Ash Development Association of Australia

COAL ASH matters

12 JUNE

THIS ISSUE - JUNE 12

Editorial:

2012, by all accounts, is proving to be a challenging year for many of our core industries of power, steel, construction and those sectors closely encumbered. Given a dynamically changing operating environment with policy pressures above the RET (renewable energy target) and domestic uncertainty caused by associated implications from the introduction of the carbon tax to increased government regulation on industry, our core industries face a number of challenges. It is key then for us to have an understanding of the success from the past to enable use to embrace new directions for innovation.

This edition outlines selected accomplishments of the Association since the last edition of Coal Ash Matters in late 2011, in particular, numerous technical publication revisions of various Association data sheets. We also welcome social media marketing to the Association with the introduction of a Twitter feed found on the Ash Development Association of Australia website.

In this edition the Ash Development Association of Australia announces the publication of a series of Technical Notes and Reference Data Sheets, as part of a series of nine reviews currently underway and due for completion at the end of 2012. Some of the existing documents are being reviewed and updated whilst other applications for coal combustion products have been identified as important and therefore reference materials were warranted. This publication has been created using the Association's collective industry experience and leading industry experts to provide guidance and advice to coal combustion product value adders, specifiers and users.

For this edition, we have included a full copy of the newly published Technical Note 11 (Use of Fly Ash to Achieve Enhanced Sustainability in Green Star) as an insert, to inform a wider audience of the benefits of using coal combustion products to enhance your sustainability objectives. As always, we welcome all feedback on any published information by the Ash Development Association of Australia, in continuing to maintain high technical standards.

The Ash Development Association of Australia has tentatively embraced the world of social media marketing with its newest edition of a Twitter feed to the Association website. The Twitter newsfeed appears on the left hand side of the home page and features regular industry updates. This news feed is especially convenient as it does not require membership with Twitter making it is accessible to anyone with internet access. We welcome your feedback. www.adaa.asn.au

Lastly, the Association will be attending and manning a display at CMIC 12 between September 19-22 www.iceaustralia.com/cmic12/. Our team is eager to meet with delegates to exchange ideas about how coal combustion products (CCPs) can support further industry developments. We look forward to reporting back to you on our experiences.

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Membership

COMPANY MEMBERS

A primary role of the ADAA is to bring together producers and marketers of coal combustion products (CCPs). Our activities cover research and development into CCP usage, advocacy and technical assistance to CCP producers and users, as well as a forum for the exchange and publication of CCP information.

For more information on the Association, visit us at **www.adaa.asn.au**

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- Alinta Energy Group Ltd
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RELATED ASSOCIATIONS

- CSIRO www.smit.csiro.au
- Association of Canadian Industries Recycling Coal Ash (CIRCA) www.circainfo.ca
- UK Quality Ash Association www.ukqaa.org.uk
- American Coal Ash Association www.acaa-usa.org
- World Wide Coal Combustion Products Network (WWCCPN) www.wwccpn.org

ADAA publishes new data sheets in 2012

The National Technical Committee embarked on a major review and update on the range of 40 Technical Notes (TN), Reference Data Sheets (RDS) and Case Studies (CS) during 2011. In September 2011, nine documents were identified to be reviewed and possibly amended by the end of 2012.

Using the Association's collective industry experience and leading industry experts to provide guidance and advice to coal combustion product value adders, specifiers and users, leading materials experts from EMS (Engineering Materials Solution) assisted the National Technical Committee with the review process. The nine documents for review with proposed titles include:

