

FROM BATTERY TO BLACK MASS

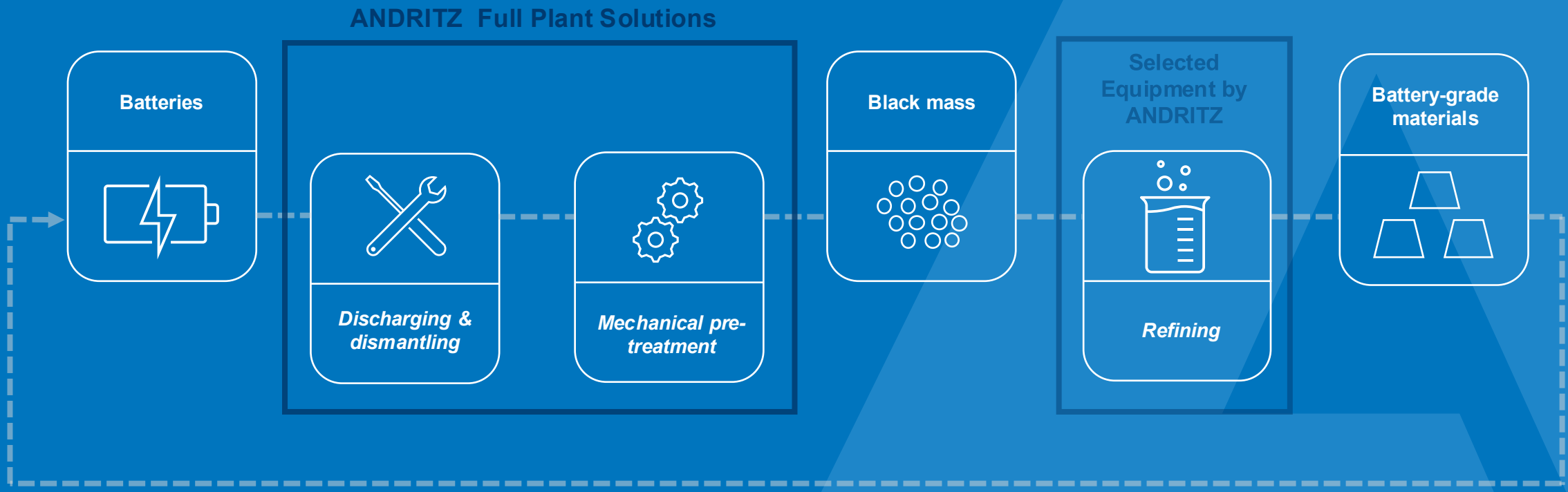
HOW MECHANICAL PRE-TREATMENT DETERMINES RECOVERY, SAFETY, AND PLANT ECONOMICS

PATRICK REITER | BATTERY RECYCLING EXPO | ATLANTA, USA | OCTOBER 28, 2026

ANDRITZ

BATTERY RECYCLING IS AN INTEGRATED VALUE CHAIN

Black mass quality connects mechanical pre-treatment with downstream metal recovery



INPUT
Heterogeneous and potentially hazardous battery material

INTERMEDIATE PRODUCT
Black mass and separated material fractions

FINAL OBJECTIVE
Recoverable battery-grade materials

FOUR OUTCOMES. ONE INTEGRATED PROCESS.

Recovery, quality, safety, and economics must be optimized together



NO SINGLE KPI DEFINES A SUCCESSFUL RECYCLING PROCESS.

