The South African Aluminium Industry Roadmap

March 2017
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## Glossary

<table>
<thead>
<tr>
<th>Term used</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st tier supplier</td>
<td>A company that is a direct supplier to OEMs. The term is especially common in the automobile industry and refers to major suppliers of parts to OEMs</td>
</tr>
<tr>
<td>2nd tier supplier</td>
<td>A company that is the key supplier to tier one suppliers, without supplying a product directly to OEM companies</td>
</tr>
<tr>
<td>3D</td>
<td>Three-dimensional</td>
</tr>
<tr>
<td>3D Printing</td>
<td>The action or process of making a physical object from a three-dimensional digital model, typically by laying down many thin layers of a material in succession</td>
</tr>
<tr>
<td>4th Industrial Revolution (Industry 4.0)</td>
<td>Following industrial revolutions brought about by steam, electricity and digitisation, the 4\textsuperscript{th} Industrial Revolution refers to an era where the current trends of automation and data exchange will lead to cyber-physical systems, the Internet of Things and cloud computing. Human-machine partnerships will increasingly drive manufacturing.</td>
</tr>
<tr>
<td>6-series aluminium alloys</td>
<td>The 6-series features magnesium and silicon as its primary alloying elements. They account for the vast majority of the tonnage of aluminium extrusions produced.</td>
</tr>
<tr>
<td>7-series aluminium alloys</td>
<td>The 7-series of alloys contain comparatively high percentages of zinc as their primary alloying element and low concentrations of silicon, nickel and manganese. They offer high strength, good machinability and are heat treatable, but have poor corrosion resistance. They are most commonly used in aircraft and military applications.</td>
</tr>
<tr>
<td>ABS</td>
<td>Automotive Body Sheet</td>
</tr>
<tr>
<td>Additive Manufacturing</td>
<td>The process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies</td>
</tr>
<tr>
<td>AHRLAC</td>
<td>Advanced High-performance Reconnaissance Light AirCraft</td>
</tr>
<tr>
<td>AIS</td>
<td>Automotive Investment Scheme</td>
</tr>
<tr>
<td>Al-Co-W alloys</td>
<td>Aluminium, cobalt and tungsten are often used as alloying elements for hard materials</td>
</tr>
<tr>
<td>Aluminium alloys</td>
<td>Aluminium alloys are a mixture of aluminium and other metals. Different metals, when added to the base aluminium impart enhanced properties to the aluminium, such as enhanced corrosion resistance, better formability, greater strength, etc.</td>
</tr>
<tr>
<td>Aluminium alloy powder</td>
<td>Powder metallurgy is the processing of parts from metal powders. Aluminium powder metallurgy currently used to produce ultra-high strength and creep resistant alloys beyond the levels possible by conventional ingot metallurgy</td>
</tr>
<tr>
<td>APDP</td>
<td>Automotive Production and Development Program</td>
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<td>ASCCI</td>
<td>Automotive Supply Chain Competitiveness Initiative</td>
</tr>
<tr>
<td>Backwardation</td>
<td>Normal backwardation occurs when the forward price of a futures contract is below the expected future spot price</td>
</tr>
<tr>
<td>Business ecosystems</td>
<td>Networks of organisations, including suppliers, distributors, customers, competitors, government agencies, involved in the delivery of a specific product or service through both competition and cooperation</td>
</tr>
<tr>
<td>Business platforms</td>
<td>Layers of infrastructure that impose standards on a system in which many separate entities can operate. It allows businesses to easily connect and build products and services on top of the platforms and co-create value, e.g. a digital platform used for sharing and transacting.</td>
</tr>
<tr>
<td>CAD</td>
<td>Computer-Aided Design</td>
</tr>
<tr>
<td>CAM</td>
<td>Computer-Aided Manufacturing</td>
</tr>
<tr>
<td>Complements</td>
<td>Two assets are said to be complements when investment in one asset increases the marginal return on the other, e.g. manufacturing capabilities, marketing channels, brand name, technology platforms, etc.</td>
</tr>
<tr>
<td>Conjuncture</td>
<td>Combination of events, normally in political, economic, social and environmental context</td>
</tr>
<tr>
<td>Contango</td>
<td>A market is said to be in Contango when the forward price of a futures contract is above the expected future spot price.</td>
</tr>
<tr>
<td>Dynamic capabilities</td>
<td>The firm’s ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments.</td>
</tr>
<tr>
<td>ESA</td>
<td>Electricity Supply Agreement</td>
</tr>
<tr>
<td>End-of life scrap</td>
<td>Final products containing aluminium that are scrapped at the end of their life cycle</td>
</tr>
<tr>
<td>Fabricator</td>
<td>Fabricates formed, shaped, casted, cut, drilled, machined, welded and assembled products, e.g. blanks for automotive panels, gearbox housings, engine blocks, light/heavy engineering and consumer durable products (ladders, furniture, formwork, scaffolding, signage) etc., transport industry (trucks, busses, trailers, marine applications, rail networks, etc.) and the architectural market such as windows, shopfronts shading products, etc.</td>
</tr>
<tr>
<td>FDI</td>
<td>Foreign Direct Investment</td>
</tr>
<tr>
<td>Final product</td>
<td>Products containing aluminium and hybrid materials, e.g. automotive panels, gearboxes, automotive assemblies, etc.</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<tr>
<td>GHG</td>
<td>Greenhouse Gas</td>
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<tr>
<td>Term used</td>
<td>Meaning</td>
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<tr>
<td>GWh</td>
<td>Gigawatt hour</td>
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<tr>
<td>IoT</td>
<td>Internet of Things. A system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction</td>
</tr>
<tr>
<td>IPAP</td>
<td>Industrial Policy Action Plan</td>
</tr>
<tr>
<td>kt</td>
<td>Kilo-ton (metric)</td>
</tr>
<tr>
<td>LME</td>
<td>London Metal Exchange</td>
</tr>
<tr>
<td>Mt</td>
<td>Mega-ton (metric)</td>
</tr>
<tr>
<td>NAACAM</td>
<td>National Association of Automotive Component and Allied Manufacturers</td>
</tr>
<tr>
<td>NDP</td>
<td>National Development Plan</td>
</tr>
</tbody>
</table>
| NDP Outcomes | 1. Education - Quality basic education  
  2. Health - A long and healthy life for all South Africans  
  3. Safety - All people in South Africa are and feel safe  
  4. Economy - Decent employment through inclusive growth  
  5. Skills - A skilled and capable workforce to support an inclusive growth path  
  6. Infrastructure - An efficient, competitive and responsive economic infrastructure network  
  7. Rural Development - Vibrant, equitable, sustainable rural communities contributing towards food security for all  
  8. Human Settlements - Sustainable human settlements and improved quality of household life  
  9. Local Government - Responsive, accountable, effective and efficient local government  
  10. Environment - Protect and enhance our environmental assets and natural resources  
  11. International - Create a better South Africa and contribute to a better Africa and a better world  
  12. Public Service - An efficient, effective and development-oriented public service  
  13. Social Protection - A comprehensive, responsive and sustainable social protection system  
  14. Nation Building - A diverse, socially cohesive society with a common national identity |
| OEM | Original Equipment Manufacturer |
| PET | Polyethylene terephthalate |
| Primary alumina | Al₂O₃ in powder form |
| Primary material/metal | Aluminium metal, usually in ingot form |
| Production scrap | Scrap emanating from the production processes |
| PV | Photovoltaic |
| R&D | Research and Development |
| RAPDASA | Rapid Product Development Association of South Africa |
| SAAI | South African Aluminium Industry |
| SADC | Southern African Development Community |
| SARA | South African Regional Aircraft |
| Secondary smelter | Produces tailored aluminium billet, powder and deoxidant mainly using scrap as infeed, and often some primary aluminium |
| Semi-fabricated product | Sheet, wire, flat rolled, extrusion, cable, shape casted, etc. |
| Sisalation | Heavy duty, durable, double sided, reflective foil laminate incorporating advanced fire retardant properties |
| SME | Shanghai Metal Exchange |
| SOC | State-Owned Company |
| UAV | Unmanned Aerial Vehicle |
| Value-added product | Alloy of aluminium with specific physical properties |
| VR | Virtual Reality |
| Well-being | The state of being comfortable, healthy and happy |
Executive Summary

The South African Aluminium Industry Roadmap (SAAIR) was initiated by the Department of Science and Technology (DST). It was developed using an external service provider under the auspices of the CSIR with input from senior government officials, academia, aluminium industry leaders, the Aluminium Federation of South Africa (AFSA) and representatives from downstream users of aluminium.

