About Nordic Swan Ecolabelled

Rechargeable batteries and portable chargers

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Nordic Ecolabelling

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Addresses

In 1989, the Nordic Council of Ministers decided to introduce a voluntary official ecolabel, the Nordic Swan Ecolabel. These organisations/companies operate the Nordic Ecolabelling system on behalf of their own country's government. For more information, see the websites:

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What are Nordic Swan Ecolabelled rechargeable batteries and portable chargers?

Nordic Swan Ecolabelled rechargeable batteries and portable chargers live up to recognised quality and safety standards, placing them among the best in the market. Strict requirements apply to the information provided to the consumer. Both of these aspects are intended to ensure that the battery or portable charger will need to be replaced less frequently, thereby "saving" the environment the burden of more batteries than necessary. Portable chargers are designed in such a way that dismantling is possible. The content of lead, cadmium and mercury is lower than the levels stipulated by the authorities in their requirements. The plastic and metals used in the casings of both battery chargers and portable chargers must fulfil strict requirements regarding chlorinated plastic, flame-retardants and types of metals.

Producers and brand owners of batteries and portable chargers must demonstrate good corporate social responsibility regarding the sourcing of conflict minerals, as well as critical raw materials and working conditions.

Why choose the Nordic Swan Ecolabel?

- Licence holders may use the Nordic Swan Ecolabel trademark for marketing. The Nordic Swan Ecolabel is a very well-known and well-reputed trademark in the Nordic region.
- The Nordic Swan Ecolabel is a simple way of communicating environmental work and commitment to customers.
- The Nordic Swan Ecolabel clarifies the most important environmental impacts and thus shows how a company can cut emissions, resource consumption and waste management.
- Environmentally suitable operations prepare rechargeable batteries and portable chargers for future environmental legislation.
- Nordic Ecolabelling can be seen as providing a business with guidance on the work of environmental improvements.
- The Nordic Swan Ecolabel not only covers environmental issues, but also quality requirements, since the environment and quality often go hand in hand. This means that a Nordic Swan Ecolabel licence can also be seen as a mark of quality.

What can carry the Nordic Swan Ecolabel?

The product group comprises the following products:

Portable rechargeable batteries

Portable batteries that are rechargeable in accordance with the definition provided in the European Union's Battery Directive, 2006/66/EC.

Rechargeable batteries sold together with, or as accessories/parts for, electrical appliances, e.g. cordless power tools, can also be Nordic Swan Ecolabelled.

However, the battery must be designed to be replaced and charged in a separate charger. It must be made clear to the purchaser that the Nordic Swan Ecolabel only applies to the battery and not to the electrical appliances, or to other elements of the package.

External battery chargers sold in combination packs with Nordic Swan Ecolabelled batteries are also eligible for a Nordic Swan Ecolabel (including when batteries are sold together with e.g. a power tool, where the charger is purchased together with the tool and the battery). It must be made clear to the purchaser of combination packs of this type that the Nordic Swan Ecolabel applies solely to the batteries and not to the charger, or to other elements of the package.

The following batteries and electrical appliances cannot be Nordic Swan Ecolabelled according to these criteria:

- Car batteries and industrial batteries.
- Primary (non-rechargeable) batteries, for which separate criteria exist.
- Batteries that are built into or form a permanent part of electronic products and where replacement of the batteries is not possible. Portable chargers (portable power banks) are exempt from this requirement, see below.
- Batteries that are built into or form a permanent part of electronic products and where the entire product is placed in a charger.
- Chargers sold for rechargeable batteries alone.

Portable chargers

A portable charger or “portable power bank” is defined as any portable energystorage device containing secondary batteries with charging circuitry, and which is used to charge portable consumer electronic devices via DC output. Portable chargers with built-in solar panels can also be Nordic Swan Ecolabelled.

The following products do not fall within the above definition of portable chargers: products with AC input, products with jump starter functions, higher-capacity power packs intended for charging high-power industrial devices, and Uninterruptible Power Supply (UPS) systems.

Summary

The overall aim of this revision is to ensure that the Nordic Ecolabelling criteria continue to ensure positive environmental benefits via ecolabelling and that the criteria are viable and clear for the industry. The revision has considered the areas that were apparent on the evaluation of the criteria. It has also focused on expanding the product group to make it possible for portable chargers (known as power banks) to be Nordic Swan Ecolabelled.

Product group message

Nordic Swan Ecolabelled rechargeable batteries and portable chargers live up to recognised quality and safety standards, placing them among the best in the market. Strict requirements apply to the information provided to the consumer.

Both of these aspects are intended to ensure that the battery or portable charger will need to be replaced less frequently, thereby “saving” the environment the burden of more batteries than necessary. Portable chargers are designed in such a way that dismantling is possible. The content of lead, cadmium and mercury is lower than the levels stipulated by the authorities in their requirements. The plastic and metals used in the casings of both battery chargers and portable chargers must fulfil strict requirements regarding chlorinated plastic, flame retardants and types of metals.

Producers and brand owners of batteries and portable chargers must demonstrate good corporate social responsibility regarding sourcing of conflict minerals, as well as critical raw materials and working conditions.

Nordic Swan Ecolabelled rechargeable batteries and portable chargers:

- Meet stringent requirements for both battery capacity and durability – to ensure a long lifetime for the battery and portable charger.
- Live up to recognised quality and safety standards – to ensure good and safe consumer properties.
- Have a low content of mercury, cadmium and lead – to reduce the spreading and use of metals.
- Meet a CSR policy – to ensure responsible use and sourcing of limited raw materials and “conflict-free minerals.

MECO and RPS analyses

To obtain an overview of the key environmental impacts in the products' life cycles, an environmental assessment of the product group was performed, as a qualitative MECO analysis for each of the four product areas. MECO stands for the assessment of Materials, Energy, Chemicals and Other characteristics and describes the principal environmental impacts during the product group's life cycle phases. This was followed by an overall RPS analysis for the product group as a whole. RPS stands for Relevance, Potential and Steerability and the analysis identifies the most relevant environmental impacts that the Nordic Swan Ecolabel has the greatest possibility of steering towards a lower environmental impact. RPS was found for the following:

- The spreading and use of metals, especially heavy metals, from the batteries.
- The quality and safety of the rechargeable batteries and portable chargers.
- Overuse of batteries: due to the use of rechargeable batteries and portable chargers for an electrical application that drains the batteries or does not charge optimally.
- Incorrect handling of used batteries in the waste flow.

Market description

A brief review of the Nordic market shows that the use of both rechargeable batteries and portable chargers is developing positively. The sale of rechargeable NiMH batteries in the Nordic countries (2015 to 2016) increased by 16% on average.

The same development is seen in the market for Lithium-ion batteries, both as the sale of “normal” batteries (e.g. AA or AAA) and of batteries for power tools, but also in particular as a built-in energy source in portable chargers. The description of the market also shows that environmental statements used in marketing by brand owners focus on rechargeability compared to disposable batteries.

Changes in the revised version

Based on the assessment, the MECO and RPS analyses and the market description, the main changes in the revision focus on:

- Expanding the criteria to include portable chargers.
- Adjustment of the requirements of capacity, durability and testing methods for both rechargeable batteries and portable chargers. There is also a new requirement concerning leakage during testing.
- New safety requirements for batteries and portable chargers.
- New requirements for corporate social responsibility regarding the sourcing of conflict minerals and critical raw materials.
- Adjustment of the consumer information requirements regarding safety and recycling.
- New requirement for the recyclable design of portable chargers.

All changes and amendments to the requirements are listed in Chapter 6. Further details of the changes to the requirements and new requirements can be found in Chapter 5.

1 Basic facts about the criteria

Version and validity of the criteria

The Nordic Ecolabelling Board adopted generation 2 of the Nordic Ecolabel criteria document for rechargeable batteries on 15 March 1996. Generation 2 of the criteria was valid until 14 September 2003.

Generation 3 was adopted by the Nordic Ecolabelling Board on 17 December 2002. Generation 3 of the criteria was extended several times and was therefore valid until 30 June 2012.

Generation 4 of the criteria document was adopted on 7 December 2010. A number of adjustments were agreed on at the management meeting on 16 February 2012, and the criteria were thus changed to version 4.1. The criteria document has subsequently been extended 5 times. Version 4.6 is valid until 31 December 2019.

Nordic Swan Ecolabel licences in the Nordic Market

Table 1: Overview of licences in the Nordic market.

Licensees	Country	Nordic marked	Battery technology
Energizer Trading Limited	Sweden	Sweden and Denmark	NiMH

2 Market analysis

Type of batteries

The technology used in commercial batteries has not changed drastically: they consist of an electrolyte and two electrodes (the anode and the cathode). The chemical reaction that takes place at the electrodes and the nature of the electrolyte influence the efficiency of a battery. The inactive components – steel casings, seals and separators – ensure the normal functioning of a battery cell. The active components comprise different chemical compounds which define the main attributes of a battery. Some of these may have a significant environmental impact if they are disposed of inappropriately (cadmium (Cd), lead (Pb) and mercury (Hg) and, to a lesser degree, – copper (Cu), nickel (Ni), lithium (Li), silver (Ag), and zinc (Zn)).

The EU Battery Directive distinguishes between three types of batteries: portable, industrial and automotive batteries. See table 2 below. Portable batteries are sealed, can be hand-carried and are neither industrial nor automotive batteries. Only portable batteries are covered by these Nordic Swan Ecolabel criteria. According to European Commission[1], approximately 75% of all portable batteries in the EU are non-rechargeable – for the "general purpose" use, leaving the rest of the market – 25%– to rechargeable batteries. Industrial batteries comprise batteries designed for professional application, often at the manufacturing level. Here, lead-acid batteries prevail in the market, at 96%, while the remaining 4% is divided equally between NiCd and other batteries. Finally, automotive batteries are used for vehicle starting, lighting and ignition systems (so-called "SLI" batteries).

NiCd batteries for use in consumer products are prohibited, except for emergency and alarm systems and medical devices. NiMH batteries provide more than twice the operating time compared to similar NiCd batteries and are a technical and environmental alternative to NiCd batteries. Most rechargeable batteries for AA and AAA sizes are NiMH and Li-ion.

Table 2: Battery types, based on their application and the chemistries used

Portable		Industrial	Automotive (SLI)
Non-rechargeable	Rechargeable		
Zink-Carbon Alkaline-manganese Lithium-Oxide	Nickel-Cadmium Nickel metal hydride Lithium-ion Lead-acid	Lead-acid Nickel-Cadmium other	Lead-acid

Portable chargers

The increasing use of smartphones and tablets, technological advances, and power outages in certain countries, are driving the growth of the overall market.

[1] European Commission (2014). Frequently Asked Questions on Directive 2006/66/EU on Batteries and Accumulators and Waste Batteries and Accumulators. Commission Services document – not legally binding. http://ec.europa.eu/environment/waste/batteries/legislation.htm (visited 8/11-2017).

The power bank market was valued at USD 7.77 billion in 2016 and is expected to grow at a Compound Annual Growth Rate (CAGR) of 21.2% between 2017 and 2022[2]. Table 3 below gives an overview of the important properties of a portable charger from a consumer viewpoint. For an overview of the most common cathode/anode materials used in Lithium-ion batteries today, see appendix 2.

Table 3: The most important characteristics of the power bank market (based on capacity range, number of USB ports, energy source, battery type and application).

By capacity range	500–3499 mAh 3500–6499 mAh 6500–9499 mAh 9500–12499 mAh 12500–15499 mAh Above 15500 mAh
By number of USB ports	One USB port Two USB ports More than two USB ports
By energy source	Electric Solar
By battery type	Lithium ion batteries Lithium polymer Batteries
By application	Smartphones Tablets Portable Media Devices Digital Cameras Laptops Others (Handheld Gaming Devices, Global Positioning System (GPS) Navigators, E-Readers, and Smartwatches)

2.1 The market development

The trend in the marked for rechargeable batteries is moving towards fully charged batteries (when purchased in the store), which are ready to be used when removed from the packaging.

NiMH batteries are the largest category for consumers within the area in which the consumer takes out the batteries of the product and puts them in a charger, e.g. batteries for game consoles, remote controls, etc. Although it is possible to use rechargeable batteries in such products, the consumer often tends to use primary batteries for such purposes. According to data from battery manufacturers, there is a trend towards using more rechargeable batteries in high-drain applications such as game consoles and cameras. Primary batteries are primarily used in low- and medium-drain applications. The Nordic market (no data from Iceland) for rechargeable batteries is developing positively. Tables 4 and 5 below show sales of rechargeable NiMH batteries (types AA, AAA and others) in the Nordic countries in 2015 and 2016, and that sales have increased in all the countries.

[2] http://www.marketsandmarkets.com/Market-Reports/power-bank-market-127595596.html (visited 08-11-2017).

Table 4: Sales of rechargeable NiMH batteries (types AA, AAA and others) in the Nordic countries in 2016, stated in units and weight[3]

Country	AA, pcs	Weight in kg	AAA, pcs	Weight in kg	Others, pcs	Others, weight in kg
Denmark	977,438	27,360	477,142	6,123	19,435	1,112
Finland	275,403	8,052	144,516	1,852	13,422	713
Sweden	1,505,728	44,900	638,388	8,506	93,717	5,005
Norway	285,360	8,526	283,431	3,692	0	0

Table 5: Total sales of rechargeable NiMH batteries (types AA, AAA and others) in the Nordic countries in 2016 and 2015, stated in units[4]

Country	2015 pcs	2016 pcs	%
Denmark	1,224,027	1,474,015	20.42%
Finland	394,682	433,341	9.79%
Sweden	1,950,258	2,237,833	14.75%
Norway	485,273	568,791	17.21%
Total	4,054,240	4,713,980	16.27%

Since the 1990s, when Sony commercialised Li-ion batteries, they have rapidly replaced their nickel-based predecessors[5]. In 1996, the total production of batteries for mobile phones was 4.9 million units; the Li-ion, NiMH and NiCd batteries shared the market at 22%, 39%, and 39%, respectively. Later, in 2005, phone production reached 177 million units, but 79% were equipped with Li-ion batteries (and 17% with Li-polymer batteries). For laptops, the situation is similar: in 1995, 1.8 million laptops were equipped with Li-ion (45%) and NiMH batteries (55%), but in 2005, Li-ion batteries led the laptop market at 92% (with total production of 3.3 million units). This was due to the specific advantages of Li-ion batteries[6]:

- Higher energy density.
- A higher number of charge cycles without "memory effect" and high energy density; as a result, battery lifetime is extended.
- Just 5% loss of charge per month due to self-discharge (NiMH loses 30%).
- A wide variety of design factors, lightweight:
- A better environmental profile.

While the NiMH batteries have a few advantages (lower cost, high current and no need for processor-controlled protection circuits), the Li-ion batteries became dominant in the market for both portable devices and EVs. Factory giants (e.g. Tesla's and Panasonic's Gigafactory, LG Chem, Foxconn, BYD and Boston Power) are going to triple Li-ion battery production, reaching up to 125 GWh capacity by 2020, which will enhance the leading role of Li-ion battery technology.

[3] Data from EPBA (6/11-2017).
[4] Data from EPBA (6/11-2017).
[5] Buchmann, I.: Batteries in a Portable World: A Handbook on Rechargeable Batteries for Non-Engineers. Richmond, British Columbia: Cadex Electronics Inc. The fourth edition, 2016.
[6] Wang, X. (2014). Managing End-of-Life Lithium-ion Batteries: an Environmental and Economic Assessment.Thesis. Rochester Institute of Technology.

LG and Samsung have also scheduled the launch of Li-ion production in Europe – in 2018[7]. Figure 1 below presents the worldwide battery market in 1990-2020. Portable chargers are part of the "portable" category in the figure.

Moreover, the European Union has decided[8] to establish "a full value chain of batteries in Europe, with large-scale battery cell production, and the circular economy at the core". Europe's largest Li-ion factory, NorthVolt, is already being built in Sweden and the planned capacity of 32 GWh is expected to be reached by 2023[9]. The company assumes that there is "a long-term market for 100-150 factories of our size".

