

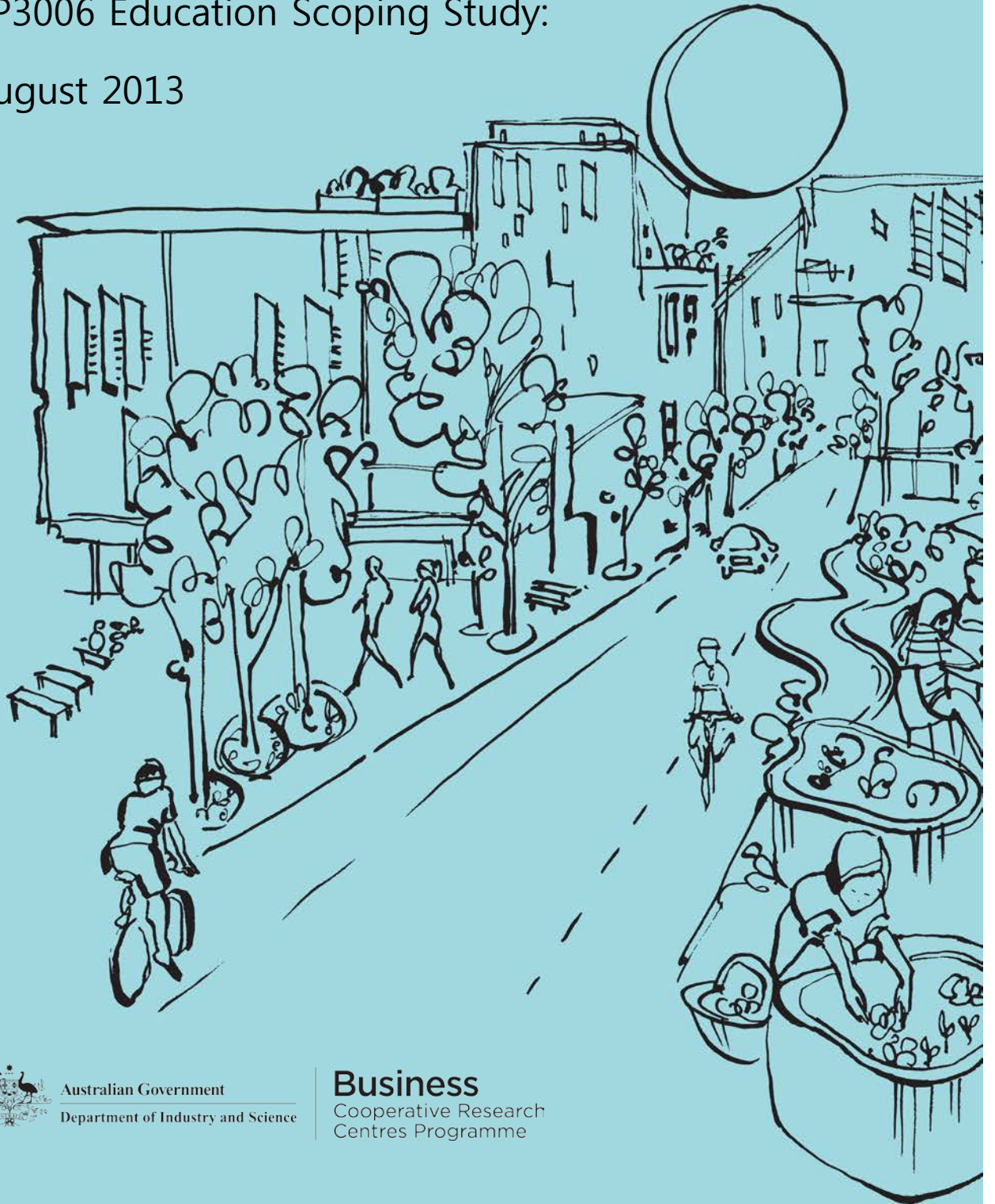


**LOW CARBON LIVING
CRC**

Education for low carbon living Final Report

RP3006 Education Scoping Study:

August 2013



Australian Government
Department of Industry and Science

Business
Cooperative Research
Centres Programme

Authors	
Title	RP3006 Education Scoping Study
ISBN	
Format	
Keywords	
Editor	
Publisher	
Series	
ISSN	
Preferred citation	

CRC PARTICIPANTS INVOLVED

Research Team

Tomi Winfree, Chief Investigator, Swinburne University of Technology, Swinburne Institute for Social Research (SISR) and the National Centre for Sustainability

Dr Aneta Podkalicka, Swinburne University of Technology, SISR

Charlie Hargroves, Curtin University, Curtin University Sustainability Policy Institute (CUSP)



Partner Investigators

University of Melbourne, Australian Urban Research Infrastructure Network (AURIN)

- Dr Jack Barton
- Associate Professor Chris Pettit
- Emma Joughin



Sydney Coastal Councils Group

- Geoff Withycombe, Regional Coastal Environmental Officer / Executive Officer
- Stephen Summerhayes, Senior Coastal Projects Officer



Project Advisory Committee

- CSIRO represented by Dr Stephen White (CRC LCL Program 3 Leader).
- Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education represented by Jason Van Ballegooyen, Previously Acting Director, Workforce Innovation & Sustainability and Paul Beerworth, Assistant Director
- Master Builders Association represented by Dr Alex Maroya (National Training Director)
- Victorian Building Authority represented by Rob Enker (Sustainability Manager) and Jenshi Joshi.
- Swinburne University of Technology represented by Professor Jay Sanjayan (Centre for Sustainable Infrastructure), Professor Shirley Leitch (Leader of the Socially Sustainable Technologies Flagship) and Elizabeth Merlot (Research Associate).
- Curtin University represented by Dr Rob Salter (Curtin University Sustainability Policy Institute).
- University of New South Wales represented by Professor John Merson (Director, Blue Mountains World Heritage Institute)
- University of New South Wales represented by Dr Susan Thompson, (Director, Healthy Buildings).

Organisations Consulted

- AECOM
- Australian Department of Climate Change and Energy Efficiency
- Australian Department of Infrastructure and Transport, Major Cities Unit
- Australian Institute of Refrigeration, Airconditioning and Heating,
- Australian Sustainable Built Environment Council
- Australian Windows Association
- BCI Media Group
- BuildSMART Australasia
- Consult Australia
- CSR
- Energy Efficiency Council
- Green Building Council Australia
- Hassell
- Housing Industry Association
- Master Builders Association (MBA)
- MBA Victoria
- NSW Department of Planning & Infrastructure
- Planning Institute of Australia
- SA Department of Environment, Water and Natural Resources
- SA Department of Further Education, Employment, Science and Technology
- SA Department of Manufacturing, Innovation, Trade, Resources & Energy
- Standards Australia
- Sydney Coastal Councils Group
- Sydney Institute - TAFE NSW
- Sydney Water
- University of New South Wales
- Urban Growth (NSW)
- Urban Renewal Authority (Renewal SA)
- Victorian Building Commission
- WA Department of Transport

Survey Participants

Self - nominated for inclusion in Final Report includes 15 of 101 respondents (distribution to over 400+ individuals).

- Carbon Training International
- Cartesia Architects
- Curtin University
- Environment and Sustainable Development Directorate (ACT Government)
- Northern Alliance for Greenhouse Action (VIC)
- NSW Office of Environment and Heritage
- PIDCOCK: Architecture + Sustainability
- Schimminger Architects
- Sydney Institute (TAFE NSW)
- The Association of Building Sustainability Assessors
- The Royal Australian Institute of Architects
- University of Melbourne
- University of New South Wales
- Urban Renewal Authority (Renewal SA)
- VIC Forests

CONTENTS

CRC PARTICIPANTS INVOLVED	2
CONTENTS	5
LIST OF TABLES	7
LIST OF FIGURES	8
EXECUTIVE SUMMARY	9
BACKGROUND	12
DEFINING LOW CARBON LIVING	12
AIMS	12
Importance of Scoping Studies	12
LINKS TO CRC MILESTONES	13
LINKS TO CRC VISION	13
SCOPE	13
Mapping	14
TERMS OF REFERENCE	16
Summary of government education and training policy	16
Industry policy	19
METHODOLOGY	22
RESEARCH DESIGN	22
OVERVIEW OF RESEARCH METHODOLOGY	22
SUMMARY OF KEY FINDINGS	23
OVERVIEW	23
FACTORS INFLUENCING THE DEMAND FOR LOW CARBON LIVING	23
Low carbon living drivers and barriers	24
Priority barriers requiring further CRC investigation	25
Frameworks, standards and guidelines currently used	26
PRIORITY OPPORTUNITIES FOR LOW CARBON LIVING IN THE BUILT ENVIRONMENT	26
Key built environment opportunities	26
Key support areas identified	29
CRITICAL OCCUPATIONAL ROLES AND ASSOCIATED KNOWLEDGE AND SKILLS	30
Occupational Roles	30
Critical knowledge and skills required	33
Potential knowledge and skills gaps	36
CAPACITY BUILDING FOR LOW CARBON LIVING	36
Requirements for capacity building	36
Available low carbon capacity building programs	37
Preferences for education services and products	39
PREFERENCE FOR DELIVERY OF CAPACITY BUILDING	39
Preference for capacity building provision	40
Preferred engagement methods	42

Preferred duration of program.....	42
Capacity building support mechanisms.....	42
Performance metrics.....	45
PARTNER FINDINGS	45
The Australian Urban Research Infrastructure Network exploration	45
Sydney Coastal Councils Group exploration.....	46
POTENTIAL FUTURE PRIORITY RESEARCH AREAS	48
CONCLUSION & RECOMMENDATIONS.....	51
KEY FINDINGS ALIGNED TO CRC MILESTONES.....	52
CAPACITY BUILDING STRATEGY	52
DIMENSIONS OF CAPACITY BUILDING	56
Communication and Engagement.....	56
Education transformation	62
Technology in practice	63
Leadership in practice.....	66
Collaboration and partnerships	67
Policy and standards.....	68
APPENDIX : SURVEY RESPONSES DETAILS	71
REFERENCE	75
ADDITIONAL REFERENCES	76

LIST OF TABLES

Table 1: Summary of government education and training policy.....	17
Table 2: Summary of industry policy	20
Table 3: Examples of codes, standards, frameworks, guidelines and tools used by organisations.....	26
Table 4: Summary of key opportunities to support low carbon living in the built environment sector	27
Table 5: Summary of key job roles, knowledge, skills and supporting programs	37
Table 6: Available capacity building programs supporting low carbon in the built environment	38
Table 7: Milestone alignment with recommended capacity building projects	53
Table 8: Community and engagement recommendations	59
Table 9: Education transformation recommendations	62
Table 10: Technology in practice recommendations	64
Table 11: Leadership in practice recommendations.....	66
Table 12: Collaboration and partnership recommendations.....	67
Table 13: Governance and standard recommendations	68
Table 14: Survey participant responses indicating the prioritised opportunities to support low carbon living in the built environment	71
Table 15: Key opportunities to support low carbon living in the built environment	73

LIST OF FIGURES

Figure 1: CRC participant mapping	15
Figure 2: Top prospective influences on organisation’s plans or intentions to contribute to low carbon living	24
Figure 3: Top barriers to engagement in educational or capacity building programs to transition to LCL	24
Figure 4: Summary of support required and prioritised in these key areas over the next 5 years to efficiently transition..	29
Figure 5: Survey responses on the 3-5 most critical existing occupational roles requiring capacity building to support low carbon living	31
Figure 6: Intentions to develop or engage with new job roles.....	32
Figure 7: Survey responses on current engagement in low carbon living education programs.....	37
Figure 8: Survey responses on performance metrics that influence participation in programs.....	41
Figure 9: : Survey responses on the most suitable method for accessing knowledge and skills to build capacity in LCL.	41
Figure 10: 3-5 most effective methods for engagement in education programs.....	43
Figure 11: Survey responses on preferred duration of engagement in an education program.....	44
Figure 12: Critical support mechanisms required by organisations	44
Figure 13: Types of online knowledge management tools	45
Figure 14: Systemic and cumulative approach to capacity building and support requirements	55

EXECUTIVE SUMMARY

The demand for low carbon living (LCL) is steadily growing across the world. Many industry sectors are looking for new opportunities to innovate, enhance productivity, reduce operational costs and contribute to sustainability. Householders are looking for solutions to reduce household bills, contribute to the community and live healthier lifestyles. Governments are also being asked to respond to the challenge of climate change in such a way that it also delivers benefits to industry and communities. The Cooperative Research Centre (CRC) stands to play a critical role in the coming decades to enable industry, householders and government to transition to LCL. The activities of the CRC are industry focused, aimed at assisting the built environment (BE) sector in Australia to reduce carbon emissions by 10 metric tons of carbon dioxide equivalent per year (10MTCO₂-e/yr) by 2020. A key aspect of achieving this goal will be to provide greater clarity around the needs of various stakeholders to appropriately identify and implement opportunities, increasing the capacity of stakeholders to deliver and implement LCL options along with providing government and industry clear guidance on increasing requirements and incentive strategies for such options.

This report outlines the findings from an *Education Scoping Study* (Study), commissioned by the CRC, to identify key areas for education and capacity building¹ for LCL of particular interest to CRC members and participants, through research, interviews, and a survey. The overall findings present a valuable resource to inform the development of projects across the CRC and target specific areas of industry and community engagement.

¹ For the purposes of this study, 'education' refers to capacity building provided through vocational education and training, higher education, industry professional development and community engagement, unless otherwise noted.

Summary of key findings

The Study findings indicate that a cumulative, collaborative, and systemic education and capacity building approach is required in order to transition to a low carbon built environment. Furthermore, strong sector leadership and effective cross-sector communication methods are required to bridge the perceived divide between industry sub-sectors and stakeholder groups. Therefore, an industry wide strategy should be developed to underpin the education and capacity building programs. This approach will draw attention to critical practices required across the entire industry to identify opportunities to be fully captured through stakeholder engagement, planning, design, construction, use and renovation or regeneration enabling a successful transition to low carbon living. Education programs must increase awareness and develop participants' capacity to identify 'fit for purpose' low carbon opportunities and the associated asset value, financial return, savings or benefits related to health and the community.

These benefits must be fully understood and communicated by intermediaries² to the decision makers³ to stimulate demand. The education initiatives must also be designed, implemented, and evaluated in an integrated or systemic way across multiple levels of practice and involving multiple stakeholder groups. This report highlights these key areas as opportunities corresponding with the identified *Dimensions of Capacity Building*.

Most job roles engaged in the BE or supporting industries will require enhanced knowledge and skills to

² Intermediaries are stakeholders who act as gatekeepers to information, assessment of opportunities or make recommendations that influence decision makers, such as property and retail services officers, built environment professionals and tradespeople, government agents, etc.

³ Decision makers are any persons or groups of people that make purchasing, use or lifestyle decisions.

successfully and effectively meet the demand for a low carbon BE now and in the longer term. Based on the biggest impacts and opportunities, the critical roles currently requiring capacity building include those of planners, building owners/managers, property services professionals, designers, architects, engineers, estimators, builders, project managers, facility managers, building assessors (energy and sustainability) and trades people. As the BE labour force needs up-skilling, so do education practitioners. It is therefore highly recommended that professional development programs be supported by an integrated approach targeting both groups within the same training program. A few potential new job roles were identified, such as:

- Integrated Energy Efficiency Retrofits Leader (new accreditation under developmentⁱ)
- Building Services Engineerⁱⁱ (listed as a specialisation under 233512 Mechanical Engineer in the release of ANZSCO Version 1.2, slated for May 14)
- Integrated Design Leader
- Weatherisation Installer or Technician
- Refrigeration Engineer (as a formalised occupation).

It is anticipated that the following roles will potentially increase in demand to effectively measure, manage and monitor energy use as well as carbon abatement:

- Building Assessor and Analyst (energy, GhG and sustainability)
- Building Scientist
- Building Management System (BMS) Controller (IT / electrical engineer / controls specialist)
- Education Professional
- Sustainability / Carbon / Climate Change Manager.

Gaps, barriers and opportunities

The survey findings indicate two key initiatives that require greater support over the next five years to bridge gaps and efficiently transition to LCL, namely: *Education programs to support low carbon living* (which received

the most ‘Highest Priority’ responses), and *Communication about low carbon living*.

Findings across the Study regarding the identification of barriers to LCL in the BE sector further supported these survey findings. The survey identified the following key barriers (in order of most to least selected):

- communication and awareness across various audiences on low carbon opportunities, methods, and technology
- availability of expertise and resources (human, financial, technological, etc.) and LCL-related education programs
- availability of technology, and tools.

During the consultation phase, further key barriers were identified:

- fragmentation of construction processes, practices, policy and poor consumer engagement
- construction quality and affordability
- risks associated with new products, variations to standard practice, short contractual responsibility and a lack of evidence-based cost–benefit analysis
- a lack of sector wide direction / targets, metrics and long-term policy.

Capacity building strategies

The Study reinforces that the current knowledge and technology used to value, plan, design, construct and operate the BE efficiently in Australia aren’t being implemented to the extent possible. The outcomes of the Study, clustered under the overlapping *Dimensions of capacity building*, suggest that the following areas should be given strong consideration by the CRC for inclusion in current and future projects:

- communication and engagement
- education transformation
- technology in practice

- leadership in practice
- collaboration and partnerships
- policy and standards.

Based on the survey and consultations, the top three critical support areas required to transition to LCL are:

- industry professional development delivered by external providers (not in-house programs, provision offered through an external education provider)
- higher education and vocational education and training focused on enhancing existing occupational job roles
- community/consumer engagement and government engagement focused on the key opportunities identified.

Typically, engagement in ongoing professional development programs is optional. Therefore, it is critical to embed the identified education opportunities into trade and professional curricula in education institutions as well as post-qualification industry and professional development programs. The industry engagement methods preferred by those surveyed include:

- face-to-face lead by a facilitator
- demonstration, conference or networking events
- work experience or on the job training
- mentoring or coaching program for individuals or small groups
- interactive online self-paced learning programs.

The consultations revealed the ongoing challenges of engaging professionals and trades in face-to-face training given the reality of professional development fatigue. The opportunities highlighted relate to independent and flexible learning, accessible when required, such as case studies, business cases, physical or virtual demonstrations, and a move toward online learning and tools (dependent on the audience and content), such as combinations of available materials and technology for whole systems, online calculators,

modelling tools, collaboration and social media engagement.

Based on those surveyed, the preferred duration of industry engagement in a program includes:

- seminar—one hour to one day with information only
- integration into current practice or job role
- qualification programs (VET / higher education) or short courses (one to four days) with assessment.

The metrics that influence the decision to engage in a capacity building program include the credibility of the program delivery team and organisation; accreditation from professional bodies; or endorsement from industry associations.

This report not only identifies the dimensions of capacity building required to successfully transition to LCL, but also the research findings that enabled the identification of these key areas:

- factors influencing demand
- priority opportunity areas
- critical roles, knowledge and skills
- capacity building preferences
- potential use of AURIN by the CRC participants and opportunities specific to local governments
- future research areas

BACKGROUND

DEFINING LOW CARBON LIVING

Given a range of existing definitions, the survey investigated respondents' agreement with a proposed definition for 'low carbon living in the built environment'. The following definition received agreement from just under 69 per cent of respondents:

Definition: *'Low carbon living in the built environment involves minimising carbon and other greenhouse gas emissions, specifically aligned to opportunities in the built environment in a manner that supports sustainable economic development, the natural environment and healthy, resilient communities.'*

Additional comments on improving the definition included:

- The definition needs to be measurable or it will be ineffective—recommendation to stipulate the amount of emissions shouldn't exceed two to three tonnes per person per annum.
- Governance must be included in the definition.
- The definition needs to change to be 'within all aspects of the built environment'.
- Rather than 'minimising', use other words such as 'improves', 'maximising' or 'optimising' or 'transitioning' our BE and lives with low carbon solutions.
- The definition needs to emphasise 'enhancing the natural environment to reduce emissions too'.

AIMS

This *Education Scoping Study* (Study) was designed to survey leading stakeholder groups and CRC participants engaged in existing low carbon education programs in order to identify perceived barriers and opportunities, required knowledge and skill sets, key industry, community and enabling roles across the built environment (BE) sectors to contribute toward a low

carbon living (LCL) society. The data and study outcomes will be used to inform the direction, evaluation and monitoring of the CRC activities and to enable CRC partners to plan further research and foster project initiatives aligned with CRC's key aims. As such, this study is conceived to benefit educational, government, industry and community groups across Australia.

The main aims were to:

- determine existing opportunities and barriers to providing LCL products and services
- identify relevant roles, delivery mechanisms, evaluation and monitoring methods to support educational and training programs
- identify future priority research areas for capacity building to be supported by the CRC LCL.

This report outlines the findings from the Study, commissioned by the CRC, to identify key areas for education and capacity building⁴ for LCL of particular interest to CRC members and participants, through research, consultations, and a survey. The overall findings present a valuable resource to inform the development of projects across the CRC and target specific areas of industry and community engagement.

Importance of Scoping Studies

CRC Scoping Studies are intended to provide a mechanism for CRC partners to initiate research in areas of keen interest to the CRC and its constituent research programs, to plan its research directions, and facilitate its research projects, and to ensure delivery of its milestones. The BE and associated practices and behaviours include multifaceted opportunities for carbon abatement in Australia. Therefore, the identification and availability of the relevant knowledge, skills and capacity building programs across industry, government and communities and the barriers to implementation are

⁴ For the purposes of this study, 'education' refers to capacity building provided through vocational education and training, higher education, industry professional development and community engagement, unless otherwise noted.

critical in developing and researching programs aimed at achieving the CRC's targets immediately and into the future.

LINKS TO CRC MILESTONES

This project is aligned with the CRC for LCL Program 3: Engaged Communities, year one Milestone 3.4, a survey and gap analysis of existing low carbon education and training programs of selected CRC precincts. The key findings and recommendations of this Study have been aligned with CRC milestones as outlined below:

The initial aim of the Study was to inform Milestone R3.4.3 and R3.4.6, listed below, by providing findings that can guide the form of such programs and inform about the target audiences, as summarised further below.

- R3.4.3 'Initial design of educational, training, and monitoring programs, for the specific communities across the CRC' (30 JUN 14).
- R3.4.6 'Pilot educational, training, and targeted professional development program for Built environment professions' (30 JUN 15).

In doing so, the Study provides valuable guidance to Milestones in both Research Programs 1 and 2, and has the potential to support the delivery of a number of Utilisation Milestones in Research Program 3, as well as drawing from the research outcomes of all programs. This is demonstrated in Table 7: Milestone Alignment with Recommended Capacity Building Projects.

