Advanced Rechargeable Batteries
On the Road to Sustainability
Supporting a Resource Efficient Circular Economy and Low Carbon Society

Sustainability Report    February 2013
This is RECHARGE’s first Report on Sustainability
It covers the main environmental, social, and economic performances of RECHARGE and of some of its member companies during the calendar periods 2011 & 2012 (unless otherwise indicated).

The objective of this report is to demonstrate how RECHARGE as a European Association with global connections is supporting a resource efficient & low carbon society.

Information Collection & Measurements.
The environmental, social, and economic performance of this report is gathered from internal reports, member companies case studies, position papers, European legislation, statistical data, and expert intelligence.

About the Association RECHARGE.
RECHARGE’s unique membership is covering all aspects of the rechargeable battery life cycle. RECHARGE is following the continuously changing regulatory and legislative environment for rechargeable batteries and is a recognized expertise centre for advanced portable and industrial rechargeable battery technologies.

The membership of RECHARGE includes suppliers of primary and secondary raw materials to the battery industry, rechargeable battery manufacturers, original equipment manufacturers, logistic partners and battery recyclers.

RECHARGE’s mission is to promote Advanced Rechargeable Batteries as a technology that will contribute to a Sustainable Society, a Resource and Energy Efficient policy and to the achievement of a Green Circular Economy.

Advanced Rechargeable Batteries can be recharged and recycled. Recharging these batteries reduces the use of raw materials and recycling them brings secondary materials in the EU economy.

RECHARGE is anticipating an emerging increase in the use of rechargeable batteries in the e-mobility and power tool industry, in the communications world, and in new renewable energy storage applications.


Additional focus is given on all safety aspects related to storage, transport, packaging, and to the health aspects of those handling these type of batteries.

RECHARGE cooperates in Europe with several other associations, and internationally with associations in Japan, USA, Korea, and China.

Information and comments can be shared through: www.rechargebatteries.org
Dear Reader,

Welcome to this first RECHARGE Report on the Association's Roadmap towards Sustainability.

This Report demonstrates how advanced rechargeable batteries play a more and more interactive role in people’s daily life, and how these developed technologies do contribute towards a more resource efficient and low carbon society.

As the use of advanced rechargeable batteries (both portable and industrial) is increasing in multiple applications such as cordless power tools (for household or professional use), e-mobility transportation (e-bikes, electric-type automobiles), e-communications devices (i-pods, i-pads, PC, mobile phones), the key challenges for the economic operators throughout the complete value chain of these products relate to transport, safety, collection, and recycling. These 4 key challenges are addressed throughout the Report.

Putting more advanced batteries on the market has resulted in the use of more raw materials (primary & secondary), and has resulted in more regulatory requirements.

RECHARGE is supportive to the approach of the EU Commission, the EU Parliament and the EU Council with regard to their initiatives concerning critical raw materials, the roadmap for a resource efficient Europe, and towards a number of directives and regulations, taking into account the competitiveness of our member companies.

The expertise within RECHARGE is offered as support to these European institutions.

We hope that you will find this report informative, interesting, and useful.
If you have any request, or comment related to the content of this Report, please contact us.

Enjoy the reading.
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Mission & Vision

RECHARGE, the Advanced Rechargeable Batteries Association is representing the interest of its Members who are partners of the Life Cycle of a Battery.

Considering the development of the European policies regarding resources and energy efficiency at the horizon 2020 and further on, RECHARGE’s Members shall contribute to the development of these objectives by manufacturing batteries, placing on the market equipment containing rechargeable batteries and by collecting and recycling those batteries at end of life to produce secondary materials that can be re-used in the European Industry.

Executive Summary & Strategy

The Increasing Role of Electrical Energy Storage Systems such as Advanced Rechargeable Batteries in our Society is observed in three major areas:

1. Communication and portable power sources
   Modern society relies on cordless electric energy sources such as rechargeable batteries. The development of mobile communication increases the opportunities for personal and business exchanges. It also decreases barriers between individuals and nations.

2. Green mobility
   In the changing world of individual and mass transport, the recent progresses made on rechargeable batteries performances open opportunities for transport with lower emissions and increased environmental performances (reduction in noise emissions and in the use of fossil fuels).

3. Electrical Energy Storage Systems
   The development of renewable energy production technologies request the buffering of off-peak production of energy and the supply of electricity in low production periods. It requires also a permanent interface between the production site and the electricity grid that can be offered, among others, by rechargeable batteries.

This increasing role of advanced batteries in our society can only be secured if RECHARGE’s Members are active in the following segments of the EU policy:
1. The renewable energy policy
Rechargeable batteries are operated in an environmentally sound manner when the electricity used for the recharge is produced by renewable sources.

2. The Raw Materials Initiative
The recycling of materials used in batteries is a critical element of the life cycle of a rechargeable battery. The recovery of materials is operated by more energy efficient processes than the production of primary materials.

3. The Resource Efficiency policy
The Resource Efficiency policy should not only consider the optimization of the recovery of valuable resources in Europe but it should also integrate the future of the European Industry. Indeed the recovery of raw materials in an efficient manner in Europe should in priority feed the European Manufacturing Industry. In this respect the EU legislation should consider that the EU Industry cannot be placed in a less competitive position than its partners at a global scale.

4. The Electric Mobility policy
Advanced Rechargeable Batteries are key technologies for the acceptance by end users of silent and emission free vehicles. When produced by renewable energy sources, electricity is an efficient mean to power transports. The definition of a European Strategy supporting the development of new battery technologies, an electric vehicle industry and an appropriate charging infrastructure will be key for the future of European Transport means.

5. CO₂ and other emissions
As the European Union has agreed to achieve a reduction of EU greenhouse gases (GHG) emissions of at least 20% by 2020 (based on 1990) and the average CO₂ level of cars put on the market in 2020 should reach 95g/CO₂, this will have certainly an impact on the development of sustainable mobility, and is directly linked with the above Electric Mobility policy.

There is a need to close the gap between the current situation and the goals of a circular and green economy and making the link with industrial development in the EU whilst creating additional employment.

It is RECHARGE’s Members objective to contribute to this EU policy framework which secures the development of the EU rechargeable battery industry and of the EU long term sustainability policy.
Advanced Rechargeable Batteries

There will be significant market increase for Portable Rechargeable Batteries:
- On a short term basis (2015-2020) in the Electrical & Electronics Equipment market
- On a longer term basis (2015 – 2025) in the E-mobility and Energy Storage market
- Diversification of applications will extend the collection issue
- Need to establish a better control of the shipment of lithium batteries
- EU companies assembling packs/modules should be aware of the strict shipping and packaging rules for Lithium Batteries.

The Battery Industry needs to anticipate:
- Overseas shipment of large quantities of batteries by not-informed actors
- Handling by not-informed commercial intermediates
- Storage of large quantities of industrial batteries at intermediate facilities
- Return of industrial batteries in non-conform status (not of the design type)
- Transport of Lithium Batteries (New vs Damaged vs Waste)
- Handling of mixed waste batteries & waste lithium batteries
- Technical and economic uncertainty of the recycling stage

Governance & Compliance statement

• The objective of the Board Meeting of RECHARGE is to review and to address, under the applicable confidentiality rules, issues concerning the RECHARGE program and its achievements.
• The minutes of the Board Meeting will have to reflect all significant matters discussed between participants
• No discussions will be held, formally or informally, during specified meeting times or otherwise, involving, directly or indirectly, express or implicit agreements or understandings related to: (a) any company’s price; (b) any company’s terms or conditions of sale; (c) any company’s production or sales levels; (d) any company’s wages or salaries; (e) the division or allocation of customers or geographic markets; or (f) customer or suppliers boycotts; or (g) any disclosure of information which may affect applicable rules on Competition Law.
• RECHARGE’s Members, as a group will make no recommendations of any kind and will not try to reach any agreements or understandings with respect to an individual company’s prices, terms or conditions of sale, production or sales levels, wages, salaries, customers or suppliers.
• RECHARGE’s Members agree to comply with the rules of the Antitrust Compliance Program communicated to them by RECHARGE’s secretariat.

Claude Chanson
General Manager
RECHARGE

Jean-Pol Wiaux
Secretary-General
RECHARGE
Chapter 1

Environment Performance following the life cycle process
1. The role of rechargeable batteries

Saft is a world leader in the design and manufacture of advanced technology batteries for industrial and defence applications. The Group is implementing its strategy for high technology lithium-ion batteries in the renewable energy storage, transportation and telecommunication networks markets.