Reference	Title (Proposed)	Status
Reference Data Sheet 3	Controlled Low Strength Material in Road Construction	Final Review
Reference Data Sheet 5	Ultra High Fly Ash Pavement Construction	Published
Reference Data Sheet 6	Cost Effective Embankment Construction	Published
Reference Data Sheet 10 (New)	Roller Compacted Dams	Final Review
Reference Data Sheet 11 (New)	CCP for soil applications, horticultural and agricultural assessment	Final Review
Reference Data Sheet 12 (New)	Modified, Stabilised and Cemented Construction Materials Incorporating Coal Combustion Products	Final Review
Technical Note 11 (New)	Use of Fly Ash to Achieve Enhanced Sustainability in Green Star	Published
Technical Note 12 (New)	CO_2 benefits using CCPs	Drafting
Technical Note 13 (New)	Naturally Occurring Radionuclides in Australian Coal Combustion Products (NORM's)	Drafting

The above documents are a sample of those which have been developed in partnership with industry partners based on need, whereas others are reviews of previous published material requiring minor updates due to changes in the industry practices, codes etc. Selected new publications to be developed will address knowledge gaps around coal combustion products in Green Star projects, understanding carbon footprint reduction opportunities, classification criteria for Naturally Occuring Radioactive Material (NORM) and benefits for using coal combustion products in roller compacted dams. Each of which will be an excellent addition to the Association's technical literature.

Ash Development Association of Australia

USE OF FLY ASH TO ACHIEVE ENHANCED SUSTAINABILITY IN CONSTRUCTION

FLY ASH TECHNICAL NOTE NO. 11

2012

INTRODUCTION

Sustainability of our built environment has become one of the most promiment considerations in building design and construction. The definitions for sustainability itself take different forms and how sustainability may be rated is currently a developing science[1,2,3]. There are many rating systems that have been developed to measure environmental impact and drive sustainable development, one example being Green Star rating tools published by the Green Building Council of Australia (GBCA)[4].

This Technical Note has been produced by the Ash Development Association of Australia to provide guidance to architects, designers, engineers, contractors and infrastructure owners in understanding how best to use fly ash to achieve enhanced sustainability in construction.

The environmental impact of using concrete, the most commonly used construction material worldwide, is being debated along with its constituent materials in research and industry spheres. Fly ash, being a by-product of coal fired electricity generation prominent across Australia, has played a key role in this debate over the past 30 years and can potentially provide future solutions to problems faced in building and infrastructure projects when applied and used properly.

The use of fly ash as a supplementary cementitious material (SCM) in concrete is well recognised for its economic and performance advantages including improved workability, mix efficiency and durability[5,6,7]. Fly ash is also widely recognised, used and specified in standards covering SCMs[8] and General Purpose and Blended Cements[9]. More recently, the focus for the use of fly ash in concrete has shifted to quantifying benefits offered in enhancing concrete sustainability[10]. This Technical Note details the benefits fly ash can provide in producing sustainable concrete and how cement replacement with by products such as fly ash can directly contribute to sustainable development whilst maintaining other criteria including:-

- Engineering design aspects;
- Constructional aspects; and
- Economic advantages.

WHAT IS SUSTAINABLE DEVELOPMENT?

Sustainable development can be generally defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs[11]. It can be broken down into three components – environmental, economic and social[12,13]. Sustainability is said to be achieved when all three components are satisfied.

Concrete has a relatively low embodied energy when compared with other construction materials. It is a high quality, low cost material which is flexible, practical and durable and thus used extensively in construction. Used in such abundance worldwide,

its impact on sustainability when considered wholistically can be significant. There is currently significant debate regarding appropriate assessment criteria for measuring environmental impact in the use of concrete and component materials[14,15,16]. Key elements that could be considered to result in a more sustainable outcome when using concrete are:-

- Resource depletion,
- Emissions to air in the production of the material (or component materials (embodied energy),
- Water consumption, and
- Waste avoidance and reduction.

Fly ash has been proven to have a lower embodied energy compared with hydraulic cement as defined in AS3972[9,17,18]. Appropriate design and contruction considerations must be undertaken when using fly ash to exploit the lower embodied energy benefits and technical properties to achieve the required design and construction criteria. These issues are discussed in some detail in the Ash Development Association of Australia Technical Note 8[7].

