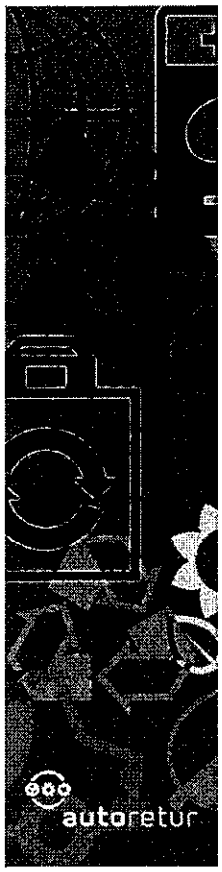


"Norwegian ELV Recycling Account"

Harald A. Damhaug, Albaran AS

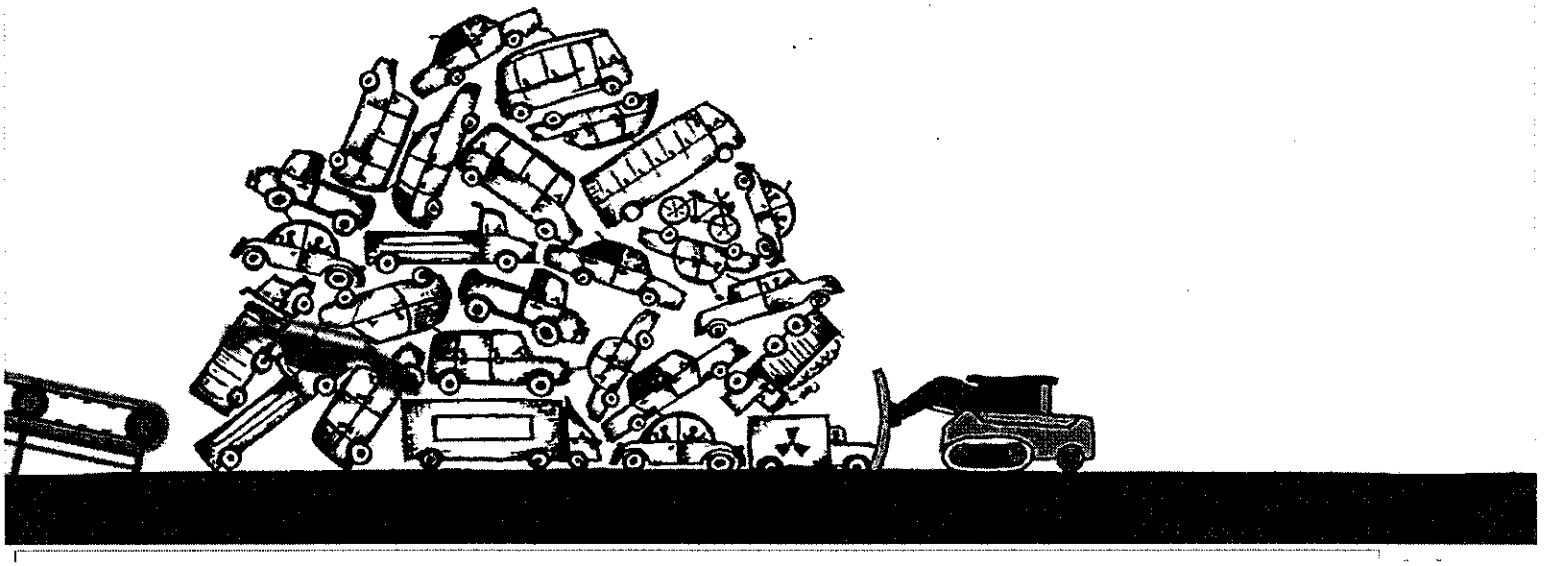
WRF 2017

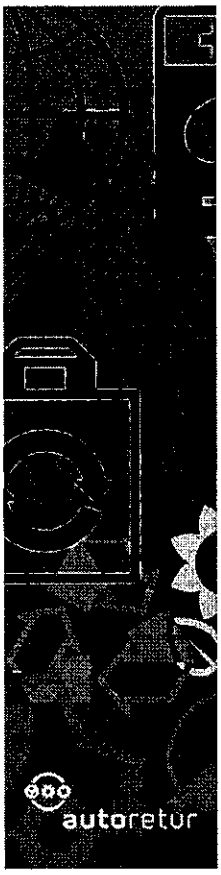
WRF 2017 Conference
Electronics & Cars Recycling
November 14-17, 2017 Macau

ALBARAN

autoretur

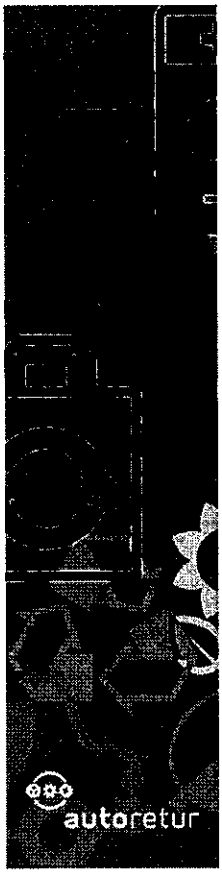
The car is dumped in a shredder





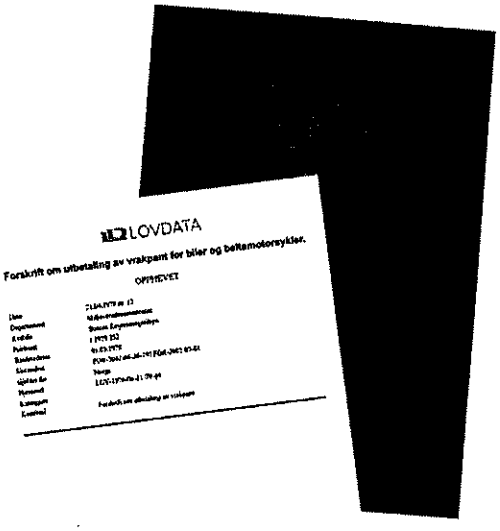
"Norwegian ELV Recycling Account"

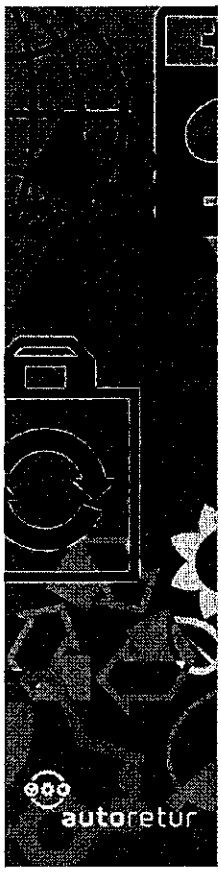
1. The story 1978-2007
2. Producers responsibility scheme 2007
3. Government Authorization
4. Collection ELVs versus wreckage incentive to last owner
5. Organization 2016
6. Autoreturs return system
7. Recycling Account
8. Compliance control and follow up authorized treatment facilities (ATF)
9. Economy-model for ATF
10. Compliance control and follow up Shredder
11. Electric vehicles and high energy batteries



1. The story 1978-2006

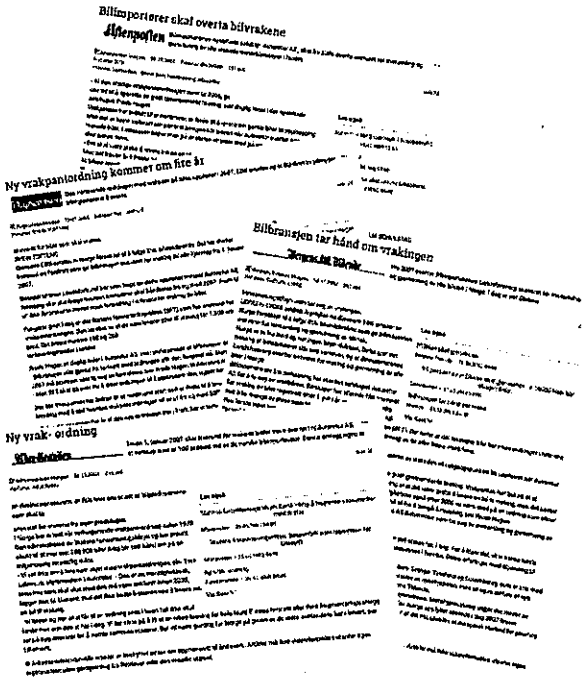
- Parliament created the State collection system in Norway 1978
- Introduced return scheme-as the first country in the world,
- Netherlands, Sweden and Denmark introduced various schemes in the 1990 's





2. Producer responsibility scheme 2007

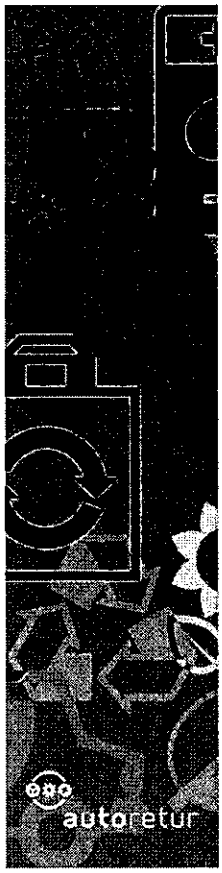
- EU directiv 2000/53/EC (ELV)
- Norwegian ELV regulation (FOR-2002-06-26-750)
- Car importers establishes the return the company Autoretur (2004)
- Autoretur, signs agreements with 2 Main operators for startup 1.1.2007


Bilimportører skal overta bilvrakene

Ny vrakpantordning kommer om fire år

Bilbransjen tar hånd om vrakingen

Ny vrak- ordning



3. Government authorization

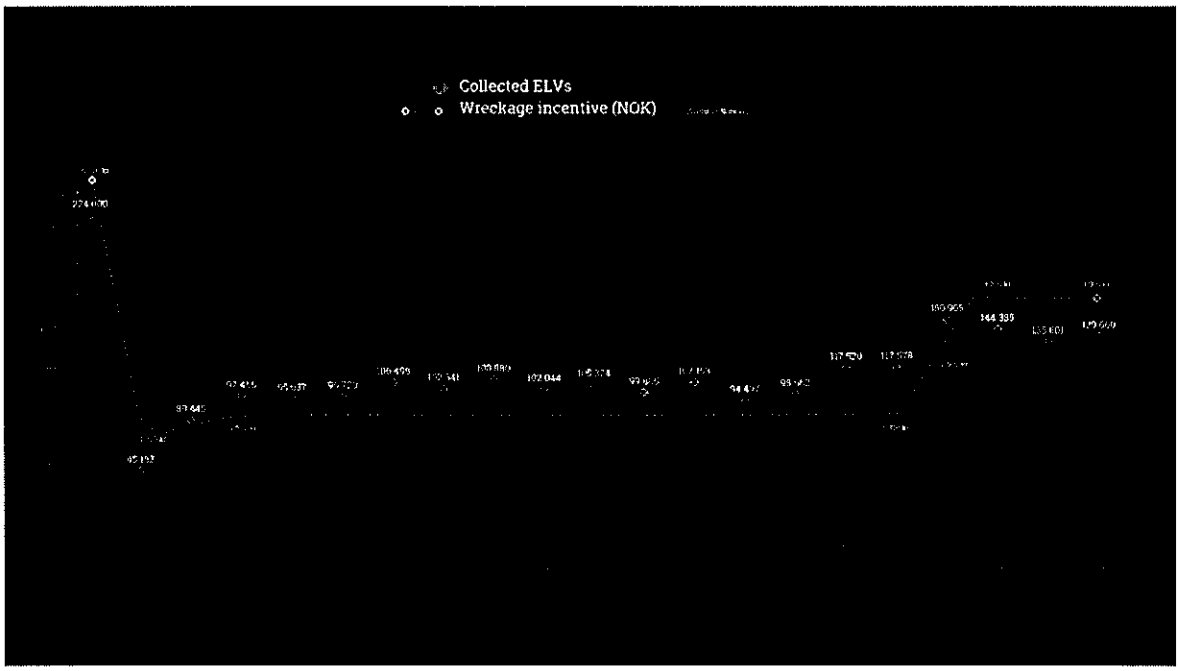
- Autoreturs' member list and the determination of producer responsibility compared to Members ' import share of new cars
- The return rate (95%) -> Nationwide network of BOPer with good access

Return rate 2007-2016

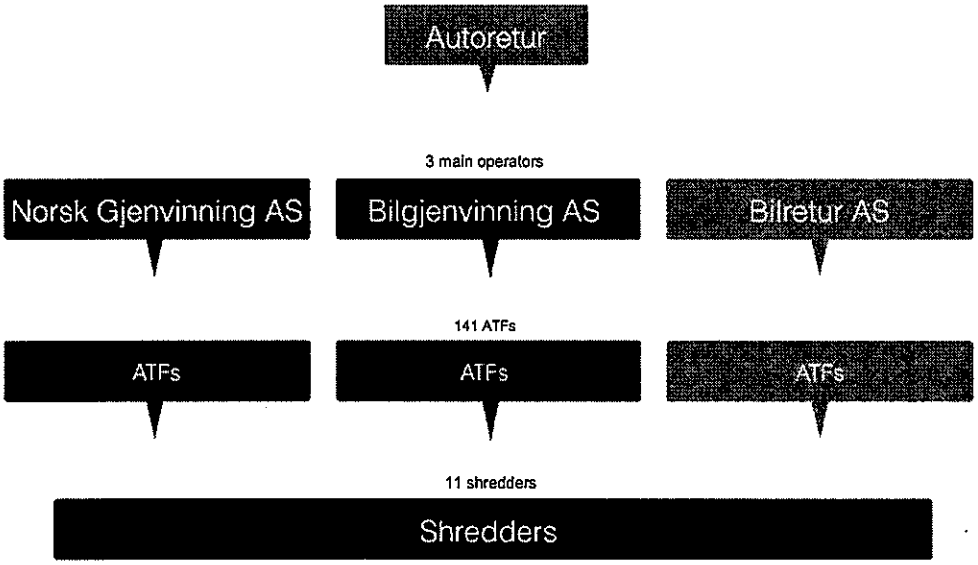
2016	2015	2014	Average 2007-2016
92,6%	95,5%	100,7%	95,9%

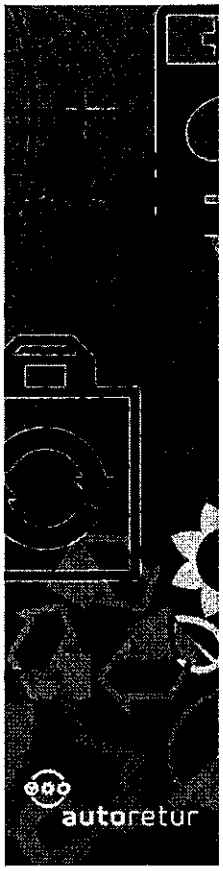
- Facilitating reuse of automobile
- Annual accounting/finance/financial strength scroll to be able to take charge of the wreckage incentive scheme after the Government

4. Collection ELVs vs. wreckage incentive to last owner



5. Autoretur's organization





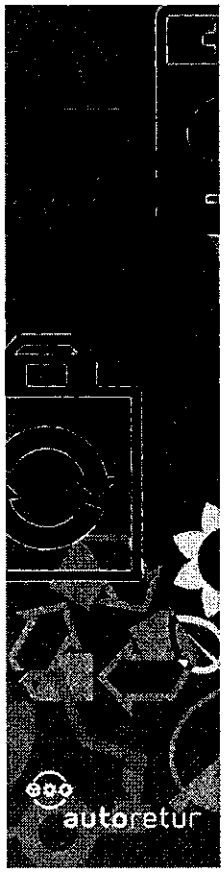
6. Autoretur's return system 2016

141 ATFs and 11 Shredders

Shredders

1. Stena Recycling, Skien
2. Hellik Teigen, Hokksund
3. Norsk Gjenvinning Metall, Fredrikstad
4. Metallco Stene, Fredrikstad
5. Norsk Metallfragmentering, Gjøvik
6. Norscrap West, Hanøytangen
7. Hermod Teigen, Egersund
8. Vartdal Gjenvinning, Vartdal
9. Norsk Gjenvinning Metall, Orkanger
10. Kuusakski, Skjellefteå, Sverige
11. H.J. Hansen, Odense, Danmark

2 400 km from South to North



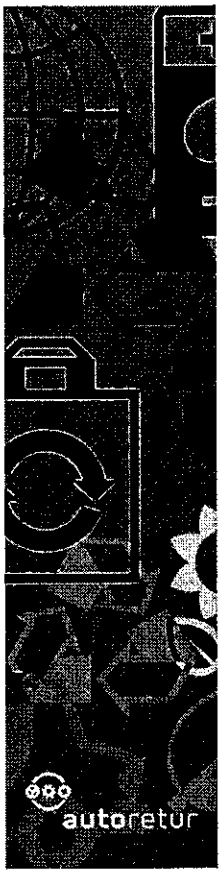
7. Recycling Account 2016

Government demand (consistent with the EU's ELV directive)

- Recycling rate (total) > 95%
- Reuse + Recycling (material) ≥ 85%,
- Deposit ≤ 5%
- Recovery (energy) -> residue

Achieved recycling rate distributed on disposing formers

Dispose	2016
	(%)
Reuse	5,8
Recycling (material)	79,4
Recovery (energy)	12,5
Deposit	2,3
Sum	100



8. Compliance control and follow up to ATF

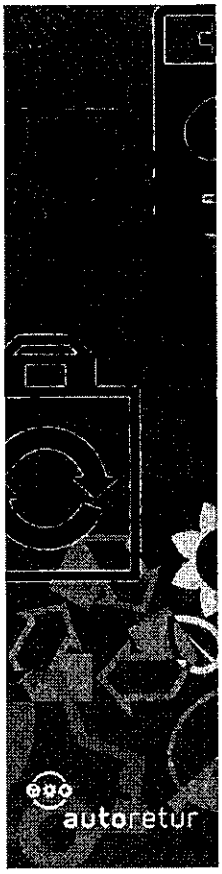
- ATF operation vs. emission permit/supervision from authority
- Reported amounts vs. results depollution/disassembly is calculated according. the average weights (kg/PCs)
- Limitations in the choice disposal forms in AutoStat (reuse/recycling/recovery/deposit)

Biloppsamlingsplass * (Gml) Agder Miljø Bilmottak AS 4849 ARENDAL

Leveringsdato * 02.10.2017

Merk! For fraksjoner merket med > foran Antall finns det gjennomsnittsvekter. Angis kun antall regnes vekt ut og omvendt.

Tekst	Avfallsfraksjonsnr	Antall		Vekt i kg	Disponering	Levert til [Endre...]
Bensin	*13 07 02				Ombruk	Ikke valgt
Diesel	*13 07 01				Ombruk / Energigjenvinning	Ikke valgt
Frostvæske	*16 01 14				Ombruk	Ikke valgt
Kjølemedium	*16 01 14				Ombruk	Ikke valgt
Spylervæske	*16 01 14				Ombruk	Ikke valgt
Spillolje 1	*13 02 05				Energigjenvinning	Ikke valgt
Spillolje 2 Ikke refusjonsberettiget	*13 02 05				Energigjenvinning	Ikke valgt
Oljeavfall fra oljeutskiller	*13 05 06				Deponi	Ikke valgt
Oljefiltere (0,3 kg)	*16 01 07	>			Materialgjenvinning	Ikke valgt



8. Compliance control and follow up to ATF

County authority's report-hazardous waste/pollutants

autostat — Rapporterings- og statistikksystem — autoretur

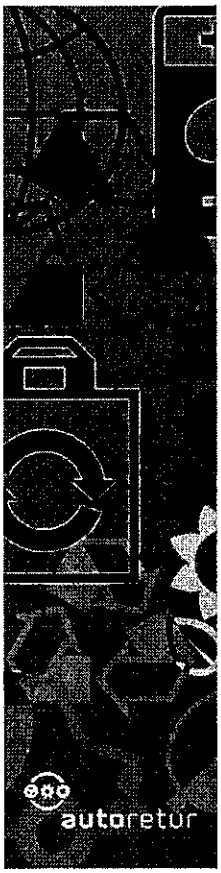
Årsrapportering for Borg Bildemontering og Karosseri Johansen				År 2016	
Avfallstype		**Innlevert**		**Innsamler**	**Lager pr. 31.12**
Bensin	*13 07 02	Kg	3 929	Ikke valgt	84 liter
Diesel	*13 07 01	Kg	577	Ikke valgt	38 liter
Frostvæske	*16 01 14	Kg	1 216	Ikke valgt	132 liter
Kjølemedium	*16 01 14	Kg			0
Spylervæske	*16 01 14	Kg	876	Ikke valgt	50 liter
Spillolje 1	*13 02 05	Kg	2 944	[redacted]	450 liter
Spillolje 2	*13 02 05	Kg			0
Oljeavfall fra oljeutskiller	*13 05 06	Kg	362	[redacted]	Beregning umulig, tømmes av eksternt firma
Oljefiltere	*16 01 07	Antall	929	[redacted]	220

9. Economy-model for ATF

- «0»- cost vision – not sustainable for Norway
- Financial support for the transport of hulks from ATF to the nearest shredder
- Minimum price guarantee for sales of steel scrap by low market price
- Revenue sharing for sales of steel scrap by high market price

10. Compliance control and follow up to shredder

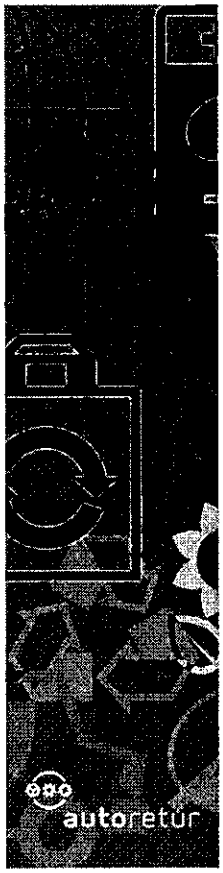
- Shredder operation vs. emission permit/supervision from authority
- Registration of received number of hulks and quantities (kg)
- Control/approving the number of hulks and quantities (kg) delivered from ATF to shredder
- Reported parameters for disposing of fractions after sorting at shredder
- Reported parameters for disposing of fractions after incineration of residue



10. Compliance control and follow up to shredder

Determination of parameters for different disposal forms post shredder technology (PST)

Affiliated shredders	(1) Parameter recycling steel scrap after shredder	(2) Parameter recycling non-ferrous metal after shredder	(3) Parameter recycling of sorted shredder light fraction (SLF)	(4) Parameter recycling of sorted shredder other fractions (SOF)	(5) Parameter residue for deposit sorted SLF	(6) Parameter residue for deposit after sorted SOF
Weighted sum:	71,05%	6,91%	5,42%	1,72%	1,84%	0,48%



10. Compliance control and follow up to shredder

Determination of parameters for different disposal forms after incineration

Affiliated shredders	(7) Parameter metal to recycling after incineration of sorted SLF	(8) Parameter non-ferrous metal to recycling after incineration of sorted SOF	(9) Parameter energy recovery by incineration of residue of SLF	(10) Parameter energy recovery by incineration of residue of SOF
Weighted sum	0,13 %	0,06 %	9,29 %	1,96 %

(11) Parameter deposit by incineration residue of SLF	(12) Parameter deposit by incineration residue of sorted SOF	(13) Parameter ash residue for recycling after incineration of sorted SLF	(14) Parameter ash residue for recycling after incineration of sorted SOF	Sum Parameters 1-14
0,26 %	0,02 %	0,84 %	0,01 %	100 %

11. Electric vehicles and high energy batteries

- The number of electric vehicles, hybrids and rechargeable hybrids in Norway surpassed 100 000 in 2016
- Forecast for 2017 predict that new car sales in Norway will end up with a total of 152.400, of which approximately half (50%) will be electric vehicles, hybrids and rechargeable hybrids
- High energy battery in ELVs disassembled by expert personnel on ATF according to special course/authorization
- On handling organized by the return company for batteries (Batteriretur AS)
- Batteriretur handles high energy batteries properly and according to agreement with car importers
- Authorized personnel operate according to instructions from car producers and "Regulations on the safety of work in and operation of electrical equipment" and "Regulations on land transport of dangerous goods"

11. Electric vehicles and high energy batteries

Quo Vadis Flat Screens

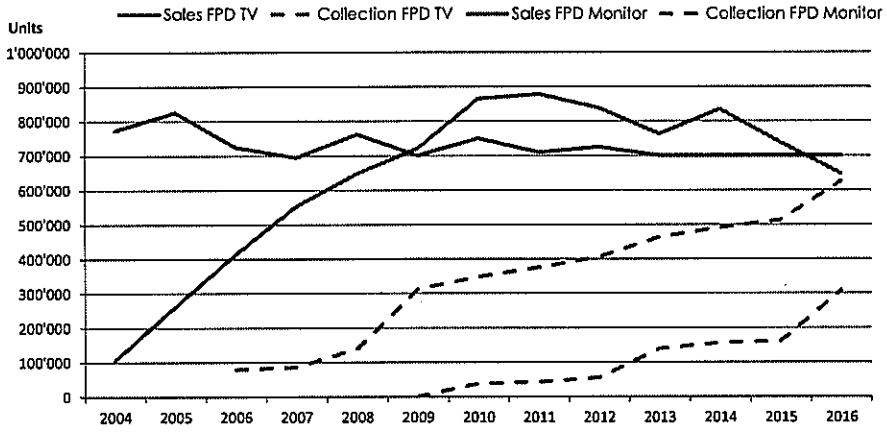
Andreas Krebs, CEO, BLUBOX™ Trading AG

Content

1. Overview Flat Screens, Market and Technologies
2. Reuse "Pros and Cons"
3. Recycling Challenges
4. Mass Balance of Flat Screens
5. The BLUBOX Technology
6. Conclusions

1. Overview Flat Screen Market

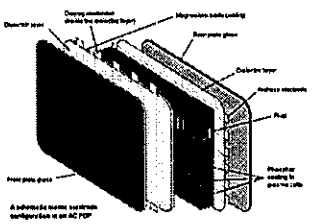
Sales and Collection of FPD's in Switzerland



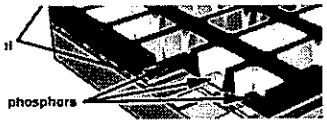
- Each year 2 people out of 10 buy a new Flat Screen
- 50% are collected for recycled
- 75% are still with CCFL backlights
- Strongest market in numbers of units

1. Overview Flat Screen Technologies

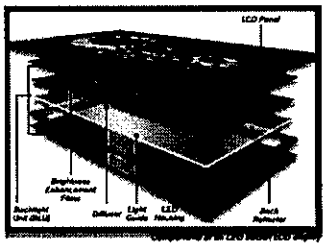
1. Plasma



Waver Technology



2. LCD / LED



CCFL - LED

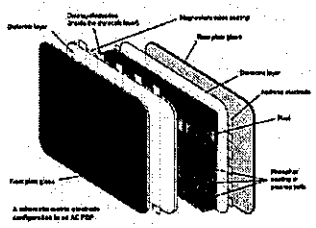
3. OLED / QLED

Light emitting
Organic - Inorganic

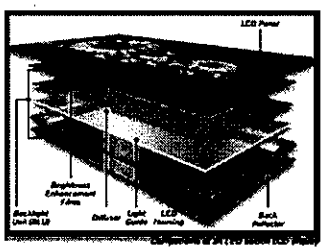
OLED QLED

1. Overview Flat Screen Technologies

1. Plasma



2. LCD / LED



is the cheapest flat screen technology

3. OLED / QLED

2. Reuse "Pros and Cons"

Pros

- Increase of lifetime.
- Reduce waste.
- Sell parts for money.
- E-waste companies becoming green.
- Creates jobs.

Cons

- E-Waste contains hazardous materials.
- No safety laws.
- Transfer the e-waste problem to other countries.

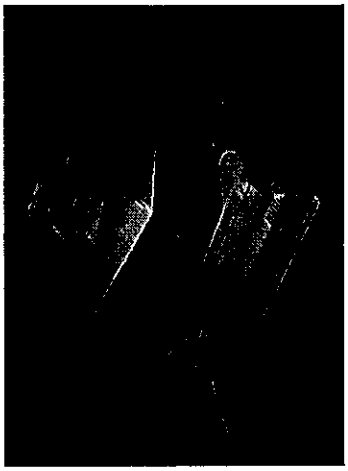
2. Beside the Benefits of Reuse

- Materials are shipped to countries with weak environmental standards.
- Not only refurbished products are shipped, but also waste.
- No one is responsible for the environmentally friendly disposal of the waste.

3. Recycling Challenges

- Low recycling value of the materials contained in flat screens.
- The handling and environmental friendly disposal of the hazardous materials.
- Limited need for recycled plastics.

4. A Typical Mass Balance of Flat Screens



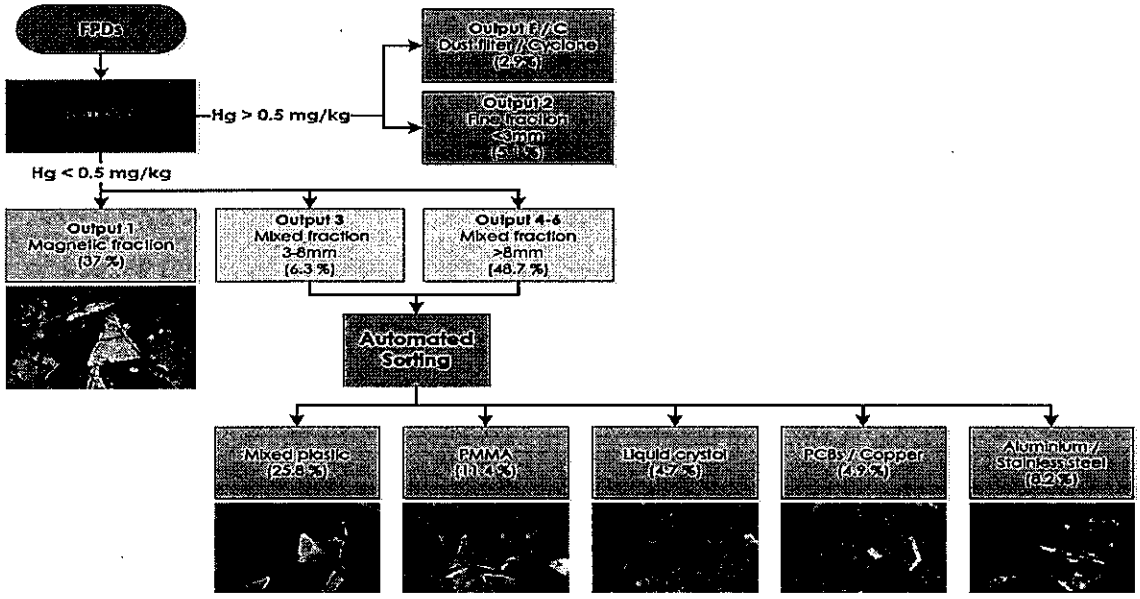
Description	Mass [%]
Ferrous metals	37.0
Aluminum, CrNi	8.0
Printed circuit boards (PCB) / Copper	7.0
Liquid crystal glass	5.0
PMMA	13.0
Mixed plastics	28.0
Backlights	1.0
Others	1.0
Total	**100.0**

5. The BLUBOX Technology

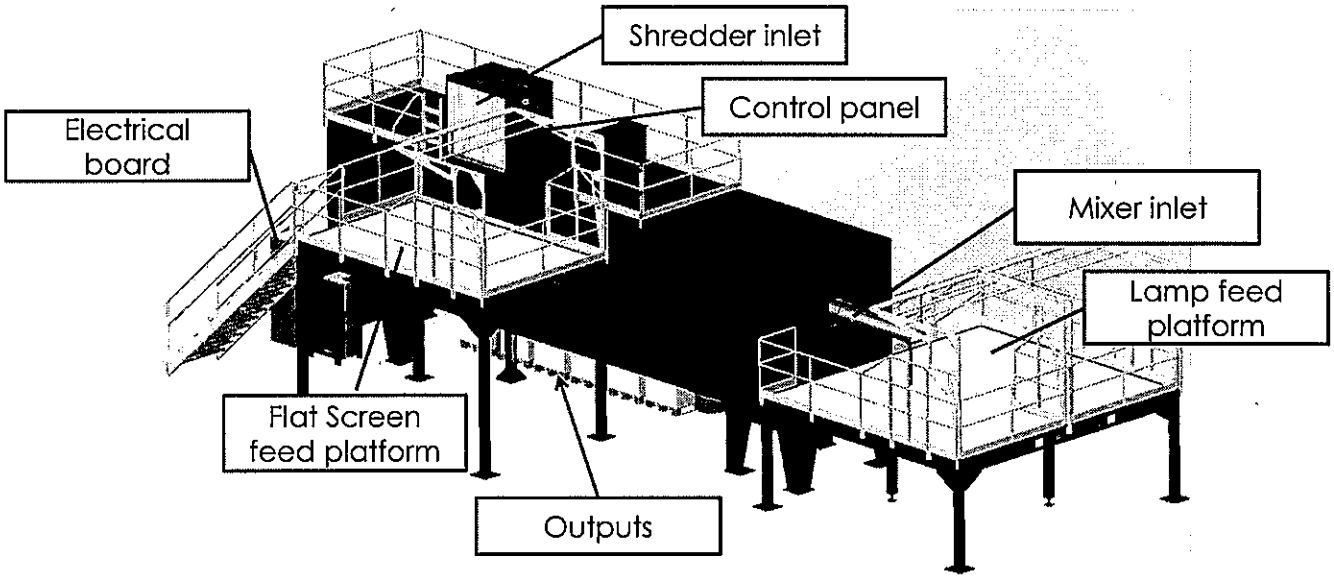
Shredding → Separation → Sorting

Shredding	Separation	Sorting
Shredder process to liberate the materials and make them available for the next process step.	Separation process to separate the hazardous from the non-hazardous material.	Sorting process to separate the materials in valuable fractions.

5. The Output Fractions from Flat Screens



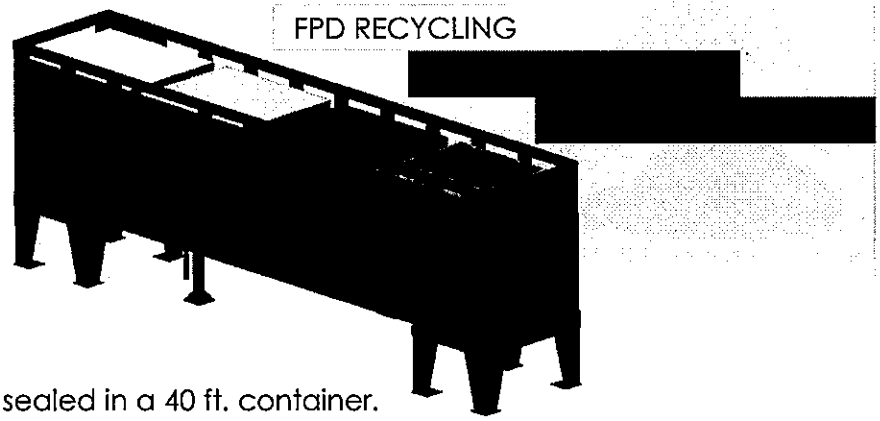
5. How Does it Work?



