REPORT ON THE 2020 REVIEW OF THE GAMES CONSOLES SELF-REGULATORY INITIATIVE

Final report date: 9 November 2020

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report is the third undertaken by the Signatories of the Games Consoles Self-Regulatory Initiative (SRI). It details the process undertaken for this review and provides the rationale leading to the proposed SRI amendments and updates after the 2019 Review. The review process includes analysing the essential elements of the SRI to determine whether revisions are necessary, and taking into consideration the latest technological, standardisation and regulatory developments to ensure the SRI is aligned with the latest developments.

The 2020 Review of the SRI started in April 2020, shortly after the 2019 Review was completed, as two Signatories announced the launch of new consoles in 2020[1]: Microsoft XBox Series S and Series X and Sony PlayStation 5. Feedback from the Commission and stakeholders was considered throughout in this report and the updated SRI document. The new version of the SRI is expected to be implemented from 1 January 2021.

The SRI remains the preferred choice for addressing energy and resource efficiency of games consoles. It continues to achieve policy objectives most expeditiously – keeping up with the speed of technology developments within the sector – and at a lesser expense than mandatory requirements. It is also a highly transparent process where Member States, stakeholders representing civil society (notably with a focus on consumers rights or the environment) and the European Commission provide input on a regular basis.

Updates of industry Compliance with the SRI

Under the SRI, each Signatory is required to submit an annual Product Compliance Report (PCR) to the Independent Inspector for each of its games consoles models in scope. The Independent Inspector then releases an Annual Compliance Report (ACR)[2].

There has been one reporting cycle since the last industry review of the SRI, covering the period from 1 January 2019 to 31 December 2019. No new models were placed on the

[1] At the time the review report is finalized, the launches are foreseen for November 2020.

[2] https://efficientgaming.eu/fileadmin/user_upload/2019_Report/Independent_Inspector_Games_Console_ACR_2019_FINAL_report_V1.1.pdf

market during that period. The Independent Inspector determined that all Signatories were compliant with their SRI commitments, as was the case for all reporting periods since 2015.

For the first time in 2019, the Independent Inspector carried out tests which initially showed that the Microsoft consoles met the automatic power-down (ADP) values for 1 out of 4 modes. This was promptly rectified through implementation of software updates, resulting in full compliance.

The revisions to the compliance section in this review mainly aim to clarify the wording, based on a couple of years of reporting (e.g. role of Independent Inspector, monitoring of the SRI.

Review of Technology

The **display technology** computational requirements increase as the gaming experience evolves. While there has been a **rapid adoption of 4K** displays and televisions, the next step in display resolution, 8K, is at the cusp of a transition from high-end technology to mass market, providing new and immersive experiences. The signatories **are introducing new consoles that are capable of handling 8K video resolution**. With that introduction, new technologies offering further improvements in compression efficiency are also maturing and/or emerging. Solid-state drive (SSD) technology has matured and is now replacing rotating-media hard disk drives on many consumer devices, enabling lower-power standby modes without as much impact on gaming experience. **Cloud computing and streaming gaming**, the next big shift in gaming, is just starting to be introduced into the market. Its adoption will depend on ubiquitous high-speed connections and its effect on aggregate energy consumption will have as many variables to consider as console gaming. **Virtual-Reality (VR) and Mixed-Reality (MR) gaming** have not had as wide an adoption as expected and will likely remain a niche market.

Energy Efficiency Proposal

The Games Consoles SRI has driven an **estimated energy saving of 25.2 TWh since its adoption**, with total savings for UHD consoles estimated at 42.1 TWh in Europe over their lifetime. These energy savings are largely due to manufacturers adopting a large variety of energy efficient technologies, which have implementing reductions in power consumption of consoles more rapidly than expected.

In line with the requirements of the SRI, a review process was initiated in 2020 to set commitments for the consoles newly included in the agreement. The Signatories incorporated energy efficiency **at the design stage** of the new consoles and assessed the feasibility of some **stakeholder suggestions**, which is why the new power caps proposed for 8K definition capable consoles **are the same** as for current UHD gaming capable consoles. It is therefore the first time the industry has been able to achieve power consumption levels which require **no increase in caps when introducing a new generation of consoles,** in spite of exponential performance increases. The energy saving for the 8k consoles is estimated at 46.4 TWh in Europe over their lifetime (when comparing new energy efficient technology introduced since UHD capable consoles). The SRI has been updated to include a Tier 5 and 6 power caps, including those applicable to 8K definition consoles.

In the European Commission's 2019 SRI review study[3], a power cap of 5 W was suggested for the next generation games consoles' **low power mode** (or rest mode). After reviewing the low power modes implemented by console manufacturers, it is clear that each console has a very different type of low power mode and function, meaning that a consistent mode definition and a common basis for power reductions is not possible. Consequently, each signatory will address reductions in low power mode power consumption for their consoles on an **individual basis**, using techniques best suited to their console's architecture and software. Each console manufacturer will continue focusing on reducing energy in their designs by fine-tuning the low-power modes that work best on their platform.

Resource Efficiency Proposal

Throughout this section of the Review Report, Signatories present their rationale for resource efficiency commitments made within the 2020 SRI Review, in line with the ambitions of the Commission's new Circular Economy Action Plan (CEAP) and national CE requirements.

The CEAP published in March 2020 identifies consumer electronics as one of the key sectors where substantial efficiency gains can be made by improving circularity. In 2021, the

3 Review study of the ecodesign voluntary agreement for the product group "videogames consoles": https://op.europa.eu/en/publication-detail/-/publication/b29e4799-e4bd-11e9-9c4e-01aa75ed71a1/language-en

Commission will propose three initiatives to make consumer electronics more sustainable. The efficiency of materials and resources are expected to play a key role, with measures to improve the lifespan of electronic devices through e.g. easier removability of components and improved reparability.

The Games Consoles SRI aims to reduce the environmental impact of games consoles over their life cycle, without compromising console performance or the gaming experience consumers receive. Under the SRI and through Signatories' environmentally aware product design, consoles have seen energy savings and enhanced resource efficiency over time. Beyond existing commitments on spare parts availability, removability/disassembly and information provision, the proposed additional commitments include improving availability of spare parts (e.g. HDD and external power supplies as of 2022) and aim at removing hazardous substances (e.g. halogenated flame retardants > 1000ppm in external plastic enclosure parts > 25 g as of 2022). This aligns with EU ambitions under its new Chemicals Strategy for Sustainability to ensure non-toxic material cycles, including in the electronics sector, as well as to move away from the use of flame retardants. Both commitments also aim to align the SRI with the equivalent requirements within the Lot 5 (Ecodesign Requirements for Electronic Displays, Regulation (EU) 2019/2021).

Other commitments were considered and thoroughly assessed, such as increasing recycled plastics content, guaranteeing battery life and removability, providing separate take-back schemes or providing information on the inclusion of critical metals to recyclers, however they were not added in the SRI for the reasons detailed in the resource efficiency section.

Summary of all proposed changes to the SRI

This section provides an overview of all the major proposed updates and changes to the SRI. The 2020 Review Report as well as the new version of the SRI (draft version 3.9.4) are to be submitted to the Ecodesign Consultation Forum for discussion and review. If formally recognised by the Commission, the updated SRI will be effective from 1 January 2021.

INTRODUCTION

Background on the Self-Regulatory Initiative

The development of the Games Consoles Self-Regulatory Initiative ("SRI") was proposed by console manufacturers in 2010 as an alternative to a mandatory implementing measure under the EU Ecodesign Directive[4]. It was formally endorsed in April 2015 via a Report from the European Commission to the European Parliament and the Council[5]. The SRI Signatories are all three game consoles manufacturers, covering 100% of consoles sold within the EU market: Microsoft, Nintendo and Sony Interactive Entertainment.

Under the Games Consoles SRI, consoles manufacturers commit to make ambitious improvements to the energy and material efficiency of their consoles, without compromising console function and performance and therefore consumer experience. This is achieved through better design, modal power caps, automatic power down (APD), market coverage, resource-efficiency / end-of-life design measures, and user information requirements for games consoles "placed on the market" in the EU.

The SRI continues to achieve policy objectives more quickly and at lesser expense than mandatory requirements:

- There are only three manufacturers, which facilitates consensus building
- The rate of technology advancement outpaces regulatory processes
- Substantial differences between platforms render standardisation difficult

As each producer develops and distributes their different console models on a global basis, the EU SRI provides *de facto* a global standard.

[4] DIRECTIVE 2009/125/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products

[5] COM(2015) 178 final - REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL on the voluntary ecodesign scheme for games consoles

Objective of the Report

As part of their obligations under the SRI, the Signatories are required to review the SRI's essential elements every two years to examine if existing provisions need to be updated and whether new commitments should be included. The review can be triggered sooner, however, if a major console change is foreseen (e.g. new generation launch). The objective of this report is to provide a detailed description of the Signatories' research and review process underlying the latest proposed amendments to the SRI, which form part of the 2020 review triggered by the planned launch of the Sony PlayStation 5, and Microsoft XBox Series X and XBox Series S next generation consoles during 2020.

Transparency of the process

Stakeholders are invited to participate in the SRI Steering Committee meetings, the details of which (meeting dates and agendas) are published in advance in the SRI website[6]. The process of updating the SRI continues to be an open and transparent one, whereby the opinions of all stakeholders are considered.

Review Process Timeline

The 2020 review is the third such review conducted by the games consoles industry. The process started in April 2020 and feedback from the European Commission and stakeholders were considered throughout in this report and the updated SRI document. Signatories followed the timeline shown in **figure 1** below for the 2020 Review.

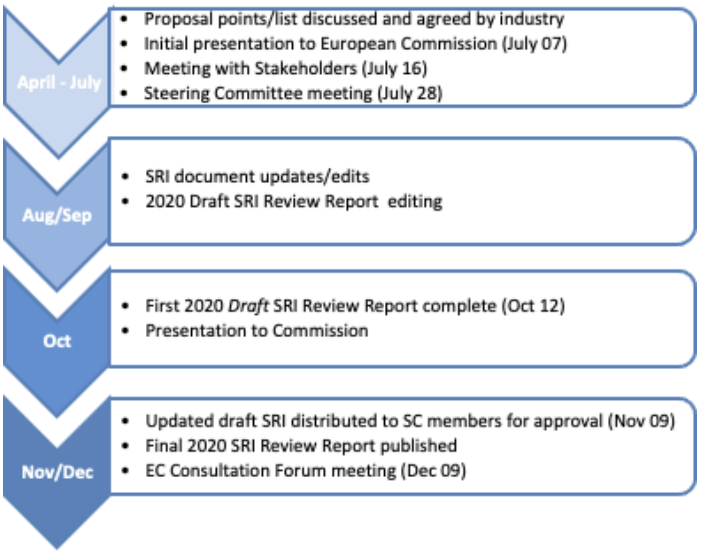

Figure 1: Timelines followed by the SRI Review process.

[6] https://efficientgaming.eu/meetings/

The new version of the SRI is expected to be implemented from 2021.

COMPLIANCE UPDATE

Background

Signatories conducted their last review of the SRI in 2019. They presented the outcome of their review at the Consultation Forum meeting that took place on 12th December 2019. During the first quarter of 2020, the Signatories submitted Product Compliance Reports to the Independent Inspector (Intertek), reporting data and compliance information on consoles placed on the market in the 2019 calendar year.

Summary of compliance since the last Review

There has been one reporting cycle since the last industry review of the SRI (carried out in 2019), involving the annual submission of data to the Independent Inspector for verification of the Signatories' compliance with the SRI requirements. This covered games consoles sold in 2019. No new models were placed on the market by the Signatories during this year, however both Microsoft and Sony Interactive Entertainment announced the launch of their respective new generation consoles. These were confirmed to be released in November 2020.

The findings of the Independent Inspector are summarised in its Annual Compliance Report published in May 2020. In October 2019, the Independent Inspector had carried out a compliance verification investigation consisting of testing randomly selected consoles to check for compliance with the SRI energy limits. The SRI provides that one of the conditions that would trigger such testing is the placing on the market of a new or revised console model.[7]

The Independent Inspector's key conclusions were:

a. The three SRI Signatories represent 100% of the EU market. Nintendo did not have a console within scope for that reporting period but is still a Signatory of the SRI.
b. Both Sony Interactive Entertainment and Microsoft provided the necessary information on non-energy requirements.
c. All console models from Microsoft and Sony Interactive Entertainment were considered compliant (see table below). The Microsoft consoles initially met the APD limit values for 1 out of 4 modes, however were considered compliant after the

[7] See "Self-Regulatory Initiative to further improve the energy efficiency of Games Consoles" Annex C - Method of Data Collection and Processing by Independent Inspector.

required software updates were implemented following the compliance verification investigation.