GREEN STAR AND HOW TO ACHIEVE CREDITS

Green Star is a national, voluntary environmental rating system that evaluates the environmental design and construction of buildings[4]. It covers different categories that assess environmental impact, including the materials category which is further divided into different material credits. The concrete materials credit awards up to 3 points for the use of sustainable concrete[19]. The purpose of the credit is designed “to encourage and recognise the reduction in greenhouse gas emissions, resource use and waste impacts associated with the use of concrete”. The Mat-5 concrete credit was recently revised by the GBCA and with respect to cement replacement it awards 1 point where the cement content is reduced by 30% or 2 points where it is reduced by 40% for all concrete used in a project. Cement replacement with fly ash can therefore directly translate to Green Star credits if the use of fly ash results in this criteria being met. To evaluate reduction levels, Reference Case Portland cement contents for different strength grades are nominated in the credit[18].

THE BENEFITS OF USING FLY ASH FOR SUSTAINABLE CONCRETE

In the published technical literature some of the effective strategies to produce more sustainable concrete is to replace a portion of the cement component with one or more SCMs such as fly ash[7,12,16]. The benefits of the use of fly ash towards more sustainable construction materials include:-

- Reduction in CO_2 emissions and embodied energy;
- Reduction in resource use;
- Re-use of industrial by-products as alternative raw materials; and
- Sustainability achieved through efficient design and enhanced durability.

Reduction in CO_2 Emissions

The manufacture of Portland Cement is an energy intensive process that releases approximately 0.820 tonne of CO_2 emissions for each tonne of cement produced[16]. In a standard concrete mix, the cement component commonly accounts for approximately 70% to 80% of the embodied energy. Fly ash, being a by-product of coal fired electricity generation, has a relatively low embodied CO_2 content related to its manufacture, estimated at 0.027 kg of CO_2 emissions per tonne,[10,16,20] that is, 3% of Portland cement manufacture. In order to better illustrate the benefit of fly ash in CO_2 emission reduction, a comparison of CO_2 emissions for typical 25 MPa and 50 MPa concrete mixes with increasing proportions of fly ash are presented in Figures 1 and 2 repsectively (following references 17, 20 and 21). The results are also summarised in Table 1 to the right.

Reducing the cement content in concrete by incorporation of SCMs such as fly ash is arguably the most efficient and economical means of reducing CO_2 emissions and embodied energy in concrete. In doing this care is needed when undertaking this to ensure that other engineering design and constructional requirements are maintained as detailed in ADAA Technical Note 8 and other industry guides[6,7]. Other benefits of using fly ash, such as reducing water demand in concrete for particular workability requirements, can be factored in when using fly ash in concrete. For example recent research on post-tensioned slabs in buildings[21] and on pretensioned bridge girders[22] has shown that simple reduction of Portland cement in concrete does not necessarily result in lowering embodied energy of the structural element. The ADAA has published additional details in ADAA Reference Data Sheet 9[23]. Through efficient design, established structural and constructional performance criteria can be met along with achievement of reduced element embodied energy. Fly ash inclusions in the concrete enhance such solutions for structural, constructional and environmental benefit[20,21].

Typical Concret Mix Details	CO2 emissions (tCO_2-e/m^3)			
	GBCA Reference Case Portland Cement Mix	25% Fly Ash mix	30% Fly Ash mix	40% Fly Ash mix
Typical 25MPa mix	0.307	0.245	0.239	0.216
Reduction in CO_2 emissions for 25MPa mix compared to GBCA Reference Case (%)		19%	27%	38%
Typical 50MPa mix	0.496	0.385	0.365	0.324
Reduction in CO_2 emissions for 50MPa mix compared to GBCA Reference Case (%)		21%	32%	44%

Table 1: Summary of CO_2 emission reductions achievable with the use of Fly Ash.

