
Review of waste strategy documents in Australia: analysis of strategies for construction and demolition waste

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Abstract: The construction industry in Australia has grown significantly in the past two decades in the wake of population growth, migration and expansion in the tertiary education industry. The growing population has necessitated extensive property development, better public transport and improved infrastructure. To achieve all of this, construction activities have been on the rise; resulting in significant growth in construction and demolition (C&D) waste generation. However, the management of C&D waste has presented issues that have proven impact on the Australian society, environment and economy. Therefore, this review study is conducted to investigate how C&D waste is dealt in eight jurisdictions of Australia. This study reviewed the strategies recommended in waste strategy documents in these jurisdictions. Particularly, the study reviewed waste recycling and recovery targets, illegal dumping and stockpiling, extended producer responsibility, the definition of waste versus resource; use of C&D recycled waste and energy from waste extraction. The results of this review have provided an insight into the approach taken in the Australian context to deal with C&D waste stream.

Keywords: Australian jurisdiction; waste legislation; construction industry; environmental protection authority; Australia.

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Malik Khalfan is an Associate Professor in the School of Property, Construction and Project Management. He is an expert in the area of supply chain and his knowledge and experience can help develop a market in which currently inadequate supply chain in recovery of C&D waste management. In 2012–2014 he was a co-leader a project on developing a supply chain framework for waste minimisation for the residential sector, this project was funded by Sustainability Victoria.

1 Introduction

The construction industry in Australia has grown significantly in the past two decades in the wake of population growth, migration and expansion in the tertiary education industry. The growing population has necessitated extensive property development, better public transport and improved infrastructure (Trading Economics, 2018). To achieve all of this, construction activities have been on the rise; resulting in significant growth in construction and demolition (C&D) waste generation.

The issue of C&D waste has become more serious during the last decade after increased construction activities and new waste policy by foreign countries that stops importing waste from outside (Shoostarian et al., 2019b). According to the NWR (2018) prepared for the Australian Department of the Environment and Energy, in 2016–2017 Australia generated 831 Kg of C&D waste per capita (NWR, 2018), which has increased

by 2% per capita over an 11 year period (2007–2017). The total waste generated has steadily increased by 1.9% from 2007 to 2017 and reached 20.4 Mt, which represents the largest source stream (43%) of all waste types. C&D waste is mostly recycled and then disposed of at landfills (Shooshtarian et al., 2019a). Hence, the C&D waste management is important from economic and environmental perspectives (Tam et al., 2018). C&D waste accounts for a significant proportion (26.9%) of the solid waste collection and recycling services industry in Australia, an industry that produces \$5.2 bn in revenue and enjoys 3% annual growth.

Therefore, in addition to the current primary and secondary legislative documents that govern different waste streams, Australian jurisdictions have also produced waste strategy documents. These documents are guiding efforts and legislation in each jurisdiction towards better management of waste including C&D waste. Waste strategy documents are an important part of waste management governance in Australia. Despite not having statutory power, they guide efforts made by different organisations and industries involved in waste management. On the one hand, they are required to be developed under relevant jurisdictional acts. On the other hand, they also have a significant impact on the jurisdictional legislative framework, through objectives, targets and reforms proposed for implementation. For instance, in Western Australia (WA), the Waste Avoidance and Resource Recovery Act 2007 under Division 1 – Waste strategy (Part 4-Management documents) commissioned the Waste Authority to prepare a draft waste strategy containing a long-term strategy for continuous improvement of waste services, waste avoidance and resource recovery.

Waste strategy documents typically provide strategies that cover a period of about five years. The primary framework underpinning Australian waste strategies is the waste hierarchy (Bonn and Götz Reichert, 1987). This framework involves a set of alternatives for dealing with waste arranged in descending order of preference. The waste hierarchy is a nationally and internationally accepted concept used to prioritise and guide efforts to manage waste. The alternatives include prevention, reduction, reusing, recycling, energy recovery, (treatment) and disposal.

However, the content and the focus of these documents differ in terms of future targets, objectives and consideration of various waste hierarchy alternatives. This review aims to identify these discrepancies and provide insight into the way that Australia strategies its effort to address the issue of C&D waste stream. The particular objectives of this study are as follows:

- To compare the extent to which jurisdictional strategy documents support improvements and clarifications in C&D waste legislation
- To explore how these strategy documents promote the establishment of schemes contributing to better management of C&D waste
- To examine the priorities of these documents for C&D waste recovery priorities
- To evaluate the view of jurisdictional waste strategy documents in the development of a domestic market for recycled C&D waste

This work is a literature review that forms part of a larger project (A National Economic Approach to Improved Management of Construction and Demolition Waste), which is being conducted at RMIT University and is supported by the Australia Sustainable Built

Environment National Research Centre. This project endeavours to foster a holistic national approach to address C&D waste issues. Its objectives include the development of a consistent approach to define and measure C&D waste, identification of influential economic factors that govern management of C&D waste, completion of a feasibility study on the creation of a marketplace for trading C&D waste and identification of opportunities to integrate supply chains model in management of C&D waste.

2 Materials and methods

In Australia, similar to legislation development waste strategy documents are prepared at the state and territory level. As shown in Figure 1, Australia has six states: Victoria (Vic), New South Wales (NSW), Queensland (Qld), South Australia (SA), Western Australia (WA) Tasmania (Tas) and two territories: Northern Territory (NT) and Australia Capital Territory (ACT). These strategy documents are typically developed and updated by the jurisdictional Environmental Protection Authority (EPA) where the main responsibility for waste streams is on this authority. In SA and WA, this document is produced by the Green Industries SA and the Waste Authority, respectively.

