -Stainless 18/8 coil	
76	plating steel parts	0,005	5-Coating	41 -Cu/Ni/Cr plating	
77	copper	0,05	4-Non-ferro	29 -Cu winding wire	
78	cover	0,10	2-TecPlastics	14 -PMMA	No
79	**Wireless charging coil**				
80	foil	0,00	2-TecPlastics	17 -Flex PUR	No
81	copper coil	0,00	4-Non-ferro	29 -Cu winding wire	
82	**Screws**	0,20	4-Non-ferro	32 -CuZn38 cast	
83					
84					
85					
86					
87					

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
88	**Weight balance for materials covered under 8-Extra:**				
89	Electronics (weight of electronics covered under "8-Extra" scaled by a	30,00	6-Electronics		
90	Battery weight (covered under "8-Extra")	37,79	6-Electronics		
91	Display (covered under "8-Extra")	15,00	6-Electronics		
92	Glass	18,00	7-Misc.		
93	Silicone	0,52	2-TecPlastics		
94					
95					
96	**ACCESSORIES**				
97	**power adapter (40g)**				
98	Back housing (PC+ABS)	6,00	2-TecPlastics	13 -PC	No
99	Front housing (PC+ABS)	6,00	1-BikPlastics	11 -ABS	No
100	Plugs	3,40	4-Non-ferro	32 -CuZn38 cast	
101	Metal clips	0,50	3-Ferro	26 -Stainless 18/8 coil	
102	Screws	0,60	3-Ferro	26 -Stainless 18/8 coil	
103	USB Connector	1,40	6-Electronics	46 -slots/ ext. ports	
104	**power adapter PCB assembly**				
105	PCB, THT/SMD, single-sided (13cm²)	13,00	8-Extra	108-FR4 PCB HAL-Finish 1-layer, double-sided per cm²	
106	Coil	5,33	6-Electronics	45 -big caps & coils	
107	Capacitors	3,00	6-Electronics	45 -big caps & coils	
108	coils	0,30	3-Ferro	25 -Ferrite	
109	small ICs	0,15	6-Electronics	48 -IC's avg., 1% Si	
110	passive components (SMD)	0,05	6-Electronics	49 -SMD/ LED's avg.	
111	solder	0,50	6-Electronics	53 -Solder SnAg4Cu0.5	
112	Electronics (weight of electronics covered under "8-Extra" scaled by a	10,00	6-Electronics		
113	**USB cable (25g)**				
114	cable (wire)	7,50	4-Non-ferro	30 -Cu wire	
115	cable (PPE insulation)	7,50	2-TecPlastics	12 -PA 6	No
116	connectors	10,00	6-Electronics	46 -slots/ ext. ports	
117					
118	**Headset (20g)**				
119	cable (wire)	4,00	4-Non-ferro	30 -Cu wire	
120	cable (PPE insulation)	4,00	2-TecPlastics	12 -PA 6	
121	earpiece	7,00	2-TecPlastics	13 -PC	No
122	speaker magnets	0,00	8-Extra	115-NdFeB magnet	
123	copper coil	0,20	4-Non-ferro	30 -Cu wire	
124	PCB remote (1cm²)	1,00	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
125	headset plug	3,00	4-Non-ferro	32 -CuZn38 cast	
126					
127					
128	**Package (200 g)**				
129	Cardboard	150,00	7-Misc.	57 -Cardboard	
130	Plastic foil	10,00	1-BikPlastics	1 -LDPE	Yes
131	Manual, printed product information	40,00	7-Misc.	58 -Office paper	
132					
133					
134					

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Task 5 – Base Cases: New EcoReport datasets

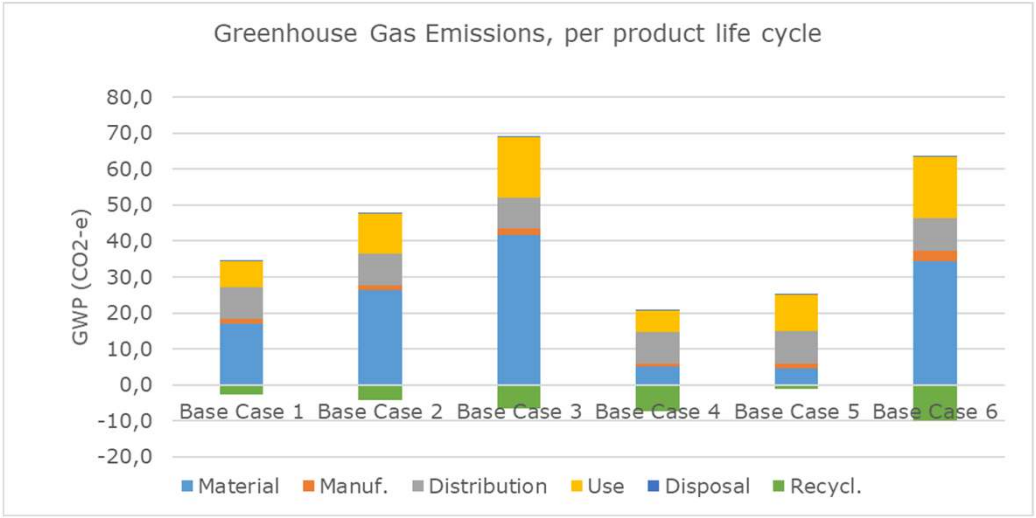
nr	Name material
unit	New Materials production phase (category '**Extra**')
100	Flex PCB Ni/Au-Finish 1-layer per cm²
101	Flex PCB Ni/Au-Finish 1-layer, double-sided per cm²
102	FR4 PCB Ni/Au-Finish 4-layers per cm²
103	FR4 PCB Ni/Au-Finish 6-layers per cm²
104	FR4 PCB Ni/Au-Finish 8-layers per cm²
105	FR4 PCB Ni/Au-Finish 10-layers per cm²
106	FR4 PCB Ni/Au-Finish 12-layers per cm²
107	FR4 PCB HAL-Finish 1-layer per cm²
108	FR4 PCB HAL-Finish 1-layer, double-sided per cm²
109	LCO-Battery (Lithium-Cobalt-Oxid)
110	NiMH battery (AAA)

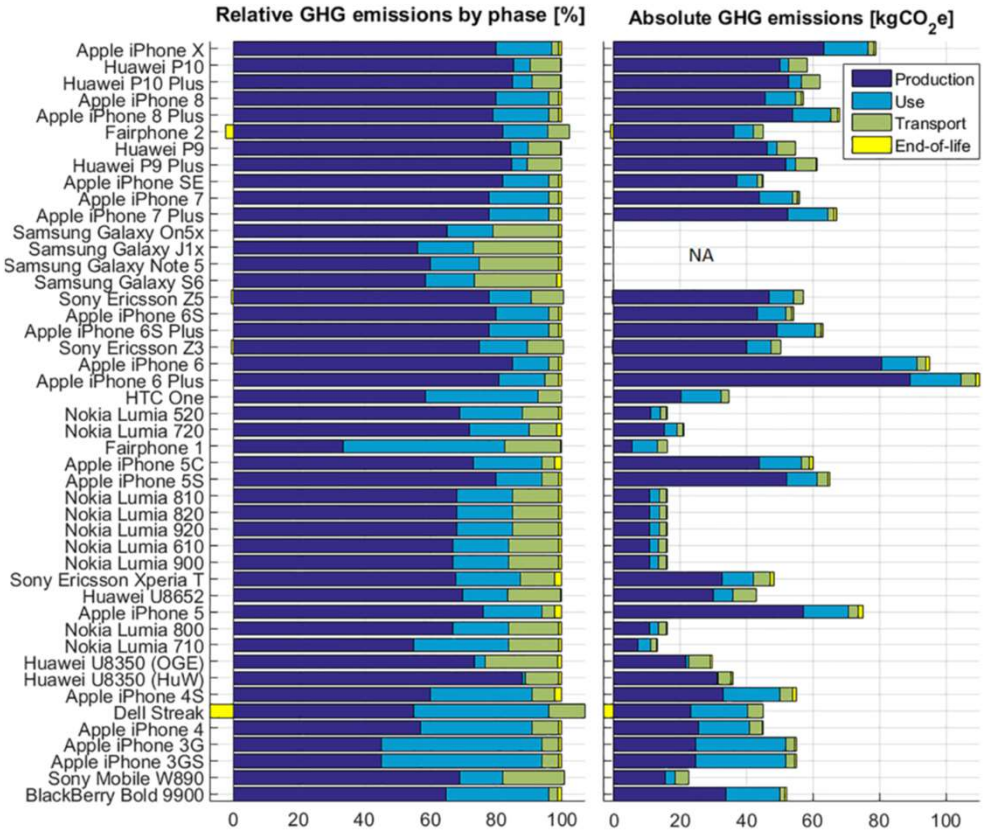
111	LCD display, smartphone, per cm²
112	LCD display, tablet, per cm²
113	AMOLED panel per cm²
114	Glass per g
115	Silicone
116	NdFeB magnet
117	IC, SoC per cm² die area
118	IC, DRAM (50% of SoC) per 1cm² die area
119	IC, NAND (60% of SoC) per 1cm² die area
120	Generic IC per 1cm² die area

Task 5 – Base Cases: Environmental assessment

	Greenhouse gas emissions per product in CO2-e	Reference year	Author
	Products	2020	Fraunhofer IZM

Life Cycle phases -->	PRODUCTION			DISTRIBUTION	USE	END-OF-LIFE			TOTAL
	Material	Manuf.	Total			Disposal	Recycl.	Stock	
Base Case 1	16,7	1,2	17,9	8,7	7,3	0,1	-2,6	0,0	31,4
Base Case 2	26,3	1,4	27,7	8,7	11,3	0,1	-4,3	0,0	43,5
Base Case 3	41,8	1,6	43,4	8,7	16,9	0,1	-6,7	0,0	62,5
Base Case 4	5,1	0,9	6,0	8,7	6,0	0,0	-1,2	0,0	19,5
Base Case 5	4,6	1,2	5,8	9,1	10,3	0,0	-1,1	0,0	24,1
Base Case 6	34,5	2,7	37,3	9,1	17,2	0,2	-10,0	0,0	53,7





(Clément et al. 2020)

December 18, 2020

Task 4/5 – Base Cases: End of Life scenarios

		Reuse	Recyc-ling[1]	Household waste	Hibernation
1	Smartphone, 5”, low-end	10%	5%	20%	65%
	total after hibernation	*10%*	*20%*	*70%*	-
2	Smartphone, 6”, mid-range	10%	5%	20%	65%
	total after hibernation	*10%*	*20%*	*70%*	-
3	Smartphone, 6,5”, high-end	10%	5%	20%	65%
	total after hibernation	*10%*	*20%*	*70%*	-
4	Feature phone	10%	5%	20%	65%
	total after hibernation	*10%*	*20%*	*70%*	-
5	DECT cordless landline phone, with charging cradle / base station	0%	22%	20%	58%
	total after hibernation	*0%*	*50%*	*50%*	-
6	Tablet	10%	5%	20%	65%
	total after hibernation	*10%*	*20%*	*70%*	-

(Task 4, Table 37)

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Task 5 – Base Cases: Societal damages

Environmental indicator	unit	MEErP, 2011	UBA, 2019	
		Rate external marginal costs to society (€/unit)	Environmental damage (€/unit)	Comments
GHG	kg CO2 eq.	0,014	0,187	187 €/t for the year 2020; for a sensitivity analysis even a value of 650 €/t is recommended by the authors
AP	g SO2 eq.	0,0085	0,01504	15.040 €/t SO2, effective in Germany
VOC	g	0,00076	0,00205	2.050 €/t NMVOC, effective in Germany
POP	ng i-Teq	0,000027		
HM1	mg Ni eq.	0,000175		
HM2	mg Ni eq.	0,00004		
HM3	mg Ni eq.	0,0003		
PAH	mg Ni eq.	0,001279		
PM	g	0,01546	0,0412	41.200 €/t PM10, effective in Germany

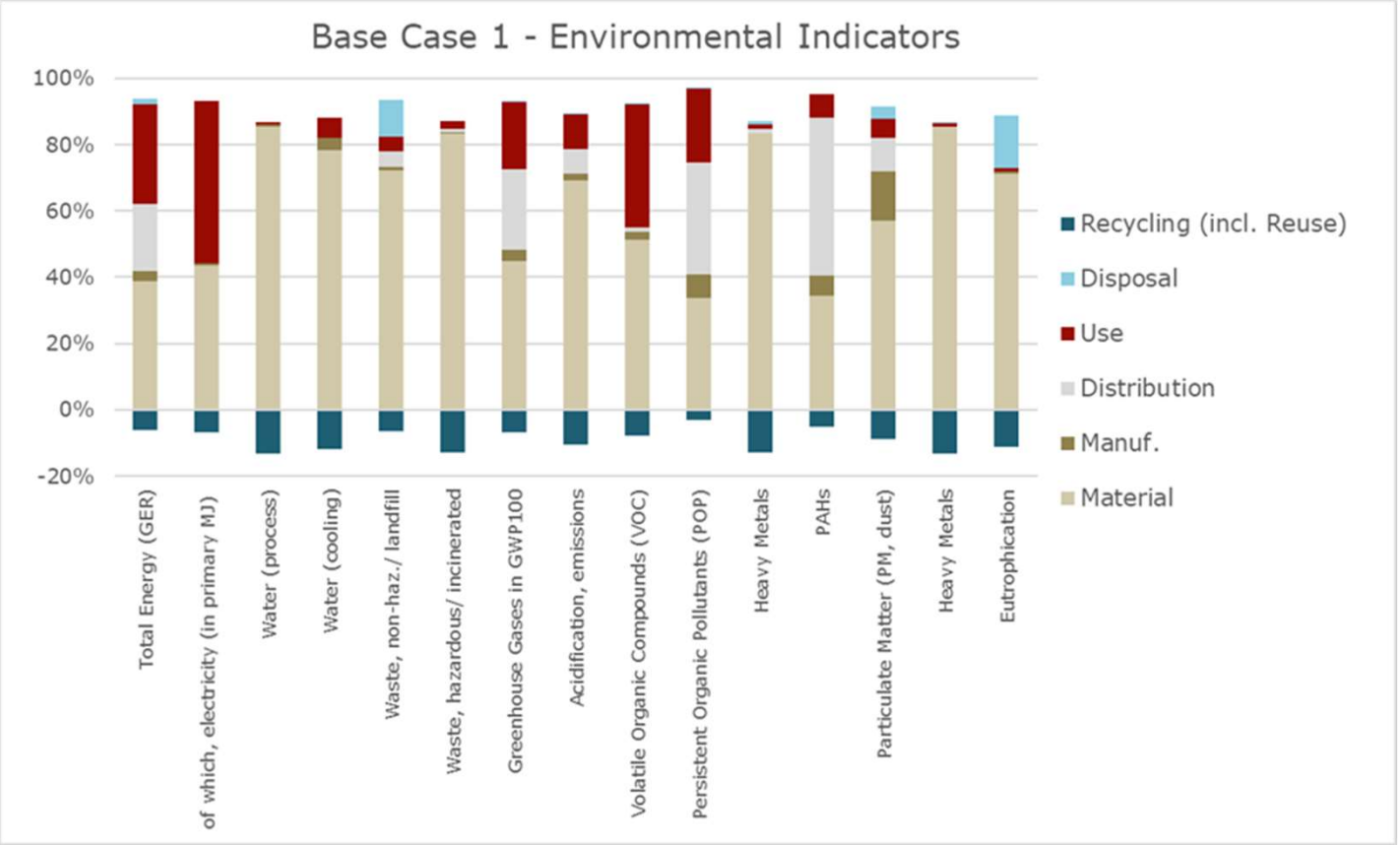
Task 5 – Base Cases: Specifics of the modelling

Q&A

short comments or questions: chat

complex comments or questions: topic -> chat AND #

Task 5 – Base Cases: Environmental assessment



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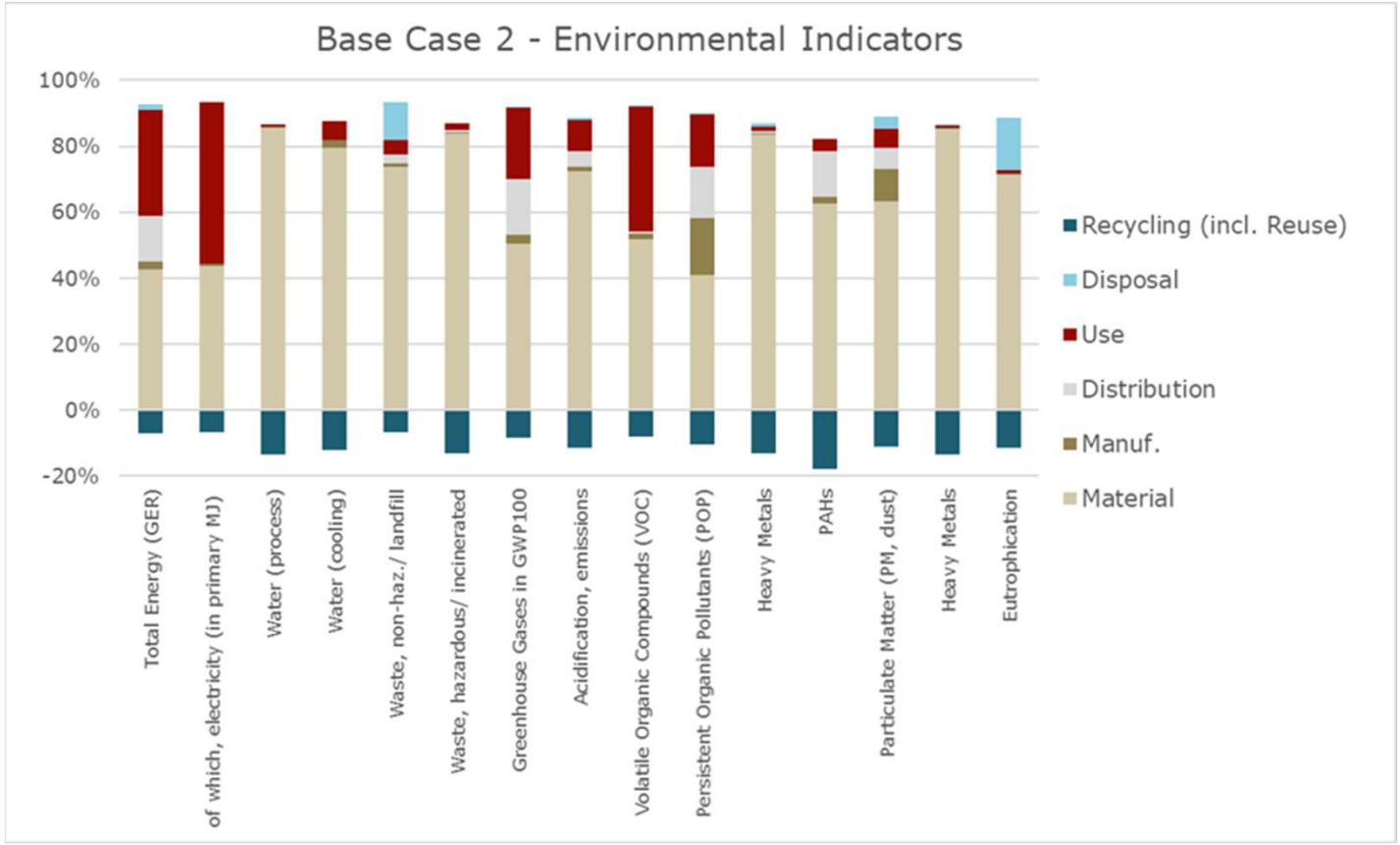
Task 5 – Base Cases: Environmental assessment



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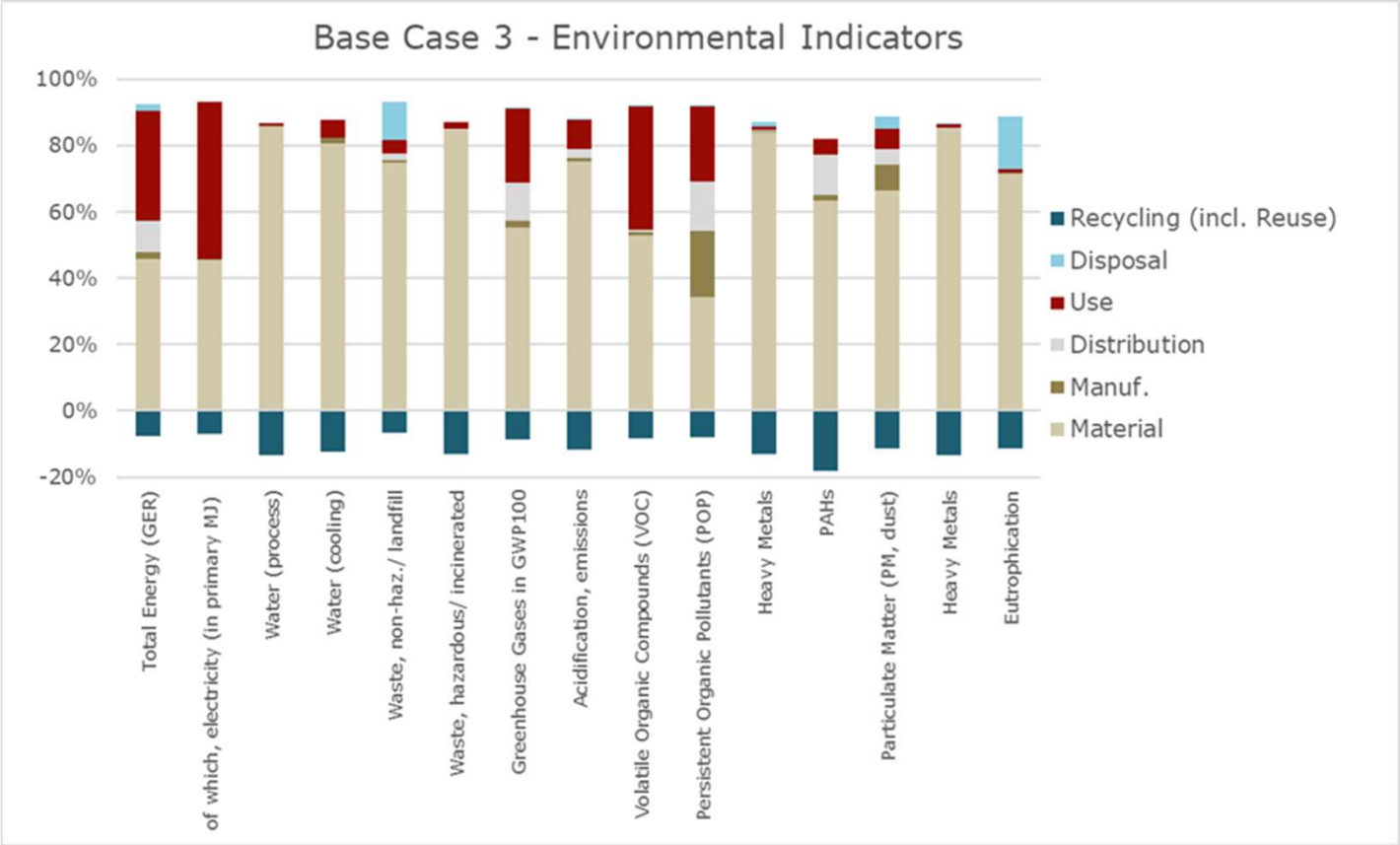
Task 5 – Base Cases: Environmental assessment