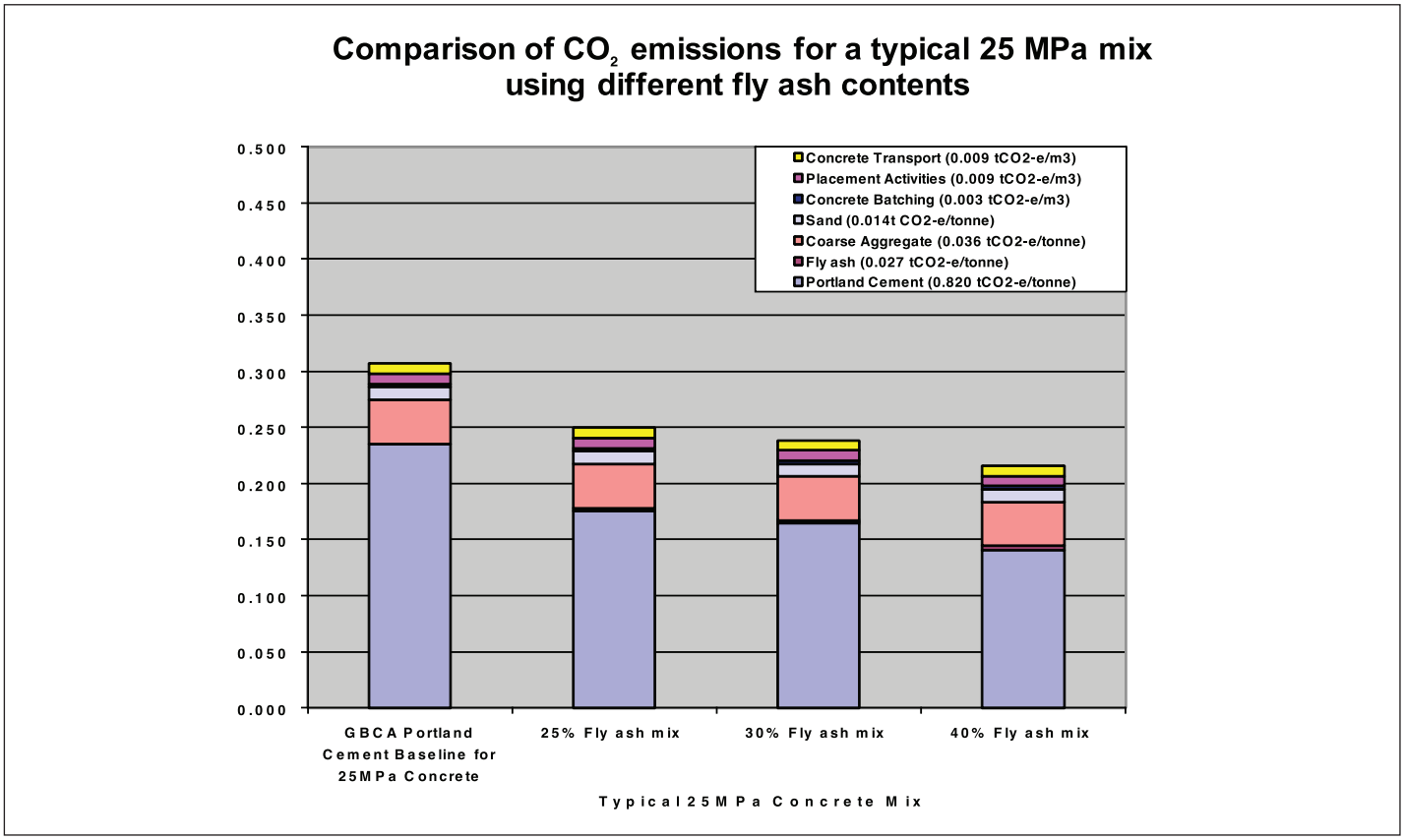

Figure 1 - Comparison of CO_2 Emissions for Typical 25 MPa Concretes With Varying Fly Ash Content (following references 17, 20 and 21)