The stakeholder representatives drafted a vision for the industry. This vision addresses growth, competitiveness, optimisation, efficiency, social well-being, unique products, markets and an export orientation. Input from expert workshops in Gauteng, KwaZulu-Natal and the Eastern Cape generated sectors with the highest potential for increasing local value addition, job creation and social upliftment and transformation. It was apparent from the industry workshops that the aluminium sector is a key element of South Africa’s industrialisation needs and that the African market on the doorstep presents a major growth opportunity.

The result of a study commissioned the South African aluminium industry, performed by the consulting group McKinsey, was used to inform the roadmap. The study envisaged three growth scenarios and quantified the opportunities by sector for each scenario. The roadmap could result in a doubling of local demand for fabricated aluminium products, with resultant doubling of employment in the industry, social upliftment with its significant multiplier effects in terms of employment, and contribution to GDP and export earnings.

Barriers to achieving the exciting growth and development identified in the roadmap include the cost and security of electricity supply to the Hillside smelter, scarce skills, distance to export markets, lack of appropriate trade barriers, availability of scrap and aging infrastructure. Attention was given to future technologies, emerging trends and behaviours both in terms of the way in which people will work, and in markets.

Issues identified, especially in the mid- and longer term, must be taken into account in the strategic plans of all stakeholders. To secure the future of a globally competitive industry, there are several issues that need to be addressed in the short term (3-year time frame).

- A shift in vision from local consumption to export of aluminium finished goods
- A long-term Electricity Supply Agreement (ESA) for the South32 Hillside smelter
- Competitively priced supply of liquid and solid primary aluminium by the Hillside smelter
- Investment in the Isizinda casthouse to recommission extrusion billet, rod, rim alloy and other products
- Focussed Government support and legislation
  – Clarity on the support for local manufacturers in the Automotive Master Plan 2020-2035 currently being developed
  – Effective trade policy – to create a level playing field against subsidised imports
  – An effective mechanism to secure affordable, quality scrap for local beneficiation
  – Enabled local content programs that support local manufacturers
- Maintain and develop an academic and research and development community that supports local growth areas, local innovation, local design and prepares young talent to enter and add value to the industry
- Prepare for the 4th Industrial Revolution by adopting flexible manufacturing principles and new manufacturing technologies and processes
This will help create an attractive investment climate and accelerate the launch of the projects currently under evaluation as well as attracting exciting new projects. It will be important for all stakeholders to work together to bring these interventions to fruition.

The Aluminium Federation of South Africa will be the custodian of this living document and host it on their web site. It will further assist in the monitoring of the implementation and communicate progress and recommend interventions.

The diagram summarises the roadmap to be discussed in the main document

The interventions are outlined in the table that follows

<table>
<thead>
<tr>
<th>Roadmap period</th>
<th>Intervention</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current (2016)</td>
<td>Maintain imports of alumina and production of primary aluminium</td>
<td>The local Hillside smelter is of crucial importance to keep the industry competitive. The technology applied is stable for the future and material should enter the value chain in South Africa at the alumina stage.</td>
</tr>
<tr>
<td>Current (2016)</td>
<td>Secure electricity supply and maintain a leading-edge smelter</td>
<td>To ensure the future of the industry and unleash the required investment in the other value-added product facilities, it is vital to secure a long-term electricity supply agreement for the primary smelter.</td>
</tr>
<tr>
<td>Roadmap period</td>
<td>Intervention</td>
<td>Discussion</td>
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<tr>
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</tr>
<tr>
<td>Current (2016)</td>
<td>Continuously upgrade and expand processing capability</td>
<td>Existing semi-fabrication foundries should be continuously upgraded and modernised. Automotive Body Sheet (ABS) (currently imported) depends on an annealing line being installed. The recycling of scrap through secondary smelters can be drastically increased if quality scrap can be secured at competitive prices so that foundries can bid effectively, especially for castings for the automotive sector. New foundries will be required if companies can secure supply contracts with Tier 1 and/or Tier 2 companies in the global supply chain.</td>
</tr>
<tr>
<td>Current (2016)</td>
<td>Maintain and expand materials and process R&amp;D</td>
<td>To arrive at the competitive edge expressed in the vision for the industry, a strong R&amp;D capacity is required for the development of new materials and processes. An own R&amp;D capability is also important, since strategic alloys are not readily available in the market. This could lead to industrialisation that is not profit oriented, but establish strategic capabilities. Partnerships would play a very important role in R&amp;D, and research institutions should be engaging with overseas research bodies to form alliances.</td>
</tr>
<tr>
<td>Medium term (2017 – 2020)</td>
<td>Restart value-added production</td>
<td>Locally produced primary material must continue to be supplied downstream in either solid or liquid form. To build a real competitive advantage in the industry, opportunities for innovation must be found around the supply of liquid aluminium, since this could be the real disruptor that will position the industry for future market leadership. This is to avoid keeping large inventory, laying out cash flow for order prepayment and to pay higher value-added prices for semi-fabricated product. It will result in a large competitive advantage for the semi-fabrication sector if the supply of liquid aluminium by the South32 smelter to the Isizinda cast-house can be increased and the reopening of mothballed parts of the Isizinda cast-house facility, such as extrusion billet, rim alloy and redraw rod can be done. The importation costs, working capital tied up and port delays will all be eliminated.</td>
</tr>
<tr>
<td>Medium term (2017 – 2020)</td>
<td>Establish product innovation and design capacity</td>
<td>The establishment of design capacity and product innovation capability is key to the success of the industry and can be located within existing business, university and CSIR resources on a co-ordinated basis as well as supported by a physical aluminium design centre.</td>
</tr>
<tr>
<td>Medium term (2017 – 2020)</td>
<td>Introduce supplier development programs</td>
<td>Supplier development programs to support the expanding industry will be necessary. One example is the automotive industry with its urgent need for more fuel-efficient vehicles, light-weighting, and the many advantages of more aluminium intensive vehicles. The way to participate in this business is to enter the OEM global supply chain, probably as a supplier to a first or even second tier supplier. Entering the supply chain (e.g. automotive) will require a process that needs to start immediately if local manufacturers are to supply parts in 3-5 years.</td>
</tr>
<tr>
<td>Medium term (2017 – 2020)</td>
<td>Adopt additive and flexible manufacturing</td>
<td>A shift towards additive and flexible manufacturing may be critical for industry success. To introduce industry and small supplier firms to this, alignment with the existing RAPDASA (Rapid Product Development Association of South Africa) is advisable, as well as the establishment of a flexible scalable volume manufacturing platform and incubator (industry playground) where development, small scale production and scale-up can be tested for aluminium specifically. This would enable smaller suppliers to enter the supply chain with advanced offerings.</td>
</tr>
<tr>
<td>Roadmap period</td>
<td>Intervention</td>
<td>Discussion</td>
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<td>----------------</td>
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</tbody>
</table>
| Medium term (2017 – 2020) | Do feasibility studies: | i) Enormous value addition to the automotive industry is possible if a local drive train manufacturing capability is initiated.  
   ii) The feasibility of the introduction of a flexible manufacturing engine plant to be used by multiple OEMs should be investigated.  
   iii) The long-term need for additional rolling mill capacity must be investigated  
   iv) The feasibility of a continuous annealing plant must be investigated in the light of increased consumption of automotive body sheet |
| Medium term (2017 – 2020) | Introduce policy and incentive support for local manufacturing | Local manufacturing leading to final products in all the market sectors should continue to be supported by policy and incentive programs. The further development of the APDP (Automotive Production and Development Program), localisation through a joint industry-government initiative such as the ASCCI (Automotive Supply Chain Competitiveness Initiative), the IPAP (Industrial Policy Action Plan) and the NDP (National Development Plan) should all recognise aluminium as an industrial material. The construction market is currently one of the largest aluminium market sectors and increasingly dominated by imports. Policy intervention is required to level the playing fields so that these volumes can be localised. Government intervention in the architectural and building market with requisite duties to level pricing playing fields and reversal of current large volume imports in this market will be beneficial to the industry. |
| Medium term (2017 – 2020) | Educate users and consumers on aluminium advantages | Education of consumers and advocacy of aluminium advantages are required for market development. The aim should be to align this education to achieve the target set for the more than doubling of local consumption of aluminium. |
| Long term (2021 – 2030) | Develop citizen business opportunities | The downstream business opportunities, and especially those around recycling should be promoted. Citizen business opportunities, especially for the poor and informal sector, in scrap recovery should continue to be supported and funded. This is already supported by the industry, e.g. through the Aluminium Beneficiation Initiative (ABI), the Down Stream Aluminium Centre of Technology (DACT) and the Entrepreneurial Hub of South32 in Richards Bay. |
| Long term (2021 – 2030) | Markets and targets | The focus should be to accelerate the industry towards the future vision in servicing needs in all six market sectors. Measurable targets include doubling the direct employment in the industry (with the resultant positive impact on dependants and indirect employment in the formal downstream industry) and doubling the volume of aluminium used by the industry in downstream manufacturing stages, including recycling. The vision will be supported through growth through localisation, establishing additive and flexible manufacturing, optimising recycling and finally sustaining growth through exports. |
Process and acknowledgements