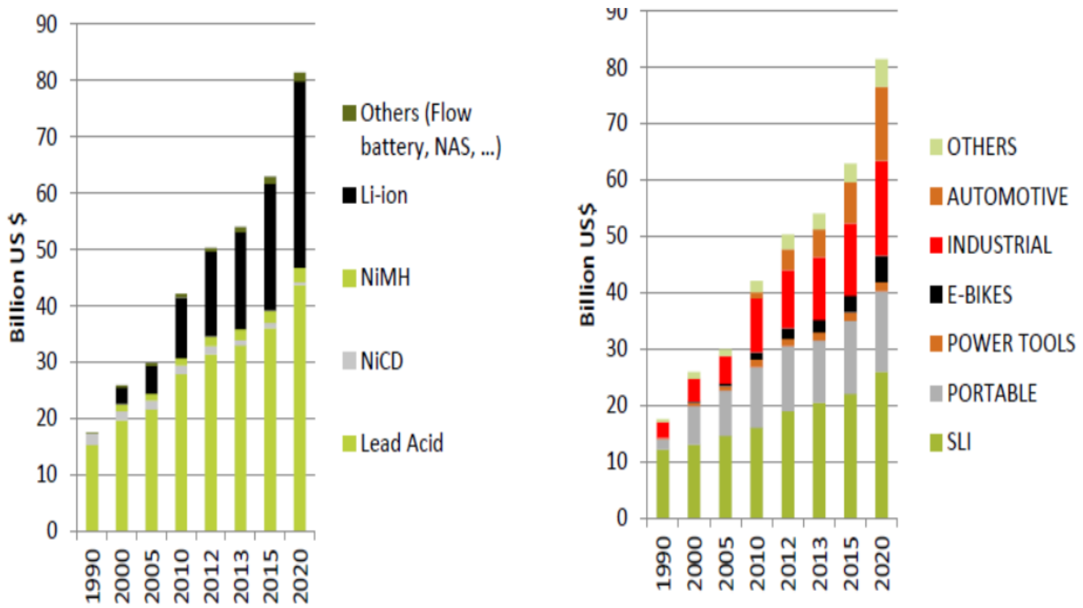

Figure 1: The worldwide battery market, 1990-2020[10]. ***SLI: start light and ignition batteries for cars, trucks, motors, boats, etc. Portables: consumer electronics (cellular (mobile phones, power banks), portable PCs, tablets, cameras, etc.). Automotive: hybrid electric vehicles (HEV), electric vehicles (VE). Others: medical - wheelchairs, medical devices, etc.***

2.2 Environment as a means of competition

Several battery manufacturers use "environmental/responsibility" in one way or another in their marketing. Energizer, for example, uses "Energizer® EcoAdvanced®" for its rechargeable batteries, where 4% of the total weight of the battery consists of recycled batteries (which account for 10% of an important active ingredient in the battery)[11]. Panasonic names its rechargeable batteries as "ecological rechargeable batteries"[12].

[7] Dmytro Kapotia: Ecolabelling criteria development for rechargeable batteries in ICT products – Justifying a new generation of requirements for batteries based on state-of-the-art in the sector, IIIEE Thesis 2017:21.
[8] http://europa.eu/rapid/press-release_STATEMENT-17-3861_en.htm (visited 2017-11-10).
[9] http://northvolt.com (visited 2017-11-10).
[10] Avicenne Energy: presentation of the battery market – development for consumer electronics, automotive and industrial. Batteries 2014 September 24-26,2014 Nice, France.
[11] http://www.energizer.com/ecoadvanced (visited 04.01.2017).
[12] http://www.panasonic-batteries.com/eu/products/product-ranges/rechargeable (visited 04.01.2017).

This characteristic is also generally used as an environmental argument. GP, for example, uses the expression ReCyko ++ on one of its rechargeable battery types[13]. In general, producers emphasise that the batteries are rechargeable and that they replace x number of primary batteries. Varta writes that one rechargeable battery replaces 300 alkaline batteries in a camera[14]. Ikea highlights its new rechargeable batteries and points out that they are better for the environment than disposable batteries[15].

2.3 Stakeholders

RECHARGE (a non-profit organisation) was founded to promote the value of rechargeable batteries and represent the interests of all of its members in the chain of battery life. RECHARGE monitors the continuously changing regulatory and legislative environment for rechargeable batteries and is a recognised expertise centre for advanced portable and industrial rechargeable battery technologies. Members include suppliers of primary and secondary raw materials to the battery industry, rechargeable battery manufacturers, original equipment manufacturers, logistics partners and battery recyclers.
http://www.rechargebatteries.org/

The European Portable Battery Association (EPBA) represents the interests of primary and rechargeable portable battery manufacturers, industries using portable batteries in their products, and distributors of portable batteries active within the European Union, and beyond. www.epbaeurope.net

The European Battery Recycling Association (EBRA) represents the companies whose main activities are battery sorting and recycling. EBRA's members are involved in the collection, sorting, treatment and recycling of used or waste batteries, whatever the technology or category – automotive, or Starting-Lighting-Igniting (SLI) batteries, industrial batteries, and consumer portable batteries (rechargeable and non-rechargeable). http://www.ebra-recycling.org/home

3 Other labels

This chapter summarises the main regulatory requirements, controls and labelling schemes for rechargeable batteries, power banks and UPS systems.

3.1 Battery Directive (2006/66/EC)

The Battery Directive 2006/66/ EC[16] (2006) applies to all batteries and accumulators in the European Union market, unless, according to Article 2.2 of the Directive, they are used in equipment intended to protect essential national security interests and equipment designed to be sent into space. The Directive has two different purposes. One is to reduce the environmental impact of batteries and the other is to coordinate the rules throughout the EU.

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[13] http://www.gpbatteries.com/int_en/batteries/rechargeable-batteries/recyko/recykoaa-1 (visited 04.01.2017).
[14] http://www.varta-consumer.no/nb-NO/Products/Rechargeables.aspx (visited 04.01.2017).
[15] http://www.ikea.com/ms/no_NO/this-is-ikea/people-and-planet/sustainable-life-at-home/index.html (visited 04.01.2017).
[16] http://ec.europa.eu/environment/waste/batteries/legislation.htm (visited 6/11-2017).

The Directive reduces environmental impacts by limiting the use of batteries containing the heavy metals cadmium, mercury and lead, and by requiring the collection of batteries. The Directive also reduces the environmental impact of batteries by requiring the recovery of end-of-life batteries and prohibiting landfill deposits and incineration of untreated batteries. All of the Nordic countries have established collection arrangements for batteries, as provided by the Directive.

The EU Battery Directive is subject to revision[17]. The task is to minimise waste and maintain material flows within the economy for as long as possible, to achieve economic, social and environmental benefits. An area of special interest is to find economic and strategic incentives for material recovery. It is also planned to consider such issues as 1) business models for collection and recycling of negative-value waste streams; 2) recycling capacity; 3) recycling technologies for new chemistries; and 4) the legal framework for reuse (the second life). For more information concerning EU legislation, see appendix 1.

3.2 Type 1 ecolabels

Type 1 ecolabels, like the Nordic Swan Ecolabel, are voluntary, multiple-criteria based, third-party programmes which award a licence that authorises the use of environmental labels on products, so as to indicate the overall environmental preferability of a product within a specific product category, based on life-cycle considerations.

There are several type 1 ecolabelling organisations that ecolabel batteries, some of which have specific criteria for rechargeable batteries, while others have criteria for consumer electronic products (ICT products) that include rechargeable batteries. Some of the most relevant are described below. All of these ecolabels are type 1 and the organisations are members of GEN (Global Ecolabelling Network).

Korea Ecolabel

Standard for rechargeable batteries[18]: The Korea Ecolabel requirements concern battery capacity, content of the heavy metals Cd, Pb and Hg, and that the packaging must be PVC-free. This limits the amount of lead (Pb) – 40 mg/kg or less; cadmium (Cd) – 10 mg/kg or less; and mercury (Hg) – 1 mg/kg or less. The Li-ion battery capacity must still be 80% of the nominal capacity after 400 charge cycles. No leakage may occur. Other criteria include requirements of consumer information (the reason that the ecolabelled battery performs better in terms of environmental impact); and safety, quality, and performance – based on the national and industrial standards. Nordic Swan Ecolabelling has chosen the same requirement level for the capacity and durability of the NiMH battery as the Korean Ecolabel.

Standard for mobile phones and for notebook computers[19]: sets restrictions concerning lead (Pb), mercury (Hg), and cadmium (Cd) in battery content, based on the Battery Directive.

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[17] http://www.prba.org/wp-content/uploads/9.1-EU-Batteries-Directive-Review.pdf (visited 2/5-2017).
[18] http://el.keiti.re.kr/enservice/enindex.do (visited 6/11-2017).
19 http://el.keiti.re.kr/enservice/enpage.do?mMenu=2&sMenu=1 (visited 6/11-2017).

In addition, there is the criterion for mobile phones concerning nickel emissions from the product and its elements, including the battery pack. The standard for mobile phones also sets the requirement for charging equipment: the product must have a structure whereby the recharging equipment may be used jointly with kindred model products with similar production times. The criterion regarding product design requires the option that the battery can be extracted and replaced. Customers must be provided with the relevant product- and service-related information.

Japan Environment Association – EcoMark

The criterion for energy consumption sets the standard energy consumption efficiency for battery-driven computers[20], based on their operational characteristics. The design criterion requires batteries to be replaceable and removable. EcoMark limits lead (Pb), mercury (Hg) and cadmium (Cd) in battery content, as well as hexavalent chromium, and specified brominated fire retardants (PBBs, PBDEs) – in accordance with the national Japanese standard. The product-related information (including the content information) and the information on battery replacement must be available via the website. The batteries are marked in accordance with national legislation on the promotion of effective utilisation of resources.

TCO Certified

TCO Certified[21] initiated the revision of the requirements for batteries in ICT products based on its own criteria, represented in the standards for smartphones, tablets and notebooks. The standards have shared requirements for batteries in portable electronics, with a minor difference between smartphones and tablets/notebooks.

The limitation of hazardous substances is based on the Battery Directive: mercury (Hg), lead Pb) and cadmium (Cd) (section A.6 for all standards). Additional criteria consider such specific hazardous substances as polybrominated biphenyls (PBB), polybrominated diphenyl ether (PBDE) and hexabromocyclododecane (HBCDD) in all components, including batteries.

The battery must be rechargeable and replaceable. A producer must provide spare parts for tablets and notebooks – for 3 years following the end of production. Instructions for professionals on how to replace components must be available.

The Blue Angel

The Blue Angel has ecolabelling criteria for mobile phones[22]. Harmful substances in plastics have been minimised to promote precautionary health protection. A number of requirements have been included to ensure the longevity of the devices.

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[20] https://www.ecomark.jp/english/nintei.html (visited 6/11-2017).

[21] http://tcocertified.com/tco-certified/tco-certified-product-categories (visited 6/11-2017).
[22] https://www.blauer-engel.de/en/products/home-living/mobiltelefone-135 (visited 6/11-2017).

The battery, for example, must meet particularly high quality standards and must naturally be replaceable by the user without expert knowledge being required. A mobile phone has to travel a long way until it finally reaches the consumer. This is why the Basic Criteria for the Blue Angel also include requirements concerning the origin of raw materials, i.e. “conflict minerals” (tin, tantalum, tungsten and gold), as well as the production conditions. Compliance with fundamental social standards at the manufacturing plant is monitored on site by independent third parties. Nordic Swan Ecolabelling has chosen the same requirement level for the capacity and durability of the lithium battery as the Blue Angel.

The Blue Angel[23] has ecolabelling criteria for uninterruptible power supply (UPS) systems. Lead batteries are currently still being used in uninterruptible power supply systems. The environmental label ensures that these lead batteries deliver the greatest possible lifespan, in order to keep the useful value of this environmentally dangerous and unhealthy material as high as possible. The Blue Angel environmental label sets additional requirements concerning energy efficiency, quality and recycling-compatible construction.

3.3 Other type of labels

EnergyStar has requirements and a labelling scheme for battery chargers[24].

3.4 Environmental Product Declarations (EPD)

In life cycle assessment, an Environmental Product Declaration (EPD) is a standardized way of quantifying the environmental impact of a product or system. While EPD do educate consumers about the product and its environmental impact, consumers should know that it is for disclosure purpose only, and does not mean that the product meets any environmental performance standards.

EPDs are referred to as type 3 environmental declarations according to ISO 14024. No EPDs for batteries are found on the international EPD page, but it has been found that the Taiwan Battery Association has developed product category roles (PCR) for ”Lithium-ion Secondary Battery Pack for Consumer Electronics” as from 2014.

3.5 Purpose of the revision of the criteria

Evaluation of the current generation 4 of the criteria for the Nordic Swan Ecolabelling of rechargeable batteries (2014 and 2016) resulted in a proposal to revise the criteria, primarily by adjusting the product group definition in order to enable the Nordic Swan Ecolabelling of portable chargers (power banks) and possibly also UPS (energy storage) systems. In addition, to adjust the requirements of capacity, capacity testing methods, the overall quality of rechargeable batteries and the possibility of new requirements for metals.

[23] https://www.blauer-engel.de/en/products/office/power-supply-systems (visited 6/11-2017).
[24] https://www.energystar.gov/products/electronics/battery-chargers (Visited 6/11-2017).

Based on the recommendations in the evaluation report, the objectives of the revision have been to:

- Establish the product group definition to cover portable chargers and possibly UPS systems.
- Adjust the requirements of capacity and testing methods for both rechargeable batteries, portable chargers and, possibly, UPS systems.
- Map the types of metals and constituents found in today's battery types in order to adjust the requirements for the use of metals.
- Examine the possibility of developing a new requirement for metal extraction.
- Examine the possibility of developing new requirements for leakage, fire safety regarding batteries/chargers and consumer information about which applications the battery is suitable for.
- Generally update current requirements to ensure they are clear and relevant.
- Update background documents in line with the revision of requirements and conclusions from MECO and RPS made in this evaluation.

About this criteria revision

The revision was conducted by Thomas Christensen (DK, product group manager) and Ove Jansson (S, project adviser). Jakob Waidtløw (DK), Randi Rødseth (N), Ove Jansson (S) and Anna Sahlman (Fin) are the national product specialists (PS).

The revision was conducted as an internal Nordic Ecolabelling project, with an ongoing dialogue with international and national stakeholders.

4 Environmental impact of the product group

The product group rechargeable batteries and portable chargers comprises different materials and types of production, but with a uniform function: namely to store energy and provide a portable source of power to charge drained electronic devices. The main component by far in a portable charger is a rechargeable battery. This means that the overall life cycles are the same as for the rechargeable batteries included in today's criteria: production of raw materials, production of batteries, and the user-facing and end-of-life battery treatment. The differences in the types of products lie in the type of battery technology. Portable chargers also consist of a special electrical circuit that controls the power flow and a closed casing (plastic or metal) surrounding the battery and circuit.

Safety and quality requirements of batteries, battery chargers and portable chargers ensure safe, energy-effective and consumer-friendly, durable. The requirements of consumer information and the recyclable design of the portable charger must ensure a high degree of recycling of the products.

A MECO analysis was performed in conjunction with Nordic Ecolabelling's revision of the criteria in 2017[25]. MECO stands for the assessment of Materials, Energy, Chemicals and Other characteristics and describes the principal environmental impacts during the a product's life-cycle phases. The MECO analyses are based on LCA studies[26][27][28] and scientific reports[29][30]. Based on the MECO analysis, an RPS analysis was conducted to identify the relevance, steerability and potential of the various environmental aspects of rechargeable batteries.

Nordic Ecolabelling uses the RPS analysis to pinpoint the environmental issues that are most relevant (R) in the life cycle of the products and to assess the potential (P) which exists for reducing adverse effects on the environment in these areas. At the same time, it is important to examine how manufacturers in particular can make changes to the products (steerability = S) that will trigger the potential for environmental improvements. This section describes the key findings of the RPS analysis. The complete analysis is in Danish, but can be requested from Nordic Ecolabelling.

The RPS analysis for rechargeable batteries and portable chargers shows that RPS has been found in a life cycle for the following areas:

- The spreading and use of metals, especially heavy metals, from the batteries.
- The quality and safety of the rechargeable batteries and portable chargers.
- Overuse of batteries: due to the use of rechargeable batteries and portable chargers for an electrical application that does not drain or optimally charge the batteries.
- Incorrect handling of used batteries in the waste flow.

The spreading and use of metals, especially heavy metals, from the batteries

When it comes to the spreading and use of metals, there are differences in which substances the batteries in the market today contain, and at which concentrations. There is thus relevance (R) and potential (P) to distinguish between more or less environmentally hazardous types of batteries. The Battery Directive, 2006/66/ EC, already regulates the content of mercury (Hg), cadmium (Cd) and lead (Pb) in batteries.

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[25] The separate MECO analysis for rechargeable batteries, portable chargers and UPS systems is written in Danish and is available on request from Nordic Ecolabelling: tc@ecolabel.dk.
[26] Giovanni Dolci et al.: Life cycle assessment of consumption choices: a comparison between disposable and rechargeable household batteries. The International Journal of Life Cycle Assessment (2016).
[27] Helgstand A.: AA batteries, disposable or rechargeable – A comparative Life Cycle Assessment of potential climate impact of rechargeable NiHM and alkaline disposable AA batteries. Linköping Universitet (2011).
[28] Mia Romare, Lisbeth Dahllöf (2017). The life cycle energy consumption and greenhouse gas emissions from Lithium-ion batteries, IVL Swedish Environmental Research Institute.
[29] Wang, X. (2014). Managing End-of-Life Lithium-ion Batteries: an Environmental and Economic Assessment. Thesis. Rochester Institute of Technology.
[30] Dmytro Kapotia: Ecolabelling Criteria development for rechargeable batteries in ICT products – Justifying a new generation of requirements to batteries based on state of the art in the sector, IIIEE Theses 2017:21.

