

# ALUMINA INDUSTRY TECHNOLOGY ROADMAP – AN UPDATE

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*A rationale, history and description of the process used to develop the Alumina Industry Technology Roadmap is presented. Key issues and outcomes are discussed.*

## Introduction

Business improvement can come from a combination of

- the application of scientific breakthroughs to a particular plant;
- business led improvement initiatives based on strategic choices, cost of production, economy of scale and technological change, and
- a focussed approach that harnesses the energies of industry, academia and governments through the application of research and development to a particular industry.

While considerable advancement has been achieved through the application of scientific breakthroughs, this approach is not always sufficient to achieve specific business goals within an industry as it is driven by academic interest rather than business imperatives.

Similarly, the approach of each business trying to manage improvement programs on a shoestring is not necessarily sufficient to remain competitive in the longer term. This is illustrated by the apparent gap in the aspirations of Chief Executives who are publicly stating aims for major operating cost reductions of up to 30 to 50% in 10 years and the organisation cohesiveness and work in progress that will underpin these changes. Most of “the low hanging fruit” has been picked. Indeed at present probably less than 50% of the operating cost of the process (caustic use, scaling, energy use etc) is being tackled seriously on a breakthrough basis. Few alumina companies have sufficient size, diversity or stability to be able to underpin major R&D programs needed to sustain major changes to the Bayer process.

It is now apparent that a sustained high level emphasis is required to be able to achieve cost reductions in the future at the rates required by Chief Executives.

Increasingly the science led and business led approaches must be complemented by a combined business and industry led approach, whereby business leaders define the strategic goals of their industry. With this vision in mind they then encourage others to work in collaboration so as to achieve these goals. This latter approach can be encouraged through the development of roadmaps for the industry, and in particular technology roadmaps.

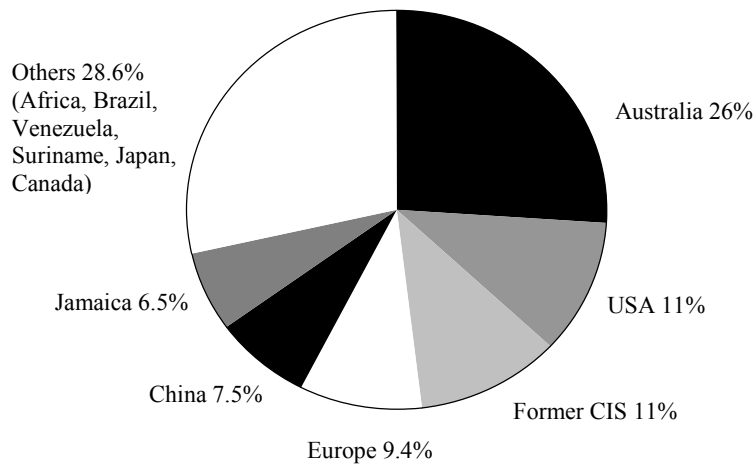
## What is a Technology Roadmap?

A technology roadmap is a strategic plan that contains a focussed, goal-based R&D agenda that can be pursued by both individual companies and collaborative partnerships within an industry, as well as help guide government and academic participation.

## Where has change come from and who are the leaders?

Over recent years it has become evident that the rate of advance within the alumina industry has been achieved through improved process stability and process chemistry, as well as building expansions with larger unit sizes of equipment. This has led to an increased plant output and economy of scale. In addition, there has been a focus on cost reduction involving input costs, including R&D, but sometimes with less than satisfying results as imposed system changes have not been capable.

Also over recent years the base of the alumina industry has shifted from Europe, USA and Japan to Australia.



% of alumina product by region

The six Australian plants produce 26% of world alumina, are characterised by being the largest plants in terms of size, and generally have the lowest cost of production.

The Australian plants are owned by the major producers including Alcoa, BHP-Billiton, Alcan, Pechiney, Comalco and Kaiser, all of whom have other global operations. In all cases the Australian plants are the largest single operations within each of these companies, but because of a variety of factor including location, history, academic and government support combined with joint venture arrangements the local management has not to date been able to lead aggressively from the front in the major step development of industry.

Clearly something is required to achieve a stepwise improvement.

In this context it is useful to look at what is happening in aluminium for part of the answer.

Since 1996 the US Department of Energy Office of Industrial Technology (DOE-OIT), working with the USA Aluminum Association Inc, (AA) acting on behalf of the US aluminium industry has been able to facilitate the introduction of major improvement programs through the development of a roadmap process, underpinned by direct support of programs that fit within this road map. Under this agreement, both industry and the DOE-OIT agreed to collaborate on industry led government supported, precompetitive research and development to increase energy efficiency and reduce costs in production of aluminium. This methodology has been successfully applied and is well documented in Ref 1, 2 and 3.