LINKS TO CRC VISION

The broad aim of the CRC is to provide government, industry and community groups with social, technological and policy tools to overcome identified market barriers preventing adoption of cost effective low carbon products and services, while maintaining industry competitiveness and improving quality of life. An improved understanding of current education, training, and capacity building programs is a key component in determining the key priority areas for barriers inhibiting

the successful uptake of low carbon opportunities in the BE. The gaps and barriers identified will determine the priority education and research programs requiring CRC support to build strategic partnerships to develop, enhance, deliver and evaluate new low carbon education and capacity building programs as designated by leading experts and international best practice.

SCOPE

Exploratory research was undertaken with CRC participant representatives and leading industry expert groups through quantitative and qualitative survey methods in parallel with qualitative consultation methods, to identify the supply of education courses, areas of high demand or enhanced knowledge and skills needs, critical gaps in delivery, barriers and bottlenecks to the delivery of education and training and the preferred delivery methods and duration.

This study has built on the methodology and findings of two unpublished reports, *Review of Energy Efficiency Skills Demands and Training Provision across the Trades and Professions* (Commonwealth Department of Innovation, 2012) and *Skills for Carbon Abatement* (Victorian Skills Commission, 2011). Both included a survey and gap analysis of existing low carbon education programs in Victoria and across Australia. This Study reviewed only the education programs in the BE aligned with CRC precincts to inform the direction, evaluation, and monitoring of the CRC's education research to accelerate toward LCL. The emphasis was on the tertiary education sector and professional development, although community engagement was discussed as was transportation relative to how the BE can support active transportation.

The project included:

- primary objectives: 5 investigation of the BE industry sectors and associated end users (community)

⁵ See Section 2.6 Terms of Reference.

based on the key CRC areas aligned to occupations requiring the capacity to support LCL products, services and advice to determine the current demand for, gaps in and inhibitors of low carbon education and implementation in Australia based on key areas of focus of the CRC

- literature review and mapping, as shown in Figure 1, to inform the consultations
- survey and consultation with key CRC participant organisations and peak bodies
- exploration of the use of AURIN to identify the potential for alternative uses and the knowledge and skills required to successfully utilise it
- exploration of the role of local government including councillors and technical staff involved in the Sydney Coastal Councils Group.

Mapping

To determine the project scope the CRC participants were mapped based on key areas of the BE as identified in *Figure 1: CRC participant mapping* to identify the potential occupational roles and opportunities associated with LCL relevant to the CRC participants.

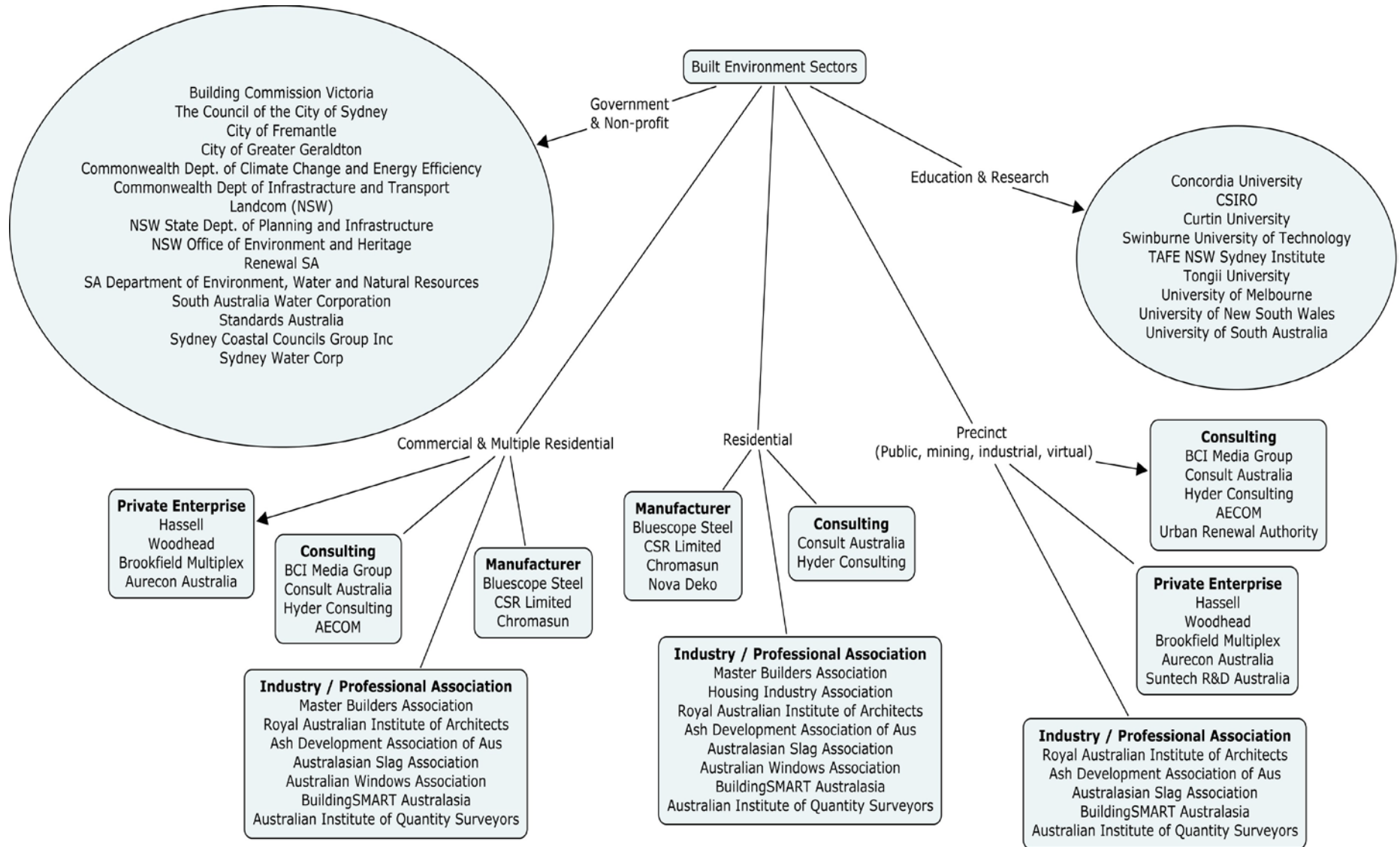


Figure 1: CRC participant mapping

TERMS OF REFERENCE

This Study draws on a multidisciplinary research team offering a solid background for future research projects within the CRC drawing on insights from innovation scholarship, theories of social change and practiceⁱⁱⁱ, whole system' theories and only a selection of examples of international best practice. The Study findings were compared against the literature review and visioning sessions to develop recommendations for education development, communication strategies, new delivery models, evaluation and support methods to transition to low carbon communities.

The Study findings include:

- identification of factors influencing organisations, including key drivers and barriers
- identification of key opportunities, job roles and associated knowledge and skills
- identification of education provision and uptake
- recommendations for new education, training and monitoring programs to build capacity, enabling industry, government and communities to adapt to a low-carbon future.

From the onset of the project, an Advisory Committee was established to provide guidance and support throughout the project. In addition, the research team worked closely with two partner organisations to highlight local government opportunities to engage communities effectively and an information portal to support planning and research. These two key areas of this Study were developed in partnership with the Sydney Coastal Councils Group and the Australian Urban Research Infrastructure Network (AURIN).

Definitions for the purposes of this study

- 'Education' includes vocational education and training, higher education, industry professional development and community engagement and capacity building, unless otherwise noted.

- 'Built environment' (BE) includes buildings, infrastructure and spaces constructed or developed to support communities.
- 'Tertiary education' includes university courses and vocational education and training.

Summary of government education and training policy

Table 1 highlights a sample of the current policies supporting sustainability and green skills capacity building, including energy efficiency, clean energy at the commonwealth level. There are also a number of community programs and local government up-skilling or improvement programs. Overall, the emphasis is on energy efficiency for professionals and trades and educator capacity building in skills for sustainability or education for sustainability. These educator courses aim to build knowledge and skills to enable educators to be well versed in all aspects of sustainability to determine where and when it is most appropriate to integrate opportunities into their courses regardless of the requirements. Based on the programs thus far, one of the main areas still requiring support is industry engagement and collaboration.

The CRC is well placed to support both of these endeavours. The other opportunities for the CRC are to ensure carbon measurement and management are included in the training in parallel with energy conservation, energy efficiency and clean energy, to disseminate resources and research findings to support training through the existing networks and to deliver training to educators and industry practitioners and at the same time to develop ongoing industry collaboration. As the CRC invigorates a sector to engage in the transition, there are many opportunities to develop more education on the position aspects, such as regeneration, resilience, adaptation, zero carbon building and carbon positive buildings.

Table 1: Summary of government education and training policy

Policy, Government Department	Target Audience Key Areas	Link
<p>Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (Department of Innovation)</p>	<p>Commonwealth Department Climate Change and Skills for Sustainability supports a number of relative policies that support resource development, education, training and professional development. The three education areas include:</p> <ul style="list-style-type: none"> • green skills agreement • skills for the carbon challenge initiative • clean energy and other skills package. <p>Additional measures include:</p> <ul style="list-style-type: none"> • prime minister's task group on energy efficiency • national strategy on energy efficiency • HVAC high efficiency systems strategy • solar cities • energy efficiency in government operations. 	<p>http://www.innovation.gov.au/pages/default.aspx</p>
<p>The Department of Innovation Professional Development Programs for VET Practitioners</p>	<p>Vocational education and training:</p> <ul style="list-style-type: none"> • professional development programs for VET practitioners in skills for sustainability • models for professional development • accredited training options • five challenges and opportunities • next steps <ul style="list-style-type: none"> ○ leadership through activities and collaboration with states and territories ○ resources ○ people 	<p>http://www.innovation.gov.au/Skills/SkillsTrainingAndWorkforceDevelopment/ClimateChangeAndSkillsForSustainability/Pages/ProfessionalDevelopmentProgramsForVETPractitioners.aspx</p>
<p>Department of Innovation Skills for the Carbon Challenge</p>	<p>Tertiary education (research, higher education, vocational education and training and workforce skills):</p> <ul style="list-style-type: none"> • aimed at supporting the transition to a sustainable, low carbon economy through opportunities to learn new skills for sustainability and enhance existing skills, knowledge and practices; objective is to build the capacity of the tertiary education sector to supply the skills needed for workers and businesses to prosper in a sustainable, low-carbon economy • The Skills for the Carbon Challenge initiative supports: <ul style="list-style-type: none"> ○ investing in research to develop a better understanding of the underlying skills issues associated with the transition to a low-carbon economy and appropriate responses ○ presenting the Skills for Sustainability—Educational Institution Award to encourage excellence in the delivery of education and training for sustainability. • Examples of programs include: 	<p>http://www.innovation.gov.au/Skills/SkillsTrainingAndWorkforceDevelopment/ClimateChangeAndSkillsForSustainability/Pages/SkillsForTheCarbonChallenge.aspx</p>

	<ul style="list-style-type: none"> ○ Workforce Innovation Program ○ Up-Skilling Existing Workers in Skills for Sustainability Pilot. 	
Department of Innovation Clean Energy Skills	<p>The Package has four elements:</p> <ul style="list-style-type: none"> • baseline mapping project • trades training • professional training • integration of energy efficiency skill focused on energy efficiency skills in the building and construction sectors, low emission technology and clean energy skills such as renewable energy. 	http://www.innovation.gov.au/Skills/SkillsTrainingAndWorkforceDevelopment/ClimateChangeAndSkillsForSustainability/Pages/CleanEnergySkills.aspx
Department of Innovation Skills for Sustainability (VET)	<p>Up-Skilling Existing Workers in Skills for Sustainability pilot</p> <p>\$1 185 000 was provided under the Workforce Innovation Program to three Industry Skills Councils:</p> <ul style="list-style-type: none"> • Construction and Property Services • ElectroComms and Energy Utilities • Manufacturing Skills Australia. <p>The project supports workers' access to industry-relevant skills for sustainability training. Skills for sustainability skill sets, as identified by the Industry Skills Councils, will be delivered by selected Registered Training Organisations.</p> <p>Department of Industry, Innovation, Science, Research and Tertiary Education has engaged KPMG to undertake a formative evaluation of the project.</p>	http://www.innovation.gov.au/skills/SkillsTrainingAndWorkforceDevelopment/ClimateChangeAndSkillsForSustainability/Pages/default.aspx
The Office for Learning and Teaching is part of the Department of Industry, Innovation, Science, Research and Tertiary Education.	<p>Higher Education</p> <p>The OLT has funding of \$58.9 million over four years through the Promotion of Excellence in Learning and Teaching in Higher Education Program. The OLT promotes and supports change in higher education institutions for the enhancement of learning and teaching.</p>	http://olt.gov.au/about-olt
Education: Events and Resources, Australian Building Codes Board	<p>Building Industry & Practitioners:</p> <ul style="list-style-type: none"> • ABCB Awareness and Education Framework • Awareness Resource Kits • Module Three—Understanding Energy Efficiency Provisions for Class 1 and Class 10 Buildings • Module Four—Understanding Energy Efficiency Provisions for Class 2 to 9 Buildings • Condensation in Buildings (2011) • Using On-Site Renewable and Reclaimed Energy Sources (2011) • A series of Energy Efficiency Handbooks • Information Seminars and National Conference 	<p>http://www.abcb.gov.au/en/-/media/Files/Download%20Documents/Education%20and%20Training/Final%20Awareness%20and%20Education%20Framework.pdf</p> <p>http://www.abcb.gov.au/education-events-resources/NCC-awareness-resource-kits/preview-of-resource-kits</p>
Department of Infrastructure and Transport	<ul style="list-style-type: none"> • National Urban Policy • Major Cities Unit • Liveable Cities Program 	<p>http://www.infrastructure.gov.au/infrastructure/mcu/urbanpolicy/index.aspx</p> <p>http://www.infrastructure.gov.au/infrastructure</p>

	<ul style="list-style-type: none"> • Urban Design Protocol • Active Travel 	http://www.infrastructure.gov.au/infrastructure/mcu/urbanpolicy/active_travel/index.aspx
Department of Finance and Deregulation	Commonwealth Property Management Framework	http://www.finance.gov.au/property/index.html
Department of Regional Development and Local Government	<ul style="list-style-type: none"> • Australian Council of Local Government • Community Infrastructure Grants Program 	http://www.regional.gov.au/
Department of Sustainability, Environment, Water and Population	<ul style="list-style-type: none"> • Sustainability Education • Living Sustainably • National Waste Policy: Less waste, more resources • Measuring Sustainability (indicators) 	http://www.environment.gov.au/education/index.html http://www.environment.gov.au/sustainability/index.html
Department of Resources, Energy and Tourism	<ul style="list-style-type: none"> • Smart Grid, Smart City • Energy Efficiency Opportunities • National Framework for Energy Efficiency (Trade and Professional Training) 	http://ee.ret.gov.au/energy-efficiency http://www.ret.gov.au/energy/Pages/index.aspx http://www.ret.gov.au/Documents/mce/energy-nfee/committees/trade/default.html
Office of Environment and Heritage NSW and the Department of Education and Communities NSW Energy Efficiency Training Program	The Energy Efficiency Training Program builds the knowledge and skills of tradespeople and professionals to support improved energy efficiency practices, products and services. Targeted energy efficiency training has the potential to stimulate new green jobs and add green skills to existing jobs by supporting innovation, workforce development and sustainable business growth.	http://www.environment.nsw.gov.au/sustainbus/trainingandeducation.htm
UTS Learning and Teaching Sustainability	Courses, Resources and a Community of Practice.	http://sustainability.edu.au/

Industry policy

Industry and Professional Groups and peak bodies have been working toward the transition to LCL and identifying the up-skilling requirements for industry. In addition to those listed in Table 1, past government reports, such as Skills for Carbon Abatement 2012 and the Built Environment Industry Innovation Council Final Report to Government 2012, have highlighted the need for more support for professional development aimed at the existing workforce, and for minimisation of industry fragmentation, through leadership, collaboration and partnerships between the tertiary sector (vocational education and training and higher education), industry and government to support more informed pathways for occupation roles aligned to the knowledge and skills required by industry. The findings from this CRC Study have continued to stress the need for knowledge and

skills development within the existing workforce. The workforce needs knowledge of and skills in measuring, monitoring, maintenance, abatement and communication strategies. It needs to develop planning and decision making tools and technical skills. It needs to be able to underpin foundation principles and guidelines with metrics for benchmarking. Table 2 provides a sample of relevant industry policies aligned with the project findings.

Table 2: Summary of industry policy

Industry or Professional Body	Description	Industry or Professional Body
ASBEC	<p>Policy Platform and Task Groups</p> <p>Latest:</p> <ul style="list-style-type: none"> • 2013: A Sustainable and Resilient Built Environment • Net Zero Emission Homes: An Industry Roadmap • Productive, Liveable and Sustainable Cities for Australia 	<p>http://www.asbec.asn.au/asbecs-policy-platform/</p>
Consult Australia	<ul style="list-style-type: none"> • Cities and Urban Development • Thought Leadership • Submissions • A New Deal for Urban Australia • Seizing the Sustainability Advantage • National Urban Design Protocol: Creating Places for People is a collaborative commitment to best practice urban design in Australia. The protocol is the result of two years of collaboration between peak community and industry organisations, States, Territories, Local Governments, and the Australian Government. • Green Star Communities Partner 	<p>http://www.consultaustralia.com.au/Home/Advocacy/CitiesandUrbanDevelopment.aspx</p>
Energy Efficiency Council	<p>Integrated Energy Efficiency Retrofit Accreditation Scheme—Public Consultation Paper on the proposed design of an accreditation scheme for the individuals who oversee and coordinate integrated energy efficiency retrofits of commercial buildings.</p> <p>Other key areas:</p> <ul style="list-style-type: none"> • recommendations for government policy • best practice guides • standard documents • resources • case studies • service directories to find facilitators and suppliers of services and products <p>The site also provides:</p> <ul style="list-style-type: none"> • energy efficiency service and product suppliers with access to the latest news from the sector • governments and the community with information on energy efficiency and the sector • Energy Efficiency members access to market insights and council activities 	<p>http://www.eec.org.au/documents</p> <p>http://www.eec.org.au/node/249</p>
Australian Institute of Architects	<ul style="list-style-type: none"> • Submission to the Federal Department of Climate Change & Energy Efficiency re National Building Energy Standard-Setting, Assessment & Rating Framework • Submission to the Productivity Commission re the PC's draft report on Barriers to Climate Change Adaptation 	<p>http://www.architecture.com.au/about-us/policy-advocacy</p>
Australian Institute of Refrigeration, Airconditioning, and Heating	<ul style="list-style-type: none"> • Offers accreditation for energy auditors • Closing the skills gap for building services and refrigeration engineers—officially recognise 'building services engineer' as a discrete occupation. The announcement coincides with the release of AIRAH's Building Services 	<p>http://www.airah.org.au/imis15_prod/AIRAH/Navigation/AboutAIRAH/PressReleases/2013_Press_Releases/2013_Press_Relea</p>

	<p>Engineer (mechanical)—model career pathway.</p> <ul style="list-style-type: none"> • Launch of the Solar Cooling Special Technical Group—the aims of the AIRAH Solar Cooling STG are to advocate for solar cooling, to develop industry practitioner skills, to provide a hub for solar cooling information sharing, and to encourage better communication between stakeholders. • Building Simulation Workshop a stunning success—with the aim of discussing all things relating to the discipline of building simulation, including best practice, legislation, accreditation, and modelling protocols. 'There are significant skills gaps in the industry that lead to sub-optimal—and sometimes substandard—work being produced.'^{iv} 'The ability to simulate the climate inside buildings—from design information and data to characterise the external climate—means that air conditioning and heating systems can be optimised, rather than just designed for what may be a highly improbable combination of extremes,' he says. 'Better informed designs can save both cost and environmental footprint.'^v • Announces PRIME Roadmap for low-emissions HVAC&R – PRIME represents the five pathways to transition, Professionalism, Regulation, Information, Measurement, and Emission abatement. 'In many ways the HVAC&R industry is still fragmented, which makes progress towards lower emissions that much more challenging. What's required is a strategy, and that's where PRIME comes in.'^{vi} 	<p>ses.aspx#15_05_2013</p>
--	---	--

METHODOLOGY

RESEARCH DESIGN

To analyse the research and develop related recommendations in the project timeframes required prior knowledge of the issues being considered in relation to vocational education and training (VET) and higher education systems, and of community-based and local council initiatives and training. The research was designed to encompass two series of questions as follows:

PART 1:

- What are the low carbon living (LCL) opportunities in the built environment (BE) as a matter of priority for the CRC participants?
- What roles are required by CRC participants to support the LCL opportunities identified and offer insight into the needs across the industry?
- What knowledge and skills should the CRC support as a matter of priority to attain LCL in the BE?

PART 2:

- Based on the key opportunities and associated knowledge and skills identified, what education is required to achieve the LCL?
- How are the knowledge and skills currently developed by CRC participants?
- What are the preferences for capacity building engagement from the perspective of CRC participants and key industry groups?
- What ongoing data collection and monitoring methods should be used to evaluate the effectiveness of capacity building programs by the CRC?
- What areas need further research?

OVERVIEW OF RESEARCH

METHODOLOGY

Based on consultations with CRC participants and key industry groups, the researchers investigated provision by VET, higher education, professional development and the various forms of non-accredited training or community capacity building. The Study has identified gaps in provision and recommended programs or additional research to bridge the gaps identified. However, it is important to review the policy responses related to them.

1. Desktop research was undertaken to identify a selection of LCL opportunities for the BE to compare with job roles and associated knowledge and skills, to provide a starting point for the consultations.
2. Consultation with CRC members, participants, key stakeholders and peak bodies in the BE to identify perceptions and preferences was done through an open online survey distributed through the CRC to over 400 stakeholders; a series of nationwide focus groups was held; and, follow-up interviews were conducted with CRC participants.
3. The findings from the desktop research, survey, focus groups and follow up interviews with CRC participants, key stakeholders and peak bodies were analysed to determine the gaps and propose a strategy and recommendations to fill the gaps to meet current and future demand for providing both national and international leadership and these findings and analyses were reported.