The potential (P) for a stricter requirement concerning the use of mercury, cadmium and lead is therefore limited, but would, however, ensure that the raw materials used in a Nordic Swan Ecolabelled battery/portable charger have a high purity, which has an impact on the quality (R) of the battery. The steerability (S) of the Hg, Cd and Pb content in the batteries is increased by requiring relevant test analyses.

New requirements of the use of conflict and critical raw minerals in battery production ensure that battery manufacturers have an active policy for the purchase and use of metals. Conflict minerals such as tin, tantalum, tungsten, gold and cobalt are often mined in conflict- or high-risk areas such as the Democratic Republic of Congo region. Critical raw materials are considered critical to our society and our well-being.

By requiring information concerning the content of the battery/portable chargers, Nordic Ecolabelling can collect evidence in order to assess how we will set requirements of the battery content in the future. Requirements of consumer information and the recyclable design of the portable charger will ensure a high degree of recycling of the products.

The quality/safety of rechargeable batteries and portable chargers

Materials composition and production methods vary between the individual product types of rechargeable batteries and portable chargers. This has a major impact on the quality of the products. It is therefore highly relevant (R) to ensure that the quality of rechargeable batteries and portable chargers is good. This can be ensured by requirements to apply quality standards (P). The steerability (S) of the quality of the rechargeable battery and portable charger is increased by requiring relevant quality parameters to be tested by independent, qualified third parties.

Imposing stringent requirements of the quality of rechargeable batteries and portable chargers not only ensures good energy efficiency, but also increases the lifetime of the battery. A long battery lifetime also leads to a smaller amount of batteries in the commercial and waste stream.

Overuse of batteries: due to the use of rechargeable batteries and portable chargers for an electrical application that drains or does not optimally charge the batteries

For the consumer, there are economic and environmental benefits from choosing the right battery or portable charger with the best capacity for the electronic application, thereby ensuring a long and optimised battery life.

As stated above, there is a high RPS from ensuring that the quality of the rechargeable batteries and portable chargers is good. Requiring information on the packaging concerning which applications the battery/ portable charger is suitable for also ensures a long and optimised battery life.

5 Justification of the requirements

This chapter presents proposals for new and revised requirements, and explains the background to the requirements, the chosen requirement levels and any changes compared with generation 4.

5.1 Definition of the product group

The product group comprises the following products:

Portable rechargeable batteries

Portable batteries that are rechargeable in accordance with the definition given in the European Union's Battery Directive, 2006/66/EC.

Rechargeable batteries sold together with, or as accessories/parts to, electrical appliances, e.g. cordless power tools, can also be Nordic Swan Ecolabelled. However, the battery must be designed to be replaced and charged in a separate charger. It must be made clear to the purchaser that the Nordic Swan Ecolabel only applies to the battery and not to the electrical appliances or to other elements of the package.

External battery chargers sold in combination packs with Nordic Swan Ecolabelled batteries are also eligible for a Nordic Swan Ecolabel (including when batteries are sold together with e.g. a power tool, where the charger is purchased together with the tool and battery). It must be made clear to the purchaser of combination packs of this type that the Nordic Swan Ecolabel applies solely to the batteries, and not to the charger or other elements of the package.

The following batteries and electrical appliances cannot be Swan Ecolabelled according to these criteria:

- Car batteries and industrial batteries.
- Primary (non-rechargeable) batteries, for which separate criteria exist.
- Batteries that are built into or form a permanent part of electronic products and where replacement of the batteries is not possible. Portable chargers (portable power banks) are exempt from this requirement, see below.
- Batteries that are built into or form a permanent part of electronic products and where the entire product is placed in a charger.
- Chargers sold for rechargeable batteries alone.

Portable chargers

A portable charger or "portable power bank" is defined as any portable energy-storage device containing secondary batteries with charging circuitry that is used to charge portable consumer electronic devices via DC output. Portable chargers with built-in solar panels can also be Nordic Swan Ecolabelled.

The following products do not fall within the aforementioned definition of portable chargers: products with AC input, products with jump starter functions, higher-capacity power packs intended for charging high-power industrial devices, and uninterruptible power supply (UPS) systems.

Background

As in the criteria for generation 4, the product group includes portable batteries that are rechargeable in accordance with the definition provided in the European Union's Battery Directive, 2006/66/EC. In this generation of the criteria, the product group has been expanded with portable chargers, often referred to as power banks. The main component by far in a portable charger is a rechargeable battery. This means that the overall life cycles are the same as for the rechargeable batteries included in today's criteria: production of raw materials, production of batteries, the user interface and end-of-life battery treatment. The difference in the types of products lies in the type of battery technology. Portable chargers also consist of a special electrical circuit that controls the power flow and a closed casing (plastic or metal) surrounding the battery and circuit.

According to Directive 2006/66/EC, a rechargeable battery is:

Any source of electrical energy generated by direct conversion of chemical energy and consisting of one or more secondary battery cells (rechargeable). Portable batteries are confined to: any battery or button cell, or any battery pack or accumulator, that is sealed, can be hand-carried and is neither an industrial battery nor an accumulator, nor an automotive battery or accumulator.

The term "sealed" applies to most - if not all - types of batteries: lead-acid, Nickel-Cadmium (Ni-Cd), Lithium-Primary, Lithium-Ion (Li-ion), Zinc Alkaline, etc. The battery is sealed during normal use in order to avoid spillage of the electrolyte out of the battery, but also to protect the battery from the introduction of air inside the battery. Both the spillage and the air inlet would reduce the service life of the battery.

Rechargeable batteries sold together with or as accessories/parts to electrical appliances, e.g. cordless power tools, can also be Nordic Swan Ecolabelled. Yet the battery must be designed to be replaced and charged in a separate charger. The trend in e.g. the cordless power tool business is moving towards the development of electrical tools[31] (both for consumers and professionals) that use the same type of rechargeable battery products. On the frequent use of electrical tools, there may be a need to replace the rechargeable battery and buy a new one. These rechargeable batteries sold as accessories/parts can be sold and marked as Nordic Swan Ecolabelled. It must, however, be made clear to the purchaser that the Nordic Swan Ecolabel only applies to the battery and not to the electrical appliances or other elements of the package.

Nordic Swan Ecolabelling has chosen to exclude batteries that are built into or form a fixed part of electrical products and that accordingly cannot be replaced. Many tools, for example, such as cheaper screwdrivers and drills, beauty products or toys, have rechargeable batteries that cannot be replaced when they get old and cannot be recharged at all. Nordic Swan Ecolabelling believes that it is an unnecessary waste of resources to have to discard an electrical appliance simply because the battery no longer functions optimally.

[31] Power tools are tools that consumers and professionals use for turning, milling, sanding, grinding, sawing, cutting, shearing, drilling, making holes, punching, hammering, riveting, screwing, polishing or the similar processing of wood, metal and other materials, as well as for mowing, cutting and other gardening activities.

Nordic Swan Ecolabelling has also chosen to exclude electronic products which contain a rechargeable battery, but where the entire product is placed in a charger, e.g. mobile telephones, portable computers, toys and household appliances such as electric toothbrushes, razors and hand-held vacuum cleaners. This is because Nordic Swan Ecolabelling does not impose further requirements on the electrical appliances into which the battery is built and it would therefore not be possible to ensure that the overall product is environmentally-friendly.

The charger plays a major role in the useful life and performance of a rechargeable battery. For this reason, Nordic Swan Ecolabelling has chosen to impose special quality requirements on chargers sold in combination with Nordic Swan Ecolabelled rechargeable batteries. It is not unusual for rechargeable batteries to be sold in combination packs together with a charger. In order to ensure that these combination packs containing rechargeable batteries can also qualify for a Nordic Ecolabel, Nordic Swan Ecolabelling has kept this option open. Nordic Swan Ecolabelled licences are not available for chargers for rechargeable batteries alone. To avoid any doubt about what the Nordic Swan Ecolabel applies to when rechargeable batteries are sold together with a charger, the Marketing section specifies how the Nordic Swan Ecolabel logo must be positioned and presents a suggestion for an explanatory text which can be used when batteries and chargers are sold together in combination packs.

A different Nordic Swan Ecolabelling criteria document allows primary batteries to be ecolabelled. Nordic Swan Ecolabelling has not combined rechargeable batteries and disposable batteries in the same criteria document, since there is an essential difference which, in most cases, will mean that rechargeable batteries represent a better choice from an environmental perspective: one of the products is a disposable product. When it runs out, it is discarded. The second product is reusable. When it runs out, it is recharged and re-used. Furthermore, primary batteries and rechargeable batteries have differing chemical compositions.

In most cases, rechargeable batteries will represent a better choice in environmental terms than primary batteries, a fact that is *inter alia* confirmed by different LCA analyses of various batteries[32][33], and Nordic Swan Ecolabelling's preference is that as many consumers as possible should use rechargeable batteries.

[32] Giovanni Dolci et al.: Life cycle assessment of consumption choices: a comparison between disposable and rechargeable household batteries. The International Journal of Life Cycle Assessment (2016).
[33] Helgstand A.: AA batteries, disposable or rechargeable – A comparative Life Cycle Assessment of potential climate impact of rechargeable NiHM and alkaline disposable AA batteries. Linköping Universitet (2011).

Portable chargers

In this criteria generation 5, it is also possible to label portable chargers. A portable charger or "portable power bank" is defined as any portable energy-storage device containing secondary batteries with charging circuitry (a PCB with voltage conversion and power management system and USP ports), which is used to charge portable consumer electronic devices via DC output. Portable chargers with built-in solar panels can also be Nordic Swan Ecolabelled.

Most portable chargers (power banks) in the market have 5 volt (V) output, due to the USB power standard[34]. Nordic Swan Ecolabelling has, however, decided not to set a 5-volt limit to the DC output, due to the development in the market, especially for charging laptops. The trend for power banks intended for charging laptops is for devices with 16V to 20V DC outputs[35].

It is not possible to label portable chargers with an AC input (direct integrated plug to power outlet), since these are designed for "stationary" charging and are therefore not portable. Portable chargers with a jump-start function are not designed for continuous charging of electronic products, and are therefore not part of these criteria. Higher-capacity portable chargers intended for charging high-power industrial devices are not included in the product group, since these products are not intended for consumer electronic devices. Uninterruptible power supply (UPS) systems are designed for "stationary" power supply/charging and are therefore not portable

5.2 Production and product description

O1 Description of the product

The applicant must submit the following information about the product(s):

- Brand and trading name(s).
- Name and contact details of production location(s) for the manufacture and brand owner(s) of batteries and/or portable chargers.
- Description of the product(s) (detailing all constituent substances present in the battery; metals, other solid substances and liquid chemical substances) in the application (weight %).
- Description of raw materials used in the casing of the battery charger or the portable charger.
- Description of materials used in the primary packaging. Primary packaging: refers to the purchase packaging for the consumer, e.g. the packaging that holds 4 batteries or one portable charger, and which the consumer encounters in sales.
- Description of the manufacturing process for the product.

✉ Description of the above points. Appendix 1 may be used. A flow chart is recommended to explain the production process.

Background to requirement O1

The requirement of the description of the product has been adjusted to include portable chargers in generation 5 of the criteria.

[34] https://en.wikipedia.org/wiki/USB (visited 10-11-2017).
[35] http://www.tespack.com/7-facts-dont-know-power-banks/ (visited 10-11-2017).

The intention of the requirement is to provide an adequate picture of the manufacturing process and the life cycle of the product and any packaging: which raw materials and production processes are used, which metals, other solid substances and liquid chemical substances are used in the battery, and so on. Details of all constituent substances present in the battery and portable charger must be given in weight-%. The requirement will thus give an insight into the product(s) in the application, in order to ensure that the application is processed correctly.

O2 Metal content of batteries

The metal content of the battery may not exceed the following limits:

Metal	Content
Mercury	< 0.1 ppm
Cadmium	< 5.0 ppm
Lead	< 5.0 ppm

It should be noted that the EU's Battery Directive 2006/66/EC permits a maximum cadmium content of 20 ppm and a maximum mercury content of 5 ppm. The test laboratory may need special equipment in order to test batteries for a mercury content of < 0.1 ppm.

At least four examples of the product in question must be analysed and all four must meet the requirement.

The metal content of the batteries must be analysed in accordance with "Battery Industry Standard Analytical Method. For the determination of Mercury, Cadmium and Lead in Alkaline Manganese Cells Using AAS, ICP-AES and "Cold Vapour". European Portable Battery Association (EPBA), Battery Association of Japan (BAJ), and National Electrical Manufacturers Association (NEMA; USA). April 1998".

Similar test methods may be approved if assessed and adjudged to be equivalent to the recommended method by an independent third party.

☒ Report from the analysis body showing the metal content of the batteries.

☒ Declaration confirming that the institution performing the analysis is impartial and fulfils the general requirements applicable to test laboratories, as described in the requirements applicable to the analysis laboratory/test institutions in appendix 5.

Background to requirement O2

The requirement of the metal content of batteries has been changed in generation 5 of the criteria. Comments from stakeholders show that test methods cannot be used for testing for arsenic. Nordic Swan Ecolabelling has therefore decided to remove the requirement for content of arsenic in criteria generation 5.

As noted above, Nordic Swan Ecolabelling is aware that substances that are harmful to the environment are used in rechargeable batteries and that some of these substances are known to offer direct technical benefits. Unfortunately, at the present time we do not have sufficient knowledge of how these harmful metals might be limited without reducing the performance of the battery. On the other hand, we have known for many years that certain harmful metals can be limited without detrimental effect for battery performance:

- Mercury, which is very hazardous to health and the environment, accumulates in the body and is known to be highly volatile.

- Cadmium, which accumulates in the body, particularly the kidneys, and is known to be hazardous to health and the environment and in certain connections is carcinogenic, mutagenic or toxic for reproduction.
- Lead, which is known to be toxic for reproduction, environmentally harmful and has negative effects on the nervous system[36].
- Arsenic, which can occur in large quantities in rechargeable batteries. Arsenic is classified as toxic (H330 or H331/H301) and hazardous to the environment (H410).

The EU's Battery Directive 2006/66/EC (2006) requires batteries to be labelled if they contain concentrations of one or more of the three metals: mercury (max 5 ppm), cadmium (max 20 ppm) and lead (max 40 ppm). In addition, the Directive prohibits the marketing of ordinary consumer batteries with a mercury content in excess of 5 ppm and a cadmium content in excess of 20 ppm. At these levels, legislation has ensured that these three heavy metals may not be added to portable batteries deliberately. Even so, pollutants may nevertheless occur.

A German test study from 2013[37], which examined around 300 batteries, taken from stores, discovered that in some batteries, represented in the market, these metals may exceed the permitted EU limit, yet this is an exception: strict control in this sector will make it possible to completely erase commercial batteries with a prohibited level of such metals. Nevertheless, according to the same study, Li-ion batteries possess a significantly better chemical profile: the level of heavy metals is much lower than is allowed under the Directive.

As far back as in generation 3 of the criteria, Nordic Swan Ecolabelling opted to introduce stricter requirements than those of the authorities in this respect, in order to ensure that only the best constituent substances with very low concentrations of pollutants of the above metals may be used in Nordic Swan Ecolabelled batteries.

The requirement refers to a test method for determining the content of the above metals, which was developed for use on Alkaline Manganese (AlMg) batteries. Nordic Swan Ecolabelling is aware that applications may be submitted for ecolabels for other types of rechargeable batteries, and Nordic Swan Ecolabelling is aware that the specified test method is old. Similar test methods may therefore be approved if assessed and adjudged to be equivalent to the recommended method by an independent third party.

O3 Requirements applicable to plastic and metal in the casing of the battery charger and in the outer casing/container that encircles the batteries/cells in the portable charger

The requirement solely applies to plastic and metal in the casing of the battery charger and the outer casing that encircles the batteries/cells in the portable charger. The requirement does not apply to the battery, the casing encircling the battery/cell itself, circuit/PCBs, wires or USB/charge ports.

[36] http://mst.dk/kemi/kemikalier/fokus-paa-saerlige-stoffer/
[37] https://www.umweltbundesamt.de/en/press/pressinformation/batteries-put-to-the-test-too-many-heavy-metals (visited May 2015).

The plastic or metal in the casing of the battery charger and the outer casing that encircles the batteries/cells in the portable charger must fulfil the following requirements:

Plastic:

- Plastic parts covering a surface > 200 mm² in the casing must be labelled in accordance with ISO 11469.
- The plastic may not be chlorinated plastic.
- Cadmium and lead must not be actively added to the plastic in the casing.
- Chloro-paraffins must not be actively added to the plastic in the casing.
- The following flame retardants must not be added to the plastic in the casing:
  a) Hexabromocyclodecane (HBCDD), tetrabromobisphenol A (TBBP-A) and tris(2-chloroethyl)phosphate (TCEP).
  b) Other halogenated organic flame retardants and flame retardants that have been given one or several of the following risk phrases may not be added:
     - H350
     - H350i
     - H340
     - H360D
     - H360F
     - H360Df
     - H360Fd

Metal:

The following metals may not be actively added to the casing in the battery charger and the outer casing that encircles the batteries/cells in the portable charger:

Lead (Pb), mercury (Hg), chromium VI (CrVI), cadmium (Cd), cobalt (Co), antimony (Sb), zinc (Zn,), copper (Cu) or nickel (Ni).

