

Market in Focus: KSA Aluminum Value Chain

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Key Highlights



The aluminum value chain broadly consists of bauxite mining and alumina refining (upstream), aluminum smelting and casting into unwrought aluminum forms (midstream), and further semi fabrication and manufacturing activities (downstream).



Global aluminum consumption is forecast to grow by 2.6% CAGR until 2030, driven by global decarbonization and sustainability targets within the transportation, electrical, construction, and packaging sectors. Advancements within the electric vehicle (EV) sector will prove to have the highest contribution to growth.



The GCC boasts a strong presence across the whole value chain, with one of the most significant opportunities within the KSA downstream value chain in industries such as foil, aerospace plates, 6 series alloys, and primary foundry alloys.



Local aluminum consumption is forecast to grow by 6.8% until 2030, as the Kingdom will capitalize on diversifying end product manufacturing capabilities, specifically within the automobile and component manufacturing sector and infrastructure to support the multiple scheduled mega projects.



With an established fully integrated aluminum complex and longevity of raw material supply, KSA proves to be an attractive ecosystem for investors wishing to enter the aluminum value chain, especially relating to operational readiness factors.

Aluminum Value Chain

The aluminum sector covers a large complex number of sectors and products, which fall under three principal value chains:

- **The upstream** value chain comprises mining metallurgical bauxite and refining it into alumina. These two activities are integrated, but in certain circumstances, such as within KSA, a refinery can stand adjacent to smelting operations if OPEX costs, particularly those associated with logistics, are more favorable.
- **The midstream** value chain includes smelting primary and secondary aluminum, which feeds molten aluminum to an integrated cast house producing billets, slabs, and/or ingots. Some smelters can supply molten aluminum directly to atomizing plants producing the necessary granule feedstock for aluminum powder manufacturers. More recent trends include specialized vehicles that provide molten aluminum to foundries to minimize energy costs associated with the requirement to re-smelt solidified ingots.
- **The downstream** segment covers the production of semi-fabricated aluminum products (semis) and their use in manufacturing processes further down the chain, e.g., transportation, electrical, construction, and packaging sectors.

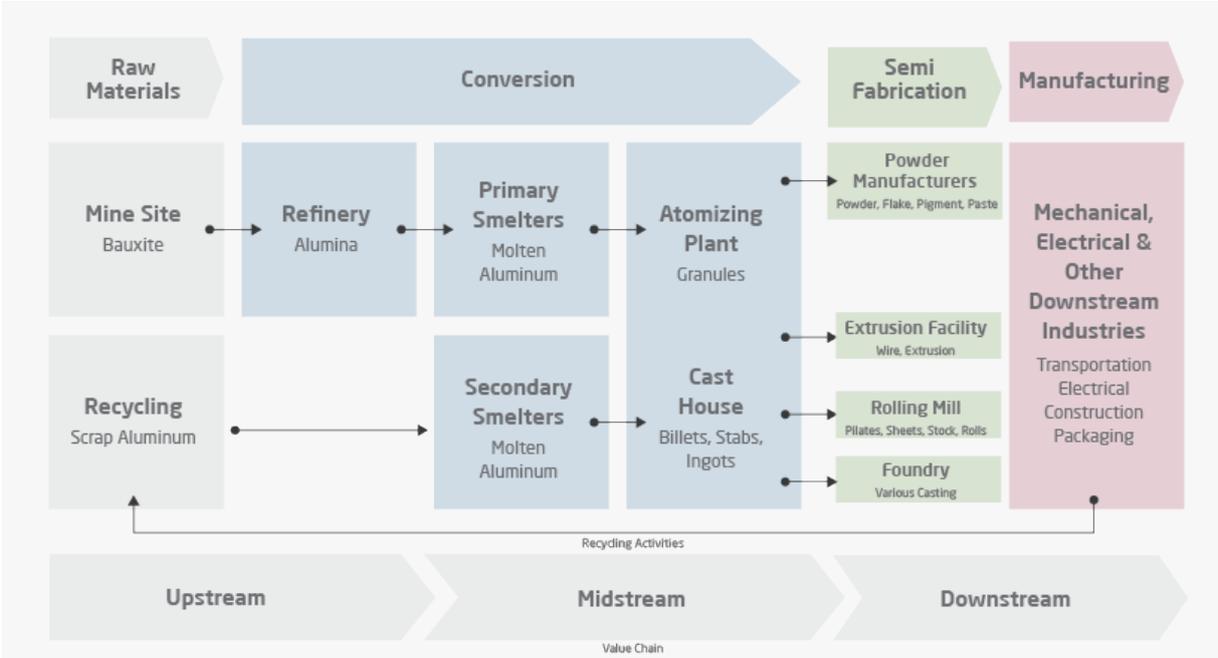


Figure 01: The Aluminum Value Chain

Global Market Drivers

Decarbonization policies and shifting towards a more sustainable world are expected to substantially impact aluminum demand. Adopting renewable energies and electric vehicles (EVs) and implementing sustainable solutions in the packaging and construction sectors will represent significant opportunities for the aluminum industry.