5. How Does it Work?

LAMP RECYCLING

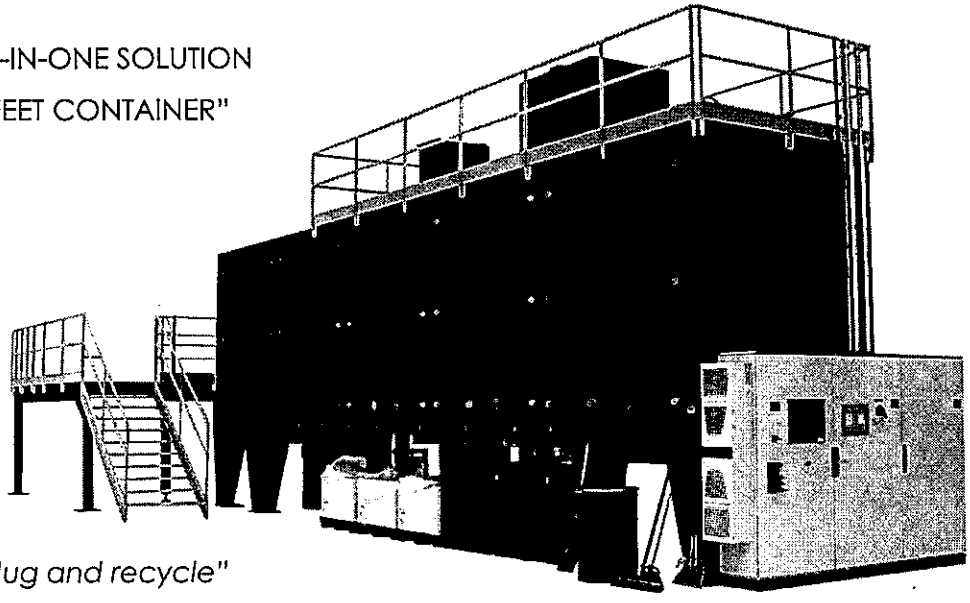
FPD RECYCLING



- The whole process is sealed in a 40 ft. container.
- Save process.
- No emissions.

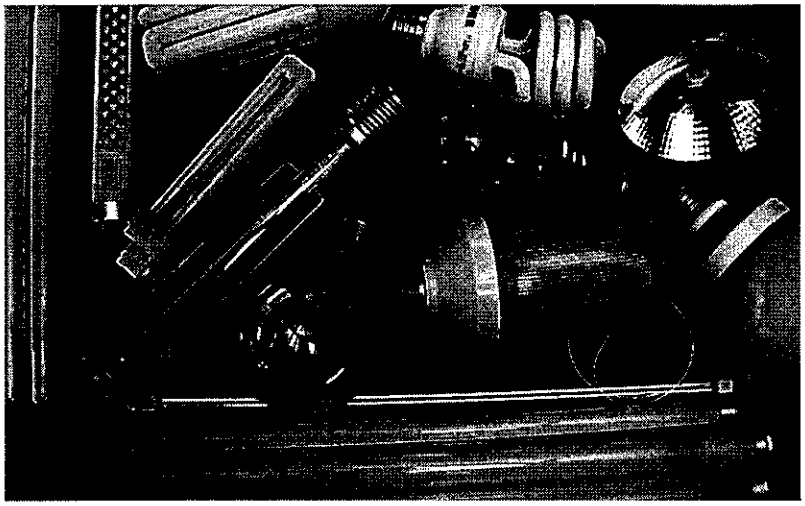
5. The BLUBOX

"THE ALL-IN-ONE SOLUTION
IN A 40 FEET CONTAINER"



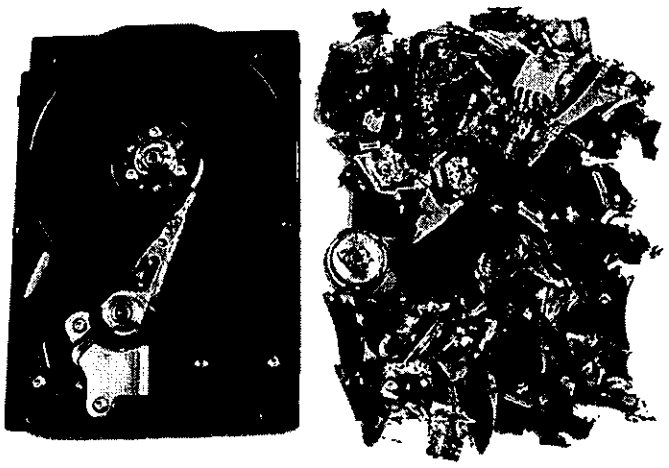
"Plug and recycle"

5. Lamp Recycling



- All kind of lamps can be treated, from fluorescent tubes to compact lamps.
- The only lamp recycling machine able to recycle LED lamps to.
- The lamp recycling can be done at the same time as the flat screen recycling.

5. Data Destruction

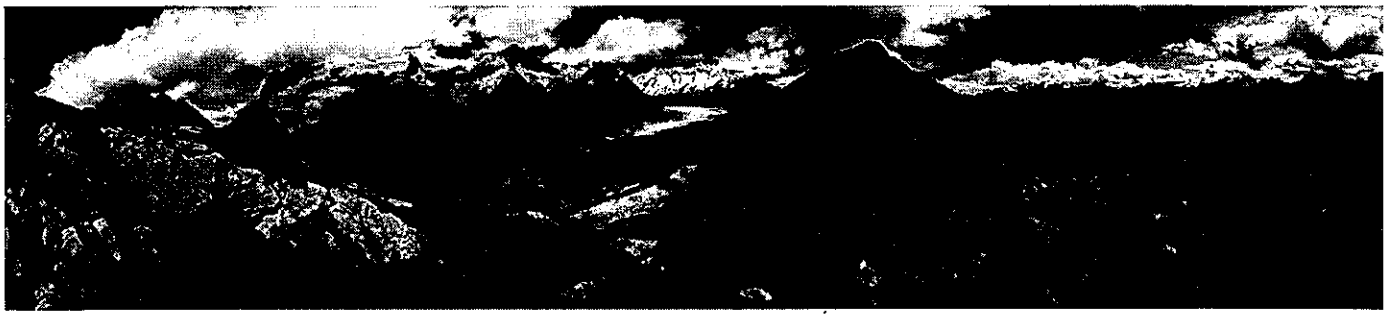


- The BLUBOX is equipped with a camera system to control the shredder room.
- The particle size of the output material can be chosen.
- The valorization of the shredded material can be increase through sorting.

6. Conclusions

- The numbers of units of flat screens sold on the market and collected for recycling increases strongly every year.
- The BLUBOX Technology is made for a environmental friendly recycling of flat screens.
- And the BLUBOX is even more useful by using it for lamp recycling and data destruction.

Thank you



Andreas Krebs
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Progress of Management in Implementation of EPR and Collection & Recovery of Traction Batteries in Chinese Automotive Industry

China Automotive Technology & Research Center

November, 2017

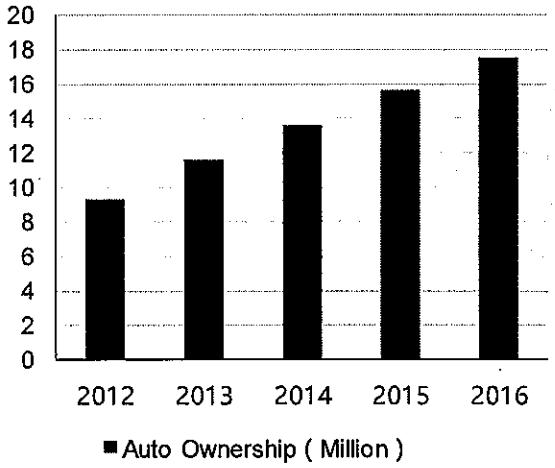
数据资源中心
Automotive Data Center

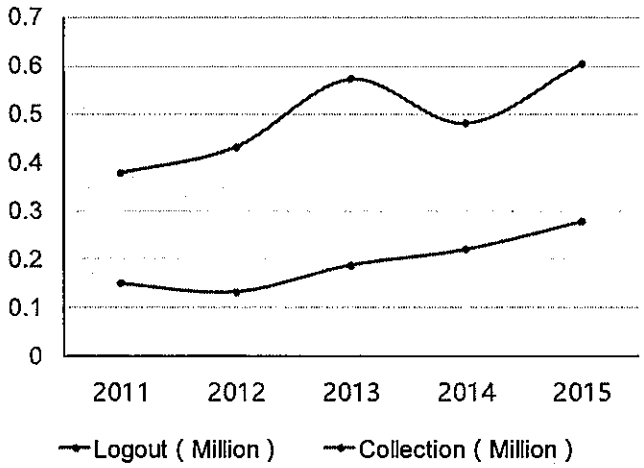
CONTENT

1 Background of EPR Implementation of Auto Industry

1.1 Present Situation and Problems

■**With the sustainable growth of car ownership, the number of the scrapped cars is increasing too.**



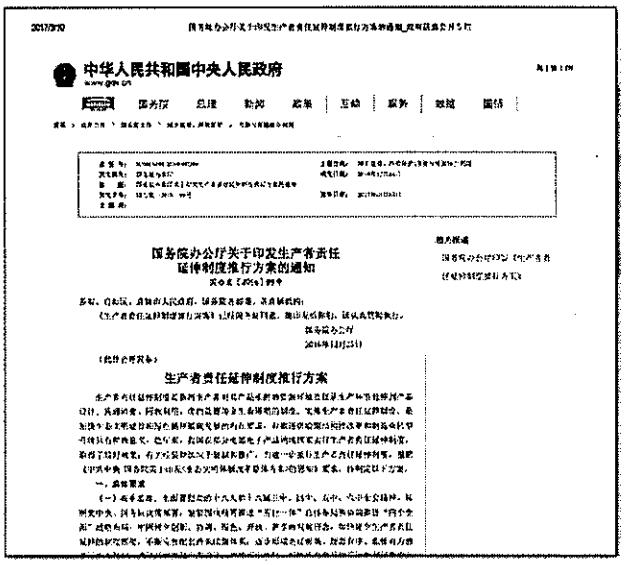


■**The number of scrapped cars in China is increasing year by year, however the number of recycling ones is low.**

1 Background of EPR Implementation of Auto Industry

1.2 EPR Implementation

■**EPR has been explored and implemented in the field of electronic products, and has achieved good results.**


中华人民共和国中央人民政府

国务院办公厅关于印发生产者责任延伸制度推行方案的通知

生产者责任延伸制度推行方案

Product range :

- EPR system will implement first on the fields of electrical and electronic products, automobile products, lead-acid battery and wrappage, etc. Based on the experience of pilot work, the application of EPR system will be expanded appropriately.

Scope of EPR responsibility:

- Carry out the eco-design, utilize renewable material, regulate the recycling and enhance the information publicity.

To perfect the relevant regulations :

- Revise the "Circulation Economy Promotion Law"
- Revise the "Recycling Management of ELVs"
- Revise the "Regulation on the Administration of the Recovery and Disposal of Waste Electrical and Electronic Products"

2 Progress and Plan of EPR Implementation of Auto Industry

2.1 Pilot Project Progress

■MIIT is responsible for EPR pilot work and has formed the "Pilot implementing project" (draft)

General Ideas

- ▪Manufacturers are subjects of responsibilities
- ▪Follow the full- lifecycle management
- ▪Emphasize on recycling and reusing of ELVs

▪Reduce environmental pollution, enhance the efficiency of resource utilization, explore an EPR model suitable to China's national conditions.

Main Purposes

Setting-up a model enterprise and explore the extension way

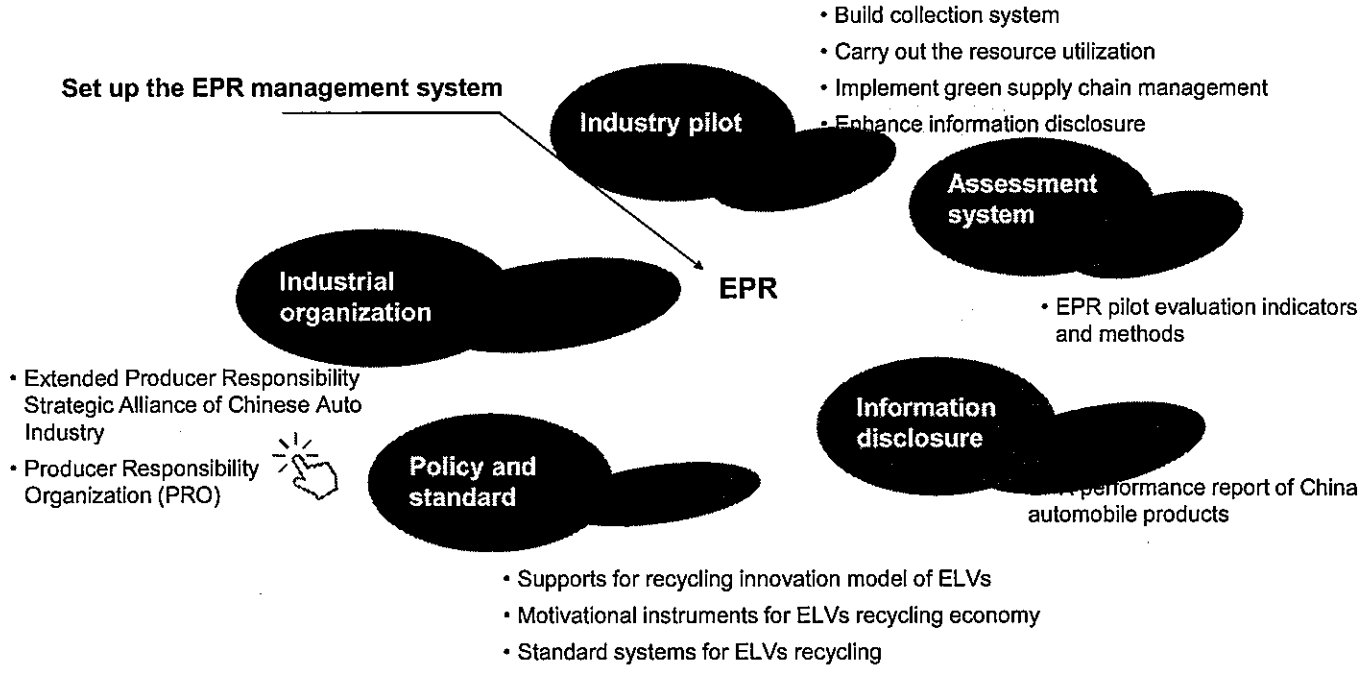
- Mark some industry benchmark enterprises to form up the EPR model suitable to Chinese characteristics
- Set up an ELVs-recycling system in the pilot area that dominated by the manufacturers.
- Improve the level of utilization of renewable resources of ELVs and make the recyclability more than **75%**.

Comprehensive management/Technical support/ Performance assessment

▪Based on the pilot experience, exploring the EPR comprehensive management system, technical support system and performance assessment system of auto products.

2 Progress and Plan of EPR Implementation of Auto Industry

2.2 Revision of the EPR management system of auto products based on the pilot project



2 Progress and Plan of EPR Implementation of Auto Industry

2.3 To set up a EPR strategic alliance

Organization

Council — Decision maker
- ◆make the decisions of the important matters of the alliance.
- ◆formulate and revise the relevant regulations and rules.

Executor — **Secretariat**
- ◆coordinate and drive the work.
- ◆undertake the work delegated by the council.

Technical committee — **Counselor**
- ◆Provide advice for alliance.
- ◆Check the research task.

Field

design	produce	consume	recycle	waste disposal
• Eco-design • Renewable material test technology • Specification for using recycled raw materials	• Construction of green manufacturing system – Green product /factory /supply chain /Area	• Construction of old part recycling system • Component reuse	• Innovative recovery model research • Model of combined recovery model – PRO	• ELVs dismantling informatization • processing waste recycling • waste recycling

Scope

Policies and laws research — EPR system building — Data platform research

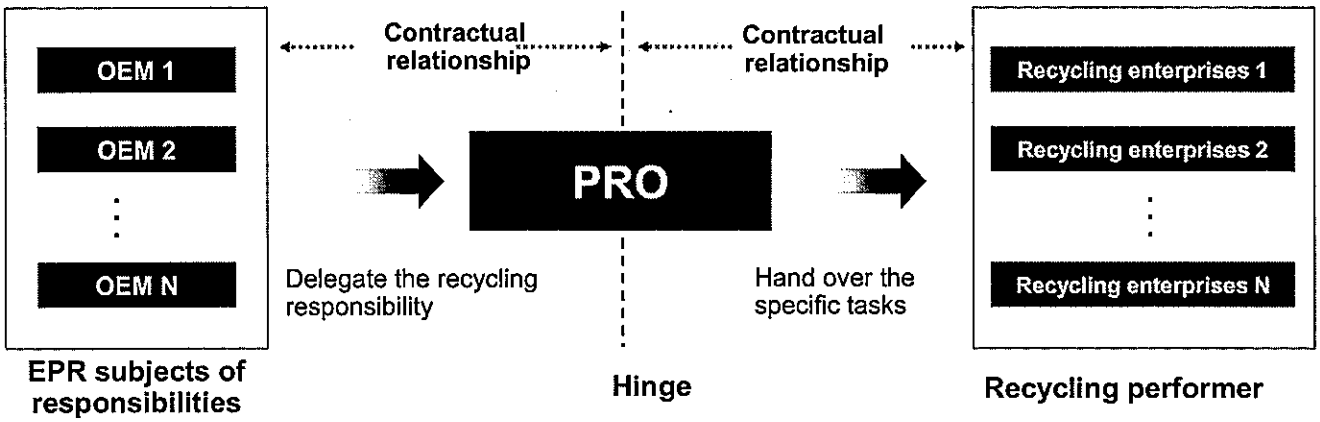
Standards research — Technical routes setting — Implementation report

2 Progress and Plan of EPR Implementation of Auto Industry

2.4 To set up Producer Responsibility Organization (PRO)

■PRO is supported by the government to assist the producers to perform product recovery responsibilities.

- Few Manufacturers try recycling of ELVs;
- There are thousands of Auto Manufacturers and over 600 ELV recycling and dismantling enterprises in China. It is complicative for both to establish full cooperation.

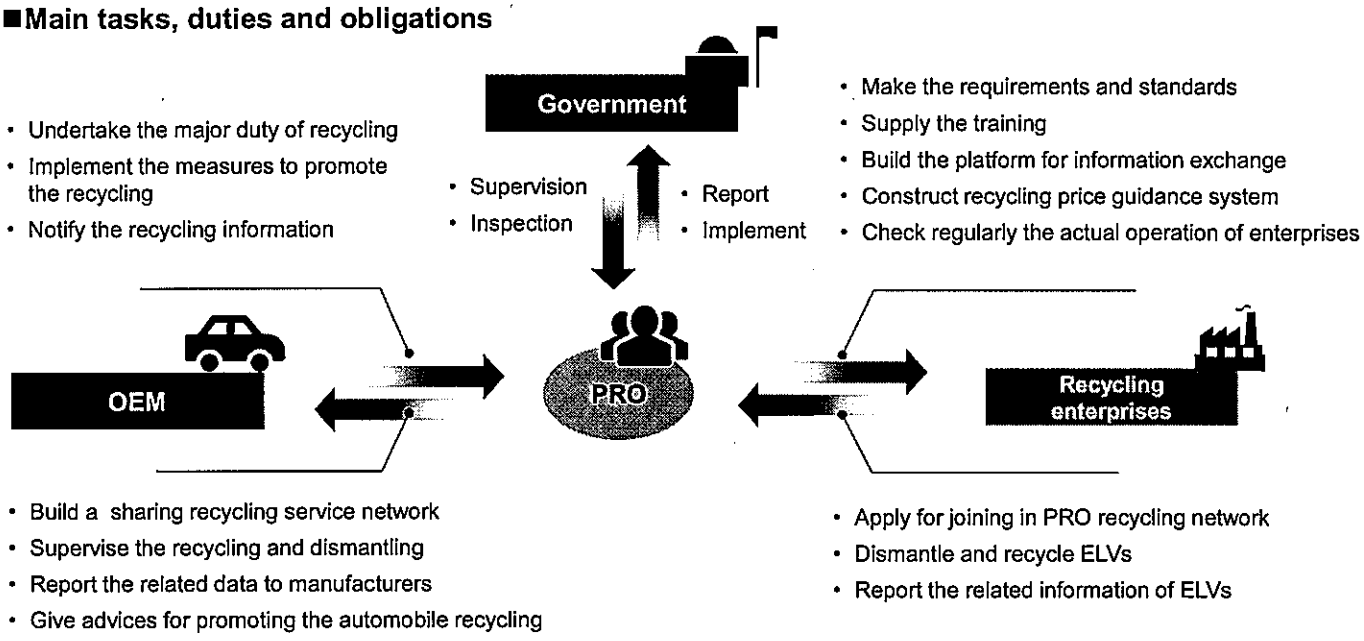


To use PRO to build a national-sharing recycling network is necessary

2 Progress and Plan of EPR Implementation of Auto Industry

2.4 To set up Producer Responsibility Organization (PRO)

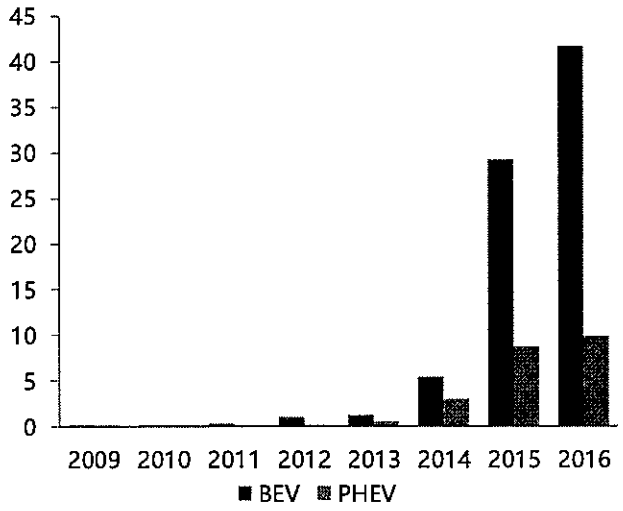
■Main tasks, duties and obligations

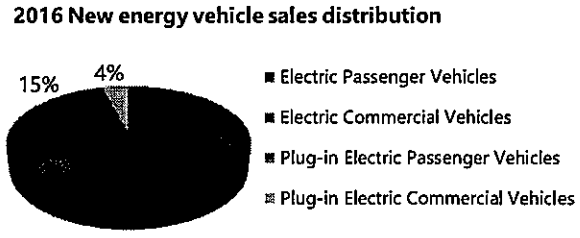


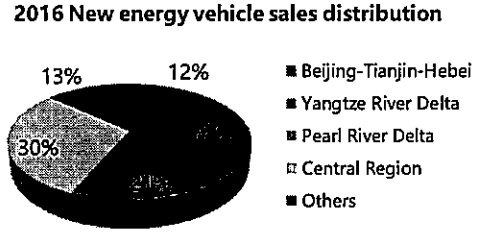
3 Background of Traction Battery Recycling Management

3.1 Present Situation

■ In recent years, China's new energy vehicle industry has exploded. The output in 2016 reached 517,000.



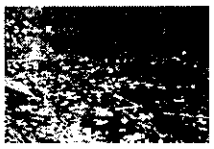




3 Background of Traction Battery Recycling Management

3.2 Problems

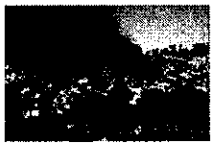
■The recyclability of the traction batteries is related to the sustainable development of the industry



◆ A lot of waste traction batteries will pollute the environment heavily.

◆ Retired batteries still contain 80% capacity.

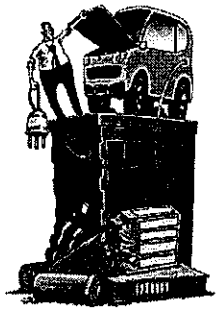
◆ There are a lot of precious metal elements in the battery.



◆ A lot of waste batteries would lead to fire or explosion.

□Lack of management measures to regulate.

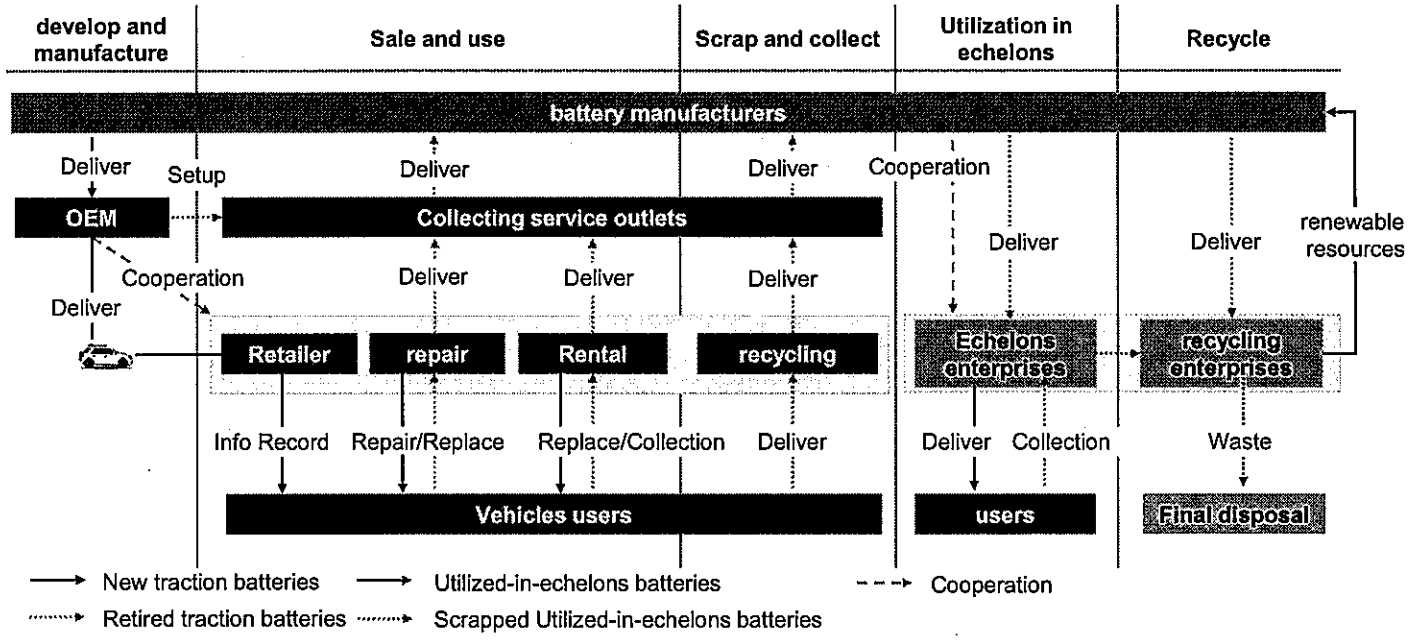
——Who is going to recycle?
——How to do?
——How to deliver?
——Management?
——Standards?
——Measures?



4 Principles of Traction Battery Recycling Management

4.1 Traction battery recycling route diagram

■Based on full- lifecycle



4 Principles of Traction Battery Recycling Management

4.2 Principles of *Tentative Administrative Rules on Traction Battery Recycling of New Energy Vehicle*

■**The *Administrative Rules* clears the scope of management, duties and requirements of related parties, measures of supervision etc., which is to form the Chinese mode of traction battery recycling.**

① Basic Principles	② Core Measure: Coding and Traceability Management	③ Supporting Measures	④ Penalty
➢Fulfill the EPR system ➢OEMs are subjects of collecting responsibilities, and the battery manufacturers ensure batteries get recycled and disposaled. ➢The idea of full- lifecycle ➢Full Market forces	➢Construct the coding standards, traceability system and information sharing mechanism ➢Make sure the products are traceable	➢lead industry-university-research cooperation ➢Encourage technology application and mode innovation ➢bettering the standard system ➢build the incentive mechanism ➢standardize the management of utilized-in-echelons products	➢Coordinately managed by departments of government ➢The penalty is related to the admittance management. ➢The departments should punish within their scope of duties

• *standard system : — GB/T 33598 Recycling of Traction Battery Used in Electric Vehicle-Dismantling Specification*
— GB/T 34014 Coding Regulation for Automotive Traction Battery
— GB/T 34015 Recycling of Traction Battery Used in Electric Vehicle-Test of Residual Capacity

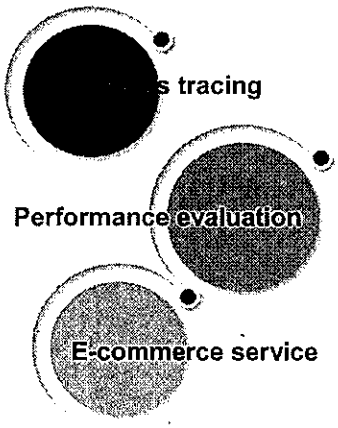
5 Traction Battery Traceability Management

5.1 Construction of Traceability Information System

Purpose
Collecting information, assessing the battery, and supporting retired battery online trade.

Orientation
A tool for data collection, analysis and inspection.

User Group
New energy vehicle manufacturers, battery manufacturers, recycling enterprises, utilizing in-echelons enterprises, reusing enterprises, etc.

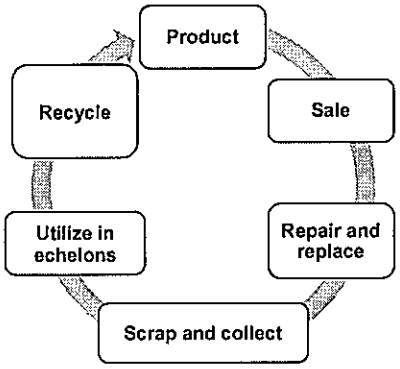


5 Traction Battery Traceability Management

5.1 Construction of Traceability Information System

◆ Products tracing

Collect information related to each part of battery's whole life circle based on the requirements of traceability.



◆ Performance evaluation

Evaluate the performance of decommissioned batteries based on the full- lifecycle and support utilization in echelons .

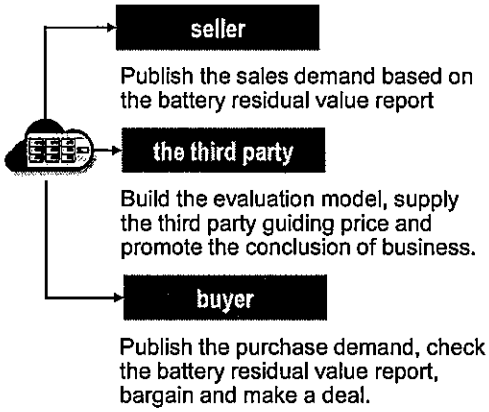
performance evaluation and reuse evaluation model

- health level
- residual life
- residual value
- the optimal scenario of utilization in echelons

Retired battery space-time distribution Economy and market value

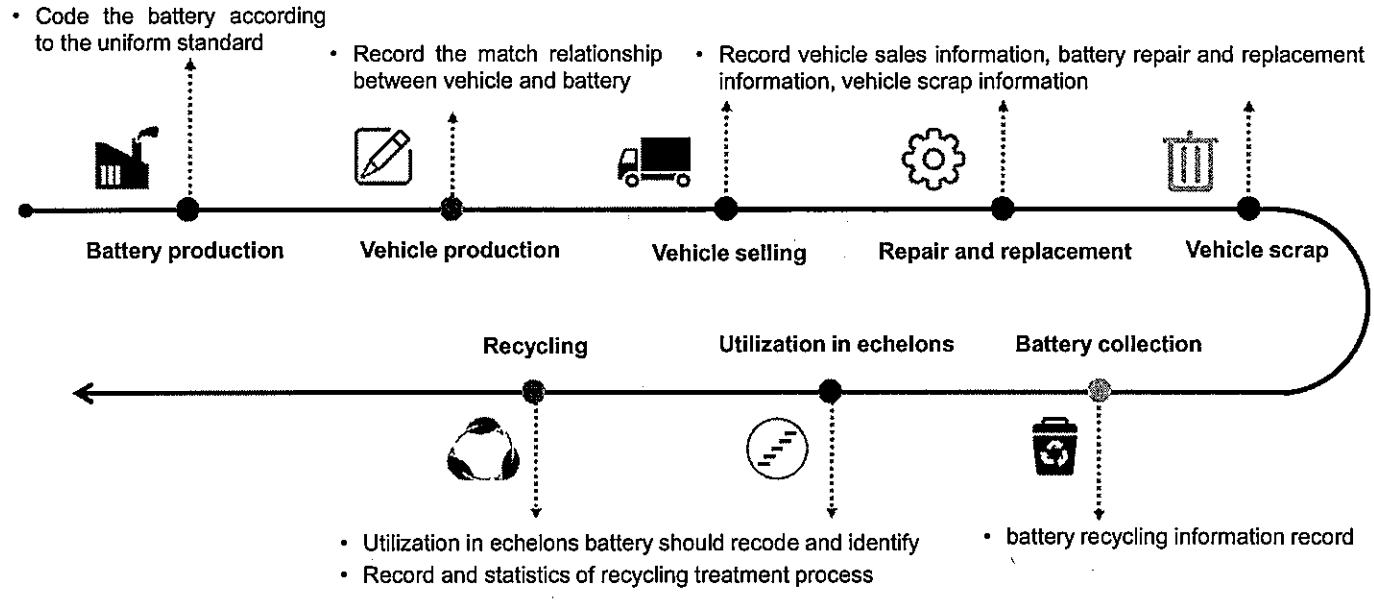
◆ E-commerce service

Establish power battery's whole life circle business model based on big data, Internet of Things, etc.