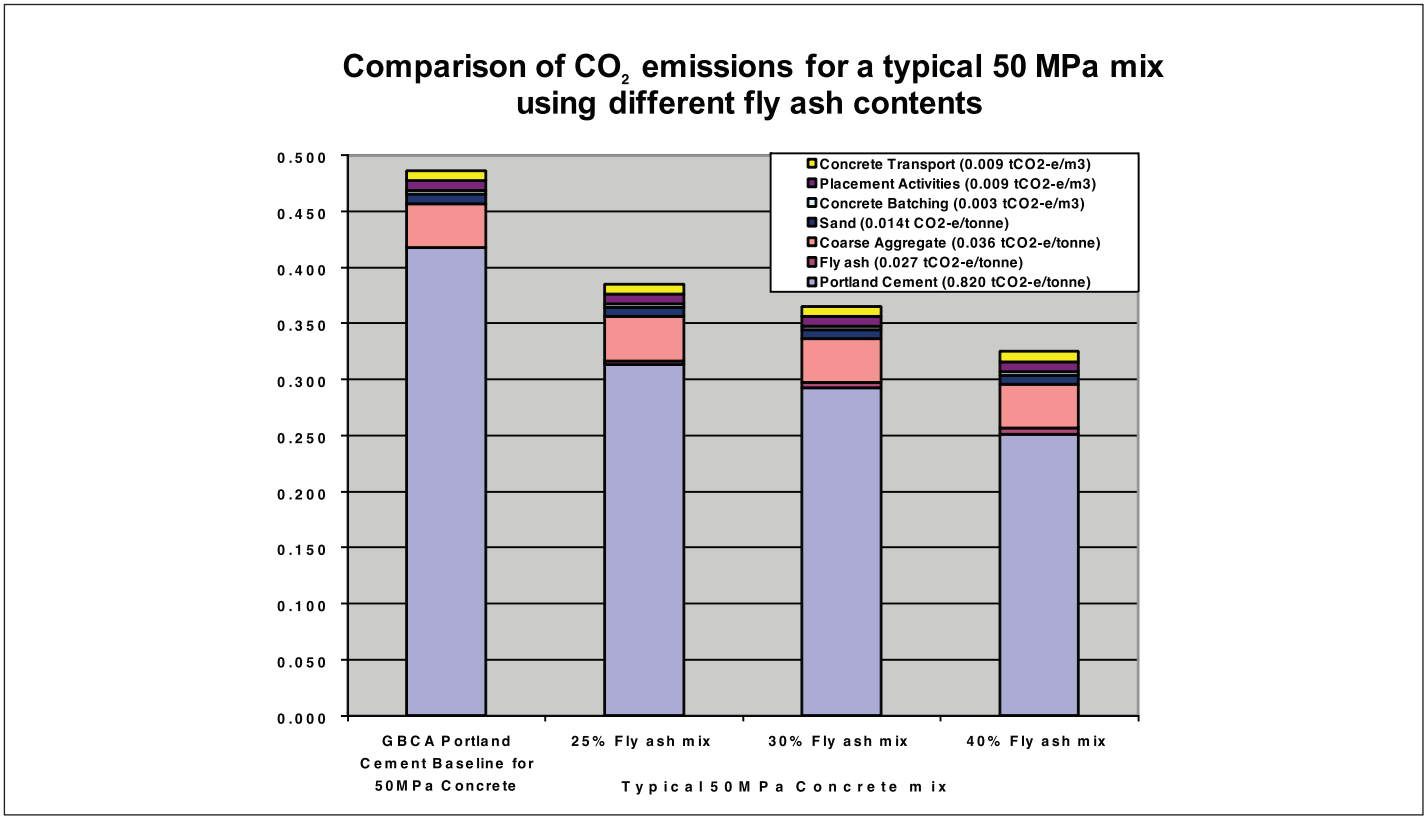

Figure 2 - Comparison of CO_2 Emissions for Typical 50 MPa Concretes With Varying Fly Ash Content (following references 17, 20 and 21)

By-Product Recovery and Reuse

In 2010, Australian coal fired power industry produced in excess of 14 million tonnes of coal combustion products, which includes fly ash, of which almost 1.9 million tonnes, or 14%, was used in concrete product manufacture[24]. Fly ash has great technical merit and is a valuable material with enormous potential for increased use in concrete. The reuse of fly ash and its diversion from long term storage ponds is highly economical as well as providing environmental and social benefits in line with the objective of concrete sustainability.