This roadmap for the South African aluminium industry has been initiated by the Department of Science and Technology and developed by the CSIR during 2016 and will be finalised in 2017. It is an industry level roadmap, intended to guide strategy and action in taking the aluminium industry into the future. The process for developing the roadmap was facilitated by TechnoScene (Pty) Ltd. Contributions have been received from a large spectrum of stakeholders in the aluminium industry. Special mention is to be made of the role the Aluminium Federation of South Africa (AFSA) played in assisting the process with data and context. The following companies and organisations made invaluable contributions:

Aerosud
AFSA (Aluminium Federation of South Africa)
AIDC (Automotive Industry Development Centre)
BMW
Business Development Coega
 Casting Services
CSIR – MSM (Materials Science and Manufacturing)
CSIR – NFTN (National Foundry Technology Network)
CSIR – NLC (National Laser Centre)
CSIR – TLIU (Technology Localisation Implementation Unit)
DST (Department of Science and Technology)
eNtsa – NMMU (Nelson Mandela Metropolitan University)

Hulamin
Isizinda Aluminium
MBSA (Mercedes Benz South Africa)
NAACAM (National Association of Automotive Component and Allied Manufacturers)
NAAMSA (National Association of Automobile Manufacturers of South Africa)
NECSA (Nuclear Energy Corporation of South Africa)
SAIF (South African Institute of Foundrymen)
South32
the dti
Toyota
Transnet
Wispeco
Zimalco

The roadmap development followed a path as shown in the schematic diagram. A visioning workshop was held with a Steering Committee appointed from industry, government and science councils. Future thinking processes were used to form a view of possible and preferred futures, and then envisaging how these futures will flow from the current realities. A customised industry roadmap model was developed, based on best practice, outlining market sub-sectors, final products, processes, knowledge, complements, dynamic capabilities, platforms and ecosystems. The roadmap content was derived from inputs during three expert workshops held in the provinces of Gauteng, KwaZulu-Natal and the Eastern Cape. From these detailed inputs sense making and analysis were done and a draft roadmap was synthesised. This draft roadmap was again tested with the Steering Committee and a group widely representative of the aluminium industry. Following these two interventions a final draft was tested through a review and consultation phase, and once all inputs were obtained, a project team meeting was held to decide on changes required. This updated document was submitted to the Steering Committee and discussed in a Steering Committee workshop, leading to this final roadmap document. In the first half of 2016, McKinsey & Company was commissioned by AFSA to develop a market overview and localisation strategy for the industry. Outcomes from this McKinsey & Company report were provided by AFSA and used as a basis and point of departure for the aluminium industry roadmap. Several detailed reports on the process were developed by TechnoScene and are in the possession of the CSIR. These reports capture process development, visioning and expert inputs and contain the detailed inputs from which the roadmap has been extracted. Best practice roadmap planning processes were followed to gain a wealth of content provided by the experts in the aluminium industry.
Steering Committee and Project Team

A Steering Committee was appointed for the roadmapping project. The members assisted in the guidance of the roadmap activities and in the visioning of where the South African aluminium industry should be in the future. Many of them attended Expert Workshop sessions and the draft roadmap discussion sessions. The assistance and commitment of the Steering Committee in positioning this roadmap are acknowledged.

<table>
<thead>
<tr>
<th>Person</th>
<th>Institution</th>
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<tbody>
<tr>
<td>Andries Uys</td>
<td>Aerosud</td>
</tr>
<tr>
<td>Colin Little</td>
<td>Hulamin</td>
</tr>
<tr>
<td>Dave Barry</td>
<td>Zimalco</td>
</tr>
<tr>
<td>Hermann Rolfes</td>
<td>Wispeco</td>
</tr>
<tr>
<td>Jasper Steyn</td>
<td>AIDC</td>
</tr>
<tr>
<td>Jeff Benson</td>
<td>CSIR</td>
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<tr>
<td>Johan Nel</td>
<td>Necsa</td>
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<tr>
<td>John Davies</td>
<td>SAIF</td>
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<tr>
<td>Kevin Morgan</td>
<td>South 32</td>
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<tr>
<td>Llanley Simpson</td>
<td>DST</td>
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<tr>
<td>Mark Krieg</td>
<td>AFSA</td>
</tr>
<tr>
<td>Muzi Manzi</td>
<td>the dti</td>
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<tr>
<td>Renai Moothilal</td>
<td>NAACAM</td>
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<tr>
<td>Robert Tshikhudo</td>
<td>CSIR</td>
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<tr>
<td>Sagren Govender</td>
<td>CSIR</td>
</tr>
<tr>
<td>Sizwe Khumalo</td>
<td>Isizinda</td>
</tr>
<tr>
<td>Wilna du Plessis</td>
<td>DST</td>
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</tbody>
</table>

The project team consisted of the following people:

<table>
<thead>
<tr>
<th>Person</th>
<th>Institution</th>
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</thead>
<tbody>
<tr>
<td>Sagren Govender</td>
<td>CSIR, Coordinator</td>
</tr>
<tr>
<td>Robert Tshikhudo</td>
<td>CSIR</td>
</tr>
<tr>
<td>Jeff Benson</td>
<td>CSIR</td>
</tr>
<tr>
<td>Neels Babst</td>
<td>CSIR, Project Manager</td>
</tr>
<tr>
<td>Llanley Simpson</td>
<td>DST</td>
</tr>
<tr>
<td>Wilna du Plessis</td>
<td>DST</td>
</tr>
<tr>
<td>Anthon Botha</td>
<td>TechnoScene, Facilitator</td>
</tr>
</tbody>
</table>
Why Aluminium?