FROM BATTERY INPUT TO RECOVERED MATERIALS

Every process step determines where material, risk, and value ultimately end up

BATTERY INPUT
Cells, modules, packs, and production scrap

PREPARATION
Classification, dismantling, and controlled discharge

SHREDDING
Opening, size reduction, and material liberation

VACUUM DRYING
Solvent removal and recovery under controlled conditions

SEPARATION
Screening, sorting, and mechanical separation

RECOVERED MATERIALS
Black mass and separated co-product fractions

RECOVERED OUTPUT STREAMS

Value is created across all fractions, not only black mass


BLACK MASS


COPPER


ALUMINUM


FERROUS

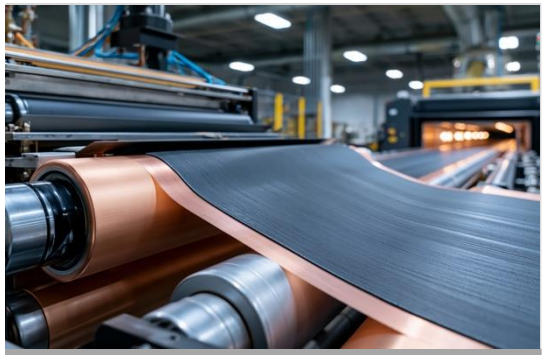

PLASTICS


SOLVENT

THE OBJECTIVE IS NOT SIMPLY TO PRODUCE BLACK MASS. IT IS TO MAXIMIZE VALUE FROM EVERY MATERIAL STREAM.

FEED VARIABILITY DEFINES THE CHALLENGE

Feed chemistry, format, condition, and construction define how the process must operate