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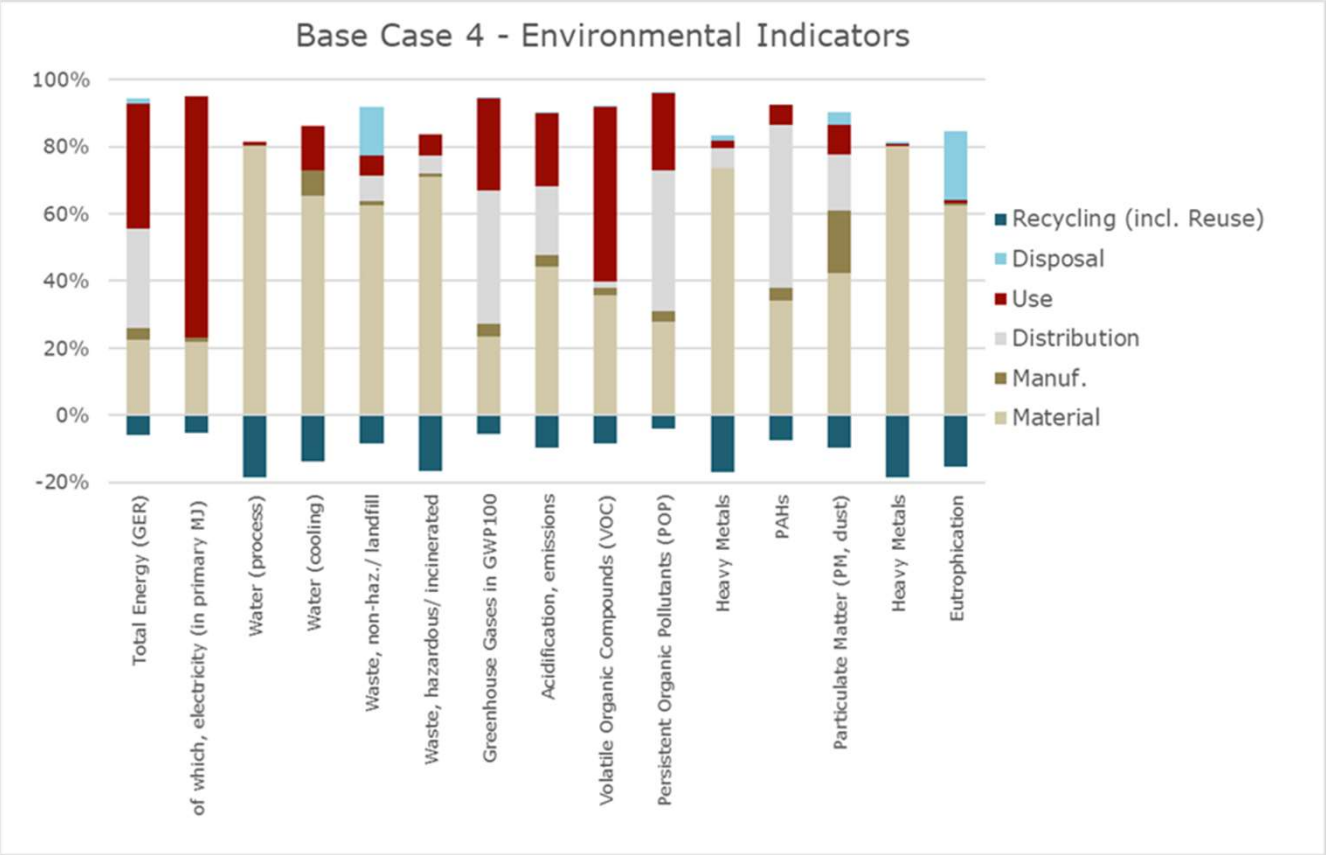
Task 5 – Base Cases: Environmental assessment



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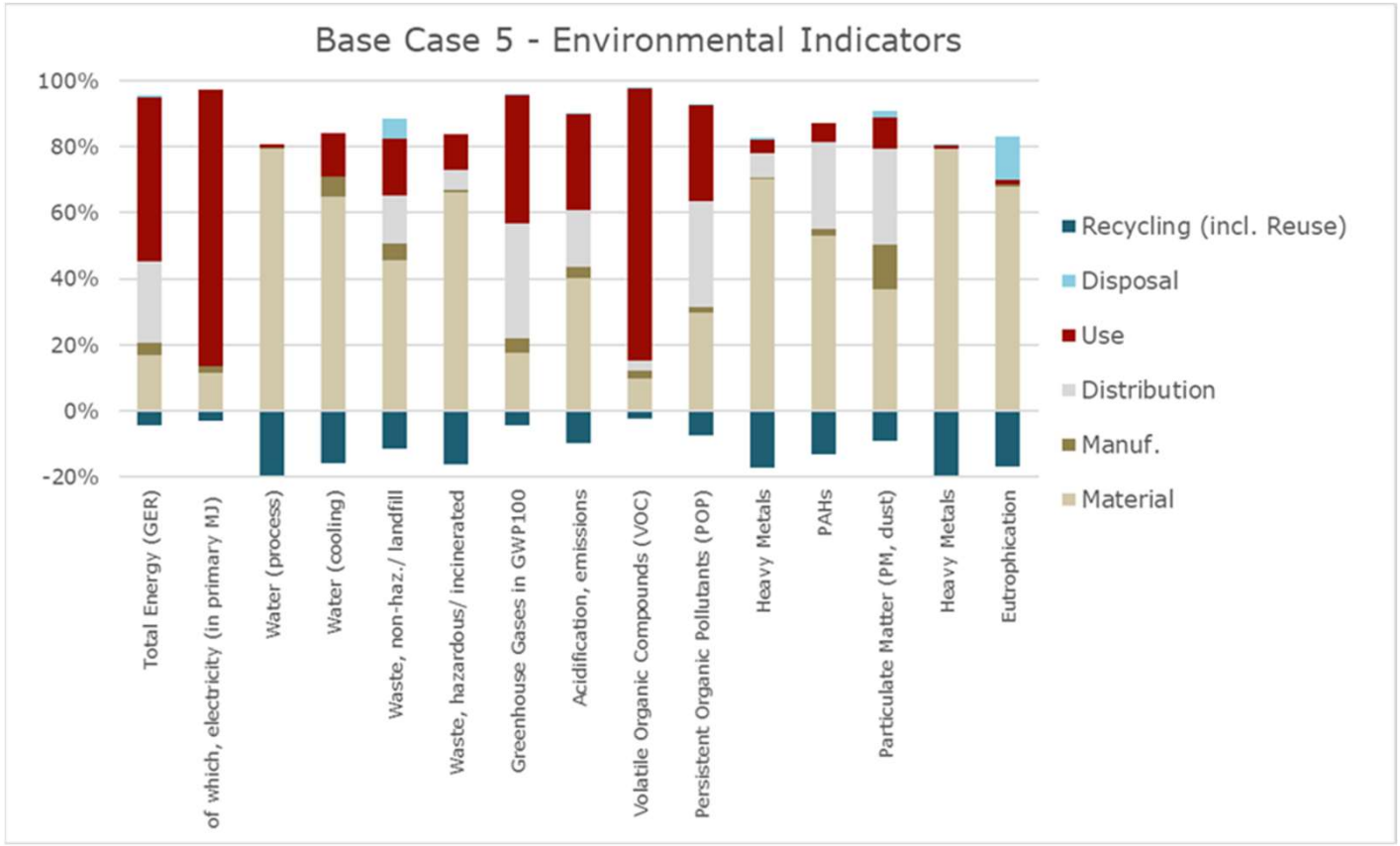
Task 5 – Base Cases: Environmental assessment



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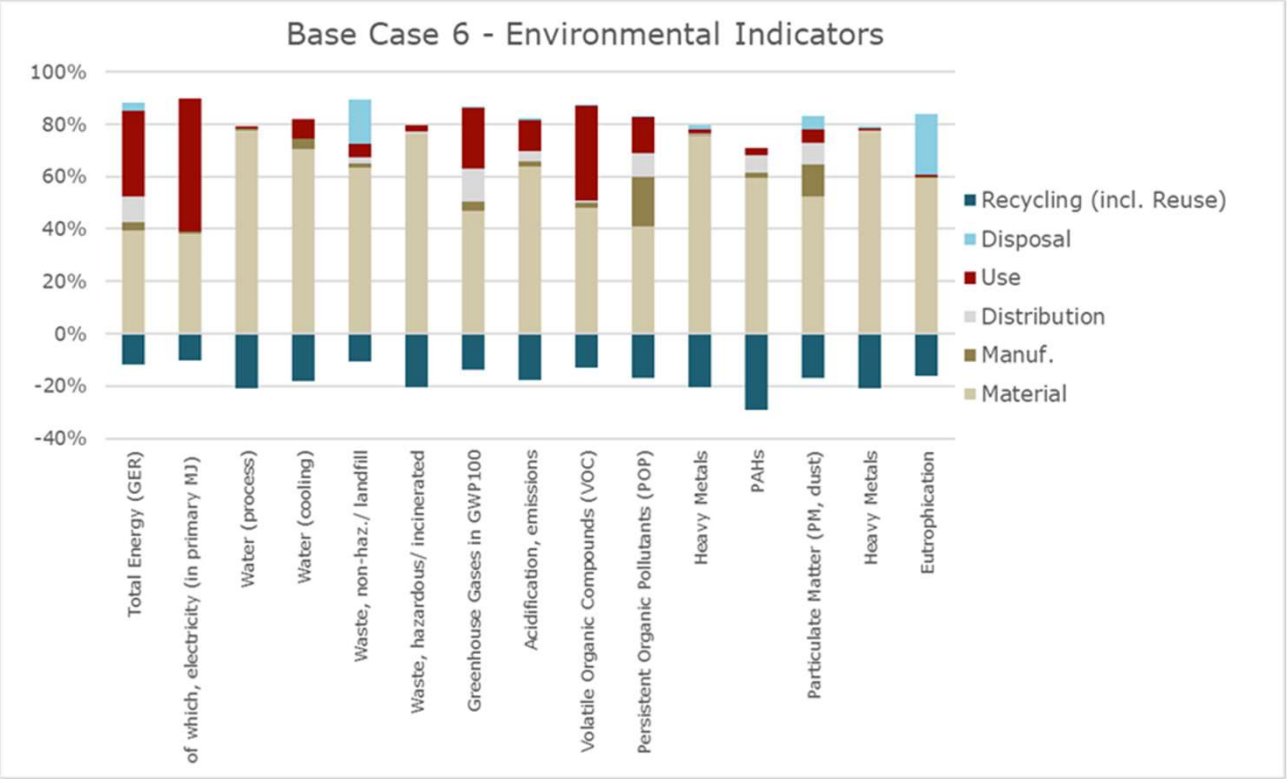
Task 5 – Base Cases: Environmental assessment



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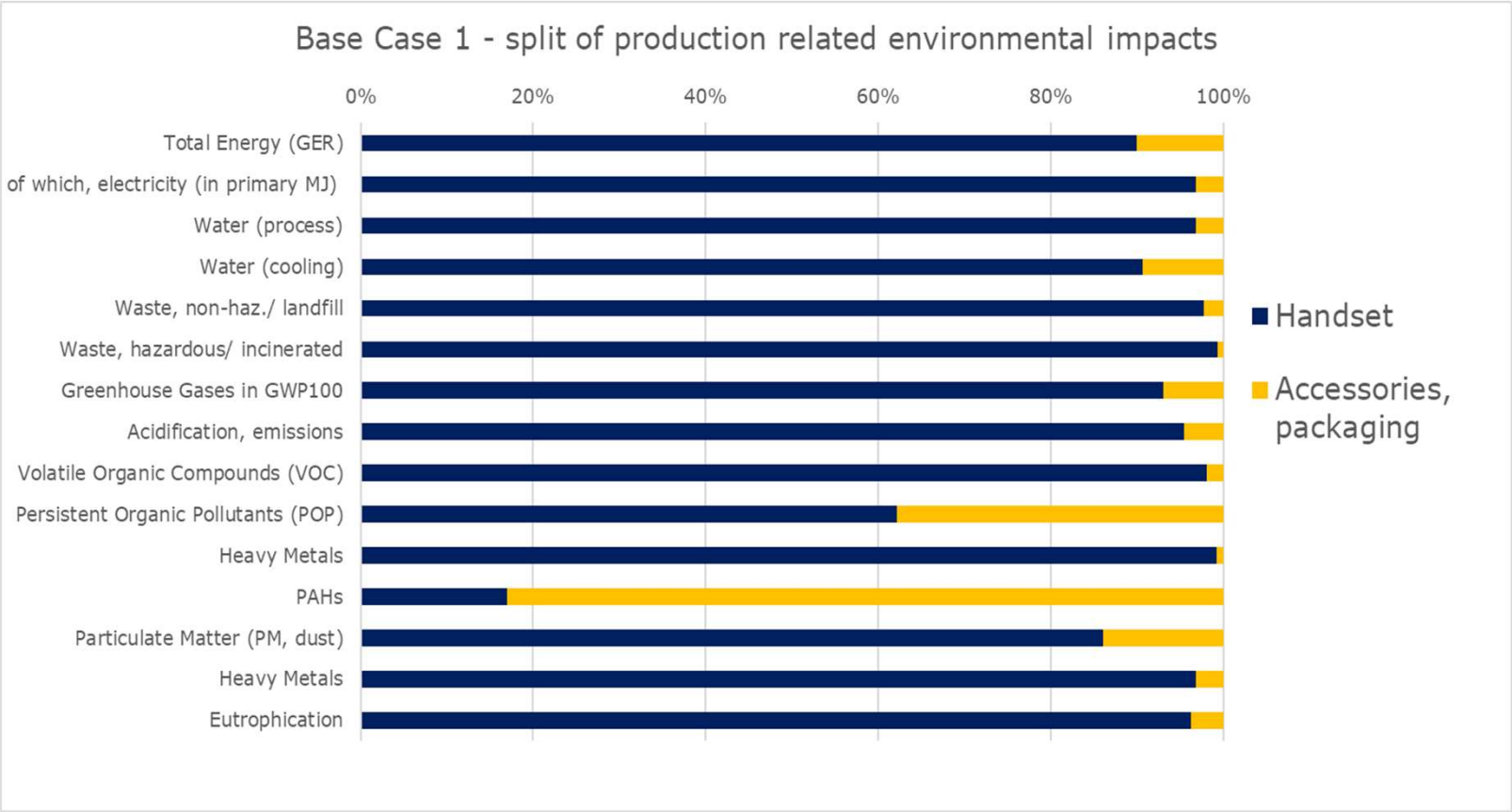
Task 5 – Base Cases: Environmental assessment



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Task 5 – Base Cases: Critical Raw Materials assessment

Critical Raw Material	Weight in g per product				Characterization factor [kg Sb eq./kg]	CRM indicator			
	Base Cases 1-3 (smartphones)	Base Case 4 (feature phone)	Base Case 5 (cordless phone)	Base Case 6 (tablet)		Base Cases 1-3 (smartphones)	Base Case 4 (feature phone)	Base Case 5 (cordless phone)	Base Case 6 (tablet)
Germanium (Ge)					18	0	0	0	0
Beryllium (Be)					12	0	0	0	0
Tantalum (Ta)	0,02	0,09	0,0005	0,04	9	0,00018	0,00081	0,0000045	0,00036
Indium (In)	0,01	0,01		0,02	9	0,00009	0,00009	0	0,00018
Platinum Group metals (PGM)	0,01	0,02	0,02	0,01	8	0,00008	0,00016	0,00016	0,00008
Gallium (Ga)	0,0004	0,005		0,002	8	0,0000032	0,00004	0	0,000016
Antimony (Sb)					1	0	0	0	0
Tungsten					0,2	0	0	0	0
Niobium (Nb)					0,04	0	0	0	0
Rare earth elements (Sc, Y, Nd)	0,1	0,1	0,21	0,75	0,03	0,000003	0,000003	0,0000063	0,0000225
Cobalt (Co)	6	3	0,7	15	0,02	0,00012	0,00006	0,000014	0,0003
Graphite (C)					0,01	0	0	0	0
Fluorspar (CaF2)					0,001	0	0	0	0
Magnesium (Mg)	5,54			20	0,0005	0,00000277	0	0	0,00001
CRM indicator						**0,00047897**	**0,001163**	**0,0001848**	**0,0009685**

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Task 5 – Base Cases: Environmental Impacts EU stock

Summary Environmental Impacts EU-Stock										
Main life cycle indicators							value	unit	%	EU totals
	BC1	BC2	BC3	BC4	BC5	BC6	all BCs			
Materials										
Plastics	0,004	0,003	0,003	0,001	0,003	0,003	**0,016**	Mt	**0,034%**	48
Ferrous metals	0,001	0,001	0,001	0,000	0,000	0,001	**0,003**	Mt	**0,002%**	206
Non-ferrous metals	0,001	0,006	0,006	0,000	0,000	0,006	**0,020**	Mt	**0,102%**	20
Other resources & waste										
Total Energy (GER)	27,915	33,495	41,252	5,802	6,481	27,199	**142,145**	PJ	**0,188%**	75.697
of which, electricity	*1,919*	*2,476*	*3,288*	*0,367*	*0,445*	*2,142*	**10,638**	TWh	**0,380%**	2.800
Water (process)*	15,752	17,037	19,879	2,737	2,176	13,396	**70,977**	mln.m3	**0,029%**	247.000
Waste, non-haz./ landfill*	0,103	0,143	0,189	0,017	0,009	0,082	**0,542**	Mt	**0,018%**	2.947
Waste, hazardous/ incinerated*	0,009	0,013	0,019	0,001	0,000	0,007	**0,049**	kton	**0,055%**	89
Emissions (Air)										
Greenhouse Gases in GWP100	1,794	2,148	2,662	0,333	0,355	1,624	**8,915**	mt CO2eq.	**0,18%**	5.054
Acidifying agents (AP)	15,836	21,745	30,547	1,774	1,988	13,520	**85,410**	kt SO2eq.	**0,38%**	22.432
Volatile Org. Compounds (VOC)	0,505	0,640	0,828	0,095	0,091	0,570	**2,730**	kt	**0,03%**	8.951
Persistent Org. Pollutants (POP)	0,093	0,157	0,143	0,022	0,025	0,141	**0,581**	g i-Teq.	**0,03%**	2.212
Heavy Metals (HM)	18,128	26,297	38,799	1,148	0,845	14,834	**100,051**	ton Ni eq.	**1,69%**	5.903
PAHs	0,296	0,729	0,713	0,080	0,130	0,719	**2,667**	ton Ni eq.	**0,19%**	1.369
Particulate Matter (PM, dust)	0,600	0,774	0,963	0,088	0,131	0,632	**3,188**	kt	**0,09%**	3.522
Emissions (Water)										
Heavy Metals (HM)	71,278	76,699	98,682	9,579	5,894	56,338	**318,470**	ton Hg/20	**2,48%**	12.853
Eutrophication (EP)	0,641	0,783	1,000	0,087	0,072	0,582	**3,166**	kt PO4	**0,35%**	900

Task 5 – Base Cases: Life Cycle Costs

	Item	LCC new product, €, per product						total annual consumer expenditure in EU27 , in mln.€					
		BC 1	BC2	BC3	BC4	BC5	BC6	BC 1	BC2	BC3	BC4	BC5	BC6
D	Product price	200	500	1.000	80	50	330	10.800	22.500	38.571	1.200	690	7.887
E	Installation/ acquisition costs (if any)	0	0	0	0	0	0	0	0	0	0	0	0
F	Fuel (gas, oil, wood)	0	0	0	0	0	0	0	0	0	0	0	0
F	Electricity	4	6	9	3	6	9	213	274	351	62	82	280
G	Water	0	0	0	0	0	0	0	0	0	0	0	0
H	Aux. 1: None	0	0	0	0	0	0	0	0	0	0	0	0
I	Aux. 2 :None	0	0	0	0	0	0	0	0	0	0	0	0
J	Aux. 3: None	0	0	0	0	0	0	0	0	0	0	0	0
K	Repair & maintenance costs	10	16	28	5	4	17	522	720	1.074	98	51	497
	Total	214	522	1.037	89	59	356	**11.534**	**23.494**	**39.996**	**1.360**	**823**	**8.664**
	Share							13%	27%	47%	2%	1%	10%
	Total all Base Cases							85.871					
	Additional societal costs	3,58	5,86	9,44	1,49	1,91	7,45	193	264	364	24	27	184
	Total all Base Cases							1.056					
Updated societal costs:													
	Additional societal costs	12,26	19,01	29,25	6,27	7,78	25,47	662	855	1.128	100	109	637
	Total all Base Cases							3.491					

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Task 5 – Base Cases: specifics of the modelling

Q&A

short comments or questions: chat

complex comments or questions: topic -> chat AND #

Break until 13:00

(next: Task 6)

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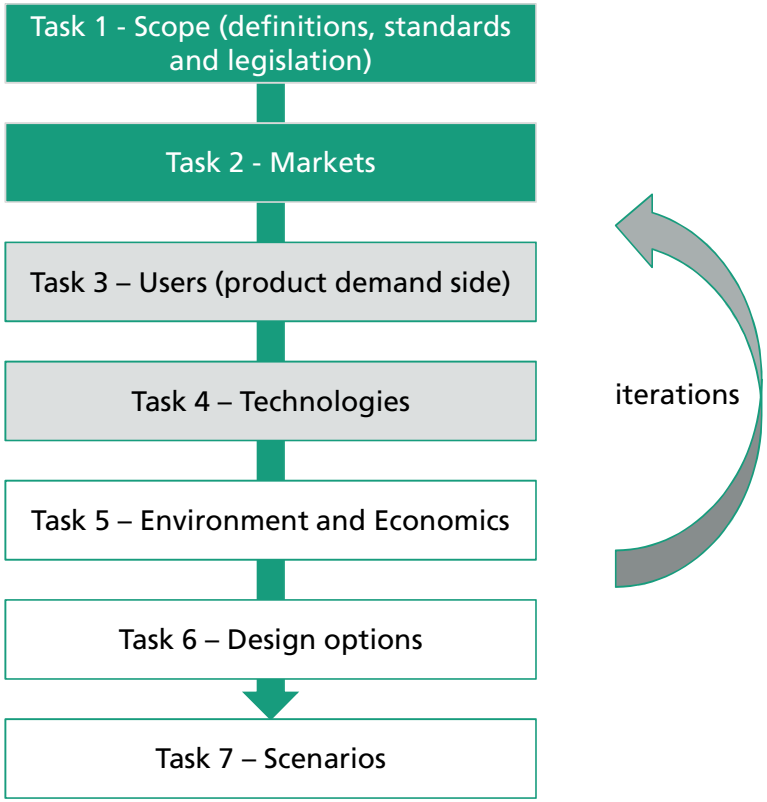
Task 6 – Design options

- **Objective** - Identify the most relevant design improvement options and quantify their influence on environmental impacts and LCC for the consumer compared to the results of Task 5 for the Base Cases.