Four major roadmaps have been produced, including

- Aluminum Industry Technology Roadmap (May 1997)
- Inert Anode Roadmap (Feb 1998)
- Aluminum Industry Roadmap for the Automotive Market (May 1999)
- Technology Roadmap for Bauxite Residue Treatment and Utilisation (Feb 2000).

To date 35 cost-shared projects have been initiated with a total of 80 technology partners. Assuming all these projects run to completion, a total of some US\$72m will have been expended in the development of technology for the aluminium industry, approximately half of that being provided by industry with matching government funding. Further, the technology road maps have focussed government sponsored research efforts and helped to align the interests of all stakeholders.

Within the alumina industry technical leadership has been more fragmented. There is a loose arrangement of technical meetings including the yearly TMS Light Metals held in the USA and three yearly Alumina Quality Workshops held in Australia. In addition, since 1990 AMIRA International has played a facilitation role in working with the Australian alumina industry (and in recent years internationally) to identify research needs, gaps in the academic infrastructure and broker research projects that link the two.

While these developments have been successful it has become apparent that they are losing momentum and are not large enough to achieve the major changes required.

Fortunately the opportunity arose whereby the DOE-OIT recognised the value of assisting the alumina industry, particularly as the AA and US based alumina industry leaders supported the road map concept.

The DOE-OIT made a major contribution of US\$30,000 to underpin the development of a global alumina industry technology roadmap. This funding was matched by the Australian Government's Department of Industry, Science and Resources under the Energy Efficiency Best Practice Program and a similar sum provided by the industry participants in the workshop. The effort was supported by AA, the Australian Aluminium Council (AAC) and the Western Australian Government's Department of Resources Development. Industry and academic representatives also contributed by supplying time and meeting their own expenses.

AMIRA International, acting in a business development role for the alumina industry, patiently and persistently led the process leading to production of the present Alumina Industry Road Map over what will be a two year process.

## Methodology

While the end output document is important, so is the process used to develop the document so as to gain understanding and acceptance.

Early in the process it was decided to use the services of Energetics, Incorporated of Columbia, Maryland, USA (Energetics) as facilitators.

Energetics have worked closely with the DOE-OIT in the development of many of the previous roadmaps and have accumulated a good basis of how to go about the task using proven systems and facilitators. They also have enough experience not to need to become involved in any technical discussion or decision, but to throw back the issues to the industry representatives charged with its development.

Any such development is only as good as the contributors. Through AMIRA International a group of 40 leaders were identified from the global industry (including all major producers, and countries including Australia, USA, Italy, India, Norway, Canada, France, Holland), together with representatives from research, construction, industry association and government groups.

Prior to the workshop a set of Draft Strategic Goals was discussed and developed through a range of iterations. The present version is outlined in Exhibit I.

### Exhibit 1. Aluminium Industry Strategic Goals for 2020

#### The Commodity Challenge

Through the application of technology

- Reduce operating costs of existing plants by 3% per annum
- Reduce total energy consumption to 25% below current bauxite specific best practice levels
- Achieve capital costs of new plants US\$500/annual ton and telling with major expansion of half this cost achieved within a framework of a return on investment before tax of greater than 18%
- Contribute to improvement of overall performance on environment health and safety to world's best practice and consistent with global sustainable development principles.

This indicates the need to

- Increase yield by 20% above current bauxite, specific best practice
- Reduce DSP caustic consumption to 30kg/t Al<sub>2</sub>O<sub>3</sub> and other losses (excluding losses to product) in best practice
- Achieve a simple, capable process by significantly reducing process variability (3 sigma of <5%), through elimination of the effects of scaling and blockages, by more reliable equipment, better materials, process automation and advanced control
- Reduce total energy consumption by 25% below current bauxite specific best practice through improved methods of calcination, cogeneration and process improvements.
- Develop capable processes to achieve a significant reduction and recycling of all other inputs and outputs including water, odours, VOCs, mercury, oxalates etc
- Focus on opportunities with synergistic industries such as caustic soda and power generation
- Develop methods to achieve a 1,000 year ecologically sustainable storage of red mud and other solid wastes in existing storages, and make substantial progress in storage for later reuse as well as achieve substantial progress in the reuse of the red mud.

#### The Product Challenge

- Improve consistency of alumina with 3 sigma limits of less than half of the present levels with emphasis on dust particle toughness after dry scrubbing and impurities including sodium and silica
- Develop in conjunction with the aluminium industry sufficiently good delivery systems such that adequate dispersion is obtained at the cell, thus allowing the alumina to readily dissolve in conventional and modified reduction cells.