Figure 1 Waste strategy documents in different Australian jurisdictions (see online version for colours)



This review study is based on the secondary data that is publicly available. The study employed a document analysis technique to compare among jurisdictional waste strategy documents. The main sources for this review study were waste strategy documents that were current and developed in each state at the time of the study.

3 Results and discussion

Comparisons between waste strategies can reveal the inconsistencies that exist between the strategies taken in different jurisdictions. It also provides the opportunity to improve the actions and strategies being advised, according to successful outcomes in jurisdictions that have led by example. In order to keep the review relevant to the context of C&D waste, only strategies that have directly or indirectly impacted on C&D waste management activities are described and compared. From the eight jurisdictions, Vic and Tas do not have a current waste strategy document at the time of review.

The following sections review the issues and strategies related to ‘waste recycling’, ‘illegal dumping and stockpiling’, ‘extended producer responsibility’, ‘definition of waste versus resource’, ‘use of C&D recycled waste’, ‘energy from waste extraction’, ‘education and engagement’ and ‘market development’.

3.1 Revision of the existing C&D waste regulatory framework

Development of jurisdictional waste strategy documents and relevant regulations go hand in hand. Ideally, objectives outlined in waste strategies inspire amendments to regulatory frameworks; some of these objectives recommend reforms according to the practical outcome of waste management regulations. However, evaluation of alignments between legislation and these strategies sometimes demonstrates fundamental differences in the study jurisdictions. These differences imply that, while the issues are identified and solutions are outlined in waste strategies documents, there is little legislative support to achieve the solutions. Therefore, it is worth examining how these strategy documents propose reforms to the existing regulatory framework in each jurisdiction. Notably, most of these strategies were written a few years ago and therefore care must be taken to exclude the strategies, actions and objectives that are already achieved and reflected in the jurisdictional regulatory frameworks. Table 1 summarises the strategies that support modifications in existing waste regulations.

It seems that the most frequently indicated strategy across jurisdictions is the review of waste regulations for their effectiveness, including checking their consistency, relevance and strength. The second-ranked demand is to revise existing levy arrangements to make sure they are a disincentive to landfilling. ACT, SA, Tas and WA are the jurisdictions that proposed this revision. Other revisions include providing legislative power to other agencies (NSW), community engagement (NT), development of a new act and regulations (Qld), building capacity in regulations to inform long term investment decisions and to provide a level playing field for industry (SA and WA), contribution to the development of a national waste policy (WA), and revising waste classifications and definitions to reflect current knowledge about waste management activities (WA).

Table 1 Strategies supporting improvements in various regulatory frameworks

<i>Objectives and strategies</i>	
ACT	<p><i>ACT Waste Management Strategy 2011–2025</i></p> <p><i>Challenges and opportunities:</i></p> <ul style="list-style-type: none"> • The safety and health risks arising from landfill gas emissions are managed across all landfills through appropriate regulation and licence requirements. <p><i>Strategies and actions:</i></p> <ul style="list-style-type: none"> • Disincentives to landfill including appropriate pricing and regulation
NSW	<ul style="list-style-type: none"> • <i>NSW Waste Avoidance and Resource Recovery Strategy 2014–2021</i> • <i>NSW Illegal Dumping Strategy 2017–2021</i> <p><i>Challenges and opportunities:</i></p> <ul style="list-style-type: none"> • Regulation and enforcement help to change behaviour, protect the environment and reduce health risks • Local councils usually regulate small-scale dumping, while the EPA regulates larger incidences <p><i>Strategies and actions:</i></p> <ul style="list-style-type: none"> • EPA provide clear and consistent regulations for waste disposal, recovery and recycling • Building the regulatory capacity of councils and public land managers
NT	<ul style="list-style-type: none"> • <i>Waste Management Strategy for The Northern Territory 2015–2022</i> <p><i>Challenges and opportunities:</i></p> <ul style="list-style-type: none"> • Existing regulation is not sufficient to provide incentives for innovative waste solutions or to deter inappropriate waste practices <p>Further review and implementation of the available environmental legislation will improve the NT PA's capacity to measure and reduce the impacts of waste handling activities and to steer practice towards achieving the preferred hierarchy of waste management options</p> <p><i>Strategies and actions:</i></p> <ul style="list-style-type: none"> • EPA will assess the waste-related components of other legislation administered by the NT EPA to determine their relevance and effectiveness as tools to improve waste management practices in the Territory • EPA is conducting a review of the WMPC Act and the Litter Act. This will provide the public, industry, government and local government with a discussion paper examining the deficiencies and strengths of the Acts in providing soundly managed waste issues
Qld	<ul style="list-style-type: none"> • <i>Queensland's Waste Reduction and Recycling Strategy 2010–2020</i> <p><i>Challenges and opportunities:</i></p> <ul style="list-style-type: none"> • Queensland's waste management legislation is out-dated and is not trying to stop waste being generated in the first place.

