Davis Langdon
An AECOM Company

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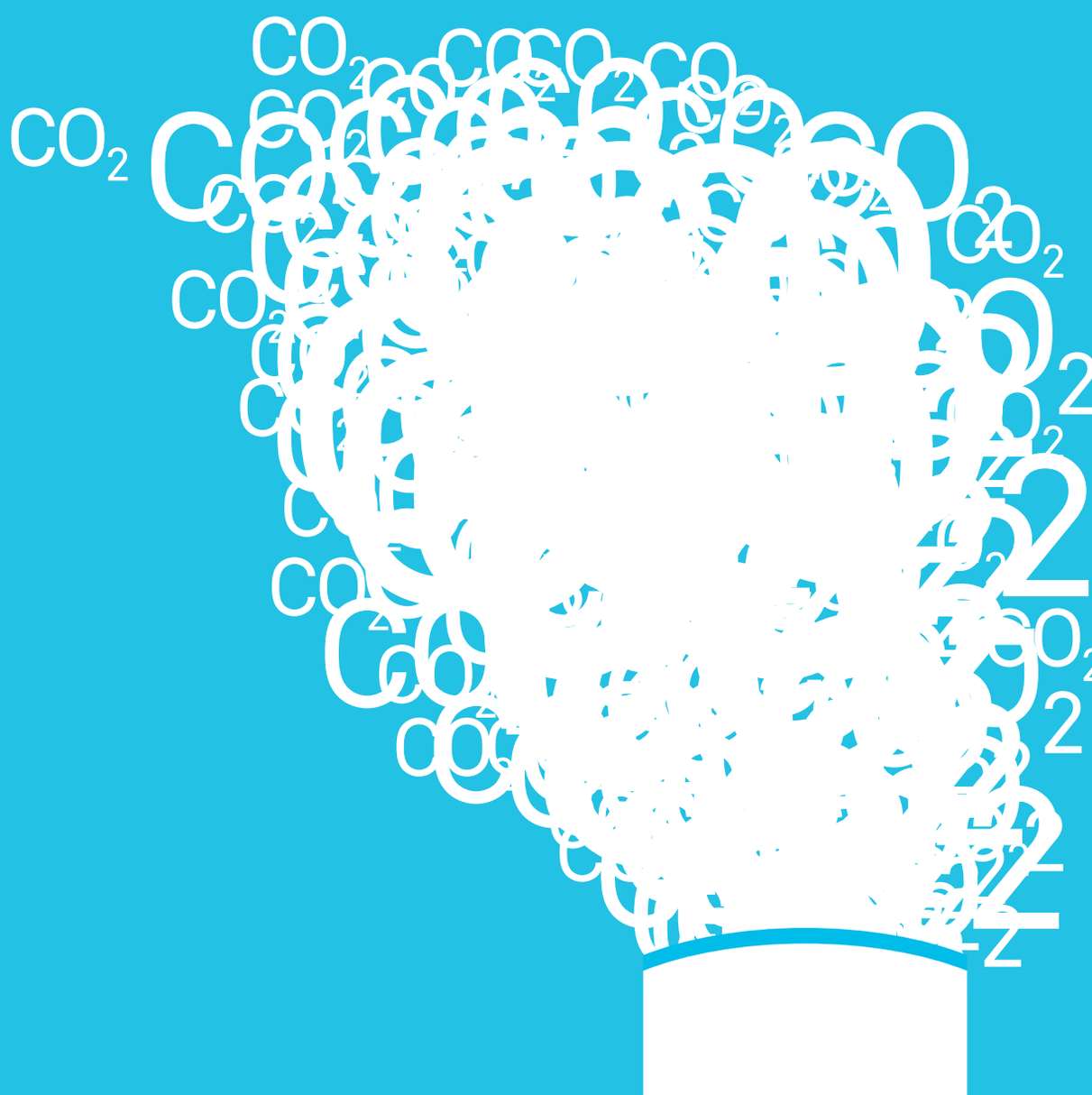
# Carbon Price on Construction Costs



# A detailed assessment on the impact on construction projects of the Australian Federal Government's proposed carbon price.

## Key Findings

In this report Davis Langdon, an AECOM company, reveals the findings of a detailed assessment on the impact on construction projects of the Australian Federal Government's proposed carbon price. The process used in generating this cost research can be applied to any form of construction including buildings and infrastructure projects to optimise material sourcing and selection.

The analysis reveals that the impact on the base supply cost of materials with high embodied carbon values, such as concrete and steel could be as high as 5 percent and 2 percent respectively without factoring in industry assistance for domestically refined and manufactured materials based on a starting price of $23 per tonne $CO_2$-e.

