WHITE PAPER

BISONAIRE BLENDING SOLUTION

EFFICIENT MATERIAL PLANNING & OPTIMIZING FOR METALS

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1 Introduction

The aluminum industry, particularly sectors engaged in melting and casting operations, is at a pivotal juncture. As manufacturers strive to meet evolving market demands, strong competition, stringent regulatory frameworks, and heightened cost pressures, they face an increasingly complex operational landscape. This white paper explores the challenges faced by these industries and introduces an innovative solution tailored to address their needs.

The primary audience for this paper includes manufacturers and operators in the aluminum industry who rely on melting and casting processes. This encompasses companies producing aluminum alloys and products, which are integral to industries such as automotive, construction and aerospace. Collectively, this industry contributed over 155 billion € to the global economy in 2023 with projections indication growth to around 275 billion € by 2032, highlighting their critical importance to modern infrastructure and technology (Expert Market Research, 2024).

These stakeholders operate in environments characterized by intense global competition, fluctuating material availability, and an increasing focus on sustainability. The need for advanced tools to optimize processes, minimize costs, and maintain high-quality standards has never been more pressing.

The metals industry faces a range of interconnected challenges that complicate production processes and threaten profitability.

1. **Complex Material Requirements**
   Aluminum manufacturers face challenges in achieving precise alloy compositions due to the variability in recycled inputs and the need for consistent product quality.

2. **Rising Cost Pressure**
   Increasing costs of energy, raw materials, and carbon compliance fees are putting significant financial strain on aluminum producers, demanding cost-optimization strategies.

3. **Dynamic Production Environments**
   Fluctuations in material availability, supply chain disruptions, and evolving customer demands require aluminum manufacturers to adapt quickly to maintain efficiency.

4. **Regulatory and Environmental Compliance**
   Stricter CO_2 emissions targets and sustainability mandates compel the aluminum industry to decarbonize while maintaining competitive production levels.

5. **Integration of Digital Solutions**
   Many manufacturers struggle to incorporate advanced digital tools into legacy systems, hindering efforts to optimize production and implement real-time planning.

Problem Statement and Relevance

These challenges not only impact operational efficiency but also pose broader strategic risks. Variability in input materials can

lead to inconsistent product quality, rework, and waste, directly affecting profitability. Rising costs and regulatory compliance pressures further squeeze margins, making it essential for manufacturers to innovate or risk losing competitiveness.

The complexity of modern supply chains and production environments highlights the inadequacy of traditional planning methods, which cannot keep pace with real-time disruptions. Moreover, the transition to sustainable practices is no longer optional; it is a market and regulatory imperative. Addressing these issues requires advanced, integrated solutions capable of balancing cost, quality, and environmental goals.

This white paper gives insights into the key challenges of the aluminum industry and explains how state-of-the-art software solutions can support companies addressing these trends.

2 Challenges & Trends

The industrial sectors engaged in melting and casting processes of aluminium are facing a multitude of challenges in maintaining operational efficiency while meeting stringent quality and regulatory demands. As this industry evolves, the need for advanced optimization solutions, becomes increasingly evident. This chapter explores the key challenges faced by especially the aluminium industry, examines their origins, and highlights emerging trends that underscore the relevance of innovative blending solutions.

2.1 Complex Material Requirements

Variability in raw materials, particularly recycled aluminum, creates significant challenges for manufacturers in maintaining alloy consistency. Aluminum scrap often contains diverse contaminants, coatings, and impurities, making it difficult to achieve precise target compositions. For instance, studies show that over **30% of secondary aluminum producers** report significant yield losses due to variations in scrap quality (Harbor Aluminum Intelligence Unit, 2022). This variability often leads to rework, reduced efficiency, and production delays, ultimately increasing costs.

Achieving precise material compositions is critical for producing alloys or products that meet stringent quality and performance requirements. Variations in raw material quality, particularly with recycled inputs like scrap metals or mixed-grade alloys, make this process highly complex. Manufacturers must also balance cost efficiency with maintaining product consistency.

This challenge stems from the inherent variability of input materials. Recycled components, though cost-effective and sustainable, often have fluctuating compositions that require careful blending. Additionally, market demands for custom alloys and advanced materials push manufacturers to operate with tighter tolerances and higher precision.

To address these complexities, industries are increasingly adopting digital tools for real-time material analysis and blending

optimization. AI-driven systems and IoT-enabled sensors provide deeper insights into material properties, enabling more accurate and efficient blending processes. This trend aligns with the broader shift toward data-driven production and the integration of recycled materials in a circular economy.

2.2 Rising Cost Pressures

Manufacturers face growing financial pressures due to rising costs for raw materials, energy, and regulatory compliance. The added burden of purchasing CO_2 certificates further strains budgets, especially in energy-intensive industries like metals.

Cost pressures are driven by volatile commodity markets, increasing global demand for raw materials, and stricter regulatory frameworks aimed at reducing carbon emissions. The transition to renewable energy and sustainable practices, while beneficial in the long term, often introduces short-term cost challenges. Companies are investing in optimization technologies to minimize waste and maximize resource efficiency.

Advanced blending solutions can reduce material costs by optimizing the use of recycled inputs and lower-quality materials without compromising quality. Additionally, as carbon markets mature, industries are expected to adopt integrated tools that track and optimize CO2 expenditures alongside production costs. The aluminum industry, being highly energy-intensive, is acutely affected by rising energy and material costs. The **average global electricity cost for aluminum smelting** increased by 20% in 2022, driven by geopolitical instability and energy shortages (International Aluminium Institute, 2023). Additionally, the cost of primary aluminum remains volatile, with prices spiking to over **€2,500 per ton** during the same period due to supply chain disruptions and increasing global demand.

The introduction of carbon compliance costs, such as EU CO_2 certificates, adds further financial strain. For aluminum producers, each ton of CO_2 emitted during smelting incurs an additional **€90-100 in compliance costs** under the EU Emissions Trading System (Statista, 2023).

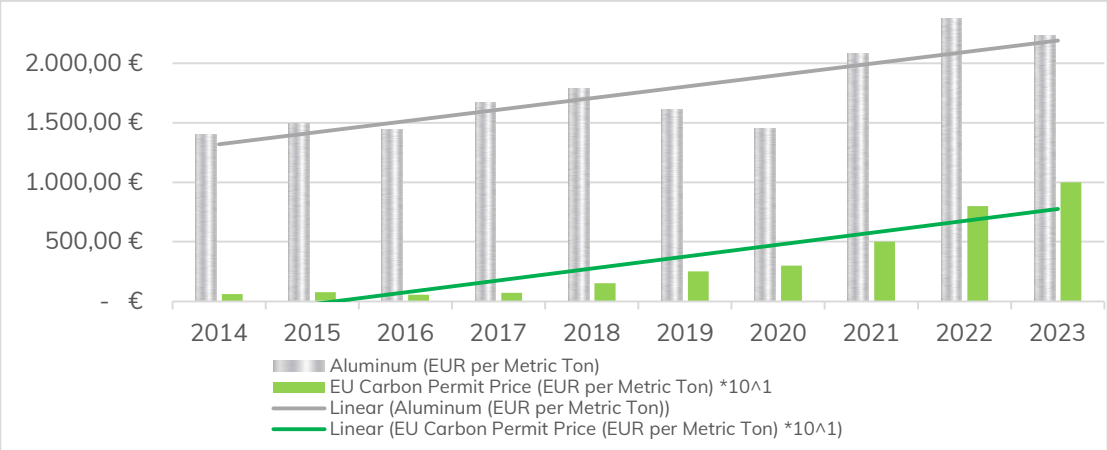

Figure 1: EU Emissions Trading System

A quote from the “Weltbank” emphasizes this burden:
"[...] aluminum production is highly energy-intensive, and the introduction of carbon pricing mechanisms can significantly impact the competitiveness of aluminum supply chains." (Weltbank, 2024)

The following diagram compares the average price per metric ton of aluminum with the EU CO_2 certificate costs over the last 10 years. This shows the volatility in the raw material market of the industry, which also grows significantly on average, as well as rising CO_2 certificate costs. (Statista, 2024)

2.3 Dynamic Production Environments

Fluctuations in material availability, production schedules, and customer demands create dynamic environments where traditional planning and blending methods struggle to keep pace. Manufacturers require flexible systems to manage real-time changes without sacrificing efficiency or quality.

This challenge arises from the complexity of modern supply chains and the increasing unpredictability of global markets. Factors such as geopolitical tensions, pandemics, and climate-related disruptions further exacerbate variability in material availability and production conditions.