SUMMARY OF KEY FINDINGS

OVERVIEW

The Study indicated that the current technology used to plan, design, construct and a use building efficiently isn't being implemented to the extent possible. The findings demonstrate that the education gaps are widely dispersed across the workforce, communities and government, including educators. These groups are engaged in fragmented systems typically with discipline specific approaches and processes. Community programs are typically delivered to a specific local community group or government planning authority resulting in duplication. However, through collaboration and partnerships, there are opportunities to learn from and adopt successful programs, share and augment resources (e.g. strategies, case studies) nationally and internationally to support the transition.

The findings from this CRC Study support the recommendation that a systemic approach needs to be developed to effectively identify and implement low carbon solutions in the BE with professionals, government and communities through more consistent communication about verified LCL opportunities and supported action through access to intermediaries.

Using the research methodology, the findings are derived from the following processes:

- an open online survey distributed through the CRC to over 400 stakeholders resulting in over 100 responses, resulting in a 25 per cent survey response rate (55 per cent from CRC participants)
- a series of nationwide focus groups with fifteen key stakeholder, including eleven CRC participant organisations and representatives from two peak bodies
- follow-up interviews with eleven key CRC participant organisations and three additional peak bodies

- circulation of the executive summary to all those consulted and every CRC participating organisation for comment and feedback to finalise the draft report
- circulation of the complete draft report to the Project Advisory Committee for feedback to finalise the report for submission.

The survey of members, participants, and key stakeholders included international and national responses from all Australian states, except Tasmania. The participants included students, researchers, educators, independent contractors, general staff, design professionals, engineers, supervisors, management, and executives. Based on the survey participants' responses, these are the types of organisations surveyed from the majority to the minority:

- Education (tertiary—both higher education and VET)
- Research
- Professional services
- Built environment
- Consulting
- Non-profit
- Construction
- Industry association
- Government (federal, state and local)
- Energy, engineer(s) (mechanical, electrical, general, etc.)
- Manufacturing, sales and distribution
- Transport, regulator(s), utility company, planning organisation

FACTORS INFLUENCING THE DEMAND FOR LOW CARBON LIVING

Demand for low carbon living (LCL) is steadily growing across the world with many industries looking for new opportunities for enhancing productivity and reducing production and operation costs; residents looking to reduce energy bills and live more sustainable, balanced lives; and governments looking to respond to the challenge of climate change in a way that delivers benefits to business and voters.

The study outcomes have identified, for instance, the *five most critical support mechanisms* required by respondents' organisations. They include: funding and

investment; standards that support LCL; expert advice; case studies; and, online capacity building resources. The most influential *prospective influences* on the organisation's plans or intentions to contribute to LCL are shown in Figure 2, with the most influential being: 1) government policy; 2) demonstrating sector leadership; 3) technology and tools availability; 4) consumer expectations and social values; and 5) financial incentives. These outcomes provide guidance as to areas on which to focus efforts.

Low carbon living drivers and barriers

The survey respondents identified what they believed were the barriers to LCL. These responses are shown in Figure 3. The top three believed barriers in order of importance were: 1) communication and awareness; 2) availability of expertise and resources (human, financial, information, etc.); and 3) availability of education programs. Further comments associated with this question highlighted institutional/organisational barriers, stakeholder interest, cost and the supply chain as also being factors.

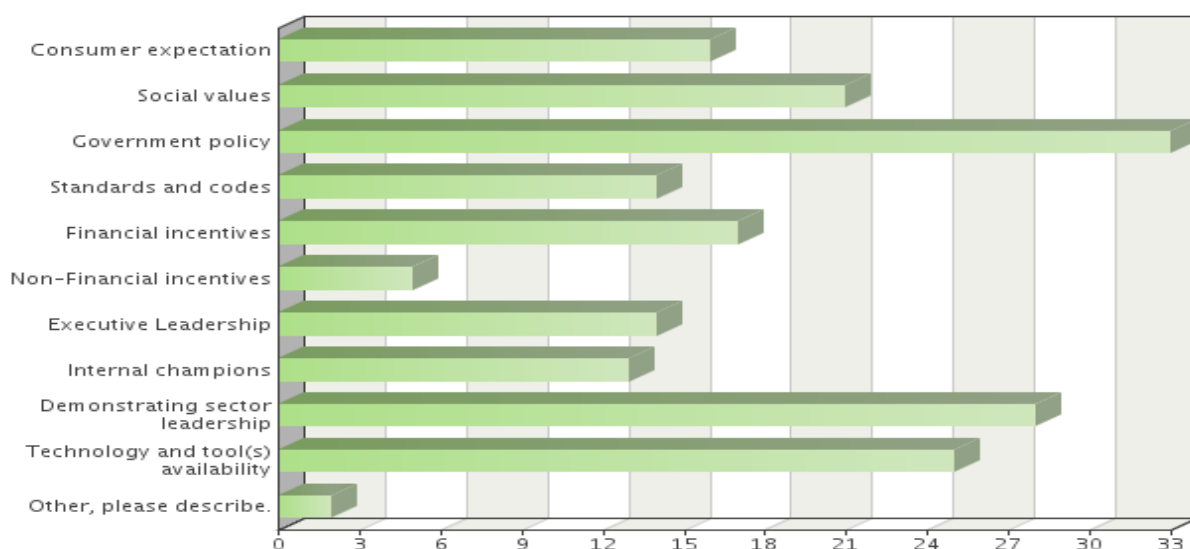


Figure 2: Top prospective influences on organisation's plans or intentions to contribute to low carbon living

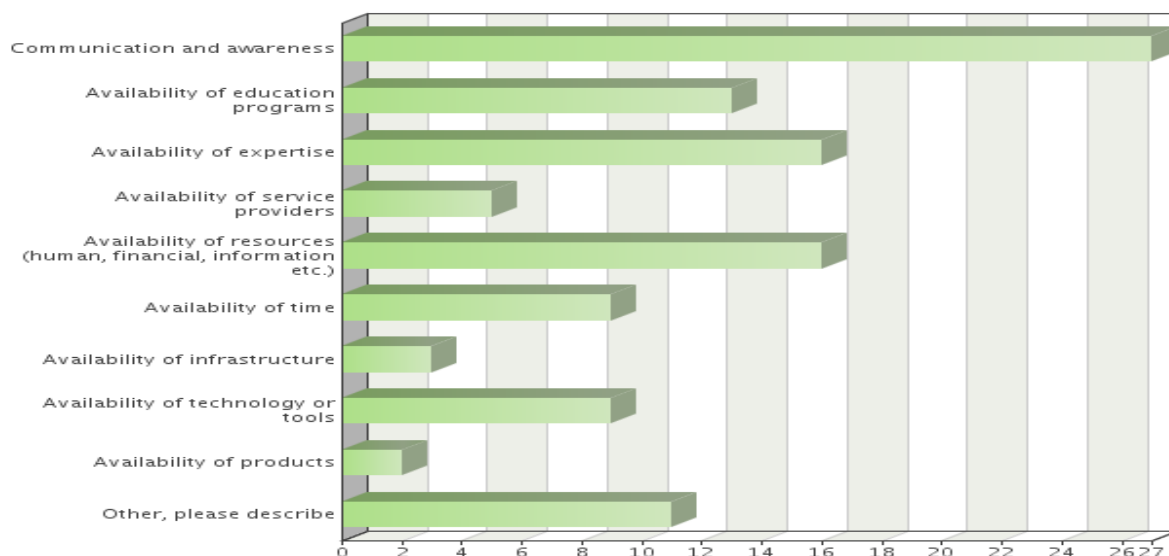


Figure 3: Top barriers to engagement in educational or capacity building programs to transition to LCL

Priority barriers requiring further CRC investigation

In response to, 'Please identify the key barrier(s) to increasing low carbon living in Australian cities and

- Informing a whole of system approach with a medium to long-term time frame.
- Attitude of people to this area—needs to be developed to be more positive.
- Barriers are the attitude of the builders and trades to undertaking low carbon strategies.
- Broad community acceptance of what low carbon living really means.
- Lack of business and consumer confidence.
- Lack of general understanding that low carbon living is urgent and mandatory.
- Ignorance of alternative solutions.
- Lack of awareness and capability within government agencies and not for profits that support communities in the transition—they are an important source of information for communities.
- Limited knowledge among real estate agents about the business case.
- Limited knowledge or training for facilities managers on how to manage buildings.
- Building and design standards.
- Lack of local champions.
- Adherence to 'think globally, act locally' mantra.
- Accurate auditing and measuring of environmental impacts.
- Information complexity about low carbon strategies in buildings.
- Knowledge on 'how to do' and demonstration that it is cost effective.
- Creating knowledge concerning how to transition to low carbon living.

towns which should be reviewed by the CRC as key areas of focus for education research and activities', survey participants offered the following:

- Split incentives between owners and tenants.
- A carbon pricing mechanism to encourage use of renewables (e.g. solar photovoltaic).
- Lifting minimum standards and government policy requirements.
- Lack of mandatory performance standards.
- Energy policy that addresses institutional barriers.
- Poor political leadership and instability.
- Counteracting aggressive anti-green lobbying.
- Convincing people (homeowners, developers, builders and planners) of the economic benefit (to them) of low carbon living.
- Skeptic that it's all too hard and costly.
- Perceived cost of implementing low carbon approaches.
- Economics of alternative solutions.
- Lack of value attributed to low carbon living in the business and broader community.
- Developing an evidence base to inform the sector.
- Developing operational case studies.
- Lack of materials and products that can easily and affordably support what we design.
- Identifying proven technologies and providing supporting evidence.
- National protocols about the embodied energy of materials.

Frameworks, standards and guidelines currently used

Contributing to low carbon living is financially beneficial to clients and part of the strong social values towards stewards of the environment...

Technology and tools, though, is a main concern.'

Consultation quote

When asked, 'Please list any frameworks, standards, and/or guidelines and associated tools used within your organisation to deliver low carbon living products and

services', respondents to the survey listed a number of known and widely used codes, standards, frameworks or guidelines and tools, as shown in Table 3. However, it is unknown how well these support collaboration between the segmented industry areas across the BE to achieve whole system, whole sector or precinct level opportunities across groups. Most items listed support reporting or design methods for individual buildings and some precinct scale tools, but not the methods to support collaborative engagement across industry stakeholders or communities required for systemic change.

Table 3: Examples of codes, standards, frameworks, guidelines and tools used by organisations

Codes & Standards	Frameworks & Guidelines	Tools
<ul style="list-style-type: none"> ISO14001 Building Code of Australia Nationwide House Energy Rating Scheme PAS 2050 Associated reporting e.f.48, 65 Kyoto CM and CEF, gold standard etc. Balanced Scorecard ISO 50001 Online Monitoring Tools for Electricity and Water AS3600 AS3582 ISO 14064 NSW RMS Standards 	<ul style="list-style-type: none"> An Environmental Management System Green Building Rating Systems (Green Star) The Living Building Challenge (http://living-future.org/lbc) Sustainability Victoria's Resource Smart Program A policy framework for achieving carbon neutrality for government operations by 2020 Living Building Challenge-based ESD frameworks AAO Protocol BASIX Thermal Comfort Protocol GHG Protocol, Evidence-based technical bulletins for customers Environment Design Guide (EDG) The TAFE Environment Officers Group (TEOG) Guidelines NCOS Carbon Neutral Program Guidelines 	<ul style="list-style-type: none"> PrecinX Cost of Carbon Abatement Tool NGERS NABERS NatHERS ArchiCAD 16 BEM tool

PRIORITY OPPORTUNITIES FOR LOW CARBON LIVING IN THE BUILT ENVIRONMENT

Key built environment opportunities

The survey and consultation participants were provided with a list of opportunities for LCL in the BE, including the following:

GhG Emissions in the commercial building sector:

The use of electricity is responsible for 89 per cent of commercial buildings' greenhouse gas emissions.

Specific operational energy applications principally responsible for greenhouse gas emissions are cooling (28 per cent), air handling (22 per cent), lighting (21 per cent) and heating (13 per cent). Heating, ventilation and air conditioning (HVAC) and lighting thus account for 84 per cent of commercial building sector greenhouse emissions,' which is similar to emissions in the residential building sector.^{vii} *Opportunities related to GhG abatement:* Currently some of Australia's biggest opportunities to reduce emissions are related to design and implementation of emission abatement

opportunities, as identified by the ClimateWorks Low Carbon Growth Plan for Australia.^{viii} In addition to infrastructure and materials to support sustainable lifestyles, most notable are low carbon transport opportunities and availability of building technology and materials, some of the opportunities with the highest abatement potential and lowest associated costs in the built environment, which can currently be carried out, relate to:

- commercial and residential buildings—both retrofit and new
 - energy waste reduction
 - modelling
 - heating, ventilation and air conditioning (HVAC)
 - elevators
 - cooking and refrigeration
 - building envelop
 - lighting
 - appliances and electronics
 - insulation

- water heating
 - cogeneration in large developments
 - industrial energy efficiency
 - re-use of waste and by-products
 - street lighting efficiency
 - solar photovoltaic
 - land management.

In an effort to prioritise key capacity building areas based on the organisational needs, the survey participants were asked a series of questions. The responses to the question, ‘*Based on your area of expertise and experience, please identify the three key opportunities for your organisation to support LCL in the BE*’, have been clustered and summarised in Table 4 to enable a quick review of the similarities as key opportunities for action. Please see Appendix 1 to review the individual responses in order of priority.

Table 4: Summary of key opportunities to support low carbon living in the built environment sector

Responses for First Priority Areas	Responses for Second Priority Areas	Responses for Third Priority Areas
Education and research dissemination	Analysis of energy consumption and target specific reductions	Education on existing resources and access to knowledge bases
Energy waste reduction	Disclosure of energy efficiency performance to residential tenants	Sensors and controls for the intelligent consumption of resources
HVAC	HVAC systems	HVAC
HVAC	Improving HVAC efficiency	HVAC
Electricity consumption reduction	Sealing the building envelope, both the structure as well as the openings	Improving power use efficiency
Enforcing minimum energy efficiency building standards	Focus on energy efficiency in the short term	Thermal efficiency using properties of materials
Building envelope	Energy waste reduction	Passive design
Energy efficient building design	Building design and construction (passive design/efficient resource use)	Buildings that produce energy and cycle water, with low embodied energy
Demonstration of carbon neutral developments	Advising building designers/developers of LCL opportunities before they build	Waste management: closing the loop, including biomass and recycling
Commercial and residential buildings	Commercial and residential buildings	Biomass for heat and electricity production
Commercial and residential buildings (retrofit and new)	Modelling	Use of LED lighting and solar photovoltaic technology (incentivised)

Commercial and residential buildings	Increased government requirements for carbon abatement in buildings	Renewable energy on a large scale (considerable roof space available)
Urban design (building and precinct design based on holistic principles)	Cogeneration in large developments	Cogeneration at precinct scale
Design of low carbon buildings	Renewable energy technologies	Cogeneration
Design of buildings to be naturally cooled and heated	Solar photovoltaic	Encouraging builders to adopt LCL techniques and building practices
Benchmarking at both building and city level	Solar photovoltaic	Focus on renewable technologies in the medium term
Uptake of low carbon technologies in our property portfolio	Electricity generation methods	Street lighting
Mandatory use of LCA in design and decision-making	Street lighting	Less carbon and greenhouse gas emission (GGE) intensive solutions in affordable housing
Building energy modelling (BEM)	The use of LED technology.	Demonstration of these new technologies/solutions.
Modelling	Lighting	Research into low carbon urban infrastructure (power, water, sewer)
Integrated project teams	New technologies/solutions to achieve LCL	Hydraulic engineering and plumbing
Domestic water heaters	Facilitate integrated team building	Reduced volume of fly ash placed in ash dams
Electro technology (photovoltaic, wind turbines, lighting and HVAC)	Closing loops to reduce waste production	Industrial energy efficiency
Clean technology	Re-use of waste and by-products	Land management
Less GGE intensive power solutions and smart grid technology	Waste process improvements	Land use & urban planning
Electricity from clean and renewable sources while reducing consumption	Retrofitting packages for entire districts	Land management
Re-use of waste and by-products	Design of low carbon communities and precincts	Transport
Re-use of waste and by-products	Planning & development control	Engaging with local communities and businesses
Waste efficiency improvements	Land management	
Cogeneration in large developments	Land Management	
Cogeneration in large developments	Low carbon transport (new modes) and town planning (pedestrian friendly).	
Research into planning and land management	Research into low carbon impact urban transport, travel behaviour, and TODs	
Improving transportation to and from work.	Products that are less GGE through supply chain approaches	
Revising standards to accommodate renewable material	Development of new materials and/or products incorporating fly ash	
Wood as low carbon renewable construction material	Low carbon footprint products	
Carbon neutral engineered wood products		
Natural solid wood products (e.g. flooring, architraves).		

The consultations also identified a number of key opportunities, such as:

- building and precinct information modelling
- building performance testing
- integrative project design / project management
- construction quality and craftsmanship

Key support areas identified

Among the survey respondents, the priority areas for greater support over the next five years to efficiently transition to LCL correspond with the perceived barriers: 'education programs to support low carbon living' being the highest priority, followed closely by 'communication about low carbon living' and then 'products for low carbon living' as indicated in Figure 4.

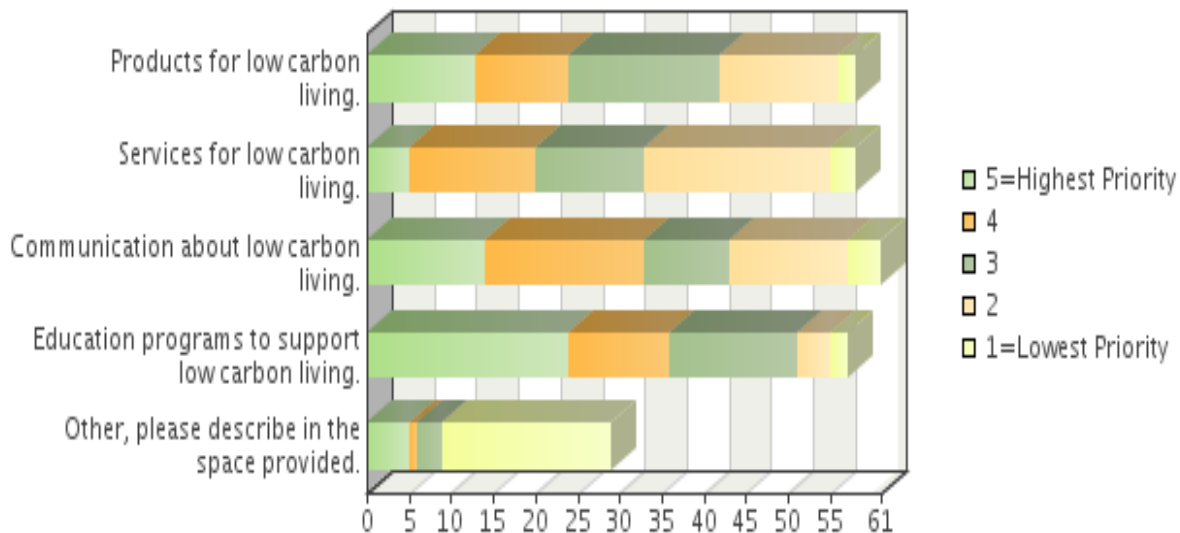


Figure 4: Summary of support required and prioritised in these key areas over the next 5 years to efficiently transition

This indicates that stakeholders may not be prepared to act or implement opportunities without more verifiable information and supporting evidence to enable informed choices. The additional comments included:

- engagement with communities to deliver a low carbon future, deliberative democracy, wide scale behaviour change
- educating building design and BE professionals and trades people together with raising awareness/demand should go hand in hand, followed by encouraging Australian companies to develop and certify key products to International Passive House standard
- leadership—industry-led research, government policies, leadership and support programs, industry policy
- built examples and demonstration projects
- technology enhancement that makes it easier and seamless—sometimes we can contribute without a significant cost of change of lifestyle, for example electric cars connected to solar power grids, joint state-federal agreement on the way forward over a significant time period
- financial incentives—taxation incentives, implementation costs incentives, price signals to stimulate the transition (water and fossil fuels), combined packages and bundled products and services with mechanisms that make the transition easier, including financial or payment options, regulatory incentives, strong and stable communications on the offers.

CRITICAL OCCUPATIONAL ROLES AND ASSOCIATED KNOWLEDGE AND SKILLS

Occupational Roles

As noted during all consultations, all roles in the BE are critical, so no one role is more important than others, therefore there is a need for systematic tailored education at all levels or interdisciplinary engagement.

The key to senior roles is the business case or the financial benefits of change; and in the mid-level roles it's awareness of and trust in the available materials and technology that support the system, as well as having the construction practices required through trades peoples to implement them efficiently and effectively.

These two groups also need access to trusted evidence (third-party testing) supporting specific approaches being undertaken coupled with example combinations of materials and integrated technology solutions. In addition, they need to be aware of and effectively manage the consequences of ineffective work practices related to energy efficiency and low carbon solutions.

Those consulted noted the importance of building the capacity of tertiary education professionals responsible for educating professionals and trades associated with the BE to ensure the emergent labour force enters the industry with the appropriate skills. As shown in Figure 5, when asked, 'Which are the 3-5 most critical existing occupational roles requiring capacity building to support the opportunities you've identified?' based on the adjusted relative frequency, the survey respondents selected in order of priority: 1) building owners / developers (54 per cent), 2) engineers (40 per cent), 3) architects (40 per cent), 4) facilities managers (33 per cent), 5) designers (28 per cent), 6) education professionals (26 per cent), 7) planners (24 per cent) and 8) procurement managers (21 per cent).

In addition to these responses, survey respondents identified the following occupational roles:

- solicitors
- LCA specialists
- electrical, environmental, mechanical, and water engineers (integrated

- senior management (such as the Vice-Chancellor or CEO)
- asset managers
- researchers
- financial and property services
- approaches)
- large scale facilities managers
- building operators
- economic valuation of the environment in financial and government services.

When asked, 'Based on your experience, please describe any other key job roles in the built environment sector required to deliver low carbon living products and services', respondents listed:

- facility managers are a critical job role
- builders and trades applying low carbon approaches and strategies
- builders with a holistic approach to building low carbon housing products
- the real estate/marketing sectors.

Although the survey responses do not emphasise the importance of builders and trades people as key job roles, the consultations strongly highlighted these roles as a critical opportunity for capacity building along with other 'intermediaries' that have the potential to influence decision makers and support the development of low carbon practices with end users or consumers. The consultations identified the supply chain as critical, suggesting that home and building owners' first line of communication and interaction is typically with intermediaries, such as professionals and tradespeople, energy assessors/auditors, suppliers and retailers, real estate and property service professionals, financial services professionals or even local council staff. These roles are considered essential in initial engagement to identify and implement project specific opportunities, including identifying return on investment potential as well as stimulating the demand for low carbon buildings as further highlighted in section 4.5 Capacity Building for Low Carbon Living. As indicated in the survey response, these roles would alleviate the important barriers related to access to experts and resources.