Task 6 – Design options

Identification of design options and assessment of their impacts

1. Analysis of limiting states and EOL (Task 3)

- Failures and other replacement causes
- Repair/upgrade/recycling operations and barriers
- Impacted parts

↓

2. Review of technical improvement options and collection of design options

- Task 4
- JRC studies (material efficiency smartphones, personal computers)
- EPEAT (optional criteria)
- Fraunhofer IZM disassembly studies

↓

3. Selection of design options

Source: Cordella et al. (2020)

Task 6 – Design options

- Reliability (9 Options)
- Operating system, software and firmware (5 Options)
- Repairability (10 Options)
- Use of materials (5 Options)
- Readiness for second use and recycling (2 Options)

49 Design Options

- Ability to recycle smartphones/parts/materials (3 Options)
- Packaging (4 Options)
- Manufacturing (6 Options)
- Energy (3 Options)
- Other features (2 Options)

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Task 6 – Design options

- Design options are grouped under the following topics:
  - Reliability
  - Operating system, software and firmware
  - Reparability
  - Use of materials
  - Readiness for second use and recycling
  - Ability to recycle devices and parts
  - Packaging
  - Manufacturing
  - Energy
  - Other features
- Costs are integrated in the lifetime model
  - Costs: sales price, electricity price, costs for repair
  - ➢ eases reflection on interplay of design options, effects on environmental aspects and costs

Task 6 – Design options

Reliability

2.2.1 DO1 Robustness of display and glass back-cover against accidental drops

2.2.2 DO2 Display scratch-resistance

2.2.3 DO3 Provision of additional screen and glass back-cover protection

2.2.4 DO4 Water and dust resistance

2.2.5 DO5 Battery endurance (cycle stability)

2.2.6 DO6 Higher battery capacities to reduce number of charging cycles and states of very low state of charge

2.2.7 DO7 Pre-installed battery management software

2.2.8 DO8 Battery status (SOH, age, cycles, peak performance) reporting

Task 6 – Design options

Operating system, software and firmware

2.3.2 DO11 Availability of update support of OS (e.g. 5 years after the placement of the last unit of the model on the market), including information on impact of updates and reversibility of updates

2.3.3 DO12 Possible use of open source OS or open source Virtual Machine software

2.3.4 DO13 Security patches latest 2 months after the release of the new update (1 month is considered to be not realistic)

Task 6 – Design options

Reparability

2.4.1 DO15 Battery removability/replacement: Joining techniques

2.4.3 DO17 Battery removability/replacement without use of tools and use of AAA batteries for cordless phones

2.4.4 DO18 Glass back cover removability/replacement

2.4.5 DO19 Display removability/replacement

2.4.6 DO20 Provision of repair and maintenance information

2.4.7 DO21a/b Availability of spare parts (priority parts, e.g. battery, display) that can be used for repair without negative implications for functionality of the device

2.4.8 DO22 Provision of information on maximum costs for display & battery replacement

2.4.9 DO23 Use of reversible and reusable fasteners (housing)

Task 6 – Design options

Use of materials

2.5.2 DO25 Use of post-consumer recycled plastics

2.5.3 DO26 Use of bio-based plastics

2.5.4 DO27 Provision of products without External Power Supplies (EPS) and other accessories

Readiness for second use and recycling

2.6.1 DO29 Reliable data erasure through encryption combined with factory reset

2.6.2 DO30 Data transfer from an old to a new product is conveniently possible via installed or downloadable tools or cloud-based services

Packaging

2.8.1 DO41 Use of fiber-based packaging materials

2.8.2 DO42 Improvement of packaging efficiency

Task 6 – Design options

Ability to recycle smartphones / parts / materials

2.7.1 DO38 Collection of products / put in place take back schemes

2.7.2 DO39 Identification, access and removal of specific parts

2.7.3 DO40 Provision of additional information for recyclers

Manufacturing

2.9.1 DO45 Renewable energy used for the manufacturing of PCBs and semiconductors

2.9.2 DO46 Ground or cargo vessel transports only

2.9.3 DO47 Area-optimised PCB design

2.9.4 DO33 Reduction of fluorinated gas emissions resulting from flat panel display manufacturing

2.9.5 DO48 Reduction of fluorinated gas emissions resulting from IC manufacturing

Task 6 – Design options

Energy

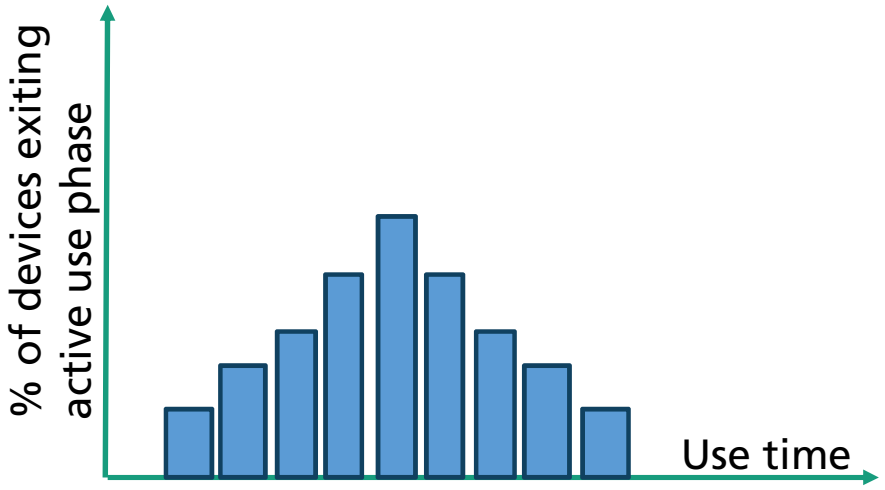
2.10.1 DO49 Extended battery endurance per full charge

2.10.2 DO50 Reduced standby power consumption (for DECT only)

2.10.3 DO51 Eco-DECT

Task 6 – Lifetime model

- Many design options affect the lifetime
- Estimations of the effect of design options on the lifetime of base case devices are needed
- Average lifetime is a statistical number
  - Products exit the active use phase and enter end-of-life distributed over time rather than all at the same point in time
  - Lifetime model takes account of the identified reasons for products reaching their end of life and how this changes over time
  - Lifetime model assumes maximum lifetime:
    - 7 years for smartphones and feature phones (BC1-4)
    - 9 years for DECT phones and tablets (BC5, 6)

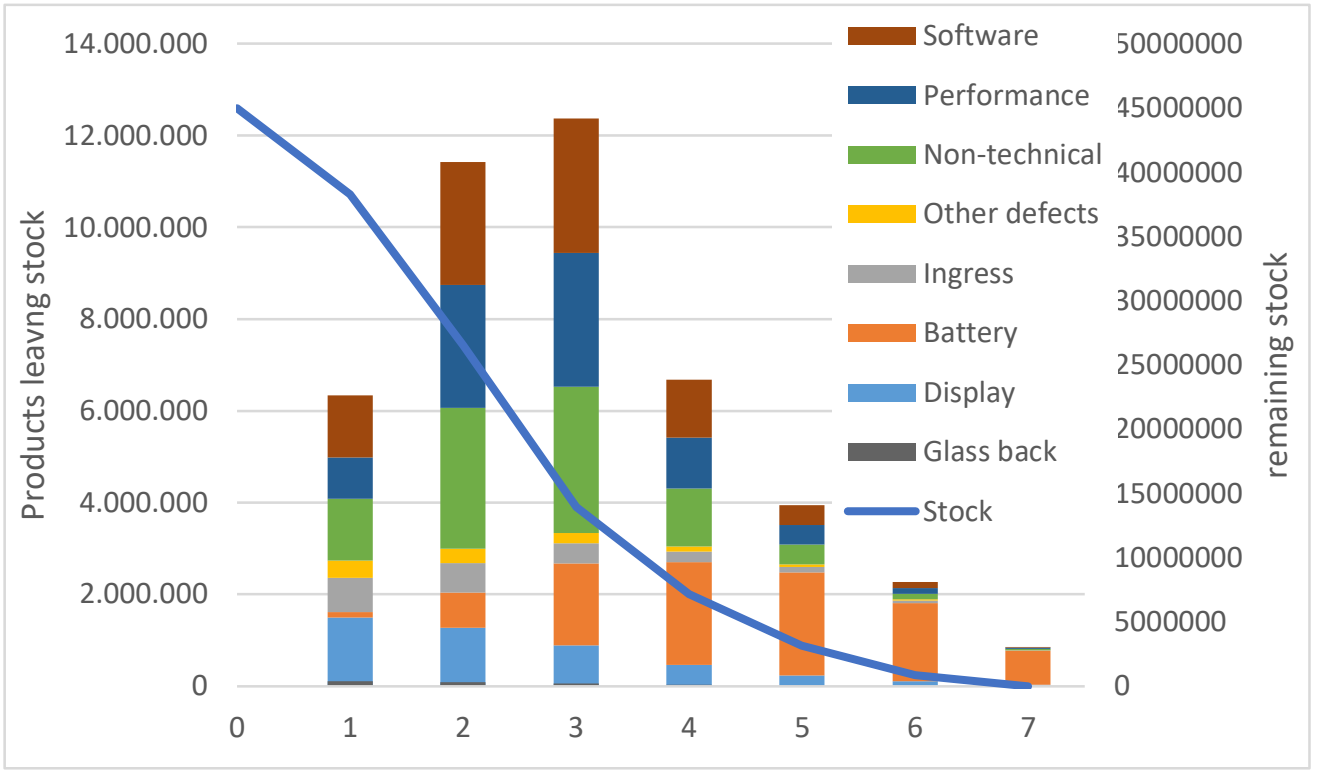


Task 6 – Lifetime model – general assumptions

- Hardware defects (based on Task 5):
  - Display damage
  - Damage of glass back cover
  - Battery failure and/or loss of capacity
  - Damages through water & dust ingress
  - Other defects
- Assumptions for hardware defects (based on Task 5):
  - Yearly failure and repair rates as percentage of remaining stock
  - Steady failure rate, exemption: battery failure rate increases over time
- Non-hardware reasons:
  - Performance-related product retirement
  - Software-related product retirement
  - Non-technical reasons (“psychological obsolescence”, etc.)
- Non-hardware reasons are adjusted to meet the average lifetime

Task 6 – Lifetime model – general assumptions

- Exemplary lifetime model for BC2
- Maximum lifetime assumed to be 7 years
- Design options are plotted on these lifetime models
- ➢ Reduction of one failure rate reduces the number of products leaving the stock *due to this specific defect*
- ➢ leading to increase *in absolute numbers* of other defects and repairs in the following years as number of products in remaining stock changes and percentaged failure rates stay the same



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Task 6 – Lifetime model

Q&A

short comments or questions: chat

complex comments or questions: topic -> chat AND #

Task 6 – Design options

Selection of design options to be explained today (full details: Task 6 report)

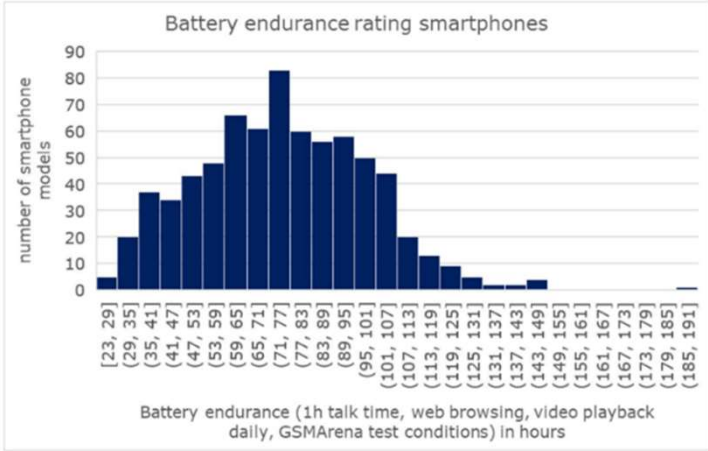
- Reliability (DO5)
- Operating system, software and firmware (DO11)
- Repairability (DO17, 19, 20, 21)
- Use of materials (DO27)
- Readiness for second use and recycling (DO29)

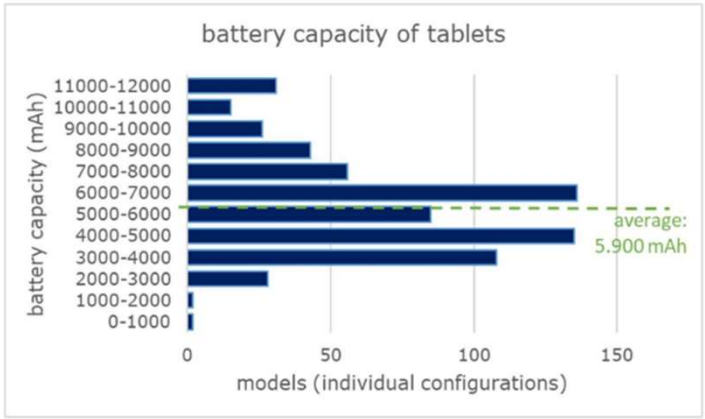
13 Design Options

- Ability to recycle smartphones/parts/materials (n.a)
- Packaging (n.a)
- Manufacturing (DO33, 48, 47)
- Energy (DO45, 49)
- Other features (n.a)

DO49 Extended battery endurance per full charge

- Sufficient battery endurance per cycle has been named as a major factor in user expectations / purchase decisions
- Battery endurance per cycle is a function of battery capacity and energy efficiency of the device
- Significant market share of devices achieve 30 % above market average battery endurance (incl. high-end)
- **Design option:** Battery endurance (per cycle) of 30 % above market average
- **Improvement:** Energy savings through less frequent charging (when energy efficiency is increased); longer battery lifetime in terms of cycles as the same number of charging cycles is stretched over a 30% longer period





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DO49 Extended battery endurance per full charge: Expected effects

Base Case	Expected effect on affected devices	Share of devices affected in base case	Cost effect on affected devices per unit
BC1: Smartphone, low-end	• Energy consumption: 30% of the active charge time in trickle charge instead • Need for battery replacement arises 30% later in time • 10% larger batteries	100%	-0,32 € Energy savings per year of use +0,40 € battery costs extended lifetime savings
BC2: Smartphone, mid-range			-0,46 € Energy savings per year of use +0,60 € battery costs extended lifetime savings
BC3: Smartphone, high-end			-0,64 € Energy savings per year of use +0,80 € battery costs extended lifetime savings
BC4: Feature phone	Not relevant	Not relevant	
BC5: DECT phone	Not relevant	Not relevant	
BC6: Tablet	• Energy consumption: 30% of the active charge time in trickle charge instead • Need for battery replacement arises 30% later in time • 10% larger batteries		-0,51 € Energy savings per year of use +1 € battery costs extended lifetime savings

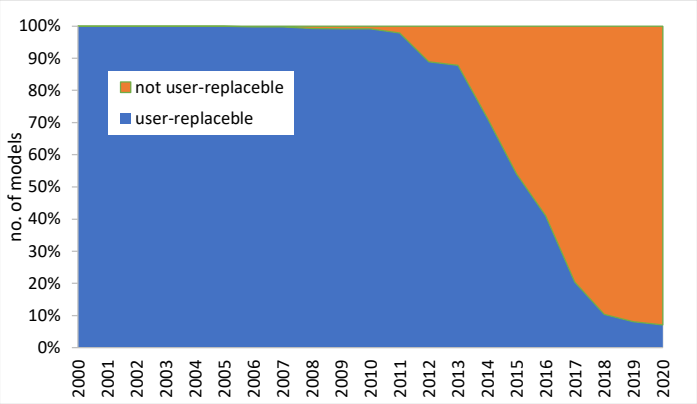
DO49 Extended battery endurance per full charge

- **Lifetime**: Considerable increase in average lifetime for some BC
- **Cost**: Slightly increased production cost for higher quality / capacity battery; energy savings due to increased energy efficiency; cost savings for user due to extended lifetime of battery and product
- **Product design**: No change expected

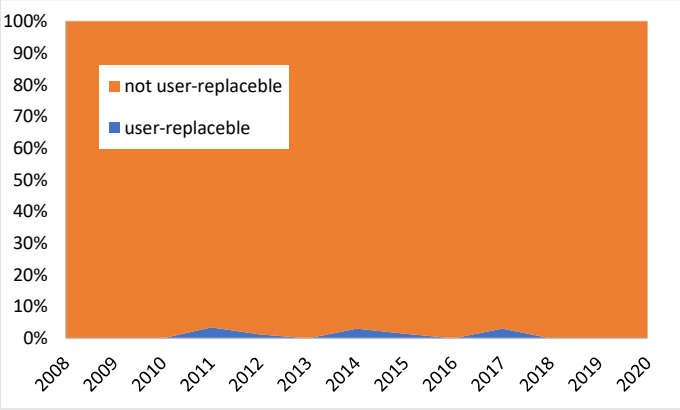
DO5	BC1	BC2	BC3	BC4	BC5	BC6
Lifetime [y]	2,5+0,086	3+0,135	3,5+0,205	3	5	5+0,112
LCC [€]	87,06-3,69	176,94-8,71	301,45-18,20	36,39	11,84	73,72-3,98

DO5 Battery endurance (cycle stability)

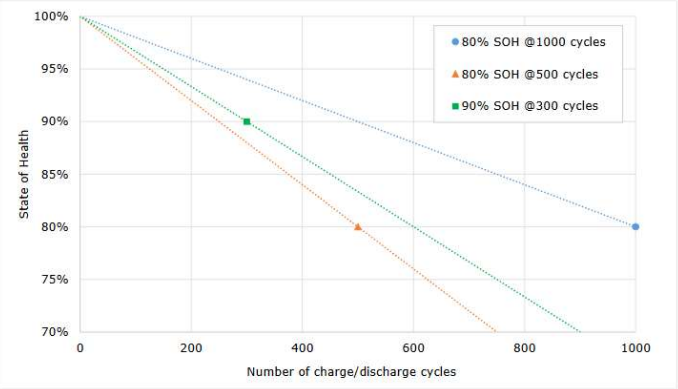
- Smartphone and tablet batteries are not commonly user-replaceable (Task 4)
- Battery-related defect rates are between 8,3 % (BC1) and 50 % (BC5) over their lifetime (Task 5)
- **Design option:** Device batteries retain at least 90% of their initial capacity after 300 full charge/discharge cycles, measured in accordance with IEC/EN 61960
- **Improvement:** 20 % increased battery endurance for affected batteries



Smartphones



Tablets



Improvement

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DO5 Battery endurance (cycle stability): Expected effects

Base Case	Expected effect on affected devices	Share of devices affected in base case	Estimated cost effect
BC1: Smartphone, low-end	20 % longer lifetime of battery	100% of devices (estimate)	+2 Euro production cost
BC2: Smartphone, mid-range	20 % longer lifetime of battery	50% of devices (estimate)	+1 Euro production cost
BC3: Smartphone, high-end	No effect (devices assumedly already have high-endurance batteries)	0% of devices (estimate)	No effect
BC4: Feature phone	20 % longer lifetime of battery	100% of devices (estimate)	+1 Euro production cost
BC5: DECT phone	No effect (cycle withstand is assumed not as relevant to battery ageing in DECT phones)	0 % of devices (estimate)	+1 Euro production cost
BC6: Tablet	20 % longer lifetime of battery	50 % of devices (estimate)	+2 Euro production cost

DO5 Battery endurance (cycle stability): Effects on LCC, product, lifetime

- **Lifetime**: Slight increase in average lifetime for BC1,2,4,6
- **Cost**: Production and repair cost increase slightly (higher quality batteries cost 1-2 Euros extra); reduced overall LCC due to reduction in battery repair frequency, longer lifetime of device
- **Product design**: No change expected

DO5	BC1	BC2	BC3	BC4	BC5	BC6
Lifetime [y]	2,5+0,074	3+0,055	3,5	3+0,126	5	5+0,047
LCC [€]	87,06-2,26	176,94-4,06	301,45	36,39-1,30	11,84	73,72-0,80

DO17 Battery removability/replacement without use of tools and use of AAA batteries for cordless phones

- **Smartphone and tablet** batteries are commonly embedded into the device and not accessible without the use of tools (approx. 90-100 % market share, Task 4)
  - **Design option:** Batteries can be accessed, removed, and replaced without the use of any types of tools, thermal energy, or solvents
  - **Improvement:** Much simpler battery replacement especially for users (DIY repair), considerably increasing the repair rate for defect batteries. Full benefits only materialize in conjunction with better spare parts availability (DO21).

- **Cordless phones** in some cases feature embedded batteries or proprietary battery pack designs that limit the long-term availability of reasonably-priced spare parts compared to using rechargeable standard AAA batteries (estimated market share: 15 %)
  - **Design option:** Use of rechargeable standard AAA batteries
  - **Improvement:** Increased repair rate for defect batteries considerably increase lifetime of devices

DO17 Battery removability/replacement without use of tools and use of AAA batteries for cordless phones: Expected effects

Base Case	Expected effect on affected devices	Share of devices affected in base case	Estimated cost effect on affected devices per unit
BC1: Smartphone, low-end	BC1-3: Repair rate for defect battery is increased from 33 % to 50 %	95 %	Battery repair cost reduced to 30 Euros
BC2: Smartphone, mid-range		95 %	
BC3: Smartphone, high-end		100 %	
BC4: Feature phone	Assumed to already have removable battery	0 %	none
BC5: DECT phone	+2,5 years lifetime	15 %	7 Euros for one extra AAA battery set
BC6: Tablet	Repair rate for defect battery is increased from 33 % to 50 %	95 %	Battery repair cost reduced to 50 Euros

DO17 Battery removability/replacement without use of tools and use of AAA batteries for cordless phones: Effects on LCC, product, lifetime («stand-alone»)

- **Lifetime**: Noticeable increase in average lifetime for all BC except 4
- **Cost**: No noticeable effect on production cost (such design has been standard in the past); drastically reduced cost for battery repair; considerable reduction of LCC for BC2+3
- **Product design**: Different design required for most smartphones and tablets, some DECT phones; possibly reduction of the ingress protection (IP67 is proven feasible, IP68 proven with rugged phones); possibly less damage of smartphone back covers as glass less likely to remain the material of choice

DO5	BC1	BC2	BC3	BC4	BC5	BC6
Lifetime [y]	2,5+0,03	3+0,049	3,5+0,082	3	5+0,338	5+0,054
LCC [€]	87,06-1,75	176,94-4,14	301,45-9,93	36,39	11,84	73,72-0,12

DO19 Display removability/replacement

- Display damage is the most frequent defect in smartphones and tablets (Task 3).
  - **Improvement:** A removable display is expected to simplify and speed up the process for professional repair shops and foster additional DIY repair.