Table 1: Consoles reported on PCR for the reporting period 2019.

Manufacturer	Games Console	Type
Microsoft	Xbox One S	Ultra High Definition Media Capable
Microsoft	Xbox One X	Ultra High Definition Gaming Capable
Sony Interactive Entertainment	PlayStation 4 (CUH-2216)	Ultra High Definition Media Capable
Sony Interactive Entertainment	PlayStation 4 Pro (CUH-7216)	Ultra High Definition Gaming Capable

Proposed compliance-related changes

Since the 2019 review, the Signatories have made additional amendments to the SRI. These revisions were made in response to comments and questions provided by stakeholders at and following the Consultation Forum meeting in December 2019. Revisions were also made to clarify the text of some existing requirements and commitments. The amendments made are listed below:

- Clarification of the wording regarding the role of the Independent Inspector (Section 4.4, Administration of the Self-Regulatory Initiative).
- Added explanatory text regarding verification testing carried out to inform on SRI performance, consumer information and non-energy requirements.
- Added a subsection to clarify ‘annual reporting’ and re-ordered a paragraph (Section 5.4, Non-compliance).
- Added a subsection to clarify ‘non-compliance following a verification investigation’ (Section 5.4, Non-compliance).
- Clarification of the wording regarding the monitoring of the SRI (Section 6, Monitoring of the Self-Regulatory Initiative).
- Added words to outline verification investigations.
- Added words regarding the PCR (Annex C, Data collection and processing).

REVIEW OF TECHNOLOGY

New consoles

As the video gaming experience evolved from small-screen black-and-white Cathode Ray Tubes (CRTs) to high-frame rate, high-dynamic response (HDR) and Ultra-High Definition (UHD), the display technology computational requirements increased (and continue to increase) in a non-linear fashion.

There has been a rapid adoption of 4K displays and televisions with some models selling for under USD $300. In addition, many media streaming providers, including YouTube, Netflix and Hulu have a significant amount of available 4K content. 4K display technology has four times the resolution of 1080p video, requiring increased computation and four times the display memory bandwidth for rendering any images, including games.

The introduction of High Dynamic Range (HDR) and wider colour gamut requires further complexity. The next step in resolution, 8K, is at the cusp of a transition from high-end technology to mass market. While 8K televisions are currently an order of magnitude more expensive than 4K televisions, the prices are dropping, and they will become common within the next few years. The Signatories are introducing new consoles that handle 8K resolution, requiring yet another increase in computation and a further four-fold increase in display memory bandwidth for image rendering to handle the approximately 33 million pixels per frame. The new videogame consoles will be able to provide new and immersive experiences in these higher resolutions that will not be possible for streaming gaming or gaming on other devices.

We expect the 8K resolution to be used primarily for gaming for the next few years. Netflix, Amazon, Hulu and other streaming services are still focused on providing more 4K content. Only a limited number of customers have the bandwidth to stream video in 8K format. Blu-ray™ does not currently support resolutions above 4K further limiting the availability of 8K media.

Solid-state drive (SSD) technology has matured and is now replacing rotating-media hard disk drives on many consumer devices and they will allow faster boot and resume times. This will allow consumers to enable lower-power standby modes without as much impact on their gaming experience. In addition, SSDs improve material efficiency as they use far fewer raw materials to manufacture and have fewer materials and components to address at the end of their life.

Future codecs

A key enabling technology in the transition to higher resolution video is the implementation of more efficient compression coding, to reduce the video storage and bandwidth requirements. The current state of the art in video coding is represented by the High Efficiency Video Coding (HEVC) standard from MPEG and ITU-T, and the AV1 specification from the Alliance for Open Media. Both HEVC and AV1 offer approximately twice the compression efficiency of the previous generation standard, H.264/AVC, i.e. they use only about half the bit-rate to provide the same subjective video quality. The downside is that they both require significantly more computational resource to encode and decode.

Looking to the future, new technologies offering further improvements in compression efficiency are already starting to emerge. During 2020, MPEG completed two new video coding specifications: Essential Video Coding (EVC) and Versatile Video Coding (VVC). These are again expected to provide approximately twice the compression efficiency of the previous generation of codecs, but at the cost of requiring greater computational resource. An indicative measure of the increased computational load is to compare software models of the new codecs with HEVC running on the same computer. When decoding 4K content, the decoder run-times for the new generation of codecs are measured to be almost twice that for HEVC.

While the computational load on the device side may increase, the compression efficiency will significantly reduce the data transmission rate and therefore reduce energy consumed in the data transmission network. The impact of this could be to reduce the energy use of the system as a whole for the service being delivered, although further research is required.

Development of silicon / end of Moore's law

Despite the continual increase in computational power and display resolution, the overall energy consumption in consoles has not increased significantly and for some aspects it has even dropped. For the first time, the SRI will require new higher-resolution consoles to conform to the same power limits as the previous generation of consoles. The SRI Signatories expect that a number of technological improvements will allow increases in game resolution without always requiring an increase in overall power consumption. This is primarily due to Moore's Law - the observation that the number of transistors in a dense integrated circuit doubles approximately every two years, by shrinking the transistors geometry and therefore increasing the number of transistors that can be fitted on a chip. As a result of this process, the amount of electricity required for a given unit of computing has gone down in step functions over the last 40 years.

However, the physical limits of silicon processing and physics have begun to put the brakes on this phenomenon, and the industry expects to see an added energy cost in the future for a commensurate increase in gaming power. The current level of technology can produce minimum transistor sizes of 10 nm commonly, with 7 nm products starting to become the standard for new CPUs. However, at 7 nm, a transistor is only about 60 silicon atoms across, close to the limit of what is possible before the effects of quantum physics override the basic electrical properties used for computing. To date, only Samsung has announced a future 5 nm technology, and Samsung only plans to use 5 nm memory ICs where smaller features are not as affected by quantum effects. The Signatories expect to see an overall slowing of the rate of the energy reduction from this process as it nears its physical limits.

State of VR/MR

Virtual Reality (VR) and Mixed Reality (MR) gaming have not had as wide an adoption as expected. Only a few new VR headsets have been introduced to the market in the past year and none have achieved any significant market penetration. We expect VR and MR gaming to remain a niche market in the near future.

Cloud gaming

Cloud computing and streaming gaming is just starting to be introduced into the market. The available streaming services are either still in beta testing or have limited gaming available. The Signatories are starting to offer streaming games to consoles and sometimes to devices other than consoles. It is more challenging to foresee the effect on energy consumption as the computing power for gaming is shifted from the console to the data centre. There could be a short-term increase in energy consumption as the data centre infrastructure for gaming is implemented. However, this could eventually lead to a long-term decrease in energy consumption. A CPU in a data centre can be dynamically reallocated to new computing loads. When one user stops playing games, a CPU can then be allocated to computing tasks for a new user. We expect server virtualization to become common for cloud gaming in three to five years. This will allow one CPU in a data centre to support multiple gamers.

Gamers will be able to play on devices they already have, whether a computer, smart phone or other device without having to purchase new hardware each time gaming performance improves. The computing power for gaming in the data centre can be maintained and upgraded in a centralized method reducing lifecycle energy costs related to shipping and distribution. Data centre equipment typically gives minimal concessions to aesthetics, reducing the amount of plastics used and thereby reducing the amount of flame retardants.

Many of the game streaming services are implementing a subscription service model. The customer doesn’t own specific games. Instead, they subscribe to a service and get access to

a library of games, similar to how streaming video services provide content. This may further shift consumers to gaming on devices that they already own and use for other purposes. The consumer will no longer need a dedicated console on which to store games that they have purchased.

Predicting energy variations for streaming gaming is difficult. The next shift in gaming may be the biggest seen in 40 years. In the early 1980s, video arcades were the standard for computer gaming, with hundreds of giant gaming cabinets in centralized locations. Within 10 years, home gaming was taking over, thereby disrupting the energy calculations for the game arcade. Users no longer consumed energy in transportation to and from the arcade. There were shifts in the lifecycle energy consumption of home games consoles relative to arcade cabinets. There were energy shifts in the manufacture and distribution of games. Finally, the higher sales of home gaming products spurred innovation that has led to the increased performance and reduced overall energy consumption of consoles over time. The shift to streaming gaming will likely be slower as it will depend on ubiquitous high-speed connections, but it will still have as many variables when calculating the effect on aggregate energy consumption.

A study by the University of Surrey and PlayStation[8] has found that carbon footprint of gaming depends on many factors, including which country you live in and which model of console you have. Two of the most important factors are the size of the game and how long you play it in total (over its lifetime). In addition, there are scenarios in which cloud gaming has lower carbon emissions than disc or downloaded games, when comparing the full life cycle carbon emissions from cradle to grave.

At present, we estimate downloading has the lowest carbon emissions compared to discs and streaming (at 0.05 $kgCO_2e$ on average per hour of gameplay using the latest PS4 system). This is relatively low compared to a typical gaming PC (estimated at around 0.09 $kgCO_2e/h$). In general, gaming is a low-carbon activity compared to other leisure activities, particularly those that involve using transport (such as going to the cinema, estimated at 2.4 $kgCO_2e/h$) Druckman et al. (2012)[9].

[8] https://epubs.surrey.ac.uk/853729/1/Joshua%20Aslan%20thesis%20final%2012-Feb-20.pdf

[9] Druckman, A., Buck, I., Hayward, B. and Jackson, T. (2012). Time, gender and carbon: A study of the carbon implications of British adults' use of time. Ecological Economics, 84, pp.154-163.

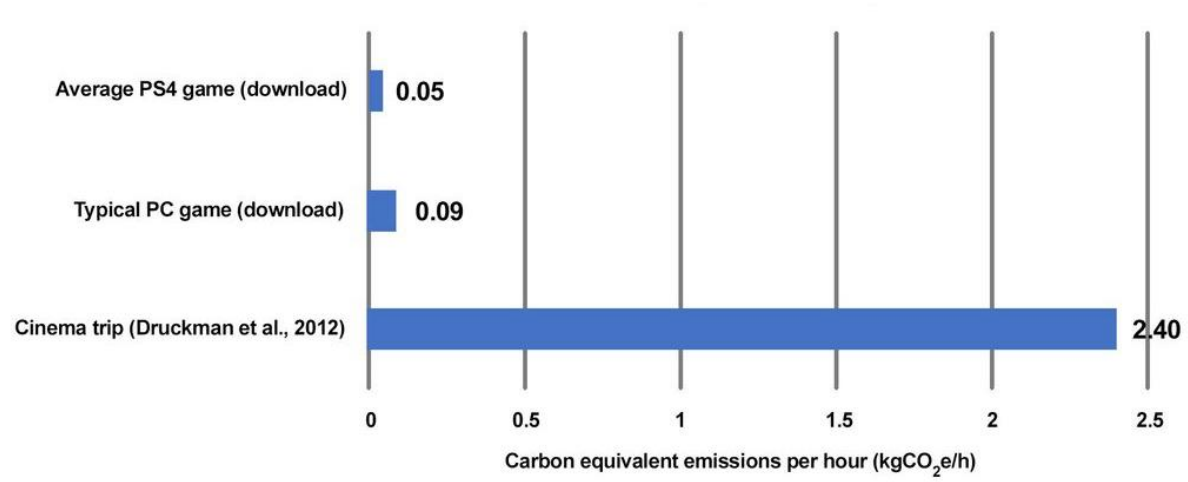

Figure 2: Estimated carbon intensity of a game downloaded in 2019 on different devices, compared to a trip to the cinema

How long you play a game for in total (over its lifetime) has an impact on the carbon footprint. For example, on average we estimate streaming using PS Now has the lowest carbon emissions for up to four to five hours of total (lifetime) gameplay, when compared to downloading, or up 20 hours compared to a PlayStation disc.