Table 1 Strategies supporting improvements in various regulatory frameworks (continued)

<i>Objectives and strategies</i>	
Qld	<ul style="list-style-type: none"> • A new legislation is needed to underpin the strategy, including promoting waste reduction and resource recovery and diverting potential resources from landfill. It also helps achieve the goals and targets of the strategy, provide a more flexible approach that can readily keep pace with changes in technology, help to regulate illegal activities more effectively and provide a level playing field for legitimate and responsible, help manage priority wastes more effectively, ensure more consistency with other states facility operators, manage priority wastes more effectively, ensure more consistency with other states <p><i>Strategies and actions:</i></p> <ul style="list-style-type: none"> • The government will deliver a new Act and regulations and amend and strengthen existing laws
SA	<p><i>South Australia's Waste Strategy 2015–2020</i></p> <p><i>Strategies and actions:</i></p> <ul style="list-style-type: none"> • Identify new opportunities through developing and promoting innovative policy, reforms and solutions. • Implement policy settings and regulation that drives progress, and encourages long term investment decisions • Monitor and evaluate the effectiveness of appropriate price signals and legislative instruments
Tas	<p><i>LGAT Waste and Resource Management Strategy 2017 – a submission to LGAT</i></p> <p><i>Challenges and opportunities:</i></p> <ul style="list-style-type: none"> • The absence of regulatory controls for the development and operation of privately operated inert landfills has provided for unregulated the establishment of these landfills that do not collect levies and are thus a market barrier to the implementation of recycling facilities for C&D material • Lack of a policy and guidelines to realise how the proposals for Energy from Waste (EfW) facilities design and establishment are to be assessed according to the relevant state legislation. • Low landfill levy is a financial barrier to recycle, invest in resource recovery and implement practices which reduce waste generation <p><i>Strategies and actions:</i></p> <ul style="list-style-type: none"> • Working towards a circular economy – establish clear objectives, performance indicators and targets for waste and resource recovery • Provide additional resources to bolster the capability of the regulator to provide improved regulation and compliance (e.g., via landfill levy)
WA	<p><i>Western Australia's Waste Strategy: Waste Strategy 2030</i></p> <p><i>Challenges and opportunities</i></p> <ul style="list-style-type: none"> • The state government can provide waste management leadership and influence waste behaviours through legislation, regulation, policies and programs that align with a national approach • Regulation and policy – to provide a level playing field and deliver efficient and effective waste management outcomes

Table 1 Strategies supporting improvements in various regulatory frameworks (continued)

<i>Objectives and strategies</i>	
WA	<p><i>Strategies and actions:</i></p> <ul style="list-style-type: none"> • Contribute to national waste policy and programs aimed at waste avoidance, resource recovery and environmental protection. • Review the scope and application of the waste levy to ensure it meets the objectives of Waste Strategy 2030. • Review and revise regulations and policies to achieve a level playing field for the industry which ensures entities that are compliant and apply best practice are not disadvantaged. • Introduce regulations to prevent unnecessary waste generation. • Review and update the regulatory framework for waste to ensure it is appropriate and reduces the environmental impacts and risks from waste management. • Revise waste classifications and definitions to reflect current knowledge to ensure waste materials are managed according to their risk and are treated and/or disposed of appropriately.

3.2 *Definition of waste versus resource*

In the National Waste Policy (2018), the concept of ‘a waste is not always waste’ is promoted in the ‘Waste as a Resource – the Circular Economy’ section. This section explains that, by applying the principles of a circular economy, Australia can support better and repeated use of its resources; the focus is on maximising the economic value of resources. According to this new way of thinking, most of materials produced are resources that can be reused, recycled and reprocessed over and over. The ability to re-define the output of resource recovery facilities as not waste is instrumental in developing markets for those output products (Hyder, 2012).

However, at the jurisdictional level, the current regulations are bound to the notion of ‘once a waste, always a waste’. This is the case irrespective of the material’s later use or commercial value. Indeed, as seen above, the waste definitions in Australian jurisdictions do not separate disposable waste and products that are recycled or converted to energy. According to this notion, until the material is actually reused, it is regarded as a waste. For instance, contaminated soil that has been processed is still waste even once it has been (re)used; that it is now ‘clean’ material does not stop it being waste. As a result, it must be kept, treated, transported and disposed of only in conformity with a licence from the EPAs. The definition of waste and the circumstances under which the waste and recycling industry requires a licence and is liable to pay landfill levies are the main outcomes of the current conceptualisation of waste in Australia.

Indeed, the definition in use in jurisdictions carries an inconsistency; while a waste is identified as unwanted, regardless of its value, it can potentially be a resource for the same or other purposes. This is a crucial issue that needs to be immediately addressed in the legislative framework. In fact, the way regulations consider waste at different levels of the waste hierarchy provides a platform for dealing with waste and associated costs (e.g., a levy). Eventually, if properly defined and implemented, the separation between waste and resources will determine the quantity of waste sent to landfill. This, in turn, can reduce the load of new materials extracted and will largely mitigate the environmental

risks created along the chain. An example of the consequences of not addressing this issue is evident in the case of Eclipse Resources Pty. Ltd. ('Eclipse') in WA, which became liable to pay approximately 21.6 million backdated levies in 2017 (Houweling and Barrett, 2017). The court ruled against Eclipse's assumption about clean fills and recycled materials received and accepted for burial not being 'waste' but resources (for re-use purposes). "The court determined that, technically, the definition of waste remains valid when it is unwanted by or excess to the needs of the source of that material" (Eclipse Resources Pty. Ltd., 2017), regardless of its later use. Despite the court's ruling, according to a piece of legislation in WA (Waste Avoidance and Resource Recovery Levy Regulation, 2008), a licensee may by application claim an exemption from levy regulations for uncontaminated soil or other clean fill under some conditions specified in the legislation.

Such rulings are a serious deterrent for industries in terms of recycling material; instead, it makes them resort to disposing of material at licenced landfill facilities to avoid liability for significant levies. In Europe, turning waste into a resource by 2020 is one of the key objectives of the EU's Roadmap to a Resource Efficient Europe. Furthermore, when waste ceases to be waste largely depends on the definition of waste. The only definition of waste that does not consider waste to always be waste is provided by NWP 2018, which distinguishes waste from resource: "Materials and products that are reused (for their original or another purpose without reprocessing) are not waste because they remain in use". Table 5 provides a summary of this issue in the jurisdictional legislative frameworks. In addition to the review of legislation, other waste related documents are reviewed as they are assumed to contribute to developing and upgrading (new) legislation that has a different perspective about when waste is a resource.