The aluminum melt cast market operates in increasingly dynamic environments marked by supply chain disruptions, fluctuating input material availability, and unpredictable customer demands. For example, global aluminum supply chains were severely impacted during the COVID-19 pandemic, with production in several regions falling by over 10% (McKinsey & Company, 2021).

Such disruptions can result in delayed shipments, reduced productivity, and underutilized resources. Manufacturers using traditional planning methods often struggle to adapt quickly to these fluctuations, leading to inefficiencies and missed deadlines. Additionally, dynamic environments increase the risk of underutilized or misallocated resources, leading to inefficiencies. Traditional planning methods lack the responsiveness required to adapt to such changes effectively.

Real-time optimization tools are becoming essential for managing dynamic production environments. Predictive analytics and AI are helping manufacturers anticipate supply chain disruptions and adjust production plans proactively. Additionally, advanced software solutions are enabling more agile furnace queue management and batch planning to accommodate shifting conditions.

2.4 Regulatory and Environmental Compliance

Stricter environmental regulations, particularly regarding carbon emissions, place significant compliance burdens on manufacturers. Industries must not only meet emissions targets but also demonstrate sustainable practices through transparent reporting and certification.

The global push for decarbonization and the adoption of circular economy principles are driving these regulatory demands. Governments and industry bodies are

implementing stricter CO_2 limits, while market pressures from environmentally conscious consumers amplify the need for sustainable production.

Sustainability is transitioning from a regulatory requirement to a competitive advantage. Companies are investing in tools that help track carbon footprints and optimize material usage for minimal environmental impact. Digital solutions like CO_2 calculators and inventory management systems are increasingly integrated into production workflows to ensure compliance and identify cost-saving opportunities. Aluminum production contributes approximately **2% of global CO emissions**, driven by its energy-intensive processes. Smelting alone accounts for **60-70%** of the industry's emissions due to the high electricity demand for electrolysis (Our World in Data, 2023). In response, governments worldwide are introducing stricter regulations, such as the European Green Deal's goal of reducing emissions by **55% by 2030**.

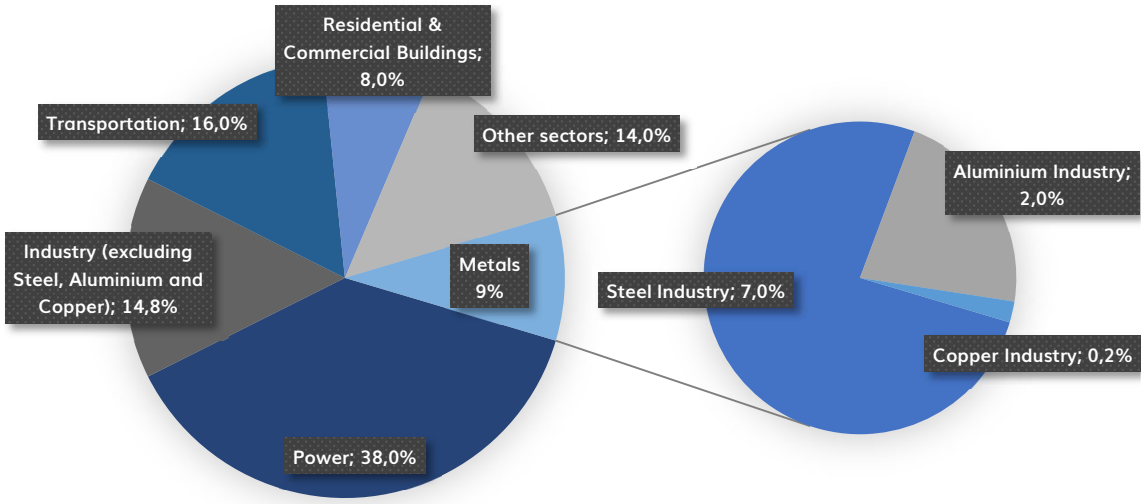

Figure 2: percentage of industry emissions

At the same time, consumer demand for sustainable products is increasing. Recycled aluminum, which uses **95% less energy** compared to primary aluminum production, is becoming a critical component of decarbonization strategies. (Our World in Data, 2020; Statista, 2023)

The attention for this challenge is growing in attention over the past years which is noticeable from reports and statements like the following two.

"Sustainability is no longer just a regulatory requirement; it is becoming a competitive differentiator for manufacturers," remarks a report by Deloitte.

"Optimal energy management is crucial to minimize environmental impact and maximize revenues through the orchestration of processes, the optimized exploitation of

available energy sources, including process off-gases, when available, and waste energy as well as optimal interaction with the energy market." Metal Journal (MDPI, 2021).

2.5 Integration of Digital Solutions

While digital transformation offers opportunities for optimization, many industries struggle to integrate advanced tools with legacy systems. Challenges include limited real-time data visibility, resistance to adopting new technologies, and the high cost of implementation.

The industrial sector has traditionally relied on manual or semi-automated processes, creating a technological gap. Aging infrastructure and siloed data systems further hinder the seamless adoption of modern technologies.

Digital transformation is crucial for the aluminum industry to remain competitive. However, many aluminum producers face challenges in integrating modern technologies with legacy systems. Surveys indicate that over **40% of aluminum manufacturers** have yet to implement Industry 4.0 technologies, citing high implementation costs and the complexity of legacy systems as major barriers (Harbor Aluminum Report, 2023).

Without robust digital tools, manufacturers miss opportunities to optimize production, predict disruptions, and improve efficiency through real-time adjustments.

3 The bisonaire blending Solution (bBS)

The bisonaire Blending Solution is a sophisticated software tool, based on the DELMIA Quintiq framework, designed to streamline material usage in industrial melting and casting processes. Primarily targeted at the metal industry, bBS optimizes the blending of raw materials and recycled components to meet specific alloy requirements. It helps manufacturers create precise product compositions by intelligently selecting and combining input materials, such as scrap metals or variable-quality alloys. Beyond metals, the bBS can also be applied to industries involved in mixed product manufacturing, where the combination of various input materials plays a critical role in meeting product specifications. This includes sectors such as chemicals, plastics, and glass production, where optimal raw material use directly impacts quality, production costs, and sustainability.

3.1 Input Material Optimization

At its core, bBS functions as a **batching and optimization platform**, seamlessly integrating with existing production and planning systems, such as ERP (Enterprise Resource Planning) and MES (Manufacturing Execution Systems). By pulling real-time data from these systems, it enables **accurate material planning** and allocation. The software compiles batches from various

input materials, each with unique compositions, ensuring that the final output meets the target alloy or product specifications. A notable feature of bBS is its ability to optimize the furnace queue. The furnace queue determines the sequence in which batches are processed, and bBS ensures that the optimal combination of materials is used for each batch, based on available stock and production requirements. This feature is especially valuable in environments where material composition fluctuates, requiring constant adjustments to maintain production quality.

With the information about the **input materials**, the **furnace queue** (e.g. imported from an external APS software) and the information about the **melting furnace** (e.g. max input amount, previously inserted material, planned and physical swamp) the blending solution will calculate an **optimized solution within the set of available input materials.** An overview of this feature including inputs and outputs can be seen in *Figure 3*.

