Government of South Australia
Green Industries SA

Reference: 79/1714

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Dear Sir / Madam

SUBMISSION TO THE GOVERNMENT PROCUREMENT INQUIRY

Green Industries SA (GISA) welcomes the opportunity to respond to the South Australian Productivity Commission – Government Procurement Inquiry.

GISA helps develop the green economy in response to the demand for clean and green produce, and the reduction of emissions to air, water and soil from industry. GISA promotes the circular economy, resource efficiency and the conservation and recovery of scarce resources. Further information on GISA can be found on our website here - www.greenindustries.sa.gov.au.

In its submission (**attachment 1**), GISA draws to the attention of the Productivity Commission the critical role procurement plays in shaping a circular economy, and associated waste, material, carbon and job benefits.

The submission presents an overview of the global, national and state policy context relating to consumption, production, waste and procurement, including the United Nations Sustainable Development Goals, China's National Sword Policy, Australia's 2018 National Waste Policy, and the State Procurement Board's *Sustainable Procurement and Value for Money Guidelines*.

As per the Commission's Terms of Reference and the Issues Paper feedback request, innovative procurement approaches from the United Kingdom and United States have also been offered for consideration.

Thank you for the opportunity to make a submission to this important Inquiry. If you require any further detail or clarification, please contact Ian Harvey, Director Strategy and Policy on 8204 1954 ian.harvey@sa.gov.au or Sharon Ede, Senior Adviser, Strategy Policy and Programs on 8204 2111 sharon.ede@sa.gov.au.

Yours sincerely

Vaughan Levitzke
Chief Executive
Green Industries SA

Date: 17/12/18

Attachment 1 - GISA Submission to the South Australian Productivity Commission – Government Procurement Inquiry

GREEN INDUSTRIES SA SUBMISSION TO THE SOUTH AUSTRALIAN PRODUCTIVITY COMMISSION - GOVERNMENT PROCUREMENT INQUIRY

18 DECEMBER 2018

PREFACE

The Government Procurement Inquiry Issues paper considers a range of important factors including reference to sustainable procurement (page 18) along with promoting innovation, inclusion and ecological sustainability (page 29). Whilst sustainable procurement is currently included in the state government's approach to procurement this aspect of procurement could be strengthened. Doing so will further highlight the government's commitment to ecologically sustainable development and support secondary processing and remanufacturing undertaken by our state's recycling and resource recovery sector – an important sector that contributes to Gross State Product (GSP).

There are a number of key international, national and state-based policy and contextual settings that support a strengthening of our state's approach to sustainable procurement.

These policy and contextual settings are provided in detail at **Attachment 1** and are also briefly listed below:

International

- United Nations Sustainable Development Goals - on 25 September 2015 countries around the world, including Australia, adopted a set of goals to end poverty, protect the planet and ensure prosperity for all as part of a new sustainable-development agenda.

- China's National Sword policy – bans and restrictions on the import of recyclable materials from South Australia and elsewhere.

National

- On 7 December 2018, Environment Ministers set a new unified direction for waste and recycling for Australia, agreeing to a new National Waste Policy.

State-based

- *Green Industries SA Act 2004* – includes relevant principles and statutory obligations such as:
    - Circular economy – internationally recognised.
    - Waste management hierarchy – internationally recognised.
    - *South Australia's Waste Strategy 2015-2020* – government endorsed policy.

- *Environment Protection Act 1993* – includes relevant principles and statutory obligations to promote the waste hierarchy and waste strategy. The South Australian Environment Protection Authority is also pursuing an extensive waste reform program to achieve sound regulation that supports fair and equitable competition, stability, growth and innovation in the waste and recycling sector.

Framed within the abovementioned policy and contextual settings, this submission brings to the attention of the Inquiry factors relating to sustainable procurement and seeks consideration of this matter by the South Australian Productivity Commission (the Commission) in its analysis and subsequent report to the Premier.

Green Industries SA (GISA) is very pleased to have the opportunity to make a submission to this Inquiry, and is able to provide further information as necessary to assist the Commission with its report.

INTRODUCTION

Waste management in South Australia

South Australia has introduced many waste management reforms over the past decade that have successfully promoted resource recovery in our state and established our reputation as a leader in this field.

The waste and resource recovery sector has grown into an economically significant part of South Australia's economy. The sector has an annual turnover of about $1 billion, contributing around $500 million to GSP and employing approximately 5,000 people.