The results of the review of strategies and regulations show that, aside from Qld, NSW and SA, other jurisdictions have largely not adopted the NPW 2018 notion (waste as a resource). In Qld, under the Waste Reduction and Recovery Act 2011 (Chapter 8), the end of waste (EOW) framework is proposed to promote resource recovery opportunities and aims to shift the common perception from 'waste is always waste' to it being valued as a resource (Waste Reduction and Recycling Act 2011). Accordingly, in this state, waste ceases to be waste when, in accordance with the EOW code or EOW approval, it stops being waste and becomes a resource. This framework replaced the beneficial use approval (BUA) framework to increase business opportunities for waste generators, waste processors and business receiving recovered material from within Qld. Furthermore, there is a discount for the residue waste levy fee; this encourages waste recycling throughout the state.

Although in other states the common perception is in favour of 'once waste is always waste', regulations are set in a way that exceptions are provided to encourage less waste disposal. In SA, disposal of 'waste fill' is exempted from the landfill levy program; the Government of South Australia (2018) also fixed the solid waste levy applicable to shedder floc (waste residue from metal recovery) disposal at \$62 (instead of the standard rate of \$76 per tonne). This discount has made C&D waste recycling more cost-effective. In NSW, the definition of C&D waste excludes excavated soil that is to be used for levelling off the site prior to construction. In these states, regulations exempt certain waste (i.e., wastes that are recycled, reused, recovered or processed) from the calculation of contribution. In NSW provides for rebates on recyclable materials that are lawfully removed from a licensed facility. In WA, operators can apply for an exemption for

recyclable materials under Waste Reduction and Recycling (Waste Levy) and Other Legislation Amendment Bill (2018).

Table 2 When waste is not waste

<i>Objectives and strategies</i>	
ACT	<p><i>Waste Management and Resource Recovery Act 2016</i></p> <p>A waste is always waste regardless of its value</p> <p><i>ACT Waste Management Strategy 2011–2025</i></p> <p>The strategy recognises waste as a resource. Deriving value from waste resources requires innovations by government and industry in order to transform waste into a valuable product.</p>
NSW	<p><i>Protection of the Environment Operations Act 1997 No. 156</i></p> <p>Regulations may provide for the exemption of specified wastes from the calculation of contributions (including for example wastes that are recycled, reused, recovered or processed) for landfill owners</p> <p><i>NSW Waste Avoidance and Resource Recovery Strategy 2014–2021</i></p> <p>A waste is always waste regardless of its value</p>
NT	<p><i>Waste Management Strategy for The Northern Territory 2015–2022</i></p> <p><i>Waste Management and Pollution Control Act 2016</i></p> <p>A waste is always waste regardless of its value</p>
Qld	<p><i>Environmental Protection Act 1994/Waste Reduction and Recycling Act 2011/WRR Act 2011 Guideline: End of Waste</i></p> <p>A waste can be approved as a resource if the department considers that it meets specified quality criteria for its specific use</p> <p><i>Queensland’s Waste Reduction and Recycling Strategy 2010–2020</i></p> <p>A waste is always waste regardless of its value</p>
SA	<p><i>Environment Protection Regulations 2009</i></p> <p>Under Part 2- Waste depot levy, landfilling ‘waste fill’ is exempted from depot levy.</p> <p><i>Environment Protection (Waste to Resources) Policy 2010</i></p> <p>Provides a mechanism by which a waste that meets specifications or standards published or approved in writing by the EPA will be considered a product (instead of a waste)</p> <p><i>South Australia’s Waste Strategy 2015–2020</i></p> <p>A waste is always waste regardless of its value</p>
WA	<p><i>Environmental Protection Act 1986</i></p> <p>A waste is always waste regardless of its value</p> <p><i>Waste Strategy 2030</i></p> <p>Principle (5) Waste as Resource: WA will adopt and implement the waste the waste hierarchy, avoiding the generation of waste where possible, maximising the recovery of waste that is generated, and protecting the environment from the impacts of disposal. It recognises that some level of waste generation is unavoidable and so encourages a circular economy approach, where any waste that is generated is valued as a resource that can be reused or recycled for the benefit of the Western Australian economy</p>

The results of this review of relevant legislation show that Australian jurisdictions need to collaborate with national organisations to reflect the concept of ‘waste is not always

waste' in their regulations. In this regard, waste strategy documents across Australia need to take a more active approach to promote this concept within authorities, the waste and recycled industry, as well as the wider community.

3.3 *Illegal dumping and stockpiling*

In addition to parental environmental protection acts and subordinate waste-related regulations, various waste management strategies and targets have been proposed in different jurisdictions to navigate efforts towards illegal dumping reduction. These strategies are typically released under the title of waste strategy and cover a certain period. Table 3 presents the relevant strategies to reduce activities known as illegal dumping.