- This measure depends on the availability of display units (DO21) to unfold its full potential.
- As long as availability for consumers is not given, the effect will be limited to those cases, where displays can be sourced from third parties or through cannibalising other defect devices.

DO19 Display removability/replacement: Expected impact

Base Case	Expected effect on affected devices	Share of devices affected in base case	Estimated cost effect
BC1: Smartphone, low-end	30 % more display defects repaired	70 %	Costs per additional display repair: –50%
BC2: Smartphone, mid-range	40 % more display defects repaired	70 %	
BC3: Smartphone, high-end	50 % more display defects repaired	95 % (use of adhesives or adhesive + screws is typical for this BC)	Costs per additional display repair: –50%
BC4: Feature phone	No effect as displays in most designs are already integrated repair-friendly	0 %	n.a.
BC5: DECT phone	No effect as displays in most designs are already integrated repair-friendly	0%	n.a.
BC6: Tablet	40 % more display defects repaired	95 %	Costs per additional display repair: –50%

DO19 Display removability/replacement: Effects on lifetime, LCC and product design

- **Lifetime:** Significant increase of lifetime in BC3, trend is noticeable in BC 1, 2 and 6.
- **Cost:** No noticeable effect on production cost (such design has been demonstrated); noticeable reduction of LCC for BC3.
- **Product design:** Different design is likely required for most smartphones and tablets. Possible reduction of the ingress protection.

DO5	BC1	BC2	BC3	BC4	BC5	BC6
Lifetime [y]	2,5+0,031	3+0,05	3,5+0,122	3	5	5+0,054
LCC [€]	87,06-1,05	176,94-2,95	301,45-9,12	36,39	11,84	73,72-0,69

DO20 Provision of repair and maintenance information

- Provision of comprehensive information (e.g. through user manuals) is necessary to support the repair/upgrade operation.
- Enabling repair information to various target groups of repairers could reduce repair costs.
- For popular devices comprehensive repair guidance is available through third parties already. For the broad market of low-end and mid-range devices such third party repair instructions are much less common and better OEM information can make a significant difference.

DO20 Provision of repair and maintenance information: Expected impact

- DO20 unveils its full potential only in conjunction with battery removability (DO15), display removability (DO19), spare parts availability (DO21) as well as reversible and reusable fasteners (DO23).
- DO20 is calculated as stand-alone with a 10% increase in repairs.

Base Case	Expected effect on affected devices	Share of devices affected in base case	Estimated cost effect
BC1: Smartphone, low-end	10 % more repaired	100 %	no effect
BC2: Smartphone, mid-range	10 % more repaired	100 %	no effect
BC3: Smartphone, high-end	10 % more repaired	100 %	no effect
BC4: Feature phone	10 % more repaired	100 %	no effect
BC5: DECT phone	not relevant		
BC6: Tablet	10 % more repaired	100 %	no effect

DO20 Provision of repair and maintenance information: Effects on lifetime, LCC and product design

- **Lifetime:** Noticeable increase of lifetime in BC3, trend is noticeable in BC 1, 2, 4 and 6
- **Cost:** Information provision does not result in additional costs. Noticeable reduction of LCC for BC3.
- **Product design:** No effect.

DO5	BC1	BC2	BC3	BC4	BC5	BC6
Lifetime [y]	2,5+0,049	3+0,07	3,5+0,1	3+0,065	5	5+0,076
LCC [€]	87,06-0,82	176,94-2,78	301,45-6,31	36,39-0,13	11,84	73,72-0,03

DO21a/b Availability of spare parts – a) shops and b) DIY

- The availability of spare parts, especially for those parts with highest failure rate, is instrumental for a repair/upgrade process.
- Lack of spare parts prevented 4% of the respondents in a study on consumer repair attitudes to repair their smartphones (Task 3).

DO21a Availability of spare parts (shops) - Expected effects

- Ensuring spare parts availability results in additional logistics costs, but it is up to the price policy of the OEM, if this results in increased product prices or increased spare parts prices.
- DO21a is calculated with no changes to purchase prices, but higher repair costs (+5%).

Base Case	Expected effect on affected devices	Share of devices affected in base case	Estimated cost effect
BC1: Smartphone, low-end	10 % more repaired	30 %	+5% repair costs
BC2: Smartphone, mid-range	10 % more repaired	20 %	+5% repair costs
BC3: Smartphone, high-end	10 % more repaired	10 %	+5% repair costs
BC4: Feature phone	5 % more repaired	10 %	+5% repair costs
BC5: DECT phone			
BC6: Tablet	10 % more repaired	50 %	+5% repair costs

DO21b Availability of spare parts (DIY) - Expected effects

- No cost effect assuming 5% cost increase on professional repairs and the additional 10% of repairs are DIY.
- The availability of spare parts for DIY unveils its full potential only in conjunction with DO23 “removable and reusable fasteners” as well as DO19 “display removability”.

Base Case	Expected effect on affected devices	Share of devices affected in base case	Estimated cost effect
BC1: Smartphone, low-end	10 % more repaired	60 %	0 EUR
BC2: Smartphone, mid-range	10 % more repaired	75 %	0 EUR
BC3: Smartphone, high-end	10 % more repaired	90 %	0 EUR
BC4: Feature phone	10 % more repaired	10 %	0 EUR
BC5: DECT phone			
BC6: Tablet	10 % more repaired	50 %	0 EUR

DO21a/b Availability of spare parts: Effects on lifetime and LCC

DO21a (shops)

DO5	BC1	BC2	BC3	BC4	BC5	BC6
Lifetime [y]	2,5+0,01	3+0,009	3,5+0,07	3+0,002	5	5+0,023
LCC [€]	87,06+0,14	176,94+0,05	301,45+0,22	36,39+0,16	11,84	73,72+0,28

DO21b (users)

DO5	BC1	BC2	BC3	BC4	BC5	BC6
Lifetime [y]	2,5+0,02	3+0,03	3,5+0,06	3+0,004	5	5+0,023
LCC [€]	87,06-1,82	176,94-4,4	301,45-9,9	36,39	11,84	73,72-1,4

DO11 Availability of update support of OS

- Discontinued OS support is a major reason for security and performance issues
- Currently, support duration is roughly in the range of the Base Case lifetimes of 2,5, 3 and 3,5 years for Base Cases 1, 2, 3 respectively
- An OS support of 5 years eliminates the OS as major lifetime limiting factor for another 2,5, 2 and 1,5 years for these 3 Base Cases

- **Design option:** Provision of OS updates until 5 years after placement of the last model on the market, including information on impact and reversibility of updates
- **Improvement:** Extended lifetime of devices

DO11 Availability of update support of OS: Expected effects

Base Case	Expected effect on affected devices	Share of devices affected in base case	Estimated cost effect
BC1: Smartphone, low-end	2,5 years longer lifetime	5%	+2 Euros purchase price
BC2: Smartphone, mid-range	2 years longer lifetime	5%	+2 Euros purchase price
BC3: Smartphone, high-end	1,5 years longer lifetime	5%	+2 Euros purchase price
BC4: Feature phone	Not relevant	n.a.	none
BC5: DECT phone	Not relevant	n.a.	none
BC6: Tablet	1 year longer lifetime	5%	+2 Euros purchase price

DO11 Availability of update support of OS: Effects on LCC, product, lifetime

- **Lifetime**: Considerable increase in average lifetime if most affected BC
- **Cost**: Increased purchase price of +2 Euros; considerable cost reduction for users through extended lifetime
- **Product design**: No change required

DO5	BC1	BC2	BC3	BC4	BC5	BC6
Lifetime [y]	2,5+0,279	3+0,219	3,5+0,097	3	5	5+0,157
LCC [€]	87,06-6,82	176,94-10,30	301,45-7,00	36,39	11,84	73,72-1,42

DO29 Reliable data erasure through encryption combined with factory reset

- Data privacy concerns are a major reason for the large amount of hibernating devices; 65% of smartphones, feature phones, tablets are assumed to go into hibernation (Task 4)
- More than 20 % of all mobile phones and tablets are hoarded after use due to privacy concerns
- Encrypting all user data on a device and deleting the key with a factory reset would increase confidence in data erasure features; both Android and iOS support this feature
- **Design option:** Implement as default
- **Improvement:** More devices become available for active reuse, partially in combination with refurbishment activities (swapping the battery)

DO29 Reliable data erasure through encryption combined with factory reset: Expected effects

Base Case	Expected effect on affected devices	Share of devices affected in base case	Estimated cost effect
BC1: Smartphone, low-end	+1,5 years	5%	+2,5€ (i.e., 50 € recommerce costs/margin per device)
BC2: Smartphone, mid-range	+1,5 years	10%	+10€ (i.e., 100 € recommerce costs/margin per device)
BC3: Smartphone, high-end	+1,5 years	10%	+15€ (i.e., 150 € recommerce costs/margin per device)
BC4: Feature phone	+1,5 years	5%	+2€ (i.e., 40 € C2C shipping costs and replacement battery)
BC5: DECT phone	n.a.		
BC6: Tablet	+1,5 years	10%	+10€ (i.e., 100 € recommerce costs/margin per device)

DO29 Reliable data erasure through encryption combined with factory reset: Effects on LCC, product, lifetime

- **Lifetime**: Increase in average lifetime, in particular for BC1
- **Cost**: Considerable cost reduction for users through extended lifetime and resale value, despite added cost for refurbishment (refurbishment process + profit margin)
- **Product design**: No change required

DO5	BC1	BC2	BC3	BC4	BC5	BC6
Lifetime [y]	2,5+0,169	3+0,046	3,5+0,087	3+0,043	5	5+0,084
LCC [€]	87,06-4,86	176,94-2,32	301,45-5,79	36,39-0,40	11,84-5,79	73,72-0,82

DO27 Provision of products without External Power Supplies (EPS) and other accessories

- Selling mobile phones, smartphones and tablets without EPS reduces the number of EPS that need to be manufactured as compatible units are likely already available in households
- Selling without headsets would result in approx. 25 % of users purchasing a headset separately
- Unbundling has been shown to result in environmental benefits due to decreased manufacturing / e-waste and smaller packaging footprint of devices

- **Design option:** Unbundle the sales of devices from EPS and other accessories (headsets)
- **Improvement:** Reduction in retail prices, environmental benefits; no effects on lifetime of devices

DO27 Provision of products without External Power Supplies (EPS) and other accessories: Expected effects

Main component	Type	Production cost [€]	Wholesale price [€]	Retail price [€]	Base Case (Mobile phones, smartphones, tablet study)
Source: Common Charger Impact Assessment Study					
EPS - USB C	USB C - Standard charger	2,50	6,-	11,-	1, 4, 5
EPS - USB C	USB C - Fast charger - USB-PD	4,-	8,-	15,-	2, 3, 6
EPS - USB C	USB C - Fast charger - QuickCharge	4,-	8,-	15,-	
Headset	Mid-range quality, wired	3,50	7,-	14,-	1, 2, 3, 4

DO27 Provision of products without External Power Supplies (EPS) and other accessories: Effects on LCC, product, lifetime

- **Lifetime**: No effect
- **Cost**: Minor reduction in LCC due to reduced retail prices
- **Product design**: No change required

DO5	BC1	BC2	BC3	BC4	BC5	BC6
LCC [€]	87,06-0,32	176,94-0,50	301,45-0,43	36,39-0,27	11,84-0,16	73,72-0,40

Design options: Manufacturing and Energy

- **DO45 Renewable energy used for the manufacturing of PCBs and semiconductors**
  - **Effect**: Reduction in carbon emissions from semiconductor/PCB manufacturing by -60 % without impacts on cost (newly installed renewable power plants cost less than cheapest fuel-based power generation options)
- **DO33 Reduction of fluorinated gas emissions resulting from flat panel display manufacturing**: Reducing PFC emissions through abatement
  - **Effect**: -5 % GHG emissions from LCD manufacturing; minor increase in manufacturing costs (between 0,05 Euro (BC1) and 0,25 Euro (BC3))
- **DO48 Reduction of fluorinated gas emissions resulting from IC manufacturing:** Reducing PFC emissions through abatement
  - **Effect**: -5 % GHG emissions from CPU/SoC, RAM, Flash manufacturing with minor increase in manufacturing costs
- **DO47 Area-optimised PCB design:** Reducing PCB cut-off in manufacturing resulting from odd shapes in low-end and mid-range devices by adding flex PCB bridges between optimized PCB
  - **Effect**: Less rigid PCB, more flex, more housing plastics for some of the base case devices; minor increase in manufacturing costs (+0,50 Euros)

Task 6 – Overview and Design Options

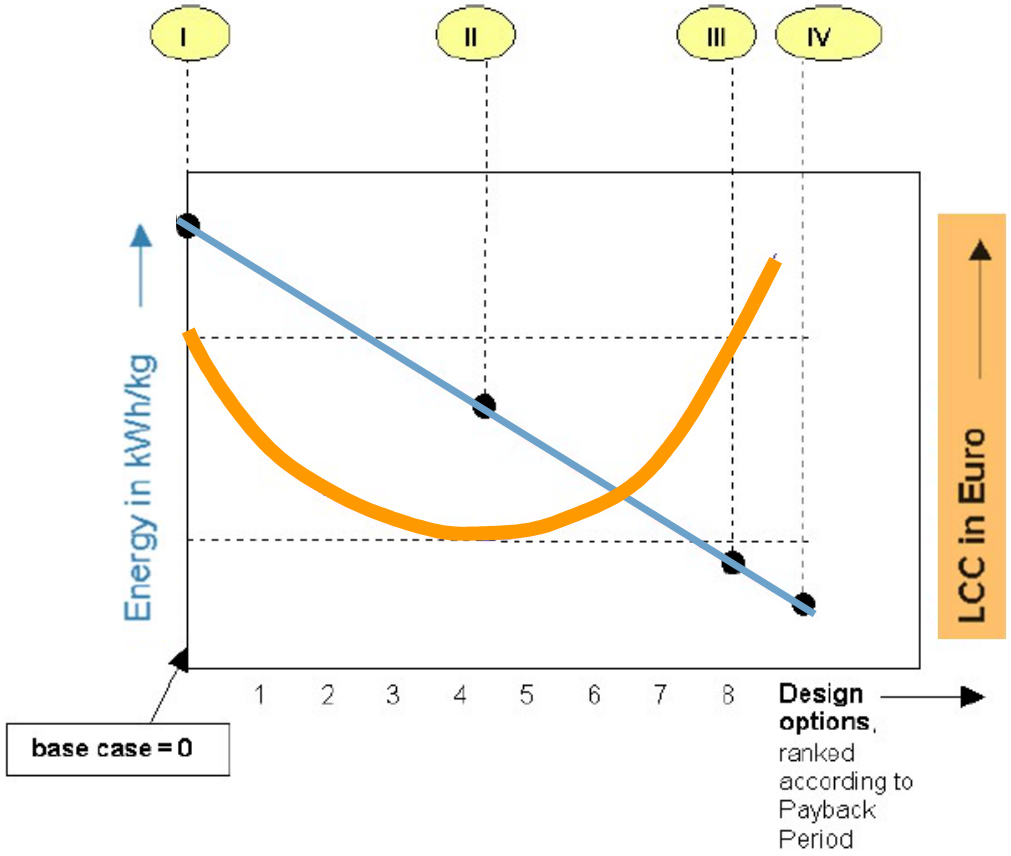
Q&A

short comments or questions: chat

complex comments or questions: topic -> chat AND #

Task 6 – LCC curves

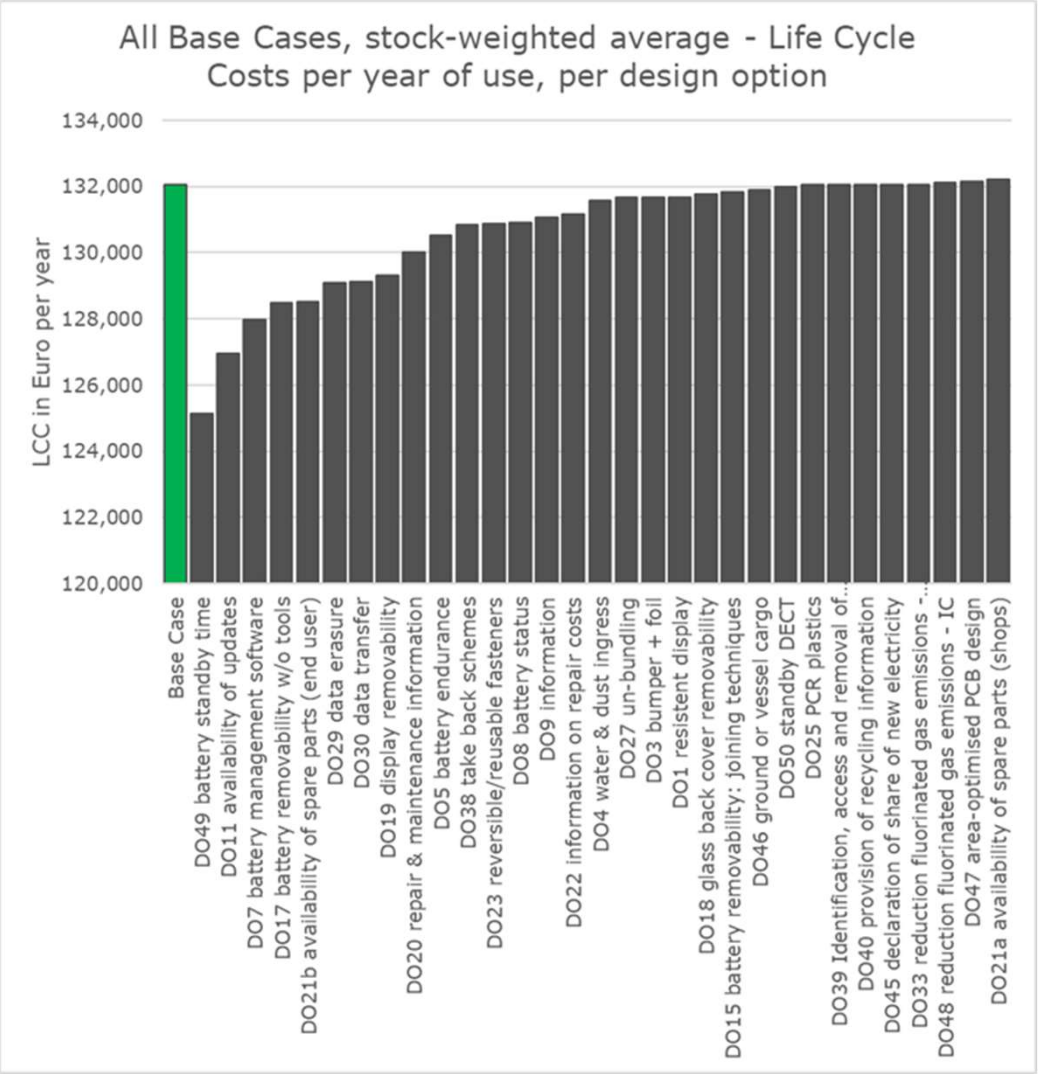
- Theory first…



I. Current status
II. Least Life Cycle Costs
III. LCC break-even
IV. Best available Technology

Task 6 – Implementation of options

- MEErP:
  - Sort by Life Cycle Costs, from lowest to highest
  - Implement one after the other
  - Observe correlations between options



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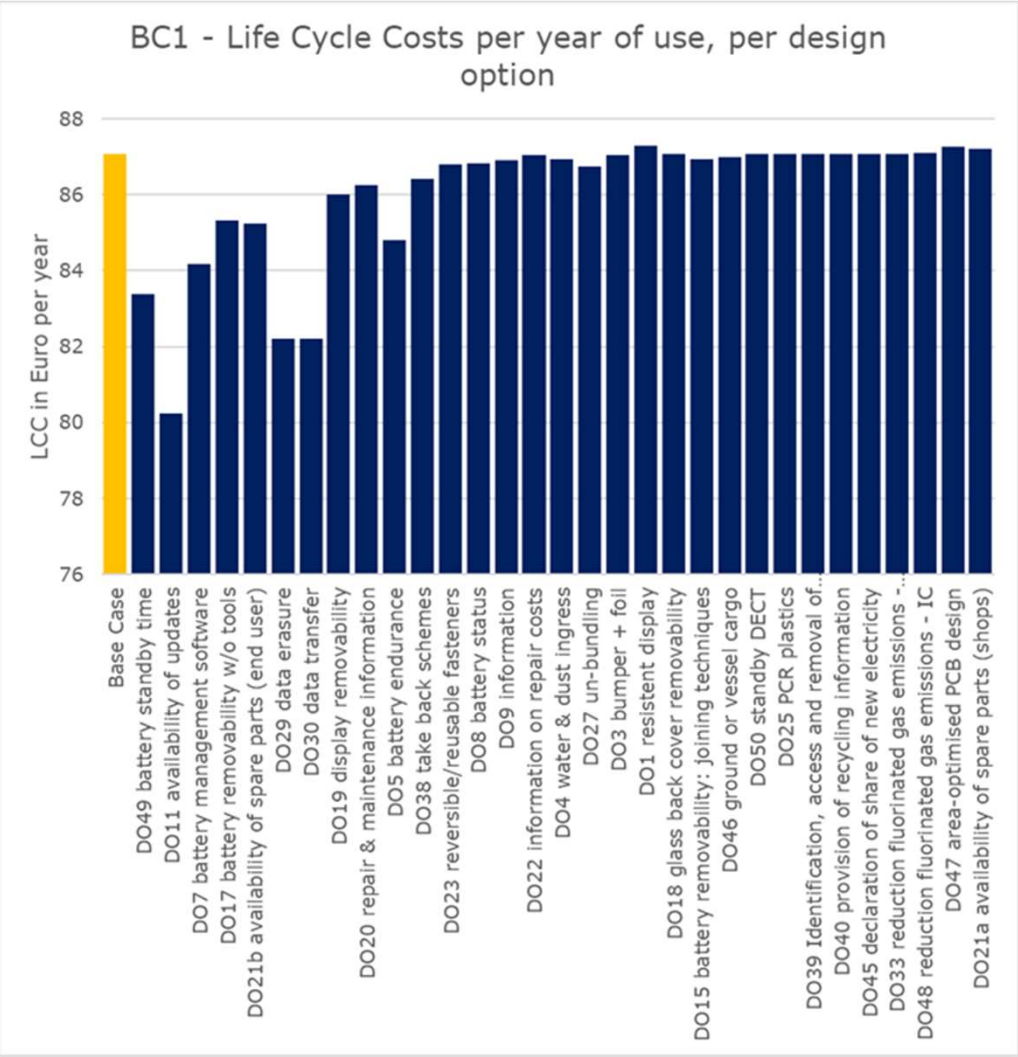
Task 6 – Implementation of options