However, given the presumed extent of industry assistance the impact reduces to less than 0.5 percent on the individual material costs of these high carbon intensive materials.

When the cost impact associated with all high carbon intensive materials is translated to overall build cost (excluding design and consultant fees), the proportional impact is far less. The dilution of this cost through the construction supply chain results in a negligible cost impact during the earlier phases of the industry assistance period. However, when industry assistance is completely removed the total cost impact is approximately 0.5 percent. This would indicate that despite many observations to the contrary, the opportunities exceed the cost implications for the property and construction industry.

Given that the overall cost impact to the construction industry is extremely low, will this scheme provide sufficient incentive for alternative designs and materials selection?

This report is based on available information regarding the proposed scheme at the time of publishing. In some instances logical and researched decisions have been used in lieu of a completed policy. In the lead up to the start of the proposed scheme on the 1 July 2012, Davis Langdon will continue to review the impact of any significant changes to the proposed scheme.

## “...the property sector’s energy use represents 23 percent of the nation’s emissions...”

### Background

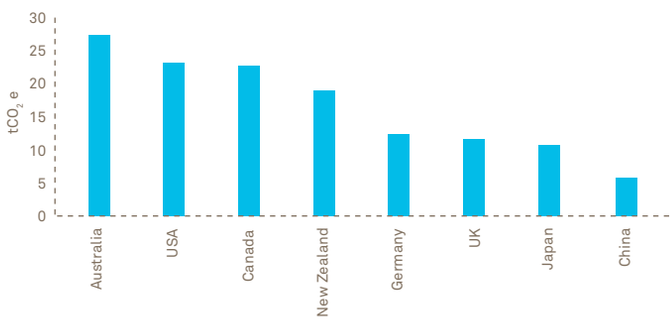
On 10 July 2011, the Federal Government released its ‘Clean Energy Future Plan’. A key element of this plan is the introduction of a carbon price starting at $23 per tonne on 1 July 2012. Businesses will either purchase or be allocated permits and will then be required to surrender a certain number of permits each year to fulfil their emissions obligations.

A fixed carbon price will remain in place for three years (indexed annually at 2.5 percent in real terms) and then on 1 July 2015, the price will be determined by a market based mechanism under a cap-and-trade emissions trading system to respond to pollution caps imposed by the government. A new independent Climate Change Authority will be established to advise the Government on the annual scheme caps, which will be set on a five-year rolling basis.

This plan is central to the government’s 2020 emissions target of at least 5 percent below 2000 levels. The 2050 emissions target has also been increased from 60 percent to 80 percent below 2000 levels in an effort to reduce Australia’s leadership status in per capita emissions.

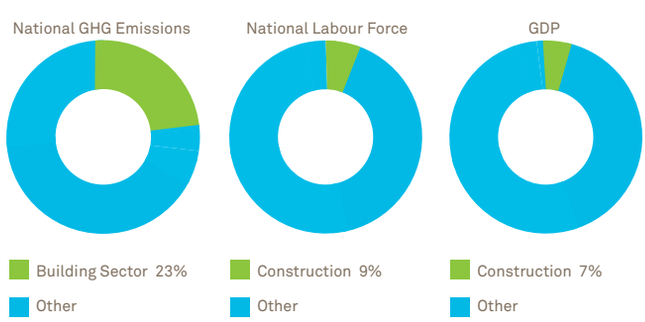
Given that the property sector’s energy use represents 23 percent of the nation’s emissions, new schemes targeted toward reducing demand should be considered as complementary to the carbon price. Investment in energy efficiency would not only reduce emissions but also support jobs within the construction sector which represents 9 percent of the national labour force. Investment in reducing the demand-side factors is also required in order to support the construction industry’s contribution to the national gross domestic product.

Emission Per Capita from Selected Nations




Source: UNFCCC

Property and Construction Influence on Australia




Source: ABS, Centre for International Economics, Davis Langdon Research

## “Investment in reducing the demand-side factors is also required”

## Application of the Carbon Price

The carbon price will apply to around 500 entities in a limited number of sectors that generate carbon pollution from the following processes:

– Stationary energy - emissions are produced from electricity generation and on-site energy supply

– Fugitive emissions - emissions released during the production, processing, transport, storage and distribution of coal, oil and gas

– Industrial processes - emissions from chemical reactions associated with manufacturing processes

– Waste - emissions predominantly from solid waste sent to landfill and from the treatment of domestic, commercial and industrial wastewater

These sectors cover around 60 percent of Australia's emissions.

Domestic marine, rail and aviation transport fuels will also be subject to a carbon price. However, these fuels will not be covered directly by the carbon pricing system but will still be subject to the carbon price through increases in fuel excises on aviation fuels and reductions in fuel tax credits on other fuels.