Total aluminum consumption is expected to grow by 19.6 Mt (i.e., 2.6% CAGR) in the following decade from 64,2 Mt in 2021 to 83,8 Mt in 2030.

Sector	2021		2030		Additional Metal Demand	
	Demand	%	Demand	%	Tons	%
Transport	14.8	23	22.2	27	+7.4	38
Electrical	7.7	12	10.9	13	+3.2	16
Construction	15.8	25	18.1	22	+2.3	12
Packaging	5.4	8	7.4	9	+2.0	10
Machinery/ Equipment	7.3	11	8.9	11	+1.6	8
Consumer Durables	3.6	6	5.0	6	+1.4	7
Foil Stock	5.7	9	6.9	8	+1.2	6
Other	3.9	6	4.3	5	+0.5	3
Total	64.2	100	83.8	100	19.6	100

Table 01: Historical 2021 vs. 2030 Demand Forecast by Sector

The sectors with the highest growth potential in terms of additional metal demand by 2030 are transportation (+7.4 Mt), electrical (+3.2 Mt), construction (+2.3 Mt), and packaging (+2.0 Mt). The four sectors collectively constitute 71% of total aluminum demand by 2030.

Transportation

Forecast to be the fastest-growing sector in terms of absolute aluminum demand by 2030. Consumption from this sector will grow by +7.4 Mt, increasing from 14.8 Mt in 2021 to 22.2 Mt in 2030. 33% of the growth comes from China, 22% from North America, and 19% from Europe. Modes of transport that use significant quantities of aluminum include automobiles, trucks, buses, trains, railcars, subways, marine, freight containers, and aircraft.

Within internal combustion engines, 1 kg of aluminum can replace up to 2 kg of steel and cast iron in many application areas, and the reduction in transport vehicle weight is substantial. The less the vehicle weighs, the less fuel consumption and harmful emissions release into the atmosphere.

The overwhelming demand within the transportation sector will boost with the shift towards EVs, which averagely contain 60-80 kg more aluminum per vehicle than those powered by internal combustion. Total EV sales are estimated to grow from 6.7 million in 2021 to 30 million by 2030, which indicates an increase from 9% to 40% share. The adoption rate of EVs depends largely on carbon emissions reduction goals set by individual countries and regions and the actions implemented toward reaching such goals. These actions can go from direct subsidies to EV purchases and traffic benefits to quotas on EV sales imposed by governments or manufacturers.

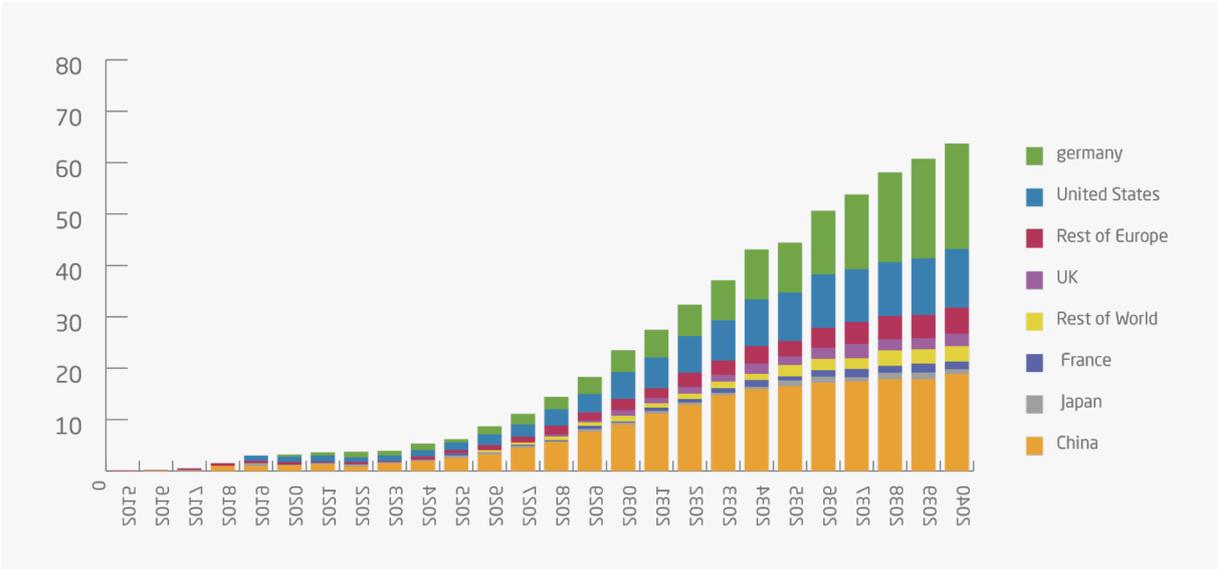


Figure 02: Projected Annual Global Electric Vehicles Sales
 Source: Bloomberg New Energy Finance, KAtusa Research, US Global Investors

The electrical sector, driven by the rise of renewable energies and the expansion of the power grid, will be another main driver for aluminum demand by 2030.