Core Blending Proce

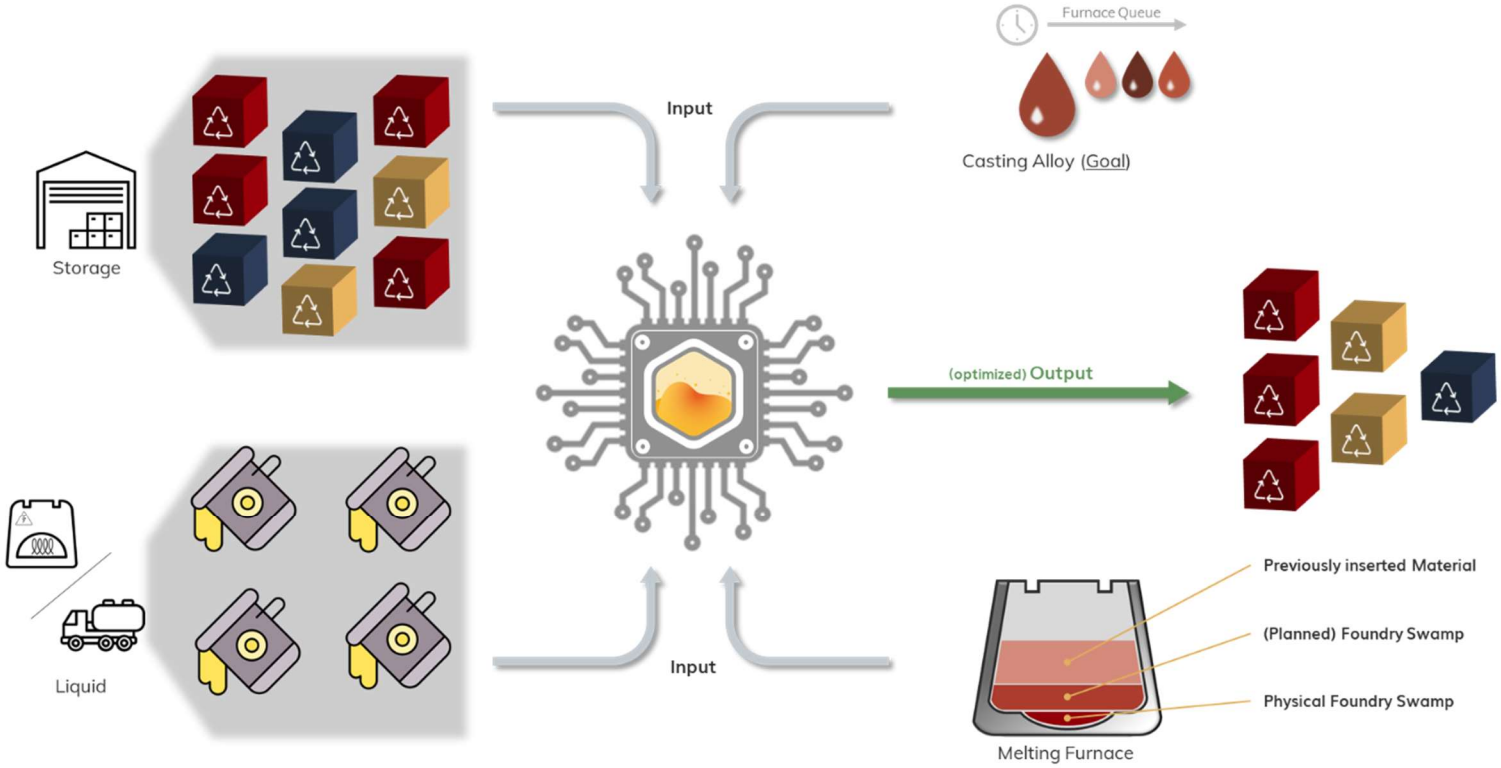

Figure 3: Core Blending Process

3.2 Inventory Optimization

bBS is designed to operate in **dynamic production environments**, where rapid changes to material availability, production schedules, or market conditions are common. The software allows production plants to adjust their material usage in real-time without sacrificing product quality.

It considers factors like stock levels and production constraints while generating optimal material combinations for each batch. Since the material availability plays a crucial role in the blending process and the selection of suitable input materials the bBS can handle multiple storage type logics. The storage types including distinct logic and constraints can be seen in *Figure 4*.

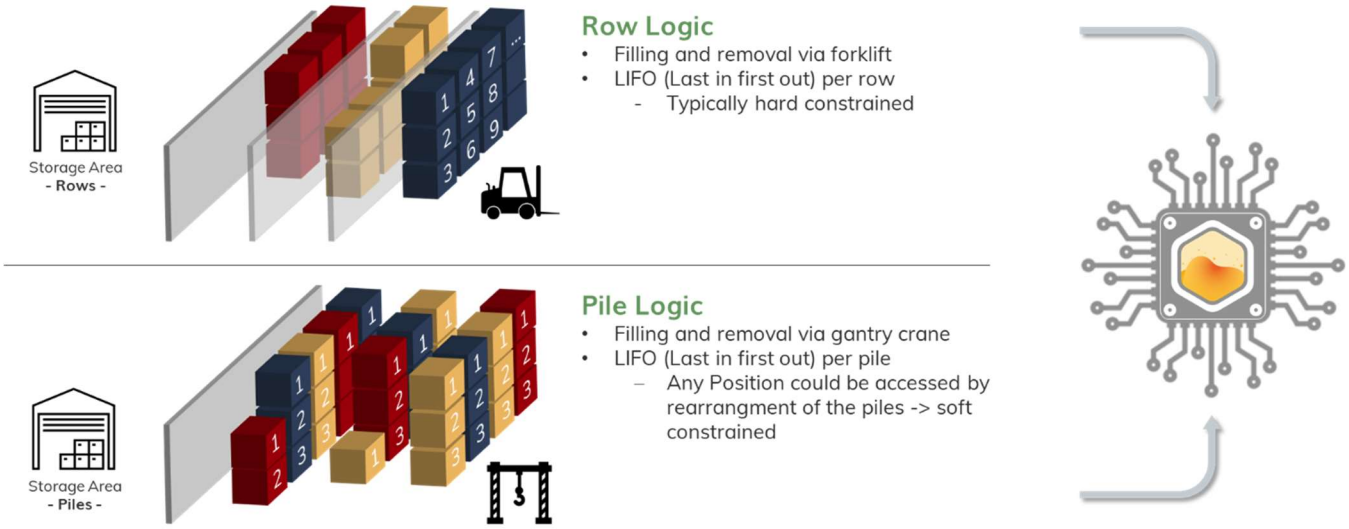

Figure 4: Storage Type Handling

In order to handle these dynamic environments, the solution offers **inventory management features** that facilitate efficient allocation of materials to specific batches or furnaces. It tracks material storage, manages stock rotation, and suggests optimal storage locations to minimize transport time within the production facility. By doing so, it helps ensure that materials are used efficiently and in a timely manner.

This is done by sending transport destination requests to the bBS coming from every new input material which needs to be stored in any storage location. To determine the optimal storage location of new incoming material the optimizer is using preconfigured storage information (e.g. max / min amount per storage, allowed alloy(-group) per storage, scrap type per storage, preferred intermediate unit level) to calculate the optimal storage location.

The information about the storage location is then sent to external systems in order to execute the material movement. This process can be seen in *Figure* 5 as well as the result of efficient sorting and allocation of materials into different storage locations.