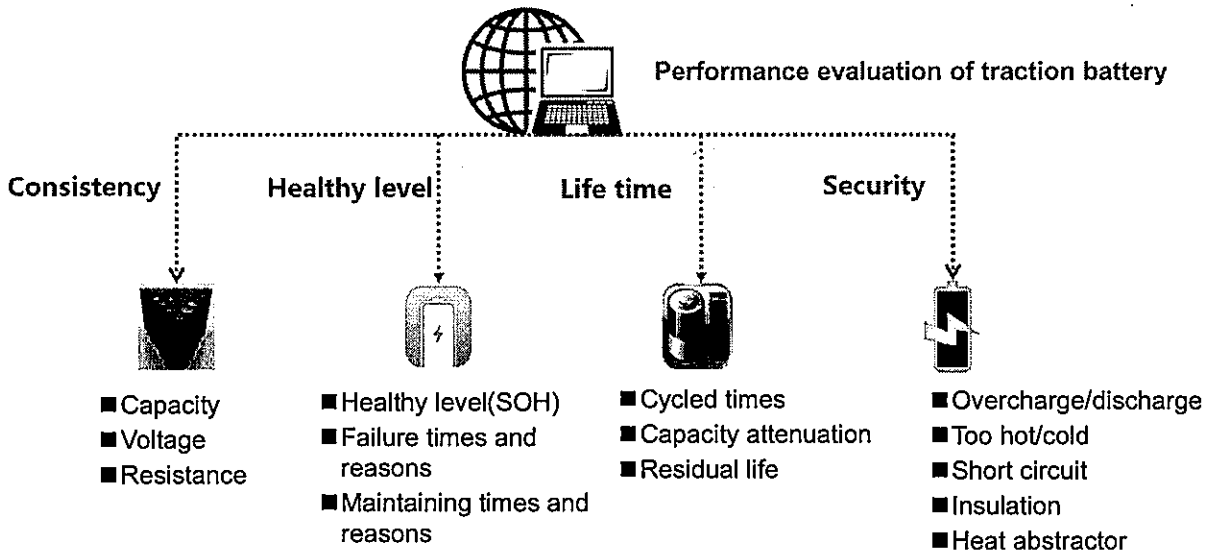
5 Traction Battery Traceability Management

5.2 Construction of Traceability Information System—products tracing



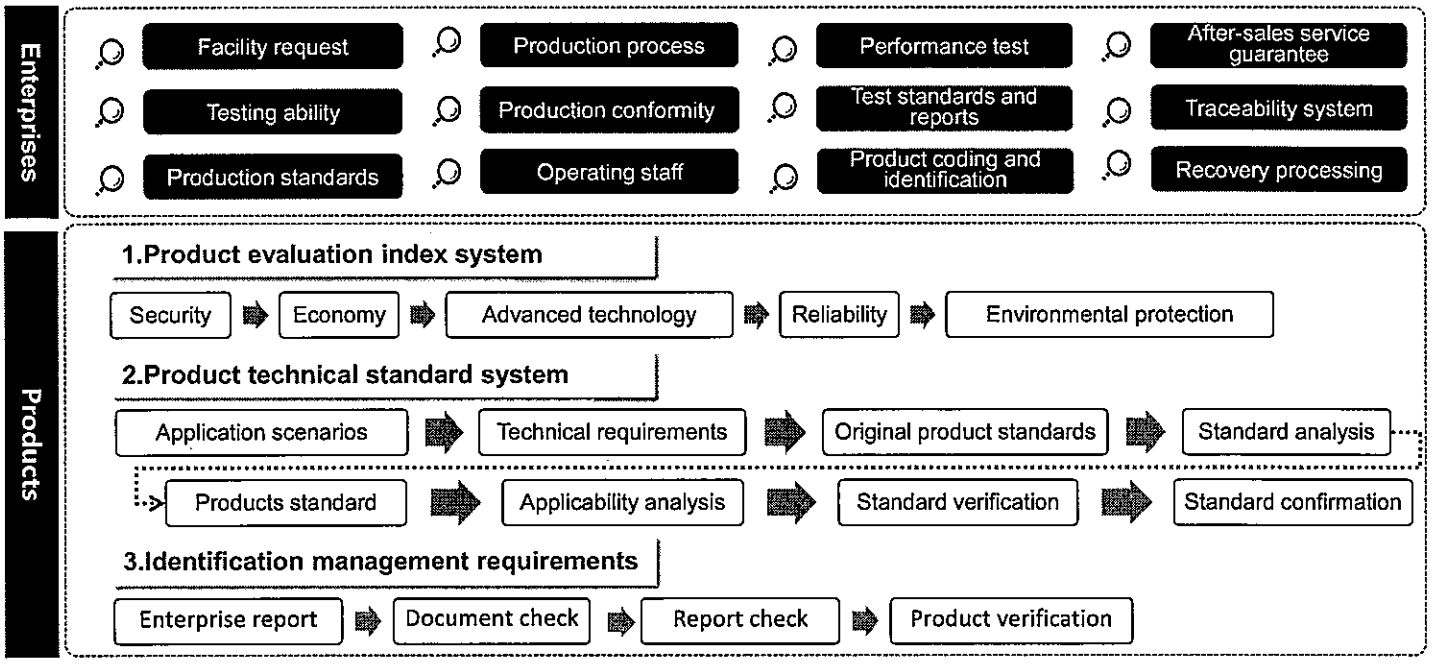
5 Traction battery traceability management

5.3 Construction of Traceability Information System—performance evaluation



6 Research on Management of Battery Utilization in Echelons

Management of battery utilization in echelons



报告结束，感谢您的聆听！
Thanks!

Making the Circular Economy a Reality

Real Life Examples

Peter Tamblyn
Sales & Marketing Manager
Asia Pacific

Macau 2017

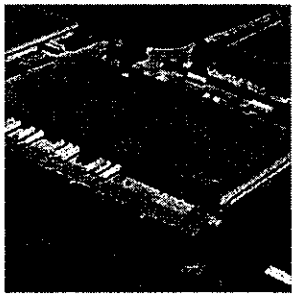
Close the Loop

Introduction to Close the Loop®

- Founded in 2001
- "Zero Waste to Landfill" business

- Located in:
  - Melbourne, Australia (HQ)
  - Hebron Kentucky, USA
  - Antwerp Belgium, EU

- Focused on:
  - Collection & reverse logistics
  - Materials recovery
  - Developing re-use solutions for recovered materials
  - **Innovation and collaboration**



Our Partners

Lexmark Canon hp KYOCERA

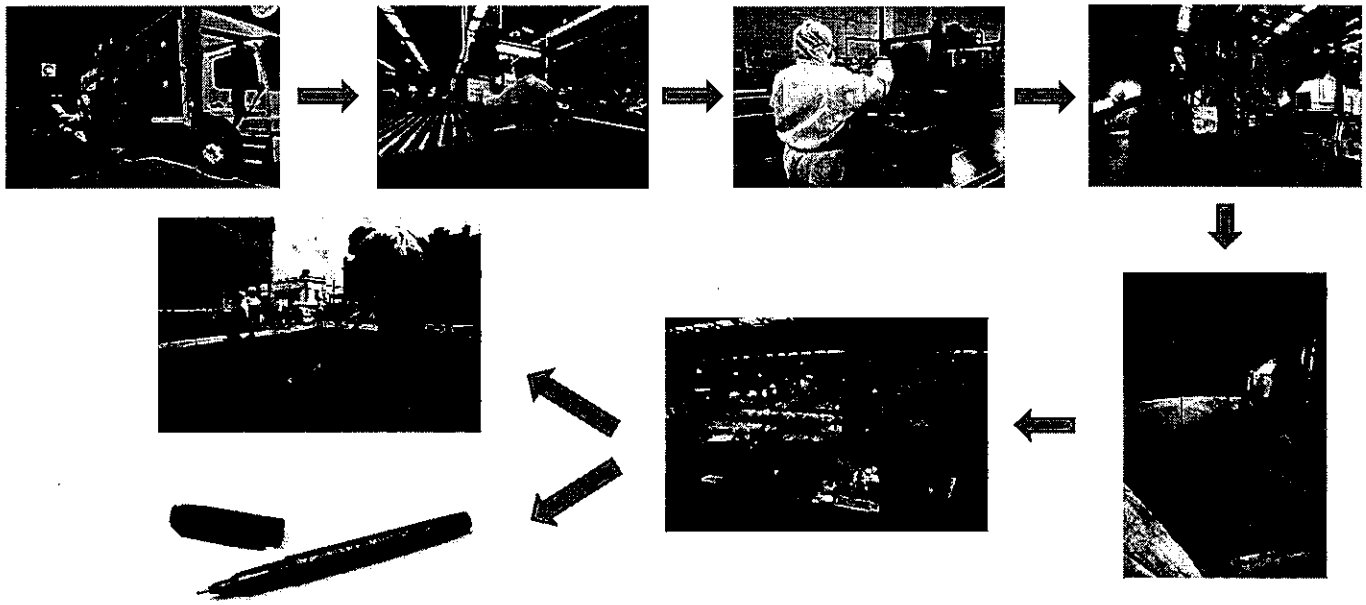
TOSHIBA EPSON

Roland FUJI Xerox KONICA MINOLTA DELL

brother OKI SAMSUNG SHARP

Circular Economy in Action

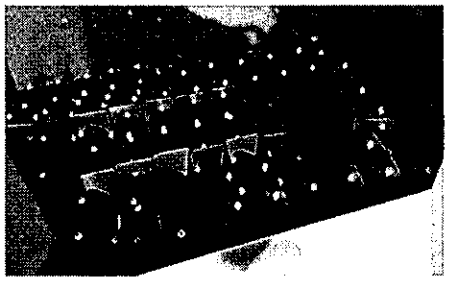
Your Printer Cartridges

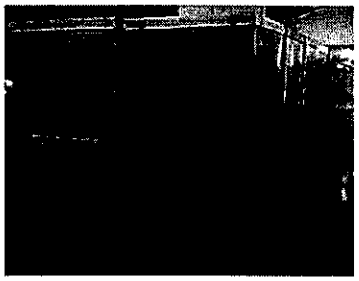


Close the Loop

Product Loops Examples

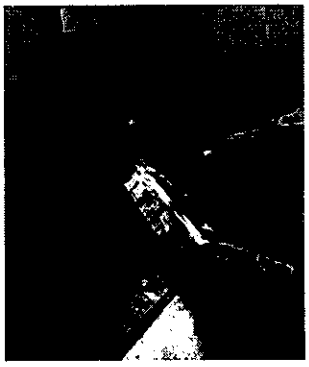
- Our manufacturing partners have a history of championing re-use of valuable resources
- As an example, Lexmark have a significant remanufacture operation where we repatriate certain used cartridges back to their plant in Juarez, Mexico
- More than 1.3 million cartridges have been shipped to Juarez

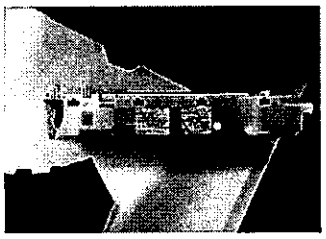


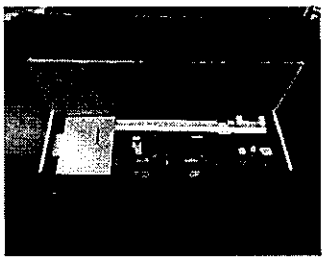


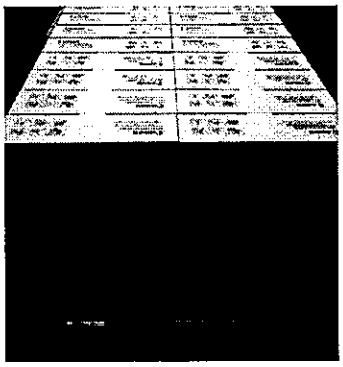
Close the Loop

Product Loops Re-Use



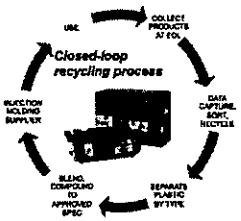


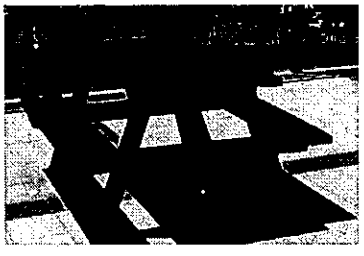




Materials loops

- CtL HIPS and ABS streams have qualified into specific polymer manufacturers for purchase by a number of our OEM partners for use in manufacturing new cartridges - a cartridge to cartridge model
- Our plastic collection bags and cable ties are made from recycled materials and are recycled again when they come back to us
- Enviroliner pens are made from recycled plastic AND recycled ink from inkjet cartridges – unique in the world. These can also be recycled again and again
- ABS plastics are also sent locally in Australia to make outdoor furniture



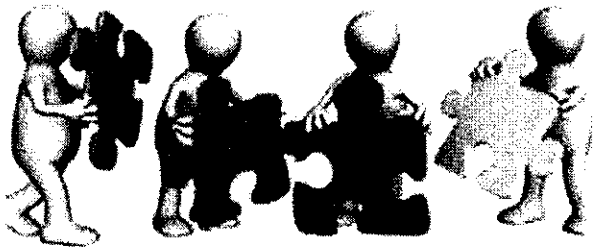


Circular Economy Thinking Drives Innovation

Why is Circular Economy thinking important?

Circular Economy Requires Partnerships

- Cannot happen in isolation
- Partnerships are the lifeblood of a circular economy outcome
- Look for partners with alignment in values and thinking
- Often can come from a completely un-allied industry
- Think laterally



Collaboration

Turning Waste into a Creative Tool

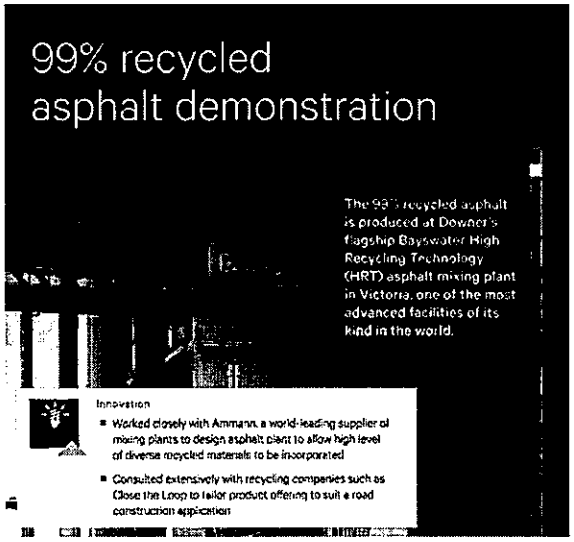
100% Recycled Artist Ink

TonerPave®

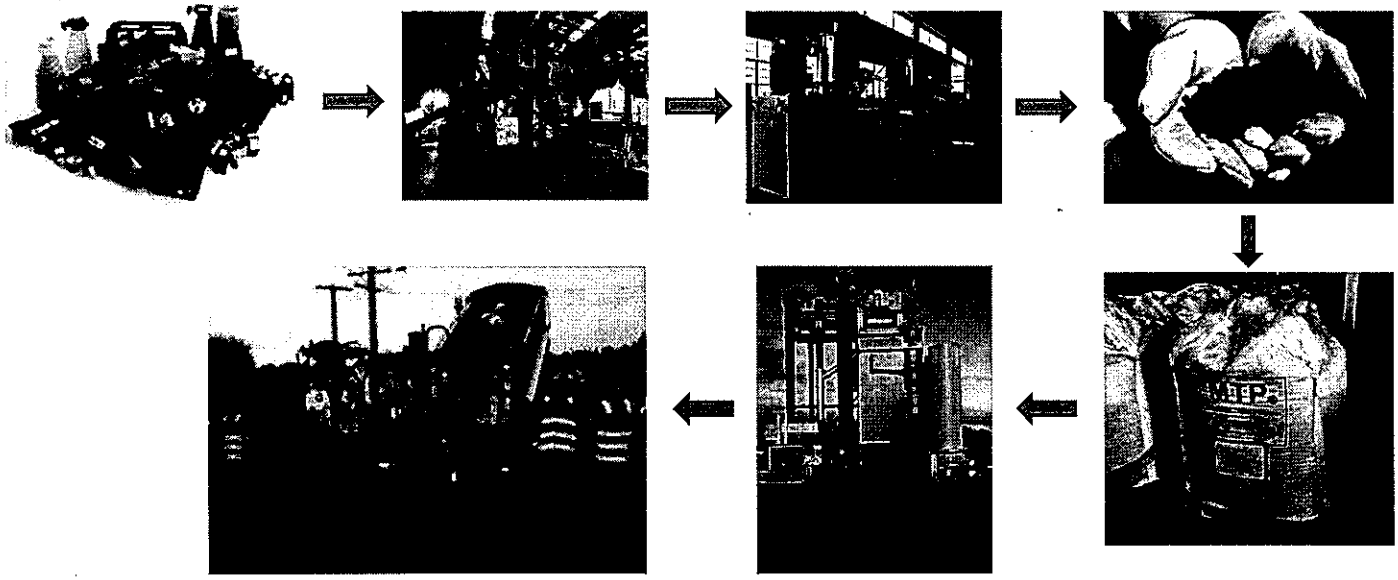
Downer

Relationships creating success

- CtL & Downer aligned in thinking and values
- Re-purposing and re-use of valuable waste streams
- Exclusive partnership
- Strong & growing Australian market, expanding to NZ
- CtL & Downer keen to leverage relationship into Europe



TonerPave® Process Flow

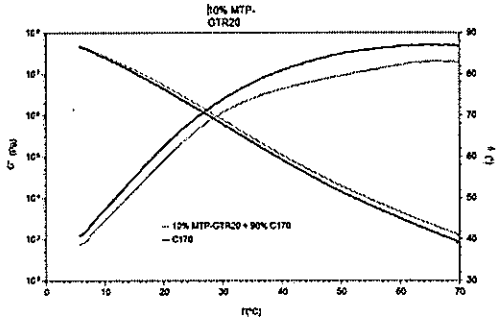


Close the Loop

TonerPave® Makes a Better Road

- Improves performance of asphalt roads
  - Increases stiffness at high temp
  - No compromise to elasticity at low temp
  - Reduced surface cracking slows ingress of water
  - Less maintenance
  - Longer lifespan and better TCO
- Produces a 23% lower carbon asphalt
- No additional cost to traditional asphalt
- WHAT A GREAT STORY!!!

Over 1,000km of TonerPave® roads laid in Australia to date (June 2017)



Close the Loop

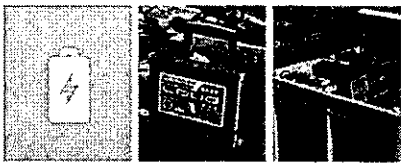
[redacted]

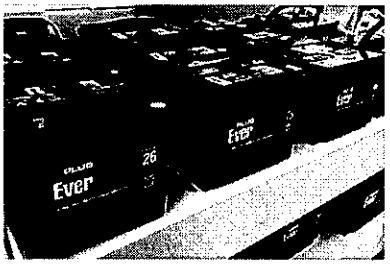
Close the Loop

Thank You

[redacted]

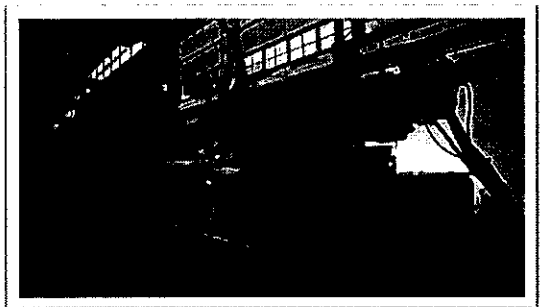
DOLAV® Car batteries Recycling by DOLAV Asia

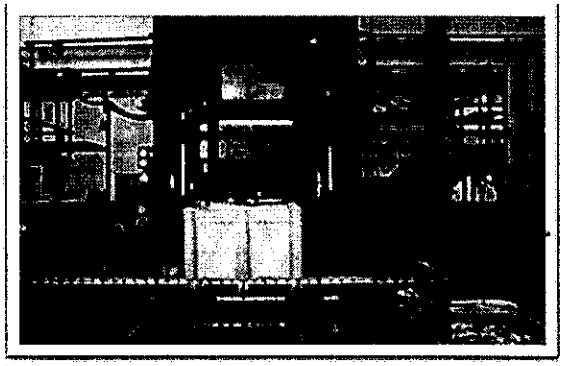


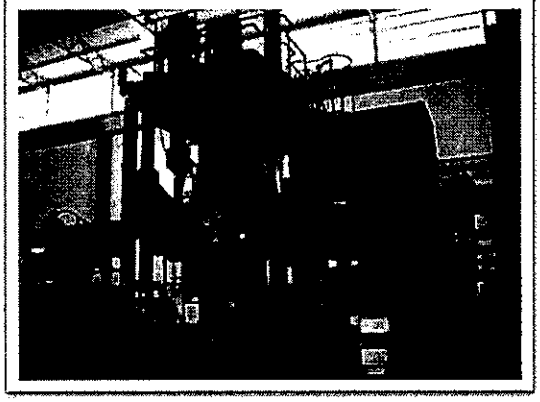


DOLAV® DOLAV Technology

Structural foam injection technology



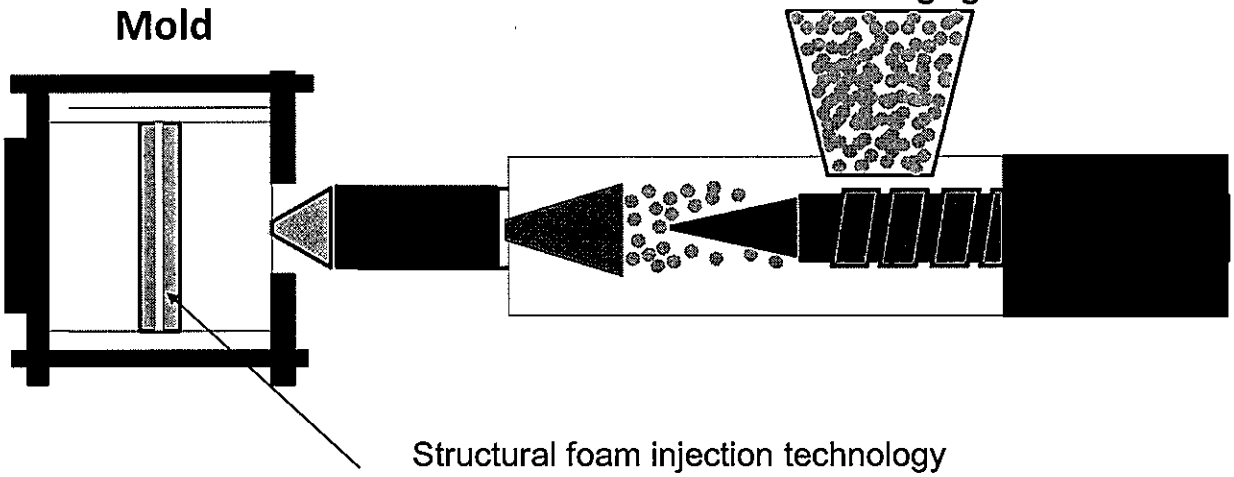




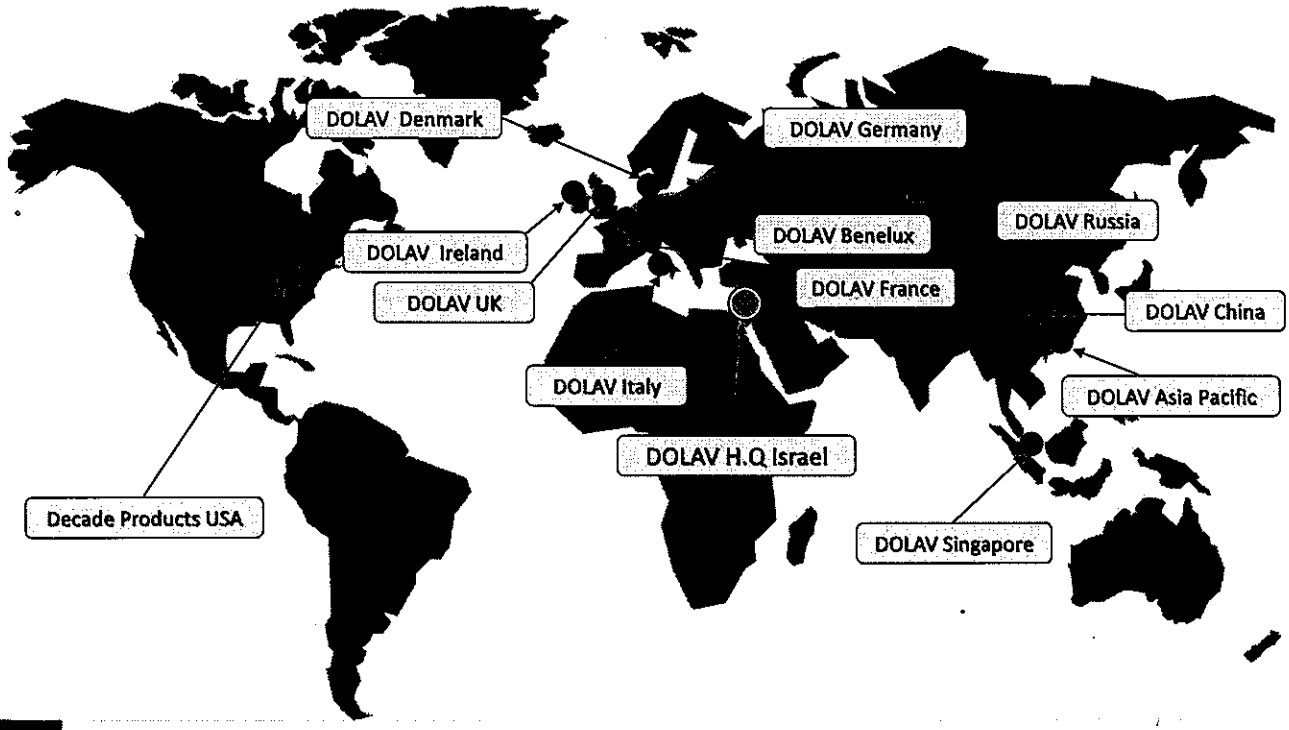
DOLAV Technology

Chemical System

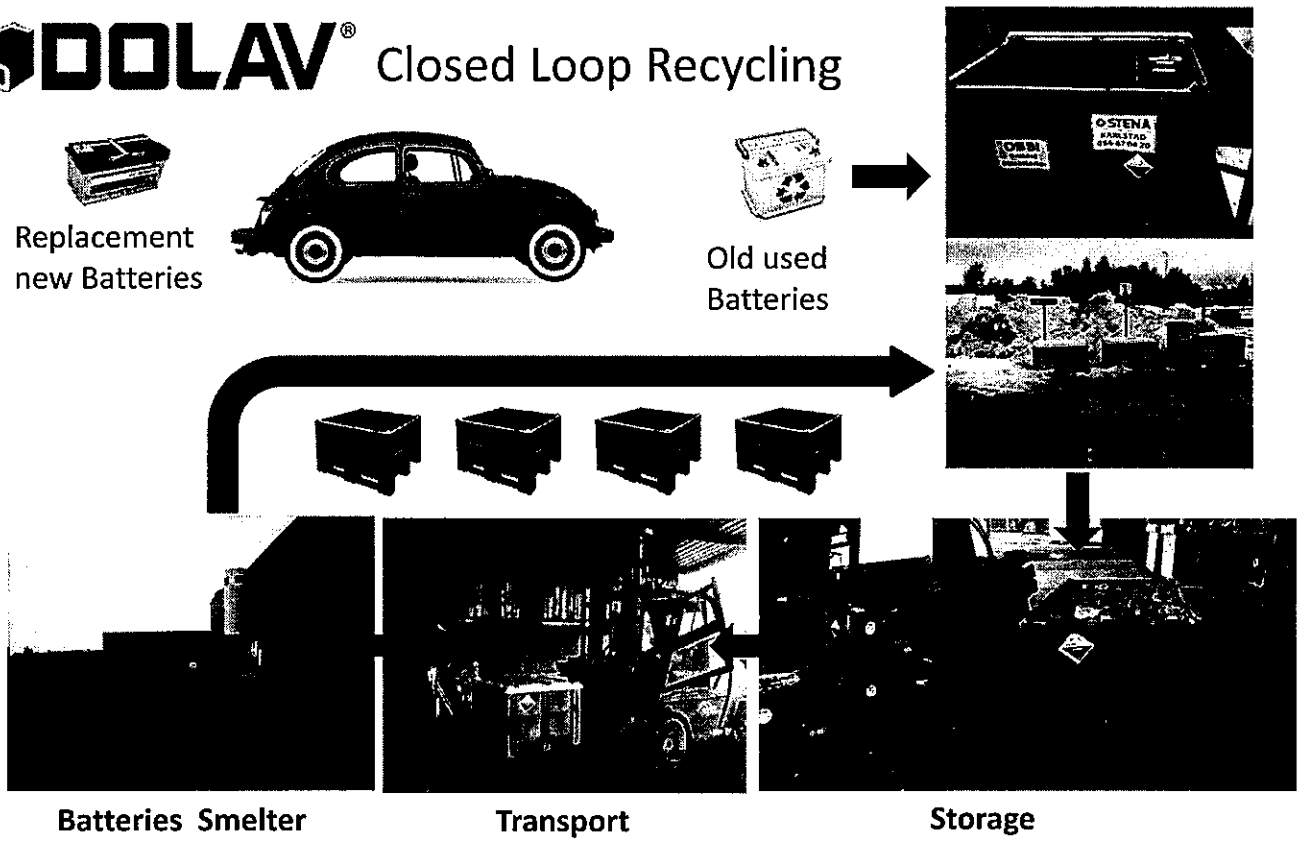
Resin + chemical blowing agent mixture



DOLAV Subsidiaries Worldwide



DOLAV® Closed Loop Recycling

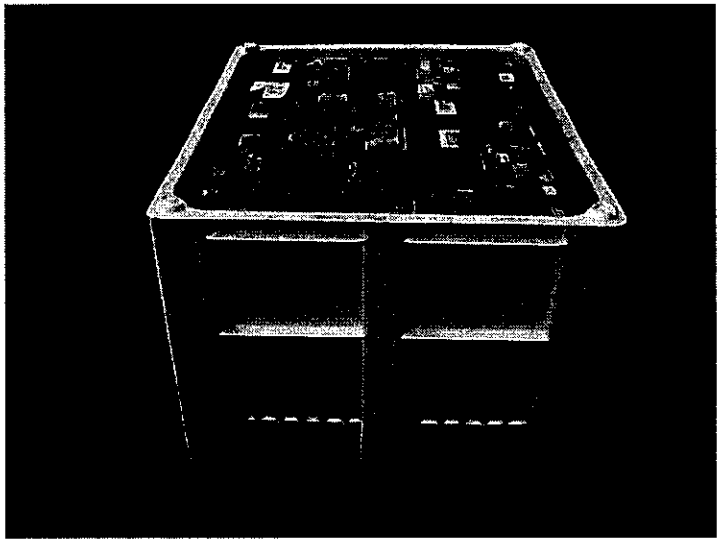


DOLAV® Handling car Batteries Need :

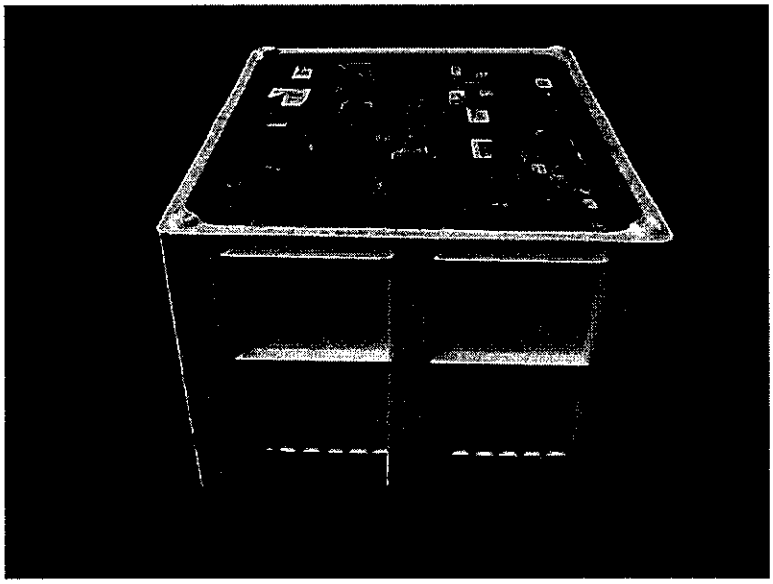
- ❖Tasted & Proven
- ❖Strength – to last
- ❖Lifting & Tipping
- ❖Stacking
- ❖Acid proof
- ❖Leak proof

DOLAV® The DOLAV Solution:

Heavy duty Box Pallet type "Battery ACE"

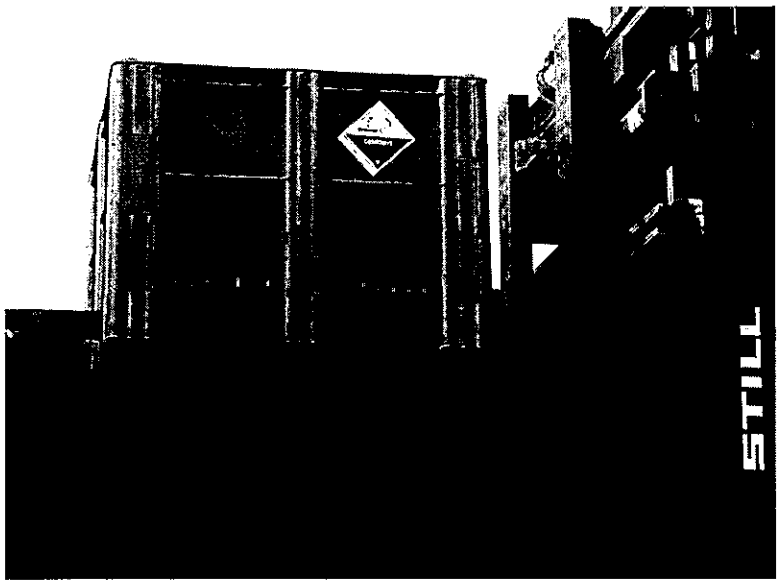


DOLAV® The DOLAV Solution:



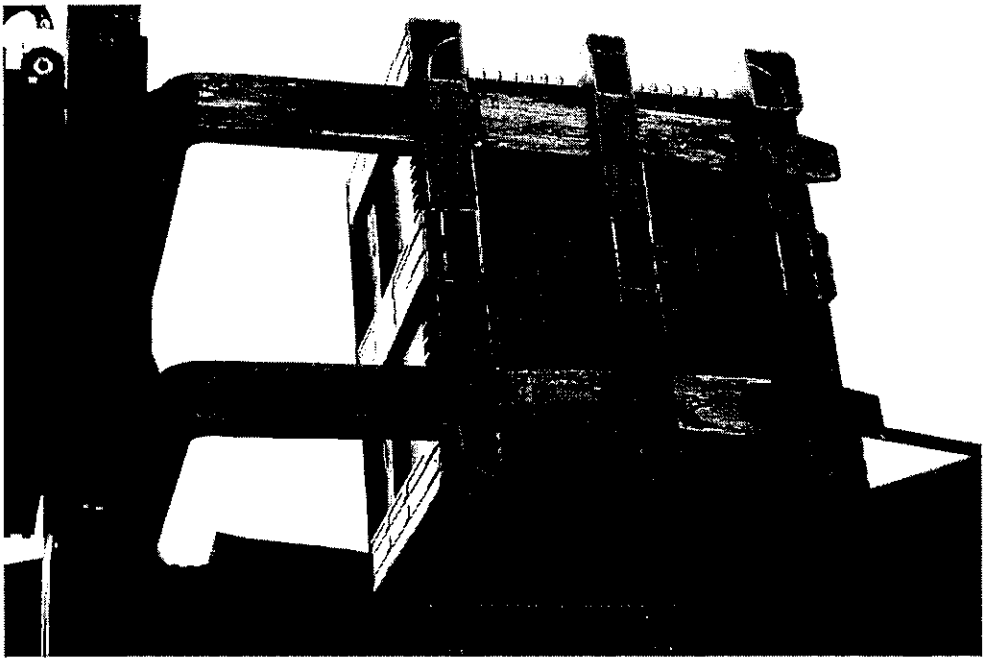
800 (kg) of lead Worth = USD 2,000

DOLAV® Lifting & Tipping



DOLAV® Lifting & Tipping

DOLAV® Lifting & Tipping



DOLAV® *Handling, Packaging & Storage Solutions*

DOLAV® H.J.HANSEN *Innovation for generations*

DOLAV® *Handling, Packaging & Storage Solutions*

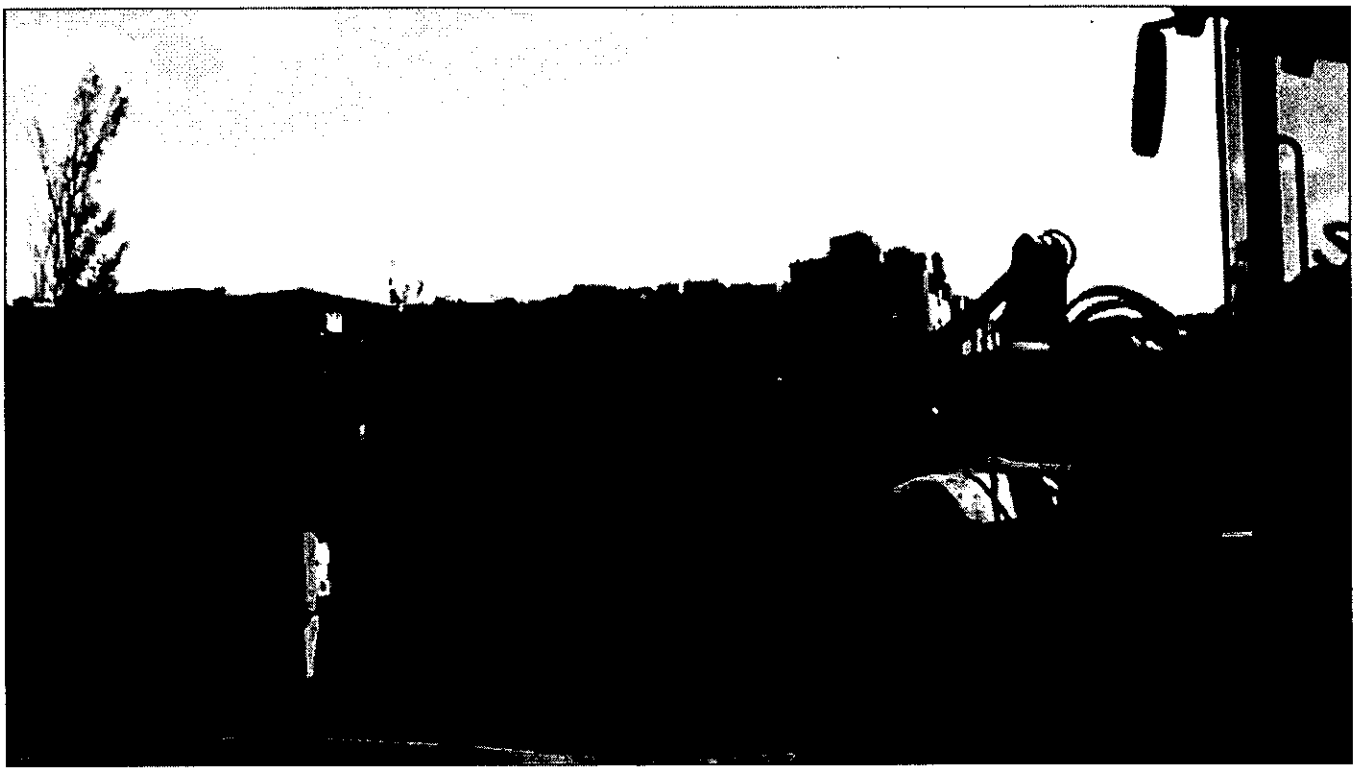
DOLAV®

SIMS METAL MANAGEMENT

DOLAV® *Handling, Packaging & Storage Solutions*

DOLAV®

RECOBAT



DOLAV® *Handling, Packaging & Storage Solutions*

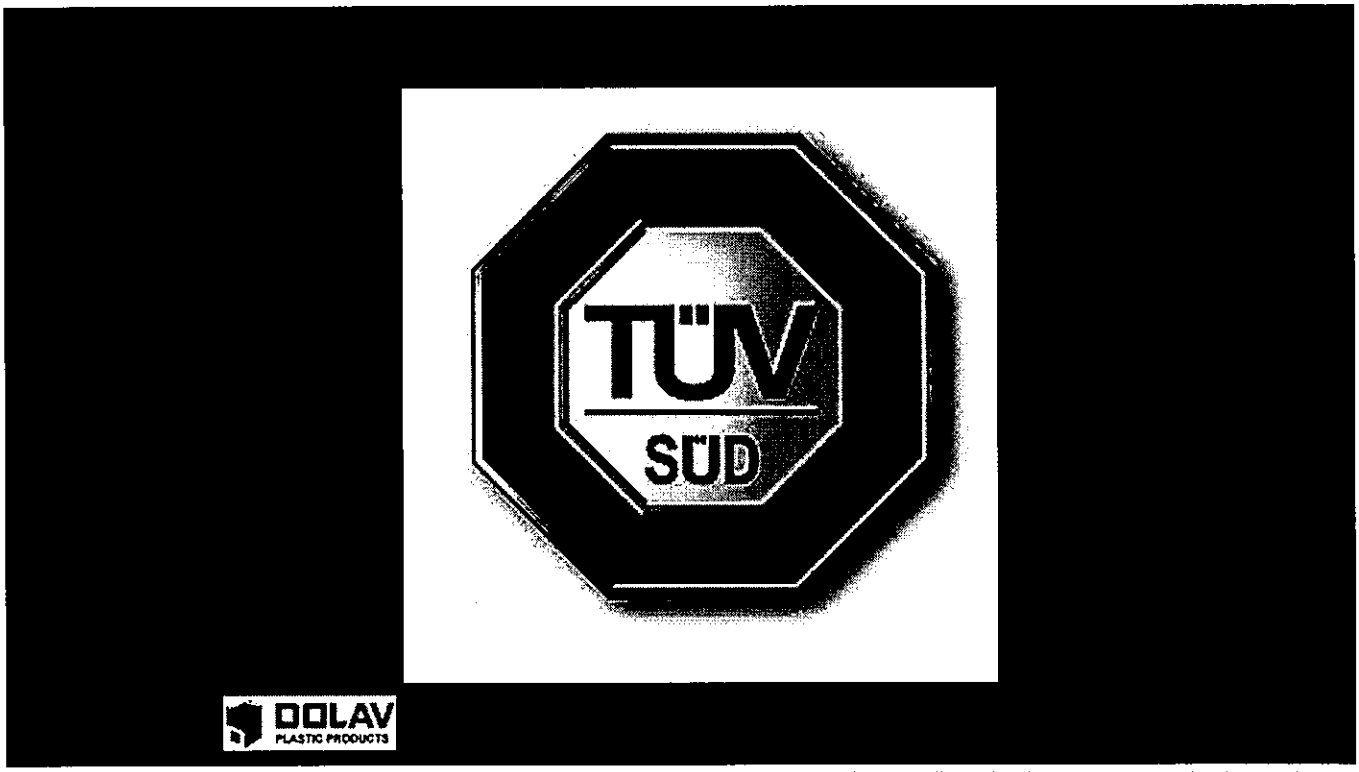
DOLAV® Car batteries Recycling

Tasted by **TÜV SÜD**

- ❖Dropped !
- ❖Crushed !
- ❖Spiked !
- ❖Rotated !

DOLAV® *Handling, Packaging & Storage Solutions*

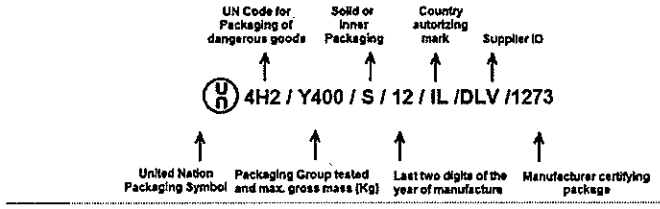
DOLAV® Car batteries Recycling



DOLAV® *Handling, Packaging & Storage Solutions*

UN50H LABEL

The U.N. marking system indicates several characteristics of the packaging, as well as information on the test levels the packaging has successfully passed. Because these test levels are related to the hazard level and physical and chemical characteristics of the substance to be filled, the markings also indicate some of the properties of the materials that may be packed in each container.
A sample of UN marking:



DOLAV® "Battery ACE" is used in: **Germany**

Johnson Controls Autobatterie

Berzelius Logistik Service (Ecobat Group)

Rethmann Group

CCR Logistics Systems

Karl Meyer

GFR Gesellschaft für Recycling

DOLAV® "Battery ACE" is used in: **France**

Guy Dauphin Environnement (Groupe Ecore)

STCM (Ecobat Group)

Enersys Derichebourg

DOLAV® "Battery ACE" is used in: **UK**

SIMS METAL MANAGEMENT

G&P Batteries (Ecobat Group)

SAR

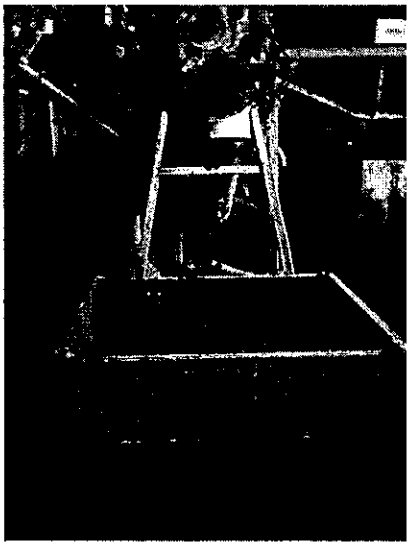
Recycling Lives

DOLAV® "Battery ACE" is used in: **Spain**

Recobat (Lyrsa Group)

Grupo LYRSA

RECOBAT

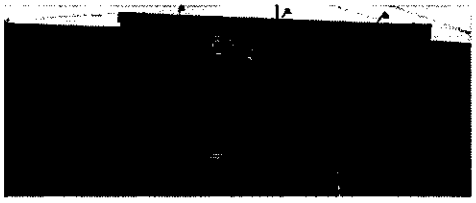


Exide EXIDE TECHNOLOGIES

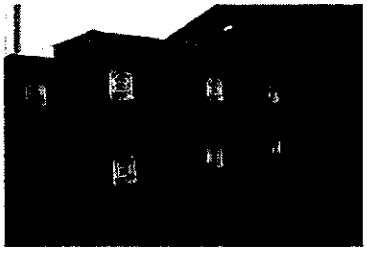
DOLAV® "Battery ACE" is used in: **Poland**

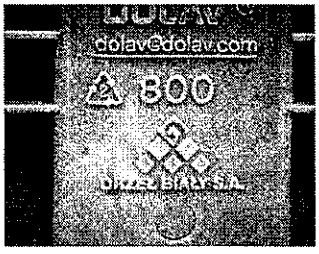
BATERPOL S.A.

Baterpol S.A



ORZEL BIALY S.A





DOLAV® "Battery ACE" What do they say ?

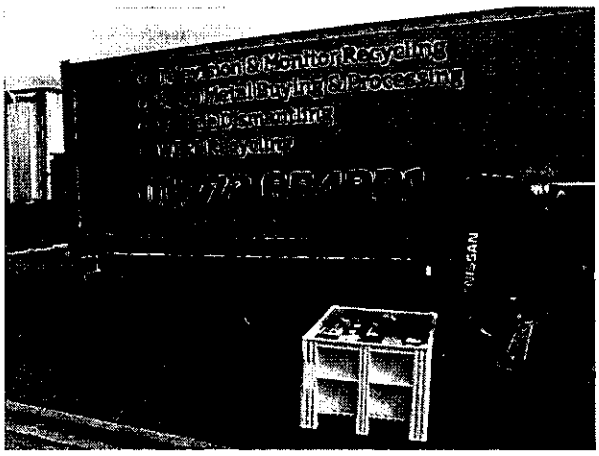
"The plastic pallet box that does the best job?

It's the Dolav ACE. The Battery ACE.
It is the best pallet box for batteries."

SAR
Specialists at Recycling, Materials Recovery and Waste Management

DOLAV® "Battery ACE" What do they say ?

"Dolav boxes have superior design.
The fixed runners do not come off when they are rotated with forklifts."



DOLAV® Handling, Packaging & Storage Solutions

DOLAV® "Battery ACE" What do they say ?

"The Dolav ACE last three times longer than other plastic box pallets,"
When we tip the batteries out, the Dolav runners do not break. Others do."

RECOBAT

Grupo LYRSA

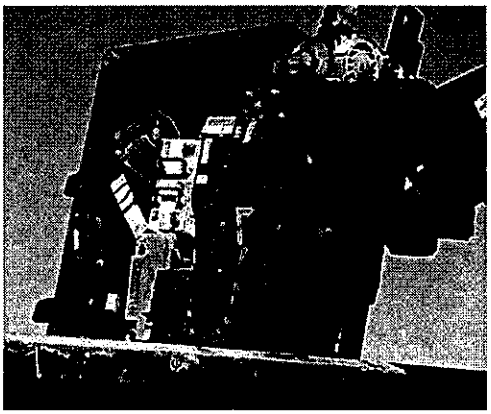
DOLAV® Handling, Packaging & Storage Solutions

DOLAV® "The Battery ACE" What do they say ?

"The Dolav Battery ACE:

- ***Meets EA standards***
- ***Resists battery acid***
- ***No leaks or spills***
- ***Is strong for batteries***
- ***Stacks with lids***
- ***Tips 180° damage free"***

SIMS METAL MANAGEMENT

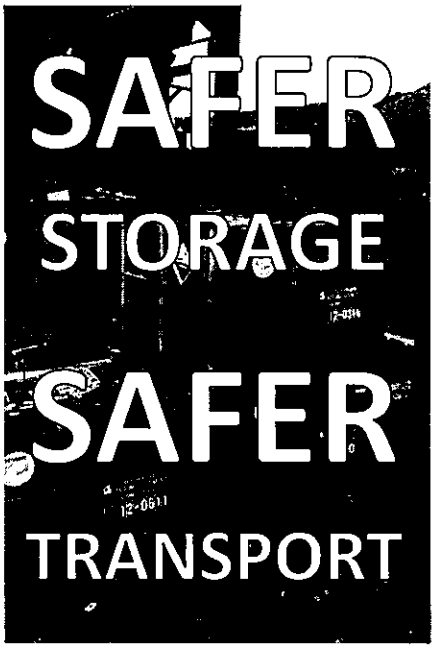


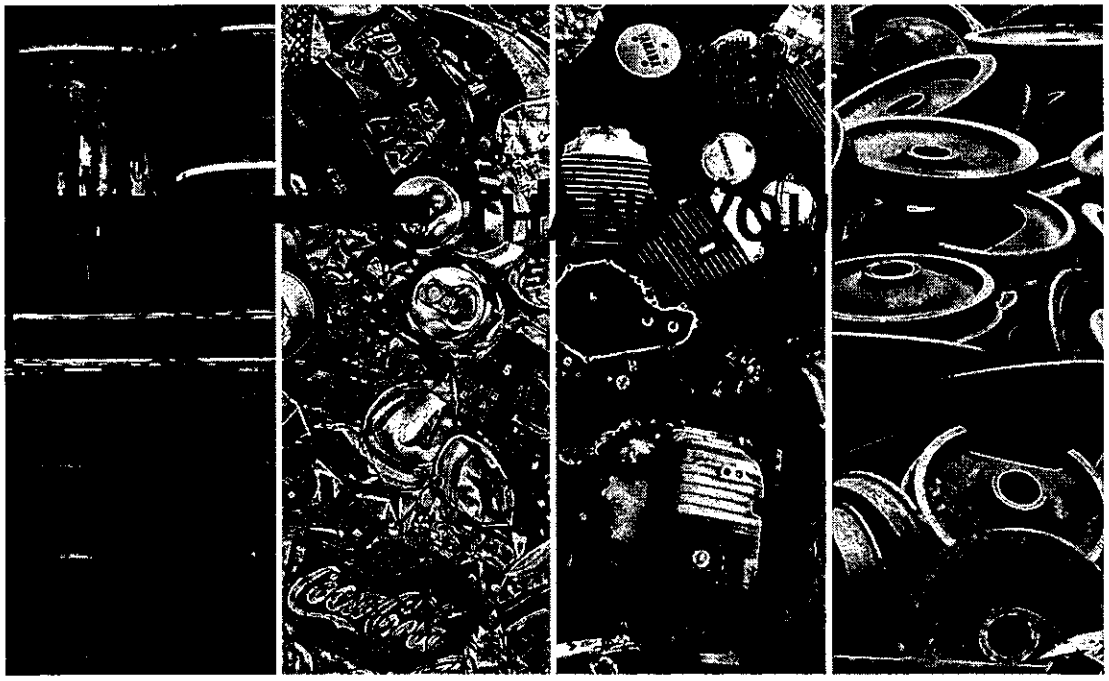
DOLAV® Handling, Packaging & Storage Solutions

For Lithium ion batteries,

Fire Retardant Dolav ACE

- *Resist fire and burning*
- *Will char but not melt and run*
- *Helps contain fire in the box*
- *Adds time for fire extinguishing*



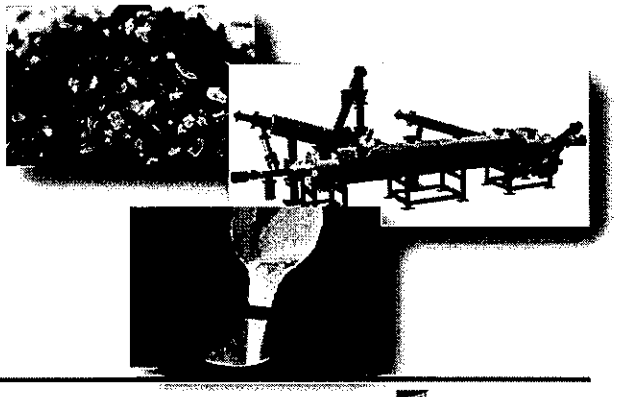


Pyrolysis – Key Technology to recover Metals from Shredder Residues

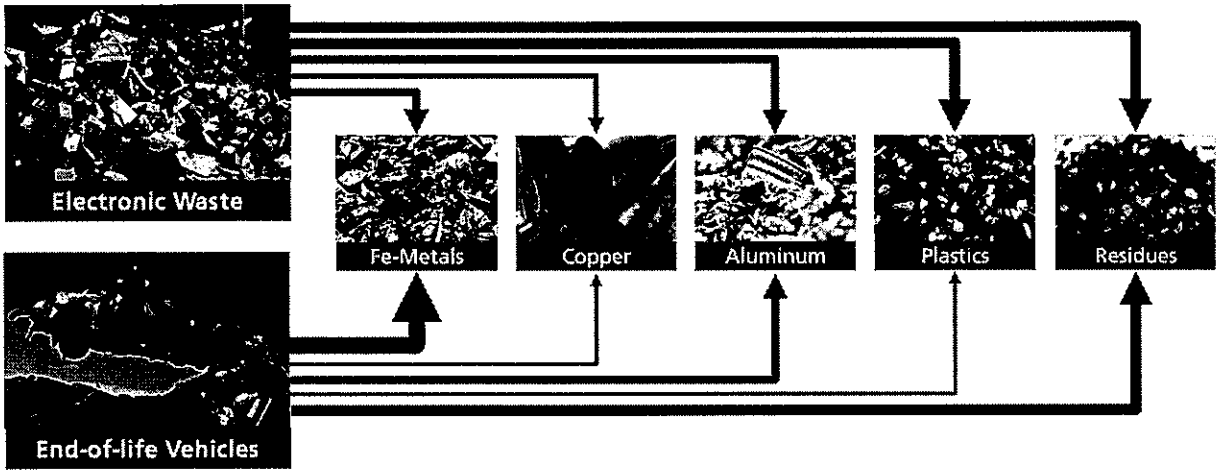
Electronics & Cars Recycling Congress – WRF 2017
November 16th 2017, Macau

Fraunhofer
UMSICHT

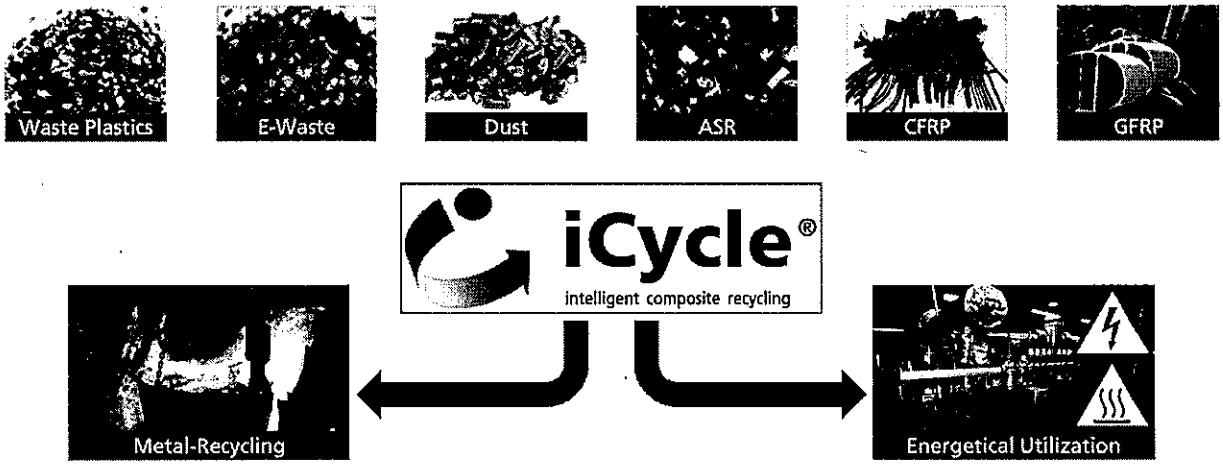
Dr. Peter Hense (Ph.D.)
M. Eng. Jonathan Aigner
Hon. Prof. Dr.-Ing. Matthias Franke
Prof. Dr. Andreas Hornung



Metals from Shredder Residues
Motivation



Metals from Shredder Residues
Key Technology: iCycle® process



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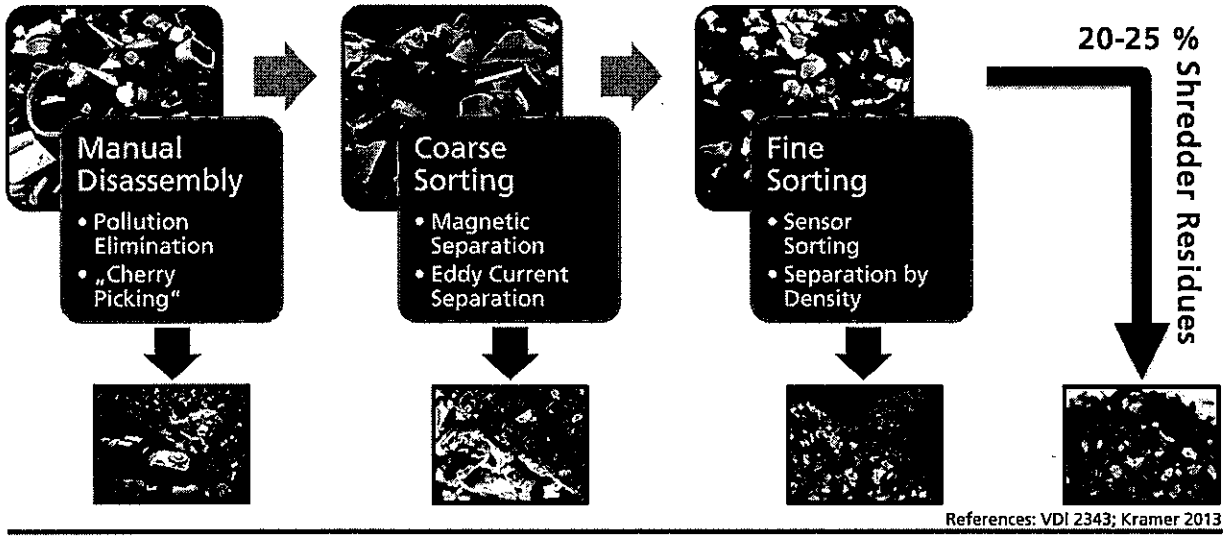
Metals from Shredder Residues
Example: Manual & Mechanical Treatment of WEEE



References: VDI 2343; Kramer 2013

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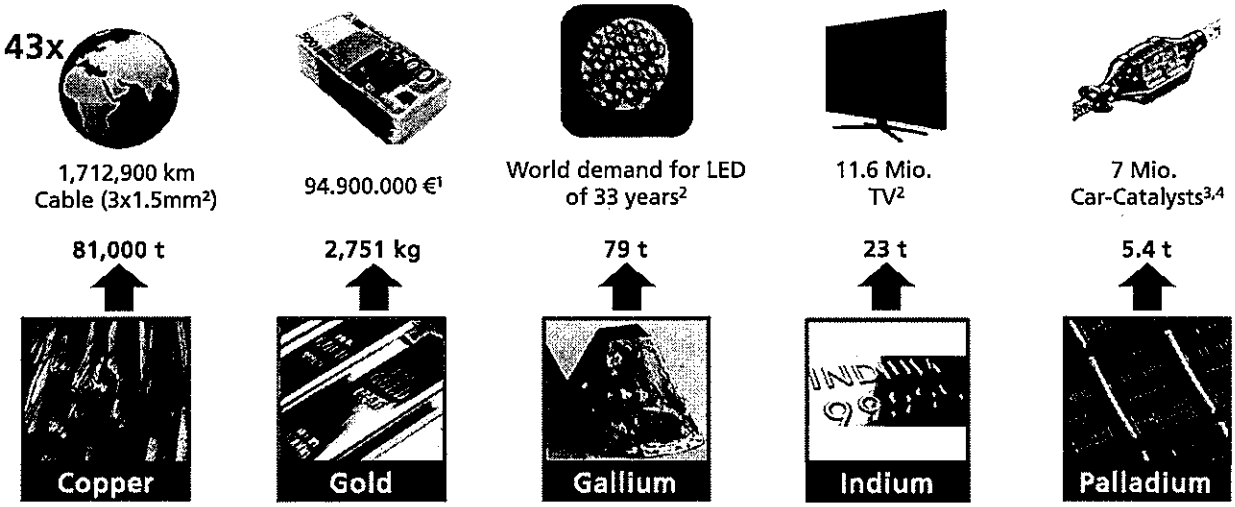
Shredder Residues from WEEE
Potential in Europe



References: [1]scheideanstalt.de; [2]Buchert et al. 2012; [3]Hagelüken et al. 2005; [4]Monolithos 2015

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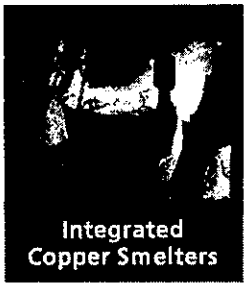
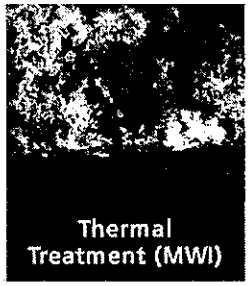
Shredder Residues from WEEE
Status Quo of Treatment



Target

- ✓ Recycling of up to 17 Metals (Ag, Au, Cu, Pd, Pt, ...)
- ✓ Recycling Rates >95 %
- × Limited Input Amounts due to high energy contents[1] (<10 % of EU Amounts)[2,3,4,5]



Status Quo

- ✓ "Production" of Power & Heat
- ✓ Recovery of Fe, Al, Cu (>2 mm)
- × No Recovery of Metals <2 mm (87 %)
- × Oxidation of Metals
- × High Costs (>100 €/t)

References: [1]Brusselaers et al. 2006; [2]Eurostat 2016; [3]Kawohl 2011; [4]Boliden 2016; [5]Katz 2013

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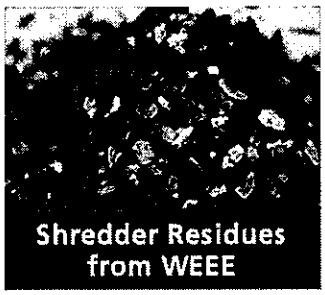
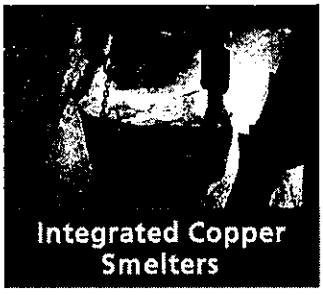
Shredder Residues from WEEE
Enabling Metal Recycling – Challenges



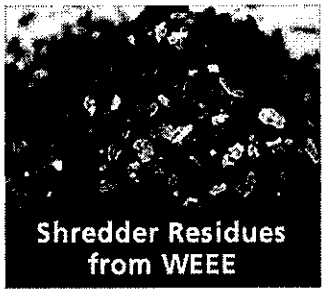
Challenges

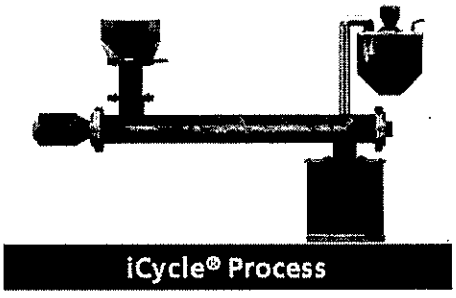
- Accumulation of Metals
- Reduction of Heating Value
- Transportable and safe Products

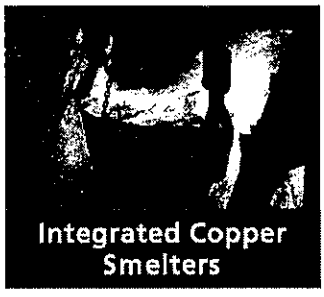
- Added Value



Shredder Residues from WEEE
Enabling Metal Recycling by Pyrolysis Treatment



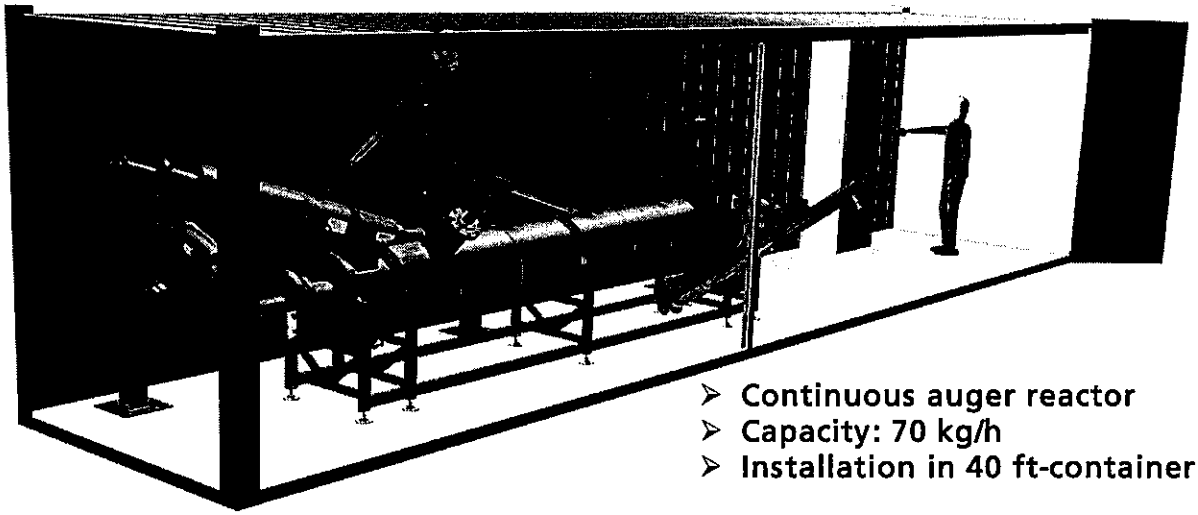




- Accumulation of metals in a solid product
- Decomposition of plastics
- Formation of high-heating by-products
- Flexible scalability