Aluminum is the single most widely used material in solar photovoltaic (PV) applications, constituting more than 85% of most solar PV components from frames to panels. Aluminum extrusions are incredibly versatile, making them a perfect option for solar panel frames. The metal can even improve solar cells. Using embedded aluminum studs can significantly increase solar panel efficiency due to the material's unique reflectivity properties.

Furthermore, aluminum-based electrical wiring has increasingly replaced copper as the conductor of choice in utility grids. The metal has more cost and weight advantages than copper and is now the preferred material for electricity transmission and distribution usages. The metal weighs half of the equivalent capacity of copper and is advantageous for the construction steps of pulling wire, suspension, and support.

Aluminum is widely utilized in construction because of its intrinsic lightness and corrosion resistance. Its application includes external facades, roofs, walls, windows, doors, staircases, railings, shelves, and several others. Energy efficiency is one of the key indicators used to evaluate the sustainable character of buildings, and intelligent façades incorporating aluminum systems have proven to decrease energy consumption in buildings by up to 50%, according to greenbuilding.world-aluminum.org.

Aluminum is used for packaging beverage cans, bottles, aerosols, trays, foils, sachets, and cartons. Its corrosion resistance and protection against UV light, containment of moisture and odor, and non-toxicity that prevents leaching or tainting the products have resulted in the widespread use of aluminum foils and sheets in food packaging and protection.

Policy & Societal Drivers

The push for reducing carbon footprint in recent years has pressured governments to adopt strategies that ensure the use of low-carbon materials across industries, including construction, electrical, transportation, and packaging sectors:

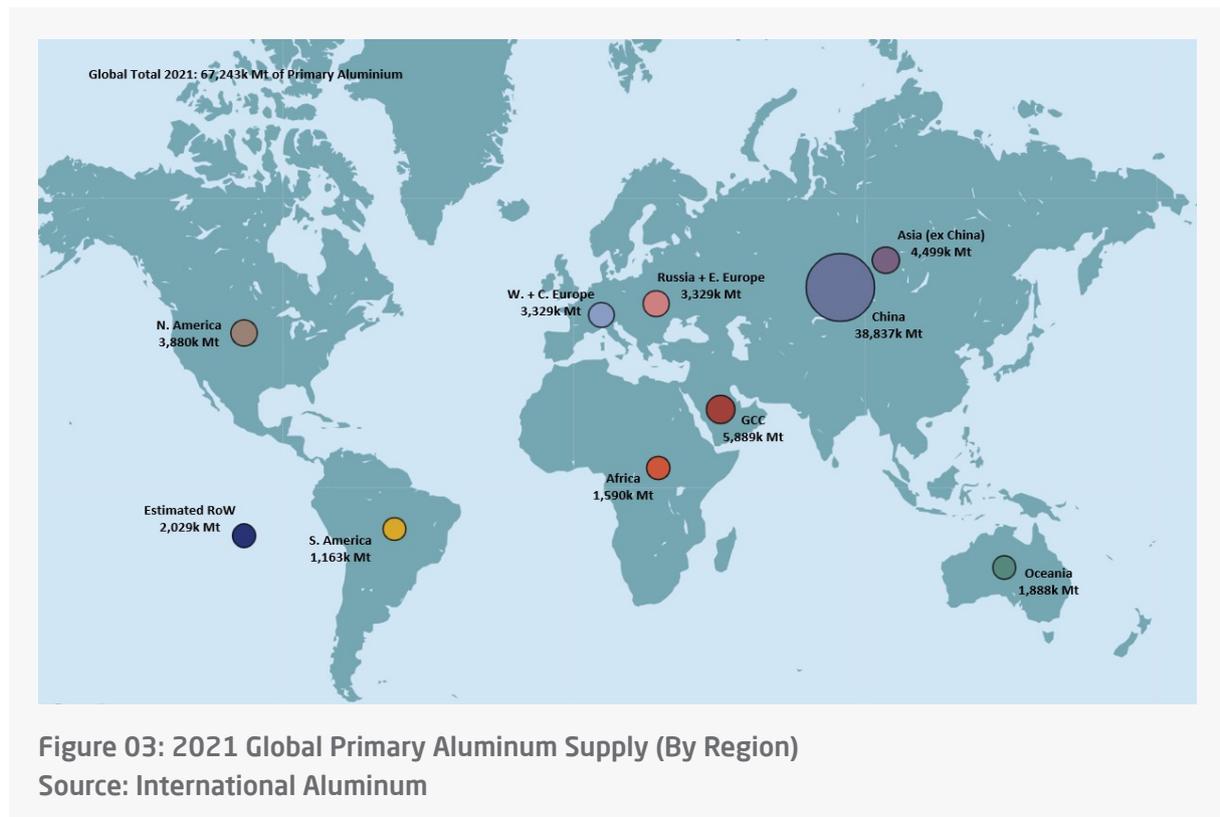
Country/ Union	Vision and Policy	
	Transportation	<ul style="list-style-type: none"> Producers are mandated to have 40% of all vehicles sold as EVs by 2030. By 2025, Govt to install charging infrastructure to service 20m EVs. New Electric Vehicle Policy: tax credits assigned based on varying metrics.
	Electrical	<ul style="list-style-type: none"> Installed capacity (Renewable Energy) targeted at over 12bn KW by 2030, which will facilitate an increase in aluminum demand (6 Series Alloy).
	Construction	<ul style="list-style-type: none"> The Ministry of Industry and Information Technology (MIIT) sets plans for low carbon emissions, replacing steel with aluminum by 2025.
	Transportation	<ul style="list-style-type: none"> Zero-Emission Vehicles program: monetary incentives to transition to zero-emissions vehicles since 2019. By 2035, mandatory target for LVs and trucks sales to be 100% zero-emission.
	Construction	<ul style="list-style-type: none"> Green Public Procurement (GPP) initiative gives global governments the ability to set high procurement standards and aims to promote positive environmental impact.
	Packaging	<ul style="list-style-type: none"> Environmental Protection Agency (EPA) established a new country-level target of a 50% recycling rate by 2030.
	Transportation	<ul style="list-style-type: none"> EU increased EV sales from 400k units in 2015 to 2,200 in 2020. Fit for 55 Policy: 100% transition from IC engines/ hybrids to EVs by 2035.
	Electrical	<ul style="list-style-type: none"> Fit for 55 Policy: a minimum 40% renewable energy sources in overall mix across the EU by 2030.
	Packaging	<ul style="list-style-type: none"> Recycling Goal of 50%. EU aluminum & metal packaging aims for 100% recycling rate in beverage can sector by 2030. European soft drinks industry pledges complete circular vision by 2030, putting pressure on plastic PET competitors.