☒ Documentation showing that the casing is labelled in accordance with ISO 11469.

☒ Declaration from the manufacturer of the battery charger or portable charger that the requirement is fulfilled. Appendix 2 may be used.

Background to requirement O3

In generation 5 of the criteria, the requirement of the plastic in the casing of the battery charger has been adjusted to include portable chargers. The requirement of flame retardants has also been adjusted so as to correspond to other Nordic Swan Ecolabelled product groups containing electronic products.

The requirement of metal in the casing of the battery charger and the outer casing that encircles the batteries/cells in the portable charger is new in generation 5 of the criteria.

The requirement solely applies to the plastic and metal in the casing of the battery charger and the outer casing that encircles the batteries/cells of the portable charger. This is because the consumer only has direct contact with the outer casing. It is also difficult for the manufacturer to have full traceability of materials that are part of small plastic pieces and electronics.

The requirement does not apply to the battery, the casing encircling the cell itself, the circuit/PCB, wires or USB/charge ports, since some of these metals are essential in the circuit/PCB, wires, USB/charge ports, etc.

Plastic

Plastic parts covering a surface > 200 mm^2 in the casing must be labelled in accordance with ISO 11469. It is almost impossible to mark small pieces of plastic and therfore a limit of >200 mm^2 is set. The same limit exists in other Nordic Swan Ecolabelling criteria, e.g. PC and imaging products.

The presence of chlorine atoms in materials affords a number of technically desirable properties, but there are adverse environmental impacts coupled to the disposal of PVC plastics, as they usually contain additives with undesirable health effects. When PVC ends up in the waste stream for incineration, this effectively means more chlorine in the waste stream. Chlorine is a prerequisite for the formation of highly toxic dioxins in the flue gas, but since there are several other sources of chlorine than PVC, the increased incineration of PVC will not necessarily lead to an increased amount of dioxin, as chlorine is not the limiting factor for the formation of dioxins in incinerators[38][39]. The extra amount of PVC will, however, increase the formation of acidic gases and will consequently increase the need for gas cleaning with gas cleaning equipment.

Combustion of 1 kg of PVC produces up to 1.7 kg of salt in flue gas cleaning. In practice, this means that more waste is generated than the amount of waste that was sent into the incinerator. This is due to the neutralising process carried out in order to avoid hydrochloric acid being formed and creating a corrosive environment in the incinerator. Not all waste incineration facilities are able to incinerate PVC products in the Nordic region. Old fractions of PVC have a high probability of containing hazardous additives, such as lead and cadmium, creating residual materials that need to be taken care of. In the case of incinerators that cannot incinerate such PVC waste, the stream is usually landfilled. In the case of incinerators that can incinerate such PVC waste, the residual products (the fly ash and bottom slag) are treated specially; the fly ash is landfilled in special landfills, and the bottom slag is also landfilled, or used as a construction material for landfills.

Flame retardants

All electrical and electronic products involve a risk of fire. Various flame retardants are used to minimise this risk. The choice of flame retardants is determined by a number of factors, such as which material is to be flame proofed, the fire protection requirements and the price. Furthermore, the flame retardant may not impair the intended technical functions of the product.

The intention of flame retardants is to provide protection throughout a product's use phase.

[38] Hjelmar, 2002: Forbrænding af PVC: Påvirkning af massestrømmene gennem et forbrændingsanlæg. DHI – Institut for Vand og Miljø.
[39] http://www.esa.chalmers.se/education/I1/text_files/pvc.pdf (report from Chalmers University of Technology, Sweden).

This is why they are deliberately manufactured so as not to degrade easily, which means that these substances can be difficult to degrade when they emerge into the environment. Most attention has been paid to *brominated* flame retardants, partly because their presence has been detected in breastmilk and blood. Of the non-brominated flame retardants, the most common are metal compounds, organic phosphorus and nitrogen compounds, and inorganic salts.

There are approximately 70 brominated flame retardants on the market, and knowledge of their properties as being hazardous to health and the environment varies. The five brominated flame retardants which have been used most and for which a lot of knowledge exists are[40] :

- Pentabromodiphenyl ether
- Octabromodiphenyl ether
- Decabromodiphenyl ether
- Hexabromocyclododecane (HBCDD)
- Tetrabromobisphenol-A (TBBP-A)

The first three form part of the group of polybrominated diphenyl ethers (PBDEs). Due to the EU Directive on Restriction of Hazardous Substances (RoHS), polybrominated diphenyl ethers and polybrominated biphenyls (PBB) have been prohibited in new electrical and electronic devices since July 2006.

The Commission decided in October 2005 that the flame retardant decaBDE[41] would generally be exempted from the prohibition laid down in the RoHS Directive. On 1 April 2008, the European Court of Justice decided that decisions of the Commission on such exemptions are not valid. Consequently, decaBDE is also prohibited in electrical and electronic products as from 1 July 2008. Flame retardants incorporated later into the RoHS Directive were the brominated flame retardants HBCDD and TBBPA.

Sweden reported on the risk assessment of HBCDD within the EC's existing substance programme. The conclusions of the report are that this substance is persistent, bioaccumulative and very toxic to aquatic organisms, and may cause harmful long-term effects in the aquatic environment. In animal experiments, HBCDD has been proved to affect the liver and thyroid, and to be reprotoxic. The risk assessment of HBCDD is complete within the EU. HBCDD has been identified as a particularly hazardous substance, SVHC (Substance of Very High Concern), and it is included on the candidate list (REACH). HBCDD is also included in the authorisation list, Annex XIV, in REACH.

TBBP-A has also undergone risk assessment within the EU's existing substance programme. This substance is classified as very toxic to aquatic organisms and may cause harmful long-term effects in the aquatic environment. TBBP-A is considered to be poorly degradable and bioaccumulative. Alternatives to TBBP-A with flame retardant effects have been developed and are being used more widely.

[40] Information from the Swedish Chemicals Agency website, sww.kemi.se (visited 28-10-2017).
[41] Pentabromodiphenyl, octabromodiphenyl and decabromodiphenyl ethers belong to the same chemical substances, polybrominated diphenyl ethers (abbreviated PBDE). These have different numbers of bromine atoms in their structures. All three are poorly degradable, persistent substances, while their bioaccumulation and toxicity differ.

TBBP-A is the most widely used brominated flame retardant in the world. It is used mostly in printed circuit boards. As it is chemically bound to the material in the printed circuit board, and hence is not spread so readily to the surrounding environment, the EU has deemed that it does not pose a risk to human health in this application. It is currently not possible to make printed circuit boards without TBBP-A, so that printed circuit boards are exempt from the prohibition of TBBP-A.

Chloroparaffins, which can also be used as flame retardants, are stable, poorly degradable compounds which may bioaccumulate in the environment. Highly-chlorinated short-chain and medium-chain chloroparaffins are very toxic to aquatic organisms and may cause harmful long-term effects in the aquatic environment. Highly-chlorinated short-chain chloroparaffins have been identified as particularly hazardous substances, SVHC, in REACH and are included on the candidate list. For this reason, Nordic Ecolabelling wishes to prohibit the use of these substances in plastic chargers for use with Nordic Swan Ecolabelled rechargeable batteries or in portable chargers.

Table 6: Summary of flame retardants, their risks and usage restrictions.

Flame retardant	Rule	Risk assessment	Nordic Ecolabelling stipulation
Polybrominated biphenyls (PBB)	Banned in new electrical and electronic equipment since July 2006 under the RoHS Directive	PBB was the first brominated flame retardant that proved to be harmful. The substance has been well studied and as far as we know PBB is no longer made.	Must not be present
Polybrominated diphenyl ethers (PBDE)	Banned in new electrical and electronic equipment since July 2006 under the RoHS Directive (since July 2008 for decaBDE)	pentaBDE: persistent, harmful to health and the environment. POP substance (UNEP) octaBDE: endocrine disruptor, persistent and bioaccumulating. POP substance decaBDE: suspected to be harmful, but risk assessment is pending.	Must not be present
Hexabromocyclod odecane (HBCDD)	Use permitted	Classed as SVHC. Included on Candidate List.	Must not be present
Tetrabromobisphenol A (TBBP-A)	Use permitted	Highly toxic to aquatic organisms. May cause damaging long-term effects in an aquatic environment.	Must not be present

Against this background, particularly the credible risk assessment, the requirement of flame retardants has been adjusted so that it corresponds to other Nordic Swan Ecolabelled product groups containing electronic products.

TCO-certified[42] have similar requirements for specific hazardous substances such as polybrominated biphenyls (PBB), polybrominated diphenyl ether (PBDE), and hexabromocyclododecane (HBCDD) in all components, including batteries.

[42] http://tcocertified.com/?s=all+in+on+PC (visited 6-11-2017).

Metal

A review of the market for portable chargers shows that there is great variety in the choice of materials and designs in the outer casing. In addition to plastic, metal is a preferred material.

The manufacture of the heavy metals zinc and nickel is associated with high energy consumption and emissions of environmentally harmful substances, which is why their use is not permitted in the casing of battery chargers and the outer casing that encircles the batteries/cells in the portable charger. It is therefore relevant to ensure that any metal used in the casing of battery chargers and the outer casing that encircles the batteries/cells in the portable charger is free of the heavy metals lead (Pb), mercury (Hg), chromium VI (CrVI), cadmium (Cd), cobalt (Co), antimony (Sb), zinc (Zn,), copper (Cu) and nickel (Ni).

Lead

Lead is a toxic heavy metal that accumulates in nature and in human beings. This means that even small quantities of lead can be harmful to health. Children are particularly vulnerable. They are generally exposed to more lead than adults via food, soil and dust, while their gastrointestinal system absorbs lead far more effectively than adults. Lead affects the nervous system. As a child’s nervous system is still developing, they are particularly sensitive to these effects and American studies have shown that, even in small quantities, lead can affect children’s learning ability and intelligence. Lead is also toxic for organisms in soil and water. If products containing lead are disposed of as waste, after incineration the lead will be present in slag and fly ash. A small amount is dispersed in smoke and dust from incineration plants.

Mercury

Mercury occurs as inorganic and organic chemical compounds, and is one of the most dangerous environmental toxins. Mercury is a threat to the environment and to human health. The organic mercury compounds are particularly toxic. Mercury compounds are extremely toxic for aquatic organisms and for mammals. Mercury, even in small quantities, can cause three chronic toxic effects. Mercury can also cause kidney damage, foetal damage and lead to contact allergy.

Chromium

Chromium (III) and chromium (VI) are used for e.g. chrome plating, in dyes and in pigments. Chromium (III) is essential, since living organisms require chromium. The different types of chromium have different effects. All chromium compounds are toxic. Chromium (VI) has particularly harmful effects, as it is carcinogenic and allergenic. A number of chromate compounds are on the Danish Environmental Protection Agency’s List of Undesirable Substances. It is therefore still relevant to include a ban on chromium in the criteria.

Cadmium

Cadmium and cadmium compounds are acutely and chronically toxic for human beings and animals. Most cadmium compounds are also carcinogenic. Cadmium is classified as very toxic by inhalation and as carcinogenic.

Cadmium can also potentially be reprotoxic and cause foetal damage. Most cadmium compounds are extremely toxic for aquatic organisms, especially in fresh water, and acutely toxic for mammals. Cadmium also has chronic toxic effects on many organisms, even in very small concentrations. Cadmium is bioaccumulative in fish and mammals and has a long biological half-life in mammals.

Cobalt

Cobalt has the same properties as those described for cadmium.

Antimony

Antimony compounds are generally harmful to health and the environment, but certain compounds also have other effects. On the list of dangerous substances, antimony compounds – with the exception of antimony tetroxide (Sb2O4), antimony pentoxide (Sb2O5), antimony trisulfide (Sb2S3), antimony pentasulfide (Sb2S5) and compounds with separate classification – carry the classifications: R20/22, H411 and H351. The substance is undergoing environmental hazard classification and risk assessment in the EU.

Zinc

Zinc is an essential metal, since living organisms require zinc. In excessive quantities zinc can be toxic for organisms in the environment and can cause stomach cramps and vomiting, and anaemia after prolonged ingestion. It can also affect rats' ability to reproduce, but it is not known whether it also has this effect on human beings. Zinc is a finite resource with a supply horizon of 20 years.

Copper

Plants, animals and humans need very small quantities of copper to survive, but it becomes toxic in higher concentrations. The body uses copper in the red blood cells, in certain enzymes and in hormones. Too much copper can cause nausea, vomiting and diarrhoea, and affect the cardiovascular system. Copper and copper compounds are listed as priority substances in the EU's Framework Directive and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. Copper is also included on the European Commission's EPER list.

Nickel

Nickel is one of the most common reasons for contact allergy in Denmark. However, cases have declined since new rules were introduced in 1991 for a large number of consumer products that are intended for direct and prolonged contact with the skin. The rules apply to e.g. jewellery, spectacles, buttons and belts, while mobile phones and laptop computers must also comply with the nickel requirements. Yet the rules do not protect all consumers, since some people are more sensitive. Even though metal elements comply with the rules, this is not sufficient to prevent particularly sensitive people from developing a nickel allergy.

Steel

The carbon content of steel is between 0.002% and 2.1% by weight for plain iron-carbon alloys. These values vary depending on the alloying elements such as manganese, chromium, nickel, iron, tungsten, carbon and so on[43] . Other materials are often added to the iron/carbon mixture to produce steel with desired properties. Stainless steel contains at least 11% chromium, often in combination with nickel, in order to resist corrosion. Some types of stainless steel, for example ferritic, are magnetic, while others, for example, austenite, are non-magnetic. Steel or stainless steel can therefore probably not be used in the casing.

O4 Battery charger, battery sizes

This requirement applies solely to chargers for rechargeable batteries of the following sizes: AAA: HR03, AA: HR6, C:HR14, D: HR20, 9V:HR 22.

If the rechargeable batteries are sold together with a charger, the charger must be suitable for use with a minimum of two battery sizes.

🖂 Declaration from the licensee that the charger can be used for charging a minimum of two battery sizes. Appendix 2 may be used.

🖂 A description/documentation of the charger confirming this must be attached.

Background to requirement O4

The requirement of the battery charger (battery sizes) remains unchanged in generation 5 of the criteria.

In order to ensure that consumers do not need to buy as many chargers as they have various battery sizes, thereby increasing the environmental impact as a consequence of increased charger production, Nordic Swan Ecolabelling's preference is that chargers that are sold together with ecolabelled rechargeable batteries should permit multiple battery sizes to be charged. As the present volume of chargers that charge three types of batteries is reduced – since few, if any, exist at all – this was changed in version 4.1 of the criteria to two battery sizes.

This requirement solely applies to chargers for rechargeable batteries for ordinary household batteries, size: AAA: HR03, AA: HR6, C:HR14, D: HR20, 9V:HR 22. Batteries for power tools (typically NiCd, NiMH and Li-ion) are normally not divided into the same battery sizes as ordinary household batteries, and are therefore not subject to the requirement. A battery for a power tool often comes with a charger of the relevant power tool. The charger can only handle one specific shape/size of battery, but the manufacturer of the power tool has ensured that the same shape/size of the battery/charger fits several of its power-tool products.

[43] Ashby, Michael F. & Jones, David R. H. (1992) [1986]. Engineering Materials 2 ((edited edition) Oxford: Pergamon Press.

5.3 Corporate Social Responsibility

O5 Sourcing of "conflict-free" minerals

The licensee and brand owner(s) must have a public conflict minerals policy and support the responsible sourcing of tin, tantalum, tungsten, gold, cobalt and their ores from conflict-affected and high-risk areas by:

a) Conducting due diligence in line with the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas; and

b) Promoting responsible mineral production and trade within conflict-affected and high-risk areas for the identified minerals, as used in components of the products and in accordance with OECD guidance.

✉ The licensee and brand owner(s) shall provide a copy of their conflict mineral policy.

✉ The licensee and brand owner(s) shall describe their due diligence activities along the supply chain for the five minerals identified.

Background to the requirement

This is a new requirement in generation 5 of the criteria. The European Commission has agreed on a framework to stop the financing of armed groups through trade in conflict minerals[44][45], after negotiations between the Commission, Council and Parliament. It aims for EU companies to source tin, tantalum, tungsten and gold responsibly. These minerals are typically used in everyday products such as mobile phones, electronic products, cars and jewellery. The regulation will be enforced in 2021. Conflict minerals are often mined in conflict or high-risk areas such as the Democratic Republic of Congo (DRC) region, Afghanistan, Colombia, the Central African Republic and Myanmar[46]. In many cases, armed groups control mineral extraction activities in order to finance their operations[47]. This illicit trade contributes to violent conflicts and severe human rights violations.