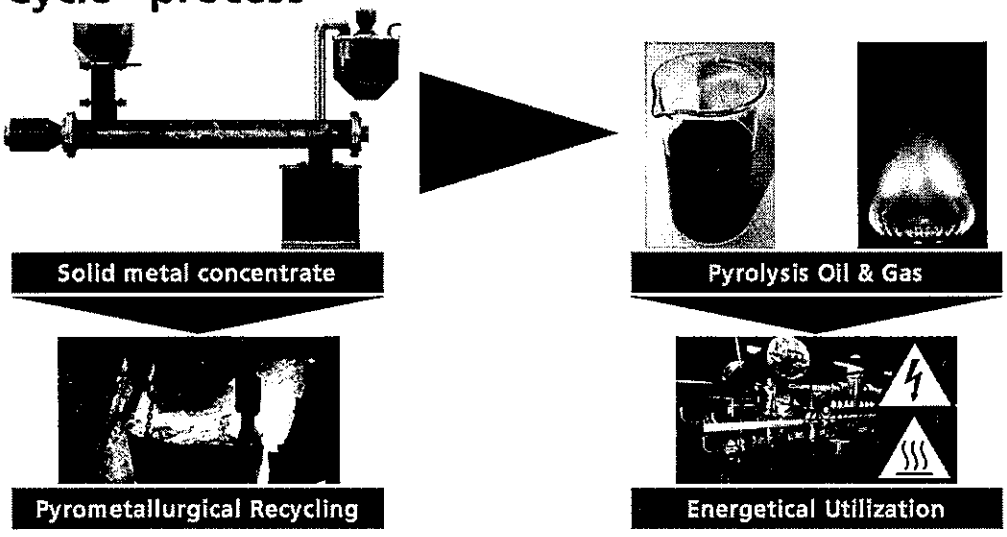
- Profitable and innovative solution

Shredder Residues from WEEE
The iCycle® process

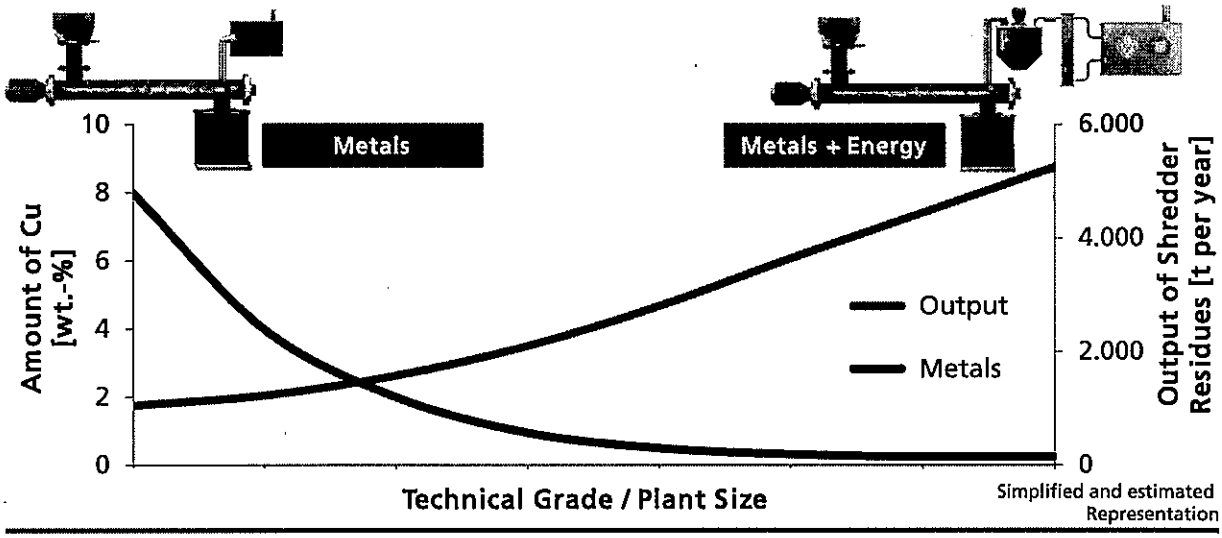


- Continuous auger reactor
- Capacity: 70 kg/h
- Installation in 40 ft-container

Shredder Residues from WEEE
The iCycle® process



Shredder Residues from WEEE
Economies of Scale



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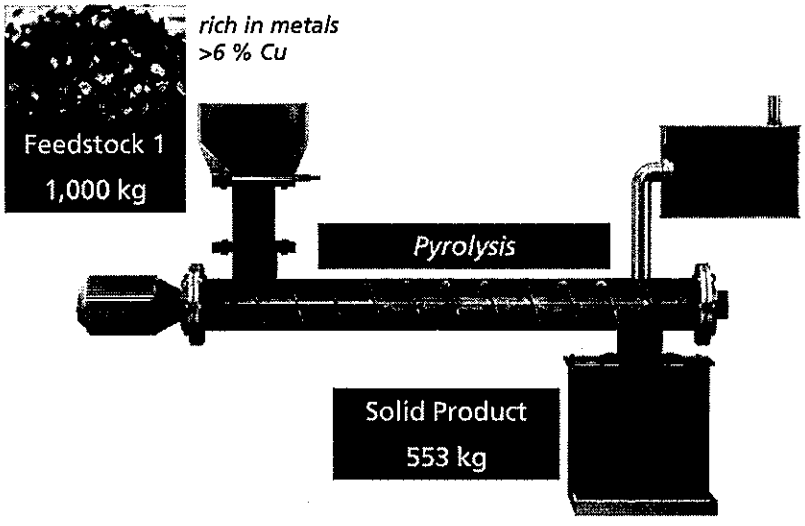
Shredder Residues from WEEE
Application Scenario I: Recovery of Metals



*Required Heat
→ 26.5 % of Feedstock

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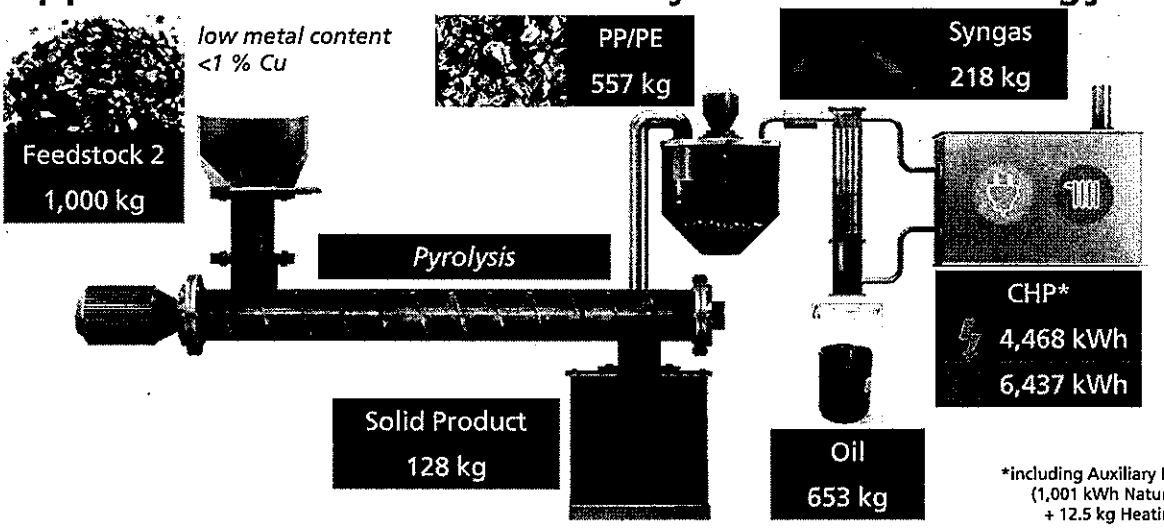
Shredder Residues from WEEE
Application Scenario II: Recovery of Metals & Energy



*including Auxiliary Energy
(1,001 kWh Natural Gas
+ 12.5 kg Heating Oil)

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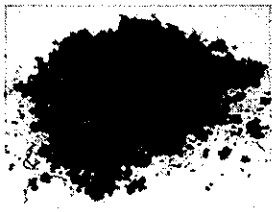
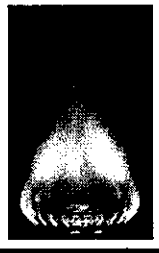
Shredder Residues from WEEE
Application Scenario: Product Quality





Metal Concentrate		Oil			Gas	
Earnings:	>1,000 €/t	H_o:	37.7 – 42.5	MJ/kg	H_o:	28.5 – 37.0 MJ/kg
Cl:	<1 wt.-%	H_2O:	<0.5	wt.-%	H_o:	35.7 – 47.9 MJ/m³
Br:	<0,5 wt.-%	ρ:	0.85 – 0.96	g/cm³	ρ:	1.1 – 1.3 kg/m³
∑ Dioxins < ChemVerbotsV*		v:	0.95 – 1,47	mm²/s		

* ChemVerbotsV: German Chemicals Prohibition Ordinance

Picture Source Gas: PSC Wisconsin

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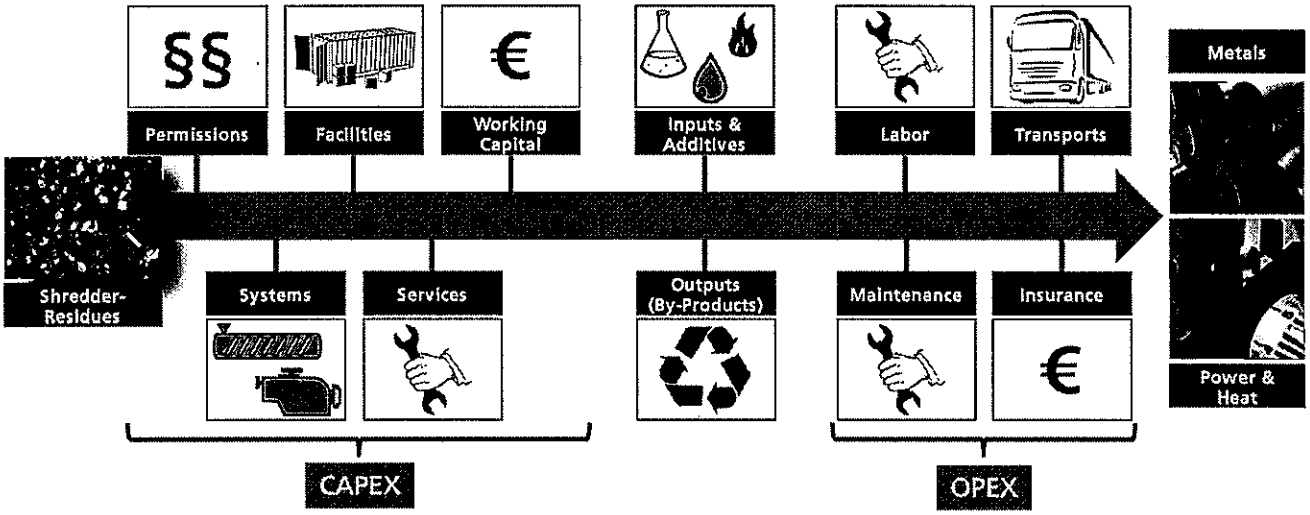
Shredder Residues from WEEE
Application Scenario: Economical Evaluation



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Shredder Residues from WEEE
Application Scenario I: Economical Evaluation

CAPEX	-372 t€
Investments	357 t€
Working Capital	15 t€

Inputs	-36 t€/a
Shredder Residues	*for free*
NaOH & activated carbon	-19 t€/a
Power	-5.9 t€/a
Nitrogen	-11 t€/a

Pyrolysis System
70 kg/h – 5,500 h/a

Outputs	222 t€/a
Solid Product	224 t€/a
Disposal	-1.9 t€/a

Key assumptions:
10 years duration
Tax Rate 29.8 %
Power (purchasing) 130.8 €/MWh
Heating: Pyrolysis gas

OPEX	-66 t€/a
Labor	-44 t€/a
Maintenance	-13 t€/a
Transports	-6.0 t€/a
Insurance	-3.6 t€/a

Depreciations	-36 t€/a

EBITDA	**120 t€/a**
EBIT	**84 t€/a**
Net Profit	**59 t€/a**
IRR	**23.0 %**
Pay-Off	**3.8 years**

Fraunhofer UMSICHT

Shredder Residues from WEEE
Application Scenario II: Economical Evaluation

CAPEX	-372 t€
Investments	357 t€
Working Capital	15 t€

Inputs	+6 t€/a
Shredder Residues	42 t€/a
NaOH & activated carbon	-19 t€/a
Power	-5.9 t€/a
Nitrogen	-11 t€/a

Pyrolysis System
70 kg/h – 5,500 h/a

Outputs	251 t€/a
Solid Product	224 t€/a
Heat	24 t€/a
Disposal	-1.9 t€/a

OPEX	-66 t€/a
Labor	-44 t€/a
Maintenance	-13 t€/a
Transports	-6.0 t€/a
Insurance	-3.6 t€/a
Depreciations	**-36 t€/a**

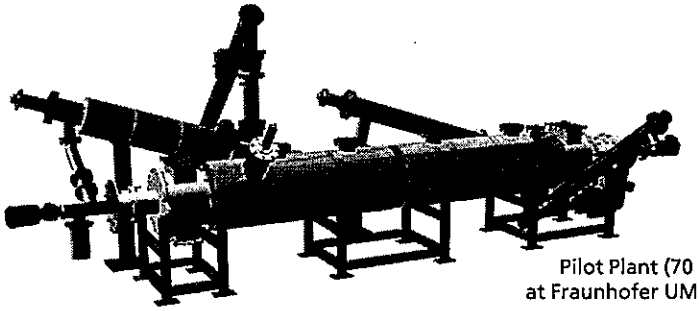
Key assumptions:
10 years duration
Tax Rate 29.8 %
Power (purchasing) 130.8 €/MWh
Heat (Sell) 31.6 €/MWh
Imputed Earnings from Shredder Residues (110 €/t)

EBITDA	**191 t€/a**
EBIT	**155 t€/a**
Net Profit	**123 t€/a**
IRR	**41.4 %**
Pay-Off	**2.3 years**

Fraunhofer UMSICHT

Conclusions
Thermo-chemical Treatment of Shredder Residues

- Profitable, innovative and patented Process
- Added Value due to Metal Recycling from Shredder Residues
- Recovery of Energy – Production of Power & Heat
- Individual Integration in existing processes
- Flexible Scalability for a decentralized treatment



Pilot Plant (70 kg/h)
at Fraunhofer UMSICHT

iCycle®
intelligent composite recycling

Fraunhofer UMSICHT

Fraunhofer UMSICHT

iCycle®
intelligent composite recycling

Thank you very much for your kind attention!

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E-Mail: peter.hense@umsicht.fraunhofer.de
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GRS BATTERIEN
GEMEINSAMES RÜCKNAHME SYSTEM

The European approach for end of life (EoL) batteries - Introduction of the German model

Tobias Schulze Wettendorf, GRS Batterien

Electronics & Cars Recycling WRF 2017

November 14 – 17, 2017, Macau, China

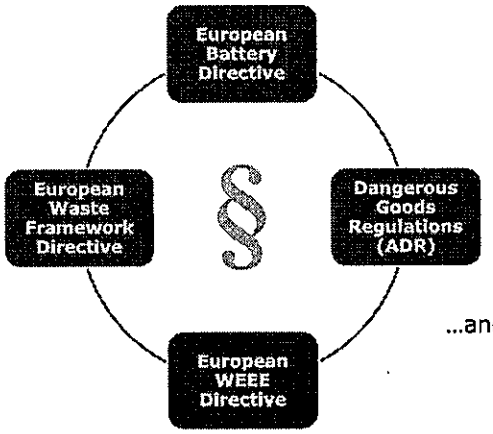
GRS BATTERIEN
GEMEINSAMES RÜCKNAHME SYSTEM

Agenda

Regulatory environment

GRS BATTERIEN GEMEINSAMES RÜCKNAHME SYSTEM

1 EU approach



...and respective national legislation.

Regulatory environment

GRS BATTERIEN GEMEINSAMES RÜCKNAHME SYSTEM

2 Producer obligations

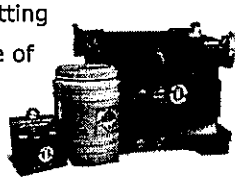
for portable batteries

- Take back spent portable batteries >45% put on market volume (POM)
  - at the point of sales
  - at municipal container parks / waste collection facilities
  - at recyclers of ELV and WEEE
- Bear the costs for admin/collection/recycle/end-user information
- Submit annual report to the government

for industrial batteries

- Offer a take back system that is free of charge for
  - distributors
  - for ELV and WEEE
- Bear the costs for recycling, only
- Submit annual report to the government

- Stiftung GRS Batterien was established in 1998 by producers' association ZVEI and leading battery manufacturers as a Non-Profit-Organisation
- Europe's largest collection system for portable and industrial batteries
- Germany-wide collection of batteries from retailers, municipalities and commercial sites (175,000 collection points)
- excellent knowledge of waste management and hazardous goods legislation
- **GRS Service GmbH** has been established in 2014 to achieve cost-cutting synergy effects and scaling effects for manufacturers within the scope of product take-back (ElektroG/Batt Act)



- operational organization of the collection of waste portable batteries, (according to section 6 Batt act) for Stiftung GRS Batterien as part of service level agreement
- supply of collection containers to retailers, municipalities and other collection points
- separate collection of high-energy batteries (lithium batteries) which are subject to ADR
- special containers and special transport for damaged lithium batteries
- nationwide pick up and **ADR compliant transport**
- proper disposal according to specifications of Batt act

Lithium batteries – a growing safety risk?

GRS BATTERIEN GEMEINSAMES RÜCKNAHME SYSTEM

Accident – pick up from a commercial collector:

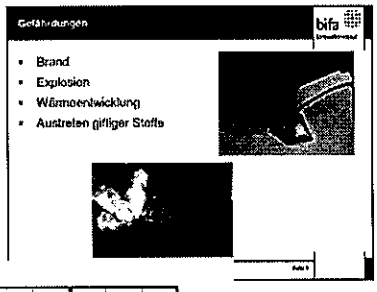
- various kinds of primary lithium batteries; mono-fraction without protection against short circuiting

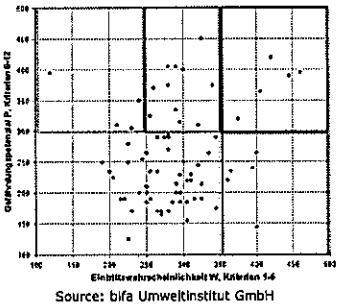
Accident – recycling plant:

- Lack of information on safety risks and proper handling
- "We've just thrown everything in there ..."

Lithium batteries – a growing safety risk?

GRS BATTERIEN GEMEINSAMES RÜCKNAHME SYSTEM





Source: bifa Umweltinstitut GmbH

Safety risks due to inappropriate handling through

>not defined battery mix
>exposed poles
>residual electric charge
>impurities, other waste
>crushed/broken batteries

High risk areas

>recycling plants for WEEE
>waste collection and recycling plants
>municipal collection points
>electrical retailers, wholesale and trade
>others, e. g. photo retailers, bike retailers, DIY

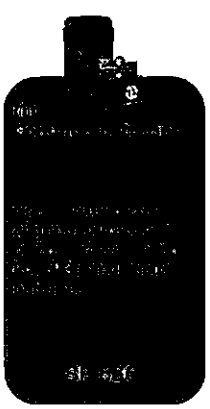
Lithium batteries are safe

if

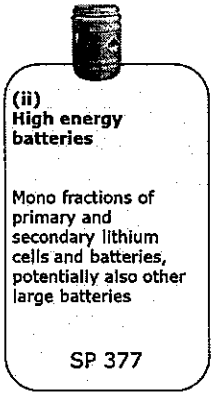
- they are put on the market correctly according international standards for dangerous goods and if they are technically checked
- they are handled with care during use and collection
- all requirements for the correct removal from WEEE are complied with

Safe and compliant collection process for used batteries

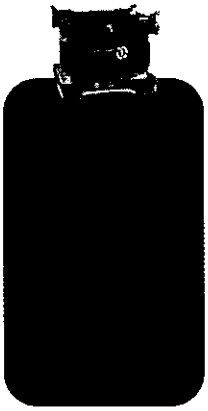
1 GRS safety standard



60 ltr drums
30 kg carton box



60 ltr drums

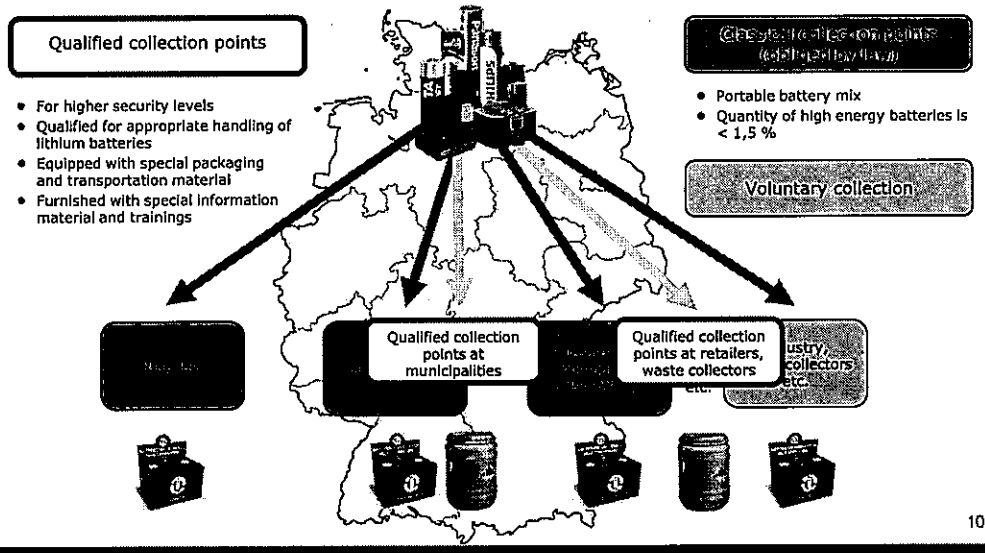


800 ltr collection container

GRS BATTERIEN
GEMEINSAMES RÜCKNAHME SYSTEM

Safe and compliant collection process for used batteries

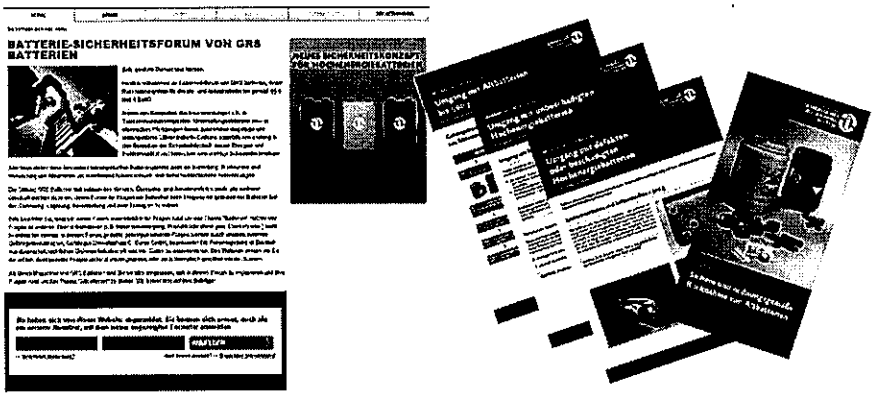
2 Collection of high energy batteries:



GRS BATTERIEN
GEMEINSAMES RÜCKNAHME SYSTEM

Safe and compliant collection process for used batteries

3 The GRS Batterien Safety platform



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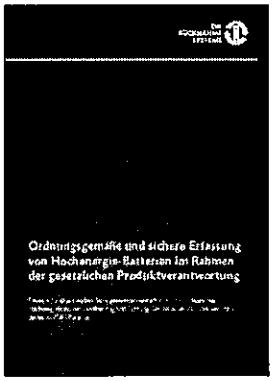
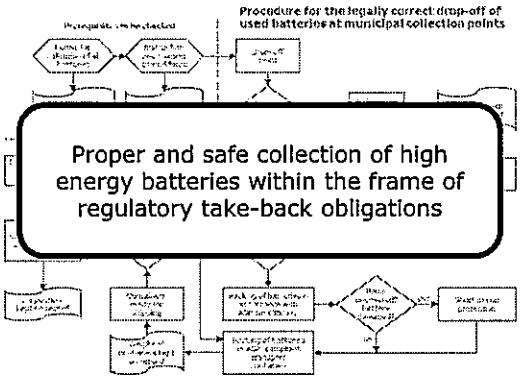
GEMEINSAMES RÜCKNAHME SYSTEM

4 GRS support (recommendations for municipal collectors)





Safe and compliant collection process for used batteries

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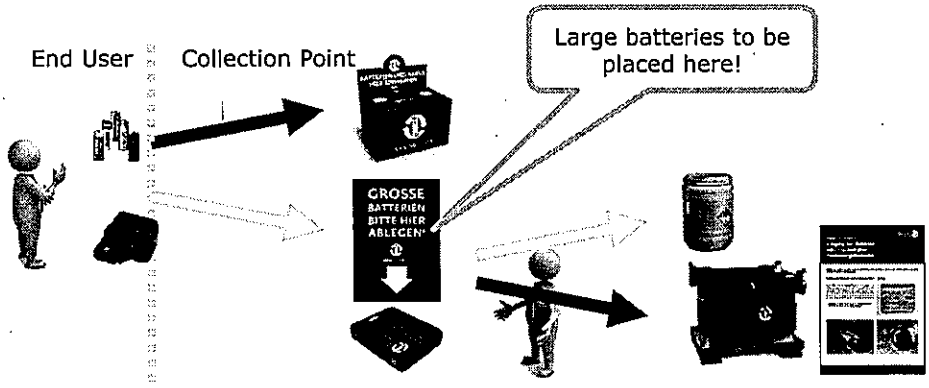
GEMEINSAMES RÜCKNAHME SYSTEM

5 Process (collection / packaging units -> transportation)



Packing & consolidation by trained staff

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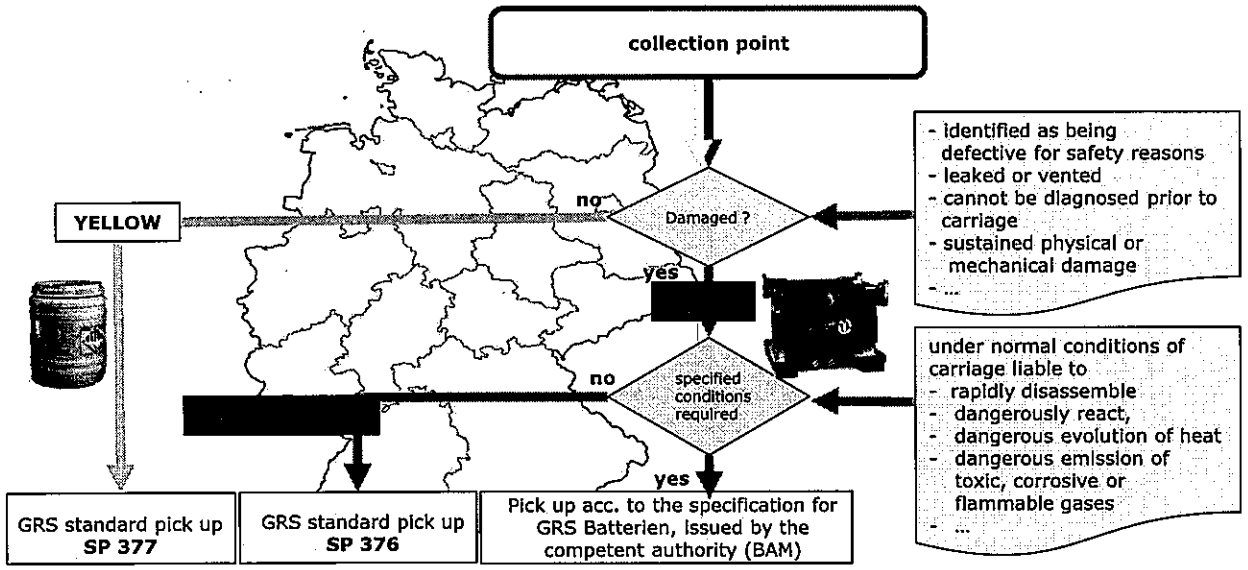
GEMEINSAMES RÜCKNAHME SYSTEM

Safe and compliant collection process for used batteries

Process for the collection of high energy batteries > 500 g:



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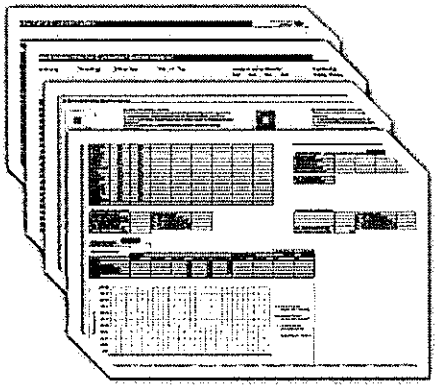
Risk assessment for packaging & transportation system

1. Simulation software

- Contracted consultancy company to develop a simulation software: assess and design a packaging and transportation concept for damaged lithium batteries
- Calculation input:
  - Battery database (composition, physical data, energetic data)
  - Substance database (phys./ chem. properties)
  - Thermodynamical fundamentals (heat transfer, convection)
- Assessment of thermal, chemical and ballistic risk dimensions



2. Batteries used for dimensioning of the packaging system

	Typical Field of Application				
	Nautic/Military	EV/HEV, SES	SES	Telecom Equipment	Gardening Equipment
Chemical system	Li-SOCl2	Li-Metal Oxide (NMC)	Li-Metal Oxide (NCA)	Li-Metal Oxide (NCA)	Li-Metal Oxide
Primary (P)/Secondary (S)	P	S	S	S	S
Appearance	Cylindric	Pouch	Cylindric	Cylindric	Cylindric
Cell/Battery mass [g]	90	15,810	19,000	30,000	6,500
Voltage [V]	3.6	44.0	48.0/ 24.0	48.0	37.0
Capacity [Ah]	18.0	53.0	45.0 / 90.0	77.0	24.8

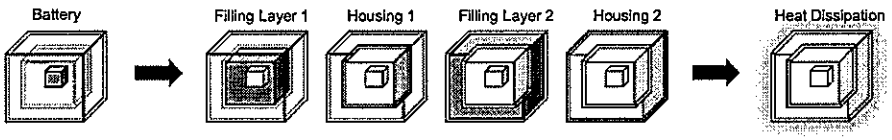
	Typical Field of Application				
	Pedelec	Pedelec	Pedelec	Pedelec	Pedelec
Chemical system	Li-Metal Oxide	Li-Metal Oxide	Li-Metal Oxide	Li-Metal Oxide	Li-Metal Oxide
Primary (P)/Secondary (S)	S	S	S	S	S
Battery mass [g]	3,000	3,220	2,500	3,650	4,353
Appearance	Cylindric	Cylindric	Cylindric	Cylindric	Cylindric
Voltage [V]	36.0	36.0	36.0	36.0	36.0
Capacity [Ah]	16.8	15.5	11.2	13.2	14.0

Risk assessment for packaging & transportation system

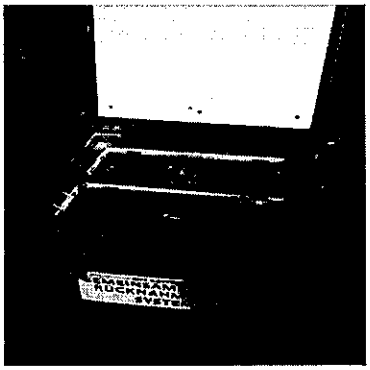
GRS BATTERIEN GEMEINSAMES RÜCKNAHME SYSTEM

3. Modelling approach

- Iterative calculation of heat distribution for thermal runaway
- Heat transfer over time through four surrounding layers up to convection at surface

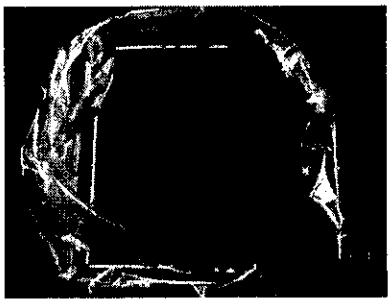
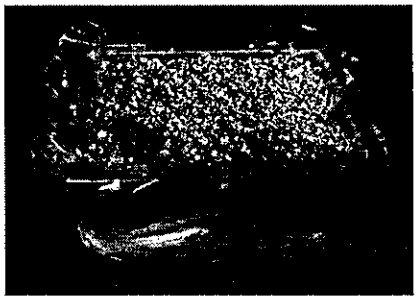


4. GRS packaging and transportation of damaged and defective lithium batteries 1/3

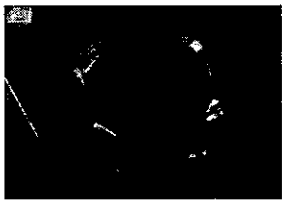



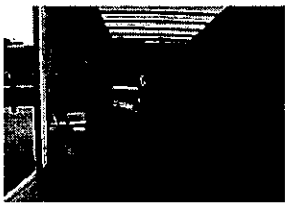

Risk assessment for packaging & transportation system

4. GRS packaging and transportation of damaged and defective lithium batteries 2/3



Following the specified conditions for GRS Batterien issued by BAM in 07/2013,
the logistics provider is taking over all responsibilities as *Consignor, Loader* and *Packer.*

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RÜCKNAHME
SYSTEM

Conclusion

Key observations

- Lithiums systems –> increasing risks for forward and take back logistics
- Safety requirements for take back are much higher than in forward logistics
- The GRS safety standard is currently the established benchmark in Europe
- GRS concept for risk assessment and safe logistics = worldwide unique
- GRS solutions are suitable for various applications in production and distribution

Contact

GRS BATTERIEN
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RÜCKNAHME
SYSTEM

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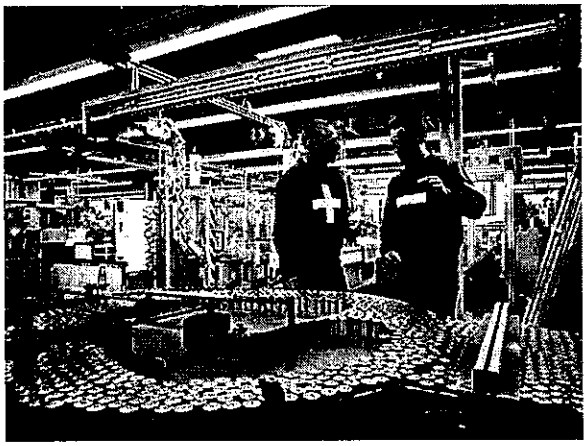
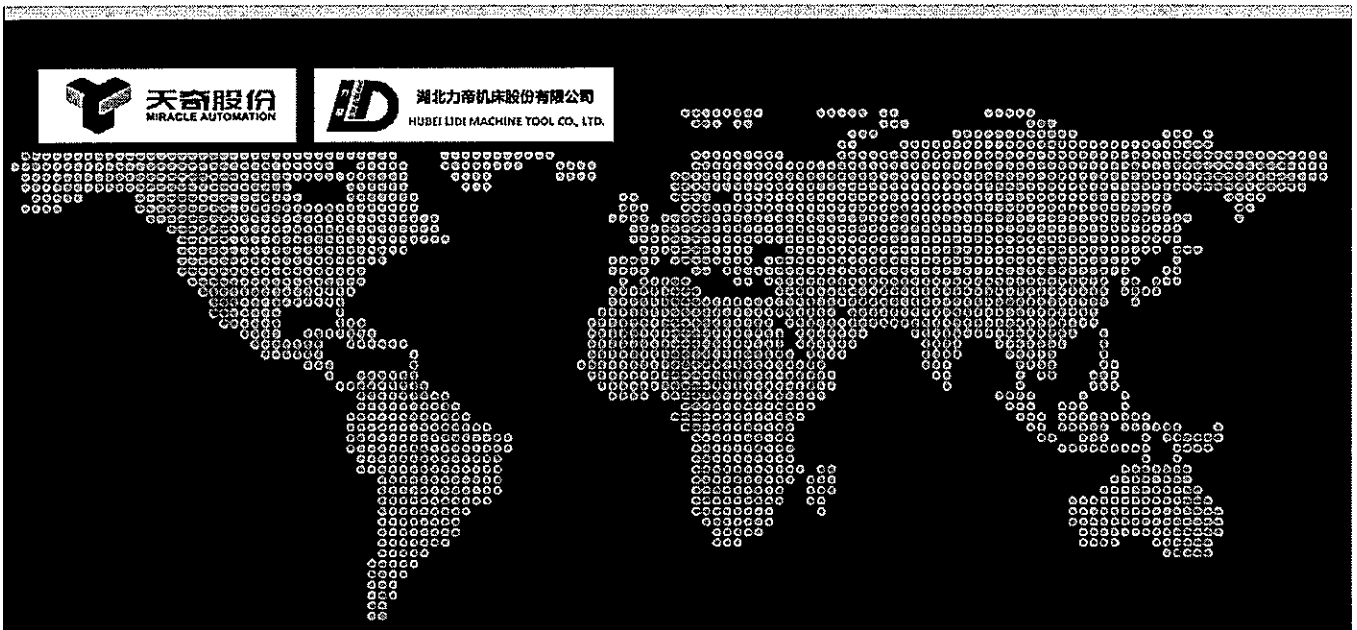
www.grs-batterien.com