However, fuel used for transport by households and light on-road commercial vehicles will be excluded from the system. Other areas not covered by the carbon pricing system include: agricultural, land sector and biofuel related emissions; fuel used in the agricultural, forestry, fishery and international aviation industries; emissions from decommissioned coal mines and emissions from waste deposited prior to 1 July 2012.

The government has also outlined several forms of industry assistance for emissions-intensive, trade-exposed (EITE) industries. Although these entities have not been fully disclosed, they will likely include steel, aluminium, glass and cement industries. Most of these industries will receive free permit assistance covering 94.5 percent of their obligation. Alternatively EITE industries deemed as less impacted by a price on carbon will receive free permits covering 66 percent on their carbon cost obligations (both reduced by 1.3 percent per annum over the scheme)

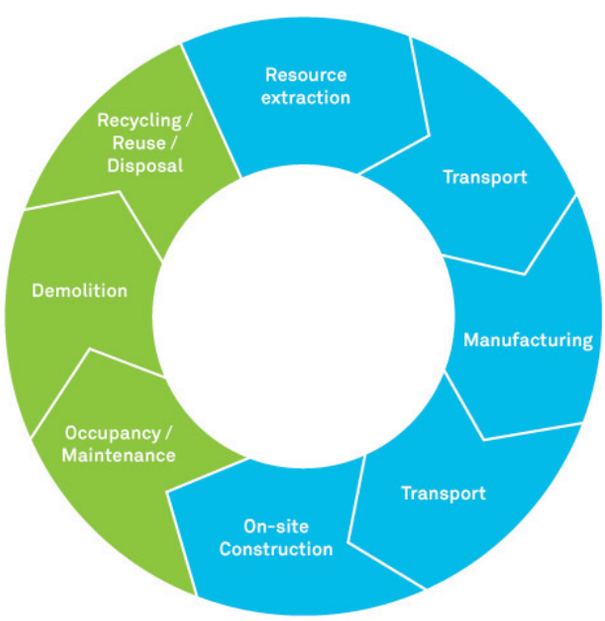
Other industries of key concern to the construction industry, including bricks, tiles, plasterboard and insulation have not currently been indentified as receiving any permit assistance under the proposed scheme.

## Measuring the Impact of the Carbon Price on Construction

In this briefing, Davis Langdon focuses on the key impacts of the carbon pricing scheme on construction costs. Using the purpose-built Davis Langdon Embodied Carbon Metric (ECM), a more detailed understanding of how individual building materials contribute to the emissions associated with a project can be achieved.

The ECM measures the carbon intensity of building materials. It is based on emission factors specific to Australia, derived from a life cycle, cradle to site approach for all materials used in construction of buildings and infrastructure. This includes emissions from the extraction of raw materials, primary energy sources, manufacturing and transport.

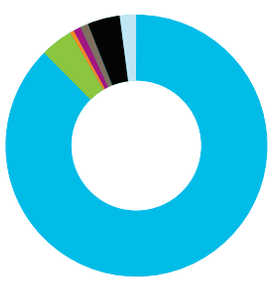
The ECM calculates greenhouse gas emissions based on the quantity of materials from the cost estimate process for a proposed development.




As can be seen in the carbon contribution by material chart below, concrete, steel, aluminium and glass are some of the most prominent carbon intensive materials in construction, representing 93 percent of the overall embodied carbon.

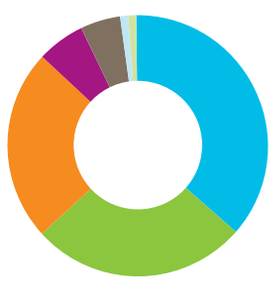
The details and coverage of the scheme are also important to consider – such as the impact of industry assistance to EITE industries. Another significant consideration is the level of imported materials used by the construction industry in Australia. This enables a clearer picture of how much cost variation can be linked back to local supply chain factors that will be affected by the carbon price.

Material Input by Weight



- Concrete - 88%
- Steel - 4%
- Aluminium - 0.4%
- Tiles - 1%
- Glass - 1%
- Gravel and Sand - 4%
- Other - 2%

Carbon Contribution by Material



- Concrete - 37%
- Steel - 27%
- Aluminium - 24%
- Other - 6%
- Glass - 5%
- Tiles - 1%
- Gravel and Sand - 1%


Inputs
- Emission factors for key materials (Including raw materials, fabrication, transport, installation)

- Location specific anywhere in Australia

* Customised for the Australian construction market by Davis Langdon, an AECOM company

Inputs
- Cost estimate data: Obtain quantities, volumes and areas of materials

- Apply carbon conversation factors

- Assess associated material impact (eg: aluminium window frames, steel stud framing)

## Carbon Price Cost Escalation

A detailed assessment on the impact of the carbon price has been conducted for two scenarios:

1. Lowest cost impact scenario - Carbon price with assistance to EITE industries
2. Highest cost impact scenario - Carbon price without industry assistance

Key materials associated with the construction industry including steel, aluminium and glass will likely receive the highest exemption of 94.5 percent (in the first year and reducing by 1.3 percent per annum) from the carbon price, thereby having a minimal impact on commercial construction prices. Although still under negotiation, cement is also expected to receive between 66 percent and 94.5 percent industry assistance to shield it from the full carbon price, with the likely result closer to the upper end of the potential benefits.