Reduction in Natural Resource Use

Cement production places a significant demand on our natural resources in terms of the processes involved in manufacture and inputs. It requires mining of natural raw materials including limestone, clay and shale as well as coal and gas for energy to drive the clinkering process. The use of fly ash as a partial cement replacement reduces the amount of cement required in concrete, this reducing this process in helping to preserve natural resources.

Durability and Service Life

The ability of fly ash to enhance the durability properties of concrete is well established[7]. More recently, the link between enhanced durability and sustainability has been explored[25]. Durable structures that are better designed to withstand chemical attack and physical stress have an increased service life and reduced need for maintenance. This maximises the return on the original capital as well as the natural resource use in the structure, translating into a higher level of sustainability measured over the life cycle of the concrete structure.

OPPORTUNITIES FOR THE USE OF FLY ASH IN SUSTAINABLE CONCRETE

The opportunities for using fly ash in the production of sustainable concrete are extensive and will continue to grow as concrete technology evolves, thus allowing the merits of fly ash to be commercially realised. With an understanding of the influences of fly ash on the early age and mechanical properties of concrete[7], it is possible to incorporate it in an appropriate proportion relevant to the design and construction requirements. Some applications and opportunities for fly ash are given below:

- Incorporation into Normal class concretes (defined in AS1379) where possible, to levels where minimum 7 day compressive strength requirements are achieved[26]. Typical proportions would be 15% to 25% for 20-32 MPa concrete and 25% to 35% for higher strength grades.
- Incorporation into Special class concretes[24] at a proportion where performance criteria can be achieved. This may vary from 15 to 30% for post-tensioned applications where early age criteria dominate, to values of 40% and over for applications where early strength is not required and acceptance age may be extended to 56 or 90 days.
- In the Green Star specification, achieving reductions in Portland cement contents in concrete relative to Reference Case levels in the concrete materials credit[4]. Specifically, reducing the Portland cement content by 30% to achieve 1 point or 40% cement reduction for 2 points.
- Up to 7.5% inclusion as a mineral addition in the manufacture of cement[27].
- As the main ingredient in alkali-activated cement, a technology based on using an alkaline solution to activate the polymerisation of fly ash (and/or slag) to produce an alternative to binders and concretes, one example being geopolymer based material. Much research is being undertaken in this area[28] and while products are not yet in common use, it is one technology that provides solutions for the future.

CONCLUSIONS

Fly ash can be crucial to achieving sustainable concrete. Fly ash when used appropriately can; reduce costs, cement contents and associated embodied CO_2 emissions, placing less demand on the use of natural resources when used in concrete. Its inclusion in concrete can also increase structure service life and reduce maintenance of concrete structures. These attributes are acknowledged by the GBCA using the Green Star rating tool where fly ash becomes a key strategy to reduce Portland cement levels in concrete by a defined 30% for 1 point and 40% for 2 points under the concrete materials credit.

While there is already awareness as to the benefits that fly ash can provide in the quest for sustainable concrete, given the volumes of fly ash being produced and technological advances in the concrete industry, much potential remains to further exploit its advantages. The challenge to achieve a sustainable concrete future will however require a paradigm shift by designers and builders from an accelerated construction schedule approach to a focus on increasing durability, service life and embodied energy, through the conservation of our natural resources using by-products where appropriate.