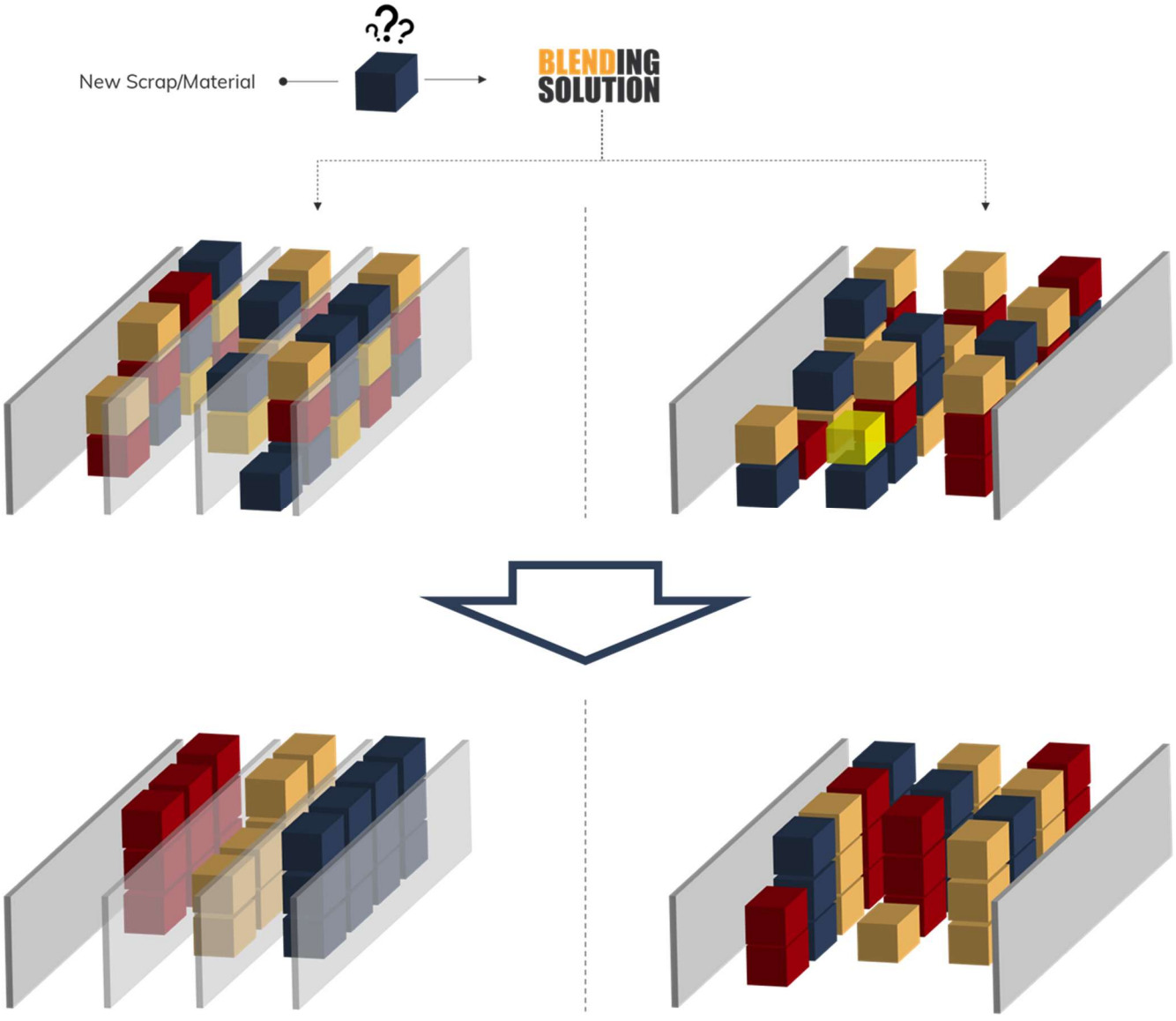

Figure 5: Transport Destination Request & Storage Optimization

3.3 Intermediate Units

Since many companies are using intermediate units to insert their input materials into the furnaces the bBS is also providing the functionality of configuring, creating and using these units in order to plan their production. To do so every intermediate unit must be linked to the storage locations and furnaces they can reach out to. Once this configuration is done the user is able to plan fitting intermediate units per furnace. This matching can be seen in *Figure* 6.

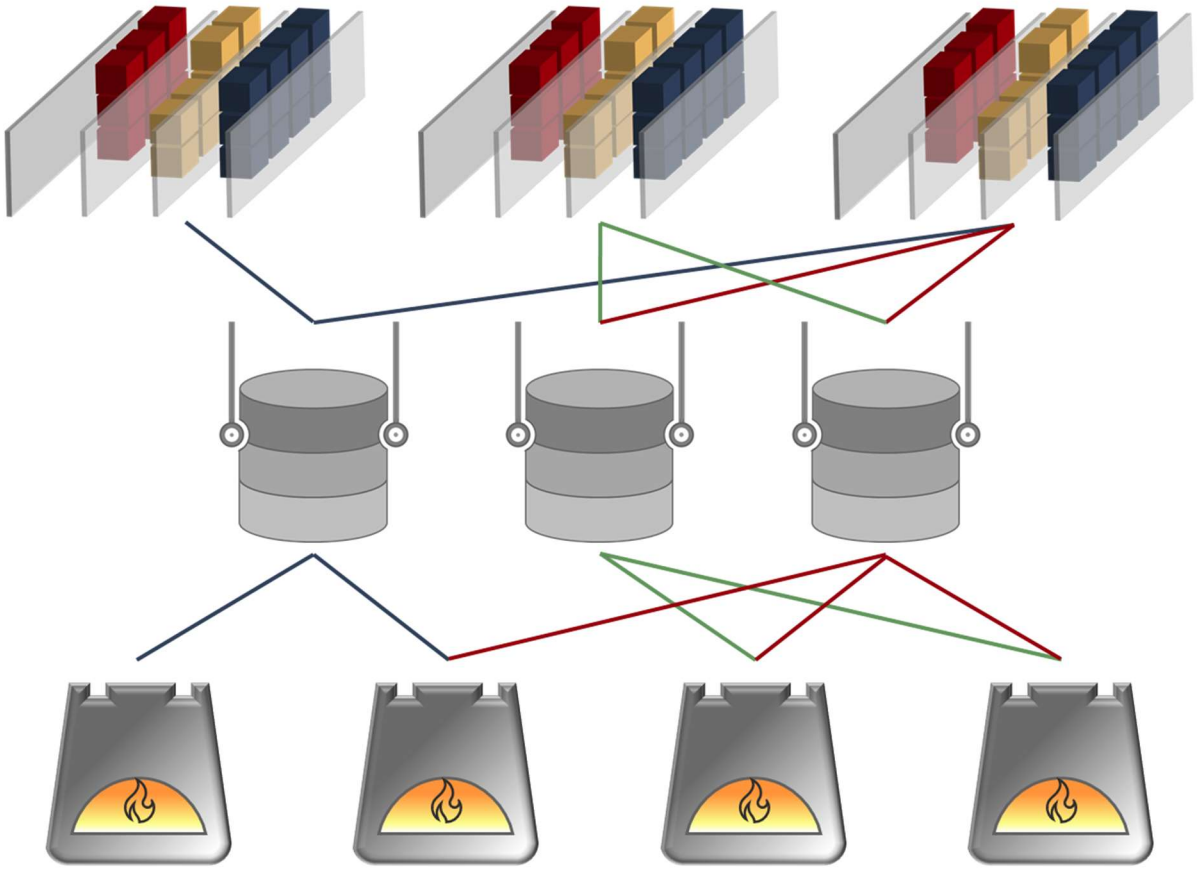

Figure 6: Intermediate Unit Matching

Every intermediate unit has a configurable set of layers each with configurable logic. This means that it is possible to define which input materials can or must be loaded into the predefined intermediate unit layer. Additionally, to define which material should be loaded in which layer it is possible to define maximum and minimum amounts of material per layer also based on the planning of other layers.

This functionality can be used to prevent the intermediate units of getting damaged through inserting material in unfavorable sequence, improve loading capacity through reasonable layering of materials and reduce melting loss by ensuring that materials with a high melting loss factor will not be inserted without a top layer.

This logic is illustrated in the following figure (*Figure 7*).

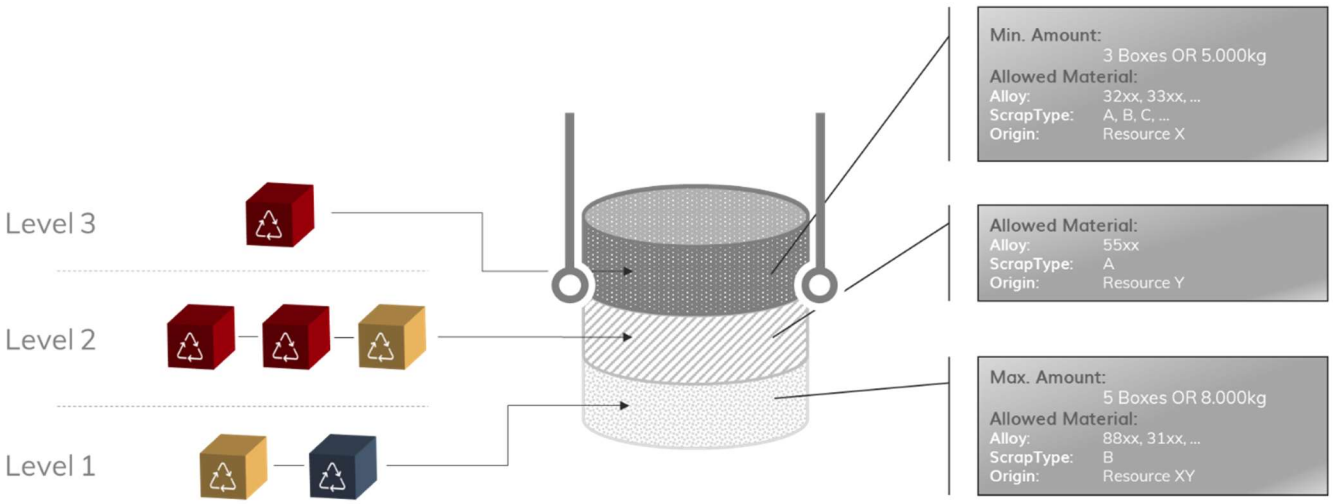

Figure 7: Intermediate Unit Layers

3.4 Direct Material Usage

As in chapter 0 explained, the bBS provides the functionality of calculating the optimal storage location for new input materials. By now, only storage locations were considered as possible locations for the material but in the case of an ongoing loading of an intermediate unit there might be the possibility to replace some planned input material with the new incoming material.

This will reduce the number of transport orders and thus save time and costs.

To do so, the optimizer is calculating whether it would be worth replacing a planned material with a new incoming one based on the configuration. There are multiple ways to configure the direct material usage only takes place if it is worth it and gives business benefit. This process is also displayed in the following figure.