Why should South Africa have an aluminium industry? The country has been involved in building its aluminium industry for over 70 years. Primary aluminium production began with the Bayside smelter being commissioned in Richards Bay in KwaZulu-Natal 45 years ago. The Hillside smelter came into operation in 1995. Based on these smelters, a diversified downstream industry has been developed along the value chain, with alumina imported, mainly from Australia, and local value added product castings, semi-fabricated product, final products and recycling. But a history of being in aluminium value chain production is not enough to warrant the continuation of such an industry in any country. The future of the industry depends on the new market requirements that are absorbing aluminium in a myriad of products, driven by the consumer revolution. The industry has the potential to create many jobs, significant foreign exchange earnings and especially as the goal of South Africa is to get to 6% GDP growth rate, a product such as aluminium that is shown to have a vast array of applications is needed for the future development of the economy.

Aluminium has been, is, and will always be the material of the future. In the context of the re-industrialisation of South Africa, it has a proud past and a key role to play in the future.

It has unique properties:

<table>
<thead>
<tr>
<th>Use it over and over</th>
<th>Light, yet strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is repeatedly recyclable without losing its properties, resulting in no immediate threat for depletion. Recycled aluminium also comes at a significant energy saving, when compared to producing the primary material.</td>
<td>Its lightness (⅓ the weight of steel) and strength, especially when alloyed with other materials, is making our automobiles, trucks, trains and aeroplanes lighter and more fuel efficient.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low maintenance</th>
<th>It is aesthetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is durable and corrosion free, as a result of a resilient oxide layer that forms on the material. This results in low maintenance.</td>
<td>Architecturally, aluminium allows for innovative designs and it is used as structural and cosmetic components in buildings, from skyscrapers to houses.</td>
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<tr>
<th>It can be worked</th>
<th>It is a good reflector</th>
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<tbody>
<tr>
<td>Malleable and easy to form and join, it provides a versatile material for many castings, extruded, rolled products and stamped components.</td>
<td>Both heat and light are reflected well from aluminium surfaces, making it attractive for lighting and heat shields.</td>
</tr>
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<tr>
<th>It is receptive to coatings</th>
<th>It is non-magnetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food, drinks, pharmaceuticals and cosmetics are packaged by choice in coated aluminium.</td>
<td>It protects against interference of magnetic fields.</td>
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<table>
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<tr>
<th>It’s a good conductor</th>
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<tbody>
<tr>
<td>It is an excellent conductor of heat and electricity and about half the weight of copper in conductors. Even though larger cross sections are required, pylon spacing increases, reducing cost and complexity.</td>
</tr>
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</table>
From the 115 Mt of alumina produced in 2015, 58 Mt of primary aluminium was produced, using 764 GWh of electricity. It is expected that the volume of primary aluminium produced in 2020 will increase to 97 Mt. 18 Mt of scrap was produced in 2015, a figure that is expected to increase to 31 Mt in 2020. It only takes 5% of the energy to remelt scrap compared to primary production. Of all the aluminium produced so far in the world, 75% is still in use. 60% of aluminium in use is recycled. The distribution of primary aluminium production in the world is shown below.

Aluminium is a commodity. The aluminium price is driven by a variety of factors. The London Metal Exchange (LME) sets the daily price based on many factors, but mainly supply and demand. (This has lately been skewed badly by investors buying contracts for future delivery allowing them to make a return if the Contango price is higher than the cost of storage and insurance. So while there has been oversupply, LME prices shot up as all the metal was bonded for future delivery). The role of Contango and backwardation in futures further determine the price. Supply and demand and stockpiling by countries also influence the commodity price.

Source:
3. The European aluminium Industry's Sustainability Roadmap to 2025
4. AFSA
South Africa has been in primary aluminium production for 45 years and in the secondary production for over 70 years. In 2015, 720 kt of primary aluminium was produced by the Hillside smelter. Semi-fabricated products of 289 kt was produced in 2015 of which 155 kt was locally used. The South African aluminium industry contribution to the GDP is 0.68%, but holds a large growth potential through enhanced uptake in many new products, with the automobile industry leading this growth. As the OEM industry follows global demands for aluminium-based products, it makes major investments, a dramatic increase in suppliers follows, providing scope for entrepreneurs who can service the industry, generating employment and contribution to GDP. South African aluminium products hold 1.5% share of all exports. The number of people employed directly in the aluminium industry (value chain up to semi-fabricated products) is 11 600. These people have 55 700 dependents, a ratio of 1:4.8. The number of people in indirect formal employment, that is in the sectors that fabricate final products using aluminium, is 28 900, a ratio of 1:2.5. In addition to the formal employment, a large number of people in the informal sector benefit from the aluminium industry, mainly as scrap collectors or waste pickers.
Future thinking on the aluminium industry in South Africa

**Drivers**
- High demand for socio-economic development and human well-being
- Policy for environmental protection and industry development
- Stabilisation of supporting ecosystems for energy supply, sustainable business development, environmental impact reduction and logistics
- Incorporation of new technologies and processes for exploiting the attractive physical properties of aluminium and related alloys

**Barriers**
- High cost of energy and labour
- Non-availability of skills and human capital
- Difficulty of access to markets, limited market size and narrow focus
- Varying dynamics of regulation in the scrap market
- Lack of import restrictions
- Ageing infrastructure

**Possibilities**
- Potential for social upliftment, sustainable and growing industry employment, and supporting sustainable communities
- New market opportunities and synergies between market segments
- A large contributor to the circular economy
- Potential for novel alloys, aluminium intensive products and generating and retaining intellectual property

**Emerging market behaviour**
- New consumer and customer dynamics
- Increased social instability
- Political uncertainty put new demands on decision making
- Increased environmental awareness and legislation
- Emergence of regional trade agreements
- Long-term impact of China
- Emerging African markets

**Emerging technologies**
- Fast advances in materials technology
- Shift to new process technologies
- Design intensive product technology
- Environmental demands dictate product design
- Substitute materials threat to aluminium
- Composite materials, where aluminium is one of the component materials

**Emerging events**
- Geopolitical: SADC stability; leadership change
- Economic: Downgrades; exchange rate fluctuation; trade relations; market access
- Natural: Climate change
- Social: Influx of foreigners
- Demographic: Generational spectrum
Possible futures for aluminium in South Africa

Five possible futures emerge from a scenario approach. The scenario axes are determined by the level of control the industry will have in future and the level of uncertainty. Utilising the technology-behaviour-events triangle on the previous page, the level of control is determined by how disruptive emerging technologies will be and how behaviour will be managed. The uncertainty lies in the events that may emerge.

Using a metaphor of a journey into the future, the environment where there is both control and certainty is equated to an *amazing race*. There will still be severe competition, but the experience in this future will be pleasant. Having control, but not being certain will lead to an *adventure* where new paths can be explored, but surprises may lurk in unknown events. Not being in control, but having certainty will lead to a *quest* to move forward and gain that control by managing the technologies and behaviours of the future. Being uncertain and not having control may lead to a lot of “random walk” and thus the reference to *Monte Carlo* that indicates the notion of gambling and hoping for “pot-luck”, or taking a chance that whatever is available will prove to be good or acceptable. Often ignored in futures planning is the wild card. This is a scenario that is highly unlikely, but should it happen, it will have a severe impact on the future. This may be the final *stumbling stone* for the industry. Any severe changes to the electricity supply agreements to the Hillside smelter could cause such a stumbling stone for the entire industry.