废金属加工装备高端制造“四化”实践

——成套化、智能化、精细化、环保无害化

目　　录

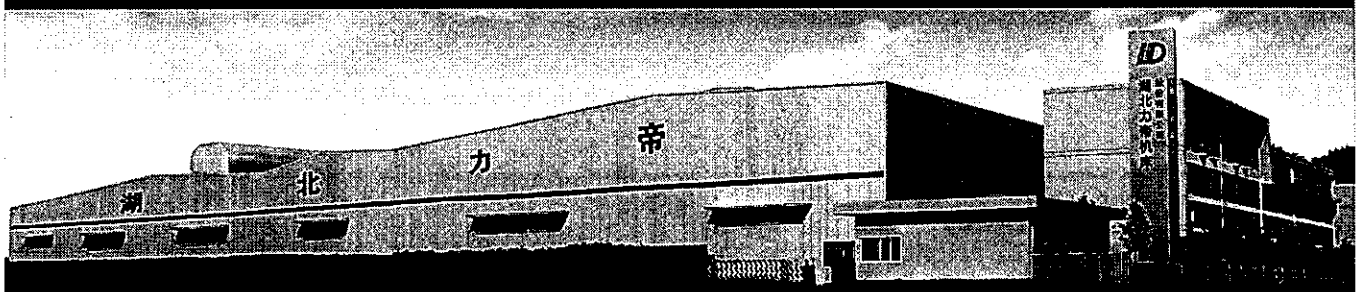
公司简介

湖北力帝机床股份有限公司位于世界水电之都，是一家集研发、设计、生产、销售、外贸服务为一体的高新技术企业。是国内最早开发金属回收机械的厂家，已有四十多年历史。

致力于废钢加工，汽车拆解，有色金属加工及分选，再生资源综合利用，环保节能等五大板块，提供集成解决方案，成套设备和服务。大型废钢加工设备中国市场占有率超70%！

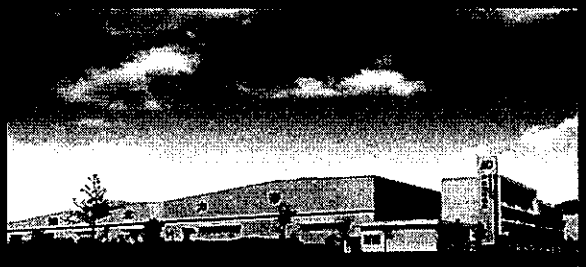
多次荣获国家、部、省级各类奖项，多次国家863计划承担单位，国家重点高新技术企业、省级技术中心，院士工作站。

产品远销国内外20多个国家与地区

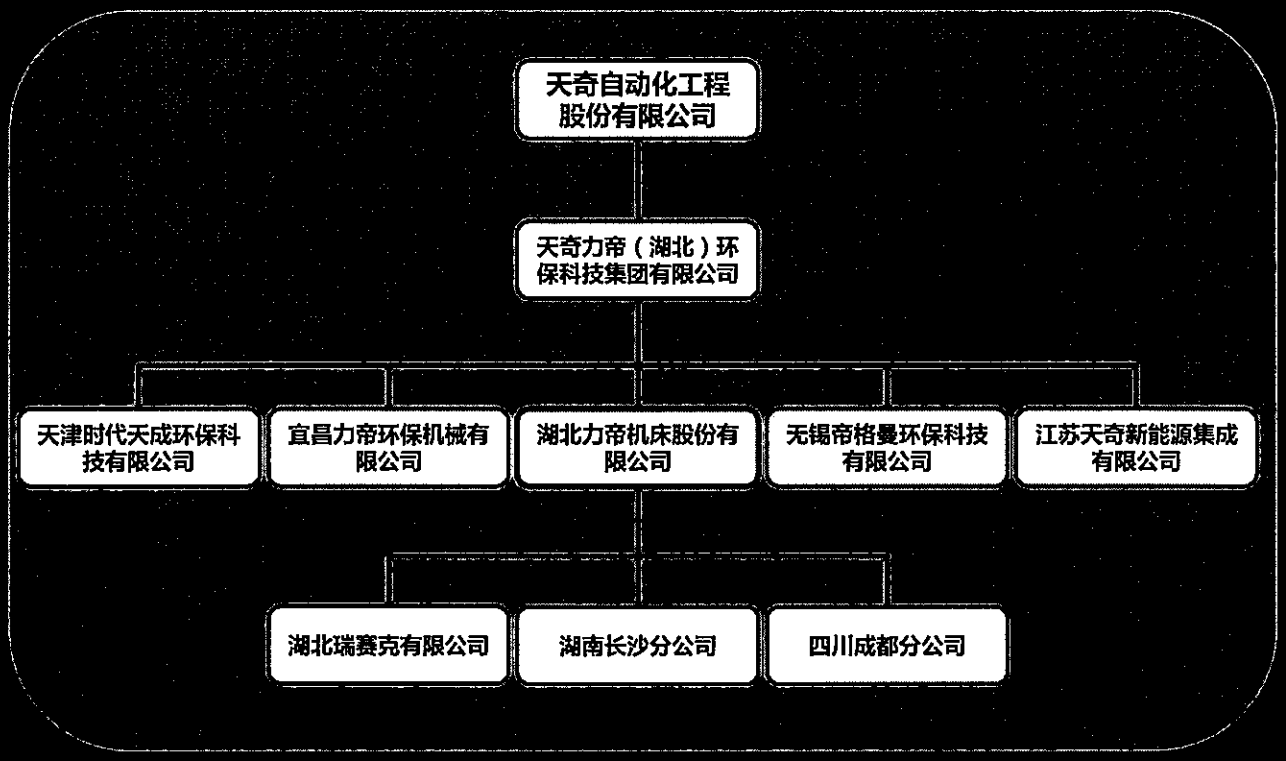


公司简介

天奇力帝（湖北）环保科技集团有限公司

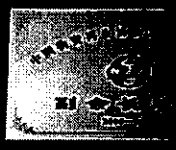


公司组织结构



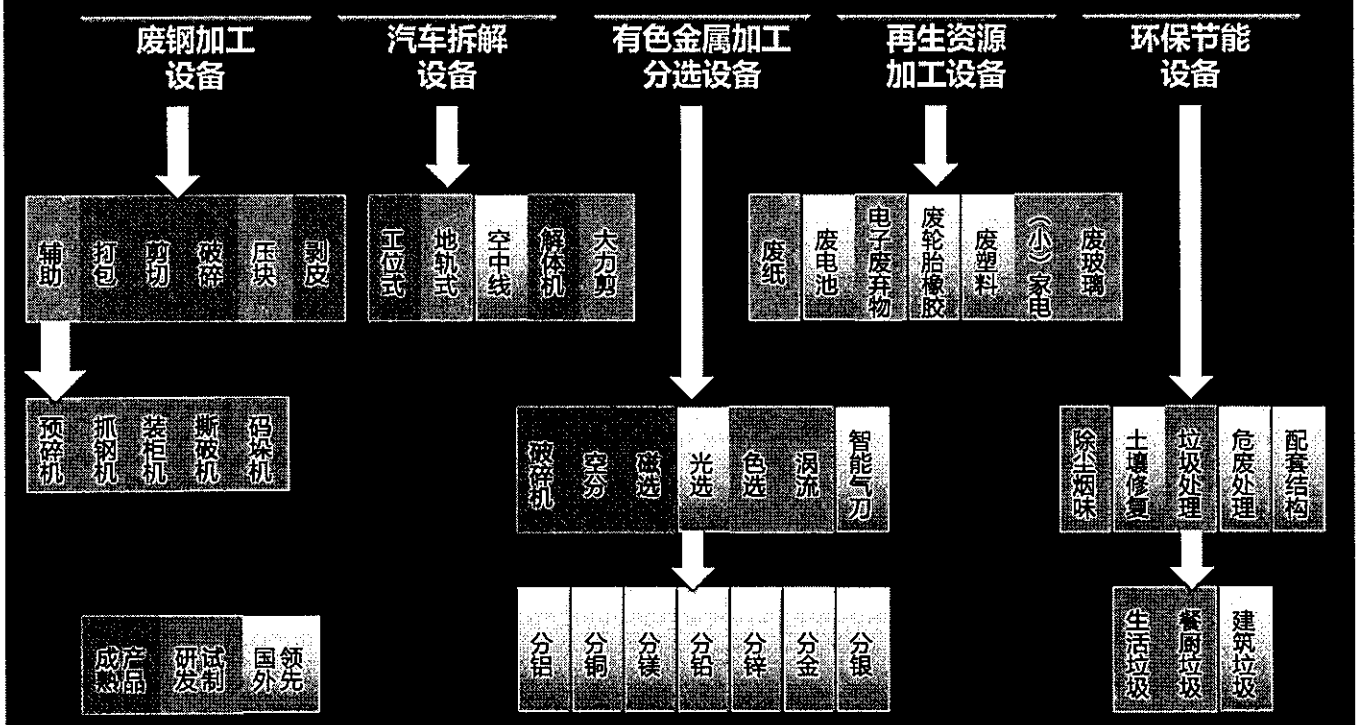
行业地位

中国废钢铁应用协会副理事长单位
中国物资再生协会副会长单位
中国有色金属工业协会再生金属分会常务理事单位
中国环保机械行业协会副会长单位
中国循环经济协会技术装备委员会副主任委员
中国再生资源回收利用协会会员
中国环保机械标准委员会委员
中国金属学会会员
中国环境产业协会会员
国家级高新技术企业
全国唯一的金属回收机械研究所



天奇股份 MIRACLE AUTOMATION　湖北力帝机床股份有限公司 HUBEI LIDI MACHINE TOOL CO., LTD.

产品体系



天奇股份 MIRACLE AUTOMATION　湖北力帝机床股份有限公司 HUBEI LIDI MACHINE TOOL CO., LTD.

研发能力

研发能力　联合承担2013年国家科技部“863”计划

国家高技术研究发展计划（863）计划

湖北力帝机床股份有限公司联合武汉理工大学、东风鸿泰汽车资源循环利用有限公司合作承担了2012年度国家高技术计划（863）课题**“退役乘用车回收拆解与资源化关键技术研究”**，实施期三年（2013-2015）。

废金属破碎分选处理技术及大型化设备产业化项目

项目结论：湖北力帝机床股份有限公司研发制造的废钢破碎线，填补国内空白，彻底改变了我国废钢破碎生产线全部依靠进口的局面。在废钢资源循环利用工程中起着至关重要的作用，具有很好的应用发展前景。

国家战略性新兴产业智能制造装备发展专项项目

PSX-88104型（4000马力）废金属破碎生产线研发有应用项目，2013年5月该项目通过国家级科技成果鉴定，**鉴定意见为：**“该项目填补了国内空白，其主要性能达到同类产品的国际先进水平，对提高我国废金属回收利用技术水平意义重大。建议进一步加大推广力度。”

1250吨大型废金属剪断机和废金属破碎生产线

公司自主研发的两项重大环保设备入选了国家发改委和环保部联合发文《国家鼓励发展的环保产业设备（产品）目录（2010）年版》及2010、2012、2013、2014年版。同时入选国家发改委、环保部、科技部、工信部2012年发布的《国家鼓励的循环经济技术、工艺和设备名录（第一批）》。

二、金属回收循环利用和再生资源综合利用

- 1、金属回收设备与方案
- 2、报废汽车拆解设备与方案
- 3、废弃电器电子回收生产线
- 4、除尘、降噪、减震环保技术应用

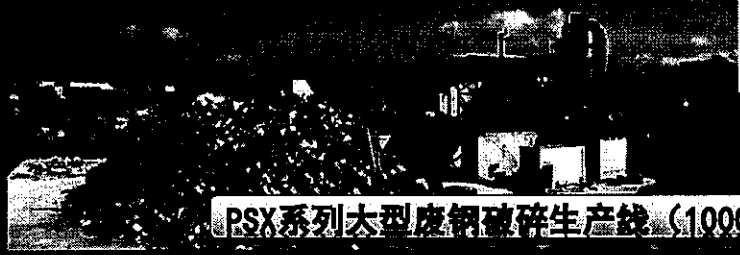
废钢加工回收成套设备

PSX-88104(4000马力）废钢破碎生产线 香港客户

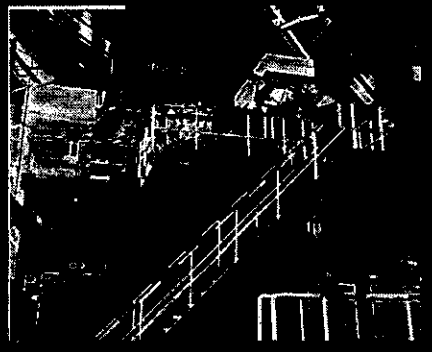
降噪 除尘 环保

湖北力帝破碎机参数对比

项目 / 机型	主机功率	出料量（吨/小时）	进料宽度（mm）	占地面积（单位均为米）	备注
PSX-6080	750Kw(1000马力)	15-25	2000	109x48x12(20)	表格一项中，括号内为配备除尘系统后的高度
	900Kw(1200马力)	18-28	2000	109x48x12(20)	
	1120Kw(1500马力)	20-35	2000	109x48x12(20)	
PSX-6096	1120Kw(1500马力)	25-40	2300	115x48x12(20)	
PSX-80104	1500Kw(2000马力)	35-45	2600	125x48x12(20)	
	2240Kw(3000马力)	45-60	2600	125x48x12(20)	
PSX-88104	3000Kw(4000马力)	70-110	2600	145x50x12(20)	
PSX-98104	4500Kw(6000马力)	100-150	2600	145x48x12(20)	



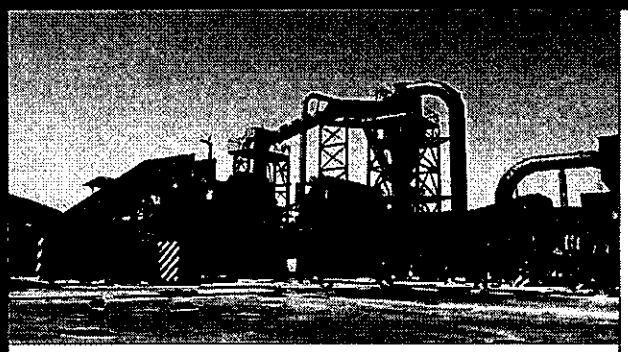
PSX系列大型废钢破碎生产线（1000马力——10000马力）

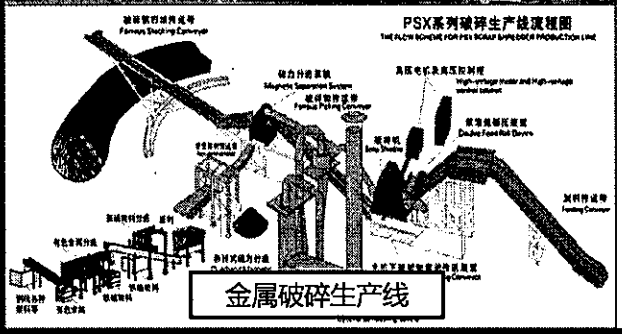


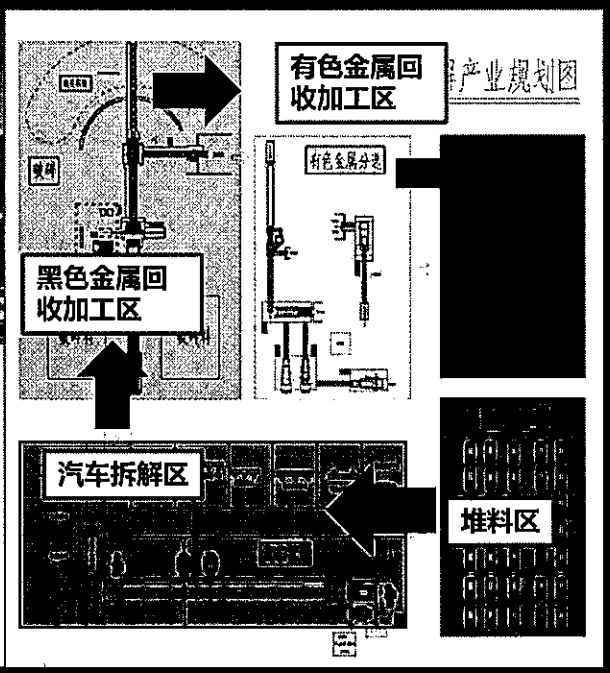
PSX-98104(6000马力）武汉

1、金属回收设备与方案

典型规划方案

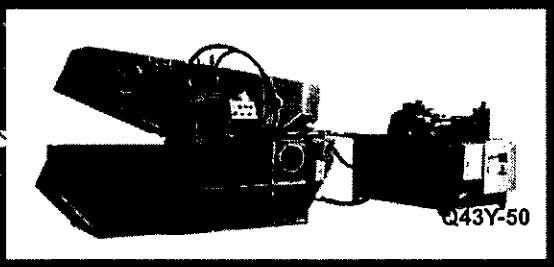






废钢加工回收成套设备

Y81系列金属打包液压机



Q43Y系列鳄鱼式剪断机

单层料箱

1、日本技术，剪切入口宽，加料型腔深
2、500T/630T/800T/1250T

双层料箱

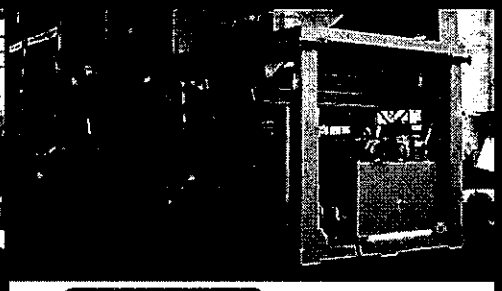
1、德国技术，剪切过程同时加料，提高效率
2、630T/700T/1000T/1250T

三层料箱

1、德国技术，适用于重型剪切
2、1000T/1250T/1600T

废钢加工回收成套设备

湖北力帝机床股份有限公司共30余种产品填补了国内空白，部分产品达到了国际先进水平。牵头制订了全部废钢利用以及加工处理设备的国家及行业技术标准。



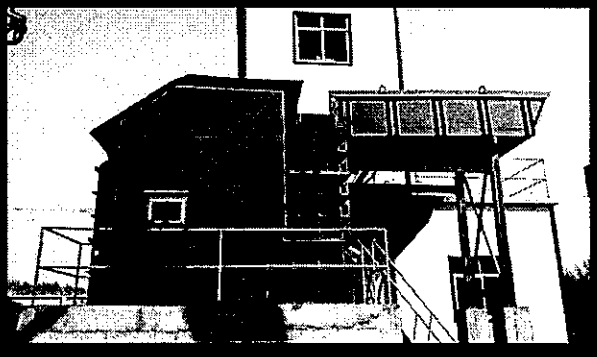
科技成果鉴定：国内首台、自主知识产权、国际先进水平

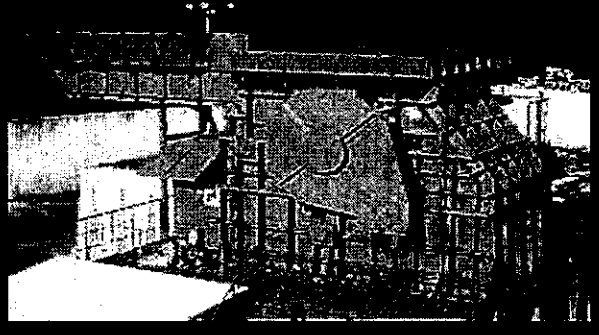
功能：可将轻薄黑色金属和有色金属物料打包成较小尺寸的包块，节约场地，增加物料的堆积密度。

规格：从100吨到1000吨等多种机型，有推包和翻包以及抓包多种出料方式，有圆形，方形，多边形等多种包块形式，可根据客户需求将物料压缩成各种密度的的包块（铁可达5，铜可达6吨/m³）。

废钢加工回收成套设备

预碎机能够对废车包块，带发动机的废车进行简单处理。和玻璃线组合利用，可提高破碎线的效率，并且节省电耗，减少破碎线的锤头、栅板损耗。此外，还可防止爆炸，提高安全保障。



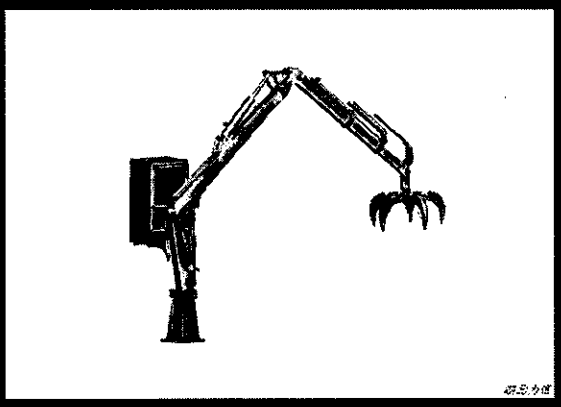


型号	产量（t/h）	电机功率（KW）	处理废料类型
TN-300	30	225	报废小汽车及包块料
TN-450	45	335	报废小汽车及包块料
TN-600	60	450	报废小汽车及包块料

1、金属回收设备与方案

废钢加工回收成套设备

ZJ-16抓料机



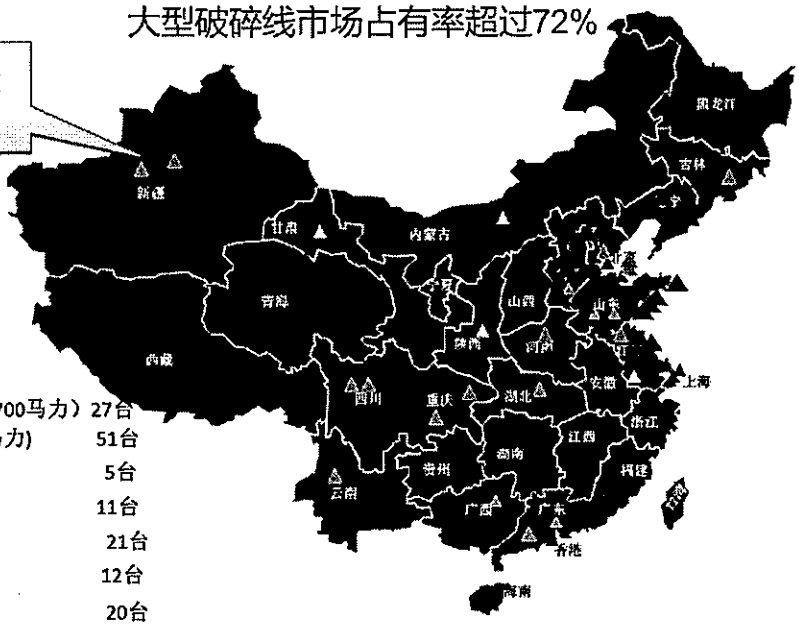
LZD100小型固定式抓钢（料）机

LZD系列小型固定式抓钢（料）机是力帝公司专门针对小型废料处理设备，包括打包机、剪断机、小型破碎机等上料、卸料而研发的抓钢机产品。

废钢加工回收成套设备

大型破碎线市场占有率超过72%

力帝破碎线业绩
147台套



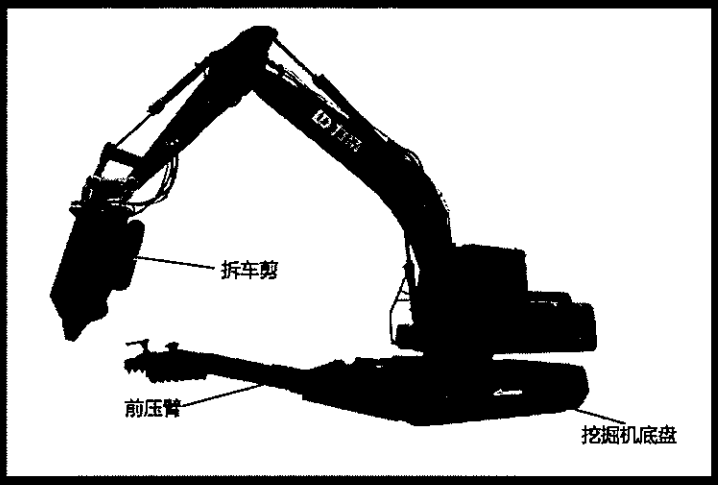
▲	PSX-5050-5070（500-700马力）	27台
▲	PSX-6080(1000-1200马力)	51台
	PSX-6096(1500马力)	5台
▲	PSX-80104(2000马力)	11台
▲	PSX-80104(3000马力）	21台
▲	PSX-88104(4000马力)	12台
▲	PSX-98104(6000马力)	20台

移动拆解设备系列

产品型号： LMD280汽车拆解机，LMD200汽车拆解机

LMD280已完成技术开发和试制，其采用20吨级挖掘机，主要针对小汽车、大型车辆（除车梁外），集装箱等物料的拆解。是目前市场上的主流产品。

LMD200采用15吨级挖掘机，主要针对小规模的汽车拆解公司，以及摩托车、家用电器的拆解，目前已完成整机的技术开发，可根据市场需求随时开展生产。



LMD280汽车拆解机实物图片

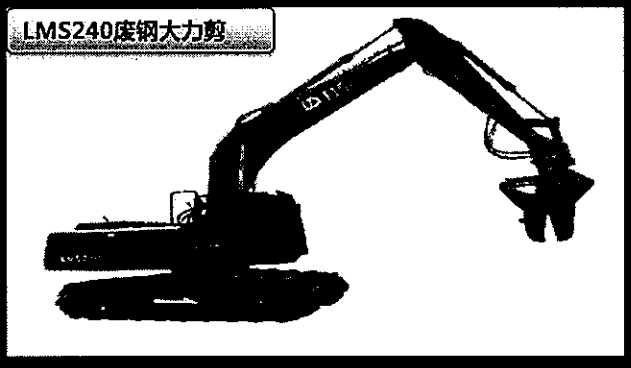
1、金属回收设备与方案

移动拆解设备系列

产品型号： LMS240废钢大力剪，LMS420废钢鹰嘴剪，LMS550废钢鹰嘴剪

废钢剪切机分为两种结构形式，小型的剪切头装配在挖掘机斗杆上，称为大力剪，已开发LMS240型号并完成试制，大力剪除了剪切废钢外，主要功能是和汽车拆解机配合使用，剪切大型车辆的车梁。

大型的剪切口形似于鹰嘴，其直接装配在挖掘机动臂上，称为鹰嘴剪，主要应用范围为重型废钢、废旧船舶、大型钢结构、钢结构厂房建筑物的拆解。已完成LMS420、LMS550两种型号整机产品的技术开发，可根据市场需求随时开展生产。



天奇股份 MIRACLE AUTOMATION

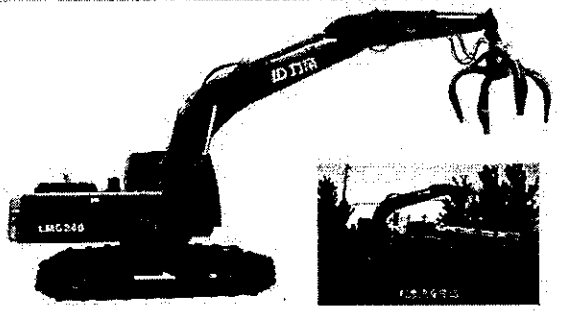
湖北力帝机床股份有限公司 HUBEI LIDI MACHINE TOOL CO., LTD.

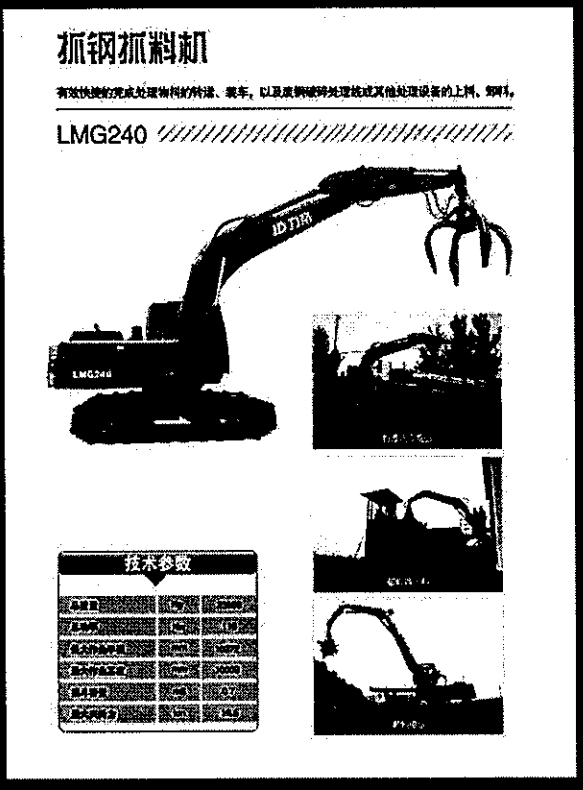
1、金属回收设备与方案

移动拆解设备系列

用于汽车破碎线及废钢破碎线的投料及卸料，以及物流的转移配送。

项目	参数
最大作业半径	10272mm
最大作业高度	10000mm
最大打开宽度	1820mm
抓斗容量	0.7m³
最大夹持力	12.5t





天奇股份 MIRACLE AUTOMATION

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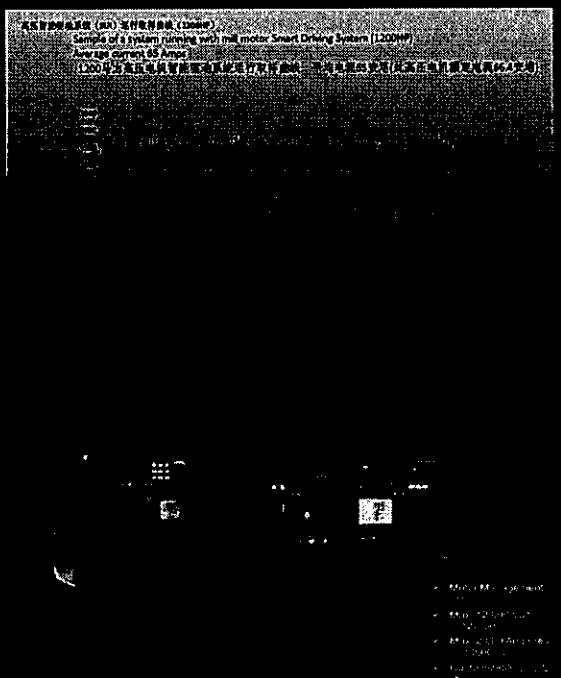
智能控制系统



天奇股份 MIRACLE AUTOMATION　湖北力帝机床股份有限公司 HUBEI LIDI MACHINE TOOL CO., LTD.

1、金属回收设备与方案

智能控制系统

破碎分选生产线系统框图

废金属、报废汽车、废家电

送料监控系统

远程监控系统

显示、操作系统

故障诊断系统

履带输送机

碾压装置

破碎主机

处理

不可破碎物识

除尘、水冷系

破碎物振动输送机

智能有色分选设

出料监控系统

物联、智能

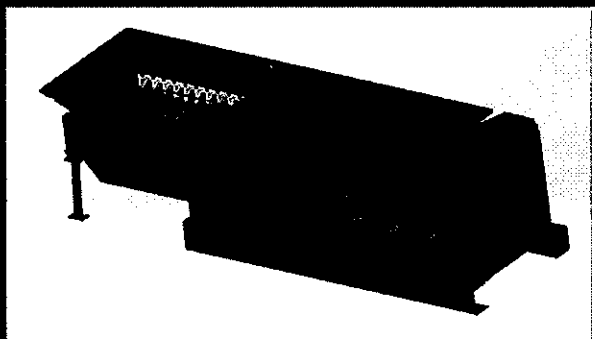
1、原有老设备升级改造；

2、远程诊断、远程维护，提供远程维修维护支持和服务；

3、完善售后服务体系，打造专业化售后服务队伍，三年内走向国际市场。

天奇股份 MIRACLE AUTOMATION　湖北力帝机床股份有限公司 HUBEI LIDI MACHINE TOOL CO., LTD.

新研发产品：撕破机



撕破机工作参数及生产预期

系统功率	528KW
系统压力	25MPa
主轴转速	8--14r/min
主轴扭矩	250000N.m
机身总重	约 62t
机身尺寸（不含输送装置）	约 10150X3000X2960
料斗开口尺寸	3500X2760(LXW)

预计处理汽车壳体 25t/小时，处理发动机壳体 15t/小时，处理型材 40t/小时。加工料撕碎后由输送机直接输出。

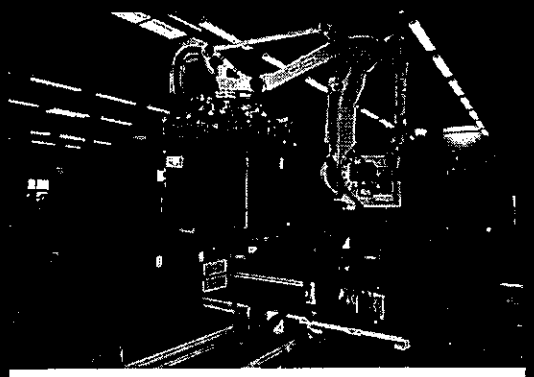
撕破机

SPC900-500撕破机采用电机作为动力源，利用液压系统驱动马达作为双轴旋转的动力，具有扭矩大、稳定可靠并且可控的优点。工作区配备两条运动缓慢的辊轴，在相互交错的刀片作用下，能有效撕碎汽车壳体、发动机壳体、铝型材等轻金属。该系统采用PLC控制，可以实现远程遥控控制，操作简单方便.