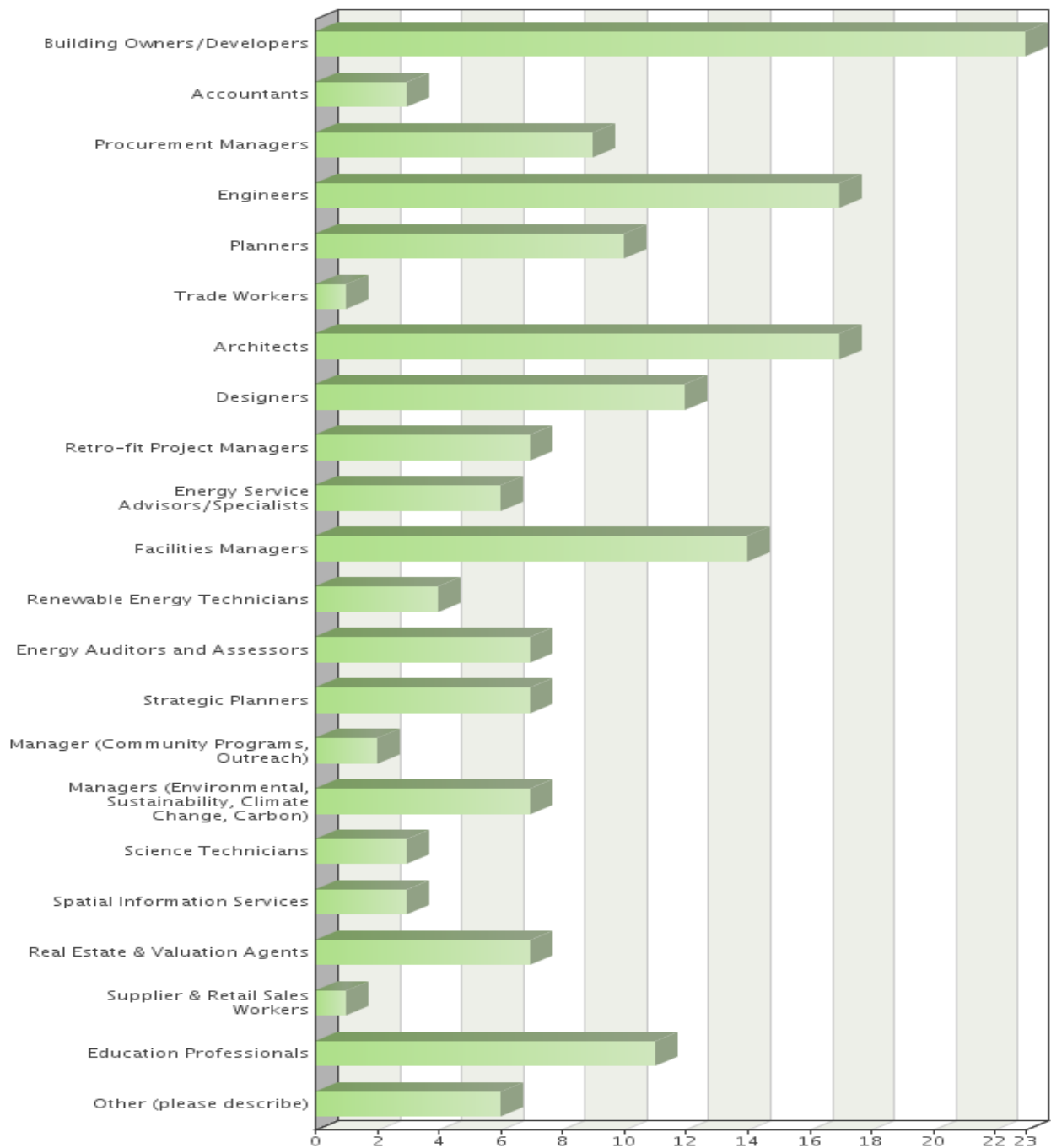


Figure 5: Survey responses on the 3-5 most critical existing occupational roles requiring capacity building to support low carbon living

Key job roles

The *key job roles* requiring capacity building identified in the consultations include those set out below in the categories indicated:

- **Potential increased demand for those with the appropriate knowledge and skills**

- energy assessors and analysts
- building scientists
- building management systems (BMS) controllers (IT / electrical engineers / controls specialists)
- sustainability / carbon / climate change managers

- education professionals
- **Roles requiring enhanced knowledge and skills**
 - built environment education professionals
 - building owners / developers
 - builders and trades people
 - architects, designers and engineers (e.g., mechanical, structural, landscape)
 - facilities managers
 - planners
 - procurement or estimators
 - property services (e.g. real estate agents, property managers and valuers)
 - financial analysts
 - policy analysts / modelling
 - marketing analysts, marketing professionals and advertisers
 - senior and executive management
 - local, state and federal government representatives and technical staff
 - community engagement outreach managers

- transportation engineers, planners and managers.

Intentions to develop new occupational roles

The consultations highlighted that these key roles may emerge as potential new job roles:

- Integrated Energy Efficiency Retrofits Leaders (new accreditation under development^{ix})
- Building Services Engineer^x (listed as a specialisation under 233512 Mechanical Engineer in the release of ANZSCO Version 1.2, slated for May 14),
- Integrated Design Leader,
- Weatherisation Installer or Technician and
- Refrigeration Engineer (formalised occupation).

When survey participants were asked, 'Is your organisation planning to develop or engage with new job roles to support the delivery of low carbon living in the built environment?' 47.5 per cent of respondents indicated 'Not at this stage', but 30 per cent selected 'Yes, in the short term (0-3 years)'.

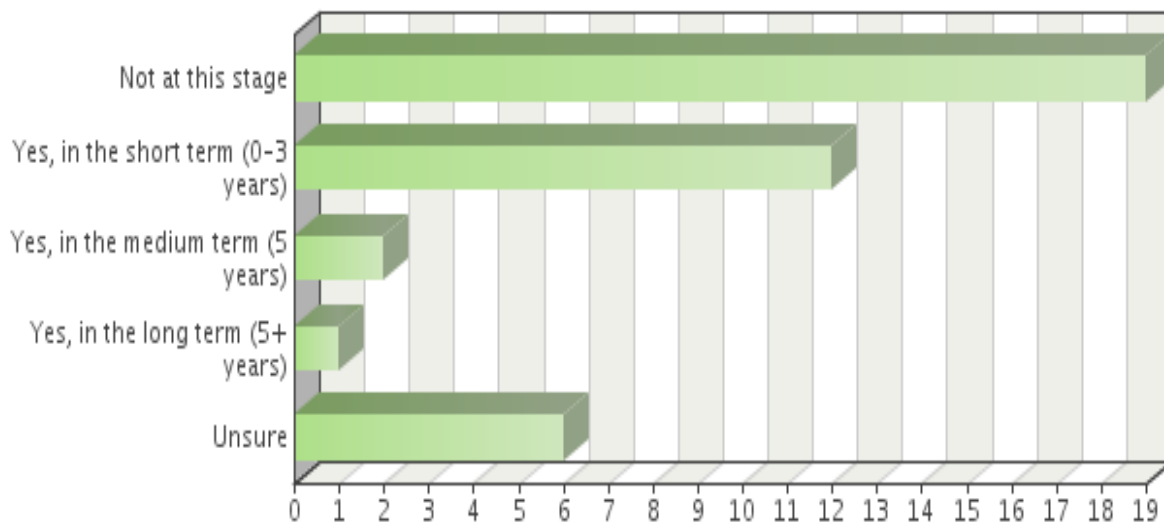


Figure 6: Intentions to develop or engage with new job roles

Some of the roles specified or skills identified by the respondents were:

- mainly consultants based on project needs
- facilities managers for sustainable management of building stock
- building designers with sustainability knowledge and skills
- construction professionals and trades that practice resource efficiency and application techniques required for low carbon buildings
- electro-technology professionals and trades to support renewable energy technologies and lighting efficiency
- waste reduction experts.

Critical knowledge and skills required

The consultations identified the need for end users to have more engagement with experts acting as intermediaries to enable them to make informed decisions based on project priorities, the materials and technology available and access to appropriately educated professionals and tradespeople, as well as supporting third parties (energy assessors, building scientists, local council staff, and so on) ensuring all the options are presented along with the business case, risks, pay back periods and recommendations for accessing additional resources, such as finances, product and technology.

Examples of critical knowledge and skills include:

Identifying and implementing opportunities and management:

- understanding the required methods relative to regulations, standards, guidelines, certifications and performance measurements
- energy conservation, energy efficiency and greenhouse gas management
- awareness and engagement in resource efficiency or waste minimisation, recovery and management

through work processes, building operations and lifestyle practices

- craftsmanship and quality management for constructing high quality and high performance buildings (e.g. construction trades and management)
- specification and selection of products, materials or practices through green purchasing including legal documents.
- technical installation methods and maintenance (e.g. renewable energy systems, HVAC&R)
- systems thinking and integrated design at the building and precinct levels (e.g. integrated building services, renewable energy, waste management, active transport systems)
- building commissioning and tuning
- building science, performance testing and verification (e.g. design and construction supporting water/energy management, indoor air quality, thermal comfort, durability)
- management of building retrofits and brownfield redevelopments
- efficient management and operation of buildings, equipment, and appliances
- Integration of renewable or low carbon technology (e.g. cogeneration & tri-generation) and materials
- identification of LCL opportunities (business case / return on investment) and support and implementation strategies (e.g. trades, strata managers, business analysts, sales)
- understanding and communicating (e.g. marketing, sales, property services and social networking) the value of energy efficiency and LCL benefits
- ability to develop economic models to support long term policy and programs
- understanding of community cultures, values and decision-making processes to develop incentive programs and engage end users

- large scale waste, energy and water management
- pedagogical approaches to inform programs, accreditation and delivery of the required knowledge and skills
- program evaluation, risk minimisation and continuous improvement
- urban heat island mitigation through landscape and urban design

Measuring, reporting and compliance:

- energy and greenhouse gas assessment, reporting and monitoring (for example, data collection and analysis) using benchmarking metrics for comparison to measure progress and value assets
- policy settings and management practices which align with low carbon strategies including risk minimisation, behavioural economics and benevolent paternalism
- energy, precinct and building modelling
- resource economics.

In the longer term, industry and government institutions will require this critical knowledge and skills:

Building information modelling (BIM) and precinct information modelling (PIM)

‘Capacity to understand the information going into the tool (theory) before and during the use. If an application is developed well, the information could be provided with ideas (rote learning applied with critical thinking application) for applied competence using simulated scenarios, etc.’ Consultation quote

- Designers/planners need to know how to build a precinct model, so how to use the tool to put information into it, analyse it and reconfigure the opportunities to re-enter the details to develop the best case.
- Engineers need design application.

- Designers need to understand the potential of the model in performance (theory).
- Operators of the building need to understand how to continue using the model to manage facilities and assets.

Holistic Approach

Overall, to enable communities to transition, the consultation respondents spoke of the need for a ‘holistic’, ‘integrated’ and ‘pathway’ approach with:

- improved communication (e.g. ‘language translation or consistency between government, industry professionals and trades people and users’);
- increased dissemination and recognition of practices, projects and opportunities across sub-sectors
- increased use of third party intermediaries (e.g. trusted sources of information such research or testing bodies, government offices or local councils, existing program leaders or champions in local communities, but also specialists who can communicate various options available in plain English through accessible case studies, displays, demonstrations, etc.) to support
 - partnership building
 - community engagement
 - broader social change.

For more information see Section 5.

When surveyed participants were asked, ‘*What are the critical knowledge and skills required, specific to the job role(s) identified, to successfully achieve the identified opportunity?*’ survey respondents identified these topics clustered under key areas.

Strategy development

- the rigorous analysis of policy propositions related to carbon
- the development of clear and consensus-based targets for LCL, the application of such targets to

specific parts of the sector, and an understanding of the research and technologies/solutions available to achieve targets

- understanding the Australian regulatory and legislative environment and knowledge of government programs and schemes to implement energy and resource efficiency
- understanding of principles of sustainability
- understanding the imperative to transition to LCL and the underlying issues
- understanding of how to achieve low cost and low carbon and emission profile
- up-skilling knowledge on available technologies and their payback cycles.

Business case

- The ability to articulate useful strategies at the project conception phase (architects, builders, trades, etc.)
- Understanding the value case of exploring opportunities over the 'business as usual approach'
- Business case development to sell energy efficiency as a financial benefit to senior executive
- Understanding the benefits of applying energy efficient technologies
- Understanding the economics of sustainability upgrades in the building sector
- Confirming the better yield and higher values realised through implementing low carbon buildings
- Engineers being able to provide early evaluation of options over a life cycle period of, say 10, 20 or 30 years proving the benefit of implementing low carbon buildings
- Understanding the benefits of applying renewable energy technologies to meet building energy loads
- Skills to incorporate reduced costs from power savings and a boost in employee productivity to the

balance sheet to illustrate their financial benefits retro-fit (i.e. Accountants)

- Understanding the co-benefits of collaborative techniques
- Acceptance of new technology and ability to analyse longer-term benefit

Technical areas

- The analysis of substitution products that deliver LCL
- The traditional roles need to be reviewed so that they have a new focus to include embedded carbon/ LCL
- Electro-technology (renewable energy, low energy lighting, etc.)
- HVAC design, management and maintenance
- Refrigeration design, management and maintenance
- Building information modelling
- Plumbing and hydraulic design
- Energy efficient / sustainable building design, construction and maintenance
- Renewable technology education, assessment, and implementation
- Energy and carbon management training and expertise
- Life cycle assessment education, assessment, and implementation
- Understanding the principles of passive solar design
- An understanding that native forest wood products have a significant role in LCL and carbon emissions abatement
- Develop public transportation infrastructure or cycling infrastructure to support popular transportation routes. (i.e. planners)
- Understanding building performance and building science
- Connecting those creating the low carbon tools with the users

Auditing, accounting, and assessment

- The use of environmental material accounting tools such as material flux analysis and life cycle assessment
- Energy assessment and management
- Auditing of the current level of carbon performance
- Environmental auditing
- Carbon management skills - carbon accounting
- As in Europe and the US, perhaps a comprehensive energy certificate should be required for the sale of residential properties.

Modelling

- Quantitative modelling and design required for understanding transforming the BE
- Quantifying the embedded energy of materials used in construction
- Use of rating tools that can identify areas for improvement and the knowledge of products that can bring these improvements (Energy Auditors and Assessors)
- Team work—ability to work in interdisciplinary roles and teams
- The ability for project team members to work collaboratively across supply chains and take responsibility for long-term outcomes, not just immediate construction outputs
- Working in conjunction with trade workers and strategic planners to secure the best solutions for energy/environment inefficiencies (managers)
- Project management that engages key stakeholders and decision makers in an integrated way

Social change

- Science that demonstrates benefits and trade-off impacts clearly twinned with approaches that allow the community to design its own plans of action

therefore giving the community ownership and self-learning ('empower the practitioner')^{xi}

- Strong social awareness of community adoption, value shifts and acceptance in community
- Community engagement
- Social marketing to encourage LCL
- Understanding social practices, behaviours of consumption and lifestyle choices
- Context-specific planning to ascertain structural contexts and how we progress towards LCL in our communities
- Identifying and introducing low carbon products.
- Context- specific planning to ascertain how we progress towards LCL in our communities

Potential knowledge and skills gaps

The consultations identified context-specific planning to ascertain how we progress towards LCL in our communities. Survey participants were asked, '*Based on your experience, please describe any other knowledge / skill gaps and associated support programs in the built environment sector required to deliver low carbon living products and services.*' Their responses are summarised in Table 5.

CAPACITY BUILDING FOR LOW CARBON LIVING

Requirements for capacity building

When asked, '*If your organisation is engaged in any education program(s) to transition to LCL please select if it is a requirement or optional and describe further in the space provided*', respondents reported in most cases 'non-applicable' (Figure 7). However, the remainder of respondents indicated that most professional development programs for the existing workforce are optional. Therefore, there is a need to embed consistent knowledge, skills and methodologies into trade and professional training in tertiary institutions as well as industry and professional associations.

Table 5: Summary of key job roles, knowledge, skills and supporting programs

Knowledge and Skill Gaps	Supporting Programs
Genuine long-term performance data of designs, devices and behaviour	Creating new policy, regulations and incentives to achieve best outcomes
Behaviour change and the role that it plays in the transition to low carbon	Marketing and awareness that prove its financial relevance and benefits
Sustainable procurement of services for construction	Development of low carbon services databases
Use of Life Cycle Assessment as part of procurement of goods	
Knowledge about indirect/embodied carbon emissions	
Carbon accounting	
Needs to show productivity gains in people's time	
The main gap is the underpinning understanding of sustainability	
Practical application of low carbon living	
Non-science/engineering courses with science/analytic skills curriculum	
Financial benefits of change (senior roles)	
Efficient materials and construction techniques (mid-level roles)	
Why things are being done and the consequence (construction trades)	

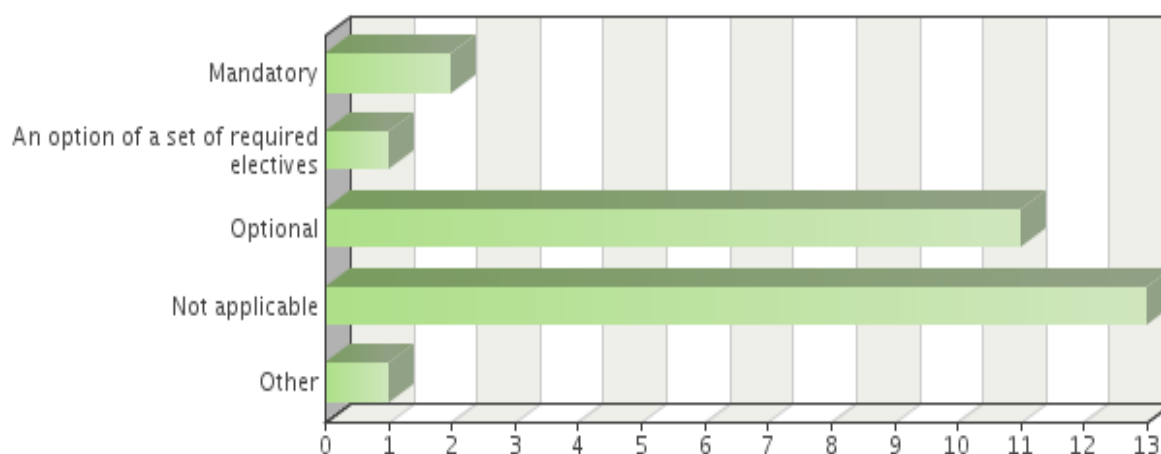


Figure 7: Survey responses on current engagement in low carbon living education programs

Available low carbon capacity building programs

In response to, 'How are the required knowledge and skills being developed? Please list 3 examples of low carbon education programs, noting the source (website if

available) and any details summarising the programs?' the survey participants listed current programs. These are set out in Table 6.

Table 6: Available capacity building programs supporting low carbon in the built environment

- | | |
|---|--|
| <ul style="list-style-type: none"> • University of Melbourne Master of Engineering (Civil, Environmental, Geomatic, Mechanical) and Master of Energy Systems • Cert IV in NatHERS Assessment • Cert IV in Home Sustainability Assessment • Cert IV in Business Sustainability Assessment • Energy Assessors TAFE NSW • UNSW Faculty of Built Environment 'Sustainable Development in the Built Environment' • Office of Environment and Heritage NSW • Carbon Management (staff) • Diploma of Sustainability (students) • Advanced Diploma in Sustainable Building Design (students) • Associate Degree in Renewable Energy Electrotechnology (students) (http://www.efslearninghub.net.au/efsframework/whatistheefsframework.aspx) • UNSW Environmental Management (http://www.civeng.unsw.edu.au/sites/default/files/courseprofiles/2013/2013-S1_CVEN9888x2501.pdf) • Sustainable Development Masters, UNSW • Monash University GreenSteps • University training through post-graduate programs • Green Star Training • Carbon Training International (www.co2ti.com and educators—www.co2ti.edu.au) • VECCI (www.carboncompass.com.au) • The AIA National seminar on Total Carbon Modelling Approach delivered by AECOM and based on the current 41 Exhibition Street development project • Climate Policy (Masters Unit) (http://handbook.curtin.edu.au/units/31/314241.html) • ACTSmart (www.actsmart.gov.au) • Energy Efficiency Exchange (www.eex.gov.au) • Make it wood - Planet Ark. (Makeitwood.org) | <ul style="list-style-type: none"> • GBCA, programs run through City West Water such as cooling tower training • City of Sydney (http://www.cityofsydney.nsw.gov.au/vision/sustainability) • Carbon Reduction Label - Carbon Trust UK - carbon in products and services we consume • Decarbonising Cities and Regions (Masters Unit) (http://handbook.curtin.edu.au/units/31/314240.html) • Just Change, an NGO initiative aimed at informing the market on Sustainability • Streamlining Cogen—Victorian Councils aiming to reduce carbon emissions, energy costs, etc. currently focusing on existing leisure and aquatic centres. Includes a Toolkit for councils and an established community of interest. • Living Building Challenge (http://living-future.org/lbc) • One Planet Living (http://www.oneplanetliving.org/index) • Black balloon campaign NSW Government • Low Carbon Australia (www.lowcarbonaustralia.com.au) • The AIA Environment Design Guide EDG, which has over 250 peer reviewed papers on sustainable design approaches and, the AIA policy on sustainability. See www.architecture.com.au. • Australian Government Home Manual www.yourhome.gov.au • eTool LCA (http://vimeo.com/52924298) • Northern Alliance for Greenhouse Action (NAGA), ongoing local government network |
|---|--|

Beyond these programs and resources listed, participants offered the following comments:

- | | |
|--|--|
| <ul style="list-style-type: none"> • Don't know of any good ones. • There is a dearth of suitable programs available. • Not known. • None known. | <ul style="list-style-type: none"> • I am unaware of low carbon education programs targeted at owners and developers. • Don't know. • There are no genuinely low carbon communities in Australia that I'm aware of. |
|--|--|

- The Planning Institute of Australia is trying to develop strategies and assessment procedures for building and investing in low carbon urban development.
- Not sure what is meant by this question, but integrating these ideas into more University and TAFE courses and closer association between government decision makers and universities is required.
- Future provision—Australian Green Infrastructure Council (maturity models and bench marking), Dr Tom Crow
- Training is limited or non-existent for finance managers and real estate agents. (Liveability has just been launched for the real estate sector though.)