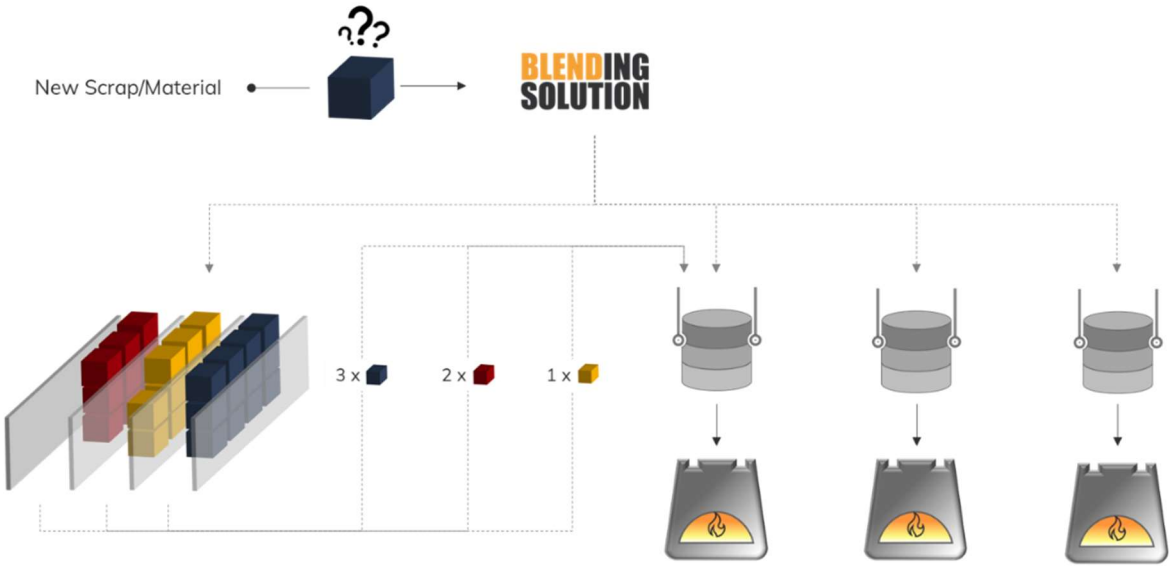

Figure 8: Direct Material Usage

Since direct inserted materials also have to match to the intermediate unit layer an averaged time calculation is available per unit layer. This is done by configuring average material removal times per storage area. Based on this time the system is calculating the planned end of the loading per intermediate unit once the planning is fixed and exported.

These estimated end times are relevant for the consideration whether a directly used material can be inserted into the correct unit layer when using it. Without this logic there might be the case that new materials are used directly but then inserted into a wrong layer. This logic is visualized in the following picture.

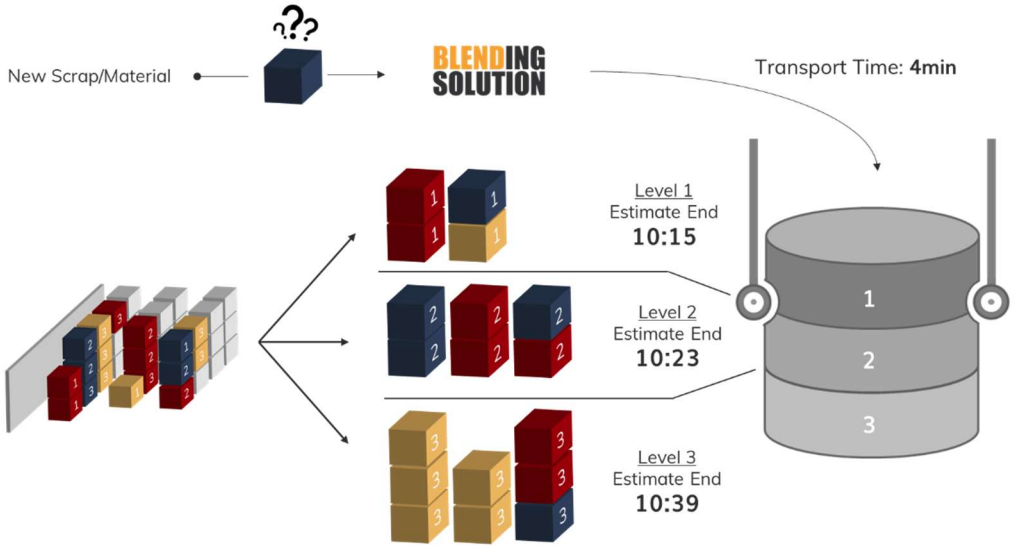

Figure 9: Time Consideration for Direct Material Usage

3.5 Processes & Planning Decisions

The following illustration shows the data and planning decision flow for the application. It is intended as an overview of the standard version of the bBS which might be adapted to individual customer needs during implementation projects.

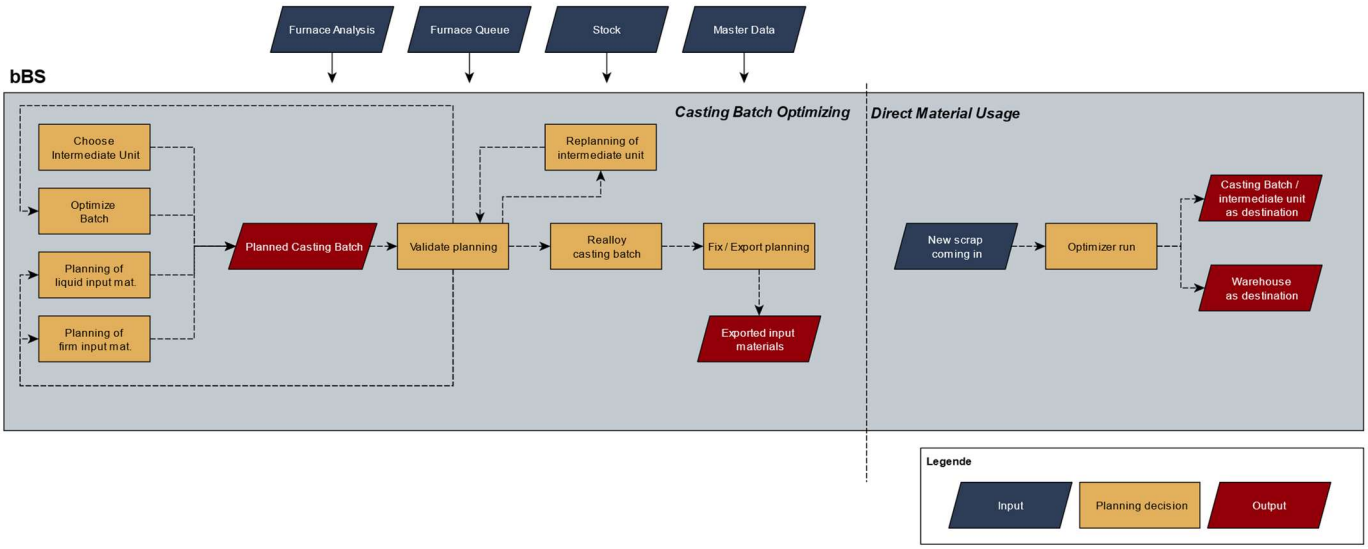

Figure 10: bBS Process & Planning Decision

3.5.1 Casting Batch Optimizing

This process is about optimizing the input materials for a specific casting batch or intermediate unit(s). This can include all types of input material available at the time of planning (Loading via intermediate units, liquid material, firm material which can be inserted directly into the furnace) and includes the processes of validating the optimizer result, optional replanning, optional re-alloying and the export of the planning to external systems (e.g. MES).

Since this planning process is often repeated several times until a batch or HEAT is finished the process can also be shown in a circle according to *Figure 11*.

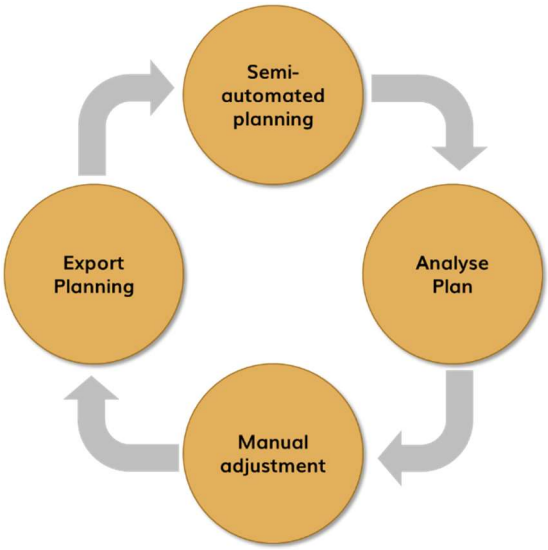

Figure 11: Process of Casting Batch Optimizing

The following describes the supporting functions of the software to the corresponding process step.