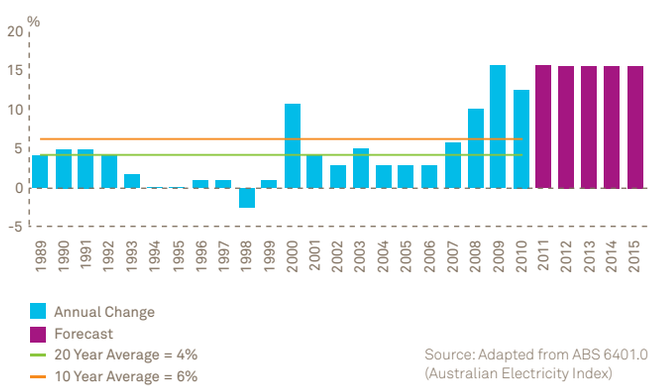
However, upstream costs associated with increases to the cost of electricity will likely be passed on. This is anticipated to be approximately a 10 percent increase per MW/h. Relative to recent electricity price trends the projection does not exceed original estimates, given the level of investment associated with upgrading ageing infrastructure in recent years.

This study examines the embodied carbon from material extraction to on-site delivery to determine the impact of a price on carbon for four construction sectors.

The impact of the carbon price when including the full benefits of the EITE industry assistance period is negligible for Health, Office, Industrial and High-Rise Residential projects with an overall cost impact of no greater than 0.02 percent. However, costs imposed by suppliers beyond the direct impact of the carbon price for additional overheads including factory upgrades are not included and should not be passed on as additional cost associated with the carbon price.

In order to assess the full potential cost impact of the carbon price, analysis has also shown that a carbon price of $23 per tonne would have a direct cost impact of less than 0.5 percent on construction projects.

Annual Retail Electricity Price Escalation - National Average




Source: Adapted from ABS 6401.0 (Australian Electricity Index)

Indicative Carbon Price Impact on Total Construction Costs by Sector

| | Area | Carbon Price with Assistance to EITE Industries | Carbon Price without Assistance to EITE Industries |
|---|---|---|---|
| Health | 15,000m² | 0.01% | 0.27% |
| Office | 60,000m² | 0.02% | 0.31% |
| Industrial | 7,000m² | 0.02% | 0.32% |
| High Rise Residential | 35,000m² | 0.02% | 0.42% |

Source: Davis Langdon Research

# “During the early phases of the scheme...the cost impact on suppliers, contractors and developers is negligible”

## Carbon Price Cost Escalation cont’d

The carbon intensity of key construction materials relative to their cost by weight varies significantly. Therefore the impact of the carbon price on construction materials varies depending on the design and building use. Relative to the total build cost, office buildings rely more heavily on concrete than high-rise residential projects mainly due to the shell and core design and minimal internal walls and fittings which contribute higher quantities of aluminium and glass (including insulation).

However, when this impact is put in the full context of total build costs, the proportional impact is far less. This is evident in the analysis which shows the cost dilution along the supply chain for the most carbon intensive materials used in a typical office building.

Excluding the industry assistance package the cost impact on material suppliers for concrete is calculated to be 4.1 percent, however, once the labour costs are considered the cost impact to contractors is diluted to 2.5 percent and then further diluted to less than 0.2 percent impact on total costs to a developer.

During the early phases of the scheme when EITE industry assistance is significant, the cost impact on suppliers, contractors and developers is negligible. This period of price stability will allow manufacturers and industry to adapt processes, material selection and design for the future without a significant impact on the bottom line and should not impact on investment decisions.