Therefore, a framework aligned to an LCL strategy or standard identifying the key job roles, required knowledge and skills and the alignment between them may be required in addition to endorsement of effective courses by industry or professional associations to lead the workforce through the required transition.

Preferences for education services and products

When asked, 'What educational services or products are required by your organisation to efficiently and effectively transition to LCL?' respondents listed the following:

Educational services

- Project leadership/management training to support clients to take leadership and supply chains to be contractually accountable
- Training for Facilities Managers
- Energy and carbon management training
- Tertiary courses preparing energy policy makers
- General professional development training (*We generally rely on expert consultancy services for specialist sustainability advice.*)
- Government legislation for LCL
- Mainstreaming sustainability into coursework learning from institutions that have embedded LCL

- The latest updates on science, research, product development and systems
- Ongoing professional development in carbon management, waste management, and principles of sustainability
- Ongoing behaviour change programs to encourage more sustainable behaviour
- Financial analysis of the best, long-term methods to achieve lower levels of greenhouse gas emissions

Products

- Products that lower energy consumption for operational energy requirements
- A series of tools to apply to various activities across the concept planning phase, building and construction phase, operation and maintenance phase, and assessment of existing buildings/processes
- Integrated solar photovoltaic panels allowing flexibility of design
- Energy performance monitoring and reporting software and tools
- Affordable energy saving fenestration [*windows*]
- Travel options that are realistic and functional alternatives to the private car travel

PREFERENCE FOR DELIVERY OF CAPACITY BUILDING

As outlined in this section, the survey and consultation participants identified several factors influencing the selection of capacity building programs based on:

- the performance metrics of the program
- the program provider
- the engagement methods
- the duration
- the support mechanisms to foster participation.

The provision of education programs is based on a variety of factors, such as the target audience, the education content and outcomes. Those consulted indicated that one or all of these methods in combination are preferred by most participants, being face-to-face facilitator-led group courses with interactive online self-paced learning requiring the integration into current job roles to support on the job training and work experience. The face-to-face learning fosters interaction and the exchange of information and skills between peers. In the current environment, the engagement and influence of social media are also critical in reinforcing learning and sharing before, during, after or even in place of formal engagement.

Alternatively, mentoring or coaching programs for individuals or in small groups would be relevant dependent on the audience's requirements. The consultations also highlighted the need for mobile applications and learning to engage professionals and tradespeople heavily reliant on mobile offices or those located on a building site during office hours. In addition, demonstrations, conferences and networking events are also required for ongoing professional development and to build communities of practice for sharing and learning from peers.

In an effort to engage industry, methods used should align with the delivery preferences; for example, the three critical capacity building program types are aligned with program duration, which may cater to various target audiences. Program types range from:

- a seminar from a minimum of one hour to a maximum of one day, potentially suitable for professionals

- on the job training focused on integration into current practices or job role, more suitable for technical staff or tradespeople
- qualification programs (tertiary) or short courses (one to four days) with assessment requirements, for those looking to advance in their profession or change careers.

Programs must be delivered by credible organisations, individuals or a delivery team with accreditation or endorsement by a professional body or industry association. Survey participants were asked, '*When considering participation in education programs, what performance metrics influence the decision? Select all that apply.*' Their responses are identified in Figure 8.

As new education programs are developed through the CRC, this summary of preferences could be considered when determining the engagement methods alongside other variables, such as the target audience, content, intended outcomes, etc.

Preference for capacity building provision

As indicated in Figure 9, when survey participants were asked, 'What has your organisation determined is the most suitable method for accessing knowledge and skills to build capacity in LCL?' they identified that the preferred engagement methods include:

- internal programs—private programs developed and delivered internally, or
- external standardised program through engagement with an education provider, industry group, and community group or government agency with others from various organisation and backgrounds.

The least preferred method is disseminated information only.

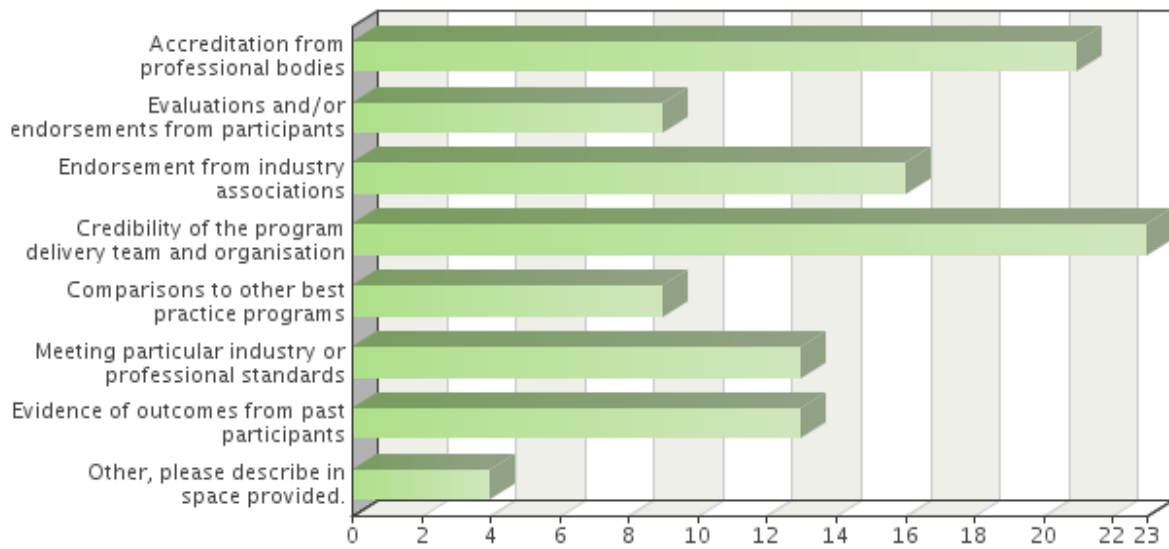


Figure 8: Survey responses on performance metrics that influence participation in programs

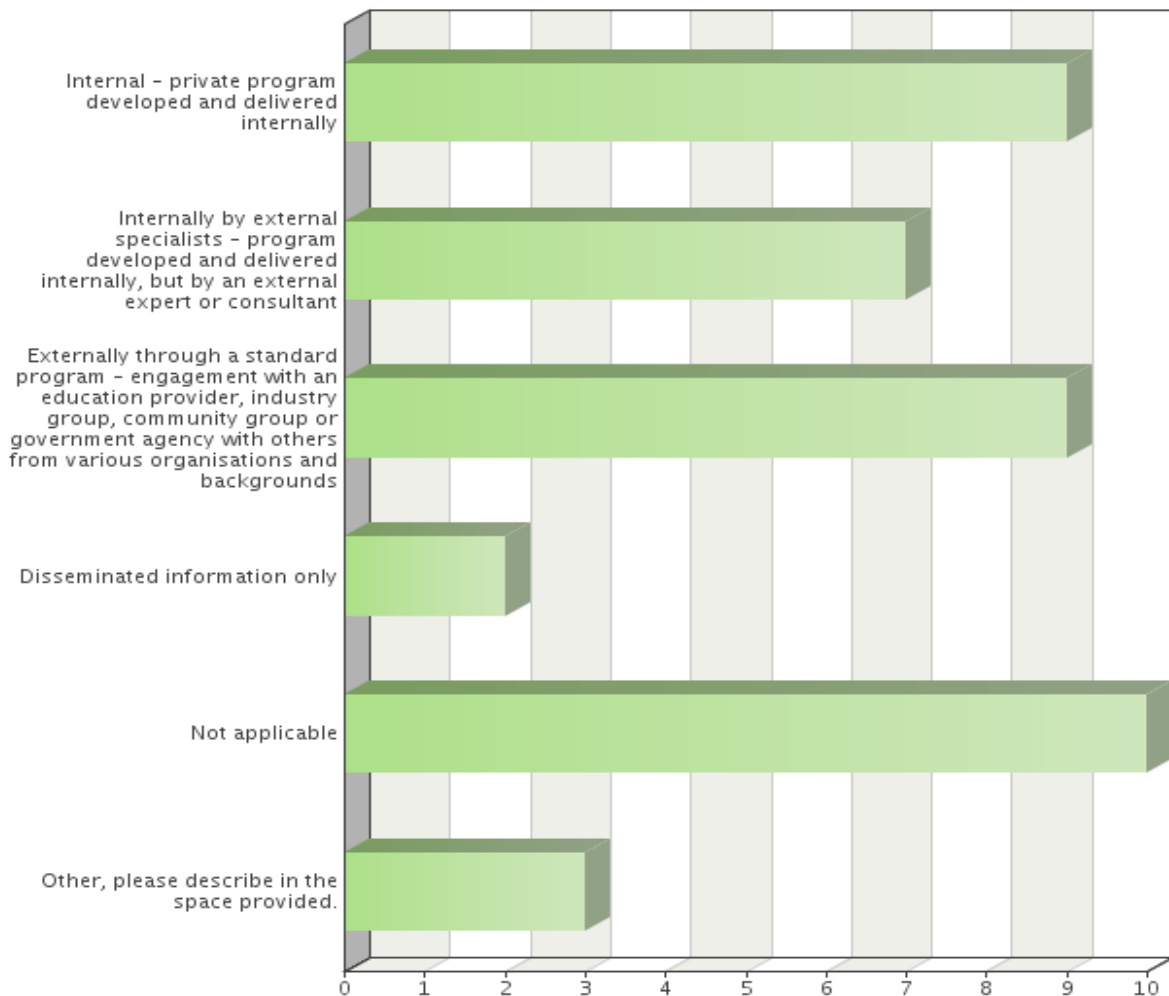


Figure 9: Survey responses on the most suitable method for accessing knowledge and skills to build capacity in LCL

Preferred engagement methods

Consultations with CRC members and representatives from peak industry bodies indicated that the preferred methods of industry engagement based on experience with past training and education programs were very mixed. Overall, the preferred engagement required a combination of approaches and communication methods, and industry endorsement was regarded as essential.

Examples of responses are listed below:

- Non-traditional methods (no chalk and talk or lectures, focused on more engagement with the audience).
- More effective online learning and mobile technology is needed.
- Mentoring on site would be the preferred method for the construction sector in particular and on the job learning with integration into work practices for others.
- Face-to-face is typically required if warranted based on content, application requirements or the needs of the target audience.
- Industry nights, seminars or conferences for keeping up to date with new technology, leading practice or demonstrations.
- Gamification⁶ would be good to trial and research the effectiveness.

The most difficult sector to engage is small to medium-sized enterprises in the residential sector (builders and trades) given workers in this sector may continue to work in the evenings to support the business and are less likely to take time away from work to attend training in a face-to-face setting.

Figure 10 indicates the survey responses to, *'What has your organisation determined is the most suitable*

method for accessing knowledge and skills to build capacity in LCL?' Additional comments included:

- Engagement needs to be blended to ensure that participants are actually getting the content and enough feedback and interaction with other learners to reinforce progress.
- We do all of these ticked (and most listed)—a mixed or blended mode we have found to work best—with strong social media back up.
- While face-to-face education is still the best way to learn, online methods are quickly improving and provide great opportunities to educate more people with fewer resources more cheaply.

The most preferred engagement methods of those surveyed include:

- face to face as part of a facilitator-led group
- demonstration, conference or networking events
- work experience or on the job training
- mentoring or coaching program for individuals or small groups
- interactive online self-paced learning programs.

Preferred duration of program

The preferred duration of engagement in an education program based on those surveyed include:

- seminar—one hour to one day with information only
- integration into current practice or job role
- qualification programs (VET / higher education) or short courses (one to four days) with assessment.

Respondents were asked, *'Please select your preferred duration of engagement in an education program.'* Their preferences are shown in Figure 11.

Capacity building support mechanisms

Respondents were asked, *'Which are the 3–5 most critical support mechanisms your organisation requires to transition to low carbon living?'* Their responses are shown in Figure 12

⁶ <http://www.gamification.org>
http://www.gamification.org/wiki/Gamification_of_Education.

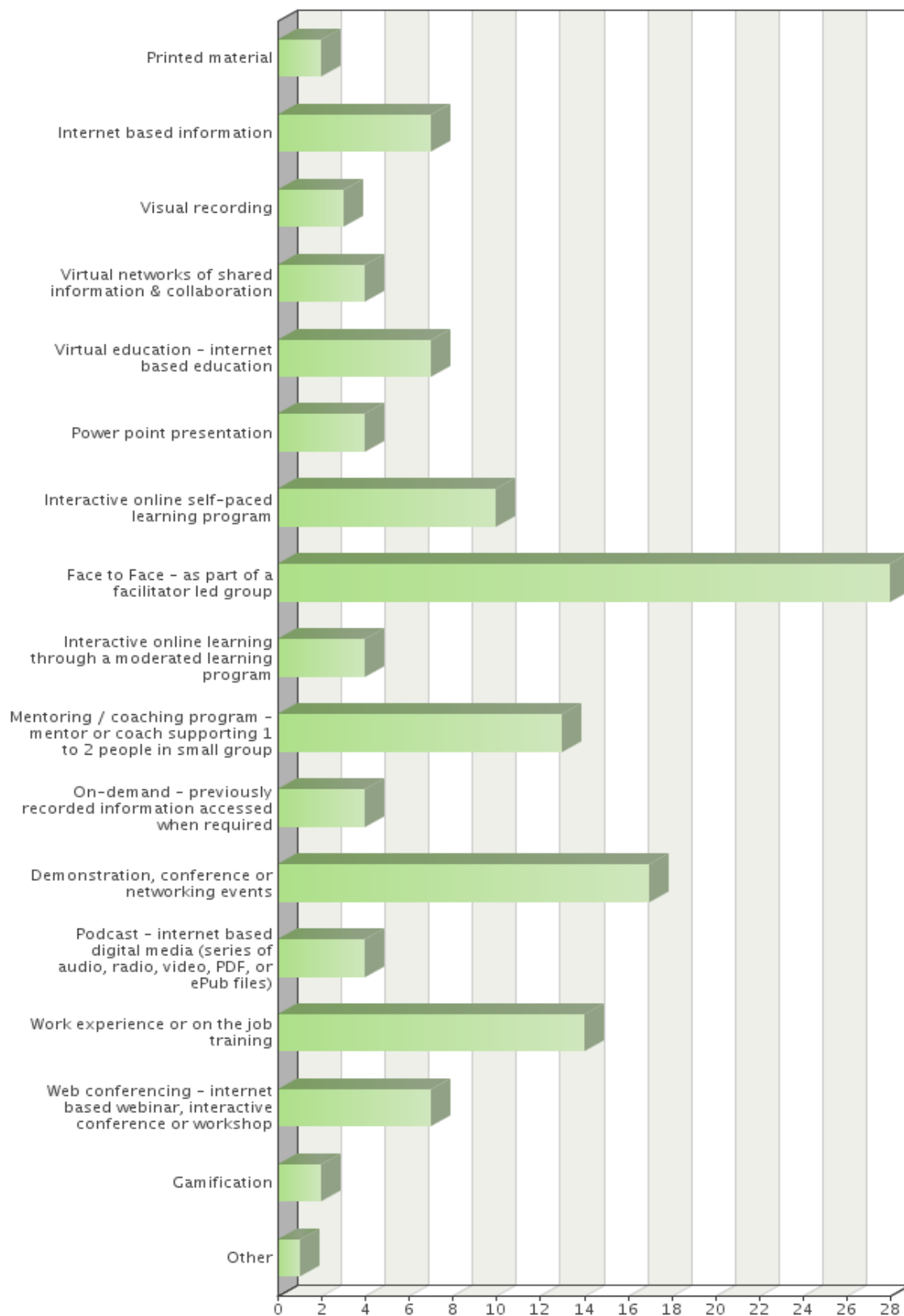


Figure 10: 3-5 most effective methods for engagement in education programs

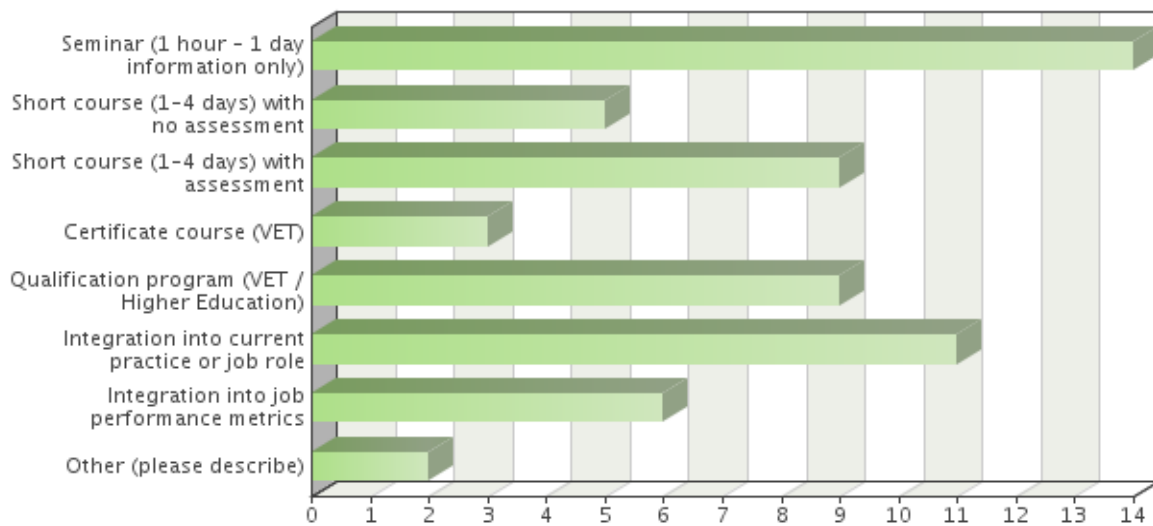


Figure 11: Survey responses on preferred duration of engagement in an education program

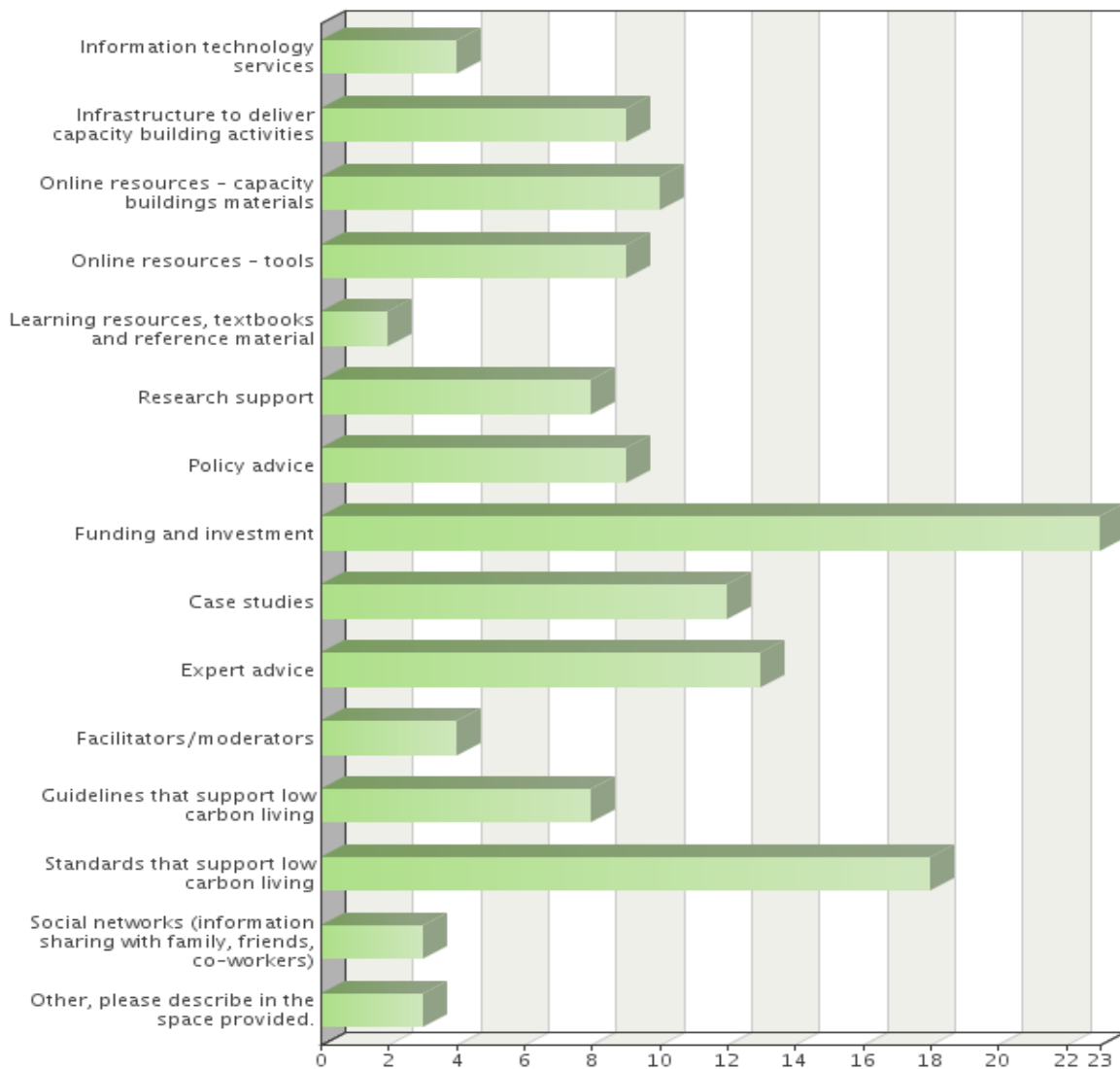


Figure 12: Critical support mechanisms required by organisations

When survey participants were asked, 'Based on your organisation's needs, which of these online knowledge management tools do you currently use or are interested in accessing?' respondents indicated that decision

support tools were the most important, followed by interactive mapping and statistical tools (which most currently use) and 3D visualisation. Responses are shown in Figure 13.