Semi- automated planning

- Trigger the batch optimizer – manual planning is optional
- Trigger the optimizer for intermediate units (assigned to a batch) – manual planning is optional
- Fix or ban materials for optimizer
- Planning of firm and fluid material (which will be directly inserted into the furnace)
- Edit Casting Batch if needed
- Adjust optimizer goals and configuration if needed

Analyse Plan

- Check the calculated/planned metal element composition after planning
- Check the assignment of intermediate units to batches
- Check the metal element composition after feedback from analysis and evaluate difference to planned/calculated metal element composition before the feedback
- Check the planned quantities and compare against feedback quantities if available

Manual Adjustment

- Re-alloying the casting batch if needed
- Re-assigning intermediate units if needed
- Optimize intermediate units or batches again if needed
- Re-planning of firm & fluid materials if needed

Export Planning

- Export planning of casting batches
- Export planning of intermediate units
- Export planning of firm and fluid materials
- Export planning of prime materials

3.5.2 Direct Material Usage

This process is triggered every time new input material enters the system without a destination. Details are explained in chapter 3.4.

3.6 Detailed Feature Overview

Feature Group	Description
Material Management & Storage Optimization	- Different storage types (row, pile, bunker) - Input materials (liquid, solid, container) - Divisible input materials - Prioritization of input materials - Assigning specific input materials to specific casting alloys - Pure-grade production + ignoring certain materials - Prioritization of input materials that have been stored for more than X days - Induction furnace as input material (pre-planning of batches/import of analysis/planning of batches/splitting of batches) - Prioritization of specific input materials based on stock levels - Inventory pre-planning → Transport Destination Request - Emptying inventories - Temporarily overriding inventory restrictions - External material inputs - Melting loss
Melting Process and Furncace Management	- Furnace swamp → configurable through WT + manual adjustment per batch - Physical furnace swamp → configurable - Direct inserting of new input material - Prioritization of intermediate units - Maximizing the load capacity of the furnace and intermediate units (tolerances in WT) - Alloying up/down → automatic suggestion of quantity & material - Matching of melting furnace to intermediate units (transport lanes) - Wet input material handling - Defining input material as plannable or not plannable based on configurable values

	- Configuration of melting / holding and casting furnaces (quantity, Area, Swamp, Availability) - Timing of material input (important for direct inserting of new materials)
Alloy and Production Planning	- Defining alloy groups - Versioning of alloys - Alloy change planning → different optimizer limits - Highlighting of PRIME in analyses - Intermediate units + constraints/configuration (level/max-min amount kg/pieces per level/lid/scrap type per level) - Consideration of terms in alloys - Import of analyses
Batch Management and Traceability	- Batch history (inputs/planning) - Pre-planning of batches for the future - Manual adjustment of batches

4 Advantages & Benefits of the bBS

In response to the challenges and trends shaping the melting and casting industries, the bisonaire Blending Solution (bBS) offers transformative advantages that address operational inefficiencies, cost pressures, and environmental imperatives. This chapter examines the key benefits of bBS and integrates them with the industry's challenges, demonstrating how these benefits directly impact emerging trends and provide a competitive edge.

4.1 Optimized material usage & cost reduction

One of the primary benefits of the bisonaire Blending Solution is its ability to optimize the use of raw materials by intelligently balancing the inclusion of recycled inputs and prime materials. Through advanced algorithms, the software identifies the most efficient combinations of available materials, ensuring that target alloys meet quality standards while minimizing material costs. This approach not only increases resource efficiency but also directly impacts financial performance, as expensive prime materials can be substituted with cost-effective recycled alternatives.

This benefit directly addresses the rising cost pressures faced by manufacturers. Volatile raw material markets, coupled with the increasing financial burden of CO2 certificates, challenge the profitability of energy-intensive industries like metals and glass. The blending solution mitigates these cost pressures by enabling the strategic use of lower-cost materials without compromising quality. Furthermore, its resource-efficient approach aligns with the broader industry trend toward sustainability, as optimizing material usage inherently reduces waste and the carbon footprint of production.

4.2 Increased flexibility in mix of alloys

The bBS is designed to offer exceptional flexibility in the selection and blending of input materials, allowing manufacturers to work with a range of material qualities and alloy compositions. This adaptability is achieved by ensuring that the target alloy parameters can be met within defined tolerance ranges, even when using inputs with varying characteristics. The ability to adjust to changing material availability or production requirements makes the software invaluable in dynamic manufacturing environments.

This flexibility addresses the challenges associated with managing complex material requirements and navigating dynamic production environments. In an era where supply chain disruptions and fluctuating customer demands are increasingly common, the ability to quickly adapt to new conditions without sacrificing product quality is a critical advantage. By enabling such adaptability, the blending solution empowers manufacturers to respond to market and production changes with greater agility, ensuring that they remain competitive in a volatile global landscape.

4.3 Increased sustainability through higher recycling rate

Sustainability is a cornerstone of modern industrial processes, and the blending solution significantly enhances the environmental profile of melting and casting operations. By increasing the proportion of recycled materials used in production, the software reduces the reliance on virgin raw materials, which are both costlier and more environmentally taxing to procure. The optimization process ensures that even high recycling rates do not compromise the final product's quality, making sustainable practices both achievable and economically viable.

This benefit directly addresses the regulatory and environmental compliance challenges facing manufacturers. Stricter carbon emissions targets and growing pressure to adopt circular economy principles are forcing industries to rethink their material strategies. By facilitating higher recycling rates, the blending solution helps companies meet these regulatory requirements while also leveraging sustainability as a competitive advantage. In a market increasingly driven by environmentally conscious consumers, demonstrating a commitment to reducing environmental impact can enhance a company’s reputation and market position.

4.4 Reduced rework and production deviation

By optimizing raw material blending and ensuring that alloys meet specifications in the first melting process, the blending solution significantly reduces the need for rework. This not only saves time and resources but also minimizes the additional costs and delays associated with production deviations. The enhanced precision of the solution results in lower reject rates, improving overall process efficiency and product consistency.

This benefit aligns with the need for precise material compositions in a production environment characterized by stringent quality requirements. As manufacturers strive to meet the demand for advanced materials and custom alloys, minimizing deviations becomes essential. The blending solution addresses this challenge by automating critical aspects of material selection and blending, reducing the likelihood of human error and ensuring that quality standards are met consistently.

4.5 Efficient storage management and resource usage

The bisonaire Blending Solution also provides robust tools for managing inventory and optimizing resource utilization. By automating the allocation of materials to specific batches and melting processes, the software helps prevent production bottlenecks and ensures timely use of available resources. This not only improves stock rotation but also reduces the risk of material obsolescence or value degradation.

This capability addresses the broader challenge of integrating digital solutions into traditional manufacturing environments. Efficient stock management is critical in industries where material costs and

availability directly influence production schedules and profitability. The blending solution supports the transition to data-driven operations by offering real-time insights into inventory levels, material quality, and batch planning. In doing so, it helps manufacturers bridge the gap between legacy systems and modern digital tools, enhancing overall operational efficiency.

4.6 Fast and transparent decision making

A key strength of the blending solution lies in its ability to integrate and analyze data from multiple sources, providing planners and production managers with clear, actionable insights. By presenting real-time feedback and enabling interactive decision support, the software facilitates quick and informed decision-making in dynamic production environments. This transparency ensures that adjustments to production parameters can be made confidently, with immediate feedback on their impact.

This capability is particularly valuable in managing the challenges of real-time production adjustments. In a sector where fluctuations in material availability, customer demands, or regulatory requirements can disrupt operations, the ability to respond quickly is crucial. The blending solution empowers manufacturers to maintain efficiency and quality, even under rapidly changing conditions, by providing the tools needed to anticipate and respond to disruptions effectively.

4.7 Increased communication & integration in IT landscape

The blending solution offers seamless integration with existing ERP, MES, and planning platforms, enabling better communication and coordination across departments. By connecting inventory data, production schedules, and planning tools, it reduces the manual effort required for data maintenance and ensures that decisions are based on accurate, up-to-date information.

This capability supports the broader industry trend toward digital transformation and interconnected operations. Many manufacturers face challenges in integrating new technologies with legacy systems, often due to siloed data and resistance to change. The blending solution addresses these challenges by offering a user-friendly, modular platform that simplifies the adoption of advanced digital tools. By fostering better communication and integration, the solution helps manufacturers build a more cohesive and efficient operational framework.

The bisonaire Blending Solution (bBS) offers a transformative approach to addressing the challenges of the melting and casting industries. By optimizing material usage, enhancing flexibility, and integrating seamlessly into existing systems, the solution empowers manufacturers to navigate cost pressures, achieve sustainability targets, and thrive in dynamic production environments.