Table 02: Global Vision & Policies Enhancing Aluminum Demand

Global Markets

Trends driven by environmental regulations, digitalization, and lightweight materials can result in repercussions for KSA and its National Industrial Strategy.

There are 268 registered primary aluminum smelters globally with a combined capacity of 76,874k tpa metal. 138 smelters (56% of the total) are based within China. India has 8 prime aluminum smelters, the largest in the world is the Jharsuguda Smelter, owned by Vedanta Resources. Russia has 18 prime aluminum smelters, 4 of which are owned by the United Company of Rusal, the biggest aluminum producer outside China.



Global unwrought aluminum production has increased from 40,800k tons in 2010 to 67,243k tons in 2021, representing an increase of 4.64% CAGR over 11 years. It has recently slowed to an increase of 1.25% CAGR between 2019-2021, with global supply adversely affected due to the following events:

- Smelter capacity reduction from 2 Chinese initiatives: the culling of illegal aluminum capacity and seasonal cuts made at smog reduction. Such initiatives have prompted aluminum producers to consider establishing plants in other more favorable global jurisdictions.
- Global economic slowdown due to COVID-19 pandemic, resulting in a decrease in global aluminum demand.

Global unwrought aluminum demand was an estimated 64,806k Mt in 2021: 39,000k Mt (60%) consumed by China, 2,900k Mt (5%) by the USA, 1,800k Mt (3%) by Germany, and 21,106k Mt (32%) by others. Global demand is predicted to grow at 2.6% CAGR until 2025. It is due to a steady demand growth within Asia, spurred by the increasing population and the growing application of aluminum in industries such as automotive and aerospace.

According to AlCircle.com, extrusion products (billets) account for 46% of global aluminum demand, followed by flat rolled products at 32% (slabs) and castings at 22% (ingots and aluminum molten metal).

GCC Regional Market

There are 6 established aluminum smelters located within the GCC. The combined supply of unwrought aluminum (alloyed and non-alloyed) within GCC of all forms (ingots, billets, slabs, and molten metal) was approximately 5,750k Mt in 2021.

Country/ Union	Upstream	Midstream	Downstream
 KSA	 Al Baitha Mine	 Al Baitha Mine	Extrusions Can Stock Automotive Sheets
 UAE	 Republic of Guinea	 Taweelah Smelter Jebel Ali Smelter	Extrusions Conductor Wire
 Bahrain		 ALBA Smelter	Extrusions Conductor Wire
 Qatar		 QAMCO Smelter	Extrusions Conductor Wire
 Oman		 SOHAR Smelter	Foil Stock Construc- tion Sheet

Table 03: Regional Capabilities by Country

All GCC countries have operations in the midstream segment of the aluminum value chain to produce primary aluminum. KSA operates its bauxite mine through Ma'aden, while UAE operates a mine in the Republic of Guinea through Emirates Global Aluminum. Regionally, the aluminum industry has strong capabilities in extrusions and conductor wire.