The South African aluminium industry is in control of its technologies and understands the behaviour of its people and markets. Certain major events, as identified above, may, however, increase uncertainty and lead to a continued “adventurous” future. Ideally, the preferred future is to enter the “amazing race”, but this presupposes that events are understood, risks are quantified and mitigation is introduced. The aluminium industry is, however, not alone responsible for mitigating these future risks. The vision will pull the industry into this preferred future.
A vision for the South African aluminium industry

Strategic visioning for the South African aluminium industry was done by first doing mind-time travel into the future. By considering emergent influences based on technology, the behaviour of people and events, a preferred future landscape was determined. The edge of disruption between the present and future was considered. By doing scenario analysis, multiple futures were determined. The vision for the South African aluminium industry is expressed by the statements in the red boxes.

The vision will now become the beacon for the roadmap which will inform strategy and policy to be adopted in the present through applying a back-casting approach. The industry is currently competitive and optimising its resources on a continuous basis. The current strategy is to grow capacity in the industry by increasing local consumption of aluminium. The industry strives to be energy-efficient, sustainable and environmentally friendly. However, to become globally competitive, and create significant employment with the resultant well-being for communities associated with it, a new aluminium industry should emerge. This will be driven by focusing on unique (niche) finished products and expanding the horizons to include regional and global export markets. In this way, the industry will grow to become a net exporter, through the path of import replacement and localisation and by entering the global supply chains through technology partnerships.

As the South African economy grows, and first world economy and GDP per capita increases, aluminium usage per capita will increase towards that of other first world countries, a substantial increase on the existing usage.
A materials flow model for the South African aluminium industry

A flow model indicating materials movement inside the aluminium industry, outside in the local market and in the regional and global exports markets, describes how the industry should transform to achieve the vision.

2016

Primary alumina is imported as feedstock for the Hillside smelter. Primary aluminium material in ingot form from the smelter is largely exported again, but also used locally downstream as feedstock for the semi-fabricators, cast houses, and by secondary smelters and foundries. Liquid metal is supplied directly to the Isizinda value added product cast-house in Richards Bay. At present only rolling slab is made in the cast-house. The local use of primary aluminium should be increased and less should be exported. New initiatives to increase the local production of value-added material through beneficiation as billet, redraw rod and rim alloy are required. This will also result in less value-added material being imported. Semi-fabricated products are also imported and these imports should be reduced as part of an import replacement directive. Some semi-fabricated products are exported. Less value-added products and semi-fabricated products should be imported. Likewise, less final products should be imported and more should be made locally, but this will depend on expansion of capabilities in the semi-fabricators and investment to remove production bottlenecks. This roadmap promotes the identification of niche markets for final products to achieve the vision of becoming a net exporter. The number of final products exported must increase dramatically. Recycling should increasingly be done locally. Scrap material is generated in the semi-fabrication, final product production and at the end-of-life of final products. A large percentage of end-
of-life scrap is exported. The recycling of scrap through secondary smelters and into semi-fabricated products must be drastically increased and scrap exports must be reduced. All exports must be reduced, save for the export of final products. All imports, but for the alumina, must be reduced. If debottlenecking and capability investments are not in place in the time frame of the roadmap, the imports of final products may be required to supply a fast-growing automotive industry.

These shifts are subsequently shown for the medium and long term time frames of the industry roadmap.
Material flow trends in the South African aluminium industry

Using the materials flow model, material flow trends over the full period of the roadmap are derived. Firstly, the local usage of aluminium is shown. This indicates a growth in local usage for all phases of the flow model according to the localisation and import replacement principle of the roadmap.

**Imports** show a decline based on the import replacement strategy that is suggested by the roadmap. The only possible growth of imports could be in final products. This scenario assumes a dramatic growth in the automotive sector needs for aluminium and the fact that additional local production capacity may not be available yet in the period spanned by the roadmap.

**Exports** in final products are to increase drastically as indicated by the vision and marginally in fabricated products. All other exports are to decline, since the materials are to be used locally for increased production.

The **recycling** trends show that the volume of scrap is expected to increase as a result of increased local production and final product usage. Imported scrap will remain controlled at low levels. Likewise, will exported scrap be reduced to utilise more locally for recycling. The recycling streams will grow as secondary smelters and semi-fabricated product foundries extend their recycling process capacity.
Responsible production of aluminium and related products in South Africa

Aluminium is a material that is in high demand and very popular because of its environmental friendliness. It reduces the carbon footprint of the transportation sector because of its high strength and lightweight properties. It reduces waste in packaging and redundant products because of its recyclability. It is used in renewable energy and water projects. It is a preferred material for its design friendliness. But the aluminium industry is also an energy and water consumer. As such, aluminium has to be produced responsibly.

Raw materials

Responsible sourcing from environmentally sensitive suppliers

Recyclability

Energy efficient Re-use of material

Emissions

Optimise greenhouse gas reduction strategies

Energy

Optimise processes and introduce energy-saving technologies. Utilise renewable energy where possible.

Water

Plan for scarcity and recycling

Waste

Minimize and treat hazardous waste in entire value chain, recycle where possible.
The South African aluminium industry and its people

An industry is as strong as its people are happy. The aluminium industry in South Africa is faced with similar societal and labour issues as the rest of the economy. It therefore has to continue doing the right and necessary things it is doing already, but also declare a human-centred approach, assure well-being for its people, by allowing them to earn a decent income, have access to services and develop a culture of being part of the aluminium community. Apart from creating jobs for communities in its proximity, the aluminium industry must also generate downstream possibilities for employment and business creation. Preferential outsourcing and procurement are mechanisms that will build such employment. Intervention in service delivery for its people and contribution to infrastructure and education are means by which the human support can be reinforced.

**Small business opportunity**
- Small business
- Opportunities along the aluminium value chain
- Outsourced services

**Employee wellbeing**
- Recognition
- Benefits
- Shareholding
- Work safety
- Health support and treatment
- Emotional & psychological support
- Stress reduction & management
- Motivation