In order to help realise the economic potential from innovation in waste and resource recovery technologies, while at the same time protecting our environment, it is important to provide the right settings to attract investment, drive innovation and create jobs. Further growth, including significant job creation, is anticipated with a continued emphasis on modernising our State's regulatory and policy settings.

Research presented in *Benefits of a Circular Economy (2017)*[1] indicates that up to 25,700 jobs could be created in South Australia by 2030 by embracing practices where maximum value is extracted from resources while in use followed by recovery and regeneration of products and materials. Up to 21,000 of these jobs are anticipated to come from material efficiency gains.

Procurement policy and practice has a critical role to play in strengthening sustainable waste management across our State and realising these benefits.

DISCUSSION

Government procurement decisions shape outcomes relating to waste and material consumption, and also local economic development, carbon emissions and generation of employment opportunities.

One of the long-term strategic objectives of *South Australia's Waste Strategy 2015-2020* (refer Attachment 1) is to "increase procurement by all levels of government of re-manufactured products".

Although there is evidence that points to the use of re-manufactured, or secondary, or recycled content products the scale of the uptake and the range of material types is not clear. Anecdotally, there seem to be a suite of barriers that restrict or limit the increased use of recycled content material including:

- lack of knowledge or awareness of product availability
- specification barriers (or perceived barriers) relating to technical performance of products
- availability of supply
- inherent conservatism within procurement decision making
- value for money

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[1] Lifecycles et al, *Benefits of a Circular Economy (2017)* commissioned by GISA and available at: https://www.greenindustries.sa.gov.au/circular-economy.

Sustainable Procurement Guideline

Supported by the Department of Treasury and Finance, the State Procurement Board (SPB) is responsible for the development of procurement policy in the South Australian Government.

In the mid-2000s, the SPB adopted its Sustainable Procurement Guideline (SPG), which was an outcome of Greening of Government Operations, a Cabinet-approved initiative.

The SPG assists government agencies to effectively integrate sustainability objectives into the procurement process, helping to identify the sustainability features of a specific procurement decision including whether the procurement utilises or promotes renewable materials such as remanufactured products and/or products that include recycled content.

The SPG can be found at:

www.spb.sa.gov.au/sites/default/files/Sustainable%20Procurement%20Guideline%20v2.2%20April%202017.pdf

The Guideline states:

> 'Public authorities have an important role in using their purchasing power to encourage suppliers to adopt sustainable practices that achieve environmental and social benefits and reduce costs. Public authorities are encouraged to:
>
> - reflect sustainable procurement and a commitment to continual improvement in organisational goals, policies and key performance indicators
> - promote awareness of sustainable procurement throughout the public authority
> - support the provision of, and access to, training programs that improve the level of staff awareness about sustainable procurement
> - include sustainable procurement in annual performance reports and set up processes to reduce, reuse or recycle goods (demand management).'

However, the Guideline indicates that public authorities must undertake a sustainability impact assessment only in the case of all procurements valued at or above $4.4 million and significant procurements below $4.4 million (as determined by the public authority). For all procurements greater than $550,000 and less than $4.4 million, public authorities are simply encouraged to take into consideration the general principles for sustainability identified in this guideline and provide a brief analysis in the acquisition plan of any sustainability issues, as appropriate.

There remains a wide gap between policy intent and how it is given effect in day to day operations, where procurement staff are unlikely to have the time or expertise to research what a 'sustainable procurement' ethos means in practice. This seems to have been the experience of the UK's *Public Services (Social Value) Act 2012*, as noted in the Issue Paper.

There needs to be a clear pathway from policy intent to operational effect, with appropriate staff provided with the information, capacity and capability needed to make multiple decisions on a day to day basis that will steer government activity towards fulfilling its policy intent.

In addition, the application of sustainable procurement must be consistent with the objects of the *State Procurement Act 2004*, including obtaining value in the expenditure of public money. It is likely that some recycled content materials cannot compete on price alone with comparable alternative products that are in high demand, however the SPB's Value for Money Guideline makes reference to the following:

Public Value: the value provided by a public authority / procurement to the residents of South Australia.

Public Value Outcomes: improving government performance itself as an asset to society; and /or delivery of specific benefits directly to persons or groups.

Value: the benefit provided by the delivery of goods or services.