Indicative Carbon Price Impact on Material Costs by Sector (excluding EITE industry assistance) based on year one of scheme

| | Concrete | Steel | Aluminium | Glass | Plasterboard |
|---|---|---|---|---|---|
| Health | 3.3% | 1.4% | 1.7% | 0.2% | 0.2% |
| Office | 4.1% | 2.0% | 1.1% | 0.2% | 0.3% |
| Industrial | 2.4% | 1.8% | 4.9% | 0.5% | 0.2% |
| High Rise Residential | 3.0% | 1.1% | 4.3% | 0.3% | 0.3% |
| Average | 3.2% | 1.6% | 3.0% | 0.3% | 0.2% |

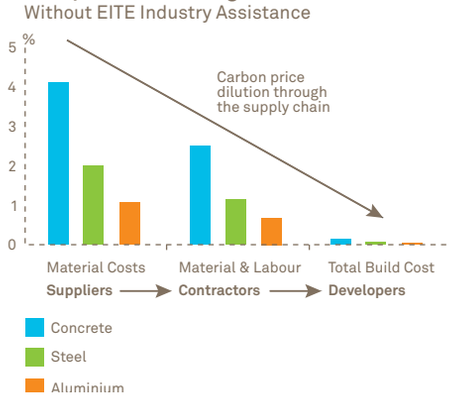
Source: Davis Langdon Research

Including Indicative Carbon Price Impact on Material Costs by Sector (including EITE industry assistance) based on year one of scheme

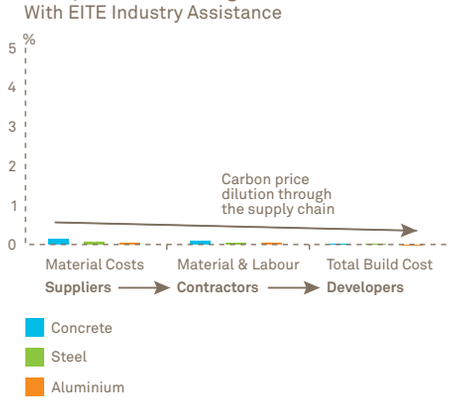
| | Concrete | Steel | Aluminium | Glass | Plasterboard |
|---|---|---|---|---|---|
| Health | 0.18% | 0.08% | 0.09% | 0.01% | 0.01% |
| Office | 0.23% | 0.11% | 0.06% | 0.01% | 0.02% |
| Industrial | 0.13% | 0.10% | 0.27% | 0.02% | 0.01% |
| High Rise Residential | 0.16% | 0.06% | 0.24% | 0.02% | 0.02% |
| Average | 0.18% | 0.09% | 0.16% | 0.02% | 0.01% |

Source: Davis Langdon Research

**Example: Office Building**
Without EITE Industry Assistance




**Example: Office Building**
With EITE Industry Assistance



## “Incorporating recycled content into the manufacturing process significantly reduces the embodied emissions”

### Opportunities for Market Transformation

The impact of a price on carbon is intended to drive market transformation. Materials used in the construction industry offer the greatest opportunities for alternative production.

The chart below shows the cumulative carbon intensity for the three largest GHG contributors in construction: aluminium, steel and concrete. Measured in tonnes of $CO_2$-e per tonne of material, it is evident that the process that contributes most to generating emissions is during the manufacturing process. This process is also more intensive for refining raw materials, however, when recycled content is used not only does this reduce waste but it also generates considerably lower embodied emissions.

Aluminium represents the greatest opportunity for recycled content in the construction industry. Incorporating recycled content into the manufacturing process significantly reduces the embodied emissions, although this can never be reduced to zero due to energy use and fugitive emissions produced by fabrication and transport.