**Infrastructure investment**
- Roads
- Schools
- Clinics & Hospitals
- Houses
- Community centres

**Housing**
- Loan schemes
- Architectural support
- Low cost housing

**Education**
- Bursaries
- Curricula input
- Career counselling
- Qualification standards
- Preferential appointment

**Community engagement**
- Information dissemination
- Social networks
- Sports events
- Cultural events

**Services**
- Water & sanitation
- Electricity
- Broadband connectivity
The roadmap addresses elements that shape the aluminium industry business space. Six market sectors were considered. Products and related services refer to the primary, value-added, semi-fabricated, fabricated and final products. A major emphasis of the roadmap is to identify final products that hold potential in the market sub-sectors. Final products may contain other materials in addition to aluminium in a hybrid system, e.g. an automobile. The industry makes use of a large spectrum of processes for making the primary, semi-fabricated, fabricated and finished products. The final element of this space is the body of knowledge that is required to sustain business. All four of these elements are supported by a foundation comprising complementary efforts, the ability to change factors of production dynamically, platforms that support business and ecosystems among which the aluminium industry co-exist and may cluster with. The roadmap is presented in terms of these elements.
Market sector sizes shown above are for 2014. The construction market leads in aluminium consumption. This was followed by the transportation market, 70% of which is automotive. Packaging applications of aluminium make up the third largest market. A category of “other” was defined in the roadmap, including medical, military, agriculture, manufacturing, and also providing for machinery and equipment in a variety of markets. This is followed by electrical applications of aluminium in the electrification of the country and in consumer goods or durables. The roadmap that follows is placed in context of these priority markets. Current emphasis is on the automotive sector, motivated by the accelerated take-up of aluminium in automobile production and the APDP (Automotive Production and Development Program) as a government incentive. This program is under review and a new support structure following its end in 2020 is expected. An expansion of the aerospace application of aluminium in South Africa is envisaged through a few aviation platforms that are under development, as well as ambitious targets by the national space strategy for satellite building and launch vehicle development. New urbanisation trends hold high potential for more aluminium uptake in smart and green buildings, and in conjunction with the expansion of interconnectivity through the Internet of Things (IoT), growth in construction and communication infrastructure is envisaged. The move towards using aluminium for packaging in food and beverages make the packaging final products an attractive niche to watch. Specialised equipment in mining, agricultural, military and medical applications will drive the “other” applications of aluminium. More electricity generation capacity being developed in the country leads to a need for transmission and distribution lines in the electricity grid with a resultant demand for aluminium cable. The use of aluminium in a variety of renewable energy structures and in large non-fossil fuel projects are potential growth points. Consumer goods have been part of the aluminium industry for a long time, with new niches spotted for off-road and adventure sports growth markets.
The road ahead...

Details of the roadmap that were extracted from visioning and expert workshops are presented in a roadmap visualisation.

Between now and the vision lies a winding road with many emerging opportunities and requirements for sustaining the industry. The roadmap highlights the present, then shows the medium term until 2020 and continues to the vision of 2030. Market sub-sectors for each of the six market sectors are identified and placed on the road ahead as signposts in the time brackets where they become important. A principle of the visualisation is that a market sub-sector that has started continues for the whole timeline. The fabricated/final products that will become the leading industry winners are highlighted on the time frame of the roadmap. Drivers for each time period based on emergent issues are shown in support of the market sub-sectors and the fabricated/final products in specific time zones.
Aluminium is prevalent in many construction applications in South Africa today. Market sub-sectors in construction include buildings, bridges and water and the use of aluminium is driven by durability and aesthetic considerations. In the medium term, the trend towards massive urbanisation and resultant smart cities will open new opportunities for aluminium in skyscrapers, prefab housing, green buildings and intelligent energy transmission. The massive housing challenge in South Africa is also an aspect of urbanisation that will drive aluminium usage, especially in lightweight prefab structures. These expansions in building structures will also require new innovations in communication infrastructure. As offshore gas resources are increasingly contributing to the energy mix in the long term, aluminium pipelines will become an opportunity for volume consumption. A continuation of the large variety of present products will be required, with expansion into some advanced products for the medium and long terms.
Several market sub-sectors where aluminium is utilised currently exist in transportation, with the largest being automotive. The current drive for aluminium volume increase in local manufacturing is mainly governed by the rapid increase in the uptake of aluminium in automotive parts such as body panels, castings and wheel rims. But to be a leading force in automotive markets, the South African aluminium industry should also look beyond the medium term. Along with massive urbanisation, requirements for mass transport will grow. Carbon emission reduction laws will drive the demand for lighter vehicles. Mass transportation will drive two market sub-sectors in parallel: larger vehicles, such as buses and trains that transport more people; and larger volumes of smaller electric vehicles. The advent of autonomous vehicles will cause a disruption in the automotive market, but open new opportunities for aluminium. Growth in regional air travel will dominate local markets for aviation. A potential disruptor in all transportation submarkets and their related products will be additive manufacturing. Advanced applications in transport will require new materials development, and especially in aerospace, new aluminium-based alloys, composites and powders may be required. Aerospace alloys are highly specialised and the industry has extremely high quality and traceability demands. To date volumes have been too low to justify setting up the required standards, procedures and quality system. Significant impact on the aluminium industry is expected should South Africa decide to invest in full drive train/gear box production by drawing international industry leaders to manufacture locally. Although disputed whether the OEMs will invest in a local flexible manufacturing engine plant, the roadmap suggests feasibility investigation in the medium term. The current high-tech developments in local airframes and armour plated vehicles will further create market pull in the transportation sector. Parallel development of road and rail freight also provides a major opportunity for increased aluminium uptake in this sector.
Aluminium in packaging markets

The use of aluminium in the packaging market is currently dominated by food and beverages and pharmaceuticals. A large variety of packaging products exists. Aviation use of rigid foil containers for pre-packed food is another large consumer of aluminium. Lightweight and hygienic concerns are the drivers. It is easy to apply a polymer barrier to aluminium to keep food and beverages hygienic. This barrier property is very important in reducing food spoilage. It is estimated that 40% of world food produced is lost to spoilage. Huge benefits to mankind lie in the reduction in wasted energy, reduction in GHG emissions, reduction in water usage, since food production is one of the largest usages, if food wastage is reduced. Aluminium has the potential to take significant market share from glass and PET in the beverage market. Durability and the barrier property of aluminium have been drivers and will remain so, but be complemented by heat transfer properties and ease of recycling.
A variety of market sub-sectors benefit from aluminium, many in the form of aluminium uptake in machinery and equipment. The structural design advantages that aluminium has, currently make it attractive for military, mining, agriculture, manufacturing and construction equipment market sub-sectors. In future, these requirements will continue, but the need for aluminium will be increased along with expansion of the 4th Industrial Revolution and its requirements for intelligent machines, and the advent of new advanced aluminium-based alloys and powders. Applications of aluminium in machinery and equipment will expand in ocean exploration and fishing, medical rehabilitation devices and support for the disabled, industrial inspection and aviation and space.
Volume expansion in aluminium cable replacing copper in transmission and distribution is a current reality. To localise this opportunity will, however, require the reopening of the redraw rod facility in the Isizinda cast-house in Richards Bay. This redraw rod is used for electrical wire and cable production. A variety of final products are used at present to service grid expansion from generation through to distribution. Significant volumes of aluminium are being used in support structures and module frames for photovoltaic (PV) cells. An expansion into renewable applications and local generation is foreseen in wind energy and energy storage where large scale batteries are a requirement for localised energy generation. In an energy market where the trend is to move into non-fossil fuel energy generation, opportunities exist for aluminium in hydropower, nuclear power, fuel cells and hydrogen storage.
Aluminium in consumer goods markets