• The world’s leading manufacturer of industrial nickel-based batteries for use in air and rail transportation, standby power applications and emergency lighting.
• The world’s leading manufacturer of primary lithium batteries for the electronics and defence industries.
• The leading European supplier of specialised, advanced technology batteries for defence and space applications and N°1 worldwide in lithium-ion satellite batteries.

Environment Policy
Even though the products we manufacture and place on the market bring about an improvement in the environmental performance of our customers, it is still our duty to ensure that the impacts of our activities are fully identified and minimized. In this respect, the Saft Group has adopted an Environmental Charter which guides our actions.

1. Identify the impacts of our activities, measure these impacts, build and maintain an environmental management system
   • Know our legal obligations, identify the environmental compartments on which our activity has an impact,
   • Identify appropriate indicators and quantify these impacts,
   • On each industrial site develop an environmental management system.

2. Reduce the impact of our manufacturing sites
   • Continue to ensure legal compliance,
   • Continue to reduce environmental impacts where it is technically and economically feasible.

3. Propose to our customers solutions which help them minimize their own impact on the environment
   • Identify with our customers the impacts of our products on the environment in their true application,
   • Develop solutions to reduce such impacts by means of product (re-)design, improved procurement, enhanced use and proper end-of life management.

4. Identify and share best practices
   • On the basis of the results obtained on the above mentioned goals, identify the best practices and share them within the different units of the Group and, when applicable, with our customers.

Commitment to quality and industrial performance
As a world leader in high technology batteries, it is the Group’s strategy to provide its customers with the best battery solutions available today and in the future. Saft is thus seeking to implement the best available practices in all fields, applying principles of performance and discipline as an ongoing policy. Saft has gathered its quality and performance improvement methods into one global programme called Saft World Class.

The Saft World Class programme is deployed in every site and concerns every function, from technical to sales, from customer service to project management.
All Saft employees are involved in the World Class programme. To continuously satisfy our customers, Saft provides training and encourages personal involvement in the continuous improvement process. Saft has always been committed to delivering to its customer the best quality products and services. The World Class programme has set **Quality first** as a key principle.

In line with its goal to deliver the best products and services to its customer, the Saft World Class programme integrates methods to continuously improve our **Industrial performance** such as Just In Time delivery, Total Productive Maintenance and Wastes reduction.

**Quality First**
Saft has always been committed to delivering the best quality products and services to its customer. The World Class programme has set **Quality first** as a key principle. This is materialized by the use of well-known methodologies throughout the Saft factories:

**ISO 9001 Standard.**
Every Saft plant is certified ISO9001:2000 standard. Most of the plants also hold additional certifications depending on their own market requirements: **Quality and environment documentation.**

**5S and Visual management**
5S and Visual management are commonly used to make visible any possible anomaly, enabling its immediate correction and resolution through Problem Solving Teams.

**Process Management**
Process Management encompasses methods such as:
- Standards for Equipment Design
- Error proofing systems
- Statistical process controls

**Industrial performance**
In line with its goal of delivering the best products and services to its customer, the Saft World Class programme integrates methods aiming to continuously improve our industrial performance.

**Delivery Performance**
Just In Time at Saft is the best response to satisfy the final customer who will receive what he needs at the time he needs it and in the quantity required. This requires flexibility and reactivity at all levels through adapted solutions.
Saft installs business processes that enable, from the formulation of the customer requirement, the quickest possible delivery to the required location.

**Industrial equipment efficiency**
With Total Productive Maintenance (TPM), Saft is able to achieve the highest level of effectiveness of its equipment and investments. The TPM approach involves all personnel in systematic and definitive elimination of causes of production losses linked to machines. It leads to increased reliability and availability of installations and contributes to flow and productivity improvement.
Leading advanced rechargeable battery manufacturer in the world

In 2011, Japanese electronics giant Panasonic transformed itself into Panasonic Group by incorporating SANYO Electric Co. and the former Panasonic Electric Works Co. The Group employs globally 330,000 members, of which approximately 4% operate in Europe. Europe represents about 9% of global sales turnover.

The Vision of the Panasonic Group is to become the no. 1 Green Innovation Company in the Electronics Industry by 2018. This means that the Group makes the ‘environment’ central to all the business activities and as such intends to realize green innovation. For this, they use a number of ‘green indexes’: (1) contribution to reducing CO₂ emissions, (2) contribution to recycling resources, (3) the size of energy systems business, and (4) the percentage of sales for no. 1 eco-conscious products. These efforts are integrated in the Panasonic Green Plan 2018, the Group’s environmental action plan.

One of the key business drivers is to actively contribute in reducing emissions through offering energy-saving products such as photovoltaic power generation systems (transforming solar light energy into electricity), household fuel cell cogeneration systems (generate electricity and heat at the same time), and energy storing products for industrial and for residential use (to ensure stable supply of power through the use of renewable energy).

Another ‘green index’ is the contribution to resource recycling. The Group is adopting the concept of a recycling-oriented manufacturing process, in order (1) to minimize the amount of total resources used, (2) to maximize the amount of recycled materials, (3) to reduce the disposal of waste from production activities, and (4) to reduce landfill close to zero.

With regard to the production of eco-friendly products, the Group has a basic policy to minimize the use of chemical substances that might adversely affect human health and the environment throughout their life cycles. This is being achieved by (1) identifying hazardous substances contained in products, (2) evaluating these substances on their environmental impacts, and (3) voluntarily reducing or discontinuing their use in case of any environmental risks.

From a social responsibility perspective, the Mission of the Group is to contribute to the progress and development of society and the well-being of people worldwide.

Panasonic Group has received a number of recognitions during 2012 for their sustainability approach.
Panasonic has various batteries for environmentally friendly automobiles based on the rechargeable battery technology for consumer products with the history for 45 years or more. Mass production of the next generation Li-ion battery has been started in addition to the Ni-MH batteries that have been supplied to car makers from 2004.

Panasonic will lead the market with various applications of its battery business

Storage Systems are necessary for the low-carbon society of the future.
Renewable energy sources such as sun and wind power can cause instability as there may be fluctuations in the power they produce.

Panasonic supplies Li-io smart batteries to industry partners. These can act as a stabilizer for renewable energy and will play a critical role in the low-carbon society of the future, where energy generation and consumption will be localized.
Since then, the company has continuously invested in and achieved further significant improvements in producing environmentally friendly products with environmentally friendly processes - for the benefit of nature and people, especially all of our staff.

• Since the year 2002, VARTA Microbattery was able to reduce the energy consumption per cell produced by 67%.
• During the same period of time, emissions of CO₂ were reduced by 74%.
• More than 90% of waste produced in the company is already recycled.
• In 2009, mercury free zinc-air button cells for hearing aid devices were introduced to the market for the first time already. Since then, VARTA Microbattery has improved the cell performance step by step. Today, the mercury free technology is produced with the same performance parameters than the conventional technology – which had been considered impossible a few years ago.

Since 2010, silver oxide button cells are manufactured without any mercury content and sold to the worldwide market. As a result, more than 3 tons of mercury per year will be saved once all customers have changed to the mercury free technology.

• VARTA Microbattery GmbH is the only battery manufacturer offering a full line-up of rechargeable hearing aid batteries to the market.
• The blister card for VARTA Microbattery’s power one mercury free zinc-air batteries is made out of FSC compliant carton board material. The FSC (Forest Stewardship Council) is an international, non-governmental organisation dedicated to promoting responsible management of the world’s forests.
• In order to support the change from environmentally critical energy sources to renewable energies, VARTA Microbattery has developed a dedicated battery system, the Battery Energy Storage System (BESS). This system will enable hundreds of thousands of home owners to store renewable solar energy directly at the place where the energy is produced in their houses. On top of supporting renewable energies, this helps to reduce the necessity of drawing additional power lines through the continents.

• For producing the mercury free zinc-air button cells, VARTA Microbattery has invested in a completely new production facility and new production lines. In order to protect the production process and our workers from disturbing influences such as dust, sophisticated filter systems have been integrated into the fab.

VARTA Microbattery GmbH’s broad activities and continuing efforts to improve sustainability were awarded again just in March 2012 by being ISO 50 001 certified. This new certification is awarded to companies having excellent processes and success in energy management.
In this section, the reader will find an overview of the key elements from the EU Batteries Directive 2006/66/EC and from the Commission Regulation 493/12 on Recycling Efficiency. We also highlight the position of RECHARGE with regard to the recycling efficiency calculation methodology, and we underlign the links between the End-of-Life Vehicles Directive (2000/53/EC) and the Batteries Directive (2006/66/EC).