Value for Money: the optimal use of taxpayer resources to achieve the intended outcomes.

The Guideline specifically notes that this includes environmental/sustainable procurement and social procurement, the intentional generation of social value through procurement processes such as purchasing from not-for-profit entities or businesses owned by designated groups.

A true value for money assessment would be informed by economic modelling that shows how such approaches are a future economic liability mitigation strategy e.g. the cost savings made in the future by procuring from social enterprises which employ marginalised people, or procurement decisions which support a circular economy and associated creation of local employment.

For example, there are a range of recycled and reprocessed materials that could be used in State-based construction and infrastructure projects including, but not necessarily limited to, aggregates, soils, organics (e.g. composts and mulches), end-of-life tyre derived products, recycled plastics, and recycled glass sand (as a substitute for virgin sands). In 2016-17 alone, over 2.5 million tonnes of masonry, clean fill and other materials were recycled in South Australia that may be suitable in road construction and maintenance and this quantity is up 15% from 2015-16 (to 2.06 million tonnes).

It is not currently known how much recycled content is used in infrastructure projects (State-based and otherwise), but it is estimated to be a lot less than what is available, partly due to the barriers discussed above.

There are benefits to the local waste and recycling industry and in turn to State and Local Government and communities should the procurement of recycled products and materials be increased. These benefits potentially include:

- Increased diversion from landfill – saving costs and reducing environmental impacts;
- "Closing the loop" on products entering the recycling stream by generating demand for recycled content products, remanufactured products and secondary resources;
- Increased environmental and social benefits for Government and the community;
- Potential (whole of lifecycle) cost savings compared to using virgin materials;
- Energy, water and material (resources) savings leading to reduced greenhouse gas emissions
- Demonstration to South Australian's of Government commitment to recycling and subsequent benefits;
- Development of new markets and contributing to resilience of existing markets.

- Jobs: it has been estimated that approximately 9.2 jobs are created for every 10,000 tonnes of waste recycled compared with 2.8 jobs for every 10,000 tonnes landfilled.[2]

By way of example, a City of Onkaparinga council road at Caribbean Crescent Happy Valley was constructed in December 2018 with 265 tonnes of asphalt with greater than 25% total recycled material content (including glass fines, plastics, and toner) with approximately:

- 139,000 plastic bag and packaging equivalents
- 39,750 glass bottle equivalents
- Toner from 3,200 used printer cartridges
- 53 tonnes reclaimed road (asphalt)

The utilisation of soft plastics and glass in this road construction provides improved performance characteristics over conventional asphalt. As a demonstration site Caribbean Crescent shows that repurposing and recycling waste materials into new streams of use is technically achievable, however, increased uptake in the market place will struggle against conventional pavement applications in the absence of a supportive sustainable procurement framework.

Promoting innovation, inclusion and ecological sustainability

To give effect to the international, national and State policy objectives relating to waste and consumption, and to respond to the global changing state of play with respect to the China Sword (refer Attachment 1, page 7), governments must use the considerable influence of their procurement power to create local markets for recycled materials.

In relation to Feedback request 4.7 and 4.8, our agency suggests investigating the success of the **Cleveland (US)** and **Preston (UK)** models concerning how to 'operationalise' the policy ethos of value for money and sustainable procurement.

Inspired by the Cleveland model from the US[3], one of the Preston model's main aspects is leveraging the procurement power of 'anchor institutions', such as universities, hospitals and government, to drive multiple policy outcomes[4].

Though SA is in part doing this with the Industry Participation Policy and other mechanisms, the Preston model goes further than specifying local suppliers and social procurement. It actively seeks to prevent wealth 'leaking' out of the local economy, by methods such as encouraging the establishment of employee owned enterprises to fill gaps in local supply, retaining jobs and wealth locally.

Spearheaded by **Matthew Brown**, head of the **Preston City Council**, this approach has put back over £500 million into the Preston and Lancashire economy over three years. The council also recently set up the Preston Cooperative Development Network (PCDN)[5], which encourages business people to create worker-owned co-operatives, and helps them to network.