Durability drives aluminium applications in the consumer goods market sub-sectors. Its designability makes it attractive for household goods and wearables. A variety of applications exist in the market that are contributing to a small, but steady demand for aluminium. In the medium term, increased use of aluminium in lighting is expected due to its visual appeal and reflective properties. Adventure tourism in South Africa is on the rise and gadgets used by these tourists represent an opportunity for future innovation. In the longer term, the Internet of Things will create opportunity for aluminium use in the integrated and automated home.
The processes that support semi-fabrication, fabrication and final product manufacturing are generic to most of the markets where aluminium is applied. Many of them are in place, but they have to be maintained and modernised on a constant basis. The present focus is on optimisation for localisation. As time progresses through the phases of the roadmap, scale-up for larger production volumes brought about by exports will have to be done. The aim in the long run should be to have an industry that is capable of world-class advanced manufacturing. It is assumed that mixed levels of technology will exist in the long term. Ultimately, the industry should ready itself to be a leading player and competitor in the 4\textsuperscript{th} Industrial Revolution. This implies incorporation of artificial intelligence, automation and creating new management realms where human-machine partnerships will be a requirement.
A significant body of knowledge exists locally and abroad that supports the aluminium industry. Tertiary education with a focus on engineering and metallurgy and artisanal skills development should be continued, scaled up and aligned with market developments. Specialised knowledge in numerical simulation, CAD, CAM and 3D modelling will be required. A strong materials and process R&D capacity in research councils and universities should be maintained and focused on market requirements and innovation opportunities along the roadmap. This applies in particular for those areas where the material flow has to be increased (refer to local use and exports in the materials flow model – arrows that grow thicker with time) to achieve the vision for the industry. Future knowledge requirements in the medium term will include industrial design, tool-making, additive manufacturing, recycling and creating harmony between industry and society. In the long term, knowledge on structural design, flexible manufacturing, robotics, intelligent machines and global competitiveness will be crucial to keep the industry on the leading edge. A very effective way of knowledge sharing and transfer is through the formation of partnerships or cooperation agreements, including research collaboration with leading laboratories in the world.
Complementary forces are recognised along the roadmap that will assist the aluminium industry on its journey towards global competitiveness. The current drive to include black industrialists as owners and business leaders in the industry, aligned with South African radical economic restructuring requirements, should be intensified. The quest for stable energy supply and cost should be continued to make the industry competitive. Driving energy efficiency is paramount and innovative energy technology upgrades may include localisation of electricity supply, utilising renewable energy. In the medium term, strong advocacy for the use of aluminium in a variety of markets will drive increased uptake in localisation initiatives and establish strong exports. Aluminium is one of many materials used in the application markets and finding solutions in hybrid materials, where aluminium is one of the components, will complement the efforts of expanding aluminium use. The home manufacturing industry that is emerging as a result of access to affordable 3D printers and materials will not only advance the use of aluminium, but also increase the awareness of aluminium as a “green” material and create preferences for the material in products. The more aluminium is used in products, especially automobiles, the larger the need will be for establishing an aluminium repairs capacity in the country. Smart cities, grids and buildings will open up new opportunities for aluminium use. The establishment of environmental awareness through legislation and individual demand will open up a recycling culture which will benefit the aluminium industry. South Africa as an advanced aerospace player, both in military and commercial airframes, and in supplying a regional air travel industry that is growing rapidly, will be very complementary to the success of the industry.
Business model agility and innovation is required to remain competitive. Businesses, and the industry as a whole, have to dynamically adapt according to market shifts and emergent opportunities and threats. Some of these dynamic capabilities are in place such as value chain integration and flexible decision making. In the medium term, as the roadmap unfolds, dynamic capabilities will have to be introduced in design for modularity, production scale-up, and supply chain agility. In the long run, competitiveness will depend on dynamically pacing the user revolution, using hybrid materials, doing complex project management, designing for additive manufacturing and recycling and initiating human/machine partnerships in the advent of the 4th Industrial Revolution.
Platforms that will support the industry

There are several external platforms that the industry can utilise to support it in reaching its vision. It is currently benefitting from the APDP, building codes and standards, duties and tariffs that apply upstream and downstream and from recycling and scrap policies and legislation. These need to be improved, optimised and applied appropriately in a constant lobby with responsible parties and authorities for these platforms. Component manufacturers and tooling developers benefit from NAACAM and AIS. In the medium term, success of the roadmap will depend on access to platforms such as long-term electricity supply; public relationship support; competitive input costs; combined OEM purchasing in all market sectors; preferential procurement from government and state-owned companies (SOCs); capital investment and foreign direct investment (FDI), including offset investment obligations; and aluminium theft reduction policies. Theft reduction will best be facilitated through formalising scrap collection, introducing community policing, developing responsible metal recyclers, scrutinising the origin of scrap and reducing the exportation of scrap aluminium. In the long term, a renewed APDP will be crucial to support the localisation and export drive in the automotive industry. This should be expanded to similar incentives in key market sectors that make use of aluminium. The National Development Plan (NDP) remains the national vision for 2030. The aluminium industry plays a vital part in the strategic development of the economy, and contributes a growing percentage to the GDP growth, thus making its contribution to realising the NDP. This roadmap also contributes to all facets of the fourteen outcomes of the NDP: education; health; safety; economy; skills; infrastructure; rural development; human settlements; local government; environment; international position; public services; social protection and nation building.
Working together with other ecosystems

No industry exists in isolation. There are several ecosystems that the aluminium industry is part of. Ecosystems that are currently supporting the aluminium industry include the OEMs, energy and water supply, standards and higher education. In rolling out the roadmap in the medium term, support from ecosystems such as supply chain development, security and environmental protection will be required. In the long term, ecosystems that include consumer preferences, the entire country moving towards an industrialisation era, finding a place in global manufacturing, establishing appropriate human/machine relationships and a culture of personal manufacturing will drive the success of the aluminium industry.
Interventions along the aluminium value chain

Specific interventions are required in the South African aluminium industry. These are superimposed on the aluminium value chain. It is necessary that the entire value chain should be supported for the success of the South African aluminium industry.

**Maintain imports of Alumina and production of primary aluminium**
The local Hillside smelter is of crucial importance to keep the industry competitive. The technology applied is stable for the future and material should enter the value chain in South Africa at the alumina stage.

**Secure electricity supply and maintain a leading-edge smelter**
To ensure the future of the industry and unleash the required investment in the other value-added product facilities, it is vital to secure a long-term electricity supply agreement for the primary smelter.
**Restart value-added production**
Locally produced primary material must continue to be supplied downstream in either solid or liquid form. To build a real competitive advantage in the industry, opportunities for innovation must be found around the supply of liquid aluminium, since this could be the real disruptor that will position the industry for future market leadership. This is to avoid keeping large inventory, laying out cash flow for order prepayment and to pay higher value-added prices for semi-fabricated product. It will result in a large competitive advantage for the semi-fabrication sector if the supply of liquid aluminium by the South32 smelter to the Isizinda cast-house can be increased and the reopening of mothballed parts of the Isizinda cast-house facility, such as extrusion billet, rim alloy and redraw rod can be done. The importation costs, working capital tied up and port delays will all be eliminated.

**Continuously upgrade and expand processing capability**
Existing semi-fabrication foundries should be continuously upgraded and modernised. Automotive Body Sheet (ABS) (currently imported) depends on an annealing line being installed. The recycling of scrap through secondary smelters can be drastically increased if quality scrap can be secured at competitive prices so that foundries can bid effectively, especially for castings for the automotive sector. New foundries will be required if companies can secure supply contracts with Tier 1 and/or Tier 2 companies in the global supply chain.

**Maintain and expand materials and process R&D**
To arrive at the competitive edge expressed in the vision for the industry, a strong R&D capacity is required for the development of new materials and processes. An own R&D capability is also important, since strategic alloys are not readily available in the market. This could lead to industrialisation that is not profit oriented, but establish strategic capabilities. Partnerships would play a very important role in R&D, and research institutions should be engaging with overseas research bodies to form alliances.

**Establish product innovation and design capacity**
The establishment of design capacity and product innovation capability is key to the success of the industry and can be located within existing business, university and CSIR resources on a co-ordinated basis as well as supported by a physical aluminium design centre.

**Introduce supplier development programmes**
Supplier development programs to support the expanding industry will be necessary. One example is the automotive industry with its urgent need for more fuel-efficient vehicles, light-weighting, and the many advantages of more aluminium intensive vehicles. The way to participate in this business is to enter the OEM global supply chain, probably as a supplier to a first or even second tier supplier. Entering the supply chain (e.g. automotive) will require a process that needs to start immediately if local manufacturers are to supply parts in 3 - 5 years.