Discounting Intra GCC aluminum trades, the GCC exported an estimated 4,044k Mt of unwrought aluminum in 2021. Thus, GCC demand is approximately 1,706 Mt of varying aluminum forms.

KSA Local Market

The global aluminum ecosystem is fragmented among many players, yet KSA has an established base along the value chain, championed primarily by Ma'aden.

KSA has an unwrought aluminum smelting capacity of 900k tpa, with historical production of approximately 790k tpa cast products. Local demand in 2021 was 426k Mt, with a considerable proportion allocated to Ma'aden's integrated Rolling Mill. Demand is forecast to grow at 6.8% CAGR until 2030 to support major construction projects and automobile manufacturing facilities.

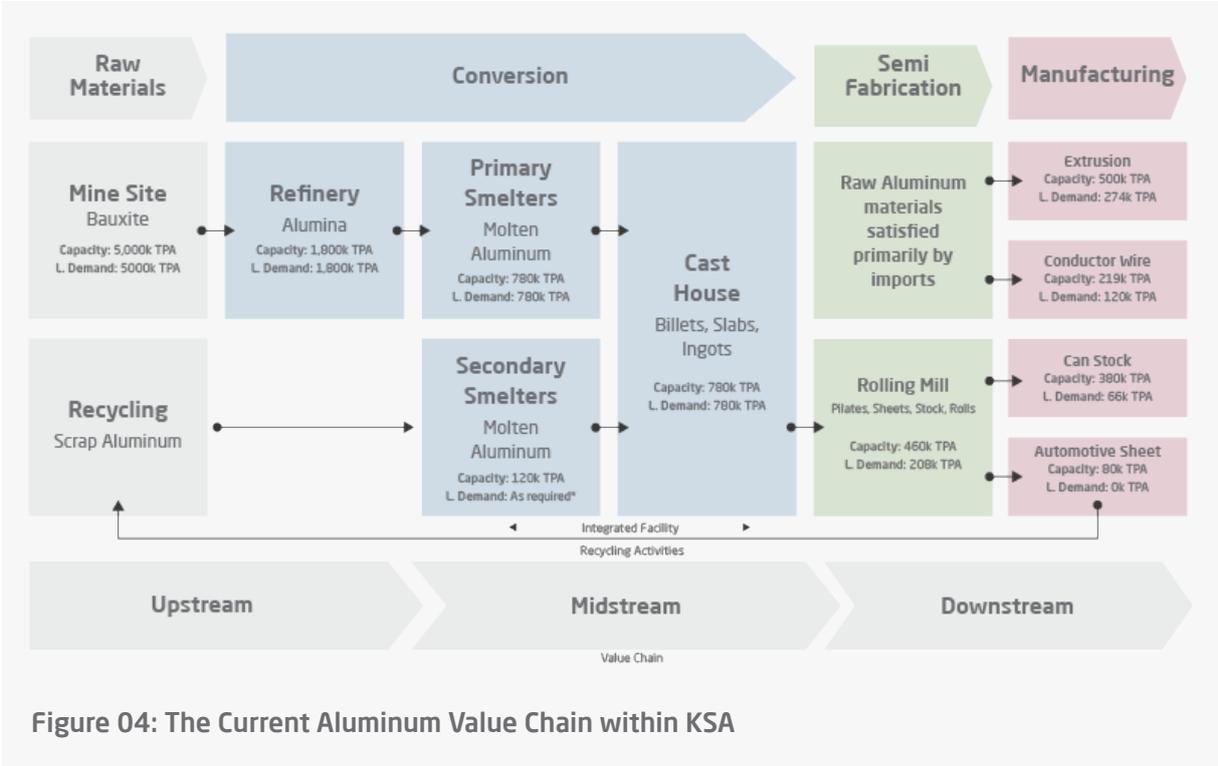


Figure 04: The Current Aluminum Value Chain within KSA

Ma'aden Bauxite and Alumina Company (MBAC) operates Al Baitha Bauxite Mine in Qassim and the associated Alumina Refinery in Ras Al Khair. The mine is configured to extract approximately 5,000k dmtu of metallurgical bauxite annually. The extract is transported by a combination of rail and truck to feed the Alumina Refinery, with a production capacity of 1,800k tpa of metallurgical grade alumina.

The Alumina is fed to the Ma'aden Aluminum Company (MAC) Primary Smelter to produce molten aluminum metal. It is then transferred to its integrated casthouse to be purified, alloyed, and cast into ingots, slabs, billets, or similar manufactured forms subject to end-use application requirements. These products, referred to as 'unwrought aluminum products', have been machined or processed by simple trimming, scalping, or descaling. Local unwrought aluminum production capacity is 780k tpa.

The Ma'aden Rolling Company (MRC) Rolling Mill can process 460k tpa of slabs to produce aluminum sheets and rolls per end-customer specifications within the automotive panel and can-stock sectors. The balance of the various unwrought aluminum forms not utilized captively is sold to export markets.