The intent was that these goals would be discussed and agreed between the industry representatives and both their Business Unit and CEO's to provide a unifying framework. Although in the end there was little disagreement in the goals, in some cases it did not appear that this discussion was adequate and an opportunity within the industry may have been missed. Nevertheless the goals provide a means of continuing to check the road map output, and further iterations, against strategic requirements.

The draft roadmap was developed over a two day workshop, held in Fremantle in May 2001.

Due to the experience and common interest of the participants and Energetics as facilitator this particular part of the process proved to be quick and effective.

The group was broken down into three subgroups based on registered interest in particular topics. These subgroups were led through a series of brainstorming, issue identification and ranking of priorities, with several reports back to the combined group.

Energetics collated all the responses on a series of coloured cards, overlaid with circles representing individual votes on priorities. These cards were then ordered and recombined, by shuffling using a pin board, into more logical groupings on the further input of the subgroups.

At the end of the process all three groups (and most individuals) reached broad agreement on the overall priorities and issues.

The meeting then set in place mechanisms and timetables for further review of the output.

#### **Output**

One output from the process is the Alumina Technology Roadmap publication. I commend it to you for your review and to use it to debate, steer and focus priorities as well as use it as a basis of communication with both your Business Unit Leader and CEO.

Much of the output was not a surprise to most of the participants. However, the process was a further step along an alignment path.

Nevertheless the process did highlight a number of serious deficiencies in the present industry approach, indicating that a steady as we go approach was unlikely to lead to achievement of the strategic goals.

From my perspective these included

- The industry is still fragmented and is not using benchmarking tools to obtain a reference standard or means of learning effectively from others. Examples include fundamental issues such as benchmarking scale formation and control within the alumina industry and learning from similar industries such as paint, kaolin, petrochemical, etc as well as learn from geological, polymer and earth sciences.

In addition, to achieve the strategic goals will require step changes which probably will need to come from outside the narrow confines of the present alumina industry and its supporting academic base.

These are areas where collaborative precompetitive projects developed by the industry through AMIRA International would be of considerable value.

- The alumina industry (and in Australia in particular) does not have a technology panel closely linked to the industry CEO's to draw together industry issues and provide leadership to resolve. Currently the industry is relying on others to provide this leadership, with the obvious deficiencies and consequences. This is an area where there are opportunities for the AAC to provide further leadership.
- The Roadmap exercise needs to be more closely linked with Australian Government action and support, in a manner to that adopted by the DOE-OIT. Adequate funding, focussed in areas compatible with the roadmap, can provide a unifying and strategic focus by which the Australian Government programs can make a difference to this one industry where Australia has the chance to dominate the world. The roadmap can act as the industry led vision and overcome the hit and miss approach that is evident in existing government programs.
- Attempts in the roadmap exercise were made to anticipate likely future alumina product requirements based on major changes to the smelting process, as well as explore more logical break points between calcined alumina production and use in the dry scrubbing process. Both areas are probably worthy of more intense future study.
- Few companies have a formal 5 to 7 year technology plan which identifies the strategic goals of the company, the part to be played by technology in achieving their goals, and a clear identification of the programs, funding and likely process rates that underlay the planned improvements. Until this is adopted as a formal planning tool management of continual improvement programs is likely to be disjointed and may not achieve the desired outcomes.

## Relationship of Other Initiatives

Currently within the mining and minerals industries there are a myriad of initiatives to address particular issues. These include initiatives based on social, political, image, sustainable development, purchasing costs, greenhouse gases, Health Safety and Environment, etc.

In some ways the Roadmap process complements the current DISR initiative based around the Light Metals Action Agenda and the AAC Industry of the Future Sustainable Development Action Agenda.

However, the Light Metal Action Agenda is necessarily broader, covering aluminium (and alumina?) titanium, magnesium and downstream and consequently lacks the specific focus, with emphasis on high level political and governmental economic issues such as investment, energy policy, greenhouse, downstream processing, market development etc.

The AAC Industry of the Future Sustainable Development Action Agenda for alumina is closely linked to issues addressed in the Alumina Industry Road Map. The opportunity exists, particularly with the leadership from alumina industry CEO's and the proposed Technology Panel to use the current roadmap as a stepping stone to achieve that agenda.

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- Ref. 1 J. Altdorfer, "DOE Follows Road Map to Al Technologies of the Future", JOM (Nov 2000)  
Ref. 2 H. S. Kinchington, J.L. Eisenhauer and J.A.S. Green, "Implementing the Aluminum Technology Road Map", Presented at the 127<sup>th</sup> TMS Annual Meeting, San Antonio, TX February, 1998.  
Ref. 3 H.S. Kinchington, J.L. Eisenhauer and J.A.S. Green, "A Technology Road Map for the US Aluminum Industry", JOM (August 1997)