The EU Batteries Directive 2006/66/EC

Article 3 – Definitions

- Battery – a source of electrical energy generated by direct conversion of chemical energy and consisting of one or more primary battery cells (non-rechargeable) or consisting of one or more secondary battery cells (rechargeable).
- Battery Pack – any set of batteries that are connected together and/or encapsulated within an outer casing so as to form a complete unit that the end-user is not intended to split up or open
- Automotive Battery – any battery used for automotive starter, lighting or ignition power
- Industrial Battery – any battery designed for exlusively industrial or professional uses or used in any type of electric vehicle
- Portable Battery – any battery, button cell, battery pack which is sealed, can be hand-carried, and is neither an industrial nor an automotive battery

Annex III – Detailed treatment and recycling requirements

- Treatment
  - Shall, as a minimum, include removal of all fluids and acids
  - Treatment, and any storage, including temporary storage, at treatment facilities shall take place in sites with impermeable surfaces and suitable weather-proof covering or in suitable containers
- Recycling
  - Recycling processes shall achieve the following minimum recycling efficiencies:
    - Recycling of 65% by average weight of lead-acid batteries
    - Recycling of 75% by average weight of nickel-cadmium batteries
    - Recycling of 50% by average weight of other batteries (= industrial)

The Commission Regulation 493/12 on Recycling Efficiency

The Commission Regulation (EU) No 493/2012 of 11 June 2012 is laying down detailed rules regarding the calculation of recycling efficiencies of the recycling processes of waste batteries and accumulators.

1. The Calculation Methodology

Article 3 and Annex 1 § 2 of the Commission Regulation (EU) N° 493/2012 describe the method for the calculation of the recycling efficiency of the recycling process of waste batteries and accumulators.

The recycling efficiency of a recycling process is calculated for:
- lead-acid batteries and accumulators,
- nickel-cadmium batteries and accumulators, and
- other batteries and accumulators.

2. Reporting Duties

Reporting Duties on the achievement of the Recycling Efficiency are governed by Article 3 §4 and Article 3 §6 of the Commission Regulation (EC) 493/2012.

According to Article 3 §4, Recyclers shall report the information shown in Annex IV, Annex V and Annex VI, as applicable, on an annual basis and shall send it to the Member State’s competent authorities by no later than four months from the end of a calendar year concerned. Recyclers shall send their first annual reports no later than the 30 April 2015.

Article 3 §6 requires that where a recycling process is carried out at more than one facility, the first recycler is responsible for submitting the information required under Article 3 §4 to the Member State’s competent Authorities.
3. Recycling Efficiency Calculation Methodology

For the calculation of the Recycling Efficiency, there is a need to distinguish between the treatment of portable battery packs and industrial batteries. This differentiated approach is illustrated in Figure 1.

1) Portable battery packs Recycling Efficiency is calculated on the weight of cells entering the Recycling process as an input fraction. The weight of the plastic outer casing of a portable battery pack is not considered as an input fraction of the recycling process (Annex 1 § 6 of Commission Regulation 493/2012).

2) Industrial batteries Recycling Efficiency is calculated on the total weight of the industrial battery, including the external jacket as indicated in Annex 1 § 6 of Commission Regulation 493/2012.

3) With regard to the achievement of the 50 % Recycling Efficiency of the rechargeable Li-ion and Ni-MH industrial batteries, the position of RECHARGE is the following:
   • To recommend the reporting of individual component flows of industrial batteries entering a recycling process in order to deliver to the relevant authority a transparent result on the RE achievement not only at cell level but also over the full range of components of the complete industrial battery in accordance with Annex VI of the Commission Regulation 493/2012.
   • To recommend that EU Member States follow a harmonized RE calculation methodology implemented on a pan European basis.
   • To recommend the achievement of 50% Recycling Efficiency at least at cell level on the battery input into the recycling process.


   • RECHARGE acknowledges a clear split between the recycling targets & objectives of the Batteries Directive and the End of Life Vehicle Directive (ELV).

Refer to p.42 ‘Interface of the Batteries Directive with other Waste Directives’.

FIGURE 1 - Schematic presentation of the differences between the recycling of portable and industrial batteries.
3. Research, Development & Innovation

The importance of Sustainable Energy Management

If society is to develop sustainable transport, it will need to go beyond powertrain technology and energy mix solutions. To reduce CO₂ emissions by 60 percent in total transport by 2050 (the goal set by the European Commission), solutions will need to incorporate energy distribution, fuel types, mobility infrastructure, and customer behavior.

As part of this integrated approach, Toyota is working on advanced research in the field of management between vehicles and homes. As we transition from internal combustion engines to electrical vehicles, transport will become a prominent part of a family’s electricity consumption profile.

The provision of renewable energy will continue to grow and the importance of distributed generation is expected to increase, highlighting one of the constraints of the current electricity distribution network. Wind and solar power generation is not sufficiently predictable, which is further complicated by the current limited buffering capacity. It is difficult and expensive to store electricity and the renewable energy generated is not always possible.

Toyota is investigating if and how PHEV’s can contribute to a viable solution, by concentrating on the Smart Grid concept. The objective of a smart grid is to ensure stable supply and optimum energy savings.

Toyota is investigating methods of stabilizing energy demand. This could be achieved by improving the capture and use of electricity generated from regional or domestic solar generations and wind turbines, as well as by talking advantage of low-cost off peak electricity. For example, storing off peak energy in the vehicle’s battery and using it to supply power to the household during peak consumption times, or using a home energy management system, which integrates the home and the car, controlling and optimizing the energy flow between them.
Renault has introduced into the market during 2012 a comprehensive line-up of electric vehicles, as part of the Z.E. range (Z.E. = Zero Emissions), at prices equivalent to a diesel vehicle, taking into account any state subsidies.

This Z.E. range fits perfectly into Renault's Environmental Policy 'eco²', which consists of 3 key criteria:

1. In any market where Z.E. vehicles are sold, Renault ensures that the industrial battery at the end of use is taken back and processed in accordance with human health, safety and environmental protection, whilst being compliant to all local regulations, and this in a cost efficient manner.
2. Within the EU, compliance with the End-of-Life Vehicle Directive, the Batteries Directive, and all other related regulations, is guaranteed.
3. Even for markets outside of the EU, Renault will ensure that it will align in these countries also to the European legislative requirements.

In order to best meet the objectives of the recycling policy, Renault has decided to establish a unique and specific recycling chain for all types of EV traction batteries: defective, damaged, and end-of-life.

The innovative character of this recycling chain is the fact that Renault controls completely the take back of Renault batteries. This is done in close collaboration with logistics operators, authorized treatment facilities (dismantlers), and with the recyclers.

This close-loop chain is sustainable, efficient, easy to operate, and cost effective.
The foremost ecological challenge for humankind is to conserve and protect the natural environment. At Bosch group, therefore, we consistently gear our operations to the efficient use of energy and resources. Eco-friendly products specifically designed to reduce pollution and minimize the use of resources already account for some 40 percent of our sales. Roughly half our research and development budget goes into such products.

We aim to reduce the emissions of carbon dioxide from our production locations around the world. By 2011, the Power Tools Division had reduced absolute CO₂ emissions by roughly 23 percent as compared to 2007, in face of increased business volume. We also gain valuable support from research alliances and from exchange with specific partners and interest groups. Our website also provides updates as to our activities and progress, as well as sustainability data.

Further detailed information can be found on our internet presentation under the following address:

At Stanley Black & Decker, we believe in excellence—in our products, our people, and our practices. We’re committed to sustainable business policies and initiatives that reduce our impact on the environment and improve the quality of life in every community we reach.

In addition to corporate level technologies and processes that reduce our environmental impacts, many of our industrial and consumer tools and solutions are designed to help our customers reduce their water consumption, energy use, and waste generation. We embrace sustainable practices in our daily operations to maximize stakeholders benefit to our environmental-economic-social bottom line.

Further detailed information can be found at http://www.stanleyblackanddecker.com/company/sustainability

**BATTERIES – OUR APPROACH**

Battery-powered tools provide users convenience, performance and value, and the demand for them has continued to grow. As the marketplace leader in cordless power tools, Stanley Black & Decker strongly supports battery recycling and safety.

Stanley Black & Decker is a leader in the design and manufacture of portable power tools. These tools have become increasingly important to our customers as their power and utility have increased. When batteries are spent, they have the potential to become a source of environmental pollution if improperly discarded. To minimize this risk, Stanley Black & Decker strongly supports the collection and recycling of spent batteries and is an active member of organizations in North America and Europe dedicated to collecting and recycling rechargeable batteries. We are proud of our pioneering efforts to establish the infrastructure through which consumers can ensure that their spent batteries are safely and responsibly managed. In the U.S. and Canada, Stanley Black & Decker belongs to the Portable Rechargeable Battery Association (www.PRBA.org) and supports the activities of the Rechargeable Battery Recycling Corporation (www.RBRC.org), and in Europe we are members of Battery Compliance Schemes in Member States where we place batteries onto the market.