SPC900-500撕破机包括机身、动力系统、润滑系统、冷却系统、输送装置、报警装置等六大部分，还可根据用户需求进行针对性设计。该机结构紧凑，可直接放置于平板车上，方便运输。

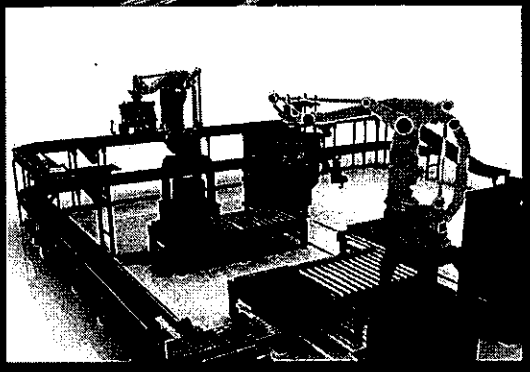
1、金属回收设备与方案

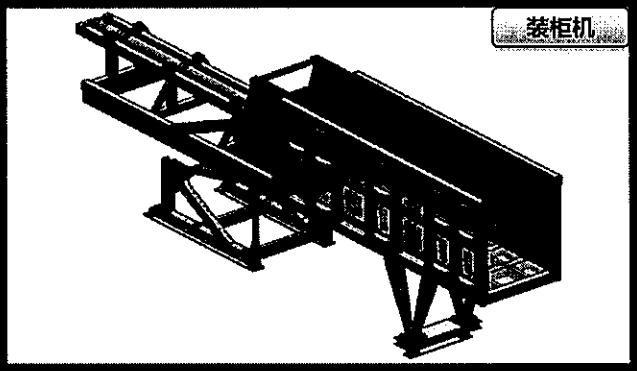
辅助设备——码垛机、装柜机



码垛机械手

能将不同外形尺寸的包装货物，整齐、自动地码（或拆）在托盘上（或生产线上等）。为充分利用托盘的面积和码堆物料的稳定性，机器人具有物料码垛顺序、排列设定器。可满足从低速到高速，从包装袋到纸箱，从码垛一种产品到码垛多种不同产品。应用于产品搬运、码垛等，广泛应用于汽车、物流、家电、医药、食品饮料等不同领域。



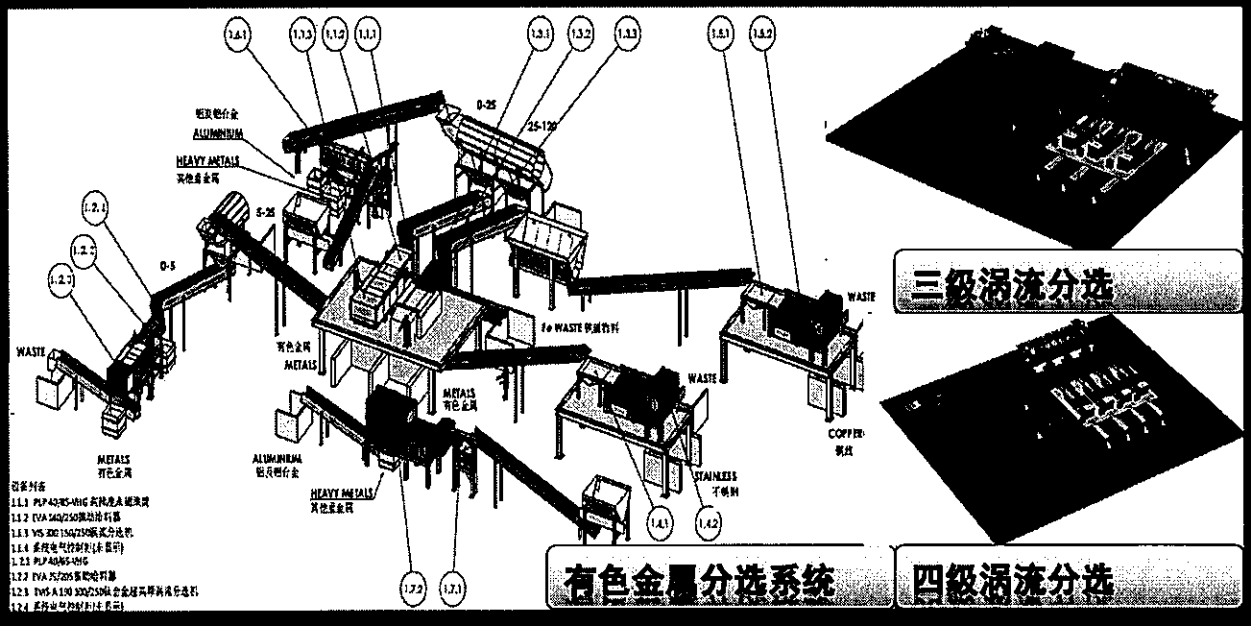


天奇股份 MIRACLE AUTOMATION | 湖北力帝机床股份有限公司 HUBEI LIDI MACHINE TOOL CO., LTD.

1、金属回收设备与方案

有色金属加工及分选

金属破碎料经过铁磁分选后进入下游分选线，进一步分选出有价值的物料，主要有有色金属，不锈钢，电线等。

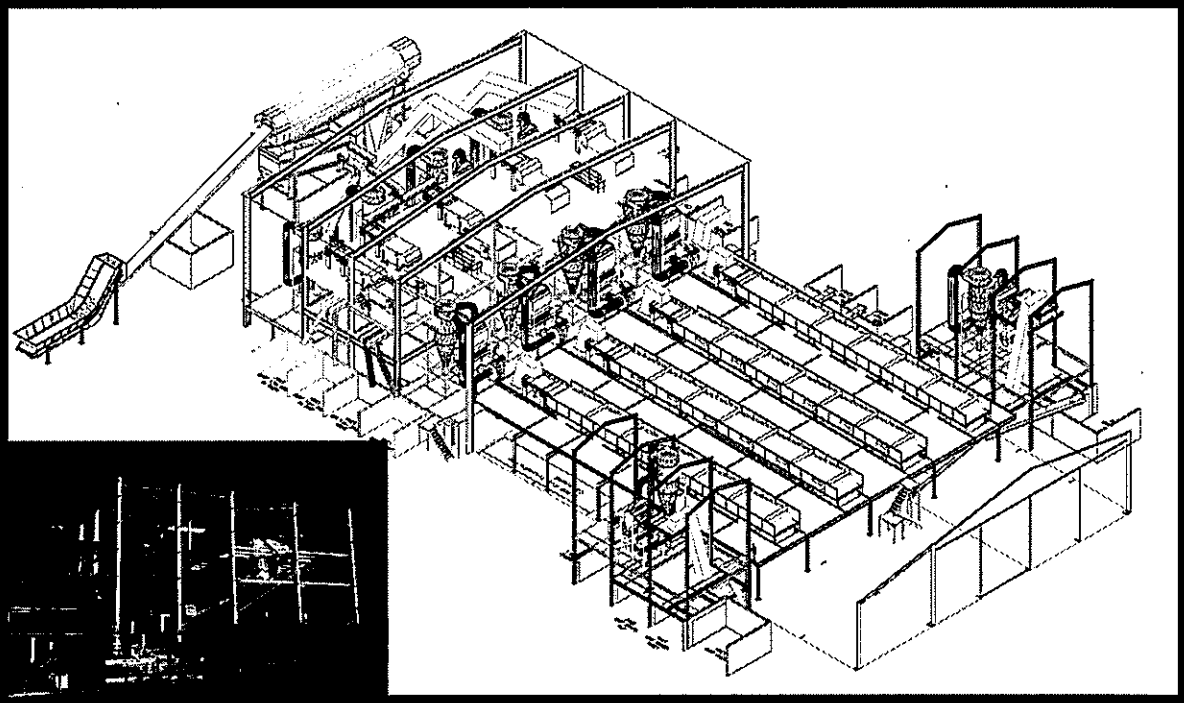


三级涡流分选

四级涡流分选

有色金属分选系统

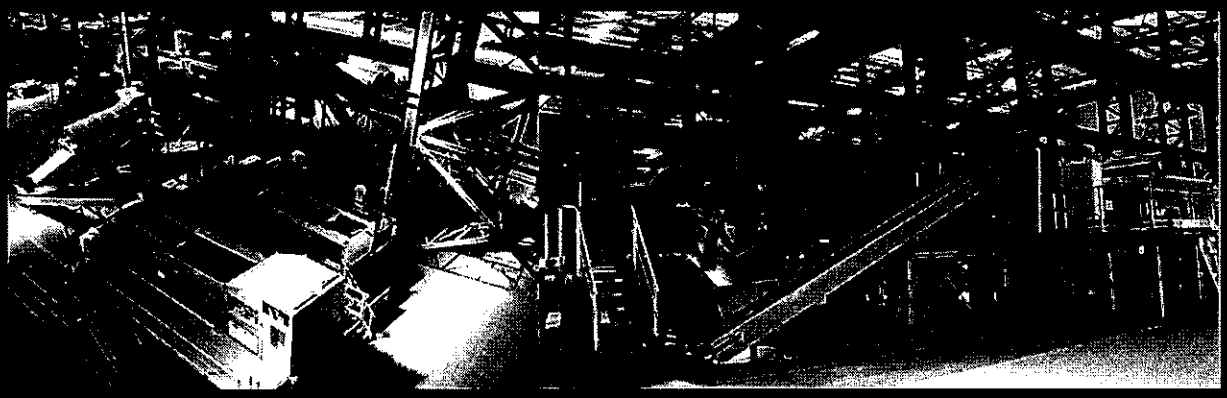
有色金属加工及分选



天奇股份 TIANQI AUTOMATION
湖北力帝机床股份有限公司 HUBEI LIDI MACHINE TOOL CO., LTD.

有色金属加工及分选

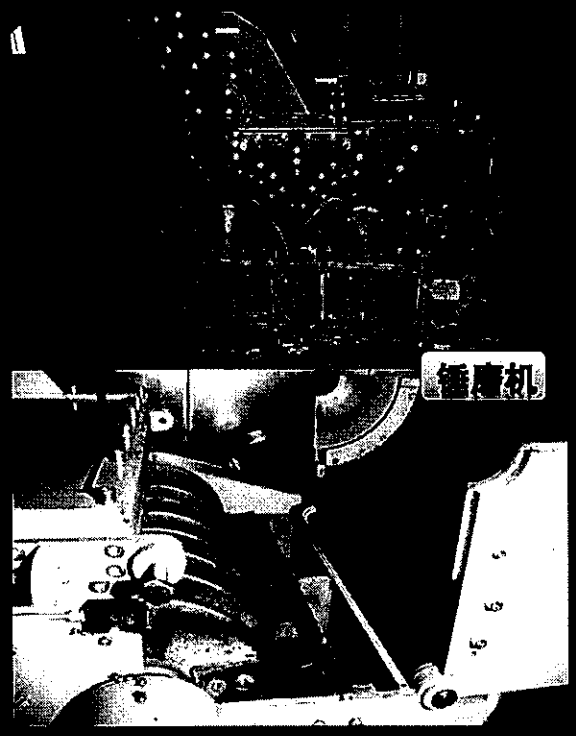
涡流分选机　　智能气刀分选机　　X光分选机　　空分装置（气流分选机）



有色金属智能分选线

1、金属回收设备与方案

有色金属加工及分选



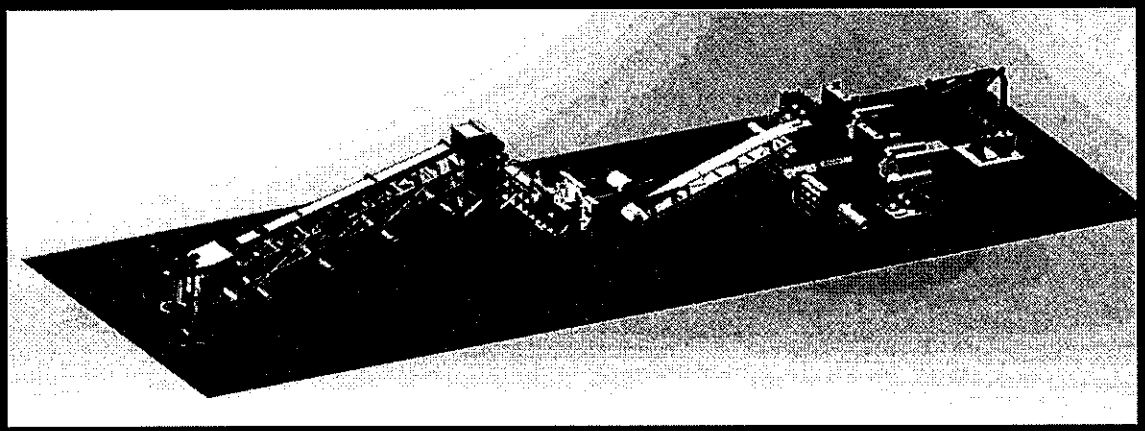
主要用于电路板和小家电的回收处理

锤击圆直径：650mm
转子直径：1000mm
转子数量:2个
锤头数量：每个转子16个锤头
单个锤头重量：8公斤
机身钢板厚度：20mm
双侧可打开，打开依靠手动控制的液压油缸。动力站驱动功率1.1KW
中央润滑系统
栅格可以更换
减震装置，电机调整滑轨以及固定装置
喂料通道采用很好的隔音处理且铺设有耐磨护板
出料斗
2个V型皮带

驱动功率：2x75KW
转子转速：1500转每分
总重8500Kg

天奇股份 MIRACLE AUTOMATION
湖北力帝机床股份有限公司 HUBEI LIDI MACHINE TOOL CO., LTD.

有色金属加工及分选



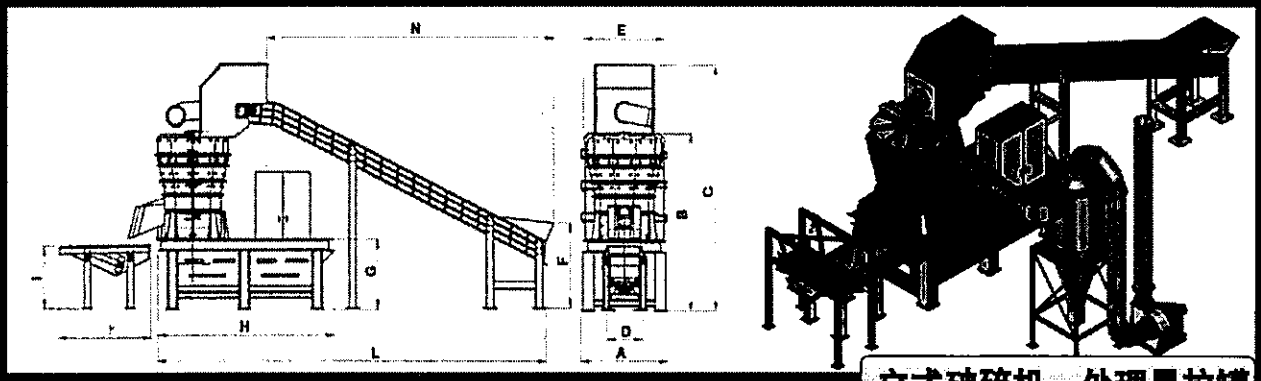
宁波博德高科有限公司隶属于博威集团，其放电废铜丝处理线要求如下：1.每小时5吨的处理量；2.要求99%的分选率。3.铜丝最终打成包块，每包重量为60±5公斤。最终的设备组成如下：悬挂链，皮带机，进料装置（油缸），鳄鱼剪，磁选系统，振动输送机，皮带机（带分料斗），打包机（带接料斗），有动力辊道，机器人，控制系统。

本线满足客户的需求，自动化程度高，可有效解放生产力，降低人力成本。

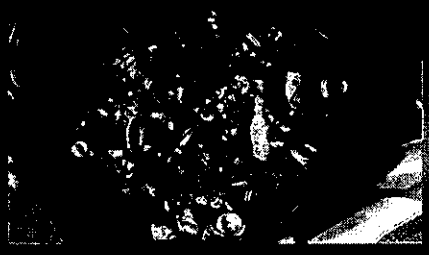
天奇股份 MIRACLE AUTOMATION　湖北力帝机床股份有限公司 HUBEI LIDI MACHINE TOOL CO., LTD.

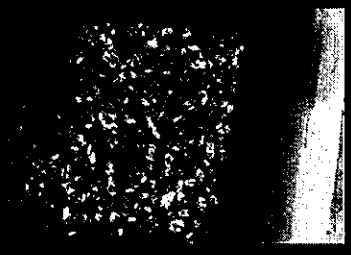
1、金属回收设备与方案

有色金属加工及分选



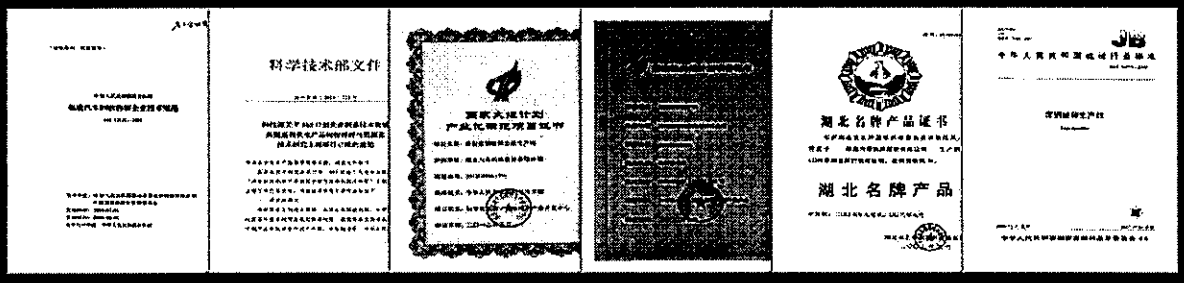
立式破碎机—处理易拉罐





天奇股份 MIRACLE AUTOMATION　湖北力帝机床股份有限公司 HUBEI LIDI MACHINE TOOL CO., LTD.

公司近年来在报废汽车拆解加工领域投入大量精力，研究开发了一系列适合中国国情的报废汽车拆解设备，投放市场后销售情况良好。2013年开始，湖北力帝承接了科技部863计划 “报废（退役）汽车回收拆解及资源化技术研究”项目，取得一系列成果。 2016年3月9日，项目顺利通过国家专家组验收！



合作单位：

湖北力帝

武汉理工大学

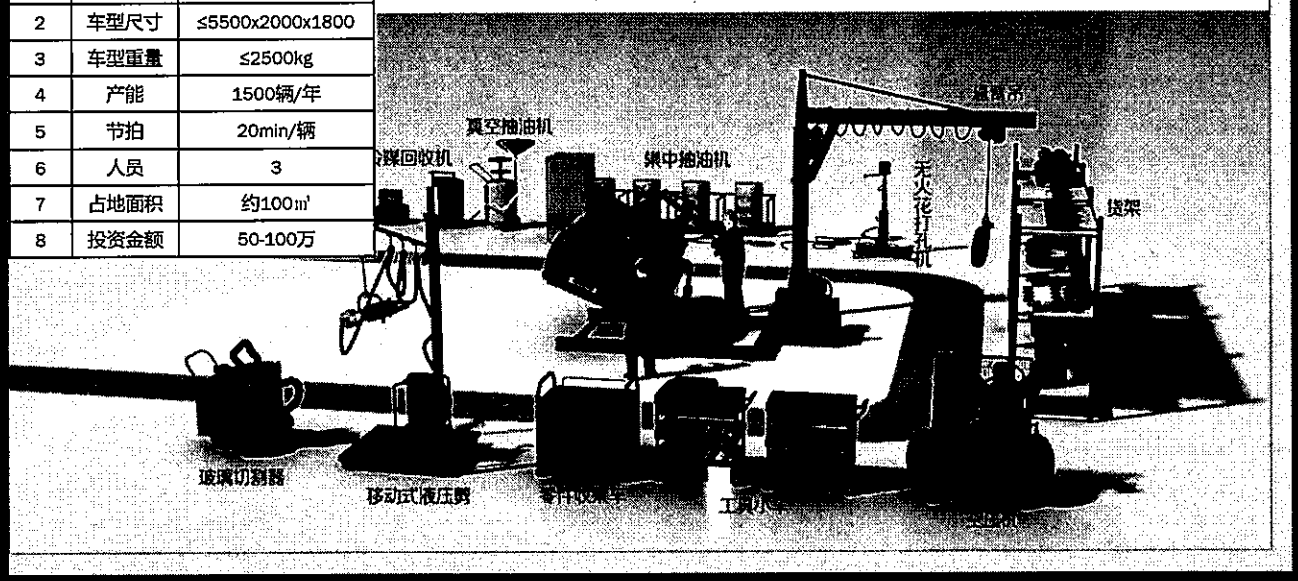
武汉东风鸿泰

2、报废汽车拆解设备与方案

拆解生产流水线

序号	项目	参数
1	拆解车型	报废乘用车
2	车型尺寸	≤5500x2000x1800
3	车型重量	≤2500kg
4	产能	1500辆/年
5	节拍	20min/辆
6	人员	3
7	占地面积	约100㎡
8	投资金额	50-100万

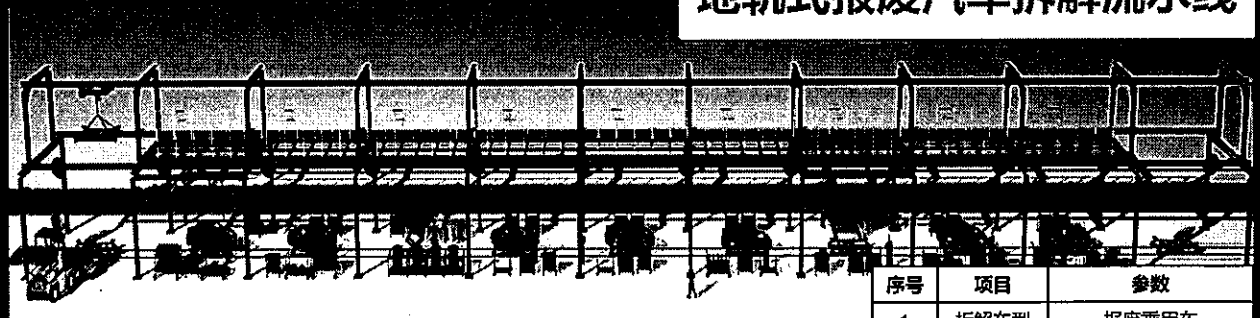
一站式报废汽车拆解



天奇股份 湖北力南机床股份有限公司

拆解生产流水线

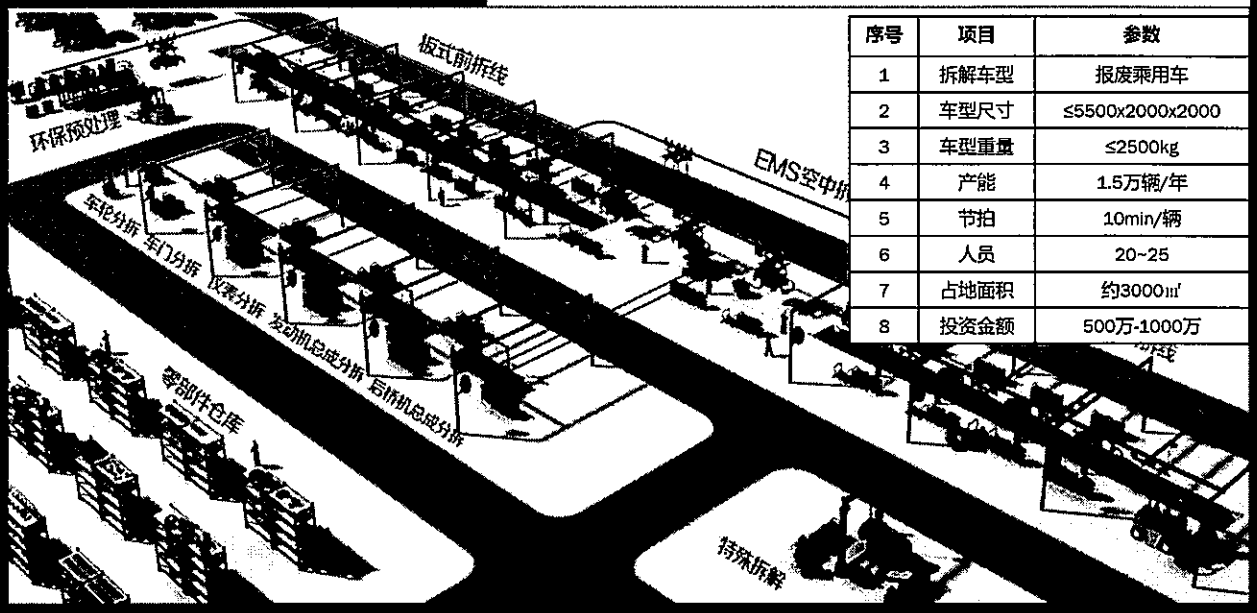
地轨式报废汽车拆解流水线



序号	项目	参数
1	拆解车型	报废乘用车
2	车型尺寸	≤5500x2000x2000
3	车型重量	≤2500kg
4	产能	6000辆/年
5	节拍	20min/辆
6	人员	15-20
7	占地面积	约1000㎡
8	投资金额	200万-500万

拆解生产流水线

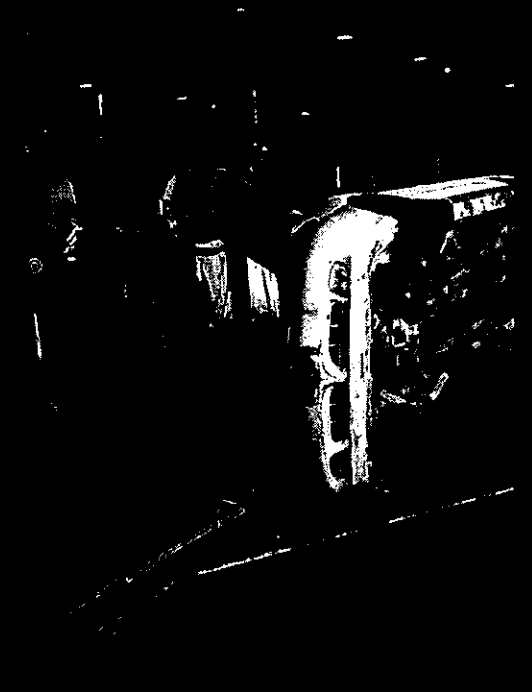
悬挂式（空中）报废汽车拆解流水线



序号	项目	参数
1	拆解车型	报废乘用车
2	车型尺寸	≤5500x2000x2000
3	车型重量	≤2500kg
4	产能	1.5万辆/年
5	节拍	10min/辆
6	人员	20~25
7	占地面积	约3000㎡
8	投资金额	500万-1000万

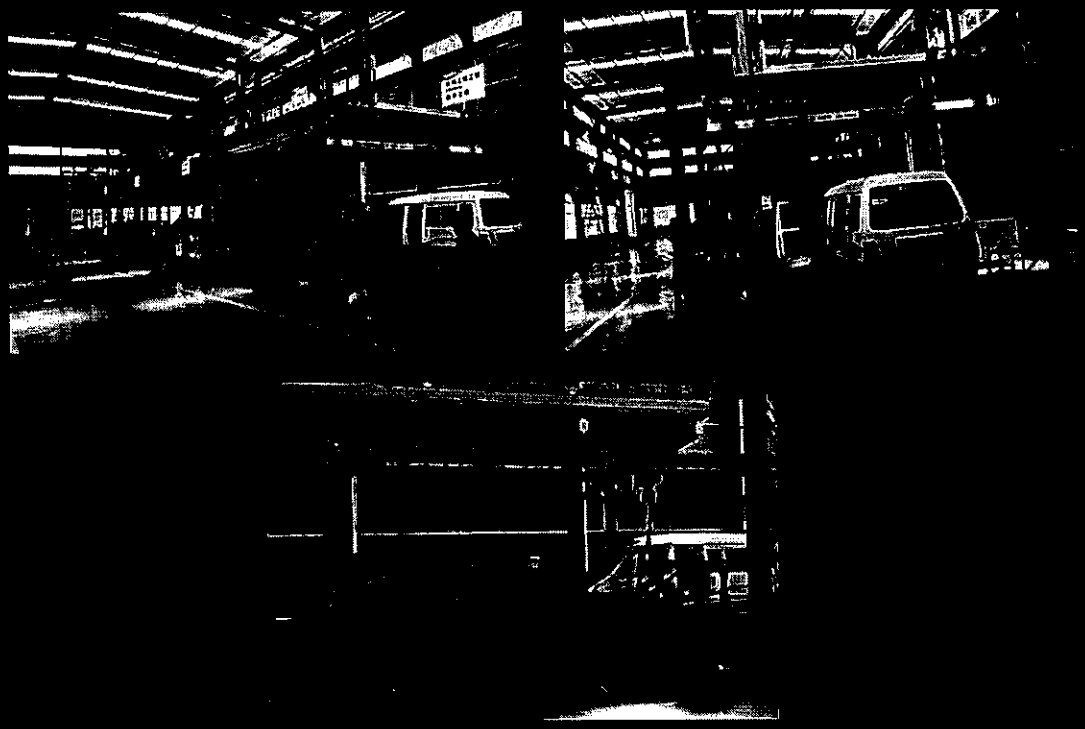
2、报废汽车拆解设备与方案

拆解线厂区现场（地轨式/板链式 + 多功能机械手）



2、报废汽车拆解设备与方案

遵义汇航机电　拆解线厂区现场（地轨式+空中返回线）



天奇股份 MIRACLE AUTOMATION
湖北力帝机床股份有限公司 HUBEI LIDI MACHINE TOOL CO., LTD.

湖北盈丰　板链+空中自行小车线

拆解线安装现场（板链+空中线）

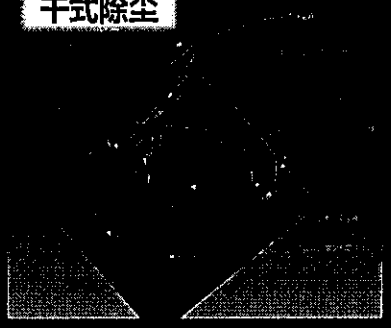
格力电器石家庄基地　拆解线调试中（板链+空中摩擦线）

4、除尘 降噪 减震环保技术应用

除尘系统及设备

湿式除尘

干式除尘

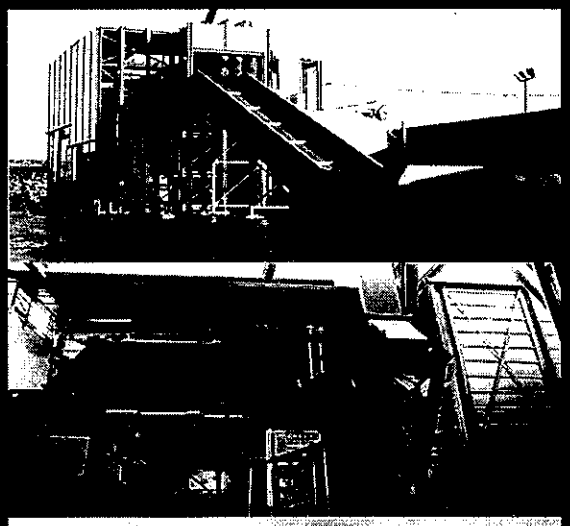


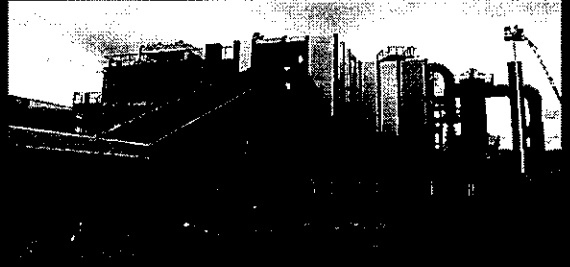
大气污染物排放标准汇总

地区	污染物	最高允许排放浓度 mg/m3	周界外浓度最高点无组织排放监控浓度限值* mg/m³	标准来源
国标	颗粒物	120（其它）	1	GB16297-1996（目前正在更新，2018年发布最新版大气污染物综合排放标准）
北京	颗粒物	30	未出（采用1.0）	DB 11/501-2017北京市大气污染物排放标准（目前正在更新，2018年发布最新版大气污染物综合排放标准）
福建厦门	颗粒物	100	1	DB 35/323-2011厦门市大气污染物排放标准
山东	颗粒物（其它）	30	未出（采用1.0）	DB 37/ 2376—2015山东省区域性大气污染物综合排放标准（2020年起按照5~20mg/m³）
广东	颗粒物（其它）	120	1	DB 44/27--2001广东省大气污染物排放标准
重庆	颗粒物	50	1	DB 50/418-2016重庆市大气污染物排放标准
上海	颗粒物	30	未出（采用1.0）	DB 31/933-2015上海市市大气污染物排放标准
陕西	颗粒物	10	未出（采用1.0）	DB61/941-2014陕西省关中地区重点行业大气污染物排放限值
贵州	颗粒物	20	未出（采用1.0）	DB52/864-2013贵州省环境污染物排放标准

1. 大气污染物排放浓度
   标准状态下（温度273K，压力101.3KPa），排气筒中每m³干排气中所含大气污染物的质量，单位mg/m³。
2. 破碎线所排放污染物主要是粉尘，灰尘类颗粒物，因此按照污染物为颗粒物的第三项目（其它）执行环保排放。
3. 排气筒高度
   自排气筒所在的地平面至排气筒出口计的高度。
4. 大气污染物排放速率
   一定高度的排气筒任何1小时排放污染物的质量，单位Kg/h。
5. 无组织排放
   大气污染物不经过排气筒的无规则排放。
6. 无组织排放监控点浓度限值
   标准状态下（温度273K，压力101.3KPa），监控点的大气污染物浓度在任何1小时的平均值不得超过的值，单位mg/m³。
7. 颗粒物（粒径小于等于10μm）PM10
   指环境空气中空气动力学当量直径小于等于10μm的颗粒物，也称可吸入颗粒物。
8. 颗粒物（粒径小于等于2.5μm）PM2.5
   指环境空气中空气动力学当量直径小于等于2.5μm的颗粒物，也称细颗粒物。
9. 大气污染物综合排放标准国标以及地方标准

降噪技术应用





1.各类环境区域解释（引用标准GB/T15190-94城市区域环境噪声适用区划分技

4 各类标准适用区域的解释

4.1 0类标准适用区域：疗养区、高级别墅区或对噪声环境要求特别严格的区域。

4.2 1类标准适用区域：居民区、文教区、居民和中小型工业混杂区，以及商业中心、港口和火车站等交通枢纽附近居民区等需要保持安静的区域。

4.3 2类标准适用区域：居住、商业和工业混合区，或城市交通干线两侧区域。

4.4 3类标准适用区域：工业区相对集中区域。

4.5 4类标准适用区域：城市道路中交通干线两侧区域，穿越城区的内河航道两侧区域，穿越城区的铁路主、次干线和轻轨交通路两侧区域。

2.工业企业噪音方面名称解释（引用标准GB12348-2008工业企业厂界环境噪声排放标准）

2.1工业企业厂界环境噪声：指在工业生产活动中使用固定设备等生产的、在厂界处进行测量和控制的干扰周围生活环境的声音。

2.2厂界：由法律文书（如土地使用证、房产证、租赁合同等）中确定的业主所拥有使用权（或所有权）的场所或建筑物边界。各种产生噪声的固定设备的厂界为其实际占地的边界。

2.3昼间、夜间：根据《中华人民共和国环境噪声污染防治法》，“昼间”是指6:00至22:00之间的时段；“夜间”是指22:00至6:00之间的时段。【县级以上人民政府为环境噪声污染防治的需要（如考虑时差、作息习惯差异等）而对昼间、夜间的划分另有规定的，应按其规定执行】