**Adopt additive and flexible manufacturing**
A shift towards additive and flexible manufacturing may be critical for industry success. To introduce industry and small supplier firms to this, alignment with the existing RAPDASA (Rapid Product Development Association of South Africa) is advisable, as well as the establishment of a flexible scalable volume manufacturing platform and incubator (industry playground) where development, small scale production and scale-up can be tested for aluminium specifically. This would enable smaller suppliers to enter the supply chain with advanced offerings.
Feasibility studies:

i) Automotive drive train manufacturing capability
Enormous value addition to the automotive industry is possible if a local drive train manufacturing capability is initiated. The feasibility of this should be investigated.

ii) Flexible manufacturing engine plant
The feasibility of the introduction of a flexible manufacturing engine plant to be used by multiple OEMs should be investigated.

iii) Additional rolling mill
The long-term need for additional rolling mill capacity must be investigated.

iv) Continuous annealing plant
The feasibility of a continuous annealing plant must be investigated in the light of increased consumption of automotive body sheet.

Introduce policy and incentive support for local manufacturing
Local manufacturing leading to final products in all the market sectors should continue to be supported by policy and incentive programmes. The further development of the APDP (Automotive Production and Development Programme), localisation through a joint industry-government initiative such as the ASCCI (Automotive Supply Chain Competitiveness Initiative), the IPAP (Industrial Policy Action Plan) and the NDP (National Development Plan) should all recognise aluminium as an industrial material. The construction market is currently one of the largest aluminium market sectors and increasingly dominated by imports. Policy intervention is required to level the playing fields so that these volumes can be localised. Government intervention in the architectural and building market with requisite duties to level pricing playing fields and reversal of current large volume imports in this market will be beneficial to the industry.

Educate users and consumers on aluminium advantages
Education of consumers and advocacy of aluminium advantages are required for market development. The aim should be to align this education to achieve the target set for the more than doubling of local consumption of aluminium.

Develop citizen business opportunities
The downstream business opportunities, and especially those around recycling should be promoted. Citizen business opportunities, especially for the poor and informal sector, in scrap recovery should continue to be supported and funded. This is already supported by the industry, e.g. through the Aluninum Beneficiation Initiative (ABI), the Down Stream Aluminium Centre of Technology (DACT) and the Entrepreneurial Hub of South32 in Richards Bay.

Markets and targets
The focus should be to accelerate the industry towards the future vision in servicing needs in all six market sectors. Measurable targets include doubling the direct employment in the industry (with the resultant positive impact on dependants and indirect employment in the formal downstream industry) and doubling the volume of aluminium used by the industry in downstream manufacturing stages, including recycling. The vision will be supported through growth through localisation, establishing additive and flexible manufacturing, optimising recycling and finally sustaining growth through exports.
By the time of developing the 2016 South African Aluminium Industry Roadmap, imports of alumina were in place, electricity supply was secured under existing agreements, processing capability was being upgraded and expanded as required and targeted materials and processing R&D was being conducted. This should be continued over the phases of the roadmap. The roadmap should also serve as a platform for strategically planning R&D. It presents a platform where industry, the academic sector and government can get together in a continued conversation and align the R&D offering with the needs of industry, as well as making industry aware of new emerging technologies and processes. This forum should be created at the pre-competitive level where a long-term R&D strategy should guide the building of a body of knowledge and research infrastructure that will drive the industry forward. By embracing the vision and establishing this synergetic approach, South Africa can become the destination for the most advanced development of aluminium solutions. In the medium term, the interventions of restarting value-added production through expanding the product offering of the Isizinda cast-house fed by liquid primary metal from the Hillside smelter, including expanding the wheel rim production capacity (using liquid material); introduction of supplier development programs; feasibility studies for a local automotive drive train production capacity, a flexible engine manufacturing plant, an additional rolling mill and a continuous annealing facility for automotive body sheet; the establishment of co-ordinated product innovation and design facility; and contributing to policy incentive support for local manufacturing, including the development of the post 2020 APDP version should be undertaken. The establishment of a flexible high volume manufacturing demonstrator and incubator should also be done in this phase. This will allow for research level scale-up, demonstration of innovations and small business support. In setting up the supplier development programs, clusters should be identified, and the political, social and economic links to each should be established. In the long term, growth through localisation should be achieved, recycling should be optimised, additive and flexible manufacturing should be adopted where appropriate and exports of final products must be the core industry growth driver. Citizen business opportunities in, e.g. scrap collection for recycling, must be developed. This roadmap should be revised after the medium and long term periods. The South African aluminium industry should take ownership of this roadmap which will be a living document hosted by AFSA. A champion should be appointed to guide implementation. The industry should build strong relationships with labour, government and the tertiary education sector to realise the vision presented by this roadmap.
A conjunctural analysis\(^1\) depends on an appropriate set of concepts for moving from basic structural features to immediate strategic concerns; the spatio-temporal horizons of action that define the conjuncture; a clear account of medium and long term goals that should guide strategy and tactics in the current moment and the ethico-political commitments that set limits to acceptable action in particular contexts on the grounds that the end does not always justify the means. The conjunctural beneficiaries of the South African Aluminium Industry Roadmap are government, the higher education sector, industry, labour and communities. The dynamics of the South African socio-economic, political, environmental, labour, cultural and technological conjuncture need to be paramount in any industry. Considering the impact of this aluminium industry roadmap on business enterprises, the industry, people and the country as a whole and expecting outcomes that will be beneficial, the roadmap is designed to lead to profit for enterprises that will generate employment; industry growth that will result in market leadership; human well-being that will bring about social stability; and global competitiveness of the country that will attract investment, both locally and from foreign sources. The roadmap is thus not a strategy, but will lead to many strategies for the conjunctural beneficiaries.

\(^1\) Jessop, B., 2012, Left Strategy, Transform Network
Epilogue

The 2016 South African Aluminium Industry Roadmap provides a holistic view of the present and future environment for the industry, presents an ambitious, but attainable vision and motivates a series of interventions over the entire aluminium value chain to take control over the future and to influence desired outcomes. The industry will have to learn to think beyond current opportunities and successes in narrow market niches only and expand its capabilities and inherent strengths to address a broad market spectrum, shifting focus from survival to sustainability to leadership. The roadmap presents a route over the medium to long term, starting with a strong present base. Reducing the reliance on imported value added materials and products through adopting an import replacement approach in parallel with a bold export-driven orientation will be required. Increasing the volume of material to be processed in the local value chain is the first step. Adopting an innovative, design-based approach to final products for increasingly demanding export markets is essential. Arguments that final products are on the perimeter of the industry will have to be abandoned, a viewpoint should be adopted that they are multipliers and producers of these products will have to be drawn into the aluminium industry ecosystem. Regulation and policy-based fairness are essential for any industry to thrive in a competitive environment, providing level playing fields, and countering unfair pricing practices or dumping where applicable, but overemphasis of these and over reliance on government support should be avoided. The drive should be towards a position of leadership through optimising existing infrastructure and knowledge, innovative and rapid response to market needs, adopting modern fabrication technology and manufacturing philosophies, advocacy to influence market development and embracing new challenges brought about by the 4th Industrial Revolution. An industry is as strong as its people that work for it and its client base. Adopting a human-centred approach in all aspects of conducting business is essential. This holds for being a responsible producer and looking after its own people and their communities. Aluminium is an exciting material, with large market potential based on environmental awareness in the world and its potential for recycling and reduction in energy usage and carbon footprint. Modern manufacturing requirements may place stress on traditional job creation in the industry, but large potential exists in the industry for novel approaches to upskilling and reskilling. The potential for downstream business creation in both the formal and informal sectors is huge and could alleviate some of the socio-economic stress in the country. The aluminium industry, with its eye on the future and a preparedness for change and open thinking has the potential to absorb and reduce conjunctural conflict in the political, social, economic and environmental context. By implementing the aluminium industry roadmap, through creating strategies, feasibility studies, new structures and projects with excitement and dedication, the industry will become a preferred investment partner, employer, knowledge attractor, innovation space and world leader.