Extrusion and conductor wire manufacturers are currently the most prominent industries within the downstream value chain. The largest extrusion producers include ALUPCO (total capacity of 85k tpa) and TALCO (total capacity of 60k tpa). Established cable manufacturers include Riyadh Cables, Saudi Cable, and Jeddah Cables.

KSA has embarked on significant industrial transformation targets underpinned by Vision 2030 mandates. Supporting policies that may affect the aluminum sector are as follows:

Opportunities

The mining and metals industry is to become the "third pillar" of the Saudi industrial base due to KSA's rich deposits of minerals. A strategic focus is the development of sustainable and globally competitive value-added semi-finished and finished metal industries (downstream) that support the Kingdom's diversification goals. In line with Saudi Vision 2030, KSA aims to maximize local aluminum production and supply primary raw materials to local aluminum-based industries.

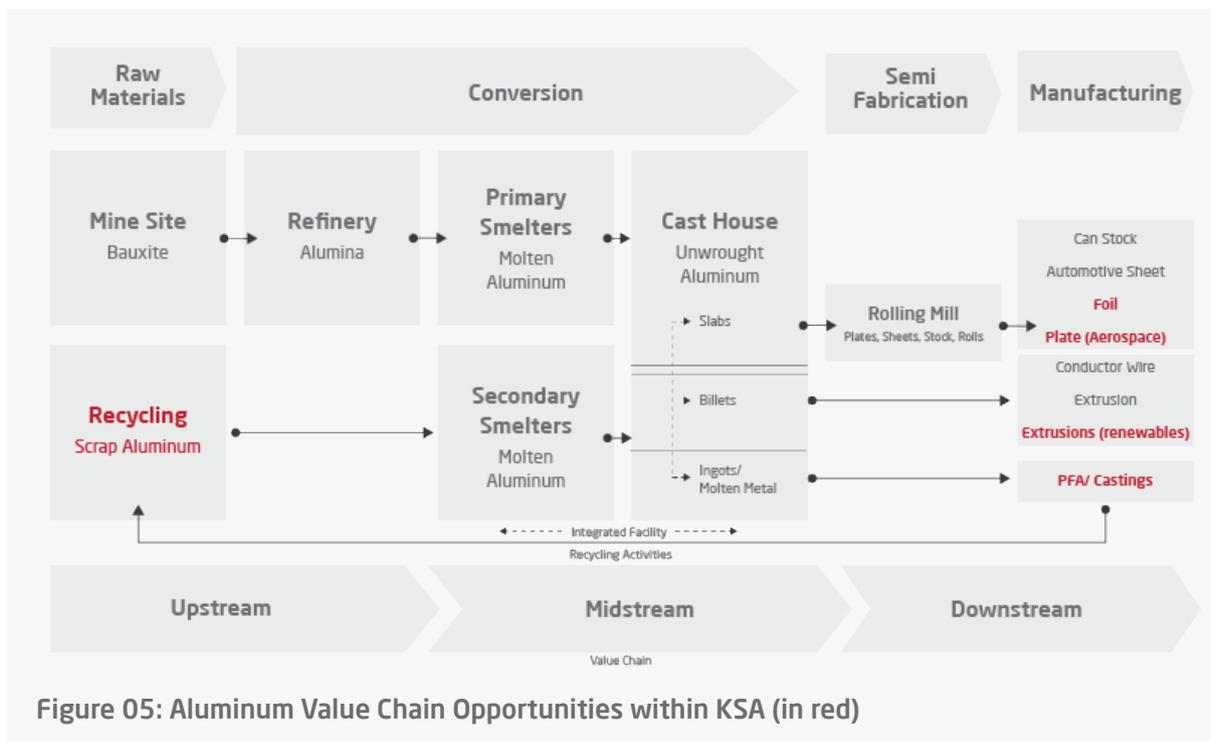


Figure 05: Aluminum Value Chain Opportunities within KSA (in red)

The following sectors within the aluminum value chain, highlighted above, are considered highly strategic with significant investment opportunities:

Recycling Activities

KSA's Ministry of Environment and Water (MEWA) is constantly working on regulating the collection of End of Life (EOL) aluminum. In this regard, the National Center for Waste Management was established in April 2019 to regulate and supervise waste management and stimulate investment and quality control. On average, over 80% of aluminum scrap generated in the GCC area comes from used beverage cans (UBC), extrusions, and engine scrap. KSA government has an ambitious development plan to diversify the economy by prioritizing industrial and manufacturing sectors.

Over 60k tpa of aluminum scrap is typically imported into KSA for processing and re-melting to produce ingots. It provides opportunities for investment in a secondary aluminum smelter.