Our Lithium ion range of batteries offers increased runtime, increased efficiency and improved performance compared with other battery platforms. By constantly monitoring tool and battery operation the intelligent electronic module and switch maximize performance and prevent damage caused by overload or temperature build up helping to increase the life of both tool and battery.
5. Transport & Logistics

Regulations for lithium batteries

The international transport regulations on shipping lithium batteries as class 9 ‘miscellaneous dangerous goods’ is not only very complicated, but also changing continually.

The content below is a summary of a report made by two experts on this subject: George Kerchner of PRBA (The Rechargeable Battery Association – USA), and Kristel Vermeersch of KVSPartners – Belgium).

The first UN Recommendations on the transport of dangerous goods date back to 1956. Forty years later, these UN Recommendations were split into 2 parts:
1. the ‘Model Regulations’, pertain to the drafting of laws and regulations on the transport of dangerous goods
2. the ‘Manual of Tests and Criteria’, containing technical information about methods of testing products to ascertain their hazard.
   a. Container requirements include provisions for material and construction, and performance testing
   b. Packaging testing is based upon the hazard level within the packing group of the content, the quantity of material, and the type of container.

Even the most experienced battery professionals are often confused by the number of overlapping complexities of international and national oversight bodies and government agencies. This increased complexity does not only come with increased regulation, but also with new battery chemistries, with new electronic equipment and mechanical devices.

More recently, the regulators have focused their attention on large quantities of lithium batteries shipped, with special emphasis on aircraft transport, and also on the transport of lithium batteries considered as waste, or as damaged or defective.

The UN Model Regulations start at the United Nations Subcommittee who meets twice per year on a two year cycle. There, the model regulations are adopted for land, sea, and air transport. ICAO (International Civil Aviation Organization) represents the specific interests of air transport regulation. The International Maritime Organization (IMO) represents the interests of the maritime regulations.

The ICAO tightens up de regulations to accommodate the conditions of air transport and airlines generally require their customers (shippers of dangerous goods) to comply with this. Furthermore, these regulations are generally harmonized, at international level, with the other modes of transport. But there are quite some variations between the regulations in the USA and in Europe, which adds to the complexity of the matter.

However, as the word ‘model’ indicates, the UN Dangerous Goods Model Regulations is intended to serve as a guidance by which countries can draft their own national regulations. The hope is, of course, that these national regulations harmonize with the international regulatory structure. That is not always the case: the fact that each sovereign nation can establish its own rules within the parameters of the UN can make for considerable confusion when transporting dangerous goods from one country to another.

In Europe, the EU supports a governmental regulatory infrastructure that monitors member nations for compliance. The European Directive 2008/68 EC established since 2008 a common regime for the regulation of transport of dangerous goods by road (ADR), by rail (RID), and by inland waterways (ADN) within or between member states. Each member state must implement and enforce laws and administrative provisions necessary to comply with this Directive. For air transport, the member states in Europe must also comply with Regulation EC 3922/911 which not only
enforces the ICAO Technical Instructions, but also imposes additional requirements pertaining to air transport of dangerous goods.

Regulations concerning large industrial batteries for hybrid and electric vehicles and for grid storage applications fall under the authorization of specific countries. For industry, this is a burden because when they transport across national borders they need authorization from each country they pass with their transport.

Most changes to the regulations are made at UN level. There are still some topics related to the transport of batteries that are currently only regulated in one particular transport mode. For safety reasons, ADR has incorporated requirements for the transport of damaged and defective batteries and for the transport of waste batteries shipped for recycling. The development of such requirements at UN level is one of the challenges the involved stakeholders, including the industry, is facing at the moment.

For industry, compliance to these regulations is key. Raising awareness and improve training and education of all involved in the manufacturing, handling, packaging, transport, and recycling of lithium batteries – small or large – is a fundamental requirement to assure compliance at national and at international level.
A strategic approach for lithium battery transportation and management

Electric vehicles are an exciting new business. It is one thing to drive them but another thing to ship them. As the market evolves, questions for shippers abound. Research suggests that by 2025, 10% of all passenger cars in China, for example, will be battery powered. DPDHL is already active in this area – and working out how to share this with customers.

Lithium-ion batteries have snuck into our lives. Tucked into power tools and vehicles, they are everywhere. Some people might imagine these smooth square items are handy, easy to pack, easy to ship. This is not necessarily the case. The lithium batteries being developed for electric vehicles are weighty, volatile, and packed with potential complex chemical reactions. Manufacturers keep looking for ways to make them lighter, safer, and longer lasting. As the technology develops, this means a fast changing logistics landscape.

Quick start
DHL has already started gathering experience in this burgeoning market. “We started with Renault, one of our earliest customers two years ago. And we quickly realized how much there is to learn,” says Dirk Weckes, Senior Supply Chain Consultant, DHL Customer Solutions and Innovation. Regulation around battery shipment is complex, and changing. Most manufacturers say the batteries must be stored in temperature controlled containers, and may not be exposed to temperatures over 25°C and humid environments. “So we need to use refrigerated containers. But those that have been used to ship food or medicines cannot be used for batteries – it isn’t allowed. And there just aren’t that many on the market,” explains Weckes.

Weighty matters
Batteries also have a limited shelf life. DHL is investigating ways they might be charged on their way to the final customer and one possibility could be using a dedicated handling and charging centre. Once the car battery is spent, it needs to be collected and disposed of. Regulations are undecided whether spent or defective batteries should be dismantled, removed from vehicles, or shipped inside the cars. If it is unclear what is wrong with the battery, shipment options are further restricted. “We don’t know what future legislation will be, but DHL is preparing to be ready for all possibilities,” says Manoëlla Wilbaut, Global Head Commercial Developments, Automotive Sector, DHL Customer Solutions & Innovation.

Solution to go
“This is not something new for us. DHL has plenty of experience with dangerous goods. What counts is how we can leverage our capabilities to help our customers,” emphasizes Wilbaut. “It was really useful to work with Renault, shipping batteries to Europe, bringing them to car dealerships, and returning spent and defective batteries. During this joint collaboration, we learned a lot together.” “Now, we have a solution in place. Other customers are asking us about these kinds of issues. The DHL Battery Solutions include REEFER containers, SMART SENSOR technology and GPS satellite systems for proactively measuring and monitoring transport conditions”. As legislation takes shape, DHL is present in different associations and interest groups. The Group has also asked research institutes to take part in several initiatives studying aspects of battery shipment. DHL Customer Solutions and Innovation is looking at packaging for used batteries. “And beyond transport, we are trying to take a structured approach to the whole supply chain,” says Weckes. “There are a lot of questions. But that’s always the case when you’re at the forefront. What’s important is that we’re ahead and we maintain this momentum.”

“Compared to other companies, DHL is really a pioneer in this area”, says Wilbaut. The Group is confident that this will become an important part of the business in the future. The key challenge is information as a lot of battery issues are linked to non compliance with legislation. DHL has built a strong centre of knowledge with experts in all regions. And the company keeps investing in it!

www.dhl.com
6. End-of-life

Everyday new E-mobility products are placed on the market, each of them even more innovative (electric and hybrid cars, e-bikes, gyro pods, ...). The efficient management of these products after the end of their lives is already the major challenge for the recycling industry.

SNAM developed a global solution in order to secure the main expected achievements. A complete collection system was set up for the "End Of Life" batteries, and for their production wastes as well, operating throughout Europe, with a full traceability of the wastes. A full range of highly efficient recycling processes were studied and implemented achieving a performance far above the legal expectancies (73% achieved in 2011 for the 50% expected within the EU Battery Directive 2006/66/EC for the li-ion e-mobility batteries). This performance is conditioned with strong commitments towards safety and protection of the environment. In 2011 SNAM introduced the “safety behavioral approach” in the industry in partnership with the BST company, which helped SNAM to hugely reduce the occupational accidents, and contributed to further increase the “safety culture” throughout the company. In 2011, SNAM implemented a complete water process system within the plant of Viviez, which already allowed to reduce drastically the industrial water consumption, and will lead to the “zero metal in water” in 2015, far before the European legal deadline in 2021. In 2012, SNAM is implementing a brand new air treatment system, in anticipation of the 2015 European CLP legislation. Indeed, the metals recovered such as Nickel, Cobalt, Lithium, Copper and also of Rare earths materials, are not wasted anymore. These secondary raw materials comply with the EU REACH regulations, and are used throughout Europe in the production of new applications. Since 2010, SNAM signed partnerships with car manufacturers (Toyota, Peugeot...) aiming at the collection and the recycling of hybrid and electric vehicles’ batteries, which are the results of the industrial processes, environmental performance, and safety concern within SNAM teams.
Umicore’s closed loop battery recycling project

Umicore ranks Number One in the 2013 Global 100 Most Sustainable Companies in the World Index, due to its strong across-the-board sustainability performance.