Table 3 Strategies proposed to reduce illegal dumping

	<i>Illegal dumping minimisation direct strategies/targets</i>	<i>Strategy document</i>
ACT	<p>Reduce litter and dumping through laws and awareness-raising (Strategy 3.1)</p> <p>Participate in national approaches to litter management (Strategy 3.2).</p> <p>ACT leads Australia in low litter and incidents of illegal dumping (Target 3).</p> <p>No quantitative target is introduced</p>	<ul style="list-style-type: none"> • ACT Waste Management Strategy 2011–2025
NSW	<p>Reduce illegal dumping by 30% by 2020 compared with 2011</p> <p>Seven approaches are proposed:</p> <ol style="list-style-type: none"> 1 Evaluation and monitoring 2 Education and awareness 3 Stakeholder engagement and capacity building 4 Regulation and enforcement 5 Building and evidence base 6 Prevention, infrastructure and clean-up 7 Evaluation and monitoring 	<ul style="list-style-type: none"> • NSW Waste Avoidance and Resource Recovery Strategy 2014–2021 • NSW Illegal Dumping Strategy 2017–2021 •
NT	<p>Work with local government and the NT Government to coordinate local efforts to prevent litter and illegal dumping (Action 7)</p> <p>No quantitative target is set</p>	<ul style="list-style-type: none"> • Waste Management Strategy for The Northern Territory 2015–2022
Qld	<p>Reduce the total amount of, and the environmental impacts from, litter and illegal dumping (Target 5)</p> <p>Reactive compliance and enforcement (Program 1)</p> <p>Education, engagement and awareness-raising (Program 2)</p> <p>Hotspots – proactive compliance (Program 3)</p> <p>Data, research and evaluation (Program 4)</p> <p>Capacity building and networking (Program 5)</p> <p>No quantitative target is set</p>	<ul style="list-style-type: none"> • Queensland's Waste Reduction and Recycling Strategy 2010–2020 • Queensland's Litter and Illegal Dumping Action Plan

Table 3 Strategies proposed to reduce illegal dumping (continued)

	<i>Illegal dumping minimisation direct strategies/targets</i>	<i>Strategy document</i>
SA	Decreased incidences and tonnages of illegal dumping No quantitative target is introduced	<ul style="list-style-type: none"> • South Australia's Waste Strategy 2015–2020
WA	Move towards zero illegal dumping by 2030 (objective 3: protect) Identify and collect required data to monitor illegal dumping and allow better targeted monitoring and enforcement (Strategy 23) Deliver a community engagement and education campaign to raise awareness of illegal dumping and its impacts (Strategy 24) Work with landowners and managers to build their capacity to tackle illegal dumping (Strategy 28) Provide relevant funding and guidance to prevent the illegal dumping of waste at charitable recycler waste collection sites (Strategy 31) Detect, investigate and prosecute illegal dumping (Strategy 33) No quantitative target is set	<ul style="list-style-type: none"> • Western Australia's Waste Strategy: Waste Strategy 2030

Although the documents listed in Table 1 may have provided different strategies that can have indirect impacts on illegal dumping, only those strategies that exclusively target illegal dumping are presented. Furthermore, two of the eight jurisdictions (Vic and Tas) do not have current waste strategies and therefore their out-dated waste strategy documents are excluded from consideration. Two states, NSW and Qld, have developed a specific strategy and action plan for illegal dumping management. Aside from NSW (target: 30% reduction by 2020), none of the jurisdictions was able to define a quantitative target to reduce illegal dumping.

According to waste strategies and submissions by different organisations and agencies to Australian Environment and Communications References Committee (2018), the main reforms proposed for better illegal dumping management are funding for education programs and enforcement through local government imposing waste levies. In terms of law enforcement, introducing a uniform levy across Australia, in particular, can reduce the motive for illegal dumping (Laviano et al., 2017).

3.4 *Extended producer responsibility*

Extended producer responsibility (EPR) is found to be a successful market-based policy approach that has been applied to different waste types and streams (Hanisch, 2000). Technically, EPR makes manufacturers responsible (financially and/or physically) for the entire lifecycle of their products during the supply chain of materials, including design, manufacture, recycling and final disposal (OECD, 2016). EPR provides an opportunity to divert additional waste away from landfills to reuse and recovery. EPR has been recognised as an incentive for producers to take into account environmental considerations when designing their products, resulting in preventing waste at the source through better product design (Environment and Communications References Committee, 2018). One submission to this committee inquiry stated that generally about

70% to 80% of the environmental impact of a product is locked in at the design phase (Environment and Communications References Committee, 2018).

These regulatory instruments enforce the price signal that ensures the entities that have the power to redesign their construction materials or to trade other materials play an active role in the management of waste produced. For this to be achieved, producers should use instruments such as design for recyclability, reduced material usage, product disassembly, reduced or eliminated the use of toxic materials, and re-manufacturability (Acree Guggemos and Horvath, 2003).

In SA and WA, EPR is a long-term objective; EPR related schemes are supposed to be developed in the future. Table 4 presents a summary of support from different states and territories of Australia reflected in jurisdictional waste management strategy documents.

Table 4 Support for development and extension of EPR and similar schemes in Australian waste strategy documents

<i>Document</i>	<i>State</i>	<i>Relevance to C&D waste</i>
ACT Waste Management Strategy: Towards a sustainable Canberra 2011–2025	ACT	EPR is recognised among the areas of improvements for further waste management and resource recovery Strategy 1.4. Reducing packaging: waste a commitment to product stewardship by the supply chain and other signatories
Waste Management Strategy For the Northern Territory 2015–2022	NT	No mention of EPR and PTB NT will facilitate and promote product stewardship programs for recycling and treating nationally significant waste streams
NSW Waste Avoidance and Resource Recovery Strategy 2014–2021	NSW	No mention of EPR and PTB NSW will continue to work with the Australian Government to introduce product stewardship initiatives at the national level under the Commonwealth Product Stewardship Act 2011
South Australia's waste strategy 2015–2020	SA	Long term objectives: Avoid and reduce wasteful use of resources in production processes and products, such as leaner production, design for the environment and EPR Promote the adoption of EPR, including State-based approaches where considered necessary, and encourage continuous improvement in existing producer responsibility and related schemes Encourage reuse of waste fill and intermediate level contaminated soils where appropriate as a priority and remediate low level and high-level contaminated soils for re-use Priorities for Action: Problematic and hazardous waste target: effective PS schemes in place by 2020