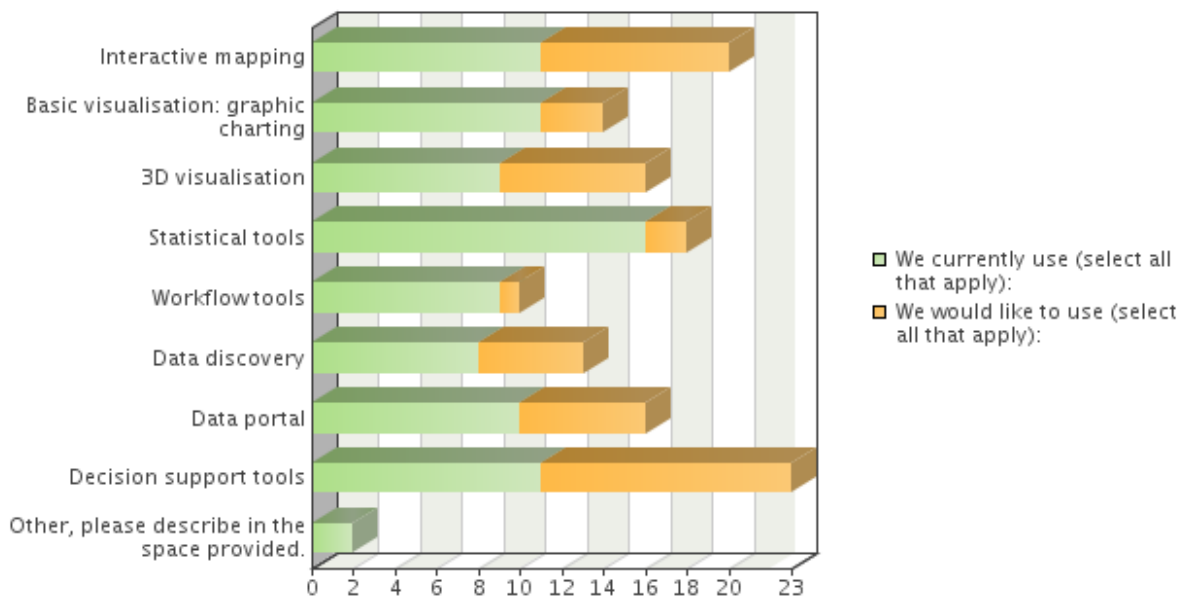


Figure 13: Types of online knowledge management tools

Performance metrics

Participants consulted were asked what metrics should be used to measure the effectiveness of capacity building programs and responded with the following recommendations:

- building performance testing and a benchmarking program to track progress
- number of people trained reflective of industry area
- development, engagement and evaluation through award schemes
- stakeholder participation in the development of travel plans, school / household / community programs based on carbon measurements
- measurement and comparison of travel and health statistics, including congestion reduction and well-being benefits, etc.
- behaviour change program evaluation
- budget allocation / spending on low carbon programs, incentives and solutions

- variation in the housing marking reflective of higher valuation of energy efficient / low carbon homes
- increased building design ratings when building permits are issued
- increased sale of low carbon products or technology
- increased demand for low carbon or zero energy buildings
- comparison of graduate attributes to occupational requirements
- program cost to benefit ratios.

PARTNER FINDINGS

The Australian Urban Research Infrastructure Network exploration

In designing communities and cities in a carbon constrained world there is a need for evidence-based tools and approaches that utilise the best available data, expert metrics and models to inform policy and decision making. The Australian Urban Research Infrastructure

Network (AURIN) is a \$20 million investment from the Australian Federal Government in developing e-infrastructure to support urban research, policy and decision making. AURIN is funded through to mid-2015 and is developing a Web portal for discovering, interrogating and visualising a myriad datasets from across the country. AURIN is developing a 'lab in the browser' where users of the e-infrastructure can shop for data from public and private sectors. Users can create maps, run statistical routines and advanced e-tools including 'walkability' and 'what if?' scenario models. There is the opportunity for the AURIN portal to support researchers, industry and government in better connecting to such knowledge resources to plan and design for LCL.

Environmental, social, economic and spatial information garnered through a partnership through the *Collaborative Research Centre for Low-Carbon Living* (CRC LCL) and AURIN may assist in knowledge transfer and to build capacity across Academia, Government and Industry. As part of the broader study the CRC LCL has undertaken a survey in which participants noted the potential to share a number of data resources including energy and resource consumption via the AURIN data portal.^{xii} Participants across the survey expressed an interest in using AURIN for interactive mapping and statistical analysis to support decisions on urban design and planning, which will lead to transitioning to LCL in urban areas.

According to the survey results, half of the participants are motivated to take part in CRC LCL due to government policy, 28 per cent to be seen to be demonstrating sector leadership and 25 per cent due to the technology and tool availability. AURIN can assist all of these aspects. Interactive mapping with visualisation, decision support and statistical tools and data discovery all rated highly on the participants' list of knowledge management tool needs. Although 80 per cent of participants had not previously heard of AURIN yet, 72 per cent felt that it would provide moderate to high benefits for accessing data; 76 per cent saw benefit for

mapping and visualisation and 60 per cent thought it would be beneficial for using eTools.

During the Semester 2 of the University Teaching calendar in 2013, AURIN is undertaking a project funded through *University of Melbourne 2013 Learning and Teaching Initiative Grant* entitled 'Utilising the Australian Urban Research Infrastructure Network to Support Online Teaching and Learning in the Built Environment'. It is anticipated this capacity building example will give students access to a plethora of datasets including energy, water, transport, building information through the AURIN Portal and tutorial in how to use this information in analysing, visualising and mapping past, present and future urban scenarios.

There exists the opportunity for the CRC LCL to contribute to the AURIN framework of data and analytical tools and to support urban research and industry training. The AURIN infrastructure has potential as a teaching and training resource to support a global network of end users in the BE and geospatial communities, such as those enabled through the International Cartographic Association Open Source Geospatial Laboratories (ICA-OSGeo Labs) Initiative.^{xiii} This international network of laboratories focuses on developing dedicated resources to support open-source geographic collaboration for academia, industry and government organisations. A successful AURIN / CRC LCL capacity building example will form a strong basis for national and international presence, knowledge sharing and collaboration.

The three recommendations for using AURIN and the capacity building opportunities are described in Section 5.4.1.

Sydney Coastal Councils Group exploration

The Sydney Coastal Councils Group^{xiv} is a member of the CRC LCL. The group has worked with the researchers to present an interesting local government example for the CRC Study on how locally produced, practice-based knowledge in sustainable management of environment can be harnessed, compared and exchanged, and serve as a research site for new, CRC-

led programs to be implemented and trialled across a number of local government agencies.

In general, the study participants viewed local government agencies as important intermediaries between government agencies, practitioners (such as manufacturers and builders) and building owners, especially homeowners. As intermediaries, local government agencies can build the capacity of stakeholders by communicating effectively and developing and promoting low carbon products and services. Local government agencies can offer demonstrations and foster collaborative opportunities across private, public and community sectors. The following education areas would support capacity building as key opportunities for local government contribution through the CRC LCL:

- communication and engagement
- standards and metrics
- leadership and collaboration.

Communication and engagement

Consistent with the survey and consultation findings of the study, local government requires the development and consolidation of a knowledge base on existing policy frameworks, programs and initiatives to determine and standardise examples of best practice, while ensuring much-needed consistency of the language used. While local government agencies have a long history of policy development, implementation and program delivery for a sustainable living, including outreach services and community engagement programs, there is a noted opportunity within the CRC LCL to establish, administer and manage a repository of best practice examples (both policy and programs).

This should include tools to support communication internally and externally about energy conservation, efficiency and alternative energy. Factsheets, economic models and business cases are possible examples. Initiatives should build on best practice in community education and development, outreach programs, demonstrations for council assets, new buildings,

retrofits and liveability. It is important to make use of opportunities to define the 'community' in various locations and to determine the market of renters, multi-residential, business owners, major property developers, planners, land release agents or owners across states and territories to engage in the low carbon transition.^{xv}

It is important to collate, distil and package available information appropriately, accounting for specific audiences' needs. A special focus was placed on development and dissemination of evidence-based business cases to guide and empower local government agencies, organisations and practitioners with the right tools to make informed decisions and engage communities. There is an opportunity for CRC to elaborate and test educational programs and economic business cases for multiple stakeholders, and to develop evaluation, auditing and benchmarking mechanisms to support local government agencies' existing and future plans to continue or expand successful programs.

Standards and metrics

Noted for further development to support comparison of buildings is the development of standardised metrics for building performance. Consistent across all consultations was noted a need to focus further research and development on the actual performance of buildings, including use and operation across retail market, council assets and individual private homes. There is need and opportunity to develop easily communicable metrics for building performance and operation, to fully value real estate, and to implement appraisals for homes, for example, using an energy label such as the USA's Energy Star.^{xvi}

Leadership and collaboration

Building internal capacity of local government councillors and technical staff to support programs and policies beyond the short-term grant schemes and political cycles was identified as one of the key strategies for local government agencies to contribute to the transition to LCL. This would involve a focus on integrated approaches across various organisational roles and leadership across different tiers of management. For

example, the enhancement of existing guidelines or development of low carbon guidelines could apply to asset managers, producers, contractors, procurement officers, and consumers.

Once the internal capacity building is completed with councillors, management and technical staff; policies and procedures need to be reviewed to support internal and external programs for energy conservation and efficiency, climate adaptation, and LCL with regard to the BE, including active transport infrastructure and planning in collaboration with other government offices. There is opportunity to review the roles of government agencies and planning requirements related to large developers. A potential management opportunity is the integration of clauses on climate change into contracts for those organisations the government engages.

In addition to commercial activities, there is a recognised potential for a greater focus on public assets such as parks and other public land. It is important to build the capacity of local government agencies to play an active role in developing deals between private and public good interests and strategic planning through integrated design and precinct information modelling. There is a recognised potential for capacity building at the level of precincts to support decentralised energy management initiatives. Here is an important opportunity for the CRC to develop and contribute knowledge about new models of energy supply and generation. This might involve emergent social partnerships between public and private organisations. It may include self-sufficient community-based initiatives. The role of support and awards schemes may also be considered.

Recognising best practice through a low carbon government awards program should be supported internationally through an Australasian awards program with Australian local government authorities and 'sister cities' overseas focusing on LCL policy, capacity building programs, and opportunities to engage communities and business to transition. Some of the most common policies and programs could be recommended for inclusion into local government agencies in Australia.

POTENTIAL FUTURE PRIORITY RESEARCH AREAS

The consultation outcomes indicate the need for further research to remove barriers and develop new methods to support future capacity building programs in these key areas:

- Establish a benchmarking system with accurate data to benchmark, measure and communicate progress (include water):
 - Benchmark buildings—residential, commercial (office, retail, mall)
 - Benchmark transport energy, e.g. via journey to work data (or in Melbourne, all journey purposes) and public transport data (Sydney Buses and Rail Corp).
- Tackle all other uses, e.g. landfills; other buildings, institutional (including government).
- Research and develop industrial design and construction methods—observing construction workers to develop innovative solutions, process and products.
- Research and develop integrated design methods and benefits and team-based simulation training.
- Develop evaluation metrics for education and behaviour change programs.
- Research co-benefits of collaboration, joint funding, health and social welfare and societal costs and benefits.
- Research and develop integrated energy systems and storage.
- Develop at precinct level fit-for-purpose, integrated services and benefits, and investigation of energy, waste, water consumption to communicate efficient use to the consumers and to aggregate the data to communicate opportunities to initiate change.
- Research and address building code and standard barriers and feedback loops for ongoing improvement.

- Implement comparative study to engage decision makers and develop case studies on policy, economics and benefits of constructing new low carbon buildings compared to retrofitting the existing building stock.
- Research intervention methods and streamlined pathways to the successful development and adoption of low carbon technology based on design, manufacturing, market entry and sales, installation, occupant demand, use, consumption practices and behaviour.
- Utilise marketing science, innovation and demand modelling (evidence-based) assessment of consumer feedback, priorities and drivers, market segmentation for demand forecasting for new buildings and retrofits, and engagement with professionals, specifically builders and tradespeople.
- Undertake further research to understand behavioural economics, market and socio-cultural aspects of energy use, identifying demand models by determining what drives and inhibits people, the workforce and government from implementation of LCL. A thorough multidimensional understanding of existing conditions at both micro- and macro-levels will determine relevant points of intervention for capacity building programs, especially for new products or methods entering the market, and facilitate the development of demand models.
- Investigate Australian construction in comparison to construction in other countries to determine how to reduce or eliminate excess costs.
- Implement national engagement to develop models of infrastructure management plans to determine how to best utilise taxes, user pays programs, and private investment.
- Develop capacity to understand building information modelling (BIM) and precinct information modelling (PIM) including the information going into the modelling tool (theory) before and during the use. If a learning application is developed well, the information could be provided along with ideas (rote

learning applied with critical thinking application) for applied competence using simulated scenarios, and so on.

- Undertake further investigation and engagement to develop a blueprint and pathway to an Australian city in 2100. Determine transition pathways, policy implications. Investigate whether benevolent paternalism can efficiently transition the workforce and communities, how communities might be engaged, and how diversity and inclusion might support the transition. As communities come to terms with future expectations, policy and actions can be carried out to support the transition.

Survey participants responded to, *'What priority educational research or capacity building areas would you recommend that the CRC further investigate to assist the built environment sector to build capacity for low carbon living?'* with:

- First, the technologies that will achieve LCL are needed. These will determine what specialised knowledge and skills will be needed.
- Auditing of the current level of carbon performance is needed and then planning is needed to ascertain how we progress towards LCL in our communities.
- E-learning tools to support interactive face-to-face education.
- Composite products.
- Development of databases freely available on line so institutions can do their own analysis.
- Integrated team formation and leadership.
- Facilities managers training and development of a professional certification body.
- Understanding barriers and opportunities in the organisational context.
- Behavioural factors behind the uptake of LCL.
- Needs analysis of potential customers.
- Overall confidence in the shift toward CLC.

- Client supply chain formation and management.
- Consumer engagement strategies.
- A series of demonstration projects (case studies) with supporting evidence of the value of what was achieved.
- Interactive tools to help assess various options at the early phase of a building project.
- Full carbon footprint accounting.
- Two priorities: the 'why' and the 'how'.
- Demonstrations of people's homes so neighbours can talk.
- Presentation of viable alternatives to typical building design, materials, and technologies.
- Life cycle assessment.
- Building collaboration.
- Overcoming intermittency issues with renewables.
- More direct and relevant teaching on how to implement ideas in reality.
- Approaching barriers for shifting senior management.
- Standards for life cycle costing.
- Standards for embodied energy and water.
- International case studies through fieldtrips to see the cases and hear from architects/engineers who were involved first hand.
- Effect of bottom up grass roots action.
- Case studies not based on exemplar practice - but rather common practice.
- Roadmap for government to follow to get from 6 Star to net zero carbon and LCL for new and existing building stock, especially the necessary regulatory and legislative changes needed to support the change.
- Changing people's motivation for low carbon products.
- Ideas based on making towns and cities more efficient.
- Empower building managers through energy efficiency programs.
- Integrate building management into day-to-day activities of staff/students.
- CAD tools (BEM, PIM) or any decision support tools.
- Material science innovations with design flexibility.

CONCLUSION & RECOMMENDATIONS

The availability of information to support Australian communities to transition to low carbon living (LCL) is improving, with the Internet providing access to an increasing number of such resources. However, the quality, coverage, and applicability of these materials require careful consideration before use. This presents a growing challenge for decision makers, practitioners, educators, and the community to select and act upon such information to suit specific priorities. For instance, part of the transition to LCL will involve the understanding, selection, and implementation of a range of standards, methods, materials, and technologies (some of which are not available in the Australian market) to support whole systems. Decision makers are drawing on various information sources to determine the appropriate combination required specific to the project needs. However, in parallel to the investment into and dissemination of tailored, evidence-based information, there is a need to consider other factors that influence decision-making and actions, including how information is received and acted upon, and what are the dynamics and processes of participation and engagement.

Given the magnitude of the LCL challenge, the findings of the Study suggest that an overarching strategy for the BE is needed to provide a scaffold for the various frameworks and guidelines. Such a strategy would assist the sector to interpret evidence and findings related to the various options and to inform application across the sector in planning, design, construction, sale, management, and use. A framework with guidelines specific to sub-sectors and climate-specific requirements or technologies (such as cogeneration and tri-generation) including demonstrations will need to be established and communicated across government, industry and community sectors, including management of the associated risks.

In an effort to consolidate the available verifiable knowledge into user friendly information, existing

national and international standards should be built upon and aligned with evidence-based methods and available materials and technology suited to the Australian context. These resources need to be effectively communicated as an industrywide national approach to the workforce and communities. This knowledge will also need to be integrated into mainstream practices through tertiary, industry and community education and engagement programs. Intermediary roles will prove effective in assisting users and the workforce to determine the most appropriate approaches, based on energy use, available materials, technology, and systematic solutions specific to individual project needs. The framework, standards, guidelines, and metric system therefore must be used to guide integration into practices, supported through intermediaries, and the outcomes must be disseminated for widespread adoption.

The framework needs a user-friendly metric system to measure and communicate energy conservation, carbon abatement, and financial savings at individual, state/territory and national levels. Institutions, government agencies, the workforce and average householders require a shift in their existing practices and work processes.

The research and communication strategies that underpin these resources need to be well established derived from reliable and evidence-based modelling, applied research programs and existing communication channels through the CRC to streamline integration of the verified methods and new technology into the workforce and communities to engage the Australian BE to transition.

Therefore, the initial overarching systemic approach for the CRC would be:

1. Communicate and engage communities, the existing workforce and government agencies about the application of tested opportunities (*the what, why and how*) through action or applied research leading to the dissemination of evidence-based research encouraging LCL practices to become mainstream.

2. Invest in capacity building for intermediary roles to engage and bridge the divide between key stakeholder groups and drive demand for LCL, healthy communities and a resilient environment through construction, sales, and lifestyle choices, by utilising case studies and business case demonstrations.
3. Support research focused on removing barriers, creating effective long-term incentives, regulatory and compliance transition scenarios, frameworks and guidelines, and decision making tools, including a benchmarking system (residential), to support all the various audiences, based on new knowledge and technology to test and report the outcomes for wider mainstream implementation over time.

See also Sections 4.2.2, 4.3 and 4.4 for a complete list of the key topics, content and capacity building requirements.

KEY FINDINGS ALIGNED TO CRC MILESTONES

The initial aim of the Study was to inform Milestone R3.4.3 and R3.4.6 by providing findings that provide guidance on the form of education programs and the target audiences. In doing so, the Study report provides valuable guidance to Milestones specific to Research Program 3, although some could potentially be aligned with projects under Research Programs 1 and 2 over the next six years to 2019 as outlined in Table 7. In addition, the outcomes of Programs 1 and 2 would also benefit the delivery of projects in Program 3, such as the development of tools, evidence-based business cases, and knowledge and skills enhancement related to technological outcomes.

The outcomes of this study align with the outcomes of other programs that will support the development of educational products or require education programs once developed, such as:

- U1.3.4 High Performance Building Investment Analysis (HPBIA) tool trialled by industry partners)

- R 2.4 Health and productivity co-benefits
- U 2.2 Automated precinct assessment tool
- U 2.3 Network utility demand forecasting
- U 2.4 Co-benefits calculator (government, community and private sector)
- R 3.3 Living Laboratories
- U3.3 Education institutions and professional associations in Australia and Asia Pacific
- U 3.4 Local Councils and other community agencies.

CAPACITY BUILDING STRATEGY

The findings of the Study suggest a range of possible areas for capacity building to support LCL. These areas are seen as being important gaps to fill cumulatively and systematically to provide a valuable opportunity for the CRC to lead the transition to LCL in Australia and demonstrate international best practice. As illustrated in Figure 14, the recommended strategy to transition the workforce, government and communities to LCL through capacity building requires a systemic approach, focused on the *what*, the *why*, and the *how*:

- Review existing knowledge and practices. Ensure existing low carbon practices, codes and standards are established through proven technologies and methods and that they are consistent, communicated, well understood and implemented effectively through education programs.
- Increase requirements, incentives and communicate opportunities using social, governance or business models and policy, such as ratcheting existing compliance to inform the requirements for LCL in standards, codes, regulations, and education and training courses.
- Develop new knowledge and test existing (unverified) knowledge through practice-based research to develop new evidence-based information and application method(s) to support the development of new standards of practice, policy, regulations and social models.

Table 7: Milestone alignment with recommended capacity building projects

Milestone	FY2 (2013 - 14)	FY3 (2014 - 15)	Year 4 (2015-16)	Year 5 (2016-17)	Year 6 (2017-18)	Year 7 (2018-19)
Education Projects	<p>Implement and invest in opportunities by minimising barriers, creating awareness and enabling access to verified resources to efficiently make decisions and implement them.</p> <p>Develop competence to assess and identify project specific opportunities, existing technology and proven application methods and drive demand.</p>	<p>Demonstration and verification of performance:</p> <p>Case studies are developed to support implication of choices beyond the initial costs to include running costs, maintenance, and environmental and social impacts and benefits.</p> <p>Guidelines and metrics are developed to enable measurement, monitoring and benchmarking achievements to communicate progress.</p>	<p>Awareness of new technology and developments or improvements to current technology and practices</p> <p>Buildings are measured against metrics to support benchmarking and communicated to public (ongoing).</p>	<p>Stakeholders are able to have more informed interactions with professionals, tradespeople in the BE and property services about options and return on investment.</p>	<p>Stakeholders are prepared and willing to uptake new technology, and potentially test unproven solutions and experimental approaches and demonstrate findings for further research.</p> <p>Individuals and communities are healthier and more resilient to change and demonstrate opportunities.</p>	<p>Demonstrate and verify performance.</p> <p>All activities are communicated for best practice demonstrations and further research internationally.</p>
Output (R)	<p>30 June 2014</p> <p>R 3.4.3 Initial design of educational, training, and monitoring programs, for the specific communities across the CRC</p> <p>R 3.4.4 Policy impediments and incentives for effective education and training assessed</p>	<p>30 June 2015</p> <p>R 1.4.5 (Integrated Building Systems) Preliminary drafts of training material and pilot professional development workshops completed in collaboration with activities within Research Program 3</p> <p>R 2.5.5 (Low Carbon Precincts) Preliminary draft of a set of training material delivered and pilot professional development workshops developed in collaboration with activities within Research Program 3</p>	<p>30 June 2016</p> <p>R 1.4.9 Final versions of the training material delivered</p> <p>R 3.4.9 Assessment of the effectiveness of the CRC professional education and training programs completed</p> <p>R 3.4.10 Provision of enhanced education and training</p>	<p>30 June 2017</p> <p>R 1.4.10 First delivery of training material and professional development programs</p> <p>R 3.4.12 Assessment of behavioural changes as a result of program initiatives completed</p> <p>R 3.4.13 Strategies for expanding successful education and training programs nationally developed</p>	<p>30 June 2018</p> <p>R 1.4.12 Second delivery of training material and professional development programs</p> <p>R 3.4.15 Assessment of effective uptake of CRC strategies at a national level completed</p> <p>R 3.4.16 Strategies for exporting these educational and monitoring skills to the Asia Pacific region through agencies such</p>	<p>30 June 2019</p> <p>R 1.4.14 Third delivery of training material and professional development programs.</p> <p>R 3.4.18 Final assessment of outcomes from the education, training and monitoring programs developed within the CRC completed.</p>

		<p>R 3.4.6 Pilot educational, training, and targeted professional development program for built environment professions established</p> <p>R.3.4.7 Assessment of the effectiveness of training and education at community level programs completed</p>	strategies via feedback from CRC research outcomes completed		as UNEP	
Utilisation (U)	<p>30 June 2014</p> <p>U 3.3.1 Information, education and training programs operating in selected CRC precincts (through network partners)</p>	<p>30 June 2015</p> <p>U 3.3.2 Information, education and training programs adopted across at least one city council jurisdiction</p>	<p>30 June 2016</p> <p>U 3.3.3 Professional development programs delivered to built environment professions by partner institutions and Network partners</p> <p>U 3.1.4 Training course delivered to property developers and potential service providers to encourage use of CRC outputs in design of products and services</p>	<p>30 June 2017</p> <p>U 3.1.5 Training course delivered for property developers and potential service providers to encourage use of CRC outputs in design of products and services</p>	<p>30 June 2018</p> <p>U 3.1.6 Training course delivered for property developers and potential service providers to encourage use of CRC outputs in design of products and services.</p> <p>U 1.3.6 Final assessment of the commercial applicability of the HPBIA tool conjunction with CRC research partners</p>	<p>30 June 2019</p> <p>U 3.3.4 One or more professional education and training packages are adopted in select regions of the Asia/Pacific.</p>

- Implement new knowledge outcomes through applied education research to disseminate findings

for integration of knowledge and methods into mainstream practice.