In September 2011, Umicore inaugurated its battery recycling plant in Hoboken, Belgium. This was the result of an intensive R&D project and has been awarded by the European Commission with the European Business Award for the Environment 2012.

Umicore recycles Li-ion and NiMH batteries, the advanced rechargeable batteries that are powering the future: electric vehicles, energy storage systems, cordless power tools, consumer electronics...

The recycled materials have a lower CO₂-footprint than the original products and save natural resources. The production process is energy efficient and is equipped with a state-of-art gas cleaning installation, avoiding emissions of hazardous compounds in the environment. Moreover, the additives that are used in the process are recycled as well.

Umicore is a world leading producer of active cathode material. Today one out of five Li-ion batteries is made with our material. For years, Umicore has been at the center of an industry revolution, leading to:

- Extended mobile phone battery usage
- Increased laptop efficiency
- Extended mileage from a single charge on electrical vehicles

The combination of producer of active cathode materials and battery recycler is unique. By closing the material loop, Umicore provides to its customers a security of supply and contributes to reduce the environmental footprint of their products.

A safe and environmentally sound recycling solution for these batteries is essential for the further development of these markets. Umicore recycles all sizes of Li-ion and NiMH batteries: from single cell batteries for mobile phones to battery packs of electric vehicles. Large battery packs are dismantled for an optimized recovery of the pure metal and plastic fractions. Umicore operates dismantling lines in Hanau, Germany and in Maxton (NC, US). In the Umicore recycling process, metals such as cobalt, nickel, copper and rare earth elements are recovered and transformed into new battery materials or materials for other high end applications. This way, Umicore closes the materials loop for some critical elements for the European economy.
BEVs and PHEVs have a significant potential to reduce CO₂ and local emissions. Their development is still in a starting phase but expecting to achieve a commercial breakthrough in the near future. Before this broad roll out of electro-mobility, end users of BEV and PHEV expect a significant reduction of TOC (total cost of ownership). Hence, sustainability and cost efficiency of the whole value chain needs to be investigated regardless the detail.

In 2011 ACCUREC and IME (Institute for metallurgy process and metal recycling / University of Aachen) set up a R&D team to work out a global comparative market study on recycling of BEV and PHEV batteries. This study compiled current status quo of market players as well as near future opportunities of possibly implemented projects from lab to production scale. Integrating those out coming results in the latest data from Roland Berger Consultant Research on productivity of current and future production cost in electro-mobility, the team figured out an enormous cost contribution coming from EOL recycling obligations (figure 1). An extensive European regulation for ELV’s and used battery recycling imposes enhanced responsibilities on industrial actors like battery producer and recycler. „To understand the importance of cost efficiency in recycling, we had set these data in
context of detailed battery production cost.” explained Prof. Dr. Bernd Friedrich, head of IME. “Considering current market conditions, this cost can achieve up to 7% of total manufacturing costs!” As today and near future, the battery cost of 30% to 50% of total BEV cost is the most impeding factor to give electro-mobility their break. „An excellent argument to improve the status quo!“ Friedrich remarks.

<table>
<thead>
<tr>
<th>Process Emission</th>
<th>- 50 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovered Saleable Products</td>
<td>+ 20 %</td>
</tr>
<tr>
<td>Process Treatment Cost</td>
<td>- 50%</td>
</tr>
<tr>
<td>Robustness (Tolerance of Impurities)</td>
<td>+ 35 %</td>
</tr>
<tr>
<td>Flexibility (Construction Variant, etc.)</td>
<td>+ 80 %</td>
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</table>

**Figure 2**

Based on previous research efforts, the team redesigned the process and verified its functionality at lab scale end of 2011. After submission this project idea to federal ministry of environment of Germany, it has been approved within the shortest time frame of 5 months. “To meet a significant improved situation, we need to tackle the core problem from two sides: reducing treatment cost as well as increasing the number of saleable secondary products” indicates Dr. Reiner Weyhe, managing director of ACCUREC. Targets for this „EcoBatRec” named project have been set (figure 2), to achieve substantial improvements in each category. Investment budget has been approved and first results are expected for verification beginning of next fiscal year.

There are opportunities for each stakeholder within the EV infrastructure value chain to gain positive returns – partnerships and alliances will be the way forwards.

**ACCUREC awarded for its outstanding performance**

In the course of a federal conference „Efficient use of raw materials“ Accurec has been awarded by the Federal Minister of Economics, Dr. Philipp Rösler, with the German Raw Materials Efficiency Award for its continuous innovative achievements in the areas subscribed above. This success is also based on continuous research cooperation with IME (Institute for Metallurgical Processing) at University of Aachen. “In the summer 2012, we have started together two further research projects, to initiate innovative processes for Thin-Film-PV-panels and EV-Car batteries” said Prof. Fr. Bernd Friedrich, head of IME. A new focus to structure the future activities in recovery of strategic metals.

Left starting
state secretary Dr. Heitzer
Dr. Reiner Weyhe (Accurec)
Dr. Albrecht Melber (Accurec)
Prof. Dr. Dr. Bernd Friedrich (IME, University Aachen)
Prof. Dr. Kümpel (President Federal Institute for Geosciences and Natural Resources)
A path to sustainability ….

With the increasing emphasis placed on protecting the environment and promoting sustainability, our Xstrata Nickel Smelter ‘ISO 14001 Certified’ located in Sudbury, Canada, commissioned a Calciner in 2007 which has the ability to safely treat complex feeds such as Li-ion and NiMh batteries while minimizing the impact on the environment.

This ISO 14001 Standard is at the core of our Environmental Management System (EMS). Thanks to this EMS program, we can achieve effective management of potential environmental impacts. This is part of Xstrata Nickel’s commitment towards enhancing the long term viability of this operation.

The treatment of cobalt and nickel containing batteries is a natural extension to our cobalt and nickel recycling business given our strong market presence and recycling history. The Xstrata Nickel Li-ion and NiMh batteries recycling process is complementary to our existing process for primary metals production, and as such leads to high metal recoveries, good process economics and strict environmental compliance. The Xstrata Nickel process begins with our smelting operation in Canada and ends with the production of electrolytic pure cobalt, copper and nickel metals from our refinery in Kristiansand, Norway.

With a well known reputation established over many years in the areas of receiving, sampling and the effective recovery of payable metals contained in waste materials, Xstrata Nickel can be a partner of choice in addressing all concerns with regards to the recycling of the metal bearing materials.

**Recycling’s positive impact**

The environmental benefits to recycling speak for themselves. Metals by nature are recyclable. They can be re-used in closed and open loop processes over and over without material degradation. At Xstrata Nickel, the recycling business enhances our ability to maximize our metallurgical assets while protecting our valuable mineral resources. There are significant environmental benefits to our recycling business.

As a primary nickel, copper and cobalt company, Xstrata Nickel is concerned with and committed to safe and sensible recycling using fair and equitable systems. Our metals are infinitely recyclable and we would hope to continue to grow our recycling business.

Sustainable development and resource efficiency go hand in hand.
ERAMET: A sustainable integrated company from the ore to recycling.

The ERAMET Group’s organizational approach involves close collaboration among researchers, engineers and operational staff with regular consultation of customers. It remains established as indispensable to driving the Group’s strategy of sustainable, diversified growth in an industry with increasingly stringent technical requirements.

ERAMET is a mining and metallurgical company present all along the value chain, from geology, mining, extractive metallurgy for manganese and nickel, use of raw materials for superalloys making to recycling.

Hydrometallurgy is supporting both ore extraction and recycling. The worldwide fall observed in the metal content of mineral ores calls for process improvements and increased recourse to hydrometallurgy. Waste recycling to recover and separate the small quantities of metal present is one of the technologies that also makes use of hydrometallurgy processes. ERAMET’s several decades of experience in hydrometallurgy (particularly for nickel and manganese) make it a significative centre of hydrometallurgy skills. This skills centre provides essential drive to development with, for example, its Sandouville (France) plant since more than 40 years, the Weda Bay Nickel project in Indonesia, or the development of the process for developing the world-class polymetallic deposit at Mabounié in Gabon.