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[2] http://www.environment.gov.au/system/files/resources/5cc6a848-a93e-4b3f-abf7-fc8891d21405/files/waste-and-recycling-employment.pdf

[3] http://community-wealth.org/cleveland; www.evgoh.com

[4] www.theguardian.com/commentisfree/2018/jan/31/preston-hit-rock-bottom-took-back-control; http://theconversation.com/preston-changed-its-fortunes-with-corbynomics-now-other-cities-are-doing-the-same-106293; www.centreforpublicimpact.org/case-study/the-preston-model-of-community-wealth-building-in-the-uk; http://cles.org.uk/coverage/the-preston-model-uk-takes-lessons-in-recovery-from-rust-belt-cleveland;; www.theguardian.com/society/2017/feb/14/poverty-was-entrenched-in-preston-so-we-became-more-self-sufficient; http://thenextsystem.org/learn/stories/episode-22-preston-model-economic-revival; www.thefifthestate.com.au/urbanism/environment/buy-local-multiple-benefits; http://prospect.org/article/losing-amazon

[5] www.preston.gov.uk/businesses/co-operatives/preston-co-operative-initiative

Also worth investigating is the work of **Michael Shuman**, a Stanford educated economist and attorney, and a leading global expert on local economics. Shuman is one of the architects of the crowdfunding reforms that became the 'JOBS Act', signed into law by President Obama in April 2012, and dozens of state laws overhauling securities regulation of crowdfunding. He has performed "leakage analyses" and related economic-development planning for a range of US jurisdictions[6].

Shuman's focus is on local economic development and how innovative, self-financing 'pollinator' enterprises can grow jobs and prosperity.

A pollinator is a self-financing economic development program or company, an approach Shuman advocates over 'attract and retain', which diverts attention away from local economic development and is both an inefficient and ineffective use of public funding.

Shuman's four principles for building prosperity locally:

- maximise local ownership, the percentage of jobs in the economy in locally owned business

- maximise local self-reliance and import replacement, not to detach from the global economy, but to engage with it from a position of strength rather than race to the bottom

- spread models of triple-bottom-line success – local business with high labour and environmental standards

- create an entrepreneurial ecosystem with the 6 Ps – planning (analyse and plug the economic leaks), people (support entrepreneurs who are leading), partners (make networks of local business more competitive as a group), purse (tap local savings/superannuation and put it to work in local businesses), purchasing (spearhead buy local campaigns by consumers, business, public agencies), policy (remove anti-local bias)

CONCLUSION

As significant procurers of goods and infrastructure, governments have an opportunity to help drive demand and create new markets for items that contain recycled materials. Key environmental impacts related to natural resource depletion and climate change resulting from energy consumed during raw materials processing can be addressed through effective sustainable procurement practices. New employment opportunities can be achieved.

[6] http://blogs.worldwatch.org/transformingcultures/wp-content/uploads/2011/02/Relocalizing-Business-Shuman.pdf

POLICY SETTINGS AND CONTEXT

INTERNATIONAL

China's National Sword Policy

The decision by China to restrict or ban the import of recyclable materials from Australia, South Australia, and other nations around the world, along with a downturn in global recycling commodity prices, has highlighted the recycling sector's vulnerability in our state and elsewhere.

Many of South Australia's recyclable materials such as mixed plastics, paper, cardboard, and scrap metal are aggregated and baled and shipped overseas. This vulnerability has generated considerable interest in finding domestic markets for recyclable materials including secondary or remanufactured products containing recycled content.

In 2018, the state government provided a $12.4 million support package to alleviate the impacts arising from China's decision to ban the import of recyclable materials. As part of the government's response measures, Green Industries SA (GISA) chairs a Sustainable Procurement Working Group – a sub-group of the SA China National Policy Working Group – to investigate increasing domestic demand for local recyclable materials and recycled-content products via government and industry procurement. The procurement group comprises representatives of State Government (GISA, EPA and DPTI), industry (Waste Management Association of Australia (WMAA), Northern Adelaide Waste Management Authority and Peats Soil) and local government (Local Government Association of SA (LGA) and City of Onkaparinga).

Procurement policy and practice is regarded as an important mechanism to support greater uptake of recycled content materials and products and in doing so support the waste and recycling sector.

United Nations Sustainable Development Goals

On 25 September 2015 countries around the world, including Australia, adopted a set of goals to end poverty, protect the planet and ensure prosperity for all as part of a new sustainable-development agenda. The Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all. The goals address the global challenges we face, including those related to poverty, inequality, climate, environmental degradation, prosperity, and peace and justice. Each goal has specific targets to be achieved by 2030. Sustainable Development Goal 12 is specifically focused on responsible consumption and production patterns.