2.4工业企业厂界环境噪声不得超过表1规定的排放限制

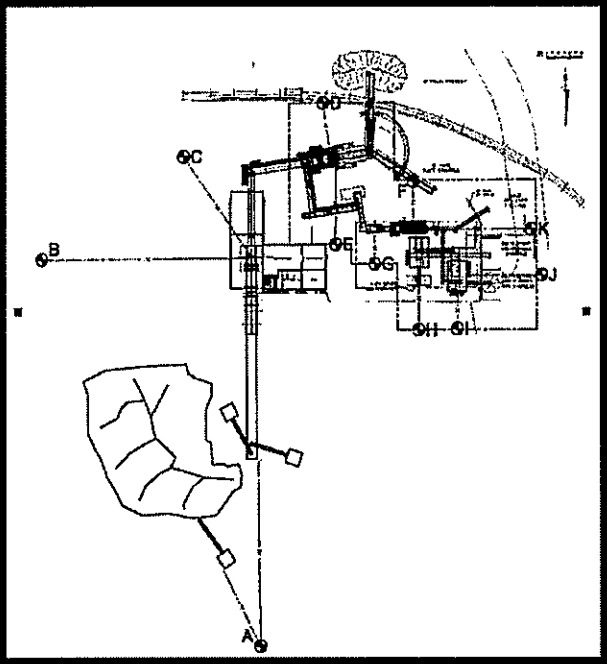
表1 工业企业厂界环境噪声排放限值 单位：dB(A)

厂界外声环境功能区类别	时间	
	昼间	夜间
0	50	40
1	55	45
2	60	50
3	65	55
4	70	55

破碎线常用高噪设备噪音

1	振动筛	93~130dB(A)	
2	风机	80~116dB(A)	
3	空压机	73~116dB(A)	
4	破碎机	85~114dB(A)	
5	电动机	75~107dB(A)	
6	水泵机组	85~106dB(A)	

降噪技术应用



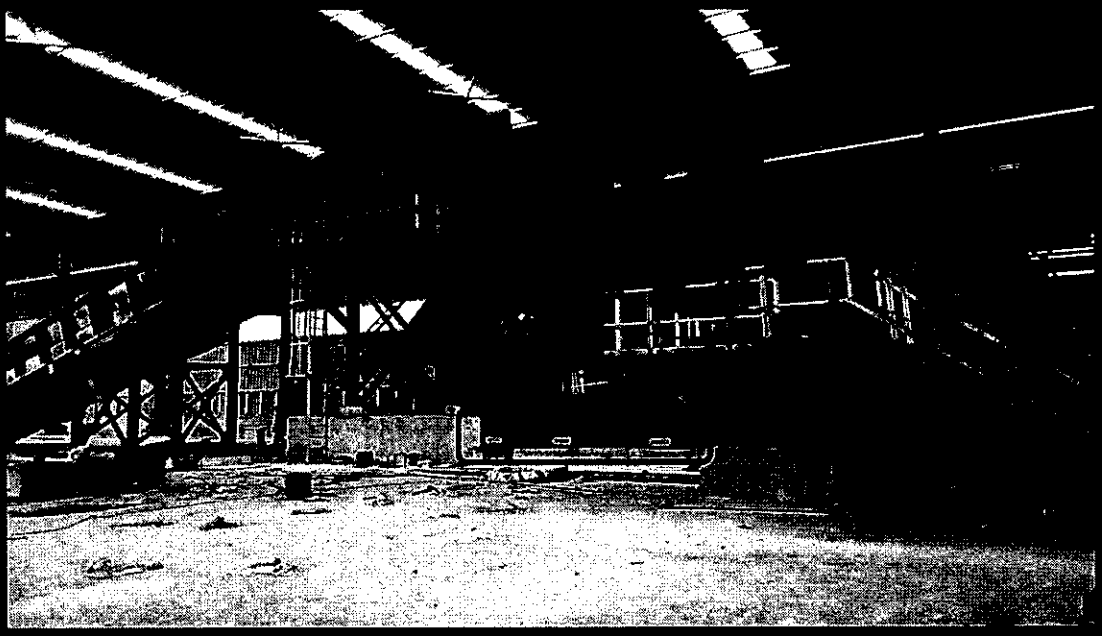
噪声等级的测量以破碎机为对象。实际测量点离设备相对较近，可以根据设计确定对应测量点较远位置的噪声等级。标准化到30~50米处的噪声辐射等级为：物料输送带处79dB，破碎机处85dB，以及破碎机之后的生产线87dB。

表 4. 破碎机设备全作业噪声等级

破碎机喂料输送带满负荷，破碎机全作业及其下游生产线作业时，空载和处理三种材料物料的等效噪声等级

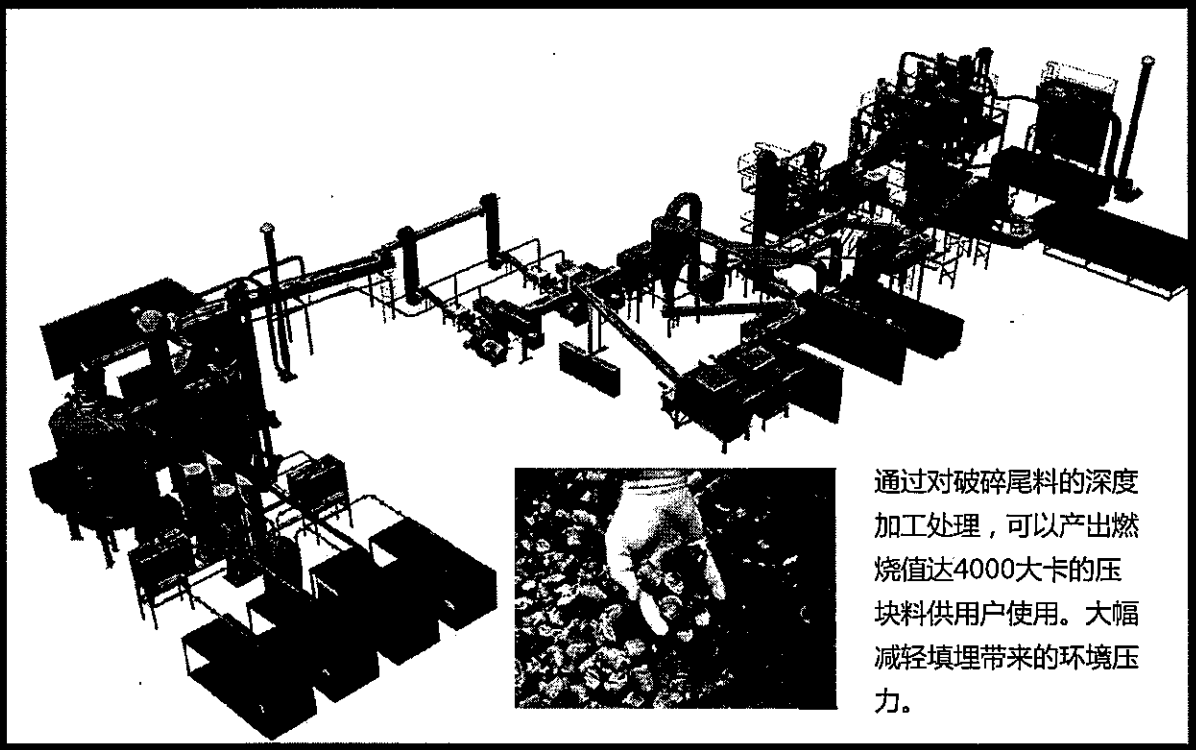
实时分析器 ID	位置	备注	时间	O/A	噪声等级
				L_p (dB)	L_A (dBA)
REC 01	A	破碎机进料口	12:58	85	80
REC 02	B	破碎机东侧	13:06	87	80
REC 03	C	破碎机南侧	13:11	99	85
REC 04	D	破送南侧	13:18	92	88
REC 05	E	破送北侧	13:27	91	88
REC 06	F	滚筒筛南侧	13:35	95	93
REC 07	G	物料仓/进料口	13:39	93	90
REC 08	H	涡流分选机	13:44	87	83
REC 09	I	空气分选机北侧	13:48	88	80
REC 10	J	空气分选机西侧	13:52	81	73
REC 11	K	滚筒筛西侧	13:57	84	78

减震技术应用



4、除尘、降噪、减震环保技术应用

国外破碎尾料处理案例



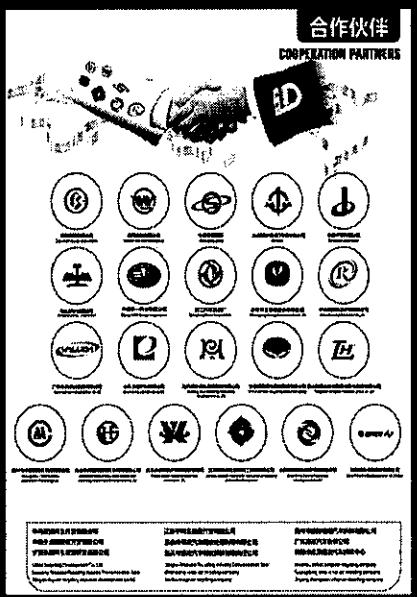
通过对破碎尾料的深度加工处理，可以产出燃烧值达4000大卡的压块料供用户使用。大幅减轻填埋带来的环境压力。

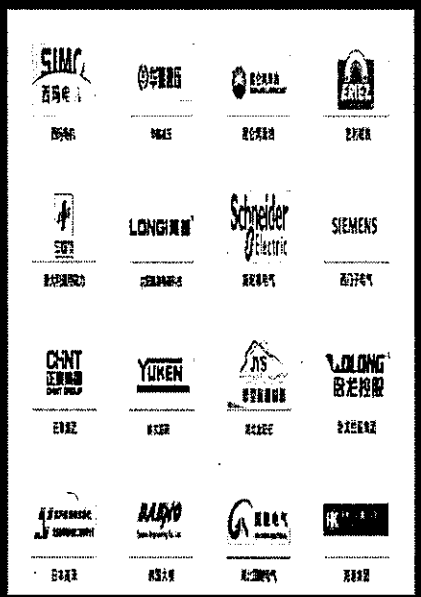
结束语

上、下游合作伙伴

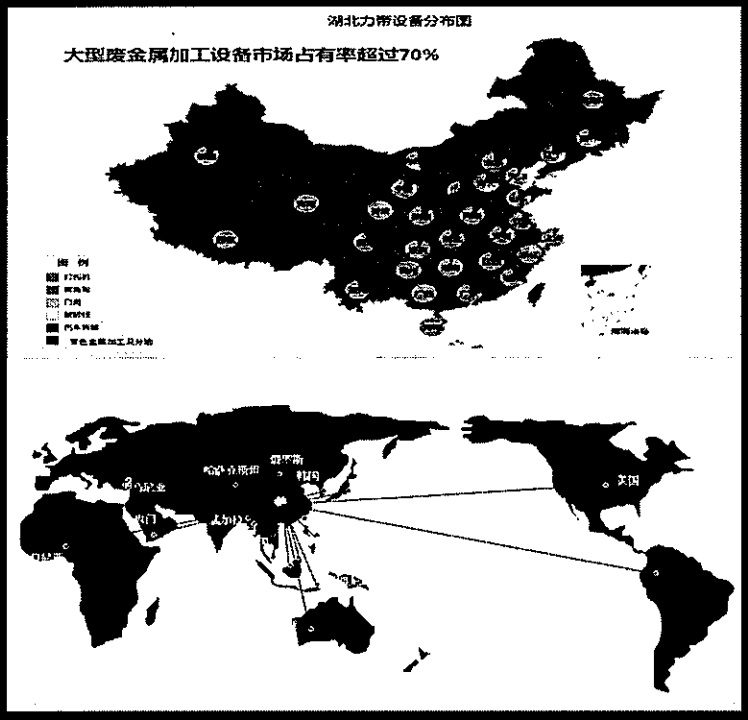
深耕行业四十余年，我们有幸结识了众多站在行业前沿的业界翘楚！

守信务实、互利共赢，与供应商建立良好合作关系。





市场覆盖



结束语

四十余年，我们有幸结识了众多站在行业前沿的业界翘楚！朋友的眼界、水平与高度，就是我们丰厚的资源。

我国再生资源产业无论从规模、数量、产业门类来说，中国都是最大的应用市场。

未来将与更多的大公司大客户形成紧密合作关系，共创共建大项目开发建设；与外围产品供应商合作，更好服务用户，实现多赢；创新、跨界、联合，共同营造健康持续的行业生态。把我们的根深深扎在行业这片沃土之中。

谢 谢

欢迎大家到湖北力帝参观指导工作！

Analysis of Economic and Social Ripple Effects of Remanufacturing-Related Industry of the Republic of Korea Using an I/O Table

2017 WORLD REMANUFACTURING FORUM Macau, China
14th-17th November 2017

Yong-Sung Jun, Ph.D. , Principal Researcher
Hong-Yoon Kang, Young-Chun Kim, Hyun-Jung Jo
Korea Institute of Industrial Technology

KITECH
한국생산기술연구원
자원순환기술지원센터

2017 World Remanufacturing Forum

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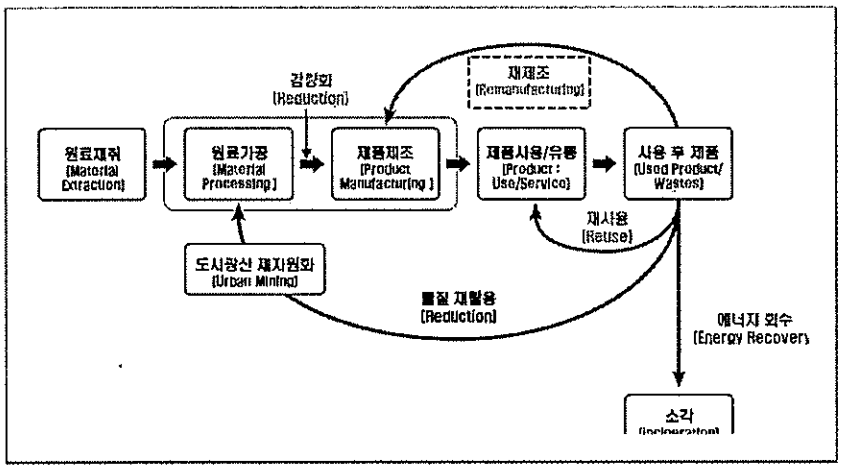
Remanufacturing Definition

- ***Remanufacturing*** **is an efficient resource circulation method** that restores the used products to the original performance through a series of processes.

Resource Recycling Concept



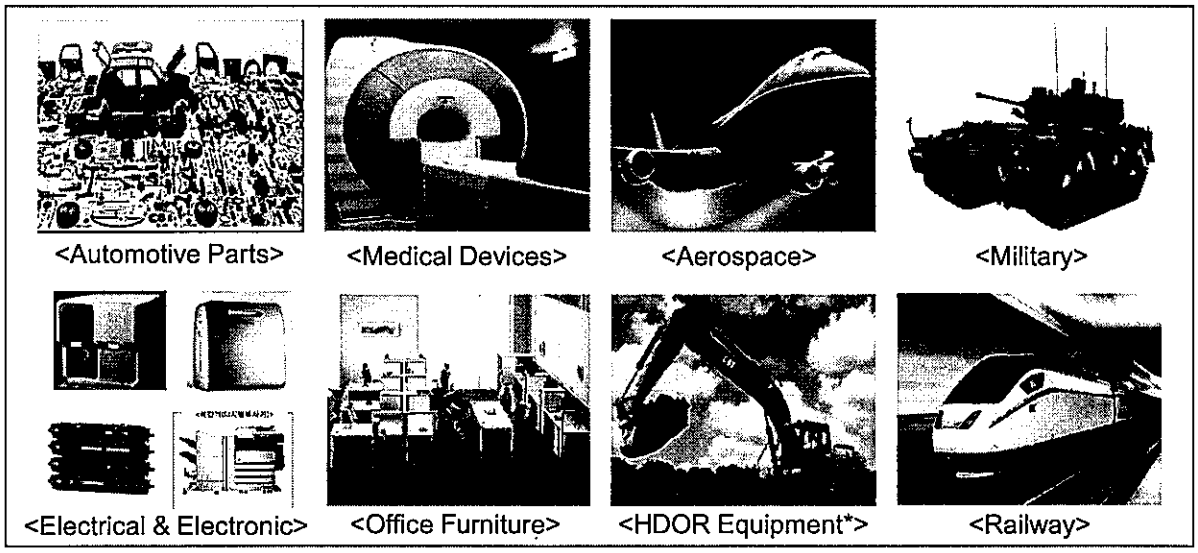
<Environmental and Economic Priority>

Reuse > Remanufacturing > Material Recycling > Energy Recovery

KITECH 한국생산기술연구원 자원순환기술지원센터

Remanufacturing Sectors

- **Remanufacturing industry** has grown **in various industrial areas.**
  - Currently, 121 product groups are being remanufactured in the classification of SIC (Standard Industrial Classification) codes. (Robert T. Lund, The Database of Remanufacturers, Boston University, 2012)



* Heavy-duty and off-road equipment

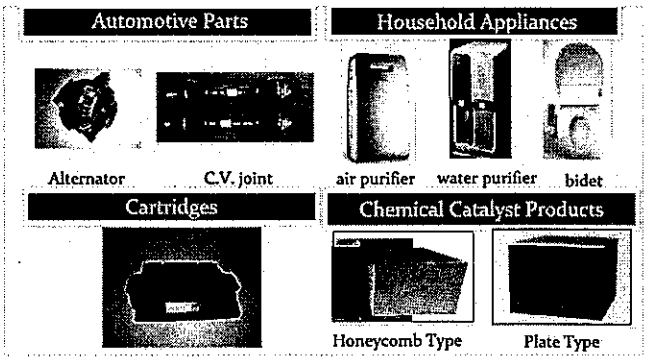
Remanufacturing in Korea – Market size

- **The remanufacturing market** has grown 11% in the last 5 years: KRW 750 billion (2010) → KRW 833 billion (2015)
  - The size of auto parts and toner cartridge market has not changed much, seemingly having reached their maturity stage.

Items	Automotive parts	Toner cartridges	Electrical and electronic equipment	Chemical catalyst product	Total
Market size of new products (unit: million USD)	560	170	1	4	695
Number of remanufacturing company	1,002	170	1	4	1,177
Number of employees	5,172	1,930	35	195	7,332

* Source : 2015 Statistics Survey of Remanufacturing Industry (KITECH CRIM)

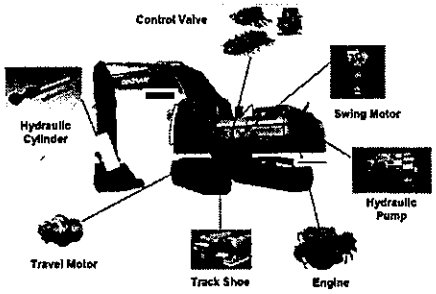
- The remanufacturing industry market is being stretched to various areas.
  - Automotive parts and cartridges → chemical catalyst products, household appliances, and construction machineries (not shown in statistics).

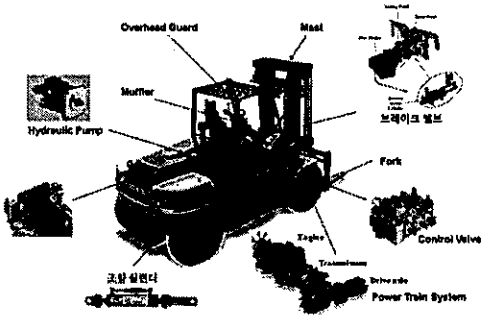


<Remanufactured products>

Remanufacturing Opportunity of Construction Machinery

- **There are 27 kinds of machines in construction machinery that can be used for construction work.**
  - The market share in the current status of used equipment and idleness/cancellation of domestic construction machinery is in the order **of forklifts (37.8%), excavators (32.3%), dump trucks (13%), concrete mixer trucks (5.6%) and loaders (5%).**
- **There are Items to be remanufactured for completed vehicles / parts for excavators and forklifts in construction machinery.**





- **Need to develop process technology for each construction machinery**
  - **Advanced disassembly technology** without damages to completed vehicles/parts
  - Eco-friendly high-efficiency **cleaning technology**
  - **Condition diagnosis technology** of a completed vehicle and a core
  - **Performance restoration technology** of a completed cle and a core
  - Alternative component parts reverse design technology of a core
  - Technology to extend the life of hydraulic and power related parts
  - Eco-painting technology of remanufactured products
  - Production process construction and test technology by stage

Comparison of Domestic and Overseas Remanufacturing Industry

- **The global remanufacturing market size is in the order of US $ 43 billion, Europe $ 34 billion, Japan $ 1.4 billion, and Korea $ 0.07 billion.**
  - Currently, **Korea has a market of $ 695 million** in the industries of **automotive parts, cartridges, electrical and electronic products, and chemical catalyst fields.**

Market Size($m)

Sectors	USA	EU	Germany	UK & Ireland	France	Italy	Japan	Korea
Aerospace	13,046	13,989	4,291	3,035	2,600	1,268	-	-
Motor vehicle parts	6,212	8,315	2,666	862	848	786	905	560
EEE	3,341	3,509	727	214	399	666	374	132
- IT products	2,682	-	-	-	-	-	374[1]	120[2]
- Consumer products	659	-	-	-	-	-	-	12[3]
HDOR equipment	7,771	4,661	1,247	573	712	609	-	-
Machinery	5,795	1,154	378	101	122	224	-	-
Medical devices	1,463	1,092	356	136	126	69	-	-
Rail	-	387	69	55	25	44	-	-
Retreaded tires	1,399	-	-	-	-	-	166	-
Marine	-	83	12	7	3	9	-	-
Catalyst	-	-	-	-	-	-	-	3
Furniture	-	348	74	38	27	74	-	-
All other	3,974	-	-	-	-	-	-	-
Total	43,000	33,539	9,819	5,021	4,862	3,749	1,444	695
Firms	8,000	7,203	-	-	-	-	1,500	1,177
Employm't('1000)	179.5	192.4	42.8	21.4	24.1	21.2	18.0	7.3

* Applied exchange rate : €1=$1.125, ¥100=$0.83, ₩1,000=$0.83

* Source : 2015 Statistics Survey of Remanufacturing Industry (KITECH CRIM)

Contents

Korea's Remanufacturing Market Outlook in 2025

- **Considering the increase of the share of remanufactured products in the A / S product market and the increase of the A / S product market (3% per year)**
- **Korea's remanufacturing market is estimated to reach 4 trillion won in 2025 and will grow 4.7 times more than 2015.**

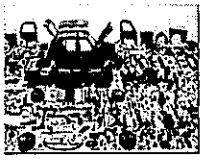
<Outlook of the expansion of Korea's remanufacturing market>

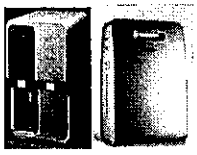
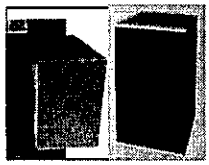
(Unit: 100 million won)

Items		Automotive Parts	Toner cartridges	Home Appliances	Chemical catalyst products	Sum
2015년	A / S market size	58,000	6,500	30,000	3,000	92,500
	Market share of remanufactured products	11.6%	22.3%	0.5%	1.3%	9.0%
	Market size of remanufacturing industry	6,740	1,450	140	40	8,370
2025년	A / S market size	77,947	8,735	40,317	4,032	131,032
	Market share of remanufactured products	40%	40%	10%	10%	30%
	Market size of remanufacturing industry	31,179	3,494	4,032	403	39,108

Research Background and Scope

- **The remanufacturing industry is a labor-intensive industry, which has three times more jobs than manufacturing industry.**
  - This industry provides win-win opportunities between large and small businesses or between original and remanufacturers
- **Remanufactured products are a kind of environmentally friendly industry that can save 70 ~ 80% of resources and energy consumption compared to new products.**
  - Remanufactured products have the same performance or function as new products, which are offered to consumers at low prices.
- **This study analyzed the economic and social ripple effects of the expansion of the remanufacturing market associated with the remanufacturing industry by using market size estimation data of the Korean remanufacturing industry.**
  - (Re-manufacturing area subject to analysis) Automobile parts, toner cartridges, electrical and electronic, chemical catalyst products
  - (Analysis method) Perform industry-related analysis using Korea's Industrial Input Table



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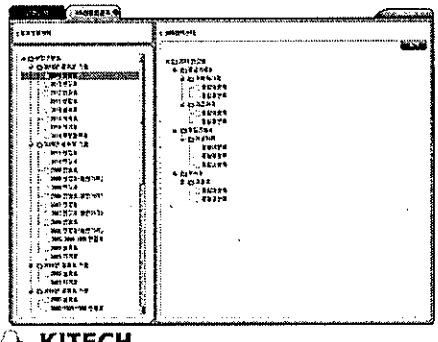
Overview of inter-industry analysis

- **Through the economic activities of a country, goods and services are produced. In the process of production, each industry establishes direct and indirect links based on the trade relations of raw materials.**
- **The inter-industry analysis is an analysis method that quantifies the interrelationships among the industries through the production activities.**
- **The inter-industry table used in the inter-industry analysis is a comprehensive statistical table that records all transactions occurring in the production and disposal of goods and services in the national economy for a certain period of time (usually one year).**
  - In order to create a practical inter-industry table in Korea, an actual table was created every five years from 1960 to 2005, and only an extension sheet was published annually after 2005.



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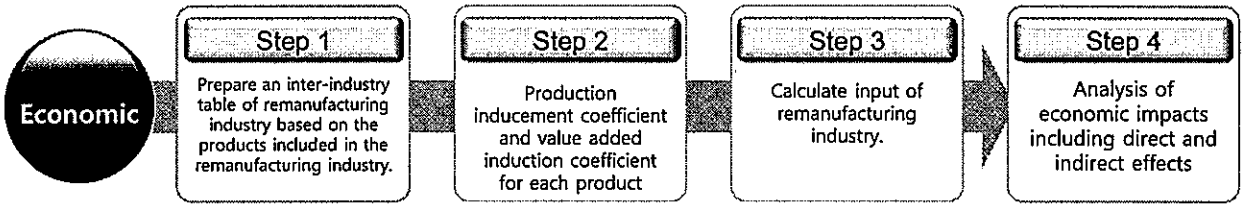
<Basic structure of the inter-industry table>

		내생부문			외생부문		수입(공제)	총산출액
		1 … i … n	중간수요계		소비 투자 수출	최종수요계		
내생부문	1	X_{11} … X_{1j} … X_{1n}	W_1		C_1 … I_1 … E_1	Y_1	M_1	X_1
	:	:	:		:	:	:	:
	i	X_{i1} … X_{ij} … X_{in}	W_i		C_i … I_i … E_i	Y_i	M_i	X_i
	:	:	:		:	:	:	:
	n	X_{n1} … X_{nj} … X_{nn}	W_n		C_n … I_n … E_n	Y_n	M_n	X_n
	중간투입계	U_1 … U_j … U_n						
외생부문	피용자보수 영업잉여 고정자본소모 순생산세	R_1 … R_j … R_n S_1 … S_j … S_n D_1 … D_j … D_n T_1 … T_j … T_n						
	부가가치세	V_1 … V_j … V_n						
총투입액		X_1 … X_j … X_n						

Analysis procedures of economic and social ripple impact

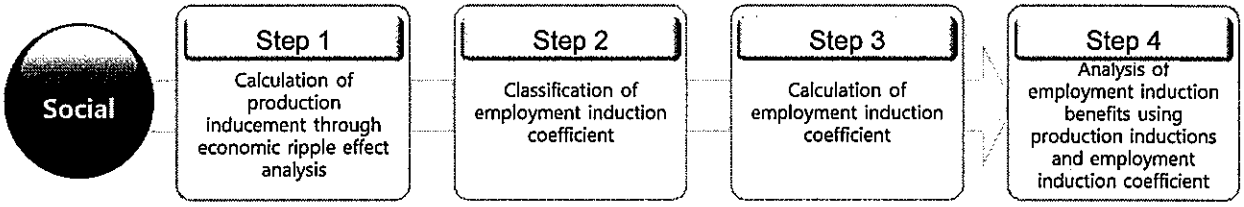
■ Economic ripple effect

- The direct and indirect economic ripple effects caused by the economic value creation of the remanufacturing industry are analyzed using the inter-industry analysis on the production inducement effect and the added value creation effect.



■ Social ripple effect

- The social ripple effects of the expansion of the remanufacturing industry are analyzed using inter-industry analysis.



Analysis of economic ripple impact (1/2)

■ Remanufacturing industry classification of basic sectors on the inter-industry table

- Classification of the remanufacturing industry for toner cartridges, electrical and electronic equipments, and chemical catalyst products

Remanufacturing products	Inter-industry table			
	Main category	Middle category	Small category	Basic category
Automotive parts	Transportation equipment	Automobile	Automotive engines and parts	Automotive parts
Toner cartridges	Chemicals	Other Chemicals	Dyes and paints	Ink
Electrical and Electronic Equipment	General machines	General purpose machines and equipment	Other general purpose machines	Air and liquid filtration purifiers
Chemical catalyst products	Chemicals	Other Chemicals	Other Chemicals	Other Chemicals

■ Calculation the production inducement coefficient and value-added inducement coefficient of 403 basic sectors of the remanufactured product

<Production induction coefficient>

Basic sectors No.	001	002	003	004	005	006	007	···	403
Name	Rice plant	Barley	Wheat	Grain	Vegetable	Fruit	Beans	···	Others
Ink	0.001707	5.4E-05	0.000284	0.002321	0.000914	0.000362	0.009096	···	0.002118
Other chemicals	0.001574	5.45E-05	0.000281	0.001022	0.00089	0.000359	0.00122	···	0.002099
Air and liquid filtration purifiers	0.001863	6.32E-05	0.000297	0.000854	0.001068	0.000433	0.000392	···	0.003099
Automotive parts	0.001443	4.99E-05	0.000245	0.000694	0.000822	0.000333	0.000347	···	0.002812

Analysis of economic ripple impact (2/2)

- **It is expected that the production inducement effect of KRW 13 trillion will occur due to the development of the remanufacturing industry.**
  - Indirect production inducing effects derived from other industries are about 70%.
    → Remanufacturing is an industry that contributes greatly to production in other industries.

Items	Estimation of '25 year market size (KRW billion)	Production inducement effect (KRW billion)			Ratio (%)	
		Direct(a)	Indirect(b)	Total(c)	Direct effect(a/c)	Indirect effect(b/c)
Toner cartridges	350	350	792	1,141	30.6	69.4
Chemical catalyst products	40	40	97	137	29.3	70.7
Electrical and electronic equipment	403	403	916	1,319	30.6	69.4
Automotive parts	3,118	3,118	7,242	10,360	30.1	69.9
Total	3,911	3,911	9,047	12,957	30.2	69.8

- **With the development of the remanufacturing industry, the value added inducement effect will be about 2.5 trillion won.**
  - The value added effect of automobile parts is the highest.

Items	Estimation of '25 year market size (KRW billion)	Value-added induction coefficient	Value-added induction coefficient effect (KRW billion)	Ratio (%)
Toner cartridges		0.599367	209	8.5
Chemical catalyst products	40	0.463326	19	0.8
Electrical and electronic equipment	403	0.690686	279	11.3
Automotive parts	3,118	0.629574	1,963	79.5
Total	3,911	-	2,470	100.0

Analysis of social ripple impact

- **Estimation of employment induction coefficient by 168 sub-categories of remanufactured products**

<Employment induction coefficient>

Basic category	Number	001	002	003	004	005	006	···	168
	Name	Rice plant	Barley and grain	Vegetable and fruit	Other edible crops	Non-edible crops	Dairy and beef cattle	···	Others
Dyes and paints		0.0034	0.0002	0.0019	0.0015	0.0001	0.0007	···	-
Other Chemicals		0.0035	0.0003	0.0018	0.0006	0.0001	0.0015	···	-
Other general purpose machines		0.0049	0.0002	0.0027	0.0005	0.0002	0.0008	···	-
Automotive engines and parts		0.0036	0.0002	0.0021	0.0004	0.0001	0.0006	···	-

- **The total employment inducement effect due to the development of the remanufacturing industry is expected to be about 34,000 people.**
  - The employment inducement effect of automotive parts is the highest.

Items	Toner cartridges	Chemical catalyst products	Electrical and electronic equipment	Automotive parts	Total
Estimation of '25 year market size (KRW billion)	350	40	403	3,118	3,911
Number of employment	1,968	172	3,631	27,981	33,768

Inter-industry analysis by items

- **In Korea's industrial structure, it has the greatest influence on the industrial plastic products industry for automobile parts, the crude oil industry for toner cartridges and chemical catalysts, and the crude steel industry for electrical and electronic products.**
  - In the case of toner cartridges and chemical catalysts, more linkage with specific industries than automotive parts and electrical and electronic products.

<Automotive parts>

Related industries	Ratio (%)
산업용플라스틱제품	6%
조강	4%
원유	4%
선철	3%
열간압연강재	3%
도매	3%
합성수지	3%
자동차용엔진	3%
석유화학기초제품	3%
나프타	2%
알루미늄괴	2%
기타 전기장치	2%
기업내연구개발	2%
산업용고무제품	2%
가계외소비지출	2%
도로화물운송	1%
주철물	1%
석유화학중간제품	1%
유연탄	1%
소매	1%
기타석탄제품	1%
기타	50%

<Toner cartridges>

Related industries	Ratio (%)
원유	8%
석유화학기초제품	8%
나프타	7%
염료,안료및유연제	7%
석유화학중간제품	5%
합성수지	5%
기초무기화합물	3%
도매	3%
기타화학제품	3%
기타	50%

<Chemical catalyst products>

Related industries	Ratio (%)
원유	9%
석유화학기초제품	9%
석유화학중간제품	9%
나프타	8%
금은괴	5%
기타기초유기화합물	4%
도매	3%
기초무기화합물	3%
기타	49%

<Electrical and electronic equipment>

Related industries	Ratio (%)
조강	5%
도매	5%
열간압연강재	4%
산업용플라스틱제품	4%
선철	3%
원유	3%
가계외소비지출	2%
합성수지	2%
기업내연구개발	2%
석유화학기초제품	2%
금속처리	2%
기타금속제품	2%
알루미늄괴	1%
발전기및전동기	1%
나프타	1%
도로화물운송	1%
기타철강1차제품	1%
금형및주형	1%
펌프및압축기	1%
유연탄	1%
기타석탄제품	1%
강관(주철강관제외)	1%
철광석	1%
밸브	1%
베어링,기어및전동요소	1%
기타	50%

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2017 World Remanufacturing Forum

Contents

Conclusions

- Korea's remanufacturing market size is estimated at KRW 837 billion by 2015, but the size of the remanufacturing market is expected to grow to KRW 4 trillion by 2025 through the expansion of remanufactured items and market share.
- Through the industry linkage analysis, the economic ripple effects of the Korean remanufacturing industry are expected to generate 13 trillion won in production inducement effect and 2.5 trillion won value added effect in the remanufacturing industry and remanufacturing related industries. It is also expected that about 34,000 jobs will be generated in the remanufacturing industry.
- In the Korean industrial structure, the remanufacturing industry is associated with various industries, and through the remanufacturing industry, the effect of producing more than twice the production inducement amount in the remanufacturing industry in the related industry is shown.
- There is a need for revitalization and continuous growth of the remanufacturing industry, which is a resource circulation industry with excellent environmental and economic effects.

Thank You for your attention!

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