Recycling is important to ERAMET’s development strategy, and is the focus of numerous research programmes. ERAMET is expanding its recycling activities in various fields, from recovery and separation of metal present in waste to the reclamation of metal waste for inclusion in production processes. ERAMET strives to recycle the waste it generates by integrating it into its processes. The Group’s alloy plants, particularly the steelworks, incorporate the use of recycled metals into their processes. As an example, 93% of the raw materials fed into the furnace at Erasteel Commentry (France) come from the recycling loop. Some projects are being developed or are under study, such as hydrometallurgy recycling of rhenium, nickel and cobalt contained in superalloy machining waste. Waste reduction and quality are now key lines of approach to selecting a new process. A major concern in optimising our own metallurgy processes is energy saving, so reducing the carbon footprint of products derived from these processes.

Finally, the fight against climate change is an action priority for the international community and all businesses that have undertaken a Sustainable Development process. Therefore, the ERAMET Group has opted to improve the energy efficiency of its facilities by setting targets for greenhouse gas emission reduction.
7. Quality Control

European Battery Recyclers Association (EBRA) managing the Certification scheme for the end-of-life battery recycling chain

In absence of a legal context on the performances to be achieved by individual operators of the value chain, there is a necessity to establish a set of European standards that will cover the collection, transport, sorting, treatment and recycling of spent batteries as well as the auditing of the value chain operators and the export of spent batteries. These standards can be presented under a voluntary European Collection and Recycling Quality Certification Scheme (BCRC) for spent batteries.

The objectives of the EU Quality Certification Scheme for the Collection and Recycling of Spent Batteries are the following:

1. Develop a set of criteria applicable at all steps of the value chain of the management of spent batteries at end of life.

2. Provide a standard reporting (on line) format for all actors in order to secure the traceability of the collected batteries and their content through the value chain from collection to raw materials production including waste generation.

3. Provide to third parties a Standard Quality Certificate that will be used to evaluate the conformity of compliance of the operators in the value chain.

4. Provide a certification tool which maintains fair competition between actors on a worldwide basis by creating a level playing field.

5. Provide a certification tool that will remain cost competitive for the participants to the Quality Certification Scheme.

6. Provide permanent SAVINGS by avoiding unnecessary repetitive and costly audits of the various actors of the chain for the recyclers as well as for the Compliance Organisations.

A set of Criteria that will be used by stakeholders of the spent battery collection and recycling value chain in Europe have been prepared and are proposed in order to guarantee the most appropriate conditions for collecting, transporting and processing spent batteries on a large scale and by a large number of actors across Europe and in the world.

There is an increasing number of stakeholders interested by such a EU-wide BCRC Scheme: Battery producers, Collection organizations for spent batteries, Logistic Operators, WEEE Disassemblers, Recyclers and other Operators.

The partners of the project are proposing to have the BCRC Scheme covering the following modules of the value chain:
Module 1: PRODUCERS
Module 2: ADMINISTRATION OF C&R SCHEME (Compliance Organizations)
Module 3: BATTERIES COLLECTORS, WEEE DISASSEMBLERS, HEV&EV BATTERY COLLECTORS
Module 4: LOGISTIC SERVICES PROVIDERS
Module 5: RECYCLING including 5.1. SORTING, 5.2. TREATMENT and 5.3. RECYCLING
Module 6: EXPORT of SPENT BATTERIES
Module 7: AUDITING

The Quality Certification Scheme should be valid for the handling of all types of batteries covered by the Battery Directive 2006/66/EC.

More particularly, EBRA is currently working on the Module 5. This module is probably the most demanding and complicated to finalize. For this reason, 3 sub-modules have been created (sorting – treatment – recycling). The one on recycling should be ready by the first quarter of 2013 and a first pilot project of a certification is planned for 2013. This is necessary in order to draw lessons and improve the concept before completing the other modules.

The partners of EBRA in this project are RECHARGE, EU-COBAT, Battery collection organizations, and other actors in the recycling chain. Every actor in the chain is welcome to join.
Chapter 2

Social performance

how the business relates to society
Engaging and communicating with consumers and business partners

Since today’s e-bikes primarily use lithium-ion type batteries, it is essential to inform the retailer, such as the bicycle shop, and the e-bike owner about the safe and secure handling of the battery.

What follows is a summary of how Specialized trains and informs the dealer network, as well as how Specialized handles the battery.

Specialized is registered at the relevant recycling scheme in any given EU Member State to meet the requirements of the Batteries Directive and the WEEE Directive. All key personnel receive transportation regulation training (ADR /IATA-DGR). All sales personnel receive instructions on how to handle Li-Ion batteries.

For every market, Specialized has nominated a “SBCU (Specialized Bicycle University) professor E-Bike.” The SBCU staff will inform the dealers in their market about the product and relevant legal matters including battery storage, handling and shipping.

Specialized advises the dealers - in case they have the opportunity - to store used, defective or “unknown” batteries outside of their premises.

Specialized has developed its own UN-approved packaging for its e-bike battery.

When a battery is defective, the dealer is requested to contact Specialized, who addresses each case on an individual basis.

If the dealer wants to return a non-damaged battery, Specialized will send the dealer a UN-approved box and detailed instructions on how to ship and secure the battery. An example of an instruction is how to seal the charging terminals to avoid a short circuit.

Electric bikes are becoming very popular throughout Europe and with all types of consumers.
Consumer education starts early
To reach our youngest “consumers”, Bebat has developed an innovative educational school program. Schools are able to visit “Villa Pila”, a so called world of batteries. This program is free of charge, and leads the audience through the different stages of collection, sorting and recycling of batteries and torches.

Target audiences are children between 9 and 12 years old. This visit consists out of 5 different aspects:
- Animated movie about battery recycling – the life cycle of a battery as seen through the eyes of a battery itself
- Interactive program with lots of experiments in which the children learn about power, electricity and batteries in a playful and practical way
- Battery wall where 100 batteries tell their story
- Factory visit: step by step visit of the heart of the building: the sorting facility
- Quiz and interactive games to test the knowledge acquired throughout the day in a fun way

Since the start of the program in 2010, Bebat receives more and more visitors every year– in the 2011-2012 school term, more than 4000 pupils visited Villa Pila. www.villapila.be

Consumer awareness and activation
To raise consumer awareness and in particular to incite consumers to return their spent batteries, Bebat initiates several activation campaigns, where consumers are called to action. www.bebatman.be

Case Limburg.net
The province of Limburg was challenged to return 20.000 kg batteries in one month. In order to engage the inhabitants, we worked in close collaboration with Limburg.net, the company managing the municipal waste recycle parks in Limburg. If Limburg succeeded in the challenge, Bebat and Limburg.net would donate 20.000 trees as well as the land necessary land to plant them on. Bebat broadcasted several humoristic short films, explaining how to use, collect and recycle batteries and torches correctly, highlighting the different Bebat collection channels available to consumers. All inhabitants received a collection bag with their daily newspaper, and the campaign was rolled out using different local media (online, social media, print, TV, radio, outdoor). The campaign was very successful – Limburg tripled their usual collection rate and collected 45000 kg, Bebat happily donated 45000 trees.

BEBAT is a Belgian non-profit organization focusing on the collection and recycling of spent batteries and torches. With over 22.000 collection points in Belgium, Bebat collects 2600 tons of batteries a year. Next to that, Bebat has an important role in consumer education, first of all in order to achieve a higher return rate, but also to raise consumer awareness on correct battery use and on the fact that 100% of the batteries collected will be recycled.
Battery Collection Day

The Battery Collection Day at the European Parliament

RECHARGE’s Battery Collection Day takes place every year in the European Parliament, hosted by a group of MEPs from across the political spectrum. The scheme was initially developed 7 years ago by RECHARGE as a way to show their responsible approach and commitment to collection and recycling.

It has now evolved into a wide ranging concept, helping to illustrate the societal values of rechargeable batteries to MEPs, European Parliament staff, and other invited officials. Participants can enjoy a lunch debate, an exhibition and various stands.

Over two days, Members of the European Parliament, EP staff members, Commission officials and other visitors are invited to return spent batteries to the RECHARGE stand and other collection boxes situated in many of the European Parliament’s open spaces. This provides an opportunity to brief officials on the societal value of rechargeable batteries. The end of the Battery Collection Day(s) is marked by a cocktail reception where there is an official counting of the collected bags and a lottery is held with prizes. Since 2005, RECHARGE has been showing the importance of collecting and recycling of batteries. During the Battery Collection Day in January 2013, around 3250 collection bags and 3500 invitations were distributed. In total, more than 600 bags of spent batteries were returned to the RECHARGE stand, containing all types of batteries: from mobile phones, cordless tools, watches, laptop computers and other Electrical and Electronic Equipment. This illustrates the interest generated by the initiative in the European Parliament.