Cobalt is not on the list in the EU Regulation on conflict minerals. More than half of the cobalt on the world market is extracted in DRC under hazardous working conditions, where child labour is used, among other things[48][49]. Cobalt is used in Lithium-ion batteries in the cathode chemistries and this is why Nordic Swan Ecolabelling has decided to include cobalt in this generation of the criteria.

There are a number of initiatives to verify and trace minerals from mines through the supply chain:

- The OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas ("the Guidance").

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[44] The EU Regulation on Conflict Minerals solely comprises tin, tantalum, tungsten and gold.
[45] http://www.consilium.europa.eu/en/press/press-releases/2016/06/16/conflict-minerals/# (visited 10-10-2017).
[46] Jaekel, T. "Far From Reality: How the EU Falls Short in Preventing the Illicit Trade of Conflict Minerals", Swedwatch, 2016.
[47] http://www.swedwatch.org/wp-content/uploads/2017/07/swedwatch_annual_progress_report_2016.pdf (visited 10-10-2017).
[48] Amnesty International, "This Is What We Die For, Human Rights Abuses in the Democratic Republic of the Congo Power the Global Trade in Cobalt", 2016.
[49] Nordic Ecolabelling (2017): Report on mining and traceability.

Licence holders/brand owners require suppliers to disclose their sourcing origins for conflict minerals by using a questionnaire template such as the EICC “Conflict Minerals Reporting Template”, or similar, in order to prevent the potential use of conflict minerals.

- iTSCi - ITRI[50] represent tin producers and smelters. This programme is a supply chain initiative to verify and trace minerals from the mine to the smelter (traceability tagging). Although full membership is focused on upstream companies (Mining, Smelters, etc), an associate membership for downstream companies exists (manufacturers, etc,). Associate members contribute to the financing of the iTSCi programme and thereby stay informed on initiative activities and specific mining sites, while also supporting the development in Africa.
- The Conflict-Free Tin Initiative (CFTI): sources conflict-free tin from the South Kivu province of DRC that implements the ITRI Tin Supply Chain Initiative (iTSCi), and the due diligence and traceability system.
- The Public-Private Alliance for Responsible Minerals Trade[51] (PPA) is a multi-sector and multi-stakeholder initiative that provides funding and support for systems that trace and certify mineral supply chains in the DRC and Great Lakes Region.
- Other relevant in-region initiatives: initiatives not stated on the list, but which prove active commitment to an initiative aimed at increasing legitimately sourced minerals. Examples of other relevant initiatives that are approved:
  - Solutions for Hope (SfH); sources conflict-free tantalum from the Katanga province of DRC (incorporates the iTSCi process and CFS programme).
  - The Certified Trading Chains initiative (CTC) is a programme supported by the German government, which certifies mines to defined performance standards.
- Member of the EICC & GeSi Conflict-Free Sourcing Initiative (CFSI). Members contribute to a number of tools and resources, including the Conflict Minerals Reporting Template; supporting in-region sourcing schemes and the Conflict Free Smelter Programme (identification of Smelters and Refiners that source conflict-free minerals).

Nordic Swan Ecolabelling requires both the licensee and brand owner(s) to provide a copy of their conflict mineral policy. If the licensees and brand owner(s) use some of the aforementioned initiatives, this can be included in the documentation of the requirement.

O6 Sourcing of critical raw materials

The licensee and brand owner(s) must have a policy for the use of raw materials included in the EU’s list of critical raw materials[52] in batteries, battery chargers and portable chargers. The list of critical raw materials can be found in appendix 3.

[50] https://www.itri.co.uk/index.php?option=com_zoo&view=item&Itemid=191
[51] http://www.resolv.org/site-ppa/
[52] http://ec.europa.eu/growth/sectors/raw-materials/specific-interest/critical_en

a) The policy must describe how the licensee and brand owner(s) work actively to phase out/recycle any critical raw materials in batteries, battery chargers and portable chargers.

✉ The licensee and brand owner(s) must submit a written policy that describes how the licensee and brand owner(s) work actively to phase out/recycle any critical raw materials in batteries, battery chargers and portable chargers.

Background to requirement O6

This is a new requirement in generation 5 of the criteria. The European Commission has listed 20 critical raw materials (CRMs) that are considered to be critical to our society and for well-being[53] (see appendix 3). The critical raw materials are chosen according to two important criteria: economic importance and access. The materials that the EU considers to be critical are: antimony, beryllium, borates, chromium, cobalt, coke, fluorite, phosphate minerals, gallium, germanium, graphite, indium, magnesite, magnesium, niobium, platinum group metals (PGM) (rare earths), heavy rare earth metals (HREE), silicon metal and tungsten. The assessment made by the EU shows that China is the most influential country in terms of global access to the 20 critical materials. The map below shows where in the world the 20 critical materials on the EU CRM list are available.

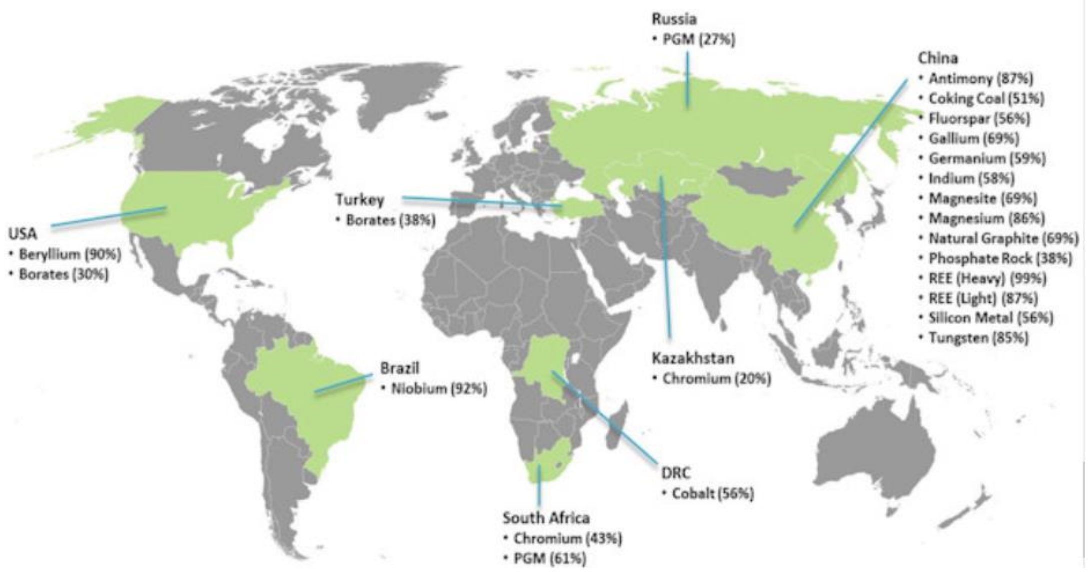

Figure 2: The major producers of the twenty EU-critical raw materials.

The economic aspects force battery producers to look for new chemical compounds, developing alternative battery technologies. The main reasons for this are: 1) to meet customers' expectations in terms of higher energy capacity and faster charging; and 2) to make the battery cheaper. Several of the 20 critical materials included on the EU list have e.g. very good conductive properties, supporting the customer's expectations in terms of a higher energy capacity. Cobalt, for example, is mainly used in Lithium-ion batteries for portable consumer electronics.

[53] http://ec.europa.eu/growth/sectors/raw-materials/specific-interest/critical_en (visited 5/11-2017).

But the market shows signs of gradually eliminating cobalt from cathode chemistries (to substitute cobalt in the battery content with nickel, manganese, and other materials[54]). Cobalt is the main contributor to the Li-ion battery price. Lithium is not among the 20 critical materials on the EU's list, but even this raw material is sourced from a narrow circle of areas: around 75% of lithium comes from the "Lithium Triangle": Argentina, Chile and Bolivia[55].

Nordic Swan Ecolabelling requires both the licence holders and brand owner(s) to address the concerns regarding the use of critical raw materials. In order to do so, the licensee and brand owner(s) must submit a written policy that describes how the licensee/brand owner works actively to phase out or recycle any critical raw materials in their batteries, battery chargers and portable chargers.

O7 Working conditions

The licensee must have a written Code of Conduct that explains how the licensee ensures compliance with the following UN conventions and the UN Global Compact at component, battery, battery charger and portable charger suppliers:

- The UN Convention on the Rights of the Child, Article 32.
- The UN Declaration (61/295) on the Rights of Indigenous Peoples.

The UN's: Global Compact[56], which comprises the following ten principles:

- Principle 1: Businesses should support and respect the protection of internationally proclaimed human rights.
- Principle 2: Make sure that they are not complicit in human rights abuses.
- Principle 3: Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining (ILO Conventions 87 and 98).
- Principle 4: The elimination of all forms of forced and compulsory labour; (ILO Conventions 29 and 105).
- Principle 5: The effective abolition of child labour (ILO Conventions 138 and 182).
- Principle 6: the elimination of discrimination in respect of employment and occupation (ILO Conventions 100 and 111).
- Principle 7: Businesses should support a precautionary approach to environmental challenges.
- Principle 8: Undertake initiatives to promote greater environmental responsibility.
- Principle 9: Encourage the development and diffusion of environmentally friendly technologies.
- Principle 10: Businesses should work against corruption in all its forms, including extortion and bribery.

The licensee must ensure that all suppliers are familiar with and comply with the Code of Conduct.

[54] Dmytro Kapotia: Ecolabelling Criteria development for rechargeable batteries in ICT products – Justifying a new generation of requirements to batteries based on state of the art in the sector, IIIEE Theses 2017:21.
[55] Nordic Ecolabelling (2017): Report on mining and traceability.
[56] http://www.unglobalcompact.org

If components, batteries, battery chargers and portable chargers are produced in countries in which these conventions are incorporated as part of the requirements of the authorities, no further documentation will be required beyond the signed application form for a licence for Nordic Ecolabelling.

☒ Licensees must submit a written Code of Conduct that explains how the licensee ensures that its suppliers comply with the requirements of the UN conventions and the UN Global Compact.

☒ A description of how the licensee's Code of Conduct is communicated to all of its suppliers.

Background to requirement O7

The requirement concerning working conditions has been amended slightly, compared with generation 4. Generation 4 of the criteria required licensees to have a plan in place for compliance with the UN Global Compact[57] , of which the aim is to lay down international principles for human rights, labour, the environment and anti-corruption. Nordic Swan Ecolabelling has adopted a common requirement for working conditions which, in addition to compliance with the UN Global Compact, also includes compliance with the UN Convention on the Rights of the Child (Article 32) and the UN Declaration (61/295) on the Rights of Indigenous Peoples.

Nordic Swan Ecolabelling is aware that it may be difficult to ensure that the working environment of all suppliers in the Nordic Swan Ecolabelled battery production chain is satisfactory. Nevertheless, Nordic Ecolabelling is convinced that as more component suppliers and battery producers are confronted with the requirement/signal from their customers that compliance with a Code of Conduct is required, the more likely it is to be achieved. Licensees must inform their suppliers about their Code of Conduct. However, the licensee is not required to guarantee that it will be complied with by its suppliers.

If component suppliers and battery producers operate in countries in which these conventions are incorporated as part of the authorities' requirements, no further documentation will be required beyond the signed application form for a licence for Nordic Swan Ecolabelling.

5.4 Packaging and information

Primary packaging: refers to the purchase packaging for the consumer, e.g. the packaging that holds four batteries or one portable charger, and which the consumer encounters in sales.

Secondary packaging: refers to the transport packaging and protects the packs of batteries and portable chargers during transport to stores and consumers.

O8 Packaging

Chlorine-based plastic may not be used in primary and secondary product packaging.

The total proportion of post-consumer recycled material in the primary packaging for the batteries must be at least 80% by weight.

[57] http://www.unglobalcompact.org

Post-consumer material is defined in accordance with ISO 14021: "Post-consumer/commercial" is defined as material created by households or commercial, industrial or institutional facilities in the role of end users of a product which can no longer be used for the intended purpose. This includes return of material from the distribution chain.

⌧ Description of the primary and secondary product packaging. Declaration from the licensee or brand owner(s) showing that the requirement is fulfilled. Appendix 4 may be used.

⌧ Documentation from packaging suppliers showing the proportion of post-consumer recycled material in their products.

⌧ Statement from the licensee showing that the total proportion of post-consumer recycled material in the primary packaging exceeds 80% weight. Appendix 4 may be used.

Background to requirement O8

The requirement to packaging has been adjusted to include portable chargers in generation 5 of the criteria.

The environmental impact of PVC is associated primarily with waste management, the use of additives, and dioxin emissions, for example in the production of PVC, plus the use of mercury in the production of chlorine. According to the report on “Hazardous substances in plastic materials”[58] published by the Norwegian Environment Agency in 2013, PVC may have over 50% plasticiser added, of which phthalates remain the most popular, since they are cheap and have solubility parameters that are very similar to the PVC polymer. PVC requires stabilisers to tolerate the temperatures needed to manufacture a PVC product (extrusion, injection moulding, etc). These stabilisers may be based on lead, metal mixtures (such as barium-zinc and calcium-zinc), tin or cadmium.

Overall, the environmental impact associated with the production, use and disposal of PVC is steadily declining, in part due to new knowledge and technical advances. However, there is every suggestion that problems associated with PVC remain. There is also inadequate control of PVC imported into the EU and the Nordic region from other parts of the world, which are not subject to the same restrictions. For Nordic Swan Ecolabelled rechargeable batteries and portable chargers, there is therefore a ban on the use of PVC in the products and their packaging.

Nordic Ecolabelling has reviewed the proportion of recycled materials in the packaging of producers of Nordic Swan Ecolabelled primary/rechargeable batteries and concluded that a figure of 80% for post-consumer recycled material in packaging is an ambitious, but attainable, level. The typical material in packaging is cardboard and PE plastic. An evaluation of primary packaging material used in portable charger banks shows that primarily the same materials as for batteries are used.

The requirement of at least 80% by weight for post-consumer recycled material applies to the total % by weight of the primary packaging.

[58] Norwegian Climate and Pollution Agency, Hazardous substances in plastic materials, Cowi, January 2013.

5.5 Electrical testing

O9 Electrical testing

Nickel-metal hydride (NiMH) batteries and cells:

Battery capacity

The battery capacity must be measured in accordance with paragraph 7.3.1 "Discharge performance at 20°C (rated capacity)" of EN 61951-2. The rated capacity (C) thereby determined must be at least as high as the nominal capacity (N) indicated on the battery and in the product documents.

Durability of the battery

The battery must achieve a minimum of 400 full charge cycles:

Full charge cycles ≥ 400

A full charge cycle is to be understood as the drain of a quantity of electricity (in ampere hours) from the battery to the amount of its nominal capacity (N) that has been stored in the battery by one or more charging processes.

The minimum number of full charge cycles achievable shall be specified in the product documents.

After 400 full charge cycles the battery must, in addition, have in a fully charged state, a remaining capacity (Q_{Rem}) of at least 80% of the nominal capacity (N):

$Q_{Rem} \geq 80\% * N$

Leakage

During testing, no leakage may occur.

The requirements concerning test laboratories and test instructions for full charge cycles are stated in Appendix 5.

Li-ion/LiP batteries and cells:

Battery capacity

The battery capacity must be measured in accordance with paragraph 7.3.1 "Discharge performance at 20°C (rated capacity)" of EN 61960-3. The rated capacity (C) thus determined must be at least as high as the nominal capacity (N) indicated on the battery and in the product documents.

Durability of the battery

The battery must achieve a minimum of 500 full charge cycles:

Full charge cycles ≥ 500

A full charge cycle is to be understood as the drain of a quantity of electricity (in ampere hours) from the battery to the amount of its nominal capacity (N) that has been stored in the battery by one or more charging processes.

The minimum number of full charge cycles achievable shall be specified in the product documents.

After 500 full charge cycles the battery must, in addition, have in a fully charged state, a remaining capacity (Q_{Rem}) of at least 90% of the nominal capacity (N):

$Q_{Rem} \geq 90\% * N$

Leakage

During testing, no leakage may occur.

The requirements concerning test laboratories and test instructions for full charge cycles are stated in Appendix 5.

☒ Complete test report, including information that no leakage has occurred during testing.
☒ Documentation showing that the test laboratory fulfil the requirement stated in Appendix 5.

Background to requirement O9

The requirement of electrical testing has been adjusted in generation 5 of the criteria, and a new requirement of leakage during testing has been added to the requirement.

The RPS analysis shows that the use phase is very important in an LCA perspective. A short-lived use stage for batteries results in a higher environmental impact. The lifespan of rechargeable batteries is significantly prolonged, since they can be used repeatedly – due to numerous charging and discharging cycles. This results in potential resource savings and decreasing waste, especially when compared with primary batteries[59].

The battery capacity is equivalent to the quantity of electricity (in ampere hours, Ah) declared by the manufacturer of the battery. Ah is the discharge current a battery can deliver over time.