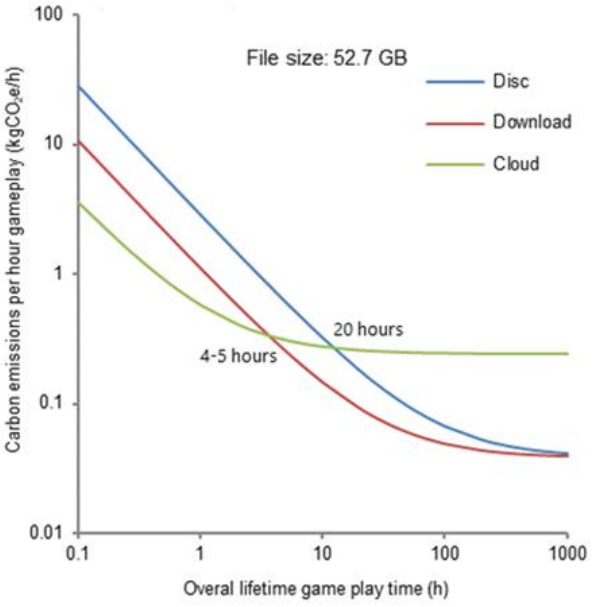

Figure 3: Estimated carbon equivalent emissions per hour gameplay for disc, download and cloud gaming

Likewise — game file size is also important. For smaller games, up to 5 GB, we estimate that downloading has the lowest overall carbon emissions compared to streaming and discs. For larger games, we estimate that streaming through PS Now has the lowest carbon

emissions if playing for just a few hours overall, while downloading them has the lowest emissions if you want to play for longer.

Cloud streaming services, such as PS Now, allows you to try hundreds of games almost instantly, and can reduce the carbon footprint of console gaming if renting games or trying before you buy (downloading).

The performance and efficiency of gaming, internet, and computing technology will continue to evolve in the future. For example, since 2000 the electricity intensity of Internet data transmission has halved every two years. As such, the thresholds at which different gaming methods have the lowest carbon impact, as explained above, will also change, and the research will require updating in the future.

ENERGY EFFICIENCY PROPOSAL

Proposed Energy Efficiency Changes

Power caps

The SRI includes commitments for power caps of active modes, as well as automatic power down (APD) requirements, to further improve the energy efficiency of games consoles. The current SRI power caps are set for navigation and media modes at high definition (HD) and ultra-high definition (UHD) resolutions. In the previous review of the SRI in 2019, definitions for the new generation of 8K definition capable games consoles were included in the agreement, as defined below:

> ***8K definition capable consoles****: Games consoles having potential of rendering video output with resolutions greater or equal to 8K (7680 pixels × 4320 lines) in addition to capability defined for ultra-high definition capable consoles.*

In line with the requirements of the SRI, a new review process was initiated in 2020 to set commitments for the consoles newly included in the agreement. The following new power caps for 8K definition capable consoles are proposed by the Signatories for consideration at the December 2020 Consultation Forum:

Table 2: Power caps for UK definition capable consoles

	HD resolution	UHD resolution
Navigation mode	70 W	70 W
Media mode	70 W	110 W

The proposed power caps for 8K definition capable consoles are the same as for current UHD gaming capable consoles. This is the first time the industry has been able to achieve power consumption levels which require no increase in caps when introducing a new generation of consoles in the history of the SRI. Previous generations of consoles have in the past required higher power caps on first release, with further reduction tiers set in later reviews of the SRI as technology is improved. The Signatories have made great efforts to ensure that this new generation of consoles meets the high expectations of stakeholders to achieve no increase in power caps, while significantly improving performance and functionality compared to the previous generation. For example, Sony Interactive

Entertainment estimate that the PlayStation 5 is up to 100 times faster than the PlayStation 4, while both the PS5 and Xbox Series X are capable of ray tracing and rendering graphics at up to four times the resolution of their predecessors.

The proposed power caps have been achieved through Signatories incorporating energy efficiency at the design stage of 8K definition capable consoles. In addition, the Signatories have listened to the suggestions of the stakeholders of the SRI and recommendations made in the independent consultant review of 2019, by utilising efficient Solid State Drive (SSD) storage. In fact, numerous bleeding-edge technologies have been incorporated in the design of the new generation consoles, including:

- 7 nm node System-on-a-Chip (SoC) architecture
- Power efficient AMD Zen 2 and RDNA 2 based architectures
- Custom Solid State Drive
- Sophisticated custom heat sink and cooling technology

The new generation consoles also make use of the energy efficient technologies adopted and used within the previous UHD media and gaming capable generation of consoles, including:

- System on a Chip technology, including media chip
- Power scaling technology
- Efficient internal power supplies

The use of these energy efficient technologies has allowed for PS5 and Xbox Series X to deliver a substantially improved gaming experience – representing a step change in both performance and energy efficiency.

Low Power Modes

In the European Commission's SRI review study completed in 2019, a power cap of 5 W was suggested for the next generation games consoles' low-power or "Rest Modes". However, after reviewing the low power modes implemented by console manufacturers, it is clear that each console has a very different type of low-power mode and function, meaning that a consistent mode definition and common basis for power reductions is not possible. Consequently, each signatory will address reductions in low power mode power consumption for their consoles on an individual basis, using techniques best suited to their console's architecture and software.

The below is by no means an exhaustive list, but should provide an insight on how the Signatories have improved the energy efficiency of their console's low power modes:

- Sony has developed new low power fast-boot, game-suspend, and battery charging functions for the PlayStation 5 that will allow the consoles to reduce power

consumption while powered down vs PlayStation 4 while also improving the gamer's experience.

- Microsoft is focusing on using the SSD technology to allow a faster boot and resume function to incentivize more users to use the low-power Standby instead of the higher-power Instant-On mode.
- The Nintendo Switch is an inherently low-power console and it has managed, via its design, that allows users to enjoy the console either via the TV screen or directly on the built-in screen, to reduce the power consumption even further compared to the previous generation.. The Nintendo SWITCH conforms with the requirements of relevant EU legislation for low power modes via its own Sleep Mode and does not offer any other selectable low power modes, thus making it the default setup of how the consumers are using the console.

Each console manufacturer will continue focusing on reducing energy in their designs by fine-tuning the low-power modes that work best on their platform.

Estimated Energy Savings

This section presents the estimated energy savings for new generation 8K definition capable consoles. The consoles included in this assessment are:

- PlayStation 5
- PlayStation 5 Digital Edition
- Xbox Series X
- Xbox Series S

Business-as-usual scenarios

The PlayStation 5 and Xbox Series X have been designed with energy efficiency in mind, adopting several new technologies that contribute to achieve energy savings. To estimate the energy savings achieved through adoption of energy efficient technologies, two business-as-usual (BAU) scenarios have been derived as baselines to compare the actual energy use of the consoles (as per ErP MEERP methodology).

Scenario 1 – Comparison to PS4 Pro and Xbox One X

The first BAU scenario estimates what the power consumption of the new generation consoles would have been had there been no improvement in technology in comparison to

the ultra-high definition gaming capable consoles (PlayStation 4 Pro and Xbox One X). For this scenario the following technological assumptions are made:

- No die shrink between generations
- No improvement in CPU energy efficiency
- No improvement in GPU energy efficiency
- No Solid State Drive

A detailed explanation of these technological assumptions and how the estimates were calculated can be found in Annex 1.

Scenario 2 – Comparison to PS3 and Xbox 360

The second BAU scenario estimates what the power consumption of the new generation consoles would have been had there been no improvement in the energy efficiency of console technology over the entire course of the SRI since 2015. This uses a comparison based on technology used within high definition consoles that predated the SRI adoption – PlayStation 3 and Xbox 360. For this scenario the following technological assumptions are made:

- Power supply efficiency is the same as for HD consoles
- Power scaling is the same as HD consoles
- Discrete CPU and GPU components (no System on a Chip architecture)

Power consumption

The power consumption for both BAU scenarios of the PlayStation 5 and PlayStation 5 digital edition consoles are listed in tables 3 and 4 below.

Table 3: Estimated power consumption of PS5 in BAU scenarios

Mode	Power consumption (W)	
	PS5 BAU 1	PS5 BAU 2
Active gaming	296.3	389.0
Media	92.9	233.3
Navigation	95.3	209.9
Standby	0.2	1.8
USB charging	5.2	N/A
Suspend	1.7	N/A
USB charging + network	6.4	N/A
Networked standby	1.0	11.7

Table 4: Estimated power consumption of PS5 digital edition in BAU scenarios

Mode	Power consumption (W)	
	PS5 digital edition BAU 1	PS5 digital edition BAU 2
Active gaming	296.3	389.0
Media	92.9	233.3
Navigation	95.3	209.9
Standby	0.2	1.8
USB charging	5.2	N/A
Suspend	1.7	N/A
USB charging + network	6.4	N/A
Networked standby	1.0	11.7

The power consumption for Xbox Series X and Xbox Series S consoles are shown below, as well as the BAU scenarios, in Tables 5 and 6 respectively.

Table 5: Xbox Series X power consumption and estimated power consumption of Xbox Series X in BAU scenarios

Mode	Power consumption (W)		
	Xbox Series X	*Xbox Series X BAU 1*	*Xbox Series X BAU 2*
Active gaming	173.0	284.8	371.4
Media	51.0	139.9	240.0
Navigation	43.0	122.8	213.8
Standby	0.4	0.5	0.4
Instant on	12.4	14.0	10.0

Table 6: Xbox Series S power consumption and estimated power consumption of Xbox Series S in BAU scenarios

Mode	Power consumption (W)		
	Xbox Series S	*Xbox Series S BAU 1*	*Xbox Series S BAU 2*
Active gaming	89.0	149.0	193.6
Media	27.0	73.1	125.1
Navigation	26.0	64.2	111.4
Standby	0.4	0.5	0.4
Instant on	10.4	14.0	10.0

The BAU estimates are not uncommon power consumption values for gaming PCs with similar specification hardware components to the PS5 and Xbox Series X.

Power consumption of the PlayStation 5 and PlayStation 5 digital edition is lower across all media and navigation modes (at 2K and 4K resolutions) compared to the launch model PS4, launch model PS4 Pro and even the most recent 2018 model, as shown in Figure 4 below. In fact, the power consumption is only a maximum of ~10 W higher in media and navigation

modes (2K) when compared to the most recent 2018 model PS4 (a console which has had an architecture die shrink, amongst many other efficiency improvements). The PS5 and PS5 digital edition have lower power consumption across all modes, when compared to all previous PS4 and PS4 Pro models.

Table 7 below compares the power consumption across all modes for PlayStation consoles[10], and shows the relative change in power consumption of PS5 compared to the PS4 Pro (2018 model). Gaming power consumption is the only mode where power has increased, due mainly to the substantial increase in performance between generations.

Table 7: Power consumption of PlayStation consoles in all modes[11]

Mode	Power consumption (W)					
	PS4 (2013)	PS4 (2018)	PS4 Pro (2016)	PS4 Pro (2018)	Δ PS5 vs PS4 Pro (2018)	Δ PS5 DE vs PS4 Pro (2018)
Active gaming	137.3	78.2	126.1	146.4	+20.8%	+21.8%
Active gaming 4K	N/A	N/A	148.1	158.2	+14.1%	+11.4%
Media	96.7	45.0	66.7	54.7	-2.1%	-2.1%
Media 4K	N/A	N/A	84.2	N/A	-10.1%	N/A
Navigation	83.7	42.2	60.4	56.1	-13.1%	-15.4%
Navigation 4K	N/A	N/A	66.7	64.3	-22.6%	-24.5%
Standby	0.30	0.20	0.20	0.20	+0.1 W	+0.1 W
USB charging	6.30	4.10	6.50	5.00	-25.6%	-26.4%
Suspend	4.00	1.80	2.30	1.70	-81.2%	-81.2%
USB charging + network	7.80	5.40	8.20	6.40	-41.1%	-42.5%
Networked standby	2.70	0.90	1.30	1.00	+/- 0.0%	-12.0%

Similarly, for Xbox Series X, power consumption in media and navigation modes, as shown Figure 6 below, is lower than previous Xbox One models, except for the more recent 2016

[10] Results based on average of five EU PS5 (CFI-1016A) and PS5 digital edition (CFI-1016B) samples, where possible. For Active gameplay, the current estimate for the PS5 disc version is based on an average of two samples only, while the rest modes for both models are based on 2-3 samples. These data will be updated as soon as possible and published in compliance with the SRI agreement. Power consumption may vary by the test condition, and future design modification.

[11] Gameplay power consumption based on preinstalled game 'Astro's Play Room'. Power consumption for different games may vary. Gameplay power consumption based on an average of three top-selling games will be published after the PS5 is released in Europe (19-Nov-2020) as per the SRI requirements. Media mode based on average of measurements for Blu-ray (Avatar) and DVD (Avatar). Media 4K based on Spider-Man Homecoming. For further information on the power consumption of PS4 and PS4 Pro consoles see: playstation.com/ecodesign

Xbox One S model. While the Xbox Series S achieves the lowest power consumption of all Xbox consoles to date.