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CRC for Low Carbon Living

On the 22 November 2011 the Government announced funding of $28 million for the CRC for Low Carbon Living. Objectives for the CRCLCL are to bring together leading researchers and key end-users to develop new tools to reduce carbon emissions and transform the built environment to a low carbon future. The Ash Development Association of Australia being a foundational supporter of the CRC bid has committed to the seven year program.

The aim of the CRC is to provide the Government and industry with social, technological and policy tools to overcome identified market barriers preventing adoption of cost effective low carbon products and services, while maintaining industry competitiveness and improving quality of life.

The CRC includes three programs of research consistent with major industry recommendations:

1. Integrated Building Systems: This program will develop (i) low-carbon-lifecycle building construction components/ materials, and (ii) building-integrated multipurpose solar products. These outputs target next generation construction practice, where step-change emissions cuts are required. New design tools, rating frameworks and Australian Standards will underpin and stimulate the market for low carbon products and services. Design tools and a solar product will be commercialised in partnership with SMEs.
2. Low Carbon Precincts: This program will develop tools that enable the design of, and stimulate the market for, low carbon infrastructure at 'precinct' scale. This will facilitate property developers and local government partners providing low carbon infrastructure at the development planning point of delivery. An emphasis on research education and training in building information modeling (BIM), and extension to a new precinct scale (PIM) platform, will dramatically improve SME design productivity. Health and productivity co-benefits analysis will demonstrate the increased value and stimulate demand for low carbon precincts.
3. Engaged Communities: This program will focus on understanding and influencing behaviour and purchasing decisions. Policy scenario analysis will quantify the effectiveness of alternative options leading to policy adoption by government partners. New low carbon living strategies that mobilise cultural and social capitals will be demonstrated. CRC research findings will be fully road tested in 'living laboratories' to ensure that results are robust, tangible and appealing. Results will be used to develop community education and training resources including those for mass media dissemination.

Integrated building systems is the primary research program of interest to the Ash Development Association of Australia.

Since the announcement, the Association has been working closely with researchers and CRC managers, to develop possible projects and funding requirements to commence in July 2012.

Ash management at Huntly Power Station

Genesis Energy, operating the Huntly Power Station in New Zealand, is one of the Association's newest members profiled in this edition. The four original 250 MW units at Genesis Energy's Huntly Power Station are predominantly fuelled using coal. These Rankine-cycle turbines are capable of being dual-fuelled and intermittently use natural gas at various times. The four units operate in a hydro firming role with output generally determined by rainfall and hydro storage rather than base load generation, which is normally associated with a thermal plant. The amount of ash produced annually therefore tends to be variable around the 50,000 to 100,000 tonnes range. The ash content of the sub-bituminous coal used (mainly from nearby Waikato coalfields) is relatively low at about 8%.

From the coal-burning process, the fly ash that is not collected by a local cement company, and all furnace bottom ash, is mixed with water into a lean-phase slurry. This is sent via a pipeline to ash settling ponds 2km from the power station. In the summer of 2011/2012, approximately 150,000 tonnes of emplaced pond ash was excavated and trucked to remediate a nearby mine void. The beneficial use of coal combustion products in mine void remediation has been developing for several years, with the purpose-built pods at the coal mine void reaching capacity soon.

Recently, recovered coal combustion products for the pond have been transported to a large municipal landfill facility where it is presently being used for two important engineering applications. The primary application is as daily cover (capping layer) on top of the fresh waste, which saves the need to utilise onsite virgin clay materials for the daily cover purpose. The second application is as an engineered fill layer (base layer) on top of the landfill's basal lining system. Genesis Energy is continuing to investigate other sustainable re-use possibilities for the power station coal combustion products, including agricultural applications.

Huntly Power Station from above

New Twitter feed introduces ADAA to social media marketing

The Association has officially jumped on the social media bandwagon with its introduction of Twitter. Although the most common use of Twitter is to 'follow' other people and organisations of interest, in this case we have linked all of our 'tweets' to a newsfeed which streams directly to the ADAA website.