PRODUCTION SCRAP

With or without electrolyte
More predictable composition



BATTERY CELLS

Cylindrical • prismatic • pouch
Different chemistries and designs



BATTERY MODULES

Mixed materials and architectures
Different preparation requirements



BATTERY PACKS

Highest design variability
Residual energy and safety risks

CHEMISTRY

NMC • NCA • LFP

FORMAT

Cylindrical • Prismatic • Pouch

CONDITION

State of charge • State of health • Age • Damage

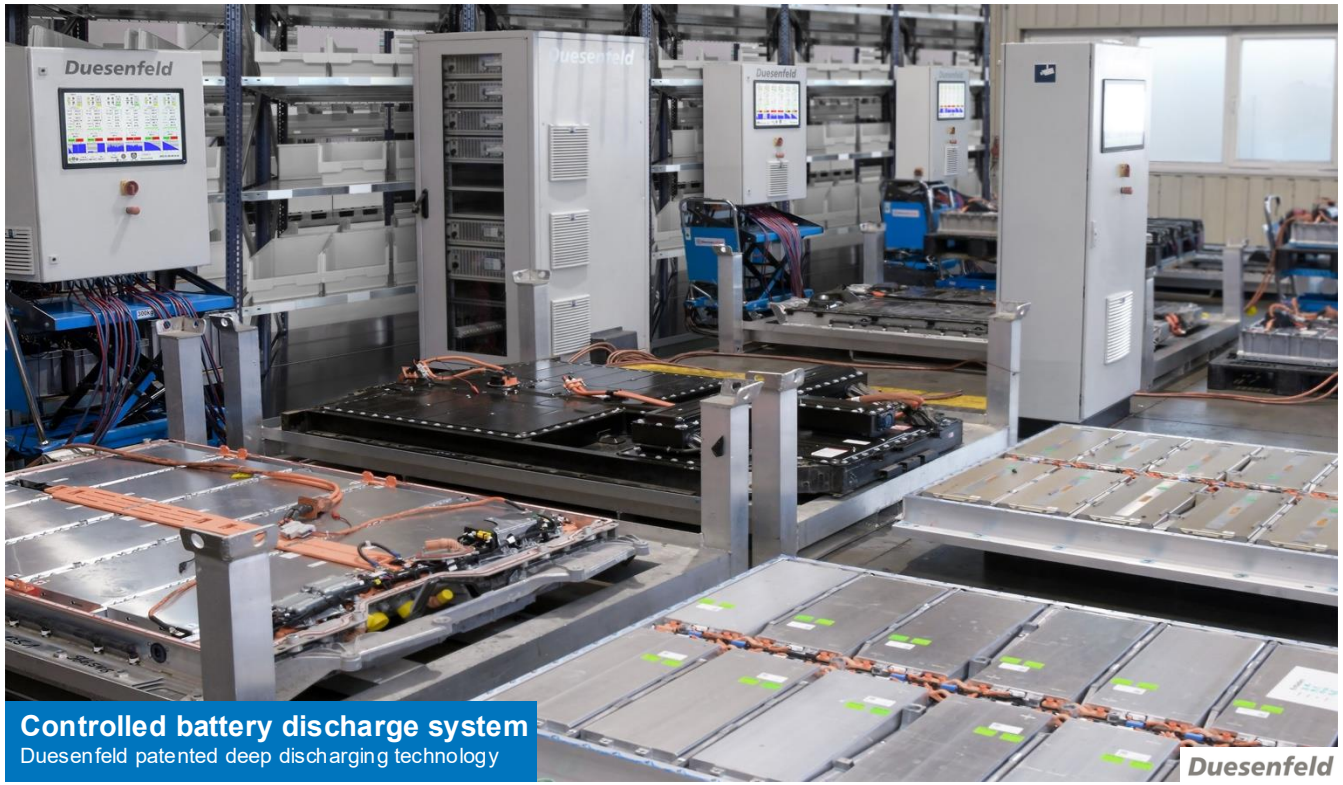
DESIGN & CONSTRUCTION

Pack architecture • Joining method • Accessibility • Material mix

NOMINAL THROUGHPUT HAS NO MEANING WITHOUT A DEFINED FEED SPECIFICATION.

CONTROL THE ELECTRICAL HAZARD BEFORE SIZE REDUCTION

Deep discharge combines electrical safety with controlled energy recovery



Controlled battery discharge system
Duesenfeld patented deep discharging technology

Duesenfeld Deep Discharging. © 2025 Duesenfeld.

AUTOMATE DEEP DISCHARGE

Connect multiple batteries in series and automatically disconnect each battery at the defined endpoint

CONTINUOUS SAFETY MONITORING

Continuously track voltage, current, and temperature while checking for abnormal conditions

RECOVER ENERGY FLEXIBLY

Reuse available energy while handling different states of charge, voltages, battery types, and ages

REMOVE THE HAZARD. RECOVER THE ENERGY.

SHREDDING CREATES CONTROLLED LIBERATION

Two stages separate robust pack opening from controlled fine shredding

ANDRITZ TWO-STAGE SHREDDERS

Two dedicated shredders separate robust pack opening from controlled fine shredding and material liberation.

Complete pack handling

Accepts complete battery packs

Two-stage size reduction

Controlled opening and liberation

Load-dependent hydraulic pushers

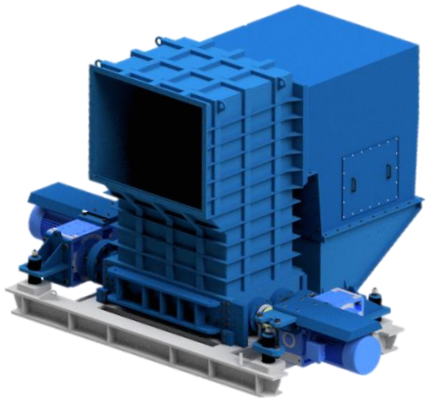
Stabilize feeding in both stages

Service-oriented design

Provides access to wear parts and rotors

SAFETY

Controlled feeding and sealed machine design support safe operation.



STAGE 1 | ADuro C-2000 PRE-SHREDDER



STAGE 2 | ADuro G-1000H FINE-SHREDDER

OUTPUT QUALITY

Defined particle size supports stable downstream separation.

MATERIAL RECOVERY

Controlled liberation keeps valuable material in recoverable streams.

PLANT ECONOMICS

Two dedicated stages balance throughput, wear, energy demand, and maintenance.

THE TARGET IS CONTROLLED LIBERATION, NOT MAXIMUM SIZE REDUCTION.

CONTROL THE MATERIAL CONDITION BEFORE SEPARATION

Low-temperature vacuum drying removes solvents while preparing material for separation



Low-temperature drying & solvent recovery
Duesenfeld patented drying technology

Duesenfeld Solvent Recovery by Low-Temperature Drying. © 2025 Duesenfeld.

OPERATE WITHIN THE PATENTED PROCESS WINDOW

Use vacuum below 300 mbar and temperatures below 80°C under defined process conditions.

RECOVER SOLVENTS. CONTROL HF FORMATION RISK

Evaporate and condense low-boiling solvents for controlled recovery.

PREPARE MATERIAL FOR SEPARATION

Produce stable, dry material for efficient screening and physical separation.

DRYING DETERMINES THE CONDITION OF EVERY DOWNSTREAM MATERIAL STREAM.

DRYING DETERMINES DOWNSTREAM PERFORMANCE

Controlled drying influences safety, recovery, output quality, and plant economics

ANDRITZ GHD-LIB VACUUM DRYER

Low-temperature vacuum drying for safe and efficient processing of shredded battery material.