Each benefit of the blending solution directly addresses critical challenges while aligning with emerging trends such as digital transformation, circular economy

practices, and data-driven production. In doing so, the solution not only improves operational efficiency but also positions manufacturers to succeed in an increasingly competitive and environmentally conscious marketplace. The bisonaire Blending Solution is more than a tool for optimization - it is a strategic enabler for achieving long-term resilience and excellence in the industrial sector.

5 Case Study

For illustrating the practical benefits of the bBS, this chapter introduces the Alucorp-Pro AG as an exemplary company using the bBS. The data used in this chapter is based on empirical evidence, however, general numbers of Alucorp-Pro AG (e.g., employee numbers and number of locations) are fictional and not aimed to depict real companies. Any similarities are purely coincidental. However, the data used for this example resembles average numbers of previous implementation projects of the bBS.

In the following case study, it is shown how the bBS enables a producer of aluminium products to reduce the share of used prime aluminium by 11.2%, resulting in a cost reduction of €8.5 million in one year.

Alucorp-Pro AG is a producer of cold-rolled and hot-rolled aluminium scrip, as well as aluminium ingots. The total production volume per year sums up to over 1,4 million tons across all three product segments. In 2022, Alucorp-Pro AG produced 1.402.000 tons distributed over three product groups with a usage of secondary (recycled) aluminium of 63,8%, including external secondary aluminium and internal process scrap from production, leaving 36,2% of primary aluminium to be purchased on commodity markets.

Rising costs for primary aluminium as well as increasing customer demand for sustainable aluminium, meaning aluminium with a low carbon footprint, led Alucorp-Pro AG to engage in actions to reduce the share of primary aluminium in production and increase the share of secondary aluminium respectively, ideally without increasing unit costs.

Alucorp-Pro AG decided to use the bBS for their optimization challenge.

In 2022, the last year without the use of the bBS, Alucorp-Pro AG sold 12.000 tons of aluminium ingots, 190.000 tons of hot-rolled aluminium scrip, and 1.200.000 tons of cold-rolled aluminium scrip. For this illustration, it is assumed that the quantity sold equals the produced quantity. The cold-rolled aluminium scrip is a product of rolling hot-rolled scrip, which itself is a product of rolling aluminium ingots. Hence, the ingots are produced using liquid aluminium and are the foundation for producing the other two product segments In producing this, 63.8% of the material is secondary aluminium, which is bought externally and also includes scrap generated internally.

For each of the production steps, i.e., from liquid aluminium to ingots, from ingots to hot-rolled scrip, and from hot-rolled scrip to cold-rolled scrip, process scrap occurs. Including this scrap in the calculation of the upfront demand for aluminium ingots, the total required amount results in 2.000.000

tons of aluminium ingots needed for producing the previously named output and including the incurring process scrap. Thus, the total amount of internally generated scrap sums up to 500.000 tons in 2022. This leaves 776.000 tons of scrap aluminium to be acquired externally in 2022. For simplicity, it is assumed that the internally generated scrap can be fully recycled and reused in production.

In 2023, the bBS came to full effect. Without changing the production process or innovation in their production line, in other words causing and reusing the same amount of internally generated scrap aluminium, and assuming the same output quantities for the three product segments, Alucorp-Pro AG managed to increase the amount of external scrap aluminium from 776.000 tons in 2022 to 1.000.000 tons in 2023, resulting in a new share of scrap aluminium in production of 75%. Thus, Alucorp-Pro AG increased the share of scrap/decreased the share of primary aluminium by 11,2% in one year. Substituting one ton of primary aluminium with one ton of scrap aluminium roughly accounts for a saving of 150€. For Alucorp-Pro AG, this saving per ton results in a total saving of 8,5 million € in year one of using the bBS ((Output in 2022 * Share of Prime in 2022) * 11,2% * 150€)).

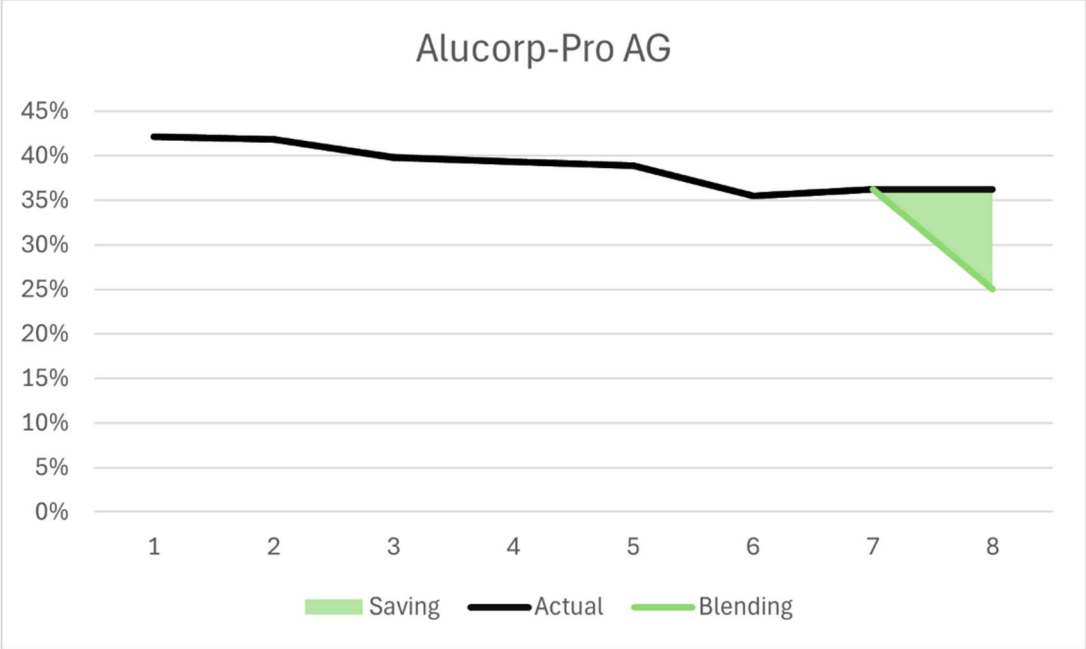

Figure 12: Alucorp-Pro AG

The bBS allowed Alucorp-Pro AG to not only reduce the share of prime aluminium in their production by 11,2% after the first year of usage, making their products more environmentally friendly, but also reduced material cost by 8,5 million € in one year by allowing a substitution of prime aluminium with scrap without decreasing product quality.

6 Technical Integration & Details

When viewed through the lens of the planning pyramid, the bBS occupies a critical role in the Advanced Planning and Scheduling (APS) layer, which sits between the strategic and operational levels (see **Fehler! Verweisquelle konnte nicht gefunden werden.**). The pyramid reflects a scale of planning from very rough and long-term at the top (strategic level) to highly detailed and short-term at the bottom (operational level). At higher levels, such as Enterprise Resource Planning (ERP), plans are broad and focused on long-term goals.

However, as planning approaches the present, it becomes increasingly detailed, requiring more granular data and real-time feedback.The bBS sits near the bottom of this pyramid, closely linked to the Manufacturing Execution System (MES) layer. It requires constant, real-time data from the production floor to adjust material input plans within minutes and adapt dynamically to changes. By offering precise, short-term scheduling and optimization, the bBS helps ensure that production remains flexible and responsive to immediate operational demands, balancing strategic goals with on-the-ground realities.