This unique approach enables anyone to view the Association's latest postings with or without an account. We would also like to encourage member organisations with a twitter account to follow us, and exchange information to ensure we stay abreast of industry news.

Twitter is also useful for more than simple news consumption. When used properly, Twitter is a powerful marketing tool for companies to keep potential and existing customers up to date on products and offers and to maintain general public relations. It has grown from more than just a messaging or status updating service and has the potential to vastly spread the effective reuse of iron and steel slags beyond its current market utilisation levels.

The Association is excited to embrace this step forward in the social media marketing world and the possibilities it can bring.

New Twitter feed available on the ADAA website

WWCCPN launches a refreshed website

Globally, it is currently estimated that more than 750 million tonnes of coal combustion products are produced annually. Coal fired power stations operating across the globe are subject to an array of varied operating environments and government policies. World Wide Coal Combustion Products Network (WWCCPN) was formed to strengthen international collaboration between respective country industry associations, being non-governmental organisations (NGO's), to inform the public, industry and governmental entities about the beneficial environmental, technical and commercial uses of Coal Ash, or more appropriately, coal combustion products (CCPs).

The network operates on a cooperative industry response basis, facilitating the collection and dissemination of industry information. The overarching aim of the network is to support member's aims to increase the awareness of the benefits arising from CCP utilisation for the environment, industry, world economies and the development of enhanced sustainability through resource recovery and conservation.

The activities of the WWCCPN are consensus driven and in April the network submitted a proposal to the World Custom Organization's Harmonized System Committee (HSC) to amend the Harmonized System in respect of Coal Ash. In summary the proposal seeks an amendment to incorporate a dedicated subheading to clearly distinguish Coal Ash from other products listed under the current subheadings under heading 26.21.

For any proposal to be considered by the HSC the value of annual global trade in Coal Ash must be more than USD $50 million. Based on trade data provided by contributing WWCCPN members, global trade of Coal Ash, equates to more than USD $101 million annually, with the long-term trend in trade and value increasing.

For further information and international data please visit www.wwccpn.org

WWCCPN launches its new and improved website

CMIC 2012

The Construction Materials Industry Conference 2012 (CMIC12) is quickly becoming the leading biennial construction materials conference in Australia. Following the successful outcomes of the 2010 conference, the Association will be again attending the conference and working with all that CMI has to offer. The theme of this year's conference is 'Essential Industry for Australia's Future'.

Delegates to CMIC12 will enjoy an insightful business program balanced by the opportunity to create and renew friendships at a number of entertaining social occasions. CMIC12 promises to expand on the successes of CMIC 10 and showcase not only the construction materials industry, but also enable delegates to network whilst enjoying the warm hospitality that the city of Melbourne and its people have to offer.

This year's conference will be held at the Melbourne Convention and Exhibition Centre, from **19- 22 September 2012.**

The ADAA looks forward to attending CMIC 12

EUROCOALASH

2012 Conference Thessaloniki, Greece
September 25-27, 2012

EUROCOAL**ASH** is an International Conference devoted to Coal Combustion Products (CCP's) and their exploitation with technical, economic and environmental benefits. The Conference will be organized every two years in another European country to meet the different CCP and market situations. By this, the focus of the Conference is subject to change in respect of the CCP market environments in that country/area.

The **EURO**COAL**ASH** 2012 will be held in Thessaloniki and will highlight the advantages of CCP's in the Construction Industry as well as encourage the utilization of CCP's as raw materials for the production of added value products. The Conference will focus on the transfer of research into practice and will enhance the development of CCP markets contributing to the economy and sustainability of constructions.

EUROCOAL**ASH** Conference target group:

- Producers, suppliers and marketers of building materials
- Construction industry stake holders
- Governmental officials
- Representatives of international and EU authorities
- Investors in innovative products
- Researchers and Academic members
- Students of Engineering faculties

Conference Website: **www.eurocoalash.org**

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