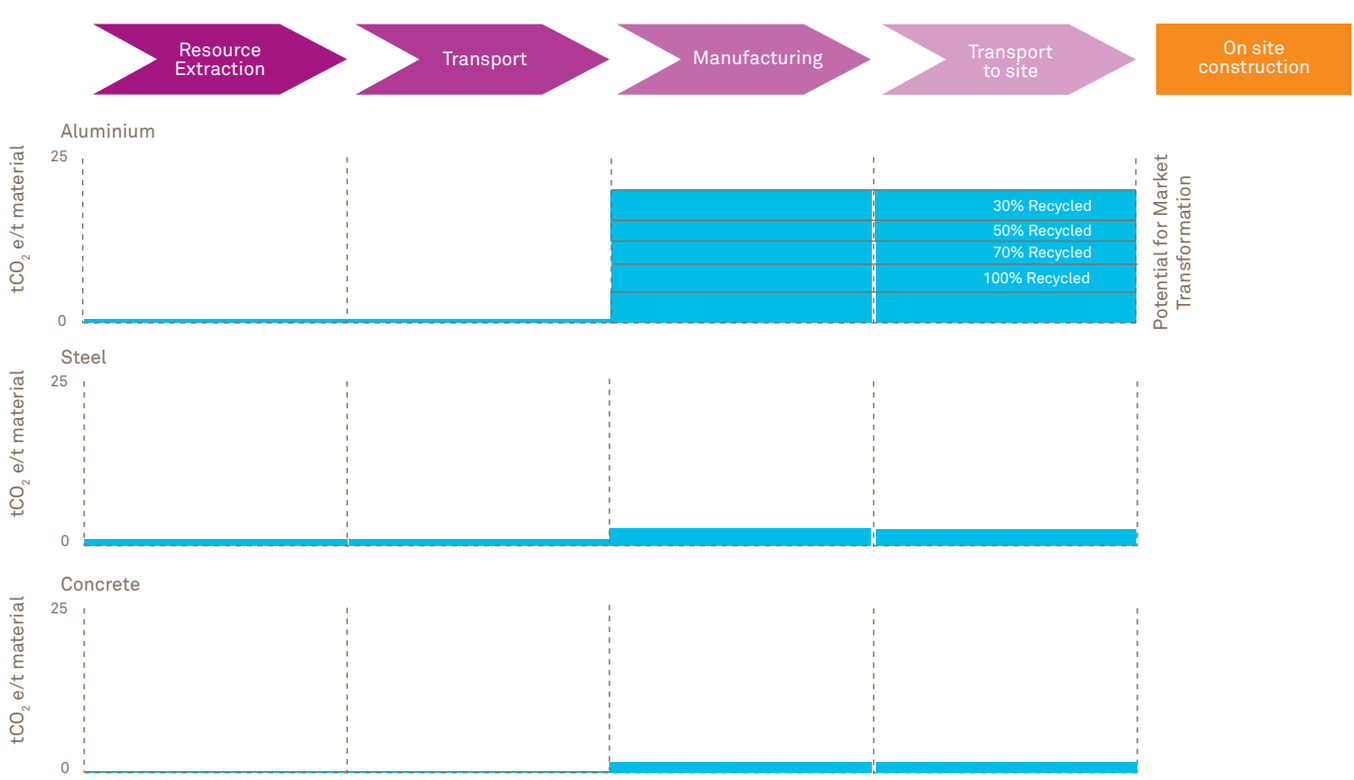
Recycled content in steel and material substitution in concrete can also be used although typically this is sometimes avoided in high load bearing areas to ensure structural integrity. However, in low load or non-structural areas the opportunity exists to source material that contains recycled content to lower the embodied carbon.

Recycled Aluminium Emissions Reduction Potential

| Recycled Material | Embodied Emissions Reduction |
|---|---|
| 30% | 24% |
| 50% | 40% |
| 70% | 55% |
| 100% | 80% |

Source: Davis Langdon Research

Cummulative Carbon Impact - Life Cycle from 'Cradle-to-Site'




Source: Davis Langdon Research

## Greater Cost Impacts from Other Challenges

The cost impact of the carbon price is only one of several major factors impacting on budget estimates. These include: foreign exchange fluctuations, new enterprise bargaining agreements, fluctuations in global material inventories and the potential for price gouging.

The Australian Competition and Consumer Commission will be tasked with investigating price gouging associated with the implementation of the carbon price. Any false or misleading claims towards price rises that businesses attribute to the carbon price may incur hefty fines.

Although in some instances it will be difficult to determine the direct impact of the carbon price, particularly through passed-on costs, it is anticipated that businesses will opt for full disclosure of all cost escalation above historical trends.

## Impact on Domestic Manufacturing

The impact of the carbon price on domestic manufacturing of carbon intensive building materials such as steel and aluminium will also have a bearing on construction costs. The extent of this will depend on how much local production is used by our domestic industries.

The Australian steel industry consists of two main producers and numerous fabrication and engineering companies. According to the World Steel Organisation, Australia ranked twenty second out of the world's top 80 steel producers at 7.6 million tonnes for 2008. The top three national producers were China (500 million tonnes), Japan (118 million tonnes) and the USA (91 million tonnes).

The rate of crude steel production in Australia has been declining since 2003 when production peaked at 9.6Mt. By 2009, this level had almost halved to 5.1Mt.

Production of primary aluminium has been more resilient. Production has increased steadily, with only a 2 percent dip in 2009 due to easing global demand. The World Bureau of Metal Statistics reports that Australia is the fourth largest producer of aluminium in the world, behind China (producing six times as much in 2009), Russia and Canada.