Table 4 Support for development and extension of EPR and similar schemes in Australian waste strategy documents (continued)

<i>Document</i>	<i>State</i>	<i>Relevance to C&D waste</i>
Queensland's Waste Reduction and Recycling Strategy 2010–2020	Qld	<p>Strategy principles</p> <p>Making better use of finite resources (energy, water, materials) by encouraging waste avoidance and improving recovery through PS or PTB schemes</p> <p>Implement state-wide action such as PS schemes on priority waste</p> <p>Qld government aims to:</p> <p>encourage and support PS arrangements</p> <p>work with industry sectors to help build on achievements made through existing schemes and help promote PS activities</p> <p>work with other industry sectors to foster new PS arrangements</p>
Waste Strategy 2030: Western Australia's Waste Strategy	WA	We will support PS and EPR as part of our approach to shared responsibility.
National Waste Policy 2018: Less Waste, More Resources	Australia	<p>Strategy 4 Product stewardship</p> <p>Develop and implement partnerships across government and business to ensure ownership and responsibility for action to minimise the negative impacts from products, ensure the minimisation of waste and maximise reuse, repair and recycling of products and materials throughout their life cycle</p>

3.5 *Target rates for C&D waste recycling*

Among the jurisdictions, NT and Tas have not specified a target for C&D waste recycling. The rest have set a target; although, in some cases, (e.g., Qld and WA) it seems to be too ambitious. Currently, only SA has achieved the target rate (90%) that is set for 2020; this state has the highest C&D waste recycling rate (91.1%), followed by Vic (82%). The lowest recycling rate for C&D was registered in NT and Tas with the average of 1%. It worth keeping in mind that these varied rates are the product of various factors, including an increase in the waste generation rate (NSW), interstate waste transfer (Qld), lack of obligatory disposal levy (Tas) and the lack of an effective waste data management system (NT).

3.6 *Support for reuse of C&D recycled materials*

In this section, the waste strategy documents of different jurisdictions were reviewed to provide an understanding of how states and territories have designed their plans for recycled waste materials. The following are the results of this review, as presented for each jurisdiction.

Table 5 Summary of waste strategy documents in different jurisdictions

		<i>Objectives and strategies</i>	<i>Document</i>
ACT	1	Less waste generated-target: reuse of goods expands in the ACT	<ul style="list-style-type: none"> • ACT Waste Management Strategy 2011–2025
	2	Full resource recovery-target increase resource recovery rate over 85% by 2025	
	3	A clean environment-target: ACT leads Australia in low illegal dumping and protection of ACT environment	
	4	Ac carbon neutral waste sector-target: ACT waste sector is carbon neutral by 2020, energy produced from waste doubles by 2020	
NSW	1	Avoid and reduce waste generation-target: reduce the rate of waste generation per capita	<ul style="list-style-type: none"> • NSW Waste Avoidance and Resource Recovery Strategy 2014–2021 • NSW Illegal Dumping Strategy 2017–2021
	2	Increase recycling-target: increase recycling rate for C& D waste to 80% by 2021–2022	
	3	Divert more waste from landfill- target: increase the waste diverted from landfill to 75% by 2021–2022	
NT	1	Engagement and education	<ul style="list-style-type: none"> • Waste Management Strategy for The Northern Territory 2015–2022
	2	Improve waste management	
	3	Improve waste data collection, monitoring and analysis	
	4	Improve the regulatory framework	
	5	Reporting and public reviews	
Qld	1	Resource efficiency	<ul style="list-style-type: none"> • Queensland’s Waste Reduction and Recycling Strategy 2010–2020
	2	Sustainability	
	3	Engagement	
	4	Capacity building	
SA	1	Developing a resource efficient economy	<ul style="list-style-type: none"> • South Australia’s Waste Strategy 2015-2020
	2	Building a stable and efficient market for investors	
	3	Forming a culture enabling the South Australian community	
WA	1	Avoid (WA generates less waste): target: 2025: 10% reduction in waste generation per capita	<ul style="list-style-type: none"> • Western Australia’s Waste Strategy: Waste Strategy 2030
	2	Recover (WA recovers more value and resources from waste) – target: 2025 increase material recovery to 70%	
	3	Protect (WA protects the environment by managing waste responsibly) – target: 2030 – no more than 15% of waste produced in Perth and Peel regions is landfilled, all waste manage and/or disposed at better practice facilities	

In the ACT, Strategy 1.7 (encourage on-site reuse of C&D waste) proposes that there is an opportunity for temporary on-site facilities in new suburban developments in the ACT where several homes are being built concurrently. These facilities will encourage local recycling of waste into products that can be used, through the development and exchange

of surplus C&D waste materials within the development site. This strategy also aligns with Strategy 2.6 (government procurement), which encourages government purchasing and use of recycled product where possible. The government, as part of this strategy, should also review the specifications used for government tendering to identify where recyclable alternatives can replace non-recyclable materials.