Double-wall heating

Efficient and gentle drying

Rotating helical agitator

Homogeneous mixing

Integrated dust filter

Minimizes product losses

Easy maintenance

Accessible shaft seal and service covers

SAFETY

Reduced reactive liquid content and lower risk of thermal events

MATERIAL RECOVERY

Evaporation and condensation of electrolyte solvents while retaining valuable materials



OUTPUT QUALITY

Stable, dry material for efficient separation and controlled impurity carry-over

PLANT ECONOMICS

Solvent recovery, lower downstream costs, and reduced material losses

DRYING IS NOT AN AUXILIARY OPERATION. IT DIRECTLY INFLUENCES EVERY DOWNSTREAM PROCESS STEP.

FROM KEY EQUIPMENT TO AN INTEGRATED RECYCLING LINE

One integrated system engineered around recovery, safety, availability, and product quality



STANDARD-LAYOUT REFERENCE
2 t/h | ~14,000 t/a

PRE-ENGINEERING & PROJECT DEVELOPMENT

Concept development • Pre-engineering • Permitting support • Basic engineering

EPC PLANT DELIVERY

Detailed engineering • Procurement • Key equipment manufacturing • Construction • Commissioning • Start-up • Handover

LIFECYCLE PERFORMANCE & SERVICES

Plant optimization • Maintenance • Spare & wear parts • Retrofit • Modernization

ANDRITZ INTEGRATES THE COMPLETE RECYCLING LINE, NOT ONLY INDIVIDUAL MACHINES.

PLANT ECONOMICS ARE BUILT INTO THE PROCESS

Feed flexibility, total recovery, and lifecycle cost determine value per tonne

MAXIMUM VALUE PER TONNE

VALUE CREATED

Feed flexibility • Black mass quality and recovery • Saleable co-products • plastics • Recovered energy

TOTAL LIFECYCLE COST

CAPEX • energy • utilities • wear maintenance • labor • downtime • disposal

COMPETITIVE COST PER TONNE

Critical for every chemistry, especially lower-value feedstocks

FEED & FORMAT FLEXIBILITY

Handles production scrap, cells, modules, and complete packs across different sizes, formats, conditions, and chemistries.

MORE ADDRESSABLE FEEDSTOCK

VALUE FROM EVERY FRACTION

High recovery and clean separation maximize black mass quality and preserve the value of metals, plastics, and solvent.

MORE SALEABLE OUTPUT

LEAN PLANT DESIGN

Low-temperature vacuum drying avoids HF formation, reducing corrosion exposure and the need for stainless-steel systems, gas scrubbing, and wastewater handling.

LOWER CAPEX

EFFICIENT & RELIABLE OPERATION

Recovered discharge energy, low heating and cooling demand, short drying cycles, solvent recovery, and two-stage shredding reduce energy, wear, maintenance, and downtime.

LOWER LIFECYCLE COST PER TONNE

THE BEST RECYCLING LINE MAXIMIZES RECOVERABLE VALUE AT COMPETITIVE LIFECYCLE COST.

THE WINNING RECYCLING LINE IS ENGINEERED AROUND VALUE

Feed flexibility, product value, and lifecycle economics must be optimized together

ONE SYSTEM. THREE DESIGN PRIORITIES.

The process, equipment, and plant configuration must work together to turn variable battery material into safe, consistent, and commercially valuable products.

1

DESIGN FOR THE FEED

Adapt to size, format, condition, and chemistry.

2

DESIGN FOR THE PRODUCTS

Control purity, recovery, and routing of every fraction.

3

DESIGN FOR LIFECYCLE VALUE

Balance CAPEX, OPEX, wear, availability, and disposal.

WHEN THESE PRIORITIES ARE ENGINEERED TOGETHER

SAFE TO OPERATE

Hazards are controlled across the complete line.

VALUABLE PRODUCTS

Every recovered fraction contributes to plant value.

COMPETITIVE PER TONNE

Lifecycle economics remain sound across changing feedstocks.

ANDRITZ TURNS PROCESS KNOW-HOW, KEY EQUIPMENT, AND PLANT INTEGRATION INTO RECOVERABLE VALUE.

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