- MEErP:
  - Sort by Life Cycle Costs, from lowest to highest
  - Implement one after the other
  - Observe correlations between options

- Too many options
- Some options make sense only in combination
- Some options (might) contradict each other



December 18, 2020

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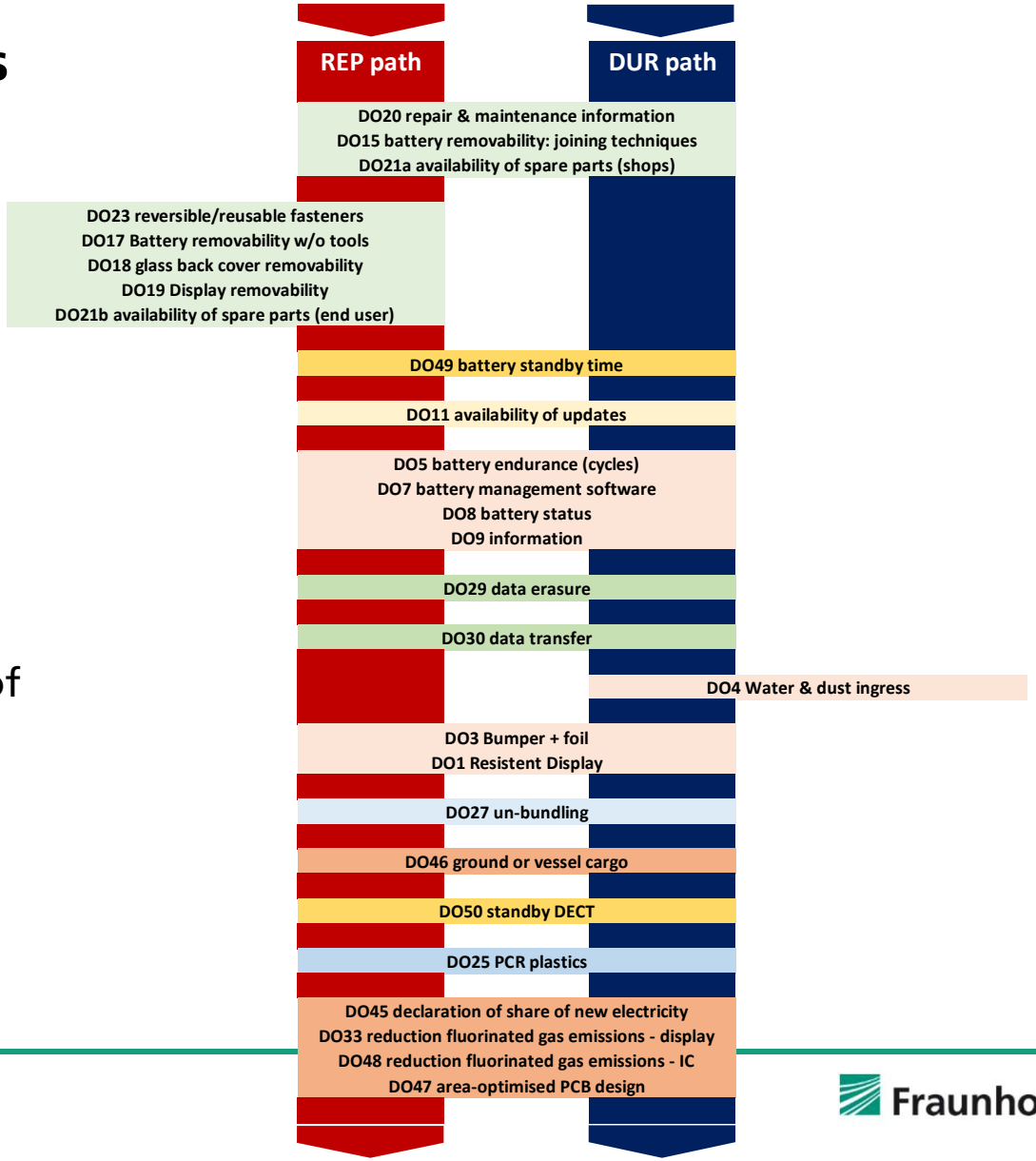
Task 6 – Implementation of options

- Implementing options on 2 “paths“:
  - a reparability dominated path with ambitious reparability options (**REP path**), and
  - a durability path, which also starts with some LCC reducing reparability options, but then implementing enhanced water and dust ingress, which rules out some of the reparability options* (**DUR path**)

*but see Task 4 update



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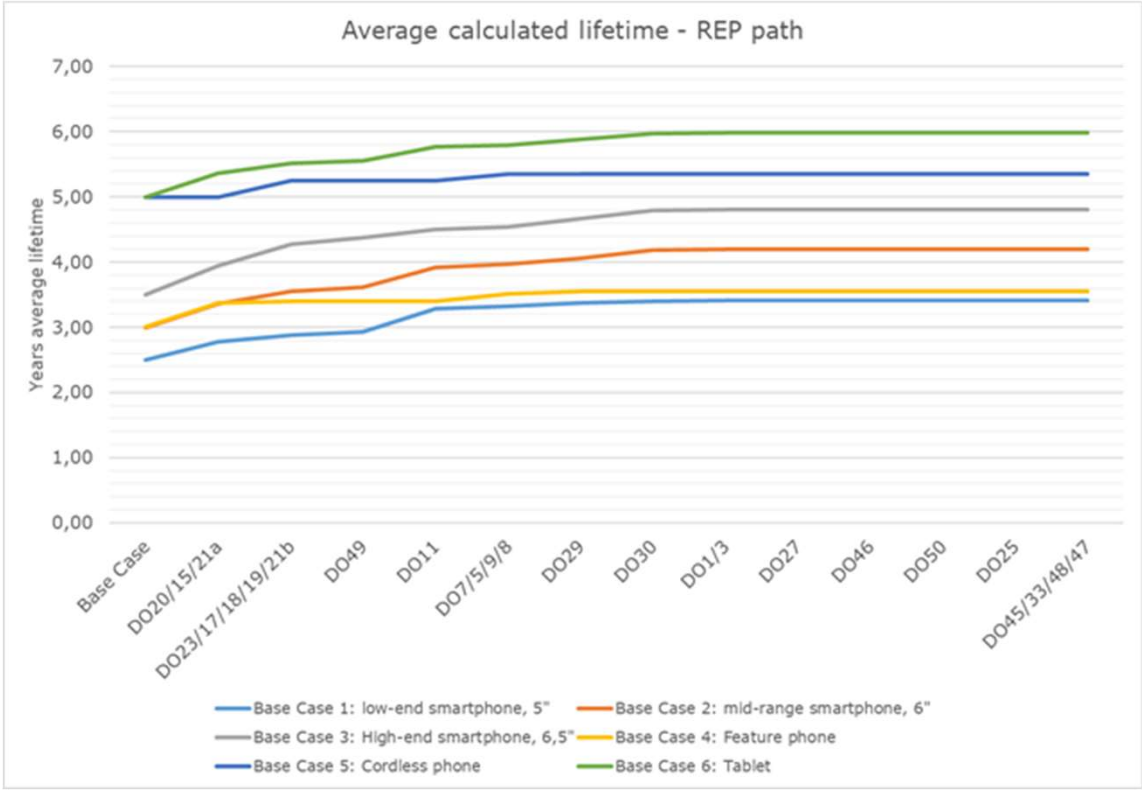
Task 6 – Implementation of options

- Effect on Lifetime



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Task 6 – Implementation of options

Q&A

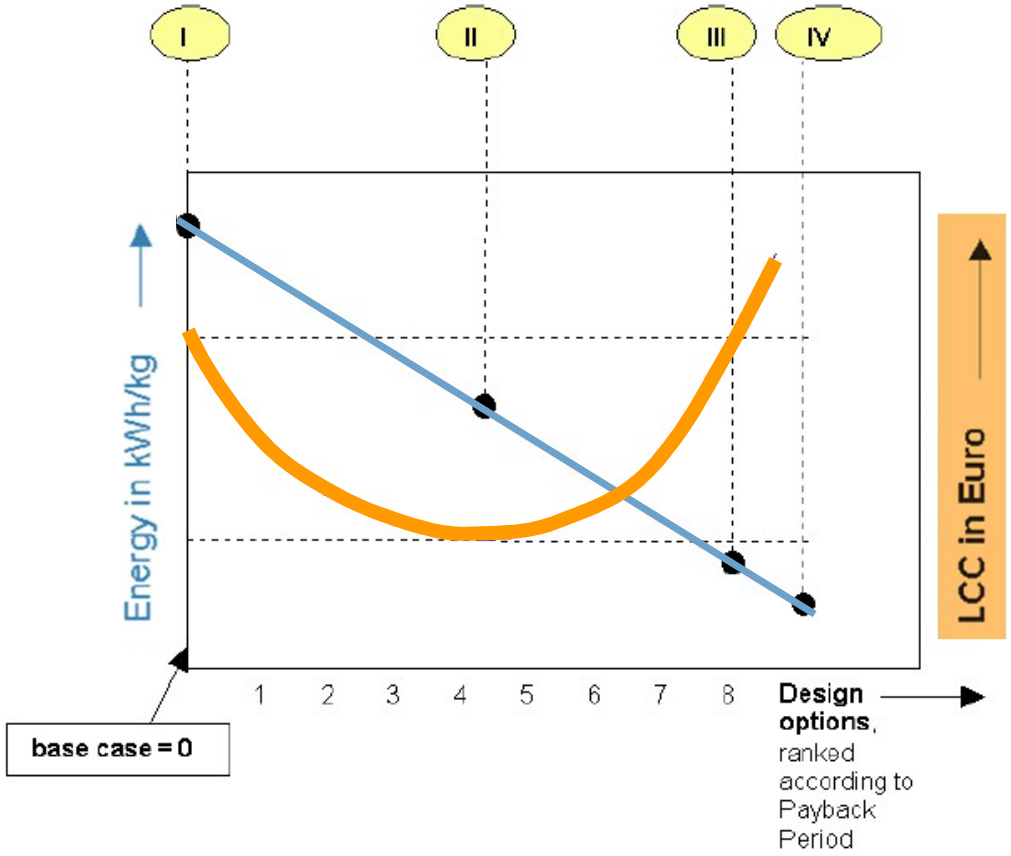
short comments or questions: chat

complex comments or questions: topic -> chat AND #

Task 6 – LCC curves

- Our approach, following the definition of the functional unit:

  "per year of use"



I. Current status

II. Least Life Cycle Costs

III. LCC break-even

IV. Best available Technology

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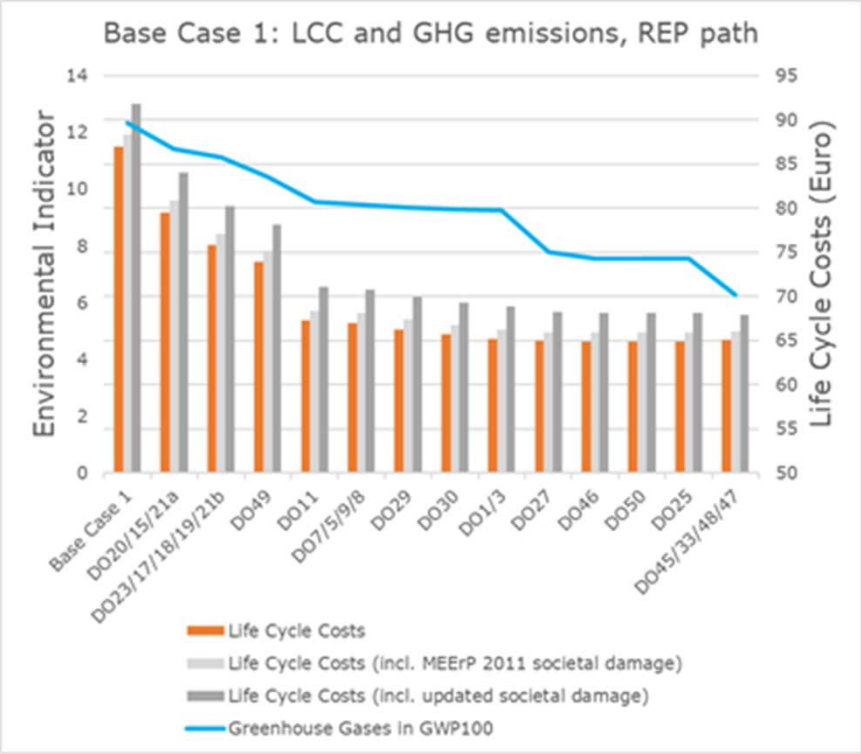
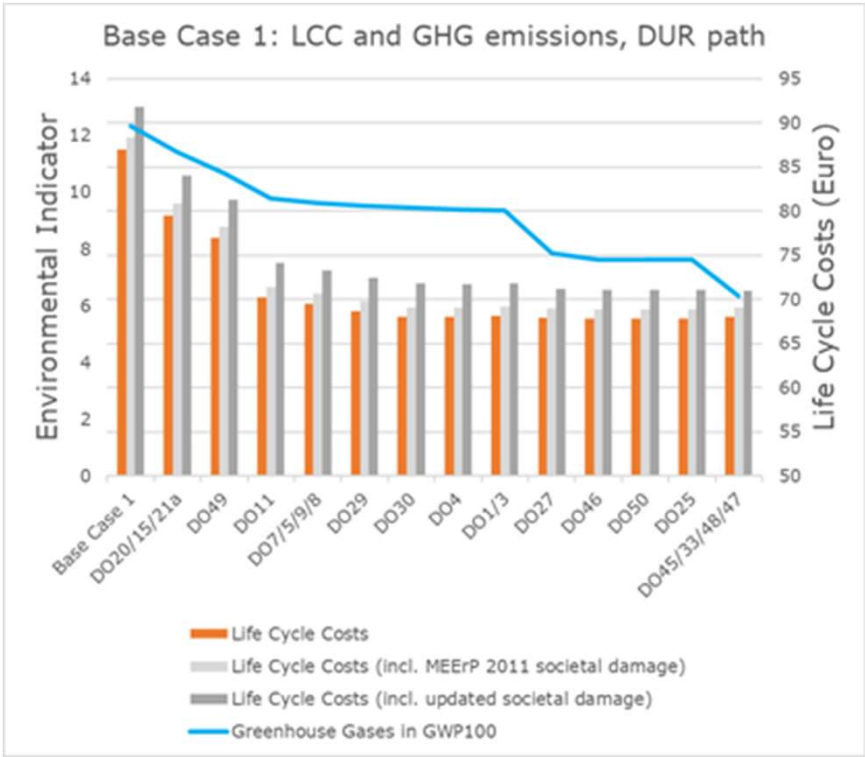
Task 6 – LCC curves

- Base Case 1





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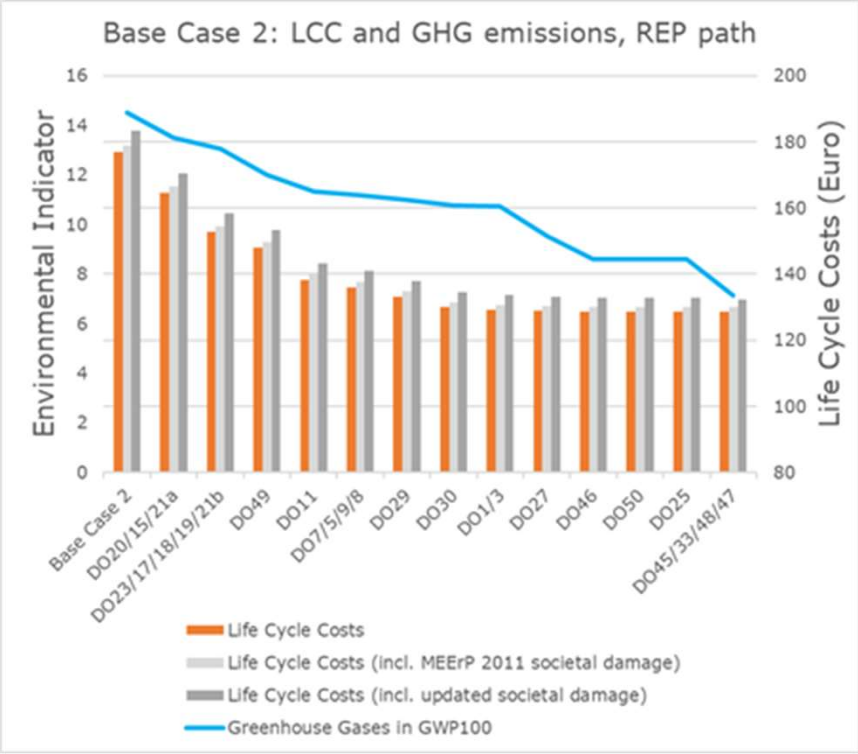
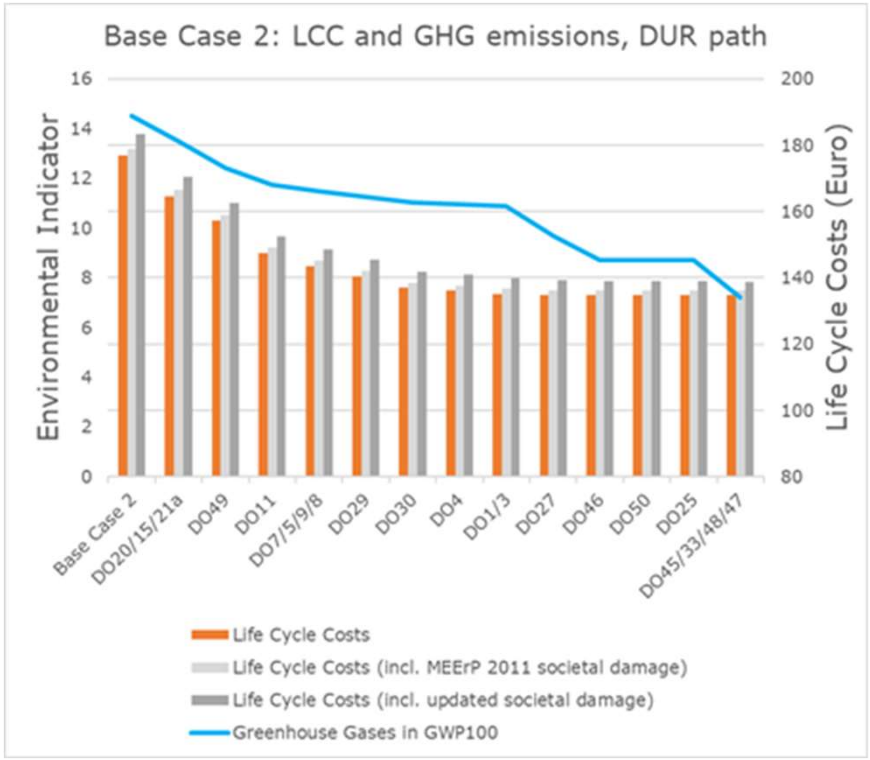
Task 6 – LCC curves

- Base Case 2





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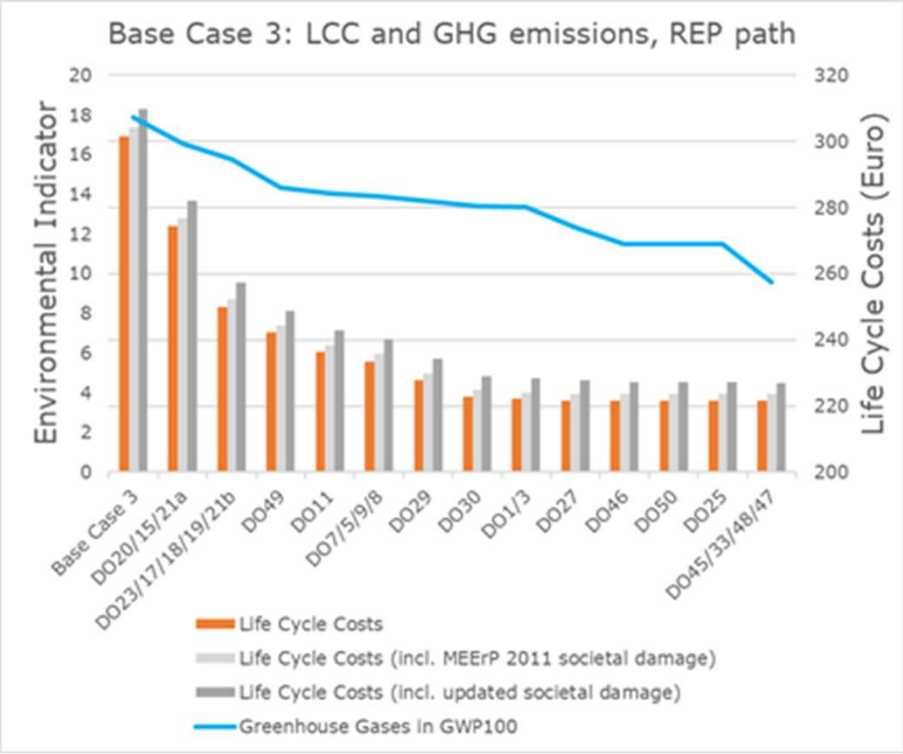
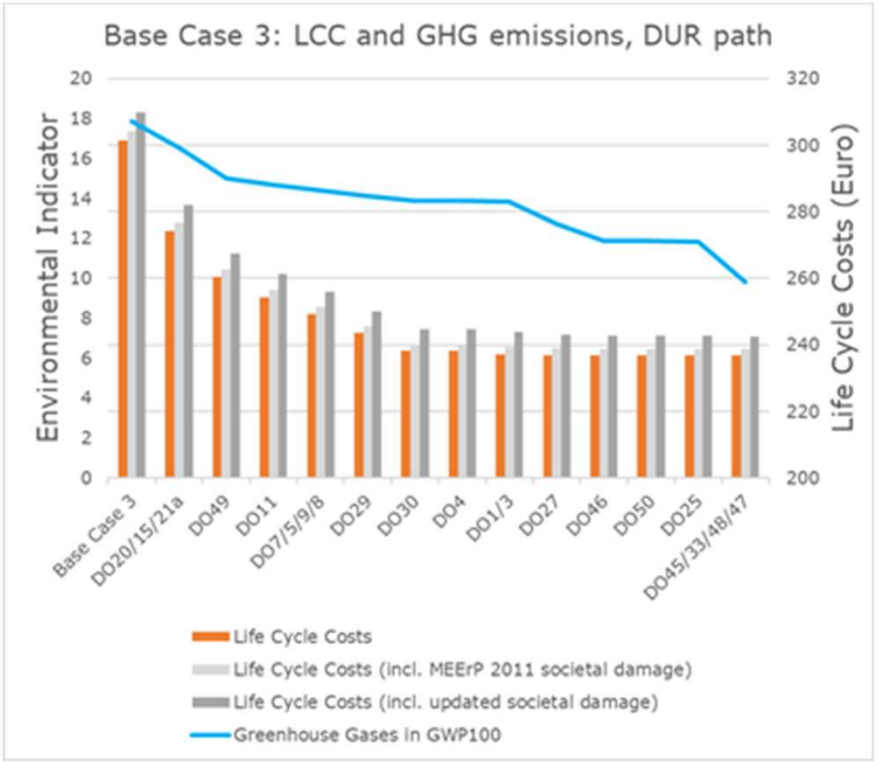
Task 6 – LCC curves