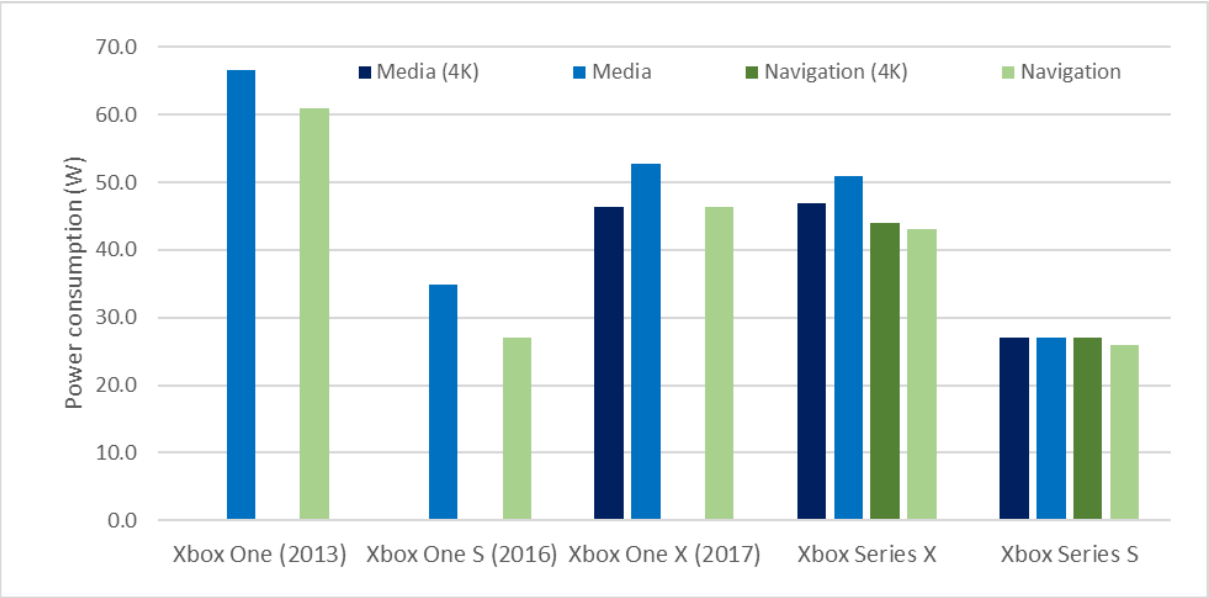

Figure 4: Power consumption of Xbox consoles in Media and Navigation modes

Power consumption in Instant On mode has been reduced also when compared to the launch model Xbox One and Xbox One X consoles. Standby power consumption has been kept at the same low level as previous consoles.

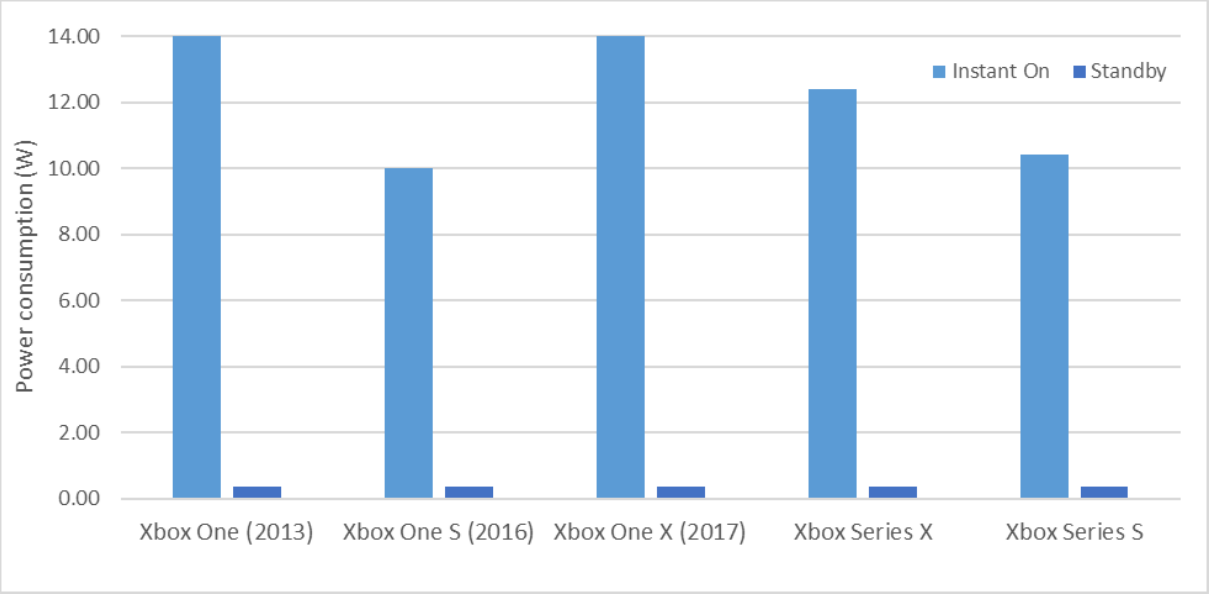

Figure 5: Power consumption of Xbox consoles in low power modes

Table 8 below compares the power consumption of Xbox consoles in all modes. Smilarly to the PS5, the Xbox Series X has increased power consumption in the gaming mode only. However, the lower performance Xbox Series S does have gameplay power consumption lower than the launch model Xbox One and Xbox One X.

Table 8: Power consumption of Xbox consoles in all modes

Mode	Power consumption (W)				
	Xbox One (2013)	Xbox One S (2016)	Xbox One X (2017)	Xbox Series X	Xbox Series S
Active gaming	106.0	62.0	107.6	173.0	89.0
Active gaming 4K	N/A	N/A	-	180.0	92.0
Media	66.7	34.8	52.8	51.0	27.0
Media 4K	N/A	N/A	-	47.0	27.0
Navigation	61.0	27.1	46.4	43.0	26.0
Navigation 4K	N/A	N/A	-	44.0	27.0
Standby	0.34	0.34	0.34	0.37	0.37
Instant on	14.00	10.00	14.00	12.40	10.40

Usage estimates

The usage estimates in this analysis are derived from the NRDC (2014)[12] report on games console energy use, based on the PlayStation 4 and Xbox One consoles. To estimate the energy use of 8K definition capable consoles, we assume that usage will not change from the previous generation, as estimated in the NRDC report. However, we do make new assumptions for the usage times in low power modes for both consoles, due to differences in functionality. For additional detail on the usage estimates, see Annex 1.

Typical Electricity Consumption in Europe

Total lifetime energy use for 8K capable consoles in Europe is estimated at 52.1 TWh. Had no energy efficiency improvements been made compared to PS4 Pro and Xbox One X, energy use is estimated to have been almost double this at 98.5 TWh (BAU 1). This is in comparison to an estimated 145 TWh, had no improvements been made since the adoption of the SRI.

[12] https://www.nrdc.org/sites/default/files/video-game-consoles-IP.pdf

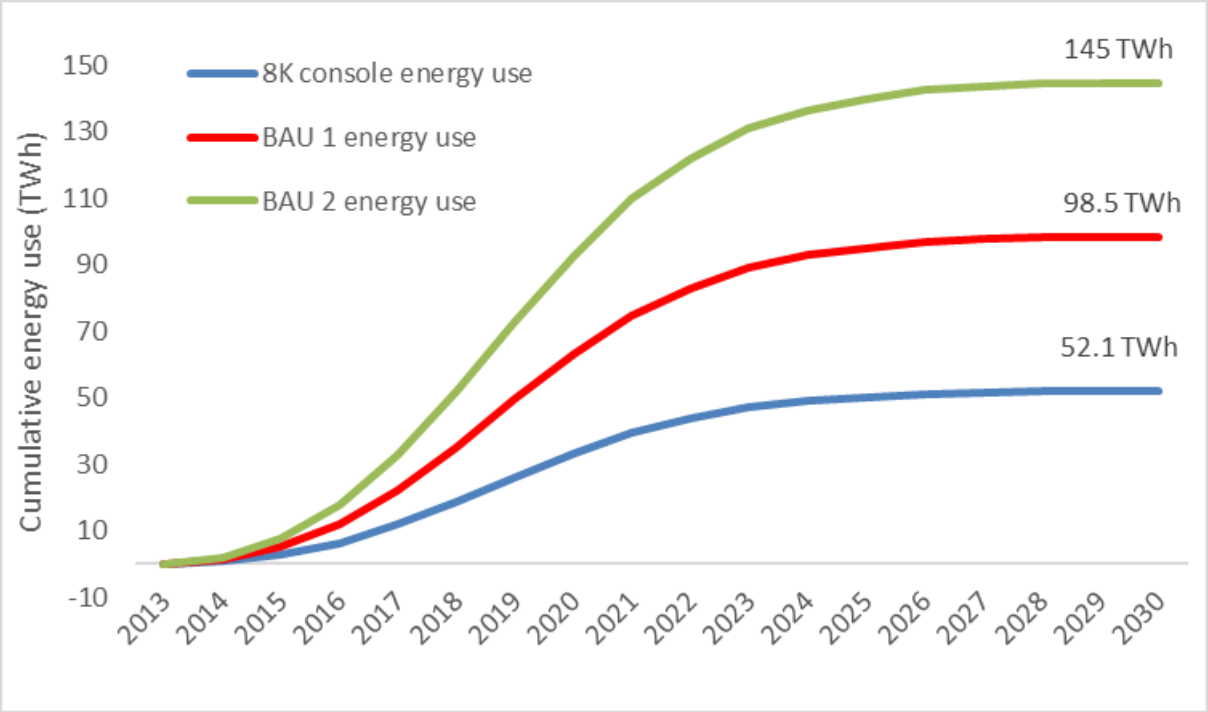

Figure 6: Estimated cumulative energy use of 8K definition consoles in Europe

The estimated lifetime energy use of 8K capable consoles above assumes there will be no further improvement in the energy efficiency of these consoles, and therefore represents a worst case. The signatories have managed to reduce the power consumption and energy use of UHD capable consoles significantly, in some cases by up to 50%, driven in large part by the continuous reviewing of the SRI commitments. It is still very early in the development of 8K capable consoles and impossible to determine future energy efficiency improvements at this stage. The calculations will be reviewed in the future to update them as and when efficiency improvements are made in the future.

Even assuming there would be no further improvement to 8K console energy efficiency in the future, annual energy savings are estimated to peak in 2026 at 6.7 TWh, based on the BAU 1 scenario (comparing to Xbox One X and PS4 Pro) – see Figure 7 below. While cumulative avoided energy use over the 8K console lifetime is estimated at 46.4 TWh in Europe.

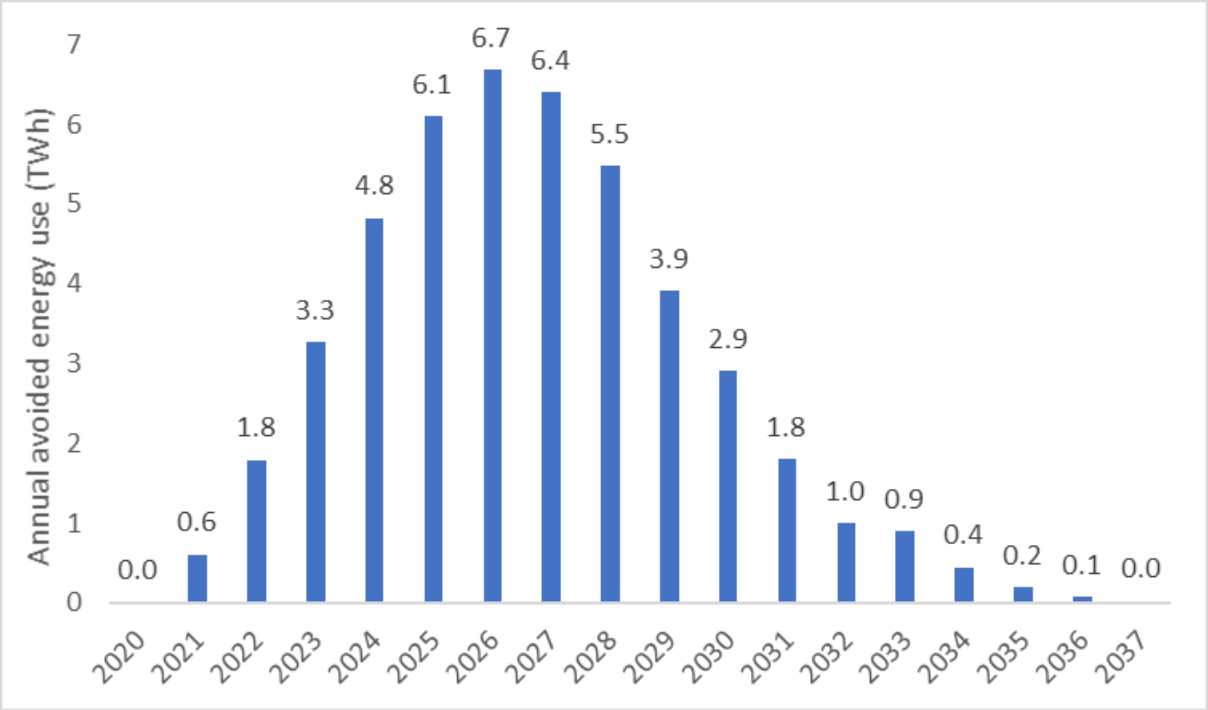

Figure 7: Estimated annual energy use avoided through energy efficient technologies used in 8KD capable consoles compared to the BAU 1 scenario (vs UHD capable consoles)

When comparing to all energy efficiency measures taken since the adoption of the SRI (BAU 2), estimated annual energy savings of 8K capable consoles peak at 13.4 TWh in 2026, see Figure 8 below. Cumulative avoided energy in this scenario is estimated at 92.7 TWh in Europe.