In NSW, the 'Waste less, recycle more' initiative (2017–2021) financially supports establishment of network between C&D companies to adopt industrial ecology. This network promotes buying products that are recycled, recyclable, repairable, refillable, reusable or biodegradable. This initiative also provides a fund for the establishment of new markets for recycled waste materials and innovation in recycling technology. The waste strategy has outlined the duties that different stakeholders can fulfil, including specifying and purchasing recycled materials (local government), separate recycling states at source to ensure that waste and recycling is handled by legitimate operators (industry and businesses) and improve the efficiency of recycling activities to expand their recycling facilities to cover more waste materials (waste recycle industry).

The main recommendations made in NT's waste strategy include 'facilitate opportunities to explore technologies for the beneficial re-use of wastes', 'collaborate with the Waste and Recycling Industry of the NT (WRINT) to identify emerging trends and issues requiring multi-faceted solutions', 'facilitate opportunities to connect waste recovery and reuse markets with key waste producers', 'work with industry and government agencies to demonstrate the economic incentives available through improved waste management and resource recovery' and 'support proposals by regional councils to consolidate recycling infrastructure at central locations'.

In Qld, the waste strategy emphasises investment in regional recycling infrastructure and developing markets for recycled products. It encourages local government to engage with the C&D sector to support research and improved best management practices, and to identify opportunities for recycling and incentivise purchase of recycled-content products. A significant strategy for encouragement of further recycling in Qld is to revise policies about price signal through landfill levy. Development of new markets for recycled material is also proposed as an effective enabler towards more waste recycling. The strategy states that businesses should modify consumer behaviour by marketing recyclable and recycled-content products.

In SA, a number of strategies have been set out to increase waste recycling activities, including 'encourage (reduce the barriers to) the greater use of products made from recycled materials', 'encourage and promote the development of sustainable local, national and international markets for re-manufactured and recycled products', 'increase procurement by all levels of government of re-manufactured products through sustainable procurement', 'attract and encourage business to develop and grow new, high value-added, re-manufacturing enterprises' and 'setting procurement policies and practices that support the use of re-manufactured products'. Regarding C&D waste, this strategy highlights the need to 'encourage salvaging and re-use of building materials' and 'Promote source separation wherever practical'.

In WA, six strategies are documented in WA's waste strategy that can improve recycling activities. It appears to be the most well thought out plan among the jurisdictions. Its strategies include 'implementing sustainable procurement practices', 'development of standards for waste derived products', 'provide funding to promote use of recycled material and development of new markets', 'develop legislative support to

increase use of recycled materials' and 'implement supportive measures and policies for local market development and government sustainable procurement'.

3.7 Energy from waste

Energy recovery from waste material is another preferred waste management method over the landfilling (Shooshtarian et al., 2019c). In the ACT's waste strategy document (Government of ACT, 2011), it is estimated that, as of 2010, new energy from waste (EfW) technologies are able to produce power for about 6% of the ACT's needs. The ACT is considering the development of a new market for energy recovered from C&D waste. On this basis, in 2009, the ACT government commissioned URS-Eco Waste to provide a list of potential materials for the development of a market for EfW. According to their findings, the ACT can use 10%–20% of volume constituted by all waste streams for EfW. The waste strategy document proposes one strategy for EfW activities: Strategy 4.3 (expand bioenergy generation and investigate new energy-from-waste technologies to generate energy).

The ACT government does not have a specific guideline for EfW and the proposals for energy recovery projects are regulated under the Planning and Development Act 2007. The ACT is working to produce an EfW policy in winter 2019. In doing so, some suggestions will be provided; these include consideration of feed-in tariffs and carbon price mechanisms (Act NoWaste, 2018). Furthermore, it is advised that the 'community support and 'buy-in' initiative' are critical factors for successful development of EfW policy (Transport Canberra and City Services, 2018).

In NSW (2018), a policy statement describes the requirements for waste energy recovery for general waste. This policy covers thermal EfW technology, sets out resource recovery criteria and provides a list of eligible (low-risk) waste fuels. According to this document, the percentage of residual waste allowed for energy recovery of C&D waste material is only up to 25% of the waste stream received at the processing facility. Although the policy presents regulatory certainty to the industry through setting the minimum requirements for the establishment of EfW facilities, there is evidence provided by the Hunter Joint Organisation of Councils that current the Waste to Energy Policy presents a barrier to the development of EfW facilities (Environment and Communications References Committee, 2018). In the Protection of the Environment Operations Act 1997, the definition of energy recovery refers to two categories:

- 1 from general waste
- 2 from hazardous and other waste.

The Act recognises an energy recovery practice when there is a recovery of more than 200 tonnes of waste. In the NT, there is no specific policy or plan to guide activities on energy recovery.

In Qld, a strategy document (Queensland Government, 2014) revealed the opportunities in the state's waste management, including new technologies to take advantage of energy recovery activities. Under this opportunity, the need for the development of specific policy is emphasised. Interestingly, Qld has released a Direction Paper (Transforming Queensland's Recycling and Waste Industry 2017) that considers energy captured from landfill gas and incineration material loss. This is in contradiction with the EOW framework premises, in which there is a baseline determining when waste

is not waste anymore and becomes a source. However, this state is exploring the potential of EfW, which is meant to develop a policy to promote the safe and sustainable delivery of waste-to-energy. Along these lines, the state government has committed to the funding of \$5 million for EfW projects for its 2018-2019 budgets, sourced from the landfill levy revenue (Queensland Budget, 2019).

SA is a pioneer in implementing EfW practices, beginning in February 2010 when the first Australian Standard for the Production and Use of Refuse Derived Fuel (RDF) was released. These standards, which are aligned with the objectives of the primary waste-related act (Environmental Protection Act 1993) and the Environmental Protection (Waste to Resources Policy 2010), outlines a risk-based approach to address the issues and considerations of producing and using RDF.