A lunch debate takes place during the second day of the exhibition. The lunch debate is an opportunity to discuss current legislative and policy issues, the place of rechargeable batteries in the circular economy and the role of rechargeable battery technology. According to the political agenda, the debate will focus on trendy topics and how RECHARGE can profile and play a role itself within its societal value.

Members of the European Commission, Permanent Representations and European Parliament participate in the lunch debate. The debate is an excellent opportunity to exchange views and provide political and technical feedback to industry representatives and policy-makers. The lunch debate on 29th. January was built around the concept of “The contribution of the rechargeable battery industry to a recycling society in a sustainable policy framework”, given the special importance to the role of resource efficiency and recyclers in today’s society. The debate was opened by Mr. Panayotov MEP (ALDE, BG). He pointed out that “Europe has a future” and that “Batteries are an important part of the future of Europe”.

In conclusion, The Battery Collection Day highlights the role played by the rechargeable battery industry in meeting not only resource efficiency goals but also low carbon society objectives through the creation of new, innovative, greener and more efficiently recyclable products.
Chapter 3

Economic performance
towards a circular, sustainable economy
The role of Recycling in the economy

In its ‘Roadmap to a Resource Efficient Europe’, the European Commission has put the following milestone: ‘By 2020, waste is managed as a resource’.

Recycling and re-use have to become attractive options for the public and private sectors due to a variety of professional collection schemes in the Member States, and the development of economic markets for secondary raw materials, including the strategic critical ones (lithium, cobalt, rare earth metals). Second life applications for lithium batteries is still a challenge.

When high quality recycling is ensured throughout Europe in a sustainable way, illegal shipments of waste should be eliminated, and landfilling virtually completely abandoned.

To accomplish that milestone, some targeted incentives should be given to the sector to improve the use of secondary raw materials, to re-use waste, and to improve recycling technologies.

In this sense, the Raw Materials Initiative (RMI) of the EU Commission, is the right way forward to help European industries, and research & innovation to engage in long-term planning and investments in the area of recycling. The challenge here is to keep the materials in Europe.

To increase recycling, a number of regulatory instruments are already applicable, such as the Eco-design Directive, the Directive on End-of-Life Vehicles, the Directive on Waste Electric and Electronic Equipment, the Batteries Directive, and the Waste Framework Directive. The interface between these legislations is a challenge.

Although the legislation has a very positive impact on recycling in Europe, it should be avoided that the same legislation would reduce innovation: what is currently missing is some kind of harmonization amongst these legal instruments with regard to definitions and objectives. This would make the whole issue more transparent, clear, and sustainable in the long term for all the economic operators involved. For example, the economic impact of the new EU Chemical Policies on business is quite a challenge.

Prepared by RECHARGE
The challenge of EV lithium batteries for second life applications

Often, when discussing the issue of second life, there is confusion about the exact meaning of ‘second life’. In this document, we define second life as 2 categories: ‘reuse’ and ‘second use’.

‘Reuse’ means using the battery completely or partly for the original application it was designed for (after inspection or remanufacturing). ‘Second use’ means using the battery for another application it was designed for, as the last owner found another use in the economy (an electric vehicle battery being used to power home electricity). Important is that in both cases, the last owner of the battery decided not to hand it over for final disposal, recycling. Therefore, re-use and second use does not apply to waste.

The potential applications for second life EV lithium batteries could be mainly found in the development of smart energy grids, in the storage of electricity, and in power supply. The question is: are these applications really feasible?

The following three studies provide a variety of answers.

In a study from June 2011 on second life of EV lithium batteries from the French Environmental Agency ADEME, the following conclusions were tabled:

- Car manufacturers, regardless of the economic model (batteries rented or purchased with the car) think that some of the batteries will be used well below a reduced capacity of 80% or 70% of the initial capacity. So the second life would be the continuation of the first life. In this case, actual flows of batteries available for second life would be lower than the theoretical flows of batteries that would have reached the thresholds of the end of first life.
- The issue of “batteries’ value” at the ultimate end of their life must be considered: if this value was posi-
tive, recycling could be an alternative to second life. However, the value of second-hand products (metals, chemicals) is now lower than the cost of recycling. It is likely that the final stage of recycling continues to be a net cost and cannot have a positive impact on the value chain of batteries reducing the initial cost. Therefore the potential use in second life is enhanced.

- If we assume a first life period of 7 to 10 years, the volumes available for a second life would only become significant beyond 2020, even in the most favorable scenario to the development of a market for electric and plug-in hybrids vehicles.
- In conclusion, this study shows that in the current state of knowledge it is appropriate to consider a “second life” for the batteries of carbon free vehicles. Several uses appear promising in so far as they could give to batteries a positive residual value at the end of their first life and thus have a beneficial impact on the development of carbon free vehicles market.

Frost & Sullivan, an English-based consultancy group, concluded in a recent study that EV batteries will have to compete with dedicated batteries used currently for second life applications, and they considered the following barriers:

- Lithium batteries have to compete in terms of cost, power, and energy storage, as most of the characteristics of lithium batteries degradation at reuse are still uncertain.
- The costs of refurbishing and connecting them into a grid are likely to be high and will be more than building new dedicated batteries for those applications, as illustrated in this energy storage value chain.
- As there are different chemistries and varied battery specifications without standardization, modules of batteries must be matched with their chemistries/manufacturer/specifications while refurbishing and repackaging. This is to ensure similar module configuration while creating larger battery packs for second life.
- There is an inherent perceived negative value attached to any reused product in the consumer mindset. This is further augmented due to the need for reliable and robust systems needed in the utility operations. EV batteries have to prove their reliability for second life.

Another study from August 2012, funded by the State of California and the U.S. Department of Energy, concluded that ‘the devil is in the details’ meaning that second life application isn’t quite as simple as it sounds:

- California has an independent operator system (ISO) that manages flow for 80 percent of California’s electricity. It matches generation with load and maintains electric frequency of the grid. Integrating the batteries into that system will be complicated.
- Not all batteries are created equal when it comes to suitability for energy storage. A lot depends on the manufacturing process and quality control.
- As a conclusion, the decision was made to extend the study with another 6 years: integrating the used batteries into a mini-grid on the UC San Diego campus to see how they fare in actual usage.

In addition to the conclusions of the above studies, one needs to consider the following challenges:

- There is the legal matter of product liability and extended producer responsibility. This is still a very grey zone as it is not always clear when the product responsibility is transferred.
- These type of expensive EV lithium batteries have a long warranty period (up to 5 years, or even more), they have a very long lifetime (7 to 10 years), components of the battery can be replaced individually (module, stack, cell) to enlarge the lifetime of the battery and reduce the warranty or service cost for the manufacturer or the consumer.
- This all makes that this EV lithium battery will be kept for its initial purpose as long as possible. As a consequence, this battery will have aged before the possibility for going into a second life application. This results in a risk of product obsolescence as the chemistry of lithium batteries is changing fast & significantly.

To predict the potential second life of an EV lithium battery, produced several years ago, will be very uncertain.
REACH stands for Registration, Evaluation, Authorization of Chemicals. The purpose of REACH is to ensure a high level of protection of human health and environment, including the promotion of alternative methods for assessment of hazards of substances, as well as the free circulation of substances on the internal market while enhancing competitiveness and innovation.

The REACH Authorization is a process designed to reduce or otherwise substitute Substances of Very High Concern (SVHC). The process is clear in its intents. To ensure that substances of very high concern are progressively substituted with less harmful alternatives provided they are technically and economically feasible.

Under the REACH Regulation, any EU Member State, or ECHA (European Chemical Agency) may propose a substance to be identified as a SVHC, based on specific criteria. Following the identification as a SVHC, a substance may be included in the Candidate List of substances which will eventually be subject to Authorization, and included into an Annex of REACH. Once included in the Annex, the substance may only continue to be used up to an official date after which its continued placing on the market and use is subject to an Authorization granted by the European Commission. The authorization itself will specify the precise uses and any conditions of use. Thus far no substances placed on the Candidate list have been the subject of an authorization, but several substances are already on the Annex.

This Candidate List is updated twice a year and is published on the ECHA website at http://echa.europa.eu/web/guest/candidate-list-table.

In August 2012, the European Commission instructed the European Chemicals Agency (ECHA) to take steps to include 38 substances including 21 lead compounds on the REACH Candidate List. Despite assertions to the contrary, the move was taken to ensure that the 2010 political commitment of Commissioners Tajani (Enterprise) and Potočnik (Environment) to have 136 substances on the Candidate List by the end of 2012 was fulfilled.