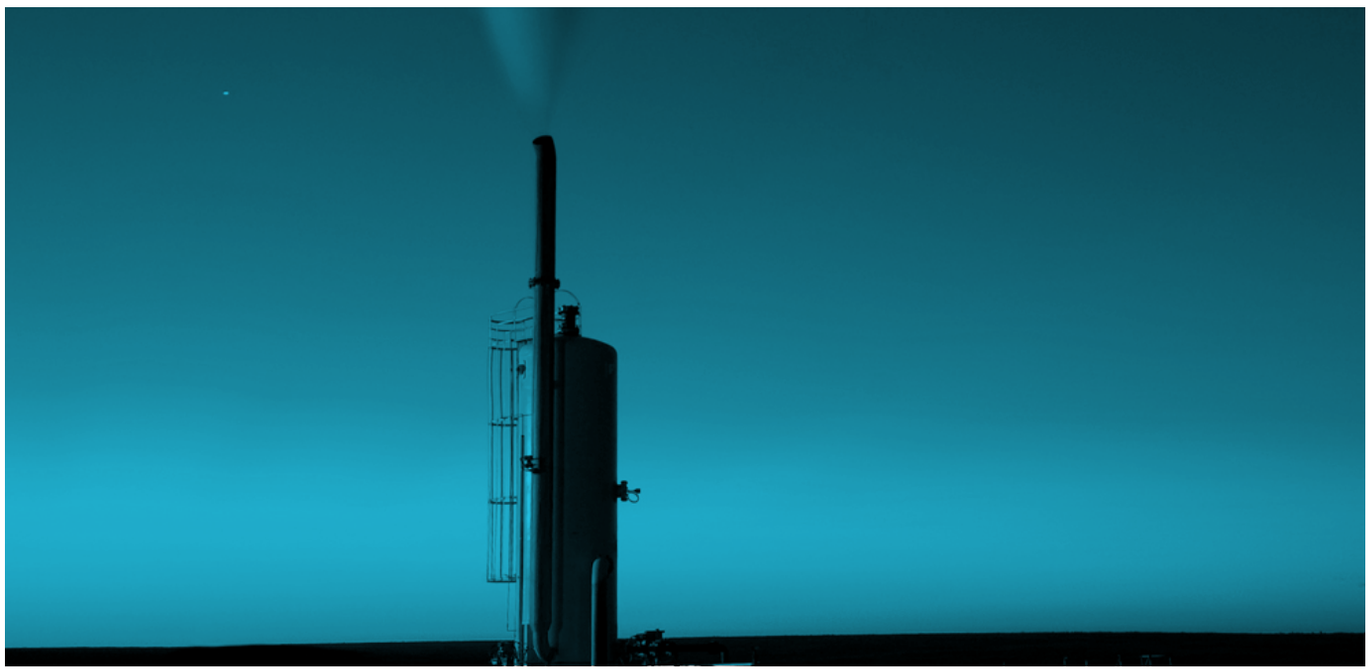
The analysis below shows that local industry consumes more imports in the aluminium sector than in iron and steel although, more than a quarter of local iron and steel consumption has been imported in recent years.

While these industries have already endeavoured to implement innovations to reduce the carbon intensity of their processes, it remains to be seen whether these will be sufficient to a successful market transformation once industry assistance ends.

Higher Carbon Intensity Materials - Trade and Local Consumption

| | Iron & Steel | Aluminium |
|---|---|---|
| | (Mt per annum) | |
| Production | 8.27 | 1.97 |
| Exports | 2.80 | 1.68 |
| Imports | 1.90 | 0.19 |
| Production Not Exported | 5.47 | 0.30 |
| Local Consumption | 7.37 | 0.49 |
| Proportion of Imports in Local Consumption | 26% | 40% |

Source: ABARES, Australian Aluminium Council, Australian Steel Institute, Davis Langdon Research



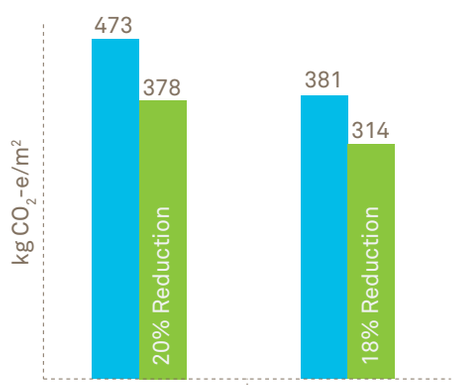
## Want to Reduce Your Construction Carbon Footprint?

It is possible to reduce the carbon footprint of a project by making informed decisions around design and selection of materials. The following two ECM case studies of an educational facility and a hospital highlight the clear benefits that understanding embodied carbon can bring to a project.

The current industry approach for an educational facility resulted in an overall carbon footprint of close to 8,000 tonnes of $CO_2$-e. This is equivalent to driving a car 715 laps around the equator or the equivalent annual electricity use of 1,250 Australian households or 1,800 Olympic-sized swimming pools filled with carbon dioxide.

By introducing a number of sustainability initiatives such as cement replacement in concrete using fly ash and granulated blast furnace slag and by lowering of concrete strength (where suitable), an overall reduction in embodied greenhouse gas emissions of 20 percent was achievable with cost implications less than the overall impact of the carbon price without considering the industry assistance.