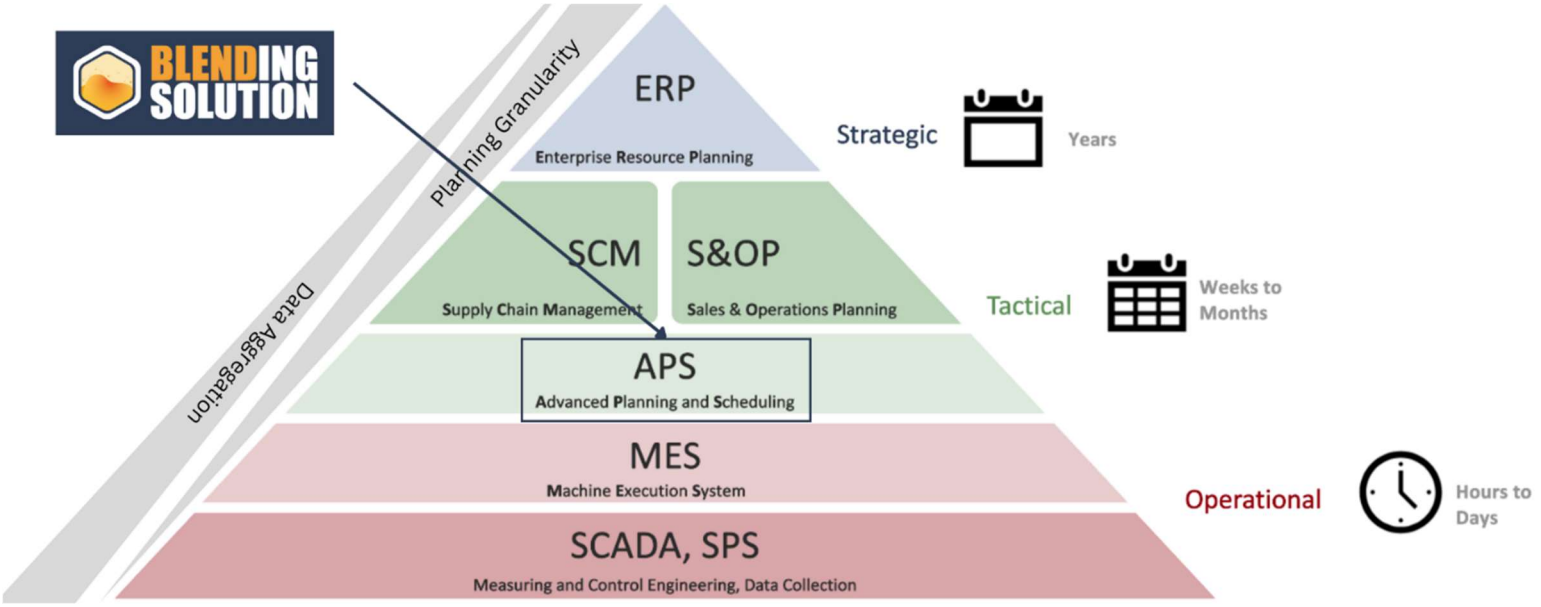

Figure 13: The bBS in the Planning Pyramid

Since the bBS is build on top of the DELMIA Quintiq framework the solutions integrates seamlessly into the DELMIA Quintiq IT landscape, enhancing the operational planning capabilities of metal production. DELMIA Quintiq offers a range of planning solutions tailored to different levels of the supply chain. At the strategic level, tools like the Demand and Macro Planner address long-term planning, focusing on sourcing strategies and high-level business goals.
The Company Planner manages Master Production Scheduling (MPS), handling tactical decisions such as order acceptance and capacity planning. At the operational level, the Scheduler solves sequencing and resource allocation challenges.

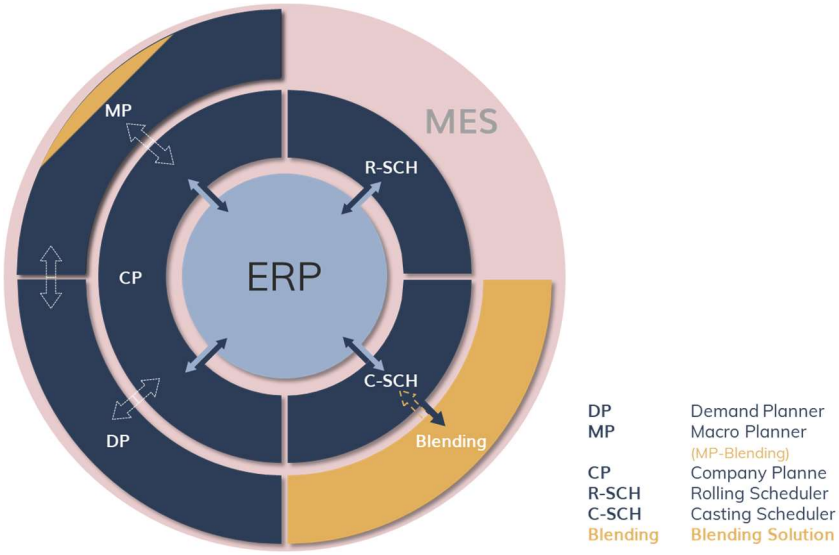

Figure 24: The bBS in the Quintiq System Landscape

The bBS complements these systems on the operational layer by optimizing material usage within the constraints of real-time production. It addresses key questions such as: How can scrap materials be best utilized to minimize costs and CO2 emissions? How can prime material usage be reduced while meeting alloy specifications? By factoring in real-time data from the Manufacturing Execution System (MES) and the Casting Scheduler, the bBS dynamically adjusts material inputs to meet operational demands while adhering to production constraints.

Its close integration with MES ensures it continuously reacts to changes on the production floor, optimizing material usage for the immediate production horizon.
While Macro Planner offers a more abstract blending feature for metal sourcing at a strategic level, the bBS focuses on short-term, operational decisions. It not only optimizes material usage but also passes critical information back to other DELMIA Quintiq systems, ensuring seamless data flow and consistent decision-making throughout the entire planning landscape.

7 Conclusion & recommendation for action

The aluminum meltcast industry is under increasing pressure to balance efficiency, cost, and sustainabislity amidst a rapidly evolving global landscape. This market is uniquely affected by its reliance on energy-intensive processes and the need to integrate recycled aluminum into production without compromising quality. Simultaneously, broader challenges faced by the metals industry, including steel and copper sectors, further compound operational complexities:

1. **Rising Energy and Material Costs**
   Energy-intensive processes like aluminum electrolysis are highly susceptible to fluctuations in energy prices. In 2022 alone, energy costs rose by over 30% globally, impacting aluminum producers disproportionately (Statista, 2023). Raw material costs, including prime aluminum, continue to escalate due to volatile commodity markets and increased global demand.
2. **Sustainability and Regulatory Pressures**
   The aluminum industry contributes approximately 2% of global CO_2 emissions, necessitating significant decarbonization efforts (Our World in Data, 2023). Governments and industries are targeting reductions, with initiatives like the European Green Deal mandating up to a 55% reduction in emissions by 2030. These regulations amplify the need for manufacturers to adopt higher recycling rates and innovative carbon-reduction strategies.
3. **Material Variability and Quality Control**
   Similar to other metals industries, aluminum producers must contend with variability in scrap quality. Achieving consistent alloy compositions is challenging, particularly as recycled materials, which can vary significantly in composition, form an increasing share of input materials. Over 60% of producers report quality assurance issues linked to scrap usage (European Steel Association, 2022; relevant for metals broadly).
4. **Dynamic Supply Chain and Production Environments**
   Aluminum meltcast operations, like other metals sectors, are increasingly affected by supply chain disruptions, fluctuating customer demands, and unpredictable production schedules. Studies show that 78% of manufacturers cite supply chain variability as a primary operational challenge (McKinsey & Company, 2023).

One possible way to address these challenges is to use optimizer supported planning software. This is necessary because of the complex planning puzzle when it comes to combining many different scrap materials to a specific composition. An example of such a software is the already established bisonaire Blending Solution (bBS).

The bBS offers an advanced software platform tailored to address these pressing challenges, especially for aluminum

meltcast operations. Built on the DELMIA Quintiq framework, bBS integrates seamlessly with existing systems to provide real-time optimization of material planning, blending, and inventory management.

Adoption of the bBS has demonstrated significant benefits, including:

- A 10%+ increase in recycled material utilization, contributing to substantial cost savings.
- Enhanced operational efficiency through data-driven insights and real-time adaptability.
- Support for meeting regulatory sustainability targets without sacrificing product quality.

The bisonaire Blending Solution empowers aluminum melt cast manufacturers to overcome industry challenges, achieve sustainability goals, and maintain competitiveness in an increasingly demanding market.

This white paper provides insights into the challenges and trends of the aluminum melt cast industry and elaborates how well established planning software like the bBS can contribute to these challenges and therefore companies in the aluminum melt cast sector.

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Daniel Steitz has been working as a Dipl. Ing in Mechanical Engineering with a focus on Production Technology, Optimization, and Organization from the Technical University of Ulm since 2002 in international S&OP, SCM, IT, and reorganization projects worldwide. One of his key areas of expertise includes the integration of new locations into globally operating corporate groups with a focus on seamless end-to-end planning.

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As a Business Consultant and Project Manager at bisonaire GmbH, his focus lies on planning and optimization in the areas of Sales & Operations Planning (S&OP) and Supply Chain Management (SCM). With practical experience in the implementation of blending solutions, Nico Martin is also a solution expert for the bisonaire Blending Solution (bBS).

About bisonaire:

Since 2019, bisonaire has been distinguished by its customized optimization solutions for the industry, ranging from consulting and software implementations to new developments and support. We offer the perfect blending solution tailored precisely to your needs.

Your Challenge is our expertise!

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