- Base Case 3





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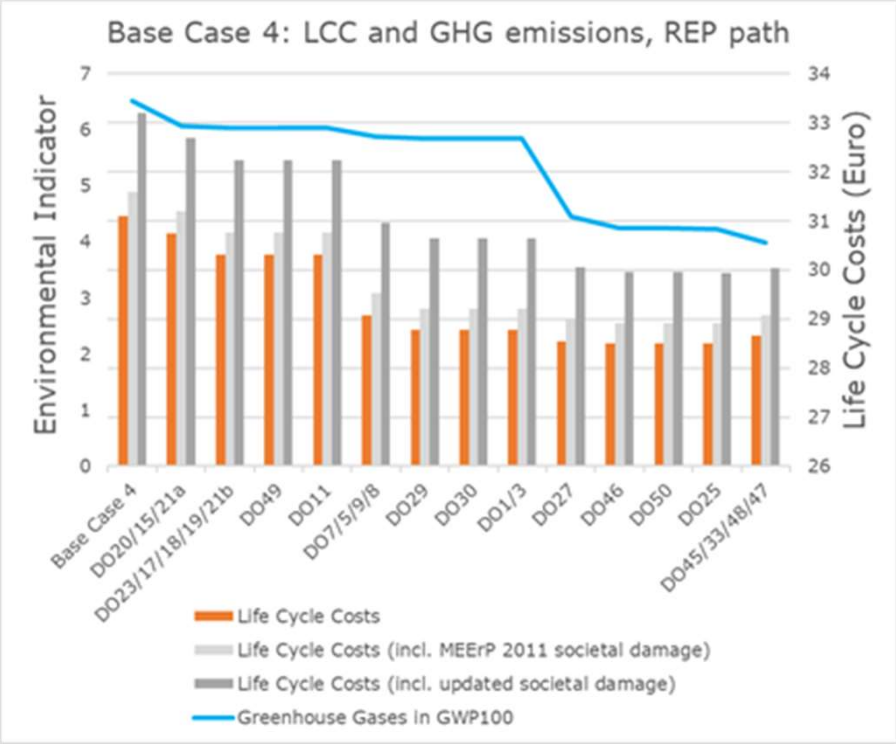
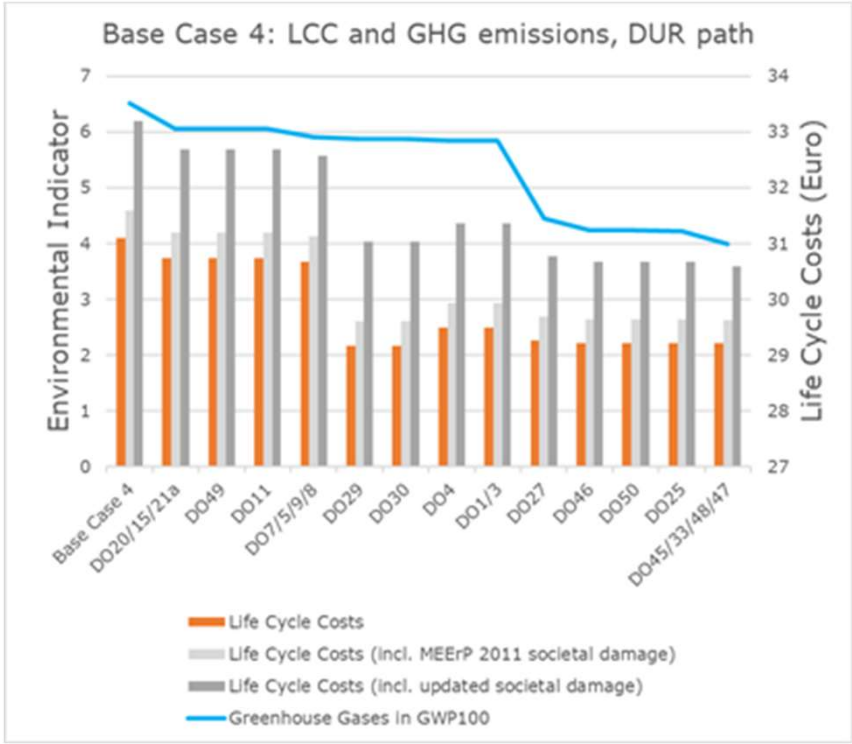
Task 6 – LCC curves

- Base Case 4





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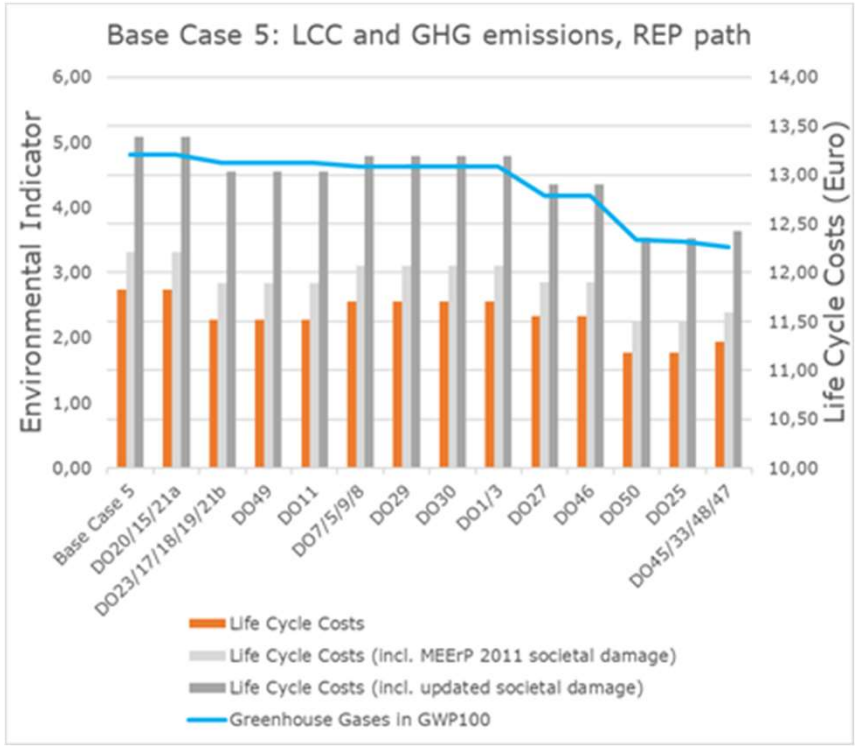
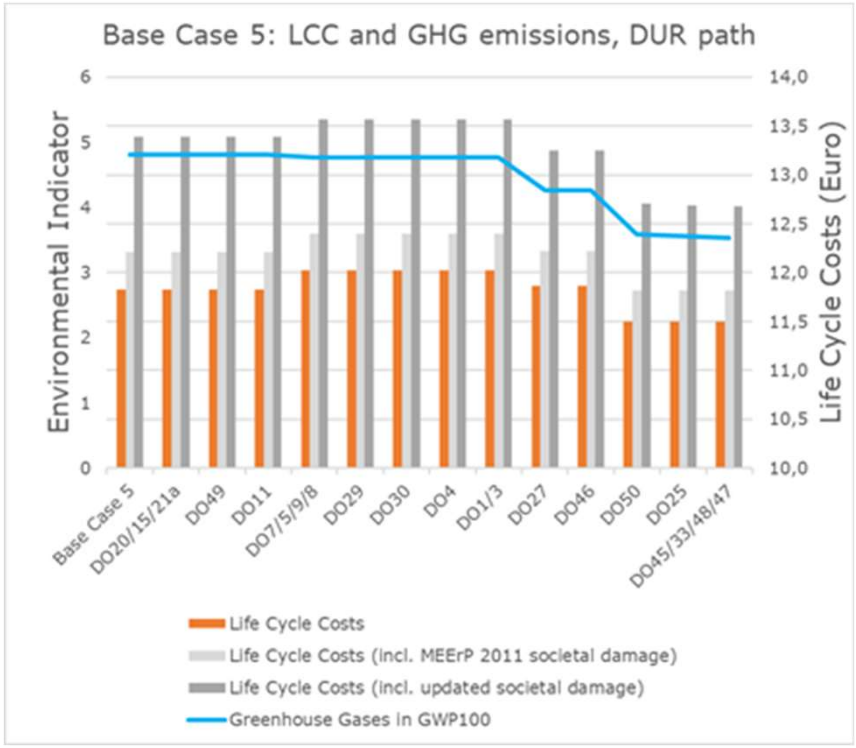
Task 6 – LCC curves

- Base Case 5





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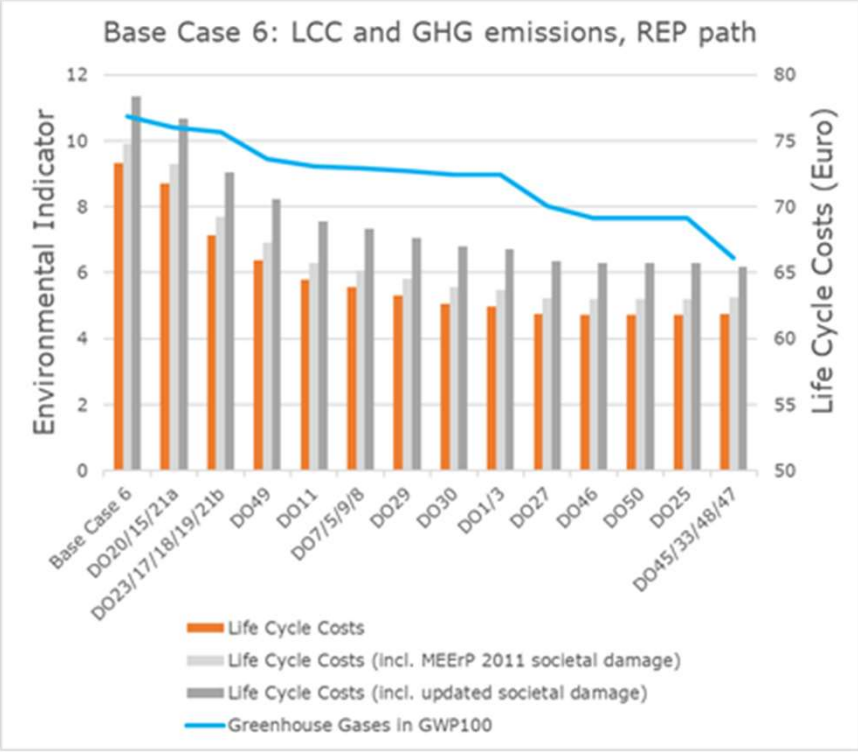
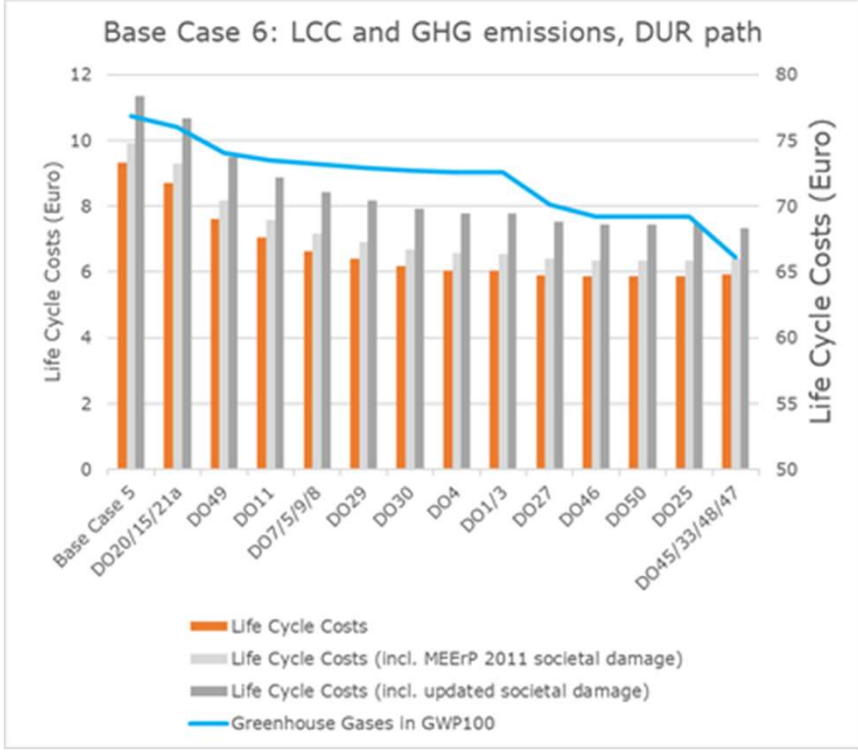
Task 6 – LCC curves

- Base Case 6





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Task 6 – LCC curves: Conclusions

- Implementation of design options leads to (almost) constantly declining Life Cycle Costs, even more so for societal Life Cycle Costs
- There is no turn-around towards increasing LLC
- Major reductions in LCC and environmental improvements through
  - Enhanced reparability
  - Increased battery endurance per full charge
  - Improved battery management and information provision
  - Extended OS support
  - Improved data erasure and confidence in processes
  - Unbundling of device and accessories
- Further environmental improvements: GHG reduction in manufacturing and distribution

Task 6 – LCC curves

Q&A

short comments or questions: chat

complex comments or questions: topic -> chat AND #

Break until 14:45

(next: Task 7)

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Task 7 – Policy Analysis

- Policy options:
  - Option 1: "No action" (i.e. business as usual)
  - Option 2: Self-regulation (if proposed by an interested party)
  - Option 3: Introduction of mandatory specific and/or generic ecodesign requirements (according to Annex I and/or Annex II of the Ecodesign Directive 2009/125/EC)
  - Option 4: Energy Labelling according to the Energy Labelling Regulation 2017/1369
  - Option 5: Ecodesign requirements combined with Energy Labelling.

Task 7 – Policy Analysis: Option 1 - “No action”

- Business-as-usual
  - Trends towards *better* material efficiency: Mature and partly declining markets, higher smartphone product prices, higher IP classes, unbundling, reducing environmental impacts throughout the supply chain, use of recycled materials, advancing recycling technologies, incentivising take back, Moore’s Law
  - Trends towards *worse* material efficiency: Sophisticated mechanics (in particular: foldable devices), IP classes in conflict with reparability, 5G, rebound effect of Moore’s Law
- France: reparability scoring from January 1, 2021, onwards; 20% of the EU27 **smartphone** market is moving towards better reparability

Task 7 – Policy Analysis: Option 2 - Self-regulation

- None proposed, except for common charger MoU proposal (2018)

Task 7 – Policy Analysis: Option 2 - Self-regulation

- …but a coordinated action of the telecommunications sector to implement a multi-criteria scoring system: EcoRating
- pushed by major telecommunications network operators
- scoring criteria:
  - Durability
  - Reparability, reusability and upgradability
  - Recyclability and recoverability
  - Use of hazardous and restricted substances
  - Use of recycled and renewable materials
  - Packaging and accessories
- The distribution channel telecommunication operators covers roughly 25-40% of the EU27 market in terms of distributed **mobile phones**.

Task 7 – Policy Analysis: Option 3 - Introduction of mandatory specific and/or generic ecodesign requirements

Aspect	Specific requirement	Generic requirement
Reparability	user replaceable battery [1]	Multi-criteria reparability scoring
	spare parts availability	
Reliability	2 years OS support	Multi-criteria reliability scoring
	IPx3	
	Battery minimum lifetime[2]	
Battery endurance (per cycle)	-	scoring or lifetime information
Confidence in data erasure and ease of data transfer	data encryption by default	user information
Unbundling	-	user information (and covered by PEF score below)
environmental footprint of the product	-	scoring system based on environmental footprint (incl. recycled content)

[1] with exemptions, if a similar effect is achieved by other means, such as battery demonstrated to last (indicatively) 1000 cycles @ 80% or unless OEM provides convenient (on-site / same-day / moderate price) battery replacement service

[2] indicatively : 300 cycles @ 80% remaining charge capacity

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Task 7 – Policy Analysis: Option 3 - Introduction of mandatory specific and/or generic ecodesign requirements

- Further specific eco-design requirements apply to cordless phones only:
  - Standby power consumption
  - Power management: EcoDECT

Task 7 – Policy Analysis: Option 3 - Introduction of mandatory specific and/or generic ecodesign requirements

- Reparability
  - Specific requirements (**smartphones, feature phones, tablets**)
    - User replaceable batteries (unless sufficiently high battery durability is demonstrated)
    - Spare parts availability for professional repair shops, covering an extended lifetime of 5 years for mobile phones and 6 years for tablets, covering at least the following priority parts (including relevant fasteners, if non-reusable):
      - Display unit,
      - battery,
      - glass back cover (if any)
    - Repair instructions for professional repair shops
    - Availability of tools to professional repair shops

Task 7 – Policy Analysis: Option 3 - Introduction of mandatory specific and/or generic ecodesign requirements

- Reparability
  - Specific requirements (**cordless phones**)
    - User-replaceable AAA standard batteries

Task 7 – Policy Analysis: Option 3 - Introduction of mandatory specific and/or generic ecodesign requirements

- Reparability
  - Generic requirements (**smartphones, feature phones, tablets**)
    - Scoring similar to French approach
      - most criteria confirmed to be relevant
    - Extended to feature phones and tablets (but adaptation of scoring scale to specifics of feature phones, tablets might be needed)
    - Information requirement

    - For inspiration, French reparability label:

Task 7 – Policy Analysis: Option 3 - Introduction of mandatory specific and/or generic ecodesign requirements

- Reliability
  - Specific requirement (**smartphones, feature phones, tablets**):
    - IPx3 (to be analysed)
    - OS support (2+ years)
  - Generic requirement (**smartphones, feature phones, tablets**)
    - New scoring system (EcoRating might serve as inspiration)
    - Different scoring scale might apply for smartphones, feature phones and tablets, depending on differences in use patterns and defects (see Task 3)

Task 7 – Policy Analysis: Option 3 - Introduction of mandatory specific and/or generic ecodesign requirements

- Reliability scoring

#	Sub-Criterion	Scoring system specifics	Relevance
1. Overload failures (constant probability)			
1.1	Resistance to accidental drops: repeated free fall tests	Survival rate for given test settings and protocol (e.g. drop height, cycles, etc.)	High
1.2	Resistance to accidental drops: Availability / provision of screen protectors and protective cases	Yes / no	High
1.3	Scratch resistance (screen, camera, fingerprint sensor, etc.)	Scratch resistance rating	Currently low, but might change with flexible / bendable displays
1.4	Protection from dust	Compliance with IP codes (up to 4 / 5 / 6)	Medium
1.5	Protection from water	Compliance with IP codes (up to 3 / 4 / 5 / 6 / 7 and above)	High

Task 7 – Policy Analysis: Option 3 - Introduction of mandatory specific and/or generic ecodesign requirements

- Reliability scoring (continued)

#	Sub-Criterion	Scoring system specifics	Relevance
2. Degradation failures (rising probability over time)			
2.1	Battery endurance (charging cycles): Minimum number of cycles with the battery properly functioning	Minimum number of cycles with the battery properly functioning	High
2.2	Battery endurance (charging cycles): Pre-installed battery management software for smart charging and provision of state of health data	Yes / no	
2.3	Battery endurance (charging cycles): Information for the correct use of the battery, including fast-charging not as default setting	Yes / no	
2.4	Reliability of ports / connectors	Specified mating / unmating cycles	Medium
2.5	Reliability of other parts (buttons, speakers, etc.)	tbd	Medium
2.6	Operating System updates	Availability of update support for X years and information on impact/reversibility of updates	High
2.7	Memory extension: slot for memory card	Yes / no, highly relevant for devices up to 32GB only	Medium
2.8	Dual-SIM	Yes / no	Low

Task 7 – Policy Analysis: Option 3 - Introduction of mandatory specific and/or generic ecodesign requirements

- Battery endurance (per cycle)
  - Generic requirement (**smartphones, feature phones, tablets**)
    - Scoring based on a benchmark, similar to GSMArena's approach:
      - Making calls
      - Browsing the web
      - Playing a video
      - Standby

Task 7 – Policy Analysis: Option 3 - Introduction of mandatory specific and/or generic ecodesign requirements

- Data erasure
  - Specific requirement (**smartphones, feature phones, tablets**)
    - Data encryption by default
  - Generic requirement (**smartphones, feature phones, tablets**)
    - Information on sound data erasure, effectiveness of factory reset

Task 7 – Policy Analysis: Option 3 - Introduction of mandatory specific and/or generic ecodesign requirements

- Reduction of manufacturing (and distribution) impacts
  - Generic requirement (**smartphones, feature phones, cordless phones, tablets**)
    - Environmental footprint scoring, including in particular:
      - PFC abatement (semiconductors, displays)
      - optimized PCB design
      - Metal parts machining
      - Renewable energy use by suppliers
      - Means of transportation
      - Unbundling
      - Recycled content

Task 7 – Policy Analysis: Option 4 – Energy Labelling

- Turn battery endurance (per cycle) scoring into an Energy Label (**smartphones, feature phones, tablets**)
  - Energy savings AND lifetime extension

Energy efficiency class	Battery endurance bench-mark [in hours]	Market coverage smartphones as of June 2020
A	155h and above	0,1%
B	131h – < 155h	1,1%
C	107h – < 131h	6,5%
D	83h - < 107h	28,8%
E	59h - < 83h	37,4%
F	35h - < 59h	22,5%
G	< 35h	3,5%

Task 7 – Policy Analysis: Option 5 – Ecodesign requirements combined with Energy Labelling

- All ecodesign requirements as in option 3, battery endurance (per cycle) scoring implemented as an Energy Label