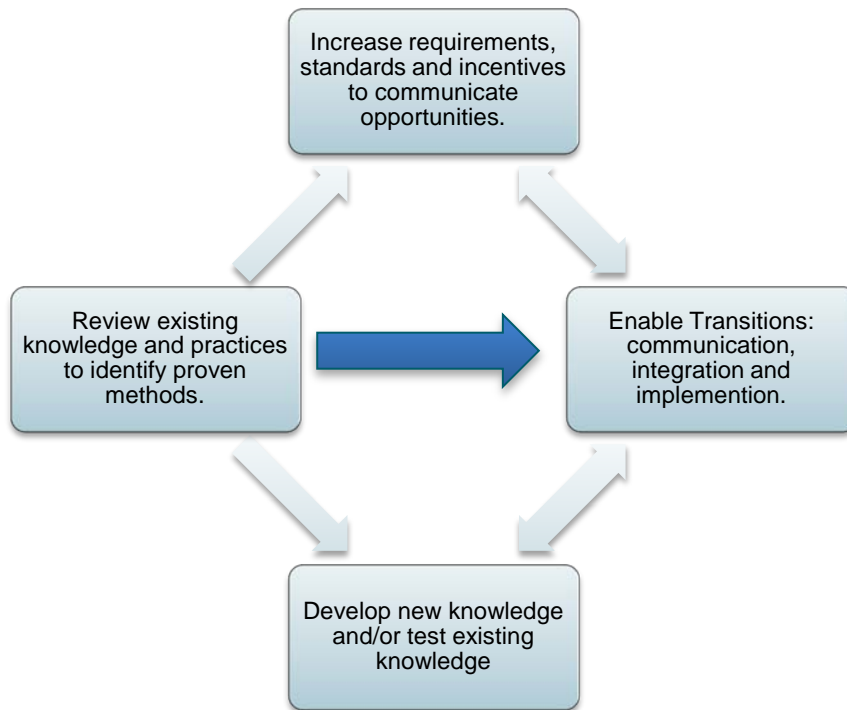


Figure 14: Systemic and cumulative approach to capacity building and support requirements

The researchers have identified dimensions to support the strategy for capacity building based on the Study findings. The dimensions of capacity building (see Section 5.4) require engagement across a series of target audiences in the BE and associated sectors supported by an established framework and guidelines. It is important that initiatives take a whole system approach ensuring that the appropriate range of opportunities is considered and implemented successfully across the range of stakeholders to fully capture the potential value. As identified in 2012, the findings of the Department of Innovation (2012), *Education Review of Energy Efficiency Skills Demands and Training Provision Across the Trades and Professions*, highlighted the need to support the supply of education and training, qualifications through Vocational education and training (VET), higher education and non-accredited sources will all have an

important role. The types of qualifications that will be relevant can be described in terms of these three broad categories:

- **Qualifications producing graduates who are accustomed to systems thinking and who have the ability to draw on diverse disciplines to solve a given problem or achieve a particular outcome;**
- **Qualifications that produce graduates with specific technical skills, which are directly relevant to discrete abatement opportunities; and**
- **Qualifications that have a component related to skills or knowledge that build sustainability awareness, which will help to normalise sustainable practices (including carbon abatement), without this necessarily being the learning focus.**

Section 5.4 briefly highlights the opportunities corresponding with each theme identified.

DIMENSIONS OF CAPACITY BUILDING

The Study reinforces that the current knowledge and technology used to value, plan, design, construct and operate the BE efficiently in Australia aren't being implemented to the extent possible. Based on analysis of the findings, the researchers have identified key areas to fill existing gaps in the immediate and longer term

providing a valuable education strategy for the CRC to support LCL in Australia and demonstrate international best practice. The key findings of the Study can be summarised in six capacity building themes informed by a whole systems or systemic innovation approach. The recommendations resulting from the Study are clustered under overlapping 'dimensions of capacity building', used to identify priority areas requiring strong consideration by the CRC relative to current and future projects:

Dimensions of Capacity Building

(Taking a Whole Systems Approach)

Communication and Engagement

Education Transformation

Technology in Practice

Leadership in Practice

Collaboration and Partnerships

Policy and Standards

Communication and Engagement

A majority of survey respondents (67.5 per cent) identified communication and awareness as the top barrier to engagement or capacity building to transition to LCL. There is an identified *disconnect between CRC stakeholders* at various levels of social organisation: individuals, businesses, amongst the community, and the workforce (between consultants, designers, engineers, energy assessors, builders, trades people, etc.), leaving gaps in assessment, the identification of practical options, access to resources and effective implementation methods. Education programs to support LCL were reported as the highest priority (42.11 per cent), followed by communication (22.95 per cent). Similarly, the consulted CRC partners have emphasised communication through sectorwide education and community engagement as critical areas to promote

uptake and a widespread change for LCL. As described by one of the study participants, the professional sector suffers from

'fragmentation [as] a huge issue: for example, between those who approve plans, architects and builders, the project doesn't match up so an [important] area is to get these groups talking and training together.' Consultation quote

Communication and engagement are essential in the shorter term to fully value and optimise the opportunities to engage in the transition to low carbon living, as individuals, amongst the community, the workforce. The areas of strategic importance identified by the study participants requiring action or further research were:

- investment in dissemination of guidelines promoting consistent principles, practices and implementation methods to promote engagement

- development of social change frameworks based on the articulation between multiple CRC stakeholders
- investment in intermediaries to identify opportunities, access resources and implement them effectively (see section 5.4.3 Technology in Practice).

To promote engagement with and between government, industry, and communities about LCL opportunities, investment in effective communication is needed through tailored messages, including fit-for-purpose solutions, viable business cases, and implementation strategies that account for available resources and expertise (human, financial and technological). However, due consideration needs to be given to social processes, for example social networks of influence and motivation, as models of communication based on information transfer only are inadequate. Indeed, as indicated in the findings, *social values* were reported as one of the top four influences on organisations' plans to contribute to low carbon living. Two important considerations for the development of such capacity emerging from the findings are: an understanding of existing cultures of practice, communication channels, social networks, and values; and, the analysis of the social and affective dimensions related to LCL such as, issues of liveability, affordability, wellbeing, and community bonds or benefits.

As indicated in the findings, *social values* were reported as one of the top four influences on organisations' plans to contribute to LCL. To determine the effective communication and engagement methods, further research is required to gain a clear understanding of various stakeholder groups (audiences), along with their socio-cultural attributes and structural conditions influencing current practices, in addition to content or message production and the most suitable methods and channels of communication. The initial area of focus should include the methods used to identify and prioritise opportunities based on individual project needs. Engagement with appropriate experts who use proven techniques is important. The opportunities require whole systems thinking and methods to determine the client's priorities assessed against the costs and benefits,

including return on investment, technology (suitability, reliability and availability) and the access to additional skilled stakeholders for implementation, all contributing to the decision to act. Finally, beyond the circulation of information, the attention needs to focus on processes through which information can be translated into practice, including a range of factors that can contribute to engagement and action.

'[There is a gap] between what "mums and dads" know vis-à-vis experts ... [It is] important to get the message implemented to micro-scale.'

Consultation quote

The outcomes would potentially add important socio-cultural dimensions to the analysis of economic and policy mechanisms that shape energy consumption behaviours and practices, including interconnected categories of sociability, liveability, comfort, affordability, house-performance, structural environments, or ***attitudes that inform 'old ways of doing things'*** (noted in the consultations).

In addition, due to the fragmentation of the industry, the advice and recommendations consumers receive can vary dependent on the expertise of the intermediary engaged, such as a designer, builder, tradesperson, manufacturer, supplier, retail professional, asset valuer, financial lender, real estate agent, and so on, leading to further confusion, perceived risk increases and ultimately a lack of action or reverting to accustomed practices and technology. Based on the research outcomes, it is recommended that an overarching framework with decision-making pathways be developed to identify the occupation roles and expected contributions of various stakeholders. Guidelines could then be developed with supporting resources to deliver consistent capacity building messages across the industry, government, education, and community sectors. Some guidelines and resources are currently available; however, consumers are still falling short of acting on them.

'It's important to train and educate across various professions, but also to look at the motivations of mainstream users' and that "in

immediate term to increase an ability to have a more informed discussion with trades so people can understand the options [available to them].'

Consultation quote

Research would determine key areas of influence based on social capital, industry advice, proven methods, product availability and government incentives. It would also offer an important context for determining how existing practices can be articulated with the LCL agenda, devising capacity building initiatives (including measurements, benchmarking, communication, implementation, education, and engagement strategies).

Due to the variety of audiences being targeted, multiple engagement models, communication methods and media channels need to be considered. However, traditional methods of communication, including interpersonal communication between professional and trade practitioners and building owners, were noted throughout consultations as very important. For example, one participant observed:

'Trades (electricians, plumbers) need to be confident about energy efficiency so they can do some of this [communication] work with people.' Consultation quote

Similarly, physical demonstrations of energy-efficient products or methods by a range of players (such as local councils, retailers and developers) in the community were identified as part of the broader communication ecology. Unsurprisingly, social media such as Facebook or Twitter, as well as mainstream television programs, would prove effective for short instructional online media. 'Do it yourself' videos or informative short fact series (for example, internet '*Smart TV streams*') were mentioned as requiring more attention given the increasing demand. The study participants reported the increasing involvement of their organisations in internet-based communication. Some cited the popularity of high-quality online reports, mobile learning, and touch technology.

As part of communication and engagement, the research identified a range recommendations aligned with key

roles, strategies and fields of action or intervention across planning, construction, property and retail services sectors, as well as local government and community sectors.

Managing risk and value capture

The most critical support mechanism identified by respondents to the survey was 'funding and investment'. The consultations confirmed this: participants repeatedly raised the need for a clear business case to be developed. Such business cases would need to be developed and communicated for the various stakeholders and communities across the CRC. The recommendation is that the business cases are not only to be developed, but are to be circulated to communicate opportunities aligned with costs and benefits, especially co-benefits.

In the residential sector in particular, the skills, integrity and professionalism of a property agent will arguably affect the decisions prospective buyers make when deciding where to live and what type of housing to purchase. Real estate agents are required to market clients' property assets to their best ability; with increasing energy costs, it is realistic to include the attributes of an energy efficient home among its marketable features. Without the establishment of building performance testing and an easy-to-use system to understand and compare ratings or energy performance criteria, purchasers and sellers are unlikely to discern the value, if any, such ratings and assessments contribute to a more energy efficient house.

Table 8: Community and engagement recommendations

Potential Project	<i>Target Audience: Description</i>
Low Carbon Living Framework	<p>All (Industry, government and community):</p> <p>Development and dissemination of an industrywide LCL framework for BE practitioners, government agencies and community through existing communication channels (including media, intermediary and social networks) This should be developed based on existing cultures of practice and values and include proven transition demonstrations, case studies and supporting guideline resources (see <i>Case Studies and Transition Demonstrations</i> in this table).</p>
Energy Efficiency and Low Carbon Reporting	<p>Energy assessors, owners and end users, built environment (BE) professionals and trades, education and research institutions (educators):</p> <p>Conducting energy / carbon audits and reporting recommendations—Supporting the development of a consistent reporting standard (commercial, industrial, residential) to communicate energy and carbon assessments and recommendations to enable consumers to easily implement opportunities including cost / benefit and co-benefit analysis for the whole life cycle of products, assets, buildings, etc. (embodied energy, operations, maintenance and end of life).</p>
Case Studies and Transition Demonstrations	<p>BE professionals & trades, community, owners and end users, associated professionals (i.e. property services, retail, suppliers), industry / professional associations, government agencies (for business and community engagement), education and research institutions (educators):</p> <p>This includes an opportunity to develop case studies, demonstrations and transition scenarios highlighting proven methods, technology and the underpinning research for the BE. In the commercial, industrial and precinct levels, energy/carbon audits, modelling outcomes and technology recommendations require demonstrations. These should support:</p> <ul style="list-style-type: none"> • an overview of the opportunities including highlighting available technologies and the proven application techniques or methods for installation and maintenance (see Implementation Methods in this table) • development using plain English and made available through accessible, popular formats (e.g. public events, media) to CRC stakeholders to assist in identifying planning, design, technology, and construction methods, including costs and benefits for affordable low energy and zero carbon houses and healthy lifestyles (both new builds and retrofits) • comparison and marketing opportunities through valuations aligned to a baseline comparison tool (residential properties in particular) for existing buildings or standard buildings built to code (see <i>Residential Metrics</i> in Table 13) • low carbon transportation examples including travel practices, road system management, new modes of transport, and transit oriented and pedestrian friendly developments • interactive learning, such as first-hand reflections through interviews and ‘how to’ demonstrations using visual media, suitable for multiple audiences and freely accessible and available online as well as on mobile devices (see Tables 10 and 11)
Investment In Intermediaries to Identify Opportunities and Access Resources	<p>Non-technical roles in property (real estate / valuation), financial and retail services, local government (town planning, community liaisons, sustainability managers, planners) and community leaders; and Technical roles include energy assessors, designers (i.e. architectural, landscape), engineers, builders and trades people:</p> <p>(See <i>Driving Demand and Value Capture and Business Cases</i>.)</p> <p>Intermediaries require capacity building to identify project specific opportunities and ensure stakeholders not only have access the appropriate information and recommendations, but are also guided through the decision-making process and implementation of these opportunities. Additional guidance may include ongoing running costs, health factors, increased asset value, accessing finances and or access to other key industry experts (tradespeople and professionals) with the knowledge and skills required to implement the recommendations or properly valuing assets.</p> <p>Energy assessors with carbon accounting and management skills are essential. They may fill a designated intermediary role, or there may be an opportunity to up-skill existing occupational roles with energy and carbon assessment skills to enable the development of recommendations during planning, construction or maintenance.</p>

<p>Development of Comprehensive Social Change Models</p>	<p>All:</p> <p>Additional research aimed at the development of social change frameworks based on understanding a web of actors, forces and relationships between them within the BE sector involving:</p> <p>Detailed mapping and analysis of existing cultures of practice within regulatory, professional, trades, property and retail services (supply chains) and community sectors (households), including intrinsic and extrinsic motivations, social values and networks, structural contexts, to determine barriers and opportunities, strong and weak linkages in order to support systemic approaches to social change and to inform the alignment with LCL Framework across CRC stakeholder groups.</p> <p>Micro-level specific—‘mums and dads’: owners/developers were identified as the key role requiring capacity building (53.49%) by the survey respondents and repeatedly identified in the consultations sessions as a priority area. Therefore, a detailed understanding and evaluation of existing practices at the level of households (e.g. access to infrastructure, financing schemes, specialised knowledge or expertise, sources of trusted information and social acceptance) is needed to support mainstream transition into LCL.</p>
<p>Implementation Methods</p>	<p>BE professionals & trades and education and research institutions (educators)</p> <p>The what, why and how—knowledge, skills and proven implementation methods based on scientific principles (e.g. building sciences) and aligned with occupation requirements need to be identified including ‘how to’ demonstrations. Each demonstration needs to outline the project priorities and specifications aligned with a variety of materials, products and technology to demonstrate proven implementation methods.</p> <p>Initially, the demonstrations need to be based on compliance with Section J of the BCA and related standards and in the longer term could align with a framework and decision-making process for engagement in low carbon opportunities and associated guidelines aligned to standardised metrics for zero energy or zero carbon buildings and precincts. This would offer a consistent approach across stakeholder groups linked to available technology and proven methods.</p>
<p>Business Cases: Develop and Disseminate</p>	<p>Non-technical roles in property (real estate / valuation), financial and retail services, local government (town planning, community liaisons, sustainability managers, planners) and community leaders, solicitors, accountants</p> <p>Technical roles include energy assessors, designers (i.e. architectural, landscape), engineers, builders and trades people:</p> <p>Areas of research identified as key components to support evidence-based business cases and modelling with long-term performance data of designs, devices and behaviour include:</p> <ul style="list-style-type: none"> • promoting autonomous housing (what would it require to take the best low-energy-rated conventional house close to or at zero net life cycle energy consumption?) • exemplars of retrofit (energy and water) to the 98 per cent of the building stock, which pre-exists, etc. • barriers for shifting senior management • analysis of substitution products that deliver low carbon living • overcoming intermittency of renewable energy supply • demonstrating project findings in various climatic regions to support affordable housing • evaluation of existing tools such as the Living Smart program • enabling engineers to provide early evaluation of options over a life cycle period of 10, 20 or 30 years on the benefits of implementing low carbon buildings • recent work on the residential rental property market, which has shown no current engagement with owners or their information sources in real estate or with tax accountants.
<p>Managing Risk & Value Capture</p>	<p>Solicitors, accountants, owners, developers, government agencies, utility companies, planners, consulting firms, etc.</p> <p>(See Business cases in this table.)</p> <p>There was a general consensus that the transition to lower carbon is a priority for organisations. In an effort to manage the risk to organisations, the CRC could invest in the development of risk management models and business cases:</p> <ul style="list-style-type: none"> • evidence-based business cases and modelling

	<ul style="list-style-type: none"> • examples of legal agreements and accountability—solicitors engaged in the development of contracts to support energy efficiency, green leases, or the transition to lower carbon through energy performance contracting, new areas resulting from BIM or PIM. • examples of the methods of engaging in BIM and PIM such as stakeholder engagement, the benefits, risk mitigation and the return on investment when planning, designing and constructing projects • how to obtain independent advice (not overly technical) to capture value through integrated design • project management to engage all key stakeholders and decision makers from pre-planning to handover • ensuring accountants have the skills to incorporate reduced costs from power savings and boosts in employee productivity to the balance sheet to illustrate the financial benefits of retro-fit managers • working in conjunction with trade workers and strategic planners to secure the best solutions for energy/environment inefficiencies.
<p>Driving Demand and Value Capture</p>	<p><i>Non-technical roles in property (real estate / valuation), financial and retail services, marketing, government agencies (urban and town planning, land release agents, community liaisons, sustainability managers, planners) and community leaders;</i></p> <p><i>Technical roles include energy assessors, BE professionals & trades (designers (i.e. architectural, landscape), engineers, builders and trades people); and</i></p> <p><i>Education and research institutions (educators):</i></p> <p>(See Tables 10 and 11.)</p> <p>Develop the key role of intermediaries:</p> <ul style="list-style-type: none"> • Inform and drive demand through the development of key marketing and communication messages for owners, developers and community stakeholders underpinned by standardised metrics, energy / carbon rating programs, product testing, and research outcomes to easily identify, communication, benchmark buildings and track progress industry or community wide progress and achievements. • Build capacity of intermediaries to communicate key messages and recommendations to engage end users in sustainable, low carbon building stock and life cycles. • Show how human productivity and health or wellbeing increases in relation to low carbon buildings, active transport, integration with the natural environment (biophilia), etc. • Develop proven engagement strategies aimed at home owners, for example, may involve multimedia content and a combination of engagement programs by local council, real estate representatives, financial lenders, industry/professional association(s) or community groups to communicate the value (economic, health, lifestyle) of LCL opportunities and options as well as related practicalities, business cases, and wellbeing criteria to drive demand. • Provide confirmation of the better yield and higher values realised through implementing low carbon buildings, especially the housing sector. • Create value by implementing sustainability and low carbon strategies at the pre-planning stages in multidisciplinary teams to support building efficiency improvements in the longer term with lower capital costs.
<p>Capturing Integrated and Comprehensive Planning Values</p>	<p><i>Owners/clients, property developers, land economists, utility companies, government, BE professionals (planners, designers, engineers, builders, project managers, quantity surveyors, facilities managers, asset managers, etc.:</i></p> <p>All commercial, industrial and precinct level stakeholders require engagement in the potential benefits of utilising BIM and PIM for planning, design, procurement, construction, building management / maintenance, asset management, and whole-of-life low carbon assessment. Develop business case for dissemination.</p> <p>Plan developments with public transportation infrastructure or cycling infrastructure for value capture. Develop business case for dissemination.</p>
<p>Australian Urban Research Infrastructure Network (AURIN)</p>	<p><i>CRC Participants:</i></p> <p>Facilitating workshops to introduce participants from the CRC LCL and provide training in the use of the e-infrastructure. This provides the capacity for harnessing existing data sources for collaboration and as a technology platform for publishing datasets and outcomes developed by CRC LCL participants.</p>

Education transformation

Curriculum renewal and training programs to embed fundamental LCL knowledge and skills, across all levels of education and capacity building as appropriate, such as energy literacy, energy efficiency, carbon accounting and management, business case and the co-benefits such as health and productivity. The findings of the Study suggest that an interdisciplinary approach should

be taken that involves bridging industry silos to prepare the current and emerging workforce for collaborative and integrative practice at various levels of education delivery for industry competence. It is clear from the findings that efforts to renew curriculum need to be targeted to specific knowledge and skills and that the process be undertaken in a collaborative and integrated way with leadership at the executive level.