The requirement of battery capacity for both NiMH batteries and Li-ion/LiP batteries is unchanged compared to the generation 4 criteria. Capacity testing is performed in order to ensure that the capacity of the batteries/cells corresponds to the actual discharge ability of fresh batteries/cells. The battery capacity for NiMH batteries shall be measured in accordance with paragraph 7.3.1 "Discharge performance at 20°C (rated capacity)" of EN 61951-2. The battery capacity for Li-ion/LiP batteries shall be measured in accordance with paragraph 7.3.1 "Discharge performance at 20°C (rated capacity)" of EN 61960-3. For all batteries/cells the rated capacity (C) thus determined must be at least as high as the nominal capacity (N) indicated on the battery and in the product documents.

Durability of the battery

Life cycle testing is performed in order to ensure that the batteries/cells have an appropriate number of charge/discharge cycles, offering an acceptable level of performance. There is a strong connection between the number of charge-discharge cycles and energy_consumption, since shorter cycles lead to uncertainty concerning energy consumption during the use phase, thereby generating a greater impact on the battery. The improved cycle_performance is the way to reduce the environmental impact[60].

The requirement of the durability of the NiMH battery has been adjusted to the same requirement level in the Koran Eco-label standard (EL764:2012) for batteries[61]. The test instructions for full charge cycles in general follow the EN 61951-2 standard, but several requirement limits have been adjusted.

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[59] Yu, Y., Chen, B., Huang, K., Wang, X., & Wang, D. (2014). Environmental Impact Assessment and End-of-Life Treatment Policy Analysis for Li-Ion Batteries and Ni-MH Batteries. International Journal of Environmental Research and Public Health.
[60] Yu, Y., Chen, B., Huang, K., Wang, X., & Wang, D. (2014). Environmental Impact Assessment and End-of-Life Treatment Policy Analysis for Li-Ion Batteries and Ni-MH Batteries. International Journal of Environmental Research and Public Health.
[61] http://el.keiti.re.kr/enservice/enindex.do (visited 6/11-2017).

The NiMH battery must achieve a minimum of 400 full charge cycles. During the test cycle, the quantities of electricity delivered (Q_i) must not fall below 75% of the original nominal capacity (N). After 400 full charge cycles, the battery must, in addition, in fully charged state have a remaining capacity (Q_{Rem}) of at least 80% of the nominal capacity (N).

The current criteria document (gen. 4) does not have an absolute requirement for remaining capacity (Q_{Rem}), but sets requirements for a specific number of charge cycles (between 300-500 cycles) within a specific period of 4 hours for different types of batteries. According to the consultant who helped to develop the requirement, 400 cycles within 4 hours correspond to 80% remaining capacity. This means that the requirement of the durability of NiMH batteries is generally at the same level as in today's criteria, generation 4. However, the requirement that the quantities of electricity delivered (Q_i) during the test cycle may not fall below 75% of the original nominal capacity (N) is a stringent version of the requirement.

The requirement of the durability of the Li-ion/LiP battery has been adjusted to the same requirement level as in the Blue Angel's criteria for mobile phones (RAL-UZ 106)[62]. The Lithium battery must achieve a minimum of 500 full charge cycles. During the test cycle, the quantities of electricity delivered (Q_i) must not fall below 75% of the original nominal capacity (N). After 500 full charge cycles the battery must, in addition, in a fully charged state have a remaining capacity (Q_{Rem}) of at least 90% of the nominal capacity (N).

In the current criteria document (gen. 4), the requirement of remaining capacity for lithium batteries corresponds to 80%. This means that the requirement of the durability of Li-ion batteries has been tightened to 90%.

A new requirement has been added that no leakage may occur doing testing. This requirement is the same as in the Koran Eco-label standard (EL764:2012) for batteries[63]. The requirement must ensure that the batteries meet high safety and quality requirements.

O10 Charged battery

The battery must be fully charged when it leaves the production site.

✉ A declaration confirming that the battery is fully charged when leaving the production site for delivery to customers/brand owners. Appendix 1 may be used.

Background to requirement 010

The new requirement for fully charged batteries supports the trend in the market towards fully charged batteries (when purchased in the store), which are thereby ready to be used when taken out of the packaging. One of the reasons for the consumer's purchase of primary batteries is that these are ready for use right away. This requirement ensures that consumers have the same experience when purchasing rechargeable batteries.

[62] https://www.blauer-engel.de/en/products/home-living/mobiltelefone-135 (visited 6/11-2017).
[63] http://el.keiti.re.kr/enservice/enindex.do (visited 6/11-2017).

5.6 Safety

O11 Battery safety

The requirement applies to both batteries and batteries used in portable chargers.

NiMH batteries/cells:

The battery must fulfil the testing requirements in EN 62133-1.

Lithium-ion/lithium polymer batteries/cells:

The batteries must fulfil the testing requirements in EN 62133-2.

The requirements concerning test laboratories are stated in Appendix 5.

☒ Complete test report.
☒ Documentation showing that the test laboratory fulfil the requirement stated in Appendix 5.

Background to requirement O11

Batteries are an essential part of many of today's high-technology products. Together with the continuous development of battery technology and the increasing perfecting of manufacturing techniques, batteries are used more widely as a “green power” enabler for all kinds of applications, whether they are high-performance Lithium-ion (Li-ion) or the more conventional nickel metal hydride cell (NiMH). This is a new requirement in generation 5 of the criteria.

The use of Lithium-ion batteries/cells (Li-ion/Li polymer) has grown exponentially in recent years, see chapter 2. While Li-ion and NiMH batteries are widely used in consumer electronics, many users are not aware that these batteries are considered to be hazardous, especially due to the risk of overheating, fire and short circuiting.

When a Li-ion battery is being charged or is charging another device, it can overheat and cause a fire hazard. This is referred to as thermal runaway. Even when not in use or being charged, the battery’s internal temperature may rise, yielding destructive and dangerous results. The fires that result from these batteries are difficult to extinguish. Even when the number of batteries in use is compared to a relatively low failure rate, the degree of danger presented by a failure is the reason for strict standards and regulations. Well-publicised incidents have resulted in numerous product safety recalls[64]. The main hazards for both NiMH batteries and Li-ion batteries:

- Explosion
- Fire
- Overheating and fire danger

Primary causes:

- Improper charging
- Improper use
- Overheating
- Electrical abuse
  - Over-current
  - Over-voltage
  - Over-temperature

[64] http://www.rechargebatteries.org/knowledge-base/batteries/lithium-ion-cell-lilon/ (visited 10/10-2017).

- Other abuses
  - Internal short-circuiting
  - Transportation
  - Miscellaneous

The batteries must fulfil the testing requirements in EN 62133: “Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications – Part 1 regarding Nickel systems and Part 2: Lithium systems”, as amended.

O12 Portable charger safety

Portable chargers (power banks) must be tested and comply with IEC 60950-1:2005+A1:2009+A2:2013 (*Information technology equipment – Safety – Part 1: General requirements).*

The requirements concerning testing laboratories are stated in Appendix 5.

✉ Complete test report.
✉ Documentation showing that the test laboratory fulfil the requirement stated in Appendix 5.

Background to requirement O12

This is a new requirement in generation 5 of the criteria. Besides safety requirements for the battery itself listed in requirement O10, the portable charger must be tested and comply with IEC 60950-1:2005+A1:2009+A2:2013 (Information technology equipment – Safety – Part 1: General requirements). The standard ensures that the portable charger is tested in order to reduce the risk of injury or damage due to the following: electric shock, energy-related hazards, fire, heat-related hazards, mechanical hazards, radiation and chemical hazards.

O13 Quality of the battery charger

If the rechargeable batteries are sold together with a charger, the charger must fulfil the following requirements:

Testing of the charger: the quality of the charger must be tested by a testing laboratory that is impartial and fulfils the general requirements applicable to the test institutions provided for in the “Analysis laboratory/test institution” chapter in appendix 5.

C = The maximum capacity (expressed as mAh) specified on the batteries that the charger is sold with.

The reference charge is defined as a constant charge at 1C, cut off at $-\Delta V = 5$ mV/cell.

Discharge to the cut-off requirement of 1 V/cell.

The resting time is set at 20 minutes between each cycle of charge/discharge and discharge/charge.

Condition of battery and termination of charged capacity at 7 cycles:

Cycle 1	Residual Discharge	C/5
Cycle 2-5	Conditioning	1C
Cycle 6	Determining reference charge	1C
Cycle 7	Charging of battery in charger	

Cycles 1-6 to be performed in equipment for testing rechargeable batteries.

The charging phase is registered in cycles 6 and 7 to determine the charged capacity for the reference charger and the test charger.

After 7 cycles the average trickle charge and no-load current for the charger are measured.

The measurement must produce the following results:

- The charger must automatically stop charging when the battery is fully charged. Fully charged is defined as a reference charge with a cut-off of –ΔV = 5 mV + 10%.
- The maximum trickle charge current must on average be < C/20, based on the lowest battery capacity that the charger is recommended to charge by the dealer.
- The maximum no-load current must on average be < C/50, based on the lowest battery capacity that the charger is recommended to charge by the dealer.

The requirements concerning test laboratories are stated in Appendix 5.

☒ Complete test report.
☒ Documentation showing that the test laboratory fulfil the requirement stated in Appendix 5.

Background to requirement O13

The requirement of the quality of the battery charger remains unchanged in generation 5 of the criteria.

The charger is a supplementary product to the main product, i.e. the rechargeable batteries. Battery producers purchase chargers from subcontractors, which limits their ability to manage, control or maintain an overview of the design and quality of the chargers. Even so, they should have scope to impose requirements concerning the charger if it is to be sold in a combination pack with the rechargeable batteries. There are considerable differences in quality between chargers and, accordingly, in the amount of current they use and the amount of wear they cause for the batteries during charging[65].

A study of 40 different battery chargers on sale in the Nordic market found major differences in the energy consumption of the individual chargers[66]. This affects not only the environmental impact of the charger itself, but also the environmental profile of the rechargeable batteries, since this will be linked to the properties of the charger.

O14 Consumer information on the battery and portable charger

Battery:

The battery (or battery pack) must be marked in accordance with EN 61951-2 (NiMH) or EN 61960 (Lithium).

The batteries must carry a clear indication of their capacity, in accordance with the requirements applicable to capacity labelling provided for in the EU's Battery Directive 2006/66/EC and regulation (EU) 1103/2010 on the capacity marking of portable rechargeable batteries.

[65] Forbrukerrapporten 07/2004.
[66] Henrik V Ebne, Forbrugerrapporten 07/2004 "Plugg og lad".

"Clear indication" means that the capacity labelling shall be expressed in terms of a unit (mAh) and that other numerical markings on the battery must not be such that the customer is likely to be misled into thinking that they represent the capacity labelling.

In addition, the battery (or battery pack) must be marked with an international recycling symbol, as given in ISO 7000 (graphical symbols for use on equipment), and specify the cell chemistry of the battery (e.g. Li-ion, Ni-MH). This symbol must be colour-coded in accordance with the recommendations of the Battery Association of Japan[67] or the draft IEC 62902 standard (Secondary batteries: Marking symbols for identification of their chemistry):

Portable charger:

Portable chargers must be supplied with the following safety information:

a) Minimum instructions for use as specified below:
   - The portable charger (power bank) will generate heat when charging. Always charge in a well-ventilated area. Do not charge under pillows, blankets or on flammable surfaces.
   - Keep the portable charger away from heat sources, direct sunlight, combustible gas, humidity, water or other liquids.
   - Do not dismantle, open, microwave, incinerate, paint or insert foreign objects into the portable charger.
   - Do not subject the power bank to mechanical shock such as crushing, bending, puncturing or shredding. Avoid dropping or placing heavy objects on the portable charger.
   - Do not short-circuit the portable charger or store it in a receptacle where it may be short-circuited by other metallic or conductive objects.
   - Do not operate the portable charger if it has been wet or otherwise damaged, so as to avoid electric shock, explosion and/or injury. Contact the dealer or authorised agent.
   - Portable charger usage by children should be supervised.
   - Please read the operating instructions (including charging instructions and information on the minimum and maximum operating temperatures) supplied with this portable charger.

b) Instructions on how to charge the portable charger.

c) Information on the minimum and maximum operating temperatures for the portable charger.

[67] Battery Association of Japan, Recycling portable rechargeable batteries, http://www.baj.or.jp/e/recycle/recycle04.html (visited 24-11-2017).

☒ A sample of the information provided on the battery.
☒ A sample of the safety information supplied with the portable charger.

Background to requirement O14

The requirement to consumer information/marking on batteries has been adjusted in generation 5 of the criteria. Batteries (or battery packs) must be marked in accordance with EN 61951-2 (NiMH) or EN 61960 (Lithium) and a recycling symbol as given in ISO 7000. There are also new requirements for the information on portable chargers (power banks).

Both the EN 61951-2 (NiMH) and EN 61960 (Lithium) standards specify minimum information requirements for the battery, such as; rated capacity, nominal voltage, date on manufacture, etc. With this new requirement, Nordic Swan Ecolabelling ensures that the batteries are marked with relevant and accepted information for consumers. The new requirement to mark batteries with an international recycling symbol, as given in ISO 7000, helps to identify the type of battery and thereby recycle the battery. This requirement is identical to the requirements in the Blue Angel Eco-Label criteria for mobile phones (RAL-UZ-106) 2017[68].

The EU's Battery Directive 2006/66/EC provides for rechargeable batteries to be labelled with their capacity in mAh. Regulation (EU) 1103/2010 governs the capacity-marking requirements for portable rechargeable batteries, including specific requirements related to their minimum size and location. The capacity label must include both the numeral and its units. The capacity label is a marking that must appear on either the battery label, the battery casing and/or the packaging.

However, the Sagentia Catella Report[69] notes that there are examples of this labelling "drowning" in other numerical values specified on the battery, which might be misinterpreted as representing the capacity of the battery. By imposing the requirement that the capacity must be clearly marked, Nordic Ecolabelling is seeking to ensure that the customer receives thorough information enabling him or her to purchase the right type of battery for their needs.

As written under requirements O10 and O11 (battery and portable charger safety) portable chargers are considered to be hazardous, due to the risk of overheating, fire and short-circuiting. Nordic Swan Ecolabel has therefore listed some minimum consumer safety instructions/information requirements that must be provided together with the portable charger. There is a strong connection between the Depth of Discharge (DoD) and the battery capacity retention of a Li-ion battery: deep DoD results in a shorter lifespan. Moreover, if the battery is constantly influenced by high voltage and temperature changes, this will enhance the degradation processes and aging. By following the basic recommendations for battery charging and the conditions for its use, it is possible to preserve the initial battery capacity, thereby extending the battery lifespan and product integrity.

[68] https://www.blauer-engel.de/en/products/home-living/mobile-phones (visited 10-11-2017).
[69] Annika Ahlberg Tidblad, Sagentia Catella, 11 July 2008, "Nordic Ecolabelling criteria for rechargeable batteries".

O15 Recyclable design of the portable charger

The portable charger must be designed in such a way that dismantling is possible. The requirement consists of the following individual requirements:

- A qualified professional, working alone, must be able to dismantle the product.
- It must be possible to separate the substances, preparations and components listed in ANNEX VII of the WEEE Directive (2012/19/EU).
- It must be possible to remove the secondary batteries/cells for recycling purposes.
- The battery/cell chemicals must be prevented from leaking during the removal.

✉ Declaration from the manufacturer of the portable charger showing that the requirements are met. Appendix 2 may be used.

Background to requirement O15

This is a new requirement in generation 5 of the criteria. Besides safety and consumer information requirements for the portable charger itself listed in requirements O12 and O14, the portable charger must be designed to make recycling easier.

As stated under O12 and O14, portable chargers are considered to be hazardous, due to the risk of overheating, fire and short-circuiting. Therefore, portable chargers are not recommended to be dismantled or opened by the consumer (O14). In a life cycle perspective, however, it is essential to recycle the batteries and other materials in the product.

According to the Battery Directive (2006/66/EC), article 11, it should be possible, when needed, to remove batteries from appliances without delay or difficulty, and at a reasonable cost, using the instructions provided. Article 11 solely applies to electrical or electronic equipment (EEE), as defined by Article 3(11) of the Battery Directive (2006/66/EC), i.e. any EEE as defined by Directive 2012/19/EU (WEEE Directive). Portable chargers are part of the WEEE Directive.

Article 11 of the Directive, as amended in 2013, contains a number of requirements in this respect. Its main objective is to ensure the removal of waste batteries and accumulators, thereby facilitating their recycling, and, by replacing them, extending the lifetime of the appliances in which they are used. This means that it should be possible to remove them without delay or difficulty and at a reasonable cost, when needed, using the instructions provided. If batteries or accumulators cannot be readily removed by end-users, it should always be possible to have them removed by “qualified professionals” (e.g. electronic repair shops or services) “independent of the manufacturer”.

The qualified professionals should be able to remove the batteries/cells from the portable charger without the risk of exposure to chemicals in the batteries/cells. Therefore, the battery and portable charger must be designed so as to ensure that there is no leakage from the battery/cell when removed.