Achieving Goal 12 requires a strong national framework for sustainable consumption and production that is integrated into national and sectoral plans, sustainable business practices and consumer behaviour, together with adherence to international norms on the management of hazardous chemicals and wastes.

Targets associated with Sustainable Development Goal 12 include, but are not limited to:

> *Promote public procurement practices that are sustainable, in accordance with national policies and priorities.*

NATIONAL

Australia's National Waste Policy 2018

In response to China's National Sword policy, in April 2018, State, Territory and Australian government environment Ministers agreed to increase the demand for recycled products. Ministers agreed to advocate for increased use of recycled materials in the goods that government and industry buy, such as paper, road materials and constructions materials, and to collaborate on creating new markets for recycled materials. Ministers also agreed to update the 2009 National Waste Policy (NWP) by the end of 2018, and that the policy would include circular economy principles.

On 7 December 2018, Environment Ministers set a new unified direction for waste and recycling for Australia, agreeing to a new National Waste Policy. The 2018 National Waste Policy provides a framework for collective action by businesses, governments, communities and individuals until 2030.

The 2018 National Waste Policy (NWP) focusses on waste avoidance, improved material recovery and use of recovered materials. It presents a common vision on priorities for responding to changing international waste markets. It will help Australia move closer to a more circular economy that eliminates waste and improve economic, social and environmental outcomes.

The NWP includes five principles that underpin waste management, recycling and resource recovery in a circular economy, including principle 3: *Increase use of recycled material and build demand and markets for recycled products.*

The NWP indicates that growth in demand for recovered and recycled materials will drive improved resource recovery in Australia. It recognises that governments have an important role to play in supporting markets for recycled goods domestically and internationally. They also develop standards, policies and procurement guidelines that focus on products that include recycled materials.

Two specific strategies have been formulated to facilitate the achievement of principle 3 as follows:

Strategy 8 – Sustainable procurement by governments
All Australian governments consider environmental issues in their approach to goods and infrastructure procurement and promote demand for recycled materials and products containing recycled content.

Strategy 9 – Sustainable procurement by business and individuals
Businesses and individuals in Australia take environmental issues into account when purchasing or manufacturing goods and services, and promote domestic demand for recycled materials and products containing recycled content.

The NWP is an important policy document endorsed by State, Territory and Australian government environment Ministers who are ultimately responsible for its implementation. Elevating the importance and ensuring implementation of sustainable procurement through South Australia's procurement processes will be an important, visible measure to meet the intent of the NWP.

The Agreed Statement of the December 2018 meeting of Environment Ministers in Canberra again reinforced the need for governments to take a unified approach with respect to the

NWP, noting 'the economic and job opportunities in re-circulating valuable resources within the Australian economy' of a circular economy approach, and specifically citing 'identifying increasing demand for recycled materials through procurement'.

SOUTH AUSTRALIA - STATE-BASED

Circular Economy Principles

It is important that society move away from the "take, make, dispose" linear consumption pathway to one which continues to return materials back into the economy.

In May 2017 Green Industries SA released the report *Creating value: The potential benefits of a Circular Economy in South Australia.*

The report quantifies the possible impacts on employment, carbon emissions, energy and materials use for South Australia if it adopted certain practices to become a more circular economy.

It conservatively estimates that by 2030 when compared to a business as usual scenario, a circular economy could create an additional 25,700 jobs (the majority of which would be through actioning material efficiency gains) and reduce greenhouse gas emissions by 27 per cent in South Australia.

Globally, the volume of materials used in building and construction alone (along with the embodied energy in them) has increased 23 fold in the last century. A study of the City of Melbourne reveals how big data, combined with a circular ethos of design and procurement, can make our cities the mines of the 21st century (see **Attachment 2**).

Through procurement, Governments can play a major enabling role in keeping recyclable materials circulating within the economy, which reduces associated resource, waste and carbon impacts of constantly replacing materials 'lost' out of the linear economy.

The Waste Management Hierarchy

The waste management hierarchy is recognised internationally as an aspirational framework for sustainability and is a key guiding principle in the *Green Industries SA Act 2004.*

The waste management hierarchy is a reference to an order of priority for the management of waste in which –

i) avoidance of the production of waste; and
ii) minimisation of the production of waste; and
iii) reuse of waste; and
iv) recycling of waste; and
v) recovery of energy and other resources from waste; and
vi) treatment of waste to reduce potentially degrading impacts; and
vii) disposal of waste in an environmentally sound manner,

are pursued in the following order –

- firstly, though avoidance of the production of waste, and
- secondly, to the extent that avoidance is not reasonably practicable, minimisation of the production of waste, and
- finally, to the extent that minimisation is not reasonably practicable, reuse of waste, and so on.