The European Commission wants to focus on “relevant SVHCs” and to have all of them on the Candidate List by 2020. However, populating the Candidate List in a liberal way could see a very significant list develop. In that case “relevant” needs to be interpreted as those substances most likely to require Authorization. This further implies a “test” for relevance.

Since 2009, the European Commission, ECHA and Member States have been promoting RMO (Risk Management Option) analysis – the test of relevance – as early as possible in the process. The Nickel Institute fully supports this and believes that consideration of relevant SVHCs for inclusion in the Candidate List should be subject to a careful Risk Management Option analysis to ensure regulatory efficiency and certainty with respect to the eventual use of authorization to control, limit and eventually eliminate the use of that substance.

Despite attempts to play down the importance of listing of substances on the REACH Candidate List as “not a ban”, the practical effect is the same as a black list. Blacklisting is extremely damaging for industry and is triggering initiatives from Original Equipment Manufacturers (OEMs) to restrict or ban their use or relocate their production and R&D outside EU.

Additionally, assessment of substance importance in meeting other EU policy goals needs to be carefully assessed as several SVHCs currently on the Candidate List are critical to achieving objectives of policy goals in areas such as the low carbon economy, resource & energy efficiency and innovation.
The Interface of the Batteries Directive with other Waste Directives

In addition to the general Waste Framework Directive (1), the EU Legislator has introduced three daughter Waste Directives to govern directly or indirectly the end of life management of batteries:

1. The ELV Directive and the Batteries Directive

The first Directive regulating the management of batteries as a part of a vehicle is the ELV Directive. It concerns both industrial and automotive batteries. With regard to the management of these batteries under the ELV Directive, the following principles should be implemented:

- When an ELV is containing an automotive or industrial battery, the complete battery weight counts towards achieving the recycling target under the ELV Directive. The Automotive or the Industrial Battery will be removed by the dismantler according to the requirements of the ELV Directive. The full battery, as removed from the End of Life Vehicle, will be delivered to the Battery Recycler.

- When a battery is at its end-of-life and is transferred from a car dismantler to a battery recycler and is made available for recycling, the recycler will report evidences about the recycling efficiency achievement on that battery according to the requirements of the Battery Directive and of the Commission Regulation 493/2012.

2. The WEEE Directive and the Batteries Directive

The second Directive that regulates the end of life management of batteries contained in equipment is the WEEE Directive. The following basic principles regulate the requirement to separate batteries from WEEE:

- In its Article 8 § 2, the WEEE Directive requires the selective treatment of materials and components of WEE and, as a minimum, the removal of components such as batteries (Annex VII).

- In a reciprocal manner, Article 12 § 3 of the Batteries Directive mentions that where batteries are collected together with WEEE on the basis of Directive 2006/66/EC, batteries shall be removed from the collected WEEE.

3. Implementation challenges

The efficiency of removal of batteries from equipment is critical both for vehicles and for EEE.

In the case of automotive batteries, there is a general acceptance that the separation of SLI (Starting – Lighting – Ignition) batteries vehicles is achieved efficiently together with the transfer of SLI batteries to recyclers. Hopefully this efficiency will be maintained in the context of the market development for electric mobility.

A special attention needs to be put on the end of life management of batteries used for electric bikes which should be transferred to battery recyclers in the most efficient conditions.

Billions of portable rechargeable batteries should be returned with mobile communication equipment and separated from such equipment. This may represent a costly activity due to the operation time and human effort.

There is a need for industry to optimize this separation operation either by automatic separation or by securing the traceability of the components of the returned battery when it is processed with equipment.

Prepared by RECHARGE
Critical Raw Materials for Advanced rechargeable batteries

This is an excerpt of a report made by RECHARGE to the Ad-hoc Working Group on defining critical raw materials: Critical raw materials for the EU. This ad-hoc Working Group is a sub-group of the Raw Materials Supply Group and is chaired by the European Commission.


During the next decade, the demand for high performance rechargeable batteries will increase as a result of the market evolution of the electrical and electronic portable equipment and of the electric vehicle market.

In the markets for portable electronic equipment and other cordless equipment, the sustained demand for rechargeable batteries observed over the last ten years should continue. The growth rate in materials demand is thus expected to reach 5% per year over the next decade. This will require an increasing use of rare earths, as well as nickel, cobalt and lithium (notably nickel- and cobalt-based specialty chemicals, and lithiated metallic oxides).

Given the greater uncertainty associated with the development of the electric vehicle being more speculative, a conservative evolution has been assumed. The resulting demand for rare earths, nickel, cobalt and lithium is based on a production of 1.0 million electric or hybrid electric vehicles in 2020.

The figures display the evolution of quantities of rare earths and nickel contained in portable batteries used in the EU between 2010 and 2020. Their tonnage in portable batteries might be multiplied by a factor of three to four for rare earths and nickel.

For rare earths, cobalt and lithium batteries represent today up to 25% of the current uses of these raw materials. An imbalance between supply and demand may occur during the market development of the e-mobility in the next ten years. The recycling of raw materials from these batteries will be essential in the EU to reduce this imbalance. The long lifespan of batteries (the average life is about seven years) will delay the availability of batteries for recycling and create gaps between the need for raw material and the availability of this source of secondary raw material.
Glossary

Contributors to the Report
### Associations - Organisations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ACEA</td>
<td>European Automobile Manufacturers Association</td>
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<tr>
<td>ADEME</td>
<td>French Environmental &amp; Energy Agency</td>
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<td>BAJ</td>
<td>Battery Association Japan</td>
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<td>BEBAT</td>
<td>Collection Scheme in Belgium</td>
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<td>EBRA</td>
<td>European Battery Recyclers Association</td>
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<td>ECHA</td>
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<td>EPBA</td>
<td>European Portable Battery Association</td>
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<td>EUCOBAT</td>
<td>European Association for national battery Collection Schemes</td>
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<td>EUROBAT</td>
<td>European Storage Battery Manufacturers Association</td>
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<td>GRS</td>
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<td>ICBR</td>
<td>International Congress of Battery Recycling</td>
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<td>PRBA</td>
<td>Rechargeable Battery Association of North America</td>
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<td>STIBAT</td>
<td>Collection Scheme in the Netherlands</td>
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<td>WRBRF</td>
<td>World Rechargeable Battery Regulatory Forum</td>
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### Transport

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<td>ADN</td>
<td>Inland Waterways Regulation</td>
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<td>ADR</td>
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<td>RID</td>
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<td>ICAO</td>
<td>International Civil Aviation Organization</td>
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<td>IMO</td>
<td>International Maritime Organization</td>
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<tr>
<td>TDG</td>
<td>Transport of Dangerous Goods</td>
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### Mobility

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<th>Acronym</th>
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<tbody>
<tr>
<td>(B)EV</td>
<td>Electric Vehicle, battery powered</td>
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<tr>
<td>HEV</td>
<td>Hybrid Electric Vehicle</td>
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<tr>
<td>PHEV</td>
<td>Plug-in Hybrid Electric Vehicle</td>
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### Legislation – Regulatory - Policy

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<td>BCRC</td>
<td>Battery Collection and Recycling Quality Certification Scheme</td>
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<td>CLP</td>
<td>Classification, Labeling, Packaging</td>
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<td>ELV</td>
<td>End-of-Life Vehicles</td>
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<td>EU-ETS</td>
<td>European Emissions Trading Scheme</td>
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<td>GHS</td>
<td>Global Harmonized System</td>
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<td>LCA</td>
<td>Life Cycle Analysis</td>
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<td>REACH</td>
<td>Registration, Evaluation, Authorization of Chemicals</td>
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<td>RMI</td>
<td>Raw Materials Initiative</td>
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<td>RoHS</td>
<td>Restriction of Hazardous Substances</td>
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<td>SVHC</td>
<td>Substances of Very High Concern</td>
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<td>UN</td>
<td>United Nations</td>
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<td>WEEE</td>
<td>Waste of Electric &amp; Electronic Equipment</td>
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<td>WFD</td>
<td>Waste Framework Directive</td>
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### Battery Chemistries

<table>
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<tr>
<th>Acronym</th>
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<tr>
<td>Li-ion</td>
<td>lithium-ion</td>
</tr>
<tr>
<td>NiMH</td>
<td>Nickel Metal Hydride</td>
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<td>NiCd</td>
<td>Nickel Cadmium</td>
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<tr>
<td>Pb acid</td>
<td>Lead-acid</td>
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Contributors to the Report

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ACCUREC
BEBAT
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SNAM
SPECIALIZED
STANLEYBLACK&DECKER
TOYOTA
UMICORE
VARTA
XSTRATA