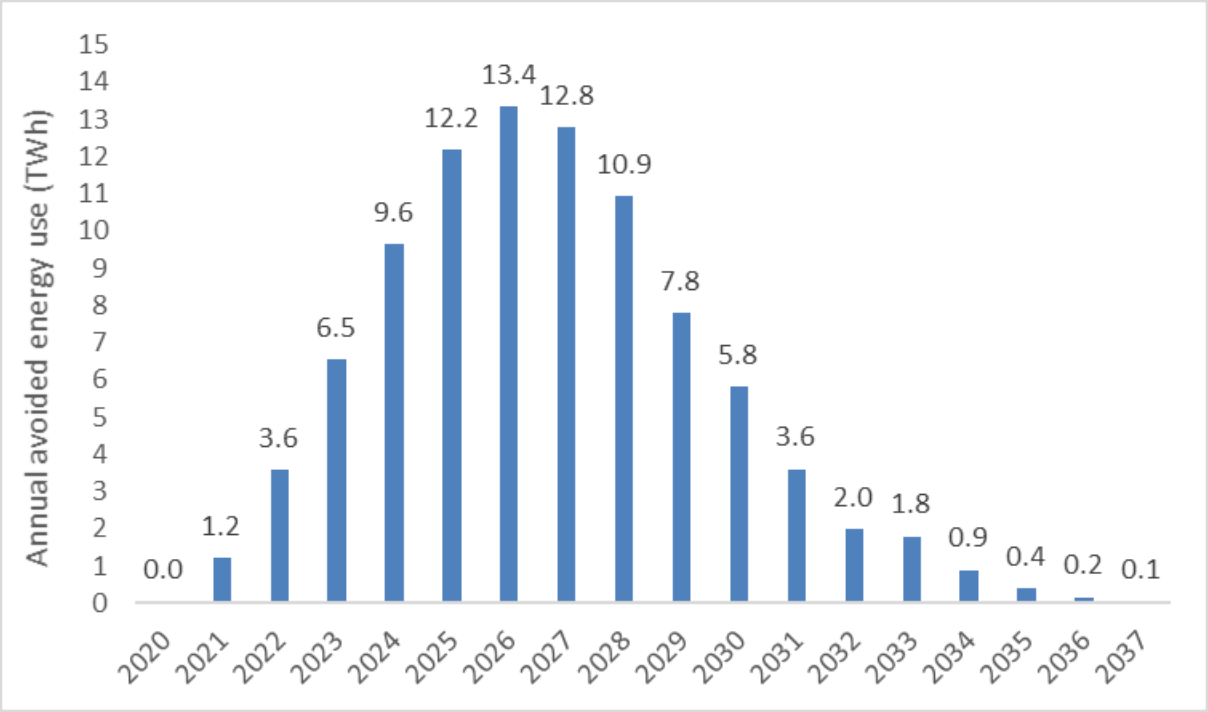

Figure 8: Estimated annual energy use avoided through energy efficient technologies used in 8KD capable consoles compared to the BAU 2 scenario (vs HD capable consoles)

Energy efficiency of PS4 and Xbox One

Estimates for lifetime energy avoidance for PS4, PS4 Pro, Xbox One, Xbox One S and Xbox One X consoles have also been updated based on most recent sales data. We estimate that over the lifetime of these consoles cumulative energy use of 42.1 TWh will be avoided through the energy efficient technologies used in these consoles driven by the requirements set in the SRI, see Figure 9 below.

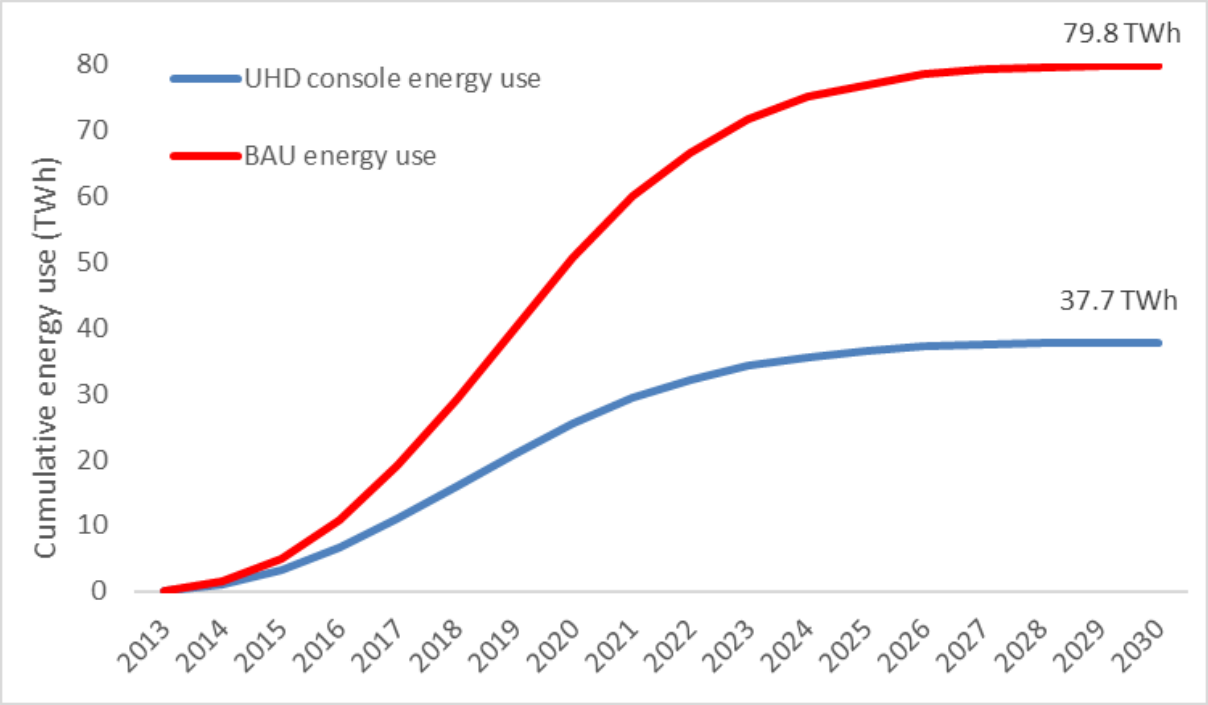

Figure 9: Estimated cumulative energy use of UHD console in Europe vs cumulative BAU energy use had no energy efficient technologies been adopted compared to the previous generation.

To date, we estimate these savings total 25.2 TWh, with 6.1 TWh of avoided energy use in 2020 alone, see Figure 10 below – compared to an initial target of 1 TWh set at the start of the SRI.

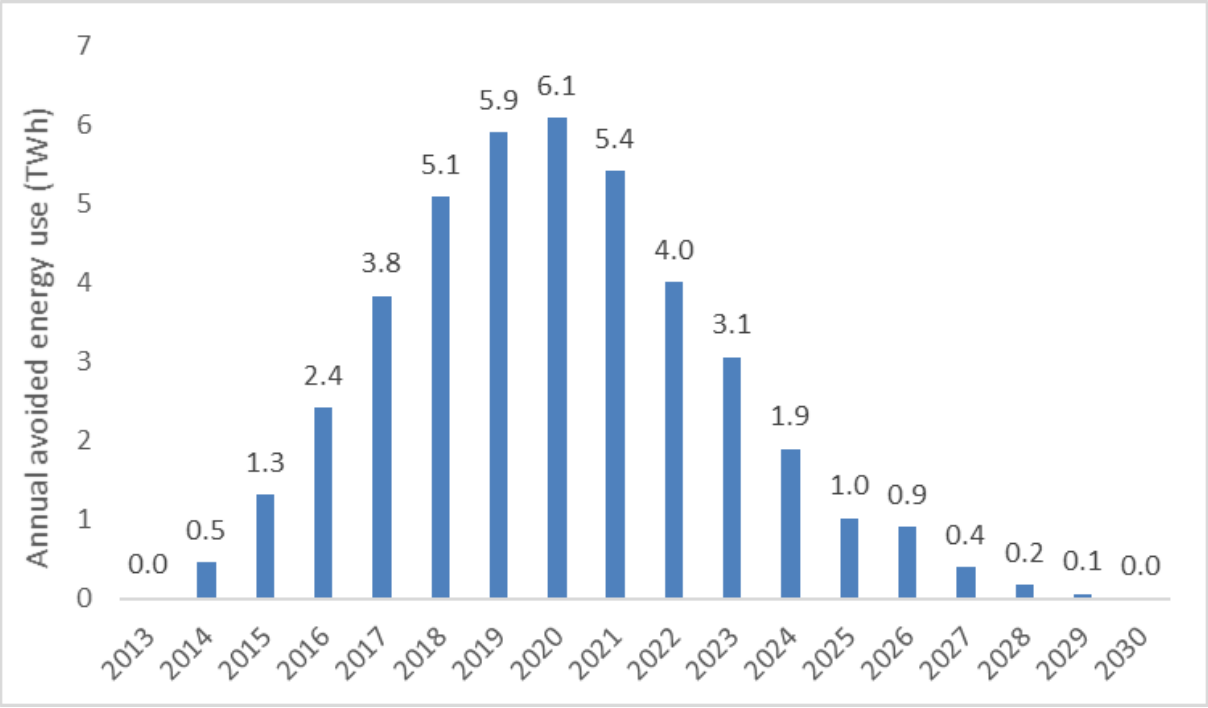

Figure 10: Estimated annual energy use avoided through energy efficient technologies used in UHD capable consoles driven by the SRI

Overall, the total lifetime energy savings of UHD and 8K capable consoles in Europe is estimate at 88.5 TWh – comparable to the electricity consumption of Belgium in 2016[13]. If all energy efficiency improvements made since the start of the SRI are accounted for in 8K capable consoles, then the total energy savings are estimated to be 135 TWh (approximate annual electricity consumption of Sweden in 2016).

[13] https://www.cia.gov/library/publications/the-world-factbook/fields/253rank.html

RESOURCE EFFICIENCY PROPOSAL

Introduction

The concept of Circular Economy (CE) is generally understood as an approach to reduce waste and enable a more efficient use of raw materials. Since the early 2000s interest in CE among environmentalists and policymakers has grown, in response to various environmental concerns, such as resource scarcity and environmental impacts of raw materials extraction and product manufacturing[14]. Therefore, the EU adopted a comprehensive CE policy package in December 2015, to support the EU to achieve its commitments under the UN Sustainable Development Goals[15].

Building on the CE actions implemented in 2015, in 2020 the Commission presented the Circular Economy Action Plan (CEAP), with the aim to: "*provide a future-orientated agenda for achieving a cleaner and more competitive Europe in co-creation with economic actors, consumers, citizen and civil organisations*"[16]. The CEAP presents a set of interrelated initiatives to establish a product policy framework that will ensure sustainable products, service and business models. The CEAP includes electronic equipment and Information and Communication Technologies (ICT) as important categories of products for action. Member States, notably France, Italy, Belgium, Switzerland, and the UK are also introducing parallel CE requirements for some products and / or packaging.