The framework stresses the need to:

- operate at the highest possible level of the hierarchy, considering social, environmental and economic practicalities
- make decisions using sound knowledge and information
- conserve materials and energy by acting to avoid waste and reduce wasteful consumption
- preserve the value of materials used, through source separation and reduced contamination.

South Australia's Waste Strategy 2015-2020 (Waste Strategy)

The development of the Waste Strategy by GISA is a statutory obligation under the *Green Industries SA Act 2004*. The Waste Strategy reflects government policy in relation to waste reduction, recovery, recycling and the diversion of waste from landfill. The Waste Strategy has three objectives, including:

> *"a stable and efficient market for investors, essentially a clearly articulated policy framework that gives a solid platform for investment decisions."*

Under this objective a key action is to:

> *"Increase procurement by all levels of government of re-manufactured products."*

For example, construction of residential and commercial buildings presents a significant opportunity to increase use of recycled materials, such as demolition waste and fly ash as a component of concrete.

Road and rail construction also has the potential to utilise significant quantities of recovered resources, in particular masonry rubble and glass. Use of plastics and crumb rubber in roads is also emerging as a significant market for recycled material.

In South Australia a City of Onkaparinga council road at Caribbean Crescent Happy Valley was constructed in December 2018 with 265 tonnes of asphalt with greater than 25% total recycle material content (including glass fines, plastics, and toner) with appropriately:

- 139,000 plastic bag and packaging equivalents
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The utilisation of soft plastics and glass in this road construction provides improved performance characteristics over conventional asphalt. As a demonstration site Caribbean Crescent shows that repurposing and recycling waste materials into new streams of use is technically achievable, however, increased uptake in the market place will struggle against conventional pavement applications in the absence of a supportive sustainable procurement framework.

Excerpt from The Conversation article on Mining Cities

http://theconversation.com/with-the-right-tools-we-can-mine-cities-87672

'We are depleting our resources at unprecedented rates. Instead of extracting dwindling raw materials from nature at ever-increasing cost, the time has come to start re-using materials from buildings and infrastructure in our cities.

We have been working on identifying the material resources in cities that could be "mined" for re-use. In a case study, we modelled more than 13,000 buildings in central Melbourne, Australia. We estimated the quantities of construction materials as well as the embodied energy, water and greenhouse gas emissions associated with constructing these buildings (if they were built today). We also modelled the replacement of materials over time and into the future.

By combining the Census of Land Use and Employment database with the Building Footprints database, we had access to basic geometric and construction-related data for each of the 14,385 buildings in this area in 2015. Of these, we modelled 13,075, as some very small or unique buildings (stadiums, railway stations, etc.) had to be discarded. We used 48 building archetypes, based on the building type (e.g. office), construction year (e.g. 1987) and height (e.g. 25 metres), to represent the different buildings in the city.

Results show that the City of Melbourne has a stock of 1.5 million tonnes of materials in every square kilometre. Just replacing worn materials to maintain this built stock is estimated to require 26 thousand tonnes of materials every year.

Rebuilding the City of Melbourne today would use about 10 petajoules of energy and 17.7 million cubic metres of water. The construction would emit 605,000 tonnes of greenhouse gases per square kilometre.

These resource requirements are simply huge. For instance, the energy used for every square kilometre built is enough to drive 700,000 cars from Melbourne to Sydney. For the 13,075 buildings modelled, we ended up with more than 500 million data points. We needed to come up with effective data visualisation to inform decision-makers about how we can mine cities.

The most important result we found is depicted in a map showing the quantities of each material within each building. We are able to do that for any given year or period. This enables us to track which materials are expected to be replaced in what quantities and in what buildings.

These maps allow us to start thinking of cities as urban mines and places of material production (supply), rather than just consumption (demand). We can imagine how a new construction project could survey what materials would be available at its start and how it can best re-use these and incorporate them into the design. This would save large amounts of energy and water, while avoiding greenhouse gas emissions and further ecosystem degradation from raw material extraction (usually far from the city).'