The ECM calculates greenhouse gas emissions based on the quantity of materials from the cost estimate process for a proposed development. A number of scenarios and design options are modelled including current typical practice and a scenario of industry best practice with ECM optimisation.




| | Education Facility | Hospital Building |
|---|---|---|
| Increased concrete costs | 8.2% | 10.3% |
| Increased overall construction costs | 0.14% | 0.2% |

| | Equivalent Operational Emissions | |
|---|---|---|
| Current Industry Practice | 13.4 years | 3.5 years |
| Industry best practice with ECM optimisation | 11.3 years | 2.9 years |

| The ECM report provides tailored emissions saving alternatives, such as: |
|---|
| alternative materials to be considered by the design team |
| alternative designs to be considered by the design team |
| the use of recycled content |
| cement replacement in concrete using fly ash or ground granulated blast furnace slag |
| coarse aggregate replacement in concrete using recycled content aggregate or slag aggregate |

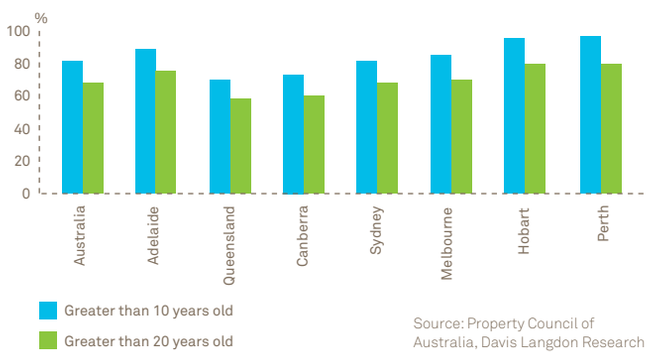
| Measurable outcomes of the assessment include: |
|---|
| the overall and per square metre embodied carbon content of the proposed development |
| a comparison of the embodied carbon content with the estimated operational carbon footprint of the proposed development |
| the translation of carbon intensity into nominal terms based on estimated carbon trading values |

## Existing Buildings – 'Present Carbon Valuation'

Existing buildings can be assessed using a Present Carbon Value approach whereby today's emission intensities can be used in replace of historical values. This method provides decision makers with a comparison of the environmental impact of a refurbishment versus new build.

Applying incentives or giving recognition to owners who chose to refurbish existing buildings in replace of knock-down and rebuild will significantly impact on the industry's contribution to overall emission reduction. Considering the size of the market greater than 10 and 20 years old this represents a significant opportunity for existing building owners and the industry.

Offices Greater than 10 & 20 Years Old

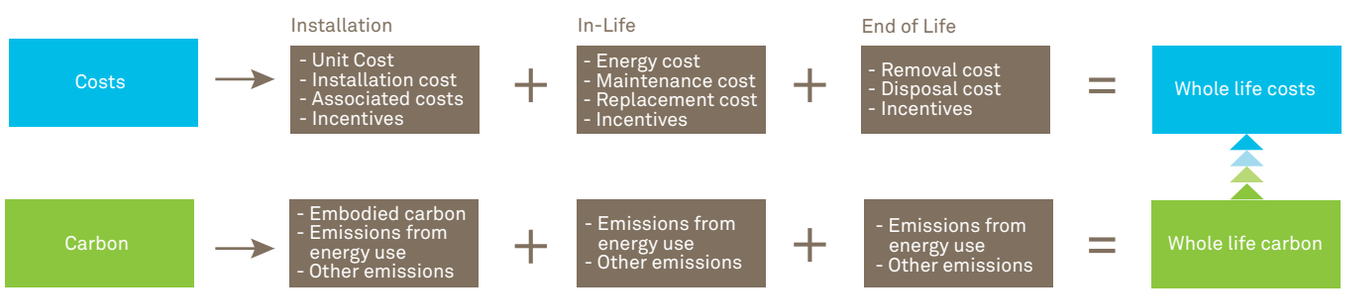



Source: Property Council of Australia, Davis Langdon Research

## Calculating Future Investment Decisions

With the introduction of a carbon price, investment decisions should take into account more than just capital costs. The cost of running, maintaining, replacing and disposing of plant and materials can have a huge financial effect on the decision to choose one system over another.

It is important to consider the impact of not only the carbon price but also the available incentives that exist during the installation, operation and disposal/re-lifing stages. Forward projections of 'whole-of-life' costs will need to consider the annual changes during the transition phase of the carbon price (up to 2015) and sensitivities associated with a fluctuating carbon price when the system moves to a market based mechanism.




Source: Davis Langdon Research

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