Specific actions foreseen for the electronics and ICT sectors under the CEAP include improving the efficiency of materials and resources used throughout the product's lifecycle, as well as prolonging the products' lifespan through more circular design and easier repairability and removability/ replaceability of parts. The electronics and ICT sectors will be the main focus of EU CEAP initiatives brought forward in 2021, including on sustainable products, circular electronics, and design requirements & consumer rights.

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[14] UNEP (2010). Resource Efficiency. Available at: http://www.unep.org/pdf/UNEPAProfleResourceAeffciency.pdf [Accessed 24th September 2020].

[15] Taranic, I., Behrens A., & Topi, C. (2016). Understanding the circular economy in Europe, from resource efficiency to sharing platforms: The CEPS framework. CEPS Special Report [E-source]. No .143. URL: https://www.ceps.eu/publications/understanding-circular-economy-europe-resource-efficiency-sharing-platforms-ceps.

[16] European Commission (2020). Communication from the commission to the European Parliament, the council the European economic and social committee and the committee of the regions. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2020:98:FIN&WT.mc_id=Twitter [Accessed 17 September 2020].

Resource efficiency commitments made within this SRI proposal and outlined by Signatories within this section of the review report aim to build on existing requirements and anticipate new changes which will be brought forward through the European Union's initiatives next year.

Methodology

In 2017 and then 2019, the signatories of the SRI performed detailed reviews of existing and proposed Ecodesign regulations, voluntary Ecodesign agreements, technical reports, and product design standards, across different product groups and geographical locations, in order to examine the potential scope eco-design measures on material efficiency. In both reports a matrix of these criteria was included, and the likely benefits and feasibility of each potential criterion evaluated. Signatories have updated and used this matrix again as a basis for this year's review. Documents previously included have been checked for updates, and anything relevant published since the 2019 review has been included.

The following table outlines the reports, standards and documents reviewed in 2019 and 2020, and the revised matrix is available in Annex 1.

Table 9: List of reports, standards and documents consulted in 2019 and 2020

Shorthand	Full Title - 2019 Review	Full Title - 2020 Review
Games Consoles VA	Self-Regulatory Initiative to further improve the energy efficiency of Games Consoles Version 2.6.3	Self-Regulatory Initiative to further improve the energy efficiency of Games Console Version 3.0 (March 2020)
CEN/CLC Durability	General method for the assessment of the durability of energy-related products prEN 45552 [Draft available through working group - November 2018]	BS EN 45552:2020 General method for the assessment of the durability of energy-related products [March 2020]
CEN/CLC Remanufacture	General method for the assessment of the ability to re-manufacture energy related products prEN 45553 [Draft available through working group - November 2018]	BS EN 45553:2020 General method for the assessment of the ability to remanufacture energy-related products [July 2020]
CEN/CLC RRU	General methods for the assessment of the ability to repair, reuse and upgrade energy related	BS EN 45554:2020 General methods for the assessment of the ability to

Shorthand	Full Title - 2019 Review	Full Title - 2020 Review
	products prEN 45554 [Draft available through working group - November 2018]	repair, reuse and upgrade energy-related products [May 2020]
CEN/CLC Recyclability	General methods for assessing the recyclability and recoverability of energy related products prEN 45555 [Draft available through working group - August 2018]	BS EN 45555:2019 General methods for assessing the recyclability and recoverability of energy-related products [December 2019]
CEN/CLC reused comps	General method for assessing the proportion of reused components in energy-related products prEN 45556 [Draft available through working group - January 2019]	BS EN 45556:2019 General method for assessing the proportion of reused components in energy-related products [June 2019]
CEN/CLC Recycled Content	General method for assessing the recycled material content in energy-related products prEN 45557 [Draft available through working group - August 2018]	BS EN 45557:2020 General method for assessing the proportion of recycled material content in energy-related products [May 2020]
CEN/CLC CRMs	General method to declare the use of critical raw materials in energy-related products BS EN 45558:2019	*Same as 2019 review*
Printer VA (Mar-19)	INDUSTRY VOLUNTARY AGREEMENT TO IMPROVE THE ENVIRONMENTAL PERFORMANCE OF IMAGING EQUIPMENT PLACED ON THE EUROPEAN MARKET Draft FY19 v.2	Industry Voluntary Agreement to improve environmental performance of imaging equipment placed on the European market [Version 3] Draft Oct-19
CSTB VA - April-18	Voluntary Industry Agreement to improve the energy consumption of Complex Set Top Boxes within the EU, Version 6.0, 2nd April 2018	*Same as 2019 review*
JRC 2019	[Joint Research Centre] Cordella M, Alfieri A, Sanfelix J, Analysis	*Same as 2019 review*

Shorthand	Full Title - 2019 Review	Full Title - 2020 Review
	and development of a scoring system for repair and upgrade of products – Final report, EUR 29711 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-01602-1, doi:10.2760/725068, JRC114337	
Lot 5	[Febuary 2019 Draft] COMMISSION REGULATION (EU) …/… of XXX laying down ecodesign requirements for electronic displays pursuant to Directive 2009/125/EC of the European Parliament and of the Council, amending Commission Regulation (EC) No 1275/2008 and repealing Commission Regulation (EC) 642/2009 (and Annexes)	COMMISSION REGULATION (EU) 2019/2021 of 1 October 2019 laying down ecodesign requirements for electronic displays pursuant to Directive 2009/125/EC of the European Parliament and of the Council, amending Commission Regulation (EC) No 1275/2008 and repealing Commission Regulation (EC) No 642/2009
Lot 9	COMMISSION REGULATION (EU) 2019/424 of 15 March 2019 laying down ecodesign requirements for servers and data storage products pursuant to Directive 2009/125/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 617/2013	*Same as 2019 review*
Lot 3 – Preparatory study	Preparatory study on the Review of Regulation 617/2013 (Lot 3) Computers and Computer Servers Task 7.1 report Presentation of policy measures [2 February 2017]	*Same as 2019 review*

Shorthand	Full Title - 2019 Review	Full Title - 2020 Review
France Roadmap for CE	Circular Economy roadmap of France: 50 measures for a 100% circular economy [2018]	*Same as 2019 review*
CE Action Plan Portugal: 2017-2020	Leading the transition [Action plan for circular economy in Portugal: 2017-2020]	*Same as 2019 review*
Waste and Resources Strategy UK	Our Waste, Our Resources: A strategy for England [DEFRA, 2018]	*Same as 2019 review*
Consultant's Report on the SRI		Review Study of the Ecodesign Voluntary Agreement for the Product Group "Videogames Consoles" Invitation to Tender no 701/PP/GRO/IMA/18/1131/10605 in application of Framework Contract No 409/PP/2014/FC Lot 2 Final Report 30th August 2019
French CE Law Package		*Measures taken from English Summary Document:* The Anti-Waste Law in the daily lives of the French people, what does that mean in practice? January 2020

Review of Current Commitments

The SRI already includes a number of resource efficiency measures, including:

- Providing of out-of-warranty repair service for games consoles
- Ensuring spare parts and the relevant technical documentation are made available to authorised repair and refurbishment centres.
- Ensuring external plastic enclosure components >100 g can be removed with commercially available tools for recycling
- Ensuring specified key components (motherboard, hard disk drive, optical drives, and internal power supply) can be removed non-destructively for repair or recycling using commercially available tools.
- Ensuring that joining and sealing techniques do not prevent the removal of components listed in point 1 of Annex VII of Directive 2012/19/EU (limited to those

applicable to games consoles and where such techniques are not required to comply with the relevant safety-related EU legislations).

- Marking of console plastic parts >25 g, specifying the type of resin, where this is technically feasible
- Making information available to recyclers/repairers on brominated flame retardants content >1000 ppm within the external plastic enclosure parts.
- Providing information to consumers on how to keep the consoles in good working condition and whether upgrading the performance of the devices is possible.
- Additionally, providing information on how to delete personal data.

As noted in the past, not only by the Signatories themselves, but also third-party independent reviewers[17], games consoles rarely show up in the waste stream[18] as consumers tend to keep and use their devices for a long period time compared to other consumer electronic products.

Review of Possible Additional Commitments

Signatories have considered several new additional potential requirements as part of the 2020 SRI review. These potential new requirements are derived from the review of technical reports, standards and documents explained in the Resource Efficiency Proposal, Introduction and Methodology section and anticipate expected developments under the EU's CEAP. The conclusions of this review are explained below.

Design for repair and reuse

- **Use of common external power supplies**

  Ecodesign measures are not appropriate legal instrument for the common charger initiative, and therefore should not substitute the Radio Equipment Directive[19]

[17] Zimmermann, T. et al. "Review Study of the Ecodesign Voluntary Agreement for the Product Group "Videogames Consoles"" August 2019; Section 4.3

[18] Peagram, R (2017) 'Review of Games Console SRI Resource Efficiency Commitments' [Online] Available at: https://efficientgaming.eu/meetings/

[19] Directive 2014/53/EU of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment.

Furthermore, if Ecodesign were to become the dedicated legislative instrument for common chargers, support from standardisation organisations is required[20].

- **Provide information on durability of consoles**

  Existing evidence and research indicate that consoles are considerably long-lasting. Signatories are active in the development of the CENELEC standards (established under the European Commission's mandate), and are not aware of any known reliable method or standard to measure or report the expected lifetime of an electronic circuit or product before it is sold. Information regarding repair, returns or current usage is only obtained after a period of use, which reflects usage time and not technical lifetime. Progress on the provision of durability information will be reviewed when CENELEC standards are published and in line with the EU's sustainable consumer agenda (specifically, any information requirements on products' sustainability, e.g. environmental characteristics, expected or guaranteed lifespan; the availability of repair services, spare parts and repair manuals; and software updates/upgrades foreseen under the "Empowering the consumer for the green transition" legislative initiative planned for Q2 2021).

Recyclability

- **Hazardous substance restrictions**

  The use of hazardous substances within electrical and electronic equipment (such as SCCP, oxo-fragmentable plastics, etc) is governed under various other EU regulations and Directives e.g. Directive 2011/65/EU of the European Parliament and of the Council (RoHS). Nevertheless, to improve recycling at end-of-life Signatories aim to align with Lot 5, by committing to the removal of halogenated flame retardants >1000ppm in external plastic enclosure parts >25 g, from January 2022. This timeline is deemed a suitable transition time to phase out halogenated flame retardants from consoles placed on the market after January 2022. This commitment is in line with EU ambitions for toxic-free material cycles under its recently published Chemicals Strategy for Sustainability, which identifies flame retardants among a list of substances of growing concern for human health.

- **Provide information on the inclusion of critical metals to recyclers**

[20] ECOS: One charger to fit them all. Using eco-design to deliver an ambitious common charger initiative. Available at: https://ecostandard.org/wp-content/uploads/2020/07/ECOS-COMMON-CHARGER-PAPER.pdf on 24/09/2020 [Accessed 24th September 2020].

Critical Raw Materials are defined by the EU as those most economically important but also have a high supply risk. In 2020 the EU added 4 new CRMs to a regularly reviewed list that now contains 47 elements, materials, and compounds. In order to contribute to current knowledge on CRM content of complex electronics products, one signatory has funded research (to be published) of CRM laboratory analyses of a console. The results show that the concentrations of CRMs made up only ~0.7% of the tested console (by weight) and were dispersed throughout the product[21] . CRMs are not currently commercially recoverable due to the need for large quantities of concentrated input material, economies of scale, and the need for advanced technology[22].

- **Including greater percentages of recycled plastics**

  Beyond technical limitations of available supply of materials, the WEEE Directive[23] states that "*producers should be encouraged to integrate recycled material in new equipment*", which has also become the target of discussions on how to 'modulate' take-back fees for WEEE compliance to incentivise ecodesign. Signatories have committed to continue to review possibilities to use recycled plastics in new console production. At present there is limited availability of recycled PC+ABS, used in consoles, that complies with flame retardant grade V0 (1.5mm) required by safety standard IEC62368[24].

- **Guaranteeing battery life and removability**

  At end-of-life Signatories ensure, as required by the Battery Directive[25] that batteries are readily removable by qualified professionals. Signatories will continue to comply with current Battery Directive requirements as well as with upcoming rules on removability, replaceability, performance and sustainability under the Batteries Regulation (revising the 2006 Directive), which is currently under discussion.