Refer to the following Invest Saudi link for further details on the investment opportunity: [Here](#)

Foil (Flat Rolled Products)

Demand for aluminum foil stock is driven by its usage in food, pharmaceuticals, cosmetics, insulation, electronics, and automotive industries. Another influential factor in the aluminum foil industry's growth is government regulations on food safety and quality standards. Such mandates influence manufacturers to develop effective packaging solutions that prevent food contamination and pressure and reduce plastic consumption. The rise in population and household income, increase in urbanization, and lifestyle changes, e.g., preference for ready-to-eat food, are expected to continue supporting the growth of aluminum foil in KSA.

Currently, there is no aluminum foil stock production in KSA; it is fully imported. Most imported foil is semi-finished (>80%) and requires further fabrication in KSA.

Refer to the following Invest Saudi link for further details on the investment opportunity: [Here](#)

Plate (Aerospace & Transport)

Demand for aluminum plates is motivated by their usage in heavy-duty applications in the aerospace, military, and transportation sectors. Aluminum plates have replaced steel, which is used in multiple end-use industries, e.g., aerospace, transportation, and power generation, due to its high flexibility, cost-effectiveness, non-corrosive, heat resistance, and high thermal conductivity. Increasing stringency in regulations for reducing vehicle weight, consequently reducing carbon emissions, is anticipated to boost the demand for aluminum plates in the automotive and aerospace industry.

KSA plans to develop its domestic supply chain of military hardware and aerospace industries and expectedly create a potential upside in domestic plate demand. Aluminum plate, machined to shape, forms the skins of jets and spacecraft fuel tanks and is used for storage tanks in many industries. Expansion of domestic ship-building capacity will increase demand for specialist aluminum plates. Currently, 100% of the local aluminum plate demand is met by imports.

Refer to the following Invest Saudi link for further details on the investment opportunity: [Here](#)

Extrusions (Renewables 6XXX Series)

The 6-series aluminum alloy is an aluminum alloy with magnesium and silicon as the main alloying elements and the Mg₂Si phase as the strengthening phase. The 6 series are heat-treated and strengthened aluminum alloys. The advantages of alloys are medium strength, high corrosion resistance, good formability, and process performance. Other benefits include good welding performance, unchanged welding zone corrosion performance, and the absence of stress corrosion cracking.

Demand for the aluminum 6 series is predominantly within the extrusion sector compelled by three factors: growth in the construction market, industrial diversification plans, and large-scale investments in automotive and infrastructure-based projects, like railways. KSA's National Investment Strategy identifies the Renewable Energy Cluster as a high-opportunity sector, with an expected domestic capacity gap for 6 series extrusions of approximately 103k tpa by 2030.

Refer to the following Invest Saudi link for further details on the investment opportunity: [Here](#)

Primary Foundry Alloys (PFA) and Castings

PFA is a value-added product predominantly used to cast automotive parts with intricate shapes customized for critical safety parts. Specific applications include transmission and driveline parts, wheels, suspension systems, steering wheels, and brake systems. Global PFA demand growth will continue from auto-light weighting and passenger and commercial vehicle manufacturing growth.

The upcoming automobile manufacturing cluster in KSA is expected to expand automotive manufacturing and will increase domestic demand for aluminum PFA. KSA's aluminum PFA demand is forecasted to reach 41kt by 2030, based on plans to produce over 300,000 vehicles in the next 10 years. The growth in the building and construction sector and infrastructure projects are also set to significantly impact the aluminum PFA market growth within KSA and the region.

Refer to the following Invest Saudi link for further details on the investment opportunity: [Here](#)



Challenges

KSA's plans to develop the downstream aluminum manufacturing sector do not come without challenges. Investors looking to enter the space must keep the following in mind:

- Securing local unwrought aluminum raw material: Aluminum producers will export metal to regions commanding the highest premium to obtain the highest price p/ton. Despite a KSA flowsheet stating an oversupply of unwrought aluminum, this does not necessarily mean selling to local markets.
- Anti-dumping and export taxes from overseas jurisdictions: Recently, some countries faced accusations of dumping aluminum products into KSA, which imposed the anti-dumping tax. Such practices, and other associated risks, must be further analyzed.
- Hot rolling mill (for alloy production) and lack of specialized labor: A different flow sheet and technology are prevalent within alloying, as presented in the opportunities section. Acquiring laborers with relevant specialized experience may be difficult.



Key Success Factors

Investors intending to establish a downstream manufacturing facility within the aluminum sector would need to satisfy the following requirements:

- A High-quality owner and management team with demonstrated experience in downstream aluminum end-product manufacturing is necessary.
- Reliable access to unwrought aluminum supply: Vertical integration affords a stable and consistent long-term aluminum supply to a manufacturing operation. The investor will obtain a committed aluminum supply agreement.
- Infrastructure: Logistics, water, electricity, and communications to support the operation should be available and functioning.
- All projects must adhere to the localization policy of KSA and utilize domestically sourced raw materials, focusing on unwrought aluminum, reagents, and chemicals.