The manufacturer of the portable charger must declare that the requirements are met.

5.7 Requirements of the authorities and quality requirements

To ensure that Nordic Ecolabelling requirements are fulfilled, the following procedures must be implemented.

O16 Responsible person and organisation

The company shall appoint individuals who are responsible for ensuring the fulfilment of the Nordic Ecolabelling requirements, for marketing and for finance, as well as a contact person for communication with Nordic Ecolabelling.

✉ Organisational chart showing who is responsible for the above.

O17 Documentation

The licensee must archive the documentation that is sent in with the application, or in a similar way maintain information in the Nordic Ecolabelling data system.

🔍 To be checked on site as necessary.

O18 Quality of rechargeable batteries and portable charger

The licensee must guarantee that the quality of the Nordic Swan Ecolabelled product does not deteriorate during the term of validity of the licence.

✉ Procedures for archiving claims and, where necessary, dealing with claims and complaints regarding the quality of the Nordic Swan Ecolabelled rechargeable batteries and portable chargers.

🔍 The claims archive is checked on site.

O19 Planned changes

Written notice must be given to Nordic Ecolabelling of planned changes in products and markets that have a bearing on Nordic Ecolabelling requirements.

✉ Procedures detailing how planned changes in products and markets are handled.

O20 Unplanned nonconformities

Unplanned nonconformities that have a bearing on Nordic Ecolabelling requirements must be reported to Nordic Ecolabelling in writing and journalised.

✉ Procedures detailing how unplanned nonconformities are handled.

O21 Traceability

The licensee must be able to trace the Nordic Swan Ecolabelled rechargeable batteries and portable chargers in production.

✉ Description of/procedures for the fulfilment of the requirement.

O22 Legislation and regulations

The licensee shall ensure compliance with all applicable local laws and provisions at all production facilities for the Nordic Swan Ecolabelled product, e.g. with regard to safety, the working environment, environmental legislation and site-specific terms/permits.

✉ Duly signed application form.

Background to the requirements

Requirements O16 to O22 are general quality assurance requirements to ensure that the Nordic Swan Ecolabelled products fulfil the requirements and comply with legislation and regulations, so that the products maintain the environmental quality which is the purpose of the requirements. Most of these requirements are general and apply to all production of ecolabelled products. Individual requirements are not justified in greater detail here.

5.8 Areas without requirements

The following proposal for requirements was discussed and analysed during the review process. However, for the reasons explained below, Nordic Ecolabelling has decided that it will not be included in the criteria generation 5.

Nanotechnology

In the current criteria, generation 4, it is a requirement that nanoparticles may only be present in the electrodes (anode/cathode material) for the purpose of increasing the energy efficiency of the batteries. If nanoparticles are used in the batteries, the producer must publish information on how batteries containing nanoparticles are to be handled by battery recycling firms. This requirement is removed in the new generation 5.

An evaluation of the requirement concerning nanoparticles shows that the documentation of the requirement is very unclear. It is not described how the manufacturer should test potential increased capacity. General experience from dialogue/working with applications suggests that lithium batteries mix nanomaterials (from tests) into the electrolyte, which causes the nanoparticles to bind into the battery, and they are thus not released. In this case the requirement to publish information on nanoparticles for recycling is not relevant.

A review of Nordic Swan Ecolabelled licences and dialogue with other producers of batteries shows that nano is only potentially relevant for the production of electrodes in lithium batteries, not NiHM batteries. Nobody uses nanotechnology in their batteries today, primarily due to lack of technology development and the price. An LCA study[70] from 2013 concludes "that despite progress in research on and development of a single-walled carbon nanotube (SWCNT) anode technology and other nanomaterials, aimed to greatly expand the horizon of Li-ion battery energy, the energy intensity of SWCNT manufacturing process itself is too high, and usually diminishes the value of achieved improvement due to associated costs".

UPS systems

Nordic Swan Ecolabelling examined the possibility of involving uninterruptible power supply (UPS) systems in the product definition in generation 5 of the criteria. An UPS is a device that allows a computer to keep running for at least a short time when the primary power source is lost. A UPS contains a battery that "kicks in" when the device senses a loss of power from the primary source. The most common battery used today in UPS systems is lead batteries, but the trend is towards the use of Li-ion batteries.

[70] Amarakoon, S., Smith, J., & Segal, B. (2013): Application of LCA to Nanoscale Technology: Li-ion Batteries for Electric Vehicles. The U.S. Environmental Protection Agency's (EPA) Design for the Environment (DfE) Program.

UPS systems are not part of the European Union's Battery Directive 2006/66/EC, given that they are not portable. UPS comes with several technologies and therefore also consists of several electrical components. On this basis, Nordic Swan Ecolabelling has decided not to include UPS systems in this criteria document.

6 Changes compared to the previous version

The following are the key amendments compared with the previous generation 4.

Proposed requirement generation 5	Requirement generation 4	Same requirement	Change	New requirement	Comment
Products that may be Nordic Swan Ecolabelled	Products that may be Nordic Swan Ecolabelled		*		The product definition has been expanded to include portable chargers.
O1			*		Description of the product has been adjusted to include portable chargers. New requirement stating that batteries must be fully charged when they leave the production site.
O2			*		The limited content of arsenic has been removed.
O3	O5		*		The requirement for plastic in the casing in battery chargers has been adjusted to also include metals and casing in portable chargers.
O4	O6	*			Battery charger, battery sizes.
O5				*	New requirement: sourcing of conflict-free minerals.
O6				*	New requirement: sourcing of critical raw materials.
O7	O11		*		The requirement concerning working conditions has been amended slightly to also include the UN convention (art 32) and declaration (61/295).
O8	O7 and O8	*			The requirements for packaging have been merged into one requirement.
O9	O12		*		The requirement for electrical testing of the capacity and durability of the battery has been adjusted regarding numbers of charged cycles and % remaining capacity. New requirement: during testing, no leakage may occur.

O10				*	New requirement: the battery must be fully charged when it leaves the production site.
O11				*	Battery safety NiMH must comply with EN 62133-1 and Li-ion with EN 62133-2.
O12				*	Portable charger safety Portable chargers must comply with IEC 60950-1:2005+A1:2009+A2:2013 part 1.
O13	O13	*			Quality of the battery charger.
O14	O10		*		Batteries must now be marked in accordance with EN61951-2, EN61960 and recycling symbols as given in ISO 7000. New safety information requirements for portable chargers.
O15				*	New requirement. The portable charger must be designed in such a way that dismantling is possible.
O16-O22	O14-21	*			Quality and official requirements.
Removed requirements					
	O3				Nanotechnology.
	O4				Information on batteries containing nanoparticles.
	O9				Collection systems for packaging and batteries.

History of the criteria

Nordic Ecolabelling adopted version 5.0 of the criteria for rechargeable batteries and portable chargers on DAY MONTH YEAR. The criteria are valid until DAY MONTH YEAR.

New criteria

As part of any future evaluation of the criteria, it will be relevant to consider the following:

- The product definition – new types of rechargeable batteries.
- The possibility of imposing further requirements on constituent substances, particularly heavy metals and the use of solvents in the production of batteries.
- The possibility of imposing requirements concerning the sourcing of conflict-free minerals and critical raw materials.
- Requirements for electrical testing – battery capacity, durability of the battery and portable charger.
- Requirements concerning safety.

Terms and definitions

Term	Explanation or definition
AC input	Direct integrated plug to the power outlet. Designed for “stationary” charging and therefore not portable.
DC output	Direct current (DC) is the unidirectional flow of an electrical charge. A battery is a good example of a DC power supply.
DoD	Depth of Discharge.
EEE	Electrical and Electronic Equipment.
Li-ion	Lithium-ion.
mAh or Ah	Milliamp hours or amp hours: the amount of power expected over time. The higher the number, the greater the capacity. This is the electrical charge (current) that passes through a specific circuit in one hour.
NiMH	Nickel-metal hydride battery.
OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas	For more information: http://www.oecd.org/corporate/mne/mining.htm
PCB	Printed circuit board.
Primary packaging	Refers to the purchase packaging for the consumer, e.g. the packaging that holds 4 batteries or one portable charger, and what the consumer encounters in sales.
Secondary packaging	Refers to the transport packaging and protects the packs of batteries and portable chargers during transport to stores and consumers.
SLI batteries	Batteries used for vehicle starting, lighting and ignition systems.
SWCNT	Single-walled carbon nanotube.
UPS	Uninterruptible power supply (UPS) systems.
USB ports	A USB port is a standard cable connection interface for e.g. personal computers and consumer electronics devices. They can also supply electric power across the cable to devices that require it.
WEEE	Waste Electrical and Electronic Equipment.
Wh-Watt hours	A measure of electrical energy equivalent to power consumption of one watt for one hour. A simple way to determine the current delivered by the power bank is to divide the watts by the voltage rating of the device. Electrical power is measured in watts and power equals the voltage multiplied by the current (amp).

Appendix 1 European legislation

Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE) was recast on 24 July 2012 as Directive 2012/19/EU[71]

The Directive implements the principle of "extended producer responsibility" whereby electrical and electronic product manufacturers are responsible for the costs of collection, treatment, recovery and disposal of their own products, and hence for preventing such object products from entering municipal waste collection systems.

Furthermore, the Directive states that member states should encourage the design and production of electrical and electronic equipment that facilitates reuse, recycling and other forms of recovery of such waste in order to reduce it. Producers should not, through specific design features or manufacturing processes, prevent WEEE from being reused, unless such specific design features or manufacturing processes present overriding advantages, for example with regard to the protection of the environment and/or safety requirements.

The WEEE Directive applies to all electrical and electronic equipment, as listed in the categories below, which is dependent on electrical current or electromagnetic fields in order to work properly, and equipment for the generation, transfer and measurement of such currents and fields, designed for use with a voltage rating not exceeding 1000V for AC and 1500V for DC, provided that the equipment concerned is not part of another type of equipment that does not fall within the scope of the Directive (Annex I (covering the period from 14 August 2012 to 14 August 2018, of the WEEE Directive)):

- Large household appliances
- Small household appliances
- IT and telecommunications equipment
- Consumer equipment
- Lighting equipment
- Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
- Toys, leisure and sports equipment
- Medical devices (with the exception of all implanted and infected products)
- Monitoring and control instruments
- Automatic dispensers

From 15 August 2018, the WEEE Directive will apply to products covered by the categories outlined in Annex III of the Directive:

- Temperature exchange equipment
- Screens, monitors, and equipment containing screens having a surface greater than 100 cm^2
- Lamps

[71] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:197:0038:0071:en:PDF

- Large equipment (any external dimension greater than 50 cm), including, but not limited to:

  Household appliances; IT and telecommunication equipment; consumer equipment; luminaires; equipment reproducing sound or images, musical equipment; electrical and electronic tools; toys, leisure and sports equipment; medical devices; monitoring and control instruments; automatic dispensers; equipment for the generation of electrical currents. This category does not include equipment included in categories 1 to 3.

- Small equipment (no external dimension greater than 50 cm), including, but not limited to:

  Household appliances; consumer equipment; luminaires; equipment reproducing sound or images, musical equipment; electrical and electronic tools; toys, leisure and sports equipment; medical devices; monitoring and control instruments; automatic dispensers; equipment for the generation of electric currents. This category does not include the equipment included in categories 1 to 3 and 6.

- Small IT and telecommunication equipment (no external dimension greater than 50 cm).

Directive 2002/95/EC on Restrictions of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment[72] (RoHS)

This Directive restricts the use of hazardous substances in electrical and electronic equipment, for the protection of human health. As from 1 July 2006, new products should not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs)[73]. This Directive covers electrical and electronic equipment as defined in the WEEE Directive. There are exemptions for some of these materials when used in certain products.

Batteries used within portable chargers are classed as hazardous waste[74].

1.4.1.3 Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators[75]

The Directive aims to reduce the impact on the environment of the manufacture, distribution, use, disposal and recovery of batteries (primary-single use, and secondary battery cells which are rechargeable, accumulators). The Directive introduces measures to prohibit the marketing of some batteries containing hazardous substances. It contains measures for establishing schemes aiming at a high level of collection and recycling of batteries with quantified collection and recycling targets.

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72 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:201:0054:0057:EN:PDF
73 http://ec.europa.eu/environment/waste/rohs_eee/events_rohs1_en.htm
74 http://www.greenit.net/downloads/GreenIT-EnvIssues-Batteries.pdf
75 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:266:0001:0014:en:PDF

The Directive sets out minimum rules for producer responsibility and provisions with regard to the labelling of batteries and their removability from equipment.

The EU Battery Directive is under revision[76]. Continuously. The task is to minimise waste and to maintain material flows within the economy for as long as possible, in order to achieve economic, social and environmental benefits. Of special interest is finding economic and strategic incentives for material recovery. Preliminary Recommendations from the working group so far:

- Definitions of Portable/Automotive/Industrial: no change.
- Definitions of Re-use and Second use: to be added, explaining the impact on Extended Producer Responsibility (EPR) and definition of "producer".
- Placing on the Market (POM) definition/ harmonisation in transposition
- If needed, replace calculation for collection rate by "available for collection".
- Recycling efficiency: no change.
- Reporting (general): keep it simple, harmonise, improve data quality.
- Quality treatment of waste batteries in the event of export: "equivalent conditions" allowing the export of waste batteries as described in a certification scheme.
- Labelling and marking: coordination with the IEC standard is ongoing.

Registration, Evaluation, Authorisation and Restriction of Chemical substances (REACH) Regulation (EC) 1907/2006[77]

The REACH Regulation came into force on 1 June 2007 and deals with the Registration, Evaluation, Authorisation and restriction of Chemical substances. The aim of REACH is to improve the protection of human health and the environment through better and earlier identification of the intrinsic properties of chemical substances. At the same time, REACH aims to enhance the innovation and competitiveness of the EU chemicals industry.

REACH was introduced because many thousands of chemicals are used in the EU, some in very large quantities, but the risks to human health and to the environment from many of these are not widely understood. REACH addresses this by making manufacturers and importers of chemicals responsible for producing data to define the hazards and risks from around 30,000 substances that are manufactured or imported in quantities of one tonne or more per year within the EU[78].

Manufacturers are required to register the details of the properties of their chemical substances on a central database, which is run by the European Chemicals Agency in Helsinki. The Regulation also requires the most dangerous chemicals to be progressively replaced as suitable alternatives are developed.

[76] http://www.prba.org/wp-content/uploads/9.1-EU-Batteries-Directive-Review.pdf (visited 2/5-2017)
77 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=oj:l:2006:396:0001:0849:en:pdf
[78] http://www.element14.com/community/community/legislation/reach?CMP=KNC-EULEGREACH&s_kwcid=TC|21070|reach%20regulation||S||8299726988

Appendix 2 Design and materials used in batteries

Lithium-ion batteries

A Lithium-ion battery can be produced with several different combinations of lithium-based cathode and anode materials. There are a few electrode (anode and cathode) materials that currently dominate battery production. It is common to use a mix of cobalt, nickel and manganese oxides together with the lithium as the cathode, but it is also possible to use an iron phosphate[79]. This is coupled with an anode, most commonly graphite. It is, however, possible to combine the cathodes with other anodes, such as the lithium-based lithium titanate. Table 7 below gives an overview of the most common cathode materials used today, while table 8 contains the anode choices[80].

Table 7: The table presents an overview of the most common battery cathode chemistries and their inherent advantages and disadvantages.

Cathode material	Abbr.	Use	Advantages	Disadvantages
$LiCoO_2$ Lithium cobalt oxide	LCO	Mainly in small-scale electronics	Performance, well understood	Safety, uses nickel and cobalt
$LiNi_{0.33}Mn_{0.33}Co_{0.33}O_2$ Lithium manganese cobalt oxide	NMC (333)	Common in EVs	Better safety and performance than LCO	Cost, nickel and cobalt
$LiFePO_4$ Lithium iron phosphate	LFP	High power option, potential choice for EVs	Excellent power, lifetime and safety, abundant materials	Low energy density
$LiMn_2O_4$ Lithium manganese oxide	LMO	Historically used in EVS, but now less common	Cheap, abundant, high power	Lifetime, low capacity means low energy density
$LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$ Lithium nickel cobalt aluminium oxide	NCA	Used in some EVs	High capacity and voltage, high power	Safety, cost, uses nickel and cobalt

When it comes to anode materials, there are fewer choices. Most common is to use a graphite anode, and this choice is by far the most common anode used in combination with the cathodes in the above table 7. A lithium-based alternative – lithium titanium oxide – is also possible. Table 8 shows the advantages and disadvantages of each type.

Table 8: The table presents an overview of the most common battery anode chemistries and their inherent advantages and disadvantages.