- **Provide separate take-back schemes for consoles**

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[21] Fenwick, Ceri (2020) 'Reviewing EU Ecodesign Policy on the Recyclability of Electronics' [PowerPoint Presentation] E-waste World Expo & Conference 18-19th November 2020 (early access in personal comms.)

[22] Ari, V. (2016) A Review of Technology of Metal Recovery from Electronic Waste, In: E-Waste in Transition—From Pollution to Resource, Mihai F. [ed], Intech

[23] WEEE DIRECTIVE 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE).

[24] IEC 62368-1 (2018) Audio/video, information, and communication technology equipment - Part 1: Safety requirements.

[25] Battery Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC.

Providing separate take-back for recycling of small WEEE products, including consoles, is not environmentally or economically efficient. As such, collection and recycling of WEEE is already organised and financed by Signatories under the WEEE Directive, a horizontal requirement that aims to increase the recycling and/or reuse of WEEE.

Proposed Resource Efficiency Changes

Availability of spare parts

As of 1 January 2022, select components (where applicable) will be made available, upon request, to independent repairers and consumers for a period of 2 years after placing the last unit of the model on the market. These include hard drives (HDD) and external power supplies (EPS). This aims to align with the design for repair and reuse requirements within the Lot 5, Ecodesign Requirements for Electronic Displays, Regulation (EU) 2019/2021 as well as with EU initiatives on sustainable products, circular electronics and consumer rights planned for publication in 2021.

Halogenated flame retardants

As of 1 January 2022, the use of halogenated flame retardants >1000ppm in external plastic enclosure parts >25 g is not allowed. Signatories aim to align with Lot 5 Ecodesign Requirements for Electronic Displays. The presence of halogenated flame retardants represents a major issue in the recycling of plastics of electronic displays. Reducing halogenated flame retardants will improve end-of-life recyclability of enclosures by permitting higher yields of recycled plastics, as well as help achieve toxic-free material cycles for games consoles by tackling both hazard and legacy issues, as prescribed under the Chemicals Strategy for Sustainability.

CONCLUSIONS AND SUMMARY OF PROPOSED CHANGES TO THE SRI

As part of their obligations under the SRI, the Signatories are required to review the SRI every two years with a view to updating existing requirements and, if necessary, including new commitments.

In the last two years, two reviews of the Games Consoles SRI have taken place, instead of only one. This stemmed from the fact that Microsoft and Sony Interactive Entertainment announced in 2019 the launch of their next generation consoles, respectively the Xbox X and PlayStation 5. Like in previous reviews carried out by the SRI Signatories, the 2020 SRI Review Report is the product of nearly an entire year of work by the SRI Signatories, taking into account the suggestions of stakeholders such as NGOs and Member States, as well as the European Commission.

Despite the significant increase in performance and functionality, the new consoles did not significantly increase their power consumption, while the current generation already in the market experienced increased energy efficiency in most operational modes since launch. Early/preliminary tests carried out by third-parties[26] showed the energy consumption of the new generation consoles to be comparable with the current generation.

The following subsections summarise key proposed changes to the SRI agreement and commitments.

Energy Efficiency Related

Added examples of peripheral devices and explanatory footnote (Section 2.2)
Merged the low power modes under one definition (Section 2.4, D)
Updated Tables 2 and 3 to include 8K power caps and additional Tiers (Section 3.1.2.1)
Clarified that 10% tolerance applies to power only (Annex A-1, 2.)

Resource Efficiency Related

Added point on component provision to external parties (Section 3.2)
Added date for the halogenated flame retardants usage restriction (Section 3.2)
Aligned text to maintain consistency with the relevant standards and Directives (Section 3.2.1)
Updated and clarified Table 5 (Annex A-2)

26 https://arstechnica.com/gaming/2020/10/xbox-series-x-unleashed-our-unrestricted-preview/

General Updates

Minor editorial clarifications throughout the SRI document
Updated text on frequency of meetings to reflect the current travel restrictions (Section 4.3)
Clarified text on role of Independent Inspector (Section 4.4)
Added text regarding the Annual Compliance Report (Section 6)
Clarified text on data collection and processing, and compliance investigations (Annex C)

Next Steps

The 2020 Review Report as well as the new version of the SRI (version 3.9.4) are to be submitted to the Ecodesign Consultation Forum[27] for discussion and review. This meeting is scheduled for 09 December 2020. If formally recognised by the Commission, the updated SRI will be effective from 1 January 2021.

[27] The Consultation Forum is an European Commission initiative that consists of representatives of Member States, industry, civil society and other relevant stakeholders. They contribute to the definition and review of implementing measures, examine the effectiveness of established market surveillance mechanisms and assess voluntary agreements and other self-regulation measures within the context of the eco-design Directive.

ANNEX 1: CALCULATION OF ENERGY SAVINGS

This annex provides further detail of how the calculations in the 'Estimated Energy Savings' section were made. To estimate the energy savings achieved through adoption of energy efficient technologies, two business-as-usual (BAU) scenarios have been derived as baselines to compare the actual energy use of the consoles (as per ErP MEERP methodology).

BAU scenarios

To estimate the energy savings achieved through adoption of energy efficient technologies, two business-as-usual (BAU) scenarios have been derived as baselines to compare the actual energy use of the consoles (as per ErP MEERP methodology).

Scenario 1 – Comparison to PS4 Pro and Xbox One X

The first BAU scenario estimates what the power consumption of the new generation consoles would have been had there been no improvement in technology in comparison to the ultra-high definition gaming capable consoles (PlayStation 4 Pro and Xbox One X). For this scenario the following technological assumptions are made:

- No die shrink: consoles based on same 16 nm architecture as ultra-high definition gaming capable consoles.
- No improvement in CPU energy efficiency: AMD estimate that there has been a +100% energy efficiency improvement in their Central Processing Unit versions between the 8K capable consoles and UHD gaming capable console generations (Zen 2 compared to Zen – see Figure 11).
- No improvement in GPU energy efficiency: AMD estimate there has be +50% energy efficiency improvement in Graphics Processing Unit versions between console generations (RDNA 2 compared to RDNA – see Figure 12).
- No SSD energy savings: Hard disc drives (HDDs) consume slightly more power than the Solid State Drives (SSDs) now used in 8K definition capable consoles, due to there being no moving components in an SSD. This scenario assumes that a typical HDD consumes 6 W before power supply losses, while an SSD consumes around 2 W.

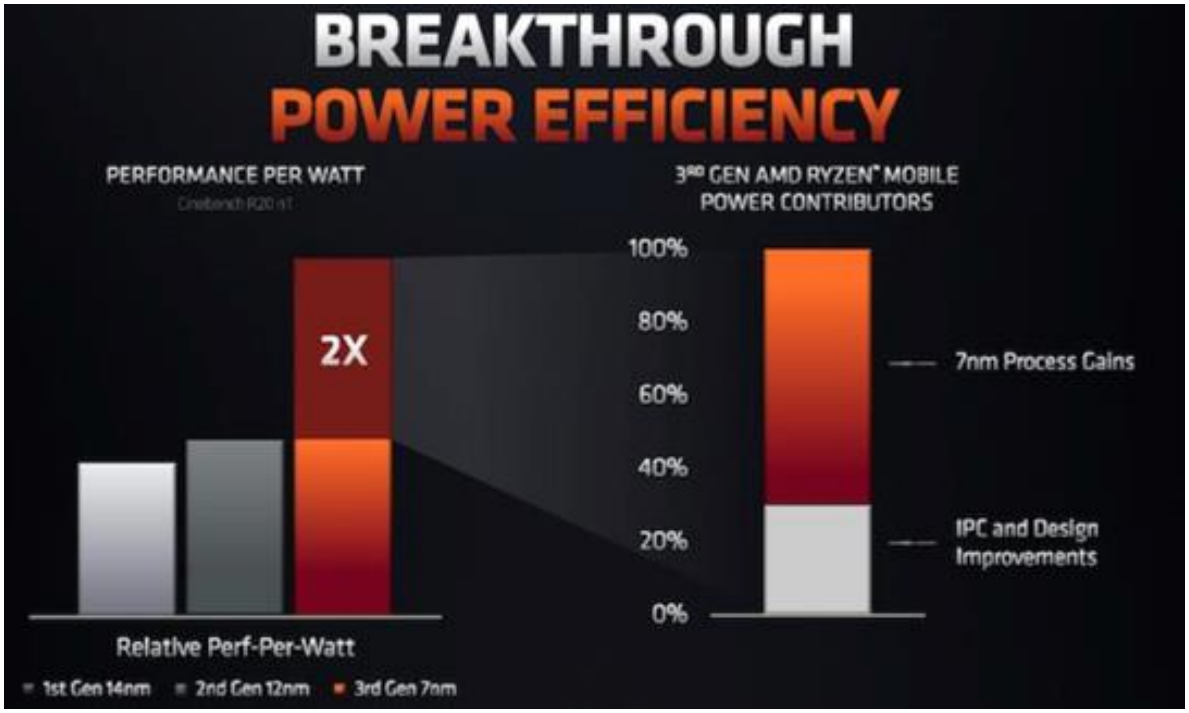

Figure 11: AMD estimated efficiency improvement between CPU generations[28]

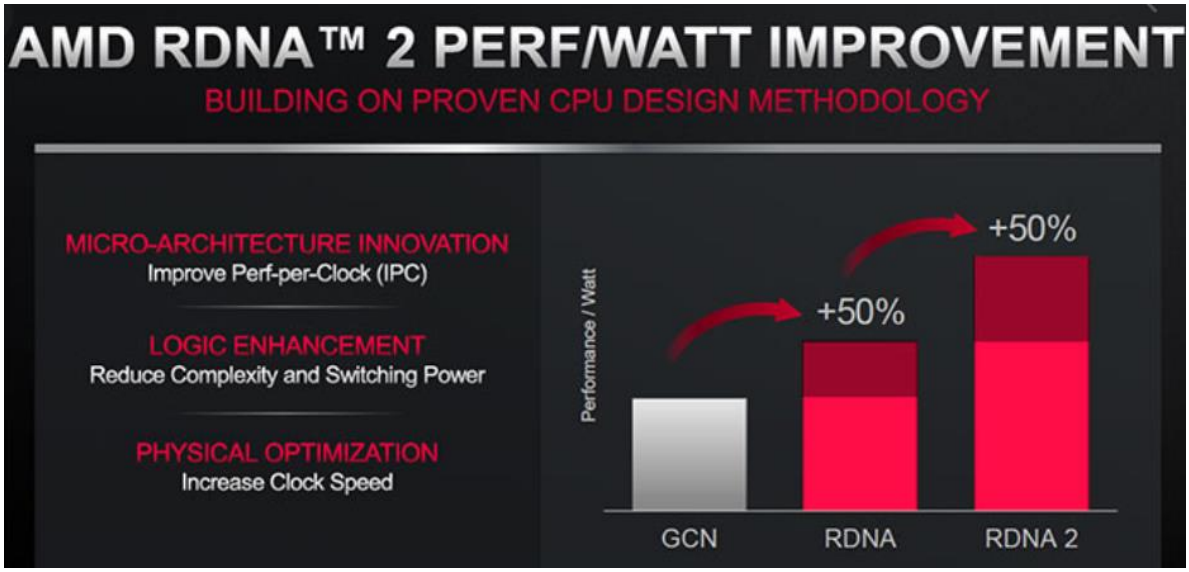

Figure 12: AMD estimated efficiency improvement between GPU generation[29]

To calculate the power consumption of the PS5 and Xbox Series X consoles without the improvement in CPU and GPU as listed above, the thermal design power (TDP) of the CPU and GPU system (components on the System-on-a-Chip), is first estimated. TDP is the

[28] https://arstechnica.com/gadgets/2020/03/amds-7nm-ryzen-4000-laptop-processors-are-finally-here/

[29] https://www.thefpsreview.com/2020/06/08/amd-reiterates-50-percent-performance-watt-improvement-with-rdna-2/

maximum amount of heat generated by a computer chip or component that the cooling system in a computer is designed to dissipate under any workload[30]. This was calculated based on the power consumption in gaming mode and accounting for power supply efficiency assumed at 90%, and DC-DC conversion efficiency assumed at 85%[31]. We make an assumption that the TDP of CPU and GPU system have a ratio of approximately 1:2.7 to the CPU and GPU respectively. This is based on the TDP of AMD components with similar specifications. AMD Ryzen 5 3600 CPU has a TDP of 65 W[32] and the AMD Radeon RX 5700 GPU has TDP of 180 W[33] (a ratio of 1:2.7). A 100% increase in the power consumption of the CPU component, and a 50% increase in the GPU component are then applied, the sum of which approximates the increase in TDP of the CPU and GPU system of the SoC, based on the AMD efficiency improvements above.