In SA, the EPA has initiated efforts to develop policy guidance for EfW facilities. A document (EPA SA, 2018) published as a result provides advice on how to grow this industry in the state. In 2018, the EPA SA invited the relevant stakeholders to comment on the considerations regarding the establishment of EfW position statement. SA's Waste Strategy document (2015–2022) indicates the issue of residual waste in SA and provided advisory support for adopting new technologies and processes to effectively manage residual waste streams.

In WA, there is not much support for energy recovery practices. The only relevant benefit espoused regarding waste related regulations is the exemption provided for the waste that is received at landfill for collecting and sorting purposes and will later be used for energy recovery. This exemption, enshrined in the Waste Avoidance and Resource Recovery Levy Regulation 2008, exempted landfill owners, by application, from paying the levy. In the waste strategy of this state, a target has been set to make sure that energy recovery practices are only applied to residual waste by 2020; this limitation reflects a commitment to following the most favourable options in the waste hierarchy. WA also released an EfW position statement in 2013 that contained general information about energy recovery potential in the state. It also recognised the need for significant developments in policies, regulations and technologies. In the same year, WSP Environmental Co was tasked with conducting a literature review on the regulatory framework, available technologies and other matters related to EfW. At the conclusion of those tasks, some recommendations were made to the WA's Minister of Environment to consider developing the EfW industry in the state (WSP Environmental, 2013). A comprehensive review of energy from waste activities in Australia is presented before (Shoostarian et al., 2019c).

3.8 Education and engagement

The role of education is highly emphasised in various waste management systems. In ACT, awareness, education and action are indicated to be necessary to reduce the waste generated and to maximise resource recovery. In NSW, education as one of the main pillars of waste strategy in this state is recommended to raise community awareness about illegal dumping repercussions. The NSW's strategy document states that education to encourage behaviour change will be fundamental to attain its goals. In NT, 'engagement and education' are among the five strategies for better waste management. This territory believes that education should improve community understanding of resource efficiency, waste avoidance, and resource recovery. In NT's authority, views education should be provided through best-practice guidance materials for handling and disposing of

commercially generated waste. In Qld, to manage priority waste (e.g., C&D waste) education and awareness campaigns are advised to target reduced generation and enhanced recovery. Furthermore, the relevant strategy document indicates that engagement and education are fundamental to behaviour change achievement that will later be reflected in better decisions and long-term improved practices. In WA, consistent state-wide engagement and education on waste avoidance behaviours with an emphasis on focus materials was assumed to result in less waste generation. In this state, developing education and engagement resources were found necessary to communicate the benefits of resource recovery and the use of recycled products, and to minimise contamination in collection systems.

3.9 Market development

Market development, as the main strategy to manage various waste streams (Shooshtarian et al., 2019d), is highlighted in the study documents. In ACT, market development for recyclable materials together with strengthening regional connections is advised for full resource recovery. In NSW, market development and encouragement of innovation are put forward to increase waste recovery. In NT, to improve waste management facilitation of opportunities to connect waste recover and reuse markets with key waste producers are suggested. In Qld, the need for building a stable and efficient market for an investor is necessitated. In WA, the issue of market development is better planned, under the second strategy of their Waste Strategy document; recover (WA recovers more value and resources from waste). The actions proposed in this strategy include the study of opportunities to promote local markets through government procurement actions and collaboration between the industry and WA's government to support market development, provide funding to promote using recycled products and market establishment, legislative support for encouraging use of recycled products and increase their demand and development of market, moving towards sustainable procurement by the WA government to support local market development. A review on factors impacting the domestic market development in Australian C&D waste is presented in Shooshtarian et al. (2019d).

One example of such a marketplace in Australia is Advisory System for Processing, Innovation and Resource Exchange (ASPIRE) platform. ASPIRE is an online marketplace (<https://aspire.csiro.au/>) which intelligently matches businesses with potential purchasers or recyclers of waste by-products. ASPIRE was developed by the CSIRO under the State Government of Victoria's Digital Futures Fund in the partnership with several Victorian councils, its operation officially kicked off as of 2018. This system requires patrons to enter details about the type and quantity of their exchangeable inputs and waste materials (outputs). Using this data, ASPIRE's Supply Chain Options Model determines optimal sources and destinations for the materials, including options for aggregation with other local businesses, appropriate investment opportunities such as compactors for low- density wastes, and local recyclers. ASPIRE is deployed using existing established council and manufacturing business networks and supports local government business sustainability programs. It captures and codifies SME material inputs, outputs (waste and by-products) and processes and has a powerful optimisation model that takes this data and provides an SME user with three things:

- a suggested B2B resource matches, both substitute inputs or sources and output destinations
- b personalised search results to support the suggested matches
- c case studies for related resource matches.

4 Conclusions

The issue of C&D waste has become more serious during the last two decades after increased construction activities and new waste policy by foreign countries. Waste strategy documents that are issued in Australian jurisdictions lay the foundations of jurisdictional waste regulatory and best practice management guideline. This study was conducted to review waste strategy documents in Australian jurisdictions to explore how they contribute to a better management of C&D waste stream. Among the eight study jurisdictions, Vic and Tas did not have a current waste strategy and hence were excluded from the review. The waste strategy documents were reviewed in the light of main issues around C&D waste stream including revision of legislative framework, definition waste as opposed to resource, waste recycling and recovery, illegal dumping, EPR, education and engagement, and market development. It is expected that the information obtained in this review study informs the efforts to improve waste strategy documents and fortiori C&D waste regulations and policies. It also provides insight into the overall policy making and practice of the C&D waste management in Australia.

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