Q&A

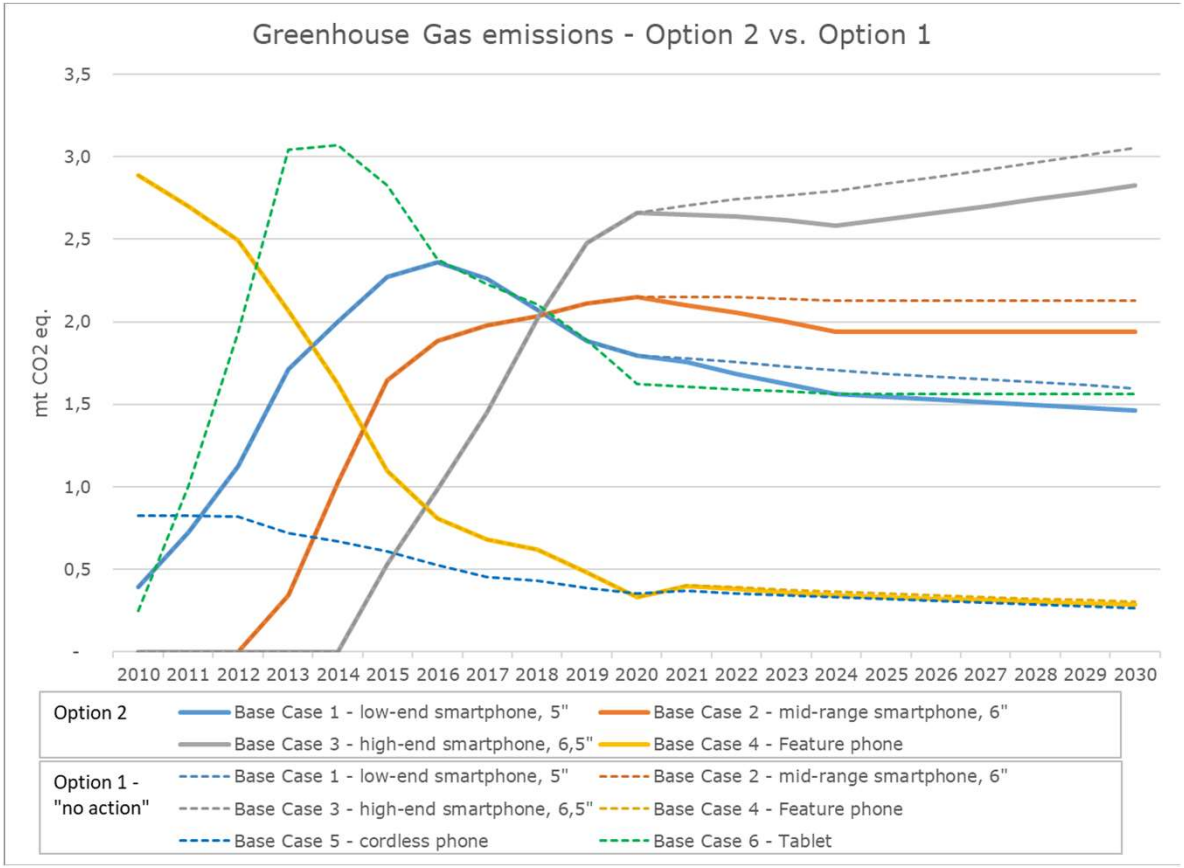
short comments or questions: chat

complex comments or questions: topic -> chat AND #

Task 7 – Scenario Analysis – Scenario 2: EcoRating

- Calculation basis for this scenario is:
  - 12,5% of the market (stock) moved towards the point of Least (societal) Life Cycle Costs by 2024, i.e. with some delay as many of the criteria address extended lifetime
  - in France, the mandatory reparability score has no additional effect on the market share covered by EcoRating through the telecommunication operators
  - Historic effects of prior versions of EcoRating are included in general market figures and not depicted separately in following tables and figures

Task 7 – Scenario Analysis – Option 2: EcoRating



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Task 7 – Scenario Analysis – Scenario 3: Ecodesign requirements

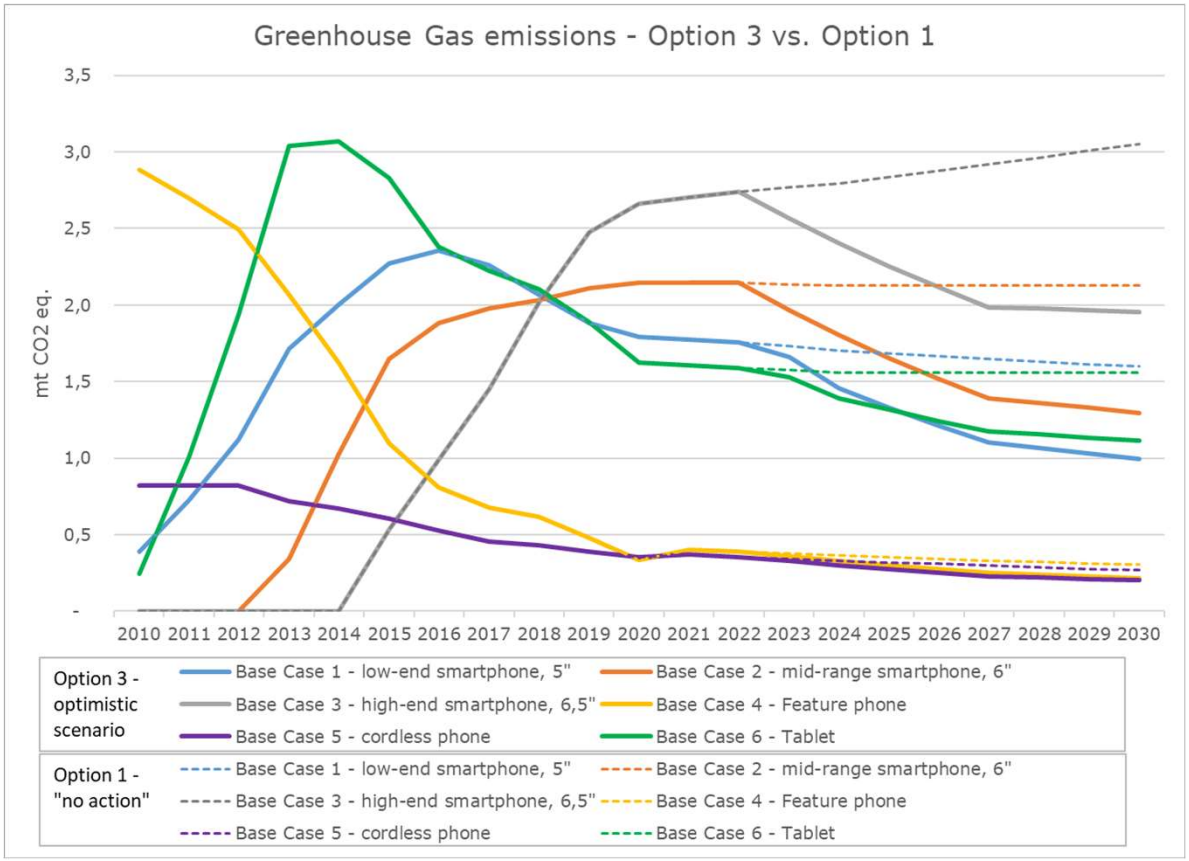
- Calculation basis for this scenario is:
  - legislation applies to products put on market from 2023
  - 100% of the stock, i.e. devices in use, meets specific requirements by 2027; note: although 100% of the sold products need to be compliant as soon as the legislation applies, the effect of legislation materialises only later, mainly through lifetime extension, as only then replacement sales will go down as intended
  - 50% of the market (stock) moved towards the point of societal Least Life Cycle Costs by 2027
    - **Conservative scenario**: DUR path as analysed in Task 6
    - **Optimistic scenario**: REP path as analysed in Task 6
  - which means, for clarity, e.g.,
    - 50% of devices sold without charger / accessories,
    - 50% of devices manufactured with fully optimised processes (PFC abatement), PCB designs, renewable energy for most relevant components and avoidance of air freight
    - 50% of devices with 5 years OS support etc.
  - Further slow increase to 60% market (stock) at point of LLCC by 2030 due to assumed increased environmental awareness

Task 7 – Scenario Analysis – Scenario 3: Ecodesign requirements

- Decline in sales compared to “no action“

	Base Case 1 - low-end smartphone, 5" Sales mln. units	Base Case 2 - mid-range smartphone, 6" Sales mln. units	Base Case 3 - high-end smartphone, 6,5" Sales mln. units	Base Case 4 - Feature phone Sales mln. units	Base Case 5 - cordless phone Sales mln. units	Base Case 6 - Tablet Sales mln. units	**Totals Sales mln. units**	Totals - Option 1 Sales mln. units	**Improvement Sales mln. units**
2022	53	45	40	18	14	23	**193**	*193*	-
2023	50	43	38	17	13	23	**184**	*190*	- **6,2**
2024	47	41	37	16	13	22	**175**	*188*	- **13,0**
2025	45	39	36	15	12	21	**168**	*188*	- **19,4**
2026	43	37	35	14	12	21	**161**	*187*	- **25,4**
2027	41	36	34	13	11	20	**155**	*186*	- **30,9**
2028	40	35	35	13	11	20	**154**	*185*	- **31,6**
2029	40	36	35	12	10	20	**153**	*184*	- **31,0**
2030	38	35	35	12	10	20	**150**	*184*	- **33,3**

Task 7 – Scenario Analysis – Scenario 3: Ecodesign requirements



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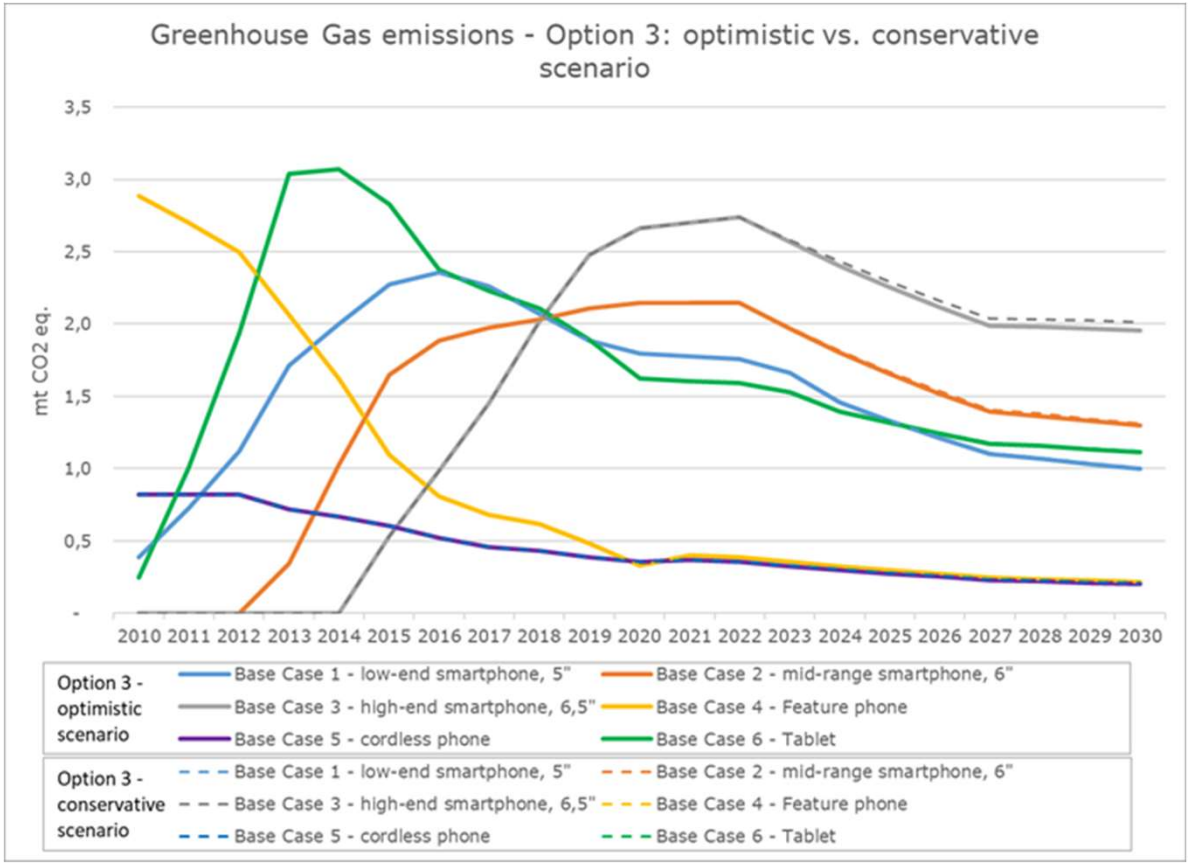
Task 7 – Scenario Analysis – Scenario 3: Ecodesign requirements



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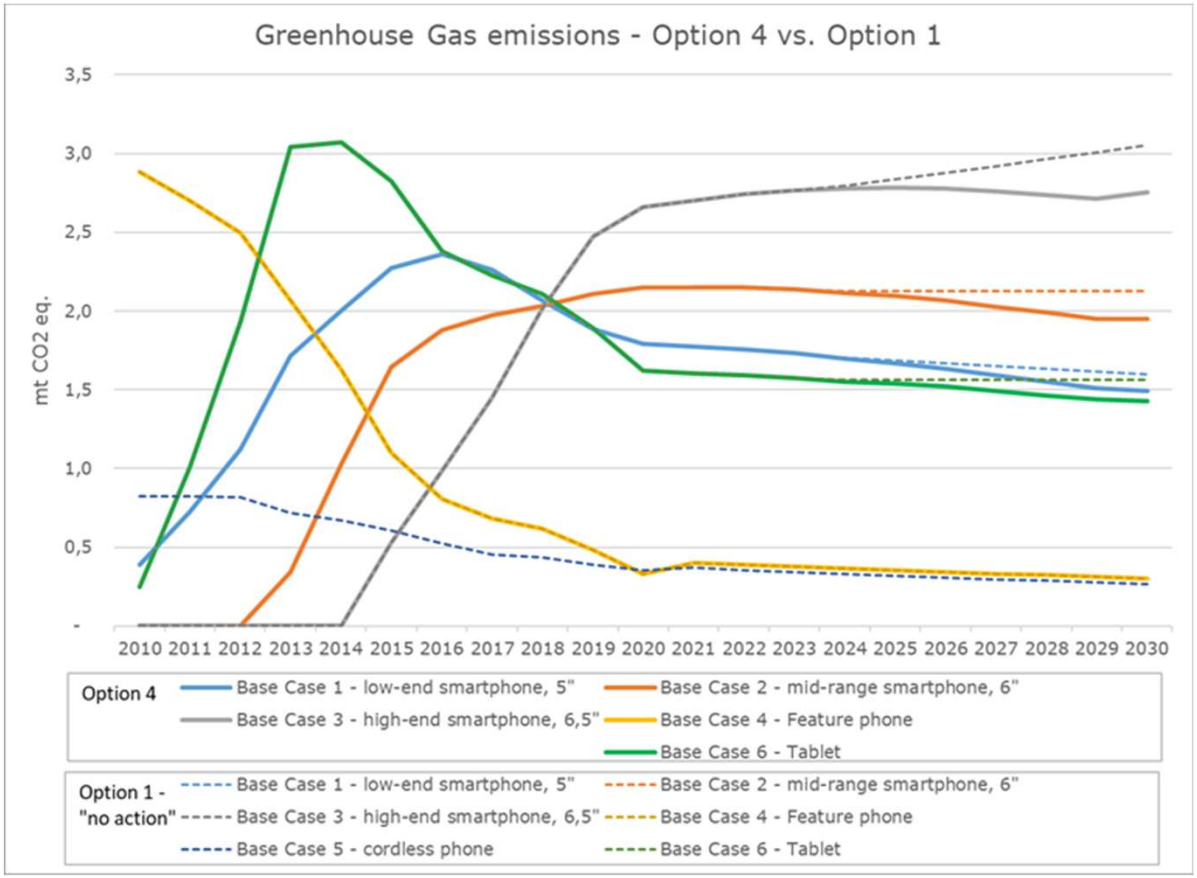
Task 7 – Scenario Analysis – Scenario 4: Energy Labelling

- Calculation basis for this scenario is:
  - legislation applies from 2023
  - 50% of the market (stock) moved towards 30% better battery endurance (per cycle) by 2027
  - 90% of the market (stock) in average moved towards 30% better battery endurance (per cycle) by 2030 (still, the average energy efficiency class is D then)

Task 7 – Scenario Analysis – Scenario 4: Energy Labelling

- Calculation basis for this scenario is:
  - legislation applies from 2023
  - 50% of the market (stock) moved towards 30% better battery endurance (per cycle) by 2027
  - 90% of the market (stock) in average moved towards 30% better battery endurance (per cycle) by 2030 (still, the average energy efficiency class is D then)

Task 7 – Scenario Analysis – Scenario 4: Energy Labelling



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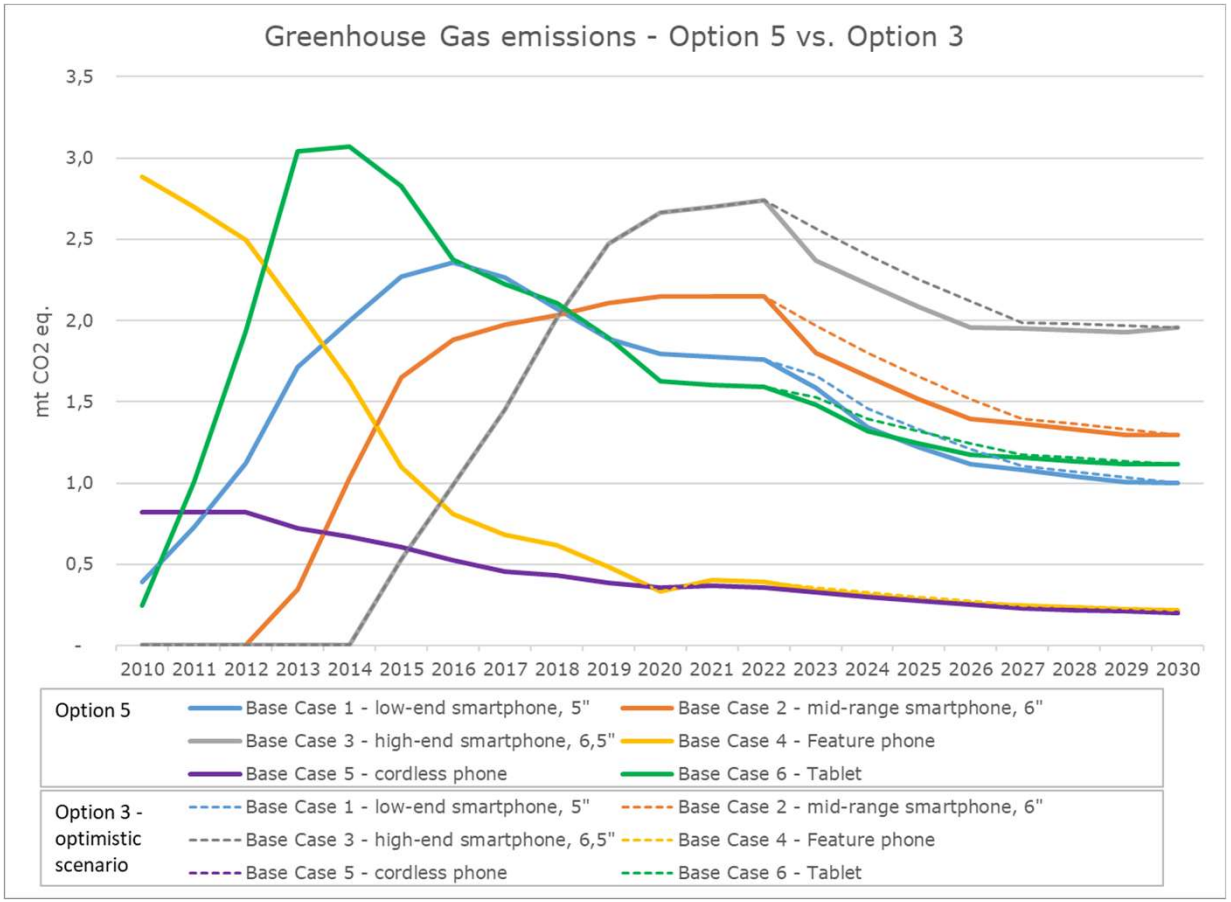
Task 7 – Scenario Analysis – Scenario 5: Ecodesign Requirements and Energy Labelling

- Calculation basis for this scenario is:
  - Same as scenario 3 (Ecodesign requirements)
  - but 50% of the market reaches the point of Least Life Cycle costs already one year earlier, i.e. in 2026

Task 7 – Scenario Analysis – Scenario 5: Ecodesign Requirements and Energy Labelling



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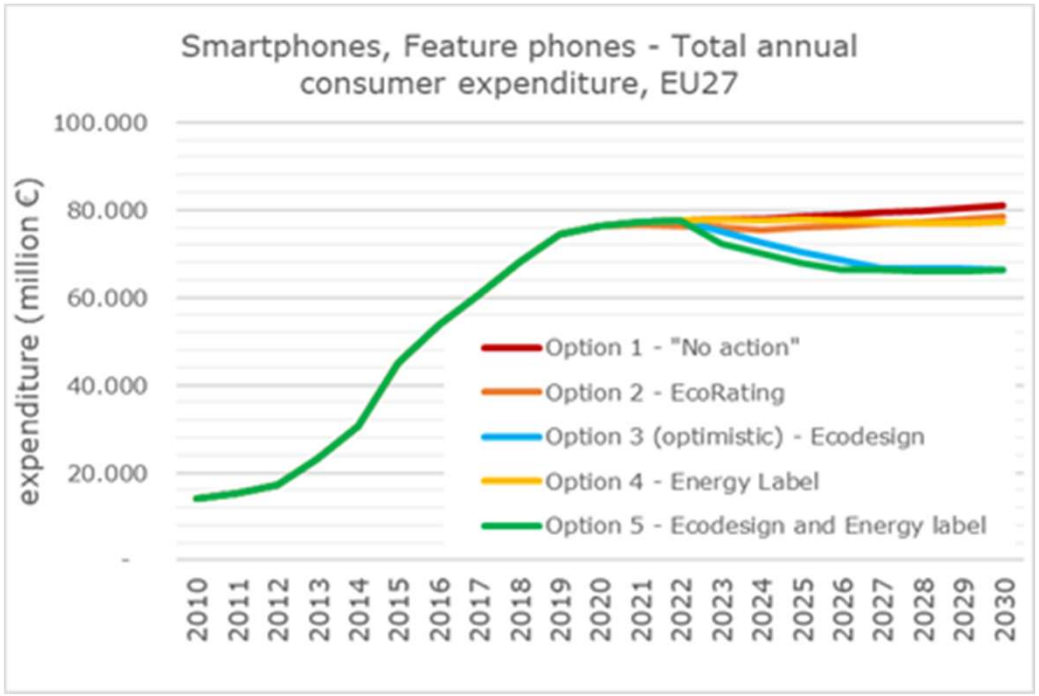
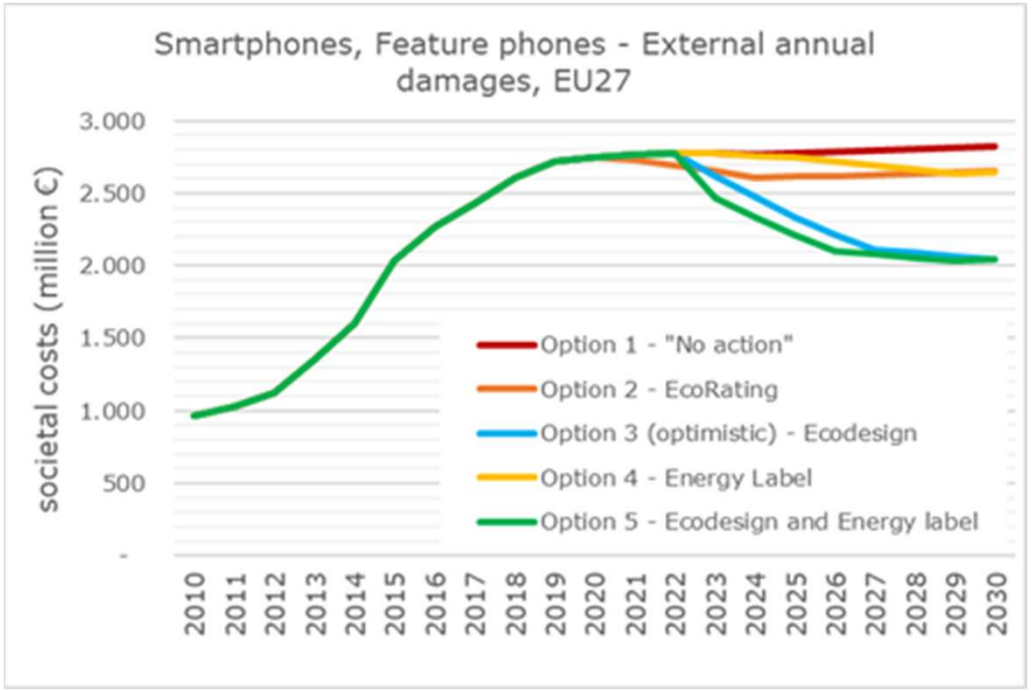
Task 7 – Scenario Analysis – Summary all scenarios, smartphones and feature phones