Ecosystem Enablers

The attractiveness of an ecosystem for upstream mining and industrial project development of any nature are evaluated against the following criteria:

Operational Readiness	Commercial	Regulatory & Legal	Social & Environmental
Strategic Global Location	Tax and Incentives	Regulatory Regime	Technical Skills
Recognized Industrial Precincts	Financing Availability	Sovereign Risk	Social Acceptability
Raw Material Inputs	Reagents and Chemical Costs	Fiscal Stability	Environmental
Logistics & Infrastructure		Rule of Law Index	

Table 04: Ecosystem Enablers

KSA is central to the circum-equatorial corridor, linking North America, Europe, and Pacific Asia. This Core Route supports the bulk of maritime traffic servicing markets. Thus, KSA has an exceptional logistical advantage in terms of a strategic global location to access feedstock materials and ship final products to end users.

The industrial maturity of KSA reflects an ecosystem able to readily absorb the aluminum sector projects across the whole value chain. KSA currently has more than 40 recognized industrial precincts managed by MODON, RCJY, and the ECA. Ras Al-Khair operations focus on the anchor investor Ma'aden, the anchor investor's, integrated aluminum and phosphate complexes, providing excellent further investment opportunities.

The fundamental raw material input for the aluminum sector is bauxite ore. As of 2021, the Ma'aden's Al Ba'itha mine contained an estimated 64m Mt of proven reserves sufficient to support a 16-year mine life at current exploitation rates. An additional 123m Mt of probable reserves have been identified, which would support a further 31-year extension to the mine life. KSA boasts a fully integrated complex where both aluminas refine. Aluminum is smelted to produce the necessary unwrought aluminum to provide feedstock to downstream manufacturing industries.

The aluminum sector is supported by a well-conceived infrastructure that includes a 1,400-kilometer railway connecting the principal bauxite mines to the Ras Al Khair industrial city, a prime port facilitating export operations, one of the world's largest desalination and power plants, and a modern residential village for staff. The downstream super hub will play a pivotal role in the KSA mining industry growth and industrial diversification by providing significant downstream investment opportunities.

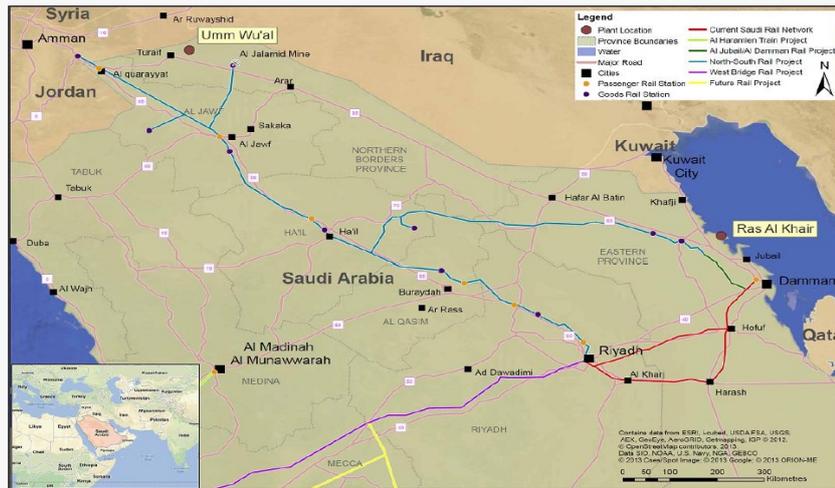


Figure 11: Ma'aden Mine and Ras Al Khair Smelter/Refinery Locations
Source: Ma'aden Annual Report 2020

The commercial benefits of conducting business within KSA are highly favorable, with one of the most attractive tax regimes relating to corporate income and withholding taxes when benchmarked against global peers. The ability to successfully secure the necessary finance to develop projects within KSA is one of the remarkable attractions to establishing a project within this region. SIDF is the financial enabler of NIDLP and Vision 2030, with a recent strategic focus on updating policies relevant to the aluminum sector. Benefits include loans of up to 75% of the project cost subject to location and grace period entitlements of 24-36 months based on the nature of the project.

The regulatory and legal system of the aluminum value chain has made substantial developments over recent years. Underpinning sectorial development is the 2020 Mining Law approved by the KSA Cabinet to accelerate foreign investment in the sector to diversify the economy away from hydrocarbons. The new law facilitates investor access to financing and supports exploration and geological survey activities. Fiscally, KSA boasts a strong financial-asset base and foreign exchange reserves, owing to good relations with the US and a long-standing and stable exchange rate system.

KSA, with an advanced oil and gas and petrochemical industry, is fortunate to have a workforce with similar skills aligned with the requirements of mineral separation and downstream operations. The industrial relations regime allows for the importation of labor to cater to skill shortages, along with an overarching Saudi nationalization scheme by the Ministry of Labour and Social Development to develop the national workforce and prioritize Saudi workers. **The social and environmental** considerations associated with projects within the aluminum value chain are well-addressed across the various regulatory bodies.



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