Example

Active gaming power Xbox Series X = 173 W

To calculate active gaming power minus power supply losses and DC-DC conversion:

173 x 0.90 x 0.89 = 135.3 = approximate TDP of CPU and GPU system

To estimate TDP of individual components of the SoC:

TDP of CPU component of system = (65 / (180 + 65)) x 135.5 W = 35.9 W

TDP of CPU component of system = (180 / (180 + 65)) x 135.5 W = 99.4 W

Above based on ratio of CPU:GPU of 65:180 W- assumption based on AMD chips with similar specs

To estimate TDP of components had no efficiency improvement been made between generations:

100% increase in CPU component power: 35.9 W x 2 = 71.8 W

50% increase in GPU component power: 99.4 W x 1.5 = 149.1 W

Total TDP of the CPU and GPU system = 71.8 W + 99.4 W = 220.9 W

ΔTDP = 220.9 W – 135.3 W = 85.6 W

Adding losses to the change in TDP: 85.6 W / (0.9 x 0.85) = 106.9 W

To estimate the power consumption of the console if an HDD was used instead of an SSD:

ΔPower consumption: 6 W (HDD power) – 2 W (SSD power) = 4W

Including power suppy losses: 4 W * 0.9 = 5 W

The change in TDP plus losses is then added to the actual PS5 gaming power consumption:

173 W + 106.9 W + 5 W= 284.8W

Estimated gameplay power consumption with no improvement in CPU and GPU = 284.8 **W**

[30] https://en.wikipedia.org/wiki/Thermal_design_power

[31] https://www.electronicproducts.com/dc-dc-converter-efficiency-revisited/

[32] https://www.techpowerup.com/cpu-specs/ryzen-5-3600.c2132

[33] https://www.techpowerup.com/gpu-specs/radeon-rx-5700.c3437

The power consumption for media and navigation mode is then calculated assuming the same ratio of power to gaming mode as for the ultra-high definition gaming capable consoles.

Scenario 2 – Comparison to PS3 and Xbox 360

The second BAU scenario estimates what the power consumption of the new generation consoles would have been had there been no improvement in the energy efficiency of console technology over the entire course of the SRI since 2015. This uses a comparison based on technology used within high definition consoles that predated the SRI adoption – PlayStation 3 and Xbox 360. For this scenario the following technological assumptions are made:

- Power supply efficiency is the same as for HD consoles: more efficient power supplies are used in the 8K capable consoles, for this scenario we estimate power supply efficiency to be 86% (the actual data is confidential, this estimate is nevertheless relatively representative of efficiency of the power supplies of past generations of consoles / computers)
- Power scaling is the same as HD consoles: UHD and 8K capable consoles have much greater power scaling ability compared to HD consoles. For this scenario ratio of power consumption between gaming and media/navigation modes is assumed to be the same as for HD consoles.
- Discrete CPU and GPU components: games consoles have utilised System-on-a-Chip (SoC) architecture since the launch of UHD consoles in 2013. SoCs integrate multiple computing components, such as the CPU and GPU, on the same chip. The integration of multiple components on one SoC results in improved energy efficiency when compared to discrete components of the same spec. AMD estimate that for UHD consoles the use of an SoC rather than discrete components resulted in an reduction of power consumption of the processor chipset of 22% (Webb, 2014). For this scenario we also use this estimated reduction for the new generation SoC power consumption.

Usage estimates

Table 10 and Table 11 below show the usage estimates used in this assessment of energy use for PlayStation 5 and Xbox Series X and Series S. The original report by NRDC assumes two hours are spent in standby mode and approximately 18 hours in networked standby mode. PlayStation 4 had five different low power modes users could enable: standby, networked standby, rest mode with USB charging of peripherals enabled, rest mode with suspend enabled (whereby applications may be suspended while the console is

powered down) and rest mode with USB charging, network connection and suspend enabled. To more accurately reflect the options available to users of PlayStation consoles we assume that usage time spent in low power modes is evenly distributed across these five modes – for the business as usual case. For PlayStation 5 the suspend mode is enabled for all rest modes. The main options available to users during set up are for USB charging and network connection to be enabled, or, standby mode with suspend for greater power savings. After 3 hours the USB charging is turned off by default. For other low power configurations users may customise the low power modes themselves. We make an assumption that most people enable the default modes, so that the usage time allocated in the BAU estimate for suspend and USB charging are allocated to the Networked standby mode – since this is the mode to which the USB charging with network connection reverts to after 3 hours.

Table 10: Estimated usage of PS5 based on NRDC (2014)

Mode	Usage estimates (h/day)	
	PS5 BAU	PS5
Active gaming	1.45	1.45
Media	1.24	1.24
Navigation	0.23	0.23
Standby	4.22	4.22
USB charging	4.22	0.00
Suspend	4.22	0.00
USB charging + network	4.22	4.22
Networked standby	4.22	12.65

For Xbox Series X and Series S, we make an assumption that usage in rest modes is split equally between Instant On and Standy. This is because standby is the default mode in Europe, and now also offers new functionality, such as periodically checking for updates.

Table 11: Estimated usage of Xbox Series X and Xbox Series S based (NRDC, 2014)

Mode	Usage assumptions (h/day)	
	Xbox Series X/Series S BAU	Xbox Series X/Series S
Active gaming	1.45	1.45
Media	2.37	2.37
Navigation	0.23	0.23
Standby	2.00	9.98
Instant on	17.96	9.98

TEC calculation

Typical Electricity Consumption (TEC) method allows for the calculation of weighted average energy usage, based on the usage time of each mode and the power consumption of the console in that mode. The formula for TEC is shown in Equation 1 below:

$$TEC = P_2 T_2 + P_2 T_2 + \cdots + P_n T_n$$

n = console use phase mode

P = power consumption in mode n (W)

T = time spent in mode n (s)

Equation 1 Typical Electricity Consumption (EnergyStar, 2015)

ANNEX 2: COMMITMENTS MATRIX

	2020 SRI Commitment
	Current SRI Commitment

Topic	Sub-topic	Description	Games Console VA Mar-20	CEN/CLC Durability	CEN/CLC Remanufacture	CEN/CLC RRU	CEN/CLC Recyclability	CEN/CLC reused comps	CEN/CLC Recycled Content	CEN/CLC CRMs	Printer VA (Oct-19)	CSTB VA - April-18	JRC 2019	Lot 5 Ecodesign Legislation	Lot 9 Ecodesign Legislation	Lot 3 - Preparatory Study	France Roadmap for CE	CE Action Plan Portugal: 2017-2020	Waste and Resources Strategy UK	Consultant's Report on the	French CE Law Pack
Design	Components and materials	Limit plastic polymer variation							X	X											
		Limit coatings on plastics							X	X											
		Design for high quality plastics recycling							X												
		Do not prevent recycling of product parts							X												
		Allow use of non-OEM components							X												
		Ban intentional use of SCCPs								X											
		Ban intentional use of (specified) flame retardants in plastics								X		X								X	
		Ban intentional use of PVC								X											
		Ban use of oxo-fragmentable plastics														X					
		Limit innovation cycles									X										
		Include Post Consumer recycled material in product																		X	
		Use a stronger fan to limit overheating																		X	
		Standardized interfaces for external power supply																		X	
	Dismantling	Allow manual separation of plastic parts with commonly available tools	X				X		X												
		Allow non-destructive disassembly of product or specified components	X				X		X	X	X				X						
		Avoid non-separable connections or joing/fastening techniques	X						X	X	X	X	X	X							
		Design for ease of access to key components/materials								X		X									
		Use Commonly Used Fasteners							X	X										X	
		Make all screws visible																		X	
	Lifespan	Discourage premature disposal														X	X				
		Extend product working life													X		X				
		Disclose Expected Lifespan													X				X		
	Markings	Mark or label parts containing substances to be removed at EoL					X						X		X						
		Mark plastics with polymer type	X						X	X			X		X					X	
		Mark plastics with flame retardant											X		X					X	
		Mark components other than plastics with flame retardant information																		X	

Documentation	End-of-Life Information for recyclers	Provide dismantling instructions to recyclers for product or to access specified components	X		X						X			X	X	X					
		Make hazardous material/substance information available to recyclers	X		X		X							X		X					
	Material Efficiency Information for End-users	Provide end-users with information regarding resource efficiency during use and EoL management	X								X					X				X	
	Make available documentation of Material Efficiency Product Aspects	Make information available to End-Users on product maintenance	X																	X	
		Make information available on results of reliability and durability assessments		X																	X
		Make information available on results of an assessment to measure the ability of a product to be re-manufactured			X																
		Make information available on results of an quantitative assessment to measure the ability of a product to be repaired, re-used and upgraded.				X															X
		Make qualitative information available on the ability of a product to be repaired	X																		
		Make information available on options for upgrading a product	X																		
		Company reporting of efforts on reuse, repair and recycling																	X		
		Make information available on results of an assessment to measure the ability of a product, and materials, to be recycled and recovered.					X														
		Verification of re-used components through documented evidence						X													
		Make information available on results of an assessment to determine the proportion of re-used components in a product						X													
		Verification of recycled material content through documentation							X												
		Make information available on results of an assessment to determine the proportion of recycled plastic content in a product									X	X									
		Make information available on results of an assessment to determine the proportion of recycled content in a product							X											X	
		Make information available on results of an assessment to determine the proportion of bio-based plastic content in a product										X									
	Material Declarations	A material declaration shall be provided for regulated CRMs.								X					X					X	
		A material declaration provided for non-regulated CRMs								X										X	
		Manage and collate technical and supplier documentation as evidence of CRM declarations								X											
		Upload material information to a database																	X		

Material efficiency Assessments	Product Scoring or labelling Systems	Creation of a scoring System for ability of a product to be re-manufactured			X																
		Creation of a scoring System for ability of a product to be repaired (and re-used and upgraded)				X							X				X				
		Product Repair Label														X					X
		Battery Accessibility Label															X				
		Part Compatability Label														X					
		Re-manufactured Product Assurance Label																	X		
		Triman logo added to product																			X
		Environmental and/or social label																			X
		Durability Index/Label																			X
	Product Calculations and Assessments	Calculation of product recyclability and recovery scores					X														X
		Assessment of accessibility of specified product parts			X		X														
		Assessment of disassembly of product			X		X														
		Assessment of the ability to access and remove parts containing CRMs					X														
		Calculation to assess the proportion of reused components in a product						X													
		Assessment of the failure rates and types of functional product parts in order to assess reliability and durability of product		X																	X
		Calculation of the recycled material content in a product							X		X									X	

Service processes	Repair	Provision of repair information for safe repair to End-Users								X					X					
		Provision of repair information to professional/independent repairers								X		X	X		X					
		Provision of repair information to authorised repairers	X									X	X		X				X	
		Limit cost of Repair										X							X	
		Repair as part of business model	X							X		X								
		Design products for repair										X								
	Software / firmware	Provide upgrade options (via software) to extend functionality									X									
		Make diagnostics for repair more accessible			X							X								
		Enable Data Deletion										X		X	X				X	
		Enable Password reset										X								
		Provide lastest version of firmware at a low cost, or free of charge and/or for a minimum period of time								X			X	X					X	
		Provide Information on availability of software/firmware inc. data deletion	X										X	X						
	Spare parts	Make Spare Parts available for a minimum time period								X			X						X	
		Make spare parts available to authorised repairers	X													X			X	
		Minimum delivery time of spare parts								X			X							X
		Make spare parts available for purchase to consumers and professional repairers								X			X							
		Provide replacement instructions for spare parts								X			X							
		Limit price of spare parts										X								
		Provision of availability, price and ordering information on Spare Parts								X		X	X			X			X	X
	Warrantee	Provision of an additional commercial guarantee										X				X		X		
		Limit price of additional guarantees										X								
		Provision of guarantee for repaired products										X								X
		Provision of guarantee for shipping of products										X								
		Warrentee labelling of product																X		
	EPR & Takeback	Eco-modulation of fees														X	X	X		X
		Increase communication between producers and recyclers														X				
		Fund repair through EPR																		X
		Extension of EPR														X		X	X	X
	Extend scope of legislation	Include Nintendo Switch in scope of material efficiency requirements of Games Console SRI																	X	
		Include Arcade/Emulator Style Devices in scope of material efficiency requirements of Games Console SRI																	X	