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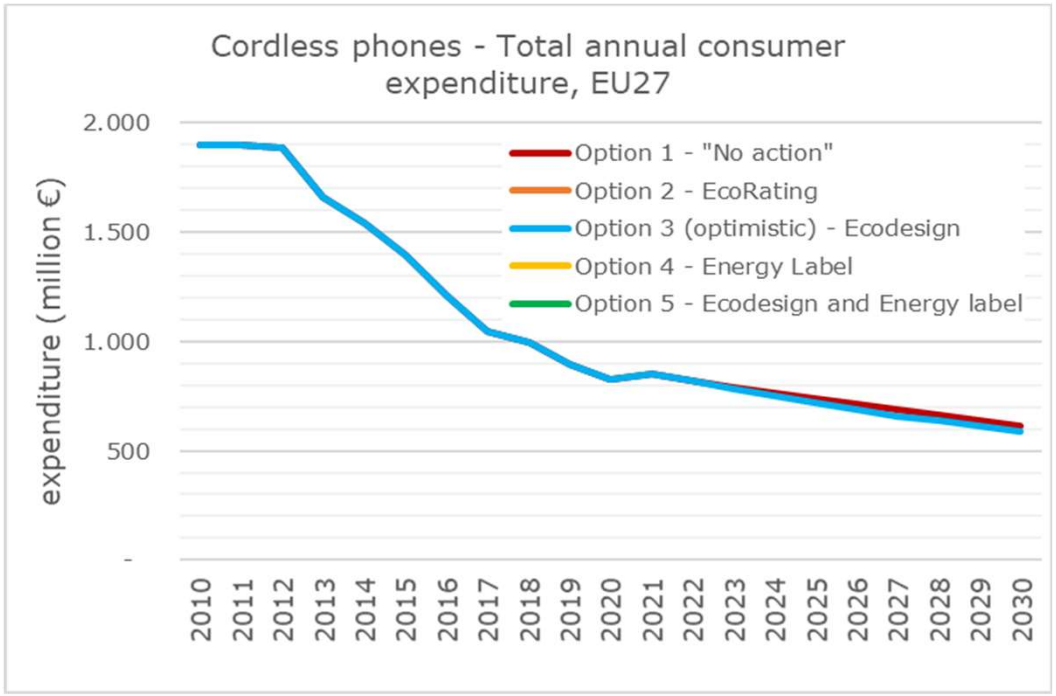
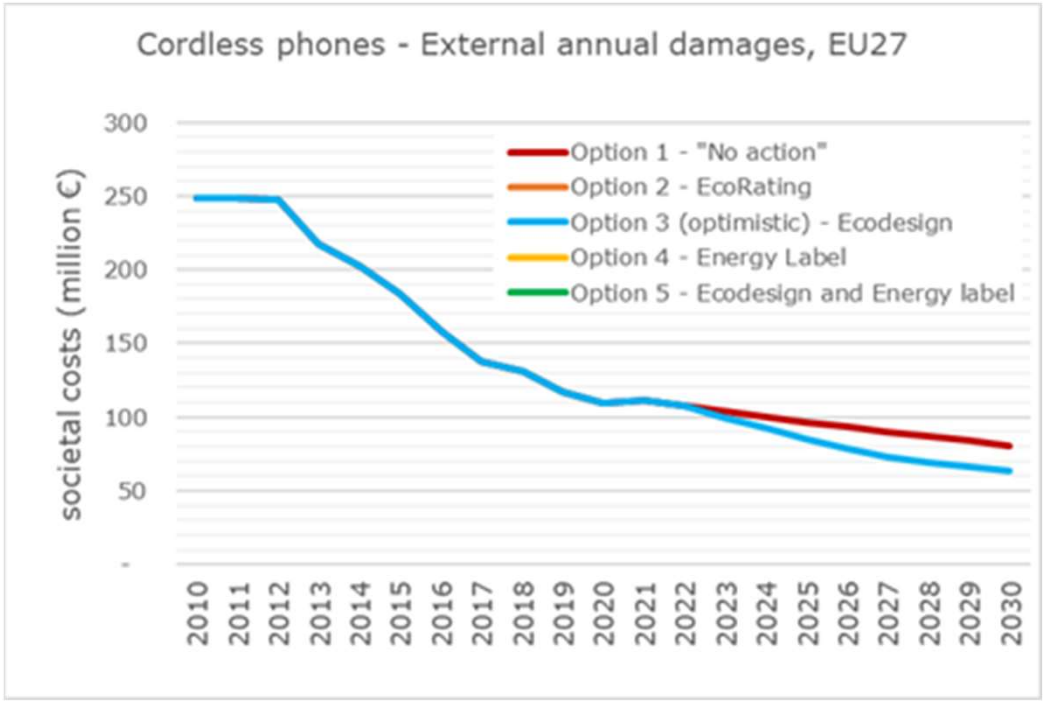
Task 7 – Scenario Analysis – Summary all scenarios, smartphones and feature phones

- Energy and GHG impacts: non-EU supply chain vs. EU27 savings

2030: smartphones, feature phones	Option 1 - "No action"	Option 2 - EcoRating	Option 3 (optimistic) - Ecodesign	Option 4 - Energy Label	Option 5 - Ecodesign and Energy label
Total Energy (PJ)					
Production	61,16	58,41	48,10	59,53	48,10
Distribution	21,67	18,79	9,29	21,02	9,29
Use	46,77	45,25	40,45	38,80	40,45
Totals	**129,61**	**122,45**	**97,84**	**119,35**	**97,84**
Greenhouse Gas emissions (mt CO2 eq.)					
Production	4,54	4,22	3,09	4,42	3,09
Distribution	1,68	1,45	0,72	1,63	0,72
Use	2,02	1,95	1,74	1,67	1,74
Totals	**8,23**	**7,62**	**5,54**	**7,72**	**5,54**

Task 7 – Scenario Analysis – Summary all scenarios, cordless phones





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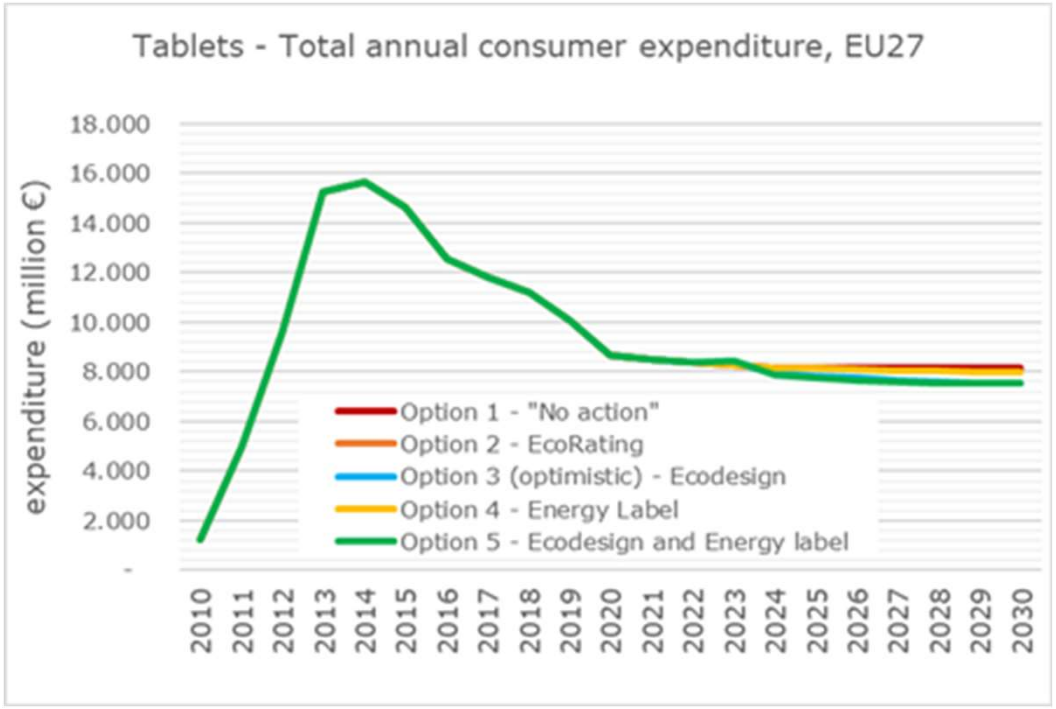
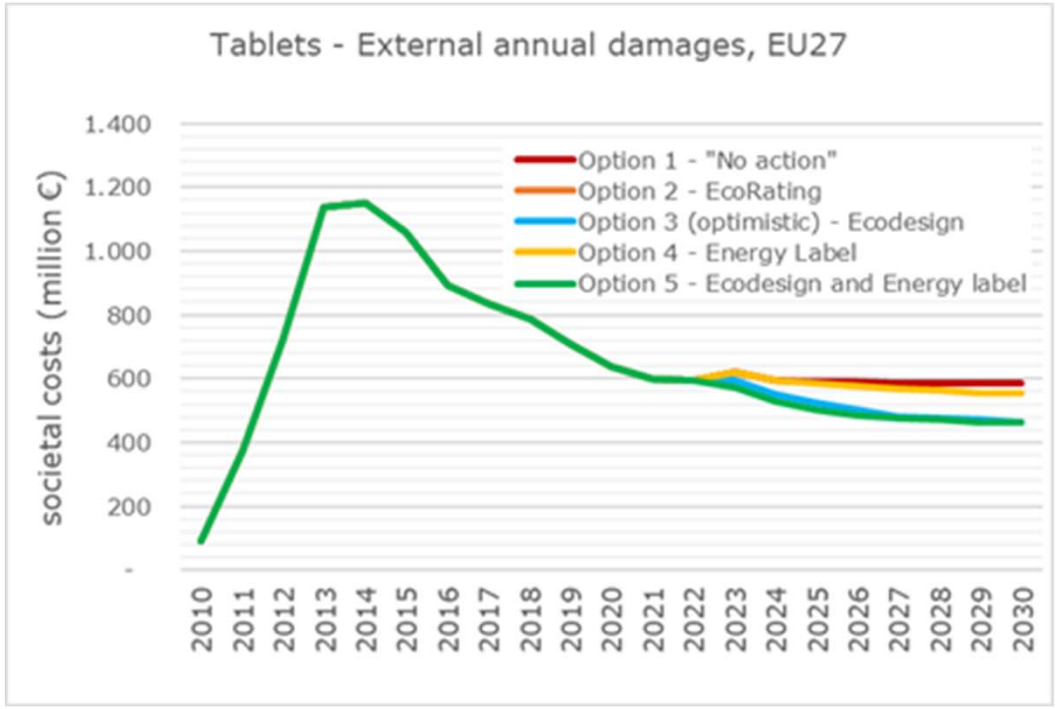
Task 7 – Scenario Analysis – Summary all scenarios, tablets





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Task 7 – Scenario Analysis – Summary all scenarios, 2030

2030, all product segments	Option 1 - "No action"	Option 2 - EcoRating	Option 3 (optimistic) - Ecodesign	Option 4 - Energy Label	Option 5 - Ecodesign and Energy label	Option 2 - EcoRating	Option 3 (optimistic) - Ecodesign	Option 4 - Energy Label	Option 5 - Ecodesign and Energy label
	absolute values					comparison with "no action"			
sales (mln. units)	183,74	180,42	150,40	177,92	150,40	98%	82%	97%	82%
total annual consumer expenditure (mln. €)	89.703	87.158	74.573	85.895	74.573	97%	83%	96%	83%
external annual damages (updated data, mln. €)	3.487	3.322	2.572	3.280	2.572	95%	74%	94%	74%
repair costs only (mln. €)	3.280	3.487	4.884	3.154	4.884	106%	149%	96%	149%
Environmental indicators (selected)									
Total Energy (PJ)	141,61	135,05	100,87	130,87	100,87	95%	71%	92%	71%
Greenhouse Gas emissions (mt CO2 eq.)	8,91	8,34	5,78	8,19	5,78	94%	65%	92%	65%
Acidification (kt SO2 eq.)	86,72	83,39	67,14	81,71	67,14	96%	77%	94%	77%
Material consumption									
Bulk Plastics (t)	13.794	13.566	9.116	13.626	9.116	98%	66%	99%	66%
TecPlastics (t)	15.787	14.880	9.638	15.388	9.638	94%	61%	97%	61%
Ferro metals (t)	4.181	4.043	3.150	4.068	3.150	97%	75%	97%	75%
Non-ferro metals (t)	29.731	28.907	22.748	28.881	22.748	97%	77%	97%	77%
Electronics (t)	36.867	35.611	27.007	35.877	27.007	97%	73%	97%	73%
Miscellaneous, mainly paper, cardboard (t)	89.993	85.279	56.040	87.493	56.040	95%	62%	97%	62%
Totals materials (t)	190.353	182.286	127.699	185.333	127.699	96%	67%	97%	67%
thereof, Critical Raw Materials (t)									
Tantalum (Ta, t)	9,2	8,9	7,3	8,9	7,3	97%	80%	97%	80%

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Task 7 – Scenario Analysis

Q&A

short comments or questions: chat

complex comments or questions: topic -> chat AND #

Task 7 – Socio-economic impact analysis: Consumers

- Product Life Cycle Costs, low-end smartphones

low-end smartphone, 5"	Status quo	Ecodesign requirements		Energy Label
		optimistic	conservative	
proxy	*Base Case*	*REP path (see Task 6)*	*DUR path (see Task 6)*	*DO49 (see Task 6)*
product use lifetime (years)	2,50	3,42	3,38	2,59
per product				
purchase price	200,00 €	205,47 €	211,32 €	200,40 €
electricity costs	3,94 €	4,26 €	4,21 €	3,23 €
repair costs	9,66 €	12,55 €	14,13 €	9,66 €
Totals consumer expenditure	213,60 €	222,28 €	229,66 €	213,29 €
external societal damages (MEErP 2011)	3,58 €	3,45 €	3,44 €	3,52 €
external societal damages (updated data)	12,26 €	9,85 €	9,83 €	11,96 €
per year of use				
purchase price	80,00 €	60,14 €	62,59 €	77,49 €
electricity costs	1,57 €	1,25 €	1,25 €	1,25 €
repair costs	3,86 €	3,67 €	4,19 €	3,74 €
Totals consumer expenditure	85,44 €	65,06 €	68,02 €	82,48 €
external societal damages (MEErP 2011)	1,43 €	1,01 €	1,02 €	1,36 €
external societal damages (updated data)	4,90 €	2,88 €	2,91 €	4,62 €

Task 7 – Socio-economic impact analysis: Consumers

- Product Life Cycle Costs, low-end smartphones, sensitivity analysis purchase price break-even

low-end smartphone, 5"	Status quo	Ecodesign requirements		Energy Label
sensitivity analysis, purchase price		optimistic	conservative	
product use lifetime (years)	2,50	3,42	3,38	2,59
per product				
purchase price - calculated scenarios	200,00 €	205,47 €	211,32 €	200,40 €
purchase price - break even	200,00 €	**275,09 €**	**270,11 €**	**208,06 €**
electricity costs	3,94 €	4,26 €	4,21 €	3,23 €
repair costs	9,66 €	12,55 €	14,13 €	9,66 €
Totals consumer expenditure	213,60 €	291,90 €	288,46 €	220,94 €
external societal damages (MEErP 2011)	3,58 €	3,45 €	3,44 €	3,52 €
external societal damages (updated data)	12,26 €	9,85 €	9,83 €	11,96 €
per year of use				
purchase price	80,00 €	80,52 €	80,01 €	80,46 €
electricity costs	1,57 €	1,25 €	1,25 €	1,25 €
repair costs	3,86 €	3,67 €	4,19 €	3,74 €
Totals consumer expenditure	85,44 €	85,44 €	85,44 €	85,44 €
external societal damages (MEErP 2011)	1,43 €	1,01 €	1,02 €	1,36 €
external societal damages (updated data)	4,90 €	2,88 €	2,91 €	4,62 €

Task 7 – Socio-economic impact analysis: Consumers

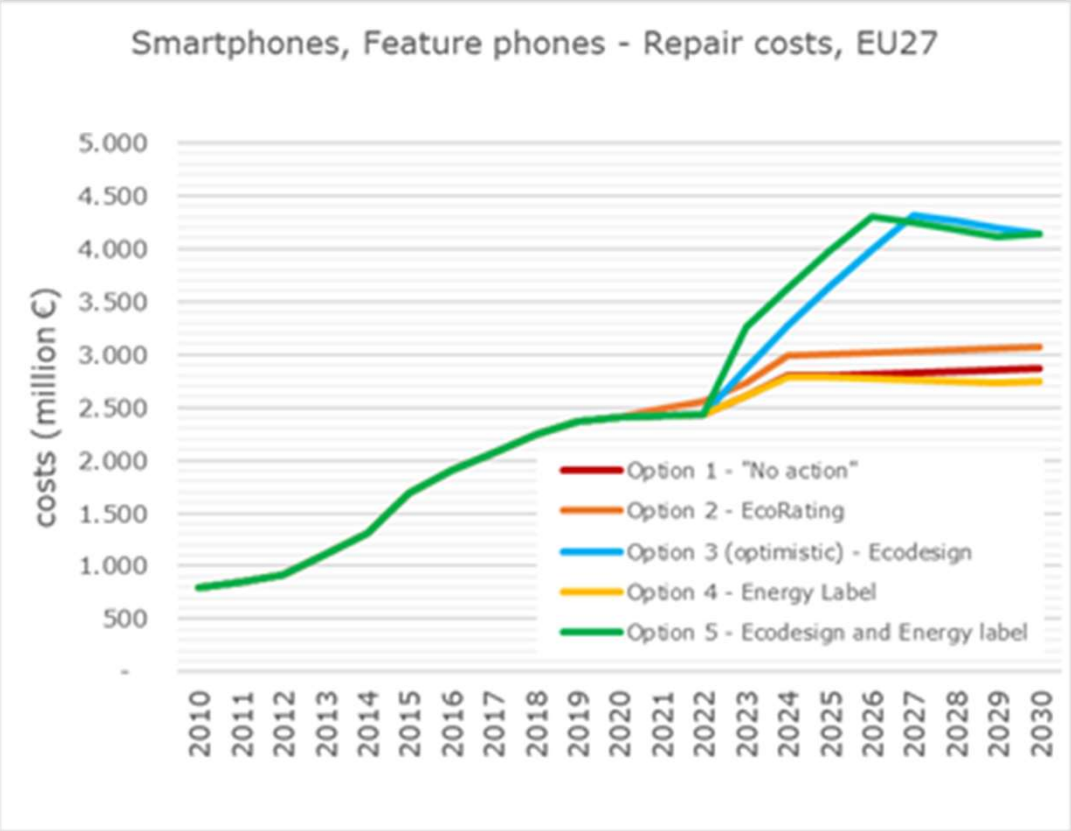
- Product Life Cycle Costs, low-end smartphones, sensitivity analysis lifetime break-even

low-end smartphone, 5"	Status quo	Ecodesign requirements		Energy Label
sensitivity analysis, lifetime		optimistic	conservative	
proxy	*Base Case*	*REP path (see Task 6)*	*DUR path (see Task 6)*	*DO49 (see Task 6)*
product use lifetime (years)	2,50	3,42	3,38	2,59
product use lifetime (years) - break-even	2,50	**2,59**	**2,68**	**2,50**
per product				
purchase price	200,00 €	205,47 €	211,32 €	200,40 €
electricity costs	3,94 €	4,42 €	4,51 €	3,23 €
repair costs	9,66 €	12,55 €	14,13 €	9,66 €
Totals consumer expenditure	**213,60 €**	**222,43 €**	**229,97 €**	**213,29 €**
per year of use				
purchase price	80,00 €	79,33 €	78,85 €	80,16 €
electricity costs	1,57 €	1,25 €	1,25 €	1,25 €
repair costs	3,86 €	4,84 €	5,27 €	3,86 €
Totals consumer expenditure	**85,44 €**	**85,42 €**	**85,37 €**	**85,27 €**

Task 7 – Socio-economic impact analysis: Repair business

- Total repair costs go up, due to more repairs
- Professional repair shops will benefit more from the conservative scenario of Ecodesign requirements,
- with the optimistic scenario more repairs shift towards the consumer, i.e. spare parts, tools and logistics costs only

- Repair, refurbishment largely within EU27



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Task 7 – Socio-economic impact analysis: OEMs / supply chain

- Massive impact on (new) sales
  - OEMs: Almost all outside EU27
  - Supply chain to a small extend in EU27
  - Some major equipment manufacturers for semiconductor equipment and similar located in EU27
- Smartphones are innovation drivers for the semiconductor industry currently
- Additional cost factors for OEMs
  - spare parts stock and logistics
  - testing

Task 7 – Socio-economic impact analysis

Q&A

short comments or questions: chat

complex comments or questions: topic -> chat AND #

AOB, Next steps

- Comments on Task 5 and 6 (preferrably) by January 8, 2021
- Comments on Task 7 by January 17, 2021

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Thank you for your attention!

- www.ecosmartphones.info
- contact@ecosmartphones.info

Closing remarks…

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