Anode material	Abbr.	Use	Advantages	Disadvantages
Graphite	Gr	Most common choice in EVs	Decent lifetime, well understood, abundant (because synthetic graphite can be used)	Inefficiency due to SEI formation
$Li_4Ti_5O_{12}$ Lithium titanium oxide	LTO	Possible to use in EVs	Excellent power and life cycle	Lower voltage means less energy, cost

[79] https://www.teknologisk.dk/ydelser/videncenter-for-batterier/teknologier/36314,2 (visited 14-11-2017).
[80] Romare M, Dahllhöf L. (2017): The Life Cycle Energy. Consumption and Greenhouse Gas Emissions from Lithium-Ion Batteries. A Study with Focus on Current Technology. IVL Swedish Environmental Research Institute.

Material content of Lithium-ion batteries

The relative weight of different pack components can help to give an understanding of the importance of different parts. Additionally, this can help to identify why the components contribute to the life cycle to different extents. In table 9 below, the typical composition of a pack is presented[81].

Table 9: The typical relative weight of different pack components is shown. The cell contributes a large part of the weight, but the pack supporting material also has an impact because it is often made from steel.

Cell component	Wt% of total battery pack
The active material in the cathode	20%
The active material in the anode	10%
Separator	1-3%
Aluminium substrate (cathode)	2-3%
Copper substrate (anode)	8-13%
Electrolyte	9-12%
Battery management system	3%
Cooling	4%
Packaging	30%

In this case, the packing contains the supporting material in the pack, often made of steel, or possibly aluminium. The choice of material for the casing naturally affects its relative contribution to the weight. The cells are the largest part of the pack and in total, the components in the pack contribute roughly 60% of the entire weight of the battery.

A German test study from 2013[82] which examined around 300 batteries, taken from stores, discovered that Li-ion batteries were in compliance with the EU Battery Directive, since the content of heavy metals was far lower than is allowed. Overall, together with alkaline manganese batteries, they had the lowest content of heavy metals.

Another study from 2013[83] conducted research into three types of Li-ion batteries and their metallic content. The test discovered that the following metals are present in high quantities:

- Aluminium (ranging from 51,800 to 341,000 mg/kg);
- Cobalt (58,000 to 278,000 mg/kg);
- Copper (54,100 to 152,000 mg/kg);
- Lithium (9,800 to 37,200 mg/kg).

[81] Romare M, Dahllhöf L. (2017): The Life Cycle Energy. Consumption and. Greenhouse Gas Emissions from Lithium-Ion Batteries. A Study with Focus on Current Technology. IVL Swedish Environmental Research Institute.
[82] https://www.umweltbundesamt.de/en/press/pressinformation/batteries-put-to-the-test-too-many-heavy-metals (visited May 2015).
[83] Kang, D. H., Chen, M., & Ogunseitan, O. A. (2013). Potential Environmental and Human Health Impacts of Rechargeable Lithium Batteries in Electronic Waste. Environmental Science & Technology.

In overall terms, these four metals represent up to 97% of all metals in the Li-ion battery content: lithium and cobalt are used for the production of cathodes; copper and aluminium – as current conductors. There are also barium, chromium, silver, thallium, vanadium, zinc, and lead, but their content is significantly lower. The analysis did not detect antimony, arsenic, beryllium, cadmium, mercury, molybdenum, and selenium in any of the Li-ion batteries analysed.

The same study also applied the Toxicity Characteristics Leaching Procedure (TCLP) to determine the metal content of discarded Li-ion batteries. The results of the assessments demonstrated:

- For all applied methods, cobalt, copper, and nickel contributed most to the total hazard potential.
- Except only three methods, where cobalt accounted for moderate hazard potential contribution, and it is often a main contributor to the total hazard potential.
- Copper demonstrated a mostly large to medium relative contribution to the total potential across all methods; exception – a minimal contribution to the human toxicity potential (HTP) from emission to water.
- Nickel is not the main contributor to any of the listed categories; but it is a nontrivial contributor to the total potential for all methods: from minimal to medium (the total HTP for the TRACI method), but across all methods.

Based on the simulated landfill situation whereby Co, Cu, Ni, and Pb would leach out in amounts that exceed allowable concentrations, the study demonstrates that this would negatively influence both the environment and human health, especially in regions that do not establish well-functioning waste collection, sorting and recycling infrastructure.

Appendix 3 List of critical raw materials

Raw materials	**Main producers (2010, 2011, 2012) End-of-life recycling input rate****	**Main sources of imports into the EU (mainly 2012)**	**Substitutability index***	**End-of-life recycling input rate****
Antimony (Stibium)	China 86%	China 92% (unwrought and powdered)	0.62	11%
	Bolivia 3%	Vietnam (unwrought and powdered) 3%		
	Tajikistan 3%	Kyrgyzstan 2% (unwrought and powdered); Russia 2% (unwrought and powdered)		
Beryllium	USA 90%	USA, China and Mozambique[84]	0.85	19%
	China 9%			
	Mozambique 1%			
Borates	Turkey 41%	Turkey 98% (natural borates) and 86% (refined borates)	0.88	0%
	USA 33%	USA 6%, Peru 2% (refined borates); Argentina 2% (natural borates)		
Chromium	South Africa 43%	South Africa 80%	0.96	13%
	Kazakhstan 20%	Turkey 16%		
	India 13%	Others 4%		
Cobalt (Cobaltum)	DRC 56% ↑	Russia 96% (cobalt ores, cobalt and concentrates)	0.71	16%
	China 6%; Russia 6%; Zambia 6%	USA 3% (cobalt ores and concentrates)		
Fluorspar (Fluorite)	China 56%	Mexico 48% ↑	0.80	0%
	Mexico 18%	China 13% ↓		
	Mongolia 7%	South Africa 12% ↓		
Gallium[85]	China 69% (refined)	USA 49%	0.60	0%
	Germany 10% (refined)	China 39%		
	Kazakhstan 6% (refined)	Hong Kong 8%		
Germanium	China 59% ↓	China 47% ↓	0.86	0%
	Canada 17%	USA 35%		
	USA 15%	Russia 14%		
Indium	China 58%	China 24% ↓	0.82	0%
	Japan 10%	Hong Kong 19% ↑		
	Korea 10%	Canada 13%		
	Canada 10%	Japan 11%		
Magnesite	China 69%	Turkey 91%	0.72	0%
	Russia 6%; Slovakia 6%	China 8%		

[84] Subject to strong fluctuations.
[85] Gallium is a by-product; the best available data refer to production capacity, not to production as such.

Magnesium	China 86% ↑	China 91% ↓	0.64	14%
	Russia 5%	Israel 5%		
	Israel 4%	Russia 2%		
Natural graphite	China 68%	China 57% ↓	0.72	0%
	India 14%	Brazil 15%		
	Brazil 7%	Norway 9%		
Niobium	Brazil 92%	Brazil 86% (FerroNiobium)	0.69	11%
	Canada 7%	Canada 14% (FerroNiobium)		
Phosphate rock	China 38%	Morocco 33%	0.98	0%
	USA 17%	Algeria 13%		
	Morocco 15%	Russia 11%		
Platinum Group Metals	South Africa 61% ↓	South Africa 32% ↓	0.83	35%
	Russia 27% ↑	USA, 22% ↑		
	Zimbabwe 5%	Russia 19% ↓		
Heavy Rare Earth Elements	China 99%	China 41% (all REEs) Russia 35% (all REEs) USA 17% (all REEs)	0.77	0%
	Australia 1%			
Light Rare Earth Elements	China 87%		0.67	0%
	USA 7%			
	Australia 3%			
Silicon metal (Silicium)	China 56%	Norway 38%	0.81	0%
	Brazil 11%	Brazil 24%		
	USA 8%; Norway 8%	China 8%		
	France 6%	Russia 7%		
Tungsten (Wolframium)	China 85%	Russia 98% ↑	0.70	37%
	Russia 4%	Bolivia 2%		
	Bolivia 2%			

(*) The “Substitutability index” is a measure of the difficulty in substituting the material, scored and weighted across all applications. Values are between 0 and 1, with 1 being the least substitutable.

(**) The “End-of-life recycling input rate” measures the proportion of metal and metal products that are produced from end-of-life scrap and other metal-bearing low-grade residues in end-of-life scrap worldwide.

Appendix 4 Analysis and testing laboratories

Testing of quality specifications must be performed by laboratories, which are accredited to the current standard and fulfil the general requirements in the standard EN ISO/IEC 17025 or have official GLP status. A non-accredited laboratory may perform tests if the laboratory has applied for accreditation according to the current testing method, but has not yet been granted approval, or if accreditation is not available for the technical specification or proposed standard. In such case, the laboratory must prove that it is an independent, competent laboratory.

The manufacturer's analysis laboratory/test procedure may be approved for analysis and testing if:

- Sampling and analysis are monitored by the authorities; or
- The manufacturer's quality assurance system covers analyses and sampling and is certified to ISO 9001; or
- The manufacturer can demonstrate agreement between a first-time test conducted at the manufacturer's own laboratory, and testing carried out in parallel at an independent test institute, and the manufacturer takes samples in accordance with a fixed sampling schedule.

Determination of battery durability for NiMH batteries and cells

Preparation of the test

1. Determination of the rated capacity (C) in accordance with EN 61951-2, paragraph 7.3.2 “Discharge performance at 20°C (rated capacity)” at an ambient temperature of 20 °C.
2. Determination or specification of the nominal capacity (N).
3. Full discharge of the battery to the end-of-discharge voltage.

Performance of the tests

1. The tests must carried out on a minimum of three batteries, in accordance with the sample size specified in EN 61951-2. All three batteries must meet the requirements listed therein.
2. Charge and discharge currents, ambient temperature and the respective periods of rest must be carried out in accordance with 61951-2, paragraph 7.5.1 “Endurance in cycles at a rate of 0.2 I_t A”.

Charge cycle test

The battery must be tested and comply with paragraph 7.5.1 (endurance in cycles) of EN 61951-2.
The charge and discharge process must be repeated (at 1.) at least until the total quantities of electricity delivered (Q_i) reach at least 400 times the amount of the nominal capacity (N):

$$\sum_{i=1}^{n} Q1 \geq 400 * N(Ah)$$

During the test cycle, the quantities of electricity delivered (Q_i) may not fall below 75% of the original nominal capacity (N). Otherwise, the test will be considered to have been failed. The following will thus apply to each cycle i:

$Q_i \geq 75\% * N ; i = \{1, \ldots, n\}$

Determination of remaining capacity

Following performance of the cycle test described above, the battery's remaining capacity (Q_{Rem}) must be determined:

1. Maximum charging of the battery according to the manufacturer's specifications.
2. Period of rest after charge.
3. Discharge of the battery to the end-of-discharge voltage.
4. During discharge: measurement of the quantity of electricity delivered. This quantity of charge recovered is called the remaining capacity (Q_{Rem}).

To comply with the requirements for the award of the Nordic Swan Ecolabel the remaining capacity (Q_{Rem}) thus measured must be at least 80% of the original nominal capacity (N):

$Q_{Rem} \geq 80\% * N.$

Compliance with this requirement will also be a prerequisite for determining the number of full charge cycles, as described below.

Determination of the number of full charge cycles

To determine the number of full charge cycles, the remaining capacity (Q_{Rem}) after the cycle test described above must be at least 80% of the original nominal capacity (N) (see the preceding condition). The number of full charge cycles shall be calculated as the quotient of the total quantities of electricity delivered, as achieved in the cycle test (Q_i), and the nominal capacity:

$$\text{Full charge cycles} = \frac{\sum_{i=1}^{n} Qi}{N}$$

Simplified calculation rule

If the number of charge cycles that can be reached by the battery has been performed using a cycle test according to EN 61951-2 paragraph 7.5 (Endurance in Cycles), or a comparable method providing for a cyclic maximum charging of the battery and the discharge of the battery to the end-of-discharge voltage, a simplified calculation method can be used to calculate the number of full charge cycles. In this case too, the method can only be used if, following performance of the cycle test, the remaining capacity (Q_{Rem}) amounts to at least 80% of the original nominal capacity (N).

The number of full charge cycles can be calculated in a simplified way by multiplying the number of charge cycles achieved by the cycle test by the quotient of the average quantity of electricity delivered ($Q_{i\_average}$) and nominal capacity (N):

$$Full\ charge\ cycles = Charge\ cycles * \frac{Qi\_average}{N}$$

Determination of battery durability for Li-ion/LiP batteries and cells

The following definitions are used to determine battery durability:

Rated capacity (C): quantity of electricity (in ampere hours) declared by the manufacturer of the cells which a single cell or composite cell can deliver during a 5-hour period when charged, stored and discharged according to the conditions specified in paragraph 7.3.1 of EN 61960-3.

Nominal capacity (N): quantity of electricity (in ampere hours), as declared by the manufacturer of the battery or battery pack on the battery and in the product documents, that is stored in the battery and can be delivered by it at a discharge current specified by the manufacturer. The nominal capacity normally equals the rated capacity. The manufacturer may, however, give a value lower than the rated capacity.

Remaining capacity (Q_{Rem}): the quantity of electricity that can be withdrawn from the charged battery ("Full Charge Capacity" according to Battery System Specifications) after performing the charge cycle test for determination of the number of achievable full charge cycles (see below). The remaining capacity decreases due to cyclisation of the battery.

Charge cycle: based on the EN 61960-3 standard, a charge cycle means the charging of a battery according to the manufacturer's specifications, and the subsequent discharge to the end-of-discharge voltage.

Full charge cycle: a full charge cycle means the charging of a battery and the withdrawal of a quantity of electricity (in ampere hours) from the amount of its nominal capacity (N). The difference between a full charge cycle and the charge cycle under EN 61960-3 is that a charge cycle is not defined by reaching the end-of-discharge voltage, but by the quantity of energy withdrawn, which is specified by the nominal capacity (N). A full charge cycle can require more (or less) than one charge cycle.

Preparation of the test

1. Determination of the rated capacity (C) in accordance with EN 61960-3, paragraph 7.3.1 "Discharge performance at 20°C (rated capacity)" at an ambient temperature of 20°C.
2. Determination or specification of the nominal capacity (N).
3. Full discharge of the battery to the end-of-discharge voltage.

Performance of the tests

1. The tests must be performed on a minimum of three batteries in accordance with the sample size specified in EN 61960-3. All three batteries must meet the requirements listed therein.

2. Charge and discharge currents, ambient temperature and the respective periods of rest must be carried out in accordance with EN 61960-3, paragraph „7.6.2 "Endurance in cycles at a rate of 0.2 I_t A".

Charge cycle test

1. Charging of the battery:
2. Period of rest after charge:
3. Discharging of the battery:
4. During discharge: measurement of the quantity of electricity delivered (Q_i).
5. Period of rest after discharge.

The charge and discharge process must be repeated (at 1.) at least until the total quantities of electricity delivered (Q_i) reach at least 500 times the amount of the nominal capacity (N):

$$\sum_{i=1}^{n} Q_i \geq 500 * N \ [Ah]$$

During the test cycle the quantities of electricity delivered (Q_i) may not fall below 75% of the original nominal capacity (N). Otherwise, the test will be considered to have been failed. This means that the following will apply to each cycle i:

$Q_i \geq 75\% * N ; i = \{1, \ldots, n\}$

Determination of the remaining capacity
Following the performance of the cycle test described above, the battery's remaining capacity (Q_{Rem}) must be determined:

5. Maximum charging of the battery according to the manufacturer's specifications.
6. Period of rest after charge.
7. Discharge of the battery to the end-of-discharge voltage.
8. During discharge: measurement of the quantity of electricity delivered. This quantity of charge recovered is called the remaining capacity (Q_{Rem}).

For compliance with the requirements for awarding of the Nordic Swan Ecolabel, the remaining capacity (Q_{Rem}) thus measured must be at least 90% of the original nominal capacity (N):

$Q_{Rem} \geq 90\% * N$.

Compliance with this requirement will also be a prerequisite for determining the number of full charge cycles, as described below.

Determination of the number of full charge cycles

To determine the number of full charge cycles, the remaining capacity (Q_{Rem}) after the cycle test described above must be at least 90% of the original nominal capacity (N) (see the preceding condition). The number of full charge cycles must shall be calculated as the quotient of the total quantities of electricity delivered that has been achieved in the cycle test (Q_i), and the nominal capacity:

$$\text{Full charge cycles}=\frac{\sum_{i=1}^{n} Qi}{N}$$

Simplified calculation rule

If the number of charge cycles that can be achieved by the battery has been performed using a cycle test according to EN 61960-3 paragraph 7.6 (Endurance in Cycles), or a comparable method providing for a cyclic maximum charging of the battery and the discharge of the battery to the end-of-discharge voltage, a simplified calculation method can be used to calculate the number of full charge cycles. In this case too, the method can only be used if, following performance of the cycle test, the remaining capacity (Q_{Rem}) amounts to at least 90% of the original nominal capacity (N).

The number of full charge cycles can be calculated in a simplified way by multiplying the number of charge cycles achieved by the cycle test by the quotient of the average quantity of electricity delivered ($Q_{i\_average}$) and nominal capacity (N):

$$\text{Full charge cycles}=\text{Charge cycles}*\frac{Qi\_average}{N}$$