(See Section 5.4.1, Table 8.)

Table 9: Education transformation recommendations

Potential Program	Target Audience: Description
Build capacity in fundamentals required by low carbon built environments	<p>BE educators</p> <p>BE Professionals and trades people as a group:</p> <p>Ensure a consistent approach through the development of capacity building programs and offering education and training programs with professionals and trades (See Technology in Practice) to develop an understanding of the foundation principles through fundamentals such as:</p> <ul style="list-style-type: none"> • Building science and performance • Energy literacy, conservation and efficiency • Zero energy design • Zero energy construction • Renewable technology education, assessment, and implementation • Integrated, regenerative and biophilic design • BIM and PIM awareness <p><i>Delivery of cross industry training on:</i></p> <ul style="list-style-type: none"> • Determining the client priorities aligned to opportunities, • Identifying low carbon strategies to make recommendations, • Selecting materials, products and technology based on the building life cycle, carbon management approaches and application of low carbon technologies • Application techniques using proven high performance work methods. • Development and engagement in multidisciplinary team education programs (engineers, architects, construction students) working on a simulated project with simulated scenarios to work together as a team to overcome the project issues related to industry expectations.
Mainstream Existing Approaches	<p>Researchers, Educators, Industry and Professional Associations</p> <p>Comparative gap analysis of existing qualifications compared to industry up-skilling programs in Australia to mainstream mandatory requirements for qualifications and mapping the availability of existing resources to VET, HE and Industry requirements for consistency.</p>
Education Accreditation Requirements	<p>Accreditation bodies and Industry Skills Councils and Education institutions (educators)</p> <p>The accreditation process is a strong catalyst for updating curriculum at universities and many accreditation bodies are increasing the requirements for LCL. VET Industry Skills Councils and registered training organisations are also being informed by industry to increase requirements for energy efficiency and sustainability. This presents a dual challenge, one to assist accreditation bodies and Industry Skills Councils to design appropriate LCL inclusions, and the second to assist educators to respond to such inclusions with rigorous materials and methods.</p>

Up-Skill Educators and Key Education Stakeholders	<p>All Educators and related stakeholders:</p> <p>Build capacity of educators across all disciplines at the secondary and tertiary levels as well as industry trainers and key education stakeholders, such as those who support the continuous improvement of national training packages and tertiary curriculum in foundation principles, work methods and curriculum renewal processes.</p> <p><i>Foundation principles recommended:</i></p> <ul style="list-style-type: none"> • Sustainability • Energy literacy, conservation and efficiency • Carbon accounting and management of both direct and indirect emissions • Low carbon transportation including travel behaviour, road system management, new modes of transport, and transit oriented and pedestrian-friendly / active-transport modes • Life cycle thinking • And the skills to facilitate learning environments that support • Communication supporting integrated discussions • Integrated teams • A working platform and projects across disciplines <p>Universities should rethink how they deliver the courses using real-world simulations and cross-disciplinary approaches for teaching and rewarding the initiative. Encourage cross-faculty collaboration within universities to facilitate learning using projects for industry while developing their skills to work together.</p>
Education Policy and Transition Pathways	<p>Government, industry and professional associations and education professionals:</p> <p>As a parallel to the development of the above items the findings of the Study will inform efforts to further support the uptake and effective delivery of education and training programs for LCL. The findings of the Study suggest a focus on both understanding current policy to identify opportunities to support LCL capacity building, along with investigating ways to enhance such policy through review of previous efforts and consideration of anticipated future changes.</p> <p>This will be a vital aspect of the CRC outputs and will inform each of the milestones aligned to the Study and it will specifically inform Milestone R3.4.4, 'Policy impediments and incentives for effective education and training' (30 JUN 14).</p>

Technology in practice

The consultations indicate that the entire BE workforce and communities require capacity building, specifically existing traditional roles requiring an understanding of the need for change relative to their industry role and effective and proven methods to integrate into work practices. The third top prospective influence on respondents to affect their organisation plans or intentions to contribute to LCL was 'technology and tools availability'. Technology in practice includes the knowledge and capability to transition to LCL through individual, community and work practices. The third most critical support mechanism identified by respondents of the survey was 'case studies and online resources'. Further findings from the survey and the partner

consultation highlight specific areas to be of focus, such as HVAC, Land Management, and interdisciplinary teams (See Table 10).

'We design and then leave people to do it by themselves.' Consultation quote

This section highlights the opportunity to build capacity to improve the performance of the BE through design, high-quality construction methods, and building management systems, by providing evidence-based scenarios that contribute to confidence in products, methods, and implementation strategies. However, it also involves engaging the property sector to fully value and communicate the benefits and costs of LCL, including the financial, social and environmental benefits (for example, reduced ongoing costs, healthy lifestyles,

and a resilient environment) to drive demand. An integrative approach to planning, design, construction, and management and use of the BE, including civil infrastructure, buildings, resource and waste

management and transport (PIM, BIM) as well as community spaces is required to achieve the optimum and most desired outcomes of individual projects or precinct level projects.

Table 10: Technology in practice recommendations

Potential Program	Target Audience: Description
Low Carbon Built Environment Fundamentals	<p>BE Professionals and Trades</p> <p>Ensure a consistent approach through the development of capacity building programs and offering education and training programs with educator capacity building to develop an understanding of the foundation principles through fundamentals such as:</p> <ul style="list-style-type: none"> • building science and performance • energy literacy, conservation and efficiency • zero energy design • zero energy construction • renewable technology education, assessment, and implementation • integrated, regenerative and biophilic design • BIM and PIM awareness <p>Delivery of cross-industry training on:</p> <ul style="list-style-type: none"> • determining the client priorities aligned to opportunities • identifying low carbon strategies to make recommendations, • selecting materials, products and technology based on the building life cycle, carbon management approaches and application of low carbon technologies • application techniques using proven high performance work methods.
Complexity of Existing Standards and Codes and Beneficial Application	<p>BE Professionals and Trades</p> <p>The complexity of Section J of the Building Code of Australia hinders proper application. To enable compliance the recommendation is to interpret the code and associated standards into plain English and develop how to guides to demonstrate various application techniques. In addition, case studies demonstrating a variety of building methods and associated costs to support cost neutral or potentially profitable application methods, technology and materials across the whole building lifecycle to identify costs and savings for builders, tradespeople and consumers. It has been recommended that this be done online through visual media in an interactive manner based on climatic zones or scenarios.</p>
Targeted Stakeholder Education: Driving Demand	<p>Property, retail and local government services to engage consumers and end users</p> <p>(See also Table 8.)</p> <p>Engage consumers through building capacity of property, retail and local government services to identify and communicate the opportunities and associated costs and benefits to drive demand for LCL.</p>
Targeted Stakeholder Building Technical Knowledge and Skills	<p>BE Professionals and Trades</p> <p>The findings of the survey and consultations highlight a set of key areas of technology and tools that provide opportunities for the sector, namely:</p> <p><i>technical competence in:</i></p> <ul style="list-style-type: none"> • construction methods for zero energy buildings (all trades and management) • conducting energy/carbon assessment/audits to account, including as built performance testing for energy conservation measures and direct and indirect emissions to develop specific options for implementation as recommendations in all areas of the BE. • use of rating tools to identify improvement areas, potential scenarios, available technology to specific

	<p>recommendation options for implementation (energy / carbon analysis)</p> <ul style="list-style-type: none"> • HVAC/R systems (design, management and maintenance) • plumbing and hydraulic design • electrical—water heaters, lighting (sensors and controls), renewable energy • cogeneration and tri-generation • identifying and assessment of integrated renewable technology opportunities and their implementation • conducting building information / energy modelling • conducting regional systems analysis of carbon flows • use of environmental material accounting tools such as Material Flux Analysis and Life Cycle Assessment and Implementation. • accessing databases of information and alternatives <p><i>Skills to:</i></p> <ul style="list-style-type: none"> • work in an integrated team and on integrated projects • understand and work within systems without negatively impacting on them • communicate to recommend alternatives and communicate the risks, costs and benefits • use decision-making tools • understand and use embedded carbon and LCL approaches • increase the generation of low/no carbon energy, with a particular focus on cogeneration technology*, smart grid technology, and various forms of renewable energy generation.
<p>Management Education: Management Strategies and Methods:</p>	<p><i>BE Professionals and Trades</i></p> <p>Retrofit project management (industrial, commercial, residential—weatherisation technicians)</p> <p>Brownfield redevelopment management</p> <p>Building and precincts tools (building / precinct management systems using quantitative modelling and design required for understanding transforming the BE.</p> <p>Procurement using life cycle assessment and thinking</p> <p>Management of facilities using building management systems</p> <p>Design landscape to support low carbon opportunities such as reducing urban heat island effects and integrated water management</p> <p>Metrics and auditing at the current level of carbon performance and planning to ascertain how we progress towards LCL in our communities</p> <p>Urban planning and land management, at both building and precinct level, including associated planning and development controls</p> <p>Improvements to waste management and reduction, including closing material loops, recycling, and reuse of waste such as fly-ash</p> <p>Low carbon transportation including travel behaviour, road system management, new modes of transport, and transit oriented and pedestrian friendly developments</p>

Leadership in practice

The second top prospective influence on respondents to affect their organisation plans or intentions to contribute to LCL was ‘demonstrating sector leadership’, both as industry competitors and as government agencies.

Based on the survey responses, the fourth top prospective influence on respondents to affect their organisation’s plans or intentions to contribute to LCL was ‘consumer expectations and social values’.

Leadership in practice focuses on the strategies and actions that demonstrate leadership in anticipation of new compliance, social license to operate or a competitive market advantage. Further, respondents are influenced to engage in an education program, based on the credibility of the delivery team and the organisation providing the program, as well as accreditation from professional bodies or endorsement from industry associations as the three main factors. These areas

could be supported by the CRC through the investigation of existing practices or the development of new demonstration projects to build the LCL profile and transfer critical implementation opportunities to the sector. Such research may focus on a particular sub-sector of the BE or a specific supply chain in line with the living laboratory methodology.

Leadership needs to be demonstrated at every level, such as individuals in the community, trades, professionals and whole of organisations. This section highlights opportunities to build capacity to demonstrate leadership in achieving LCL opportunities in the BE sector at multiple levels and increase awareness of such efforts. Build capacity to transform the education sector and embed examples of sector leadership by organisations and across the sector into curriculum in anticipation of shifts in legislation, consumer expectations, and social values related to LCL.

(See also Section 5.4.1, Table 8.)

Table 11: Leadership in practice recommendations

Potential Project	Target Audience: Description
Executive Leadership	<p>Education and research institutions, government agencies, professional and industry bodies and private sector organisations:</p> <p>Engage middle and senior management in institutional change management programs for LCL to integrate practices into operations, curriculum and disseminate approaches as case studies.</p> <p>Engage education or large organisation executives (Vice-Chancellor, senior management from outside of the organisation) in institutional changes supporting facilities, management, events, and teaching pedagogy for low carbon.</p> <p>Engage senior workforce roles in developing and communicating the business case, policies, programs and transition capacity building opportunities.</p>
Leadership Demonstrations	<p>All</p> <p>Engage industry and community leaders in public recognition of individuals, educators, building professionals and trades, private companies, government agencies or authorities, utility companies, product manufacturers, suppliers, etc. who are leading through demonstrations to develop public profiles demonstrating the demand for change and actions taken.</p> <p>Engage educators identified as champions.</p> <p>Promote effective engagement and incentive programs.</p> <p>Shift priorities of senior leadership within governments.</p> <p>Promote financial services offering varied financing/leasing models based on return on investment.</p> <p>Promote and support awards programs.</p>
Leadership and Assertiveness	<p>All</p> <p>Development of leadership skills and assertiveness to influence others within organisations, across industry, the supply chain and the community.</p>

	<p>Target:</p> <ul style="list-style-type: none"> education leaders integrating opportunities into courses and assisting others to transition institutions middle management informed of the most suitable materials and construction techniques to support recommendations and implementation architects articulating and implementing useful strategies at the project concept phase and implementing the principles of LCL as a standard builders influencing consumer to construct low carbon buildings energy assessors and tradespeople contributing to low carbon buildings through identification of opportunities and making recommendations to clients community leaders promoting transition programs and influencing others apprentices and students engaging employers in changed practices and alternative technology or materials.
Demonstrate CRC Leadership	<p>All</p> <p>Develop user-friendly guides to communicating opportunities and progress toward LCL.</p> <p>Develop and adopt an LCL standard or principles for the community to provide guidance aligned with the industry framework and government policy and programs to develop and participate in a benchmarking system (residential).</p> <p>Develop and disseminate an industrywide framework for LCL, aligned with occupational roles and competency requirements. This would include the education pathways to enhance skills, transition into new roles or career changes that align with progression toward transitioning the BE to low carbon.</p> <p>Develop and communicate local government, regional, state and territory, and national progress towards LCL, using standardised performance metrics and benchmarking systems and associated policy and programs. Communicate progress in a simplified user-friendly way to industry and community. This might include energy, financial or carbon savings, community health benefits, affordable zero carbon housing, minimising ongoing utility requirements. It might also include showing progress in the number of practitioners, trades or community groups up-skilled, etc.</p>

Collaboration and partnerships

Build capacity to develop integrated collaboration between stakeholder groups and collaborative strategies to foster consistent approaches involving mutual interrelations to optimise capacity building across the BE. Equally, to effectively manage risk and fully capture

the long-term value of LCL opportunities in the BE, development and modelling of business cases, community and societal benefits in partnership with all stakeholders is required.

‘It’s important to share information between different [professional] groups.’ Consultation quote

Table 12: Collaboration and partnership recommendations

Potential Project	Target Audience: Description
Low Carbon Living Framework	All See Table 8: Communication and engagement recommendations.
Built Environment Planning (BIM & PIM—Integrated Design Simulations)	<p>Developers, BE professionals, local and state government, land release agents, developers for design, construction and operation for low carbon living:</p> <p>Develop skills in building, transport, and civil infrastructure planning using integrative project design and delivery through simulations or real projects.</p> <p>Build capacity to understand the information going into the tool (theory) before and during the use.</p> <ul style="list-style-type: none"> If an application is developed well, the information could be provided with ideas (rote learning applied with critical thinking application) for applied competence using simulated scenarios, etc. Provide opportunity for teams to work together through applied research to understand the bigger

	<p>picture and application of opportunities.</p> <ul style="list-style-type: none"> ○ Assist designers and planners to understand the potential of the model in performance (theory), then use the tool to put information into it, analyse it and reconfigure the opportunities to re-enter the details to develop the best case. ○ Engineers need to understand and be skilled in design application. ○ Planners need to know how to build a precinct model. <p>Operators of buildings need to know how to continue using the model to manage facilities and assets.</p>
Develop or Support Collaborative Platforms	<p><i>All</i></p> <p>Establish a platform used to inform the selection of low carbon related graduate attributes and occupational standards for inclusion in future education requirements.</p> <p>Tap into the existing communities of practice for educators to support a BE collaboration.</p> <p>Develop a forum to identify barriers to building code and standards as a feedback loop for improvement.</p> <p>Tap into existing communities of practice for local government agencies to share information and collaborate.</p>
Data Sharing and Collaboration	<p>Support the AURIN portal to act as a knowledge resource for the CRC LCL, providing an e-infrastructure for data sharing and collaboration.</p>

Policy and standards

Build capacity to review and develop policy, standards, and metrics to reduce barriers and stimulate sectorwide action, supporting industry work practices, accreditation of job roles and education, and community engagement programs through ongoing monitoring and evaluation of efficacy to disseminate findings and influence the adoption of best practices. Engage government to develop a long-term bipartisan policy and implementation plans to transition the BE sector, communities and the associated education policy to enhance energy independence, construction quality, productivity and liveability.

The top prospective influence on respondents to affect their organisational plans or intentions to contribute to LCL was ‘government policy’. As Australian

governments consider options to align policy with LCL, it will be important that efforts are not reinvented and that new policies are clearly guided by the operational reality of responding to the imperative to reduce greenhouse gas emissions, balanced by the industry’s and society’s perception of appropriate action.

The second most critical support mechanism identified by respondents of the survey was ‘standards that support low carbon living’. As the imperative for reducing greenhouse gas emissions grows industry, governments, community and education institutions are looking for guidance through the recognised and respected channels as to how to respond. Standards and Codes provide a key part of this guidance and the findings of the Study suggest consideration of key areas to inform requirements of standards and codes through compliance or voluntary standards of practice.

Table 13: Governance and standard recommendations

Potential Project	Target Audience: Description
Complexity of Existing Standards and Codes and Beneficial Application	<p>Existing BE Professionals and Trades</p> <p>(See Table 10.)</p> <p>The complexity hinders proper application requiring interpretation into plain English and capacity building to support (e.g. Section J Building Code Australia). Development of project case studies to support cost neutral or profitable application methods, technology and materials.</p>

Informing the Ratcheting Requirements of Standards and Codes	<p><i>Existing requirements: BE Professionals and Trades and Owners/Developers</i></p> <p><i>Future requirements: Those involved in the creation and updating of standards and codes, along with government agencies and professional bodies seeking to inform such amendments and communicate them to members, investors, and staff</i></p> <p>(See Table 12.)</p> <ul style="list-style-type: none"> • Informing the staging of new requirements for LCL in standards and codes in a manner that is informed by industry and the education sector based on national and international efforts. • Existing Requirements: It is suggested that a study be undertaken of the current coverage of LCL in existing standards and codes. Over the last decade, both Standards and Codes related to the BE in Australia have been amended to incorporate consideration and requirements that align to LCL and the findings of the Study suggest that it is important to ensure that the current requirements are clearly understood by industry and that the capacity exists to harness such requirements to deliver cost effective LCL options. • Anticipated future requirements: It will be important for research and stakeholder consultation to inform the next round of inclusions of requirements related to LCL in various standards and codes to both reduce the political risks associated with increased requirements and provides a robust platform for the sector to achieve cost effective and profitable LCL outcomes. • Development of feedback loops to eliminate code or standard barriers to transitioning to low carbon communities to support those involved in the creation and updating of standards and codes along with government agencies and professional bodies seeking to inform such amendments and communicate them to members, investors, and staff.
Residential Metrics and Performance	<p><i>BE Practitioners & Professionals and Energy Assessors:</i></p> <p>(See Table 8.)</p> <p>Develop an easy to use voluntary metric and benchmarking system to measure residential performance as built and communicate progress and the potential to support building energy certificates for the sale of property similar to Europe and the United States of America.</p> <p>This assessment would focus on modelled and as built thermal performance, heating and cooling loads relative to annual climatic conditions and building envelop, water, air and waste management systems. Support implementation through cross sector industry best practice guidelines, methods, available technology, and the business case to communication with clients.</p>
Policy Impediments and Incentives for Effective Education and Training	<p><i>All:</i> See Table 9.</p> <p>The findings of the Study suggest a focus on both understanding current policy to identify opportunities to support LCL capacity building, along with investigating ways to enhance such policy through review of previous efforts and consideration of anticipated future changes.</p> <p>As a parallel to the development of the above items the findings of the Study inform efforts to further support the uptake and effective delivery of education and training programs for LCL.</p>
Harnessing and Enhancing Policy and Programs to Underpin Low Carbon Living	<p><i>All level of government and policy makers:</i></p> <p>Investigate Existing and Past Policy: This may involve a review of past policy, programs and initiatives across all three levels of government in Australia to identify 'lost wisdom' to inform future efforts. Areas would include a range of financial and non-financial incentives and mechanisms (such as resource pricing). This research could be enhanced through consideration of appropriate international examples.</p> <p>Research Anticipated Future Policy: This may involve a study into areas of policy that are anticipated to include greater requirement for LCL in the future. Such as study would need to be informed by stakeholder engagement with industry and professional bodies, along with investigating potential impacts and reactions of the community.</p> <p>The outputs of such studies would provide valuable capacity building opportunities for government agencies at all levels in Australia to inform both the implementation of current policy and the design of future policy aligned to reducing the carbon intensity of the BE sector potentially through:</p> <ul style="list-style-type: none"> • guidelines • metrics

	<ul style="list-style-type: none"> • incentives • policy analysis for LCL.
Policy Modelling, Case Studies and Research	<p><i>All level of government and policy makers:</i></p> <p>The findings of the Study indicate that a focus on both the understanding of current policy to identify opportunities to support LCL education, along with investigating ways to enhance such policy through review of previous efforts, modelling and consideration of anticipated future changes in the longer term.</p> <p>The outputs of such case studies, modelling or research studies would provide valuable capacity building to government agencies at all levels in Australia to inform both the implementation of current policy and the design of future policy aligned with reducing the carbon intensity of the BE sector.</p>

APPENDIX : SURVEY RESPONSES DETAILS

Of those consulted, the participants were drawn from a wide range of occupational positions or roles within their organisations. The most prevalent role category was 'other' (32 per cent listed as academic/teacher/lecturer/PhD supervisor, researcher, dean, sole operator / proprietor / consultant, architect, engineer, project coordinator, PhD candidate, chief executive officer, senior engineer, director, environmental sustainability officer, postgraduate student, casual staff, and chairmen), followed by 'Executive' (26 per cent), 'General Staff' (18 per cent), 'Manger' (17 per cent) and 'Independent Contractor' (3 per cent) or non-response (35 per cent).

The follow tables are the details of the survey responses to the critical open-ended questions for review of specific details based on each response of the top three opportunities to support low carbon built environments in order of priority. (Note, these are summarised in Table 4.)

Table 14: Survey participant responses indicating the prioritised opportunities to support low carbon living in the built environment

Priority Opportunity 1	Priority Opportunity 2	Priority Opportunity 3
HVAC	Modelling	Cogeneration
Education and research output dissemination	Analysis of energy consumption and target specific reductions	Consider sensors or other control mechanisms for the intelligent consumption of resources.
Waste efficiency improvements	Waste process improvements	
Building envelope	Energy waste reduction	HVAC
Benchmarking at both building and city level	New technologies/solutions to achieve LCL	Demonstration of these new technologies/solutions
Electricity from clean and renewable sources while reducing consumption of electricity (a building should aim to be energy self-sufficient, and able to be integrated with a local network)	Low carbon transport—requires new modes of transport, (no fossil fuels) and a more sensible approach to town planning: no more suburban sprawl, pedestrian friendly communities, car free living	We develop, design and construct buildings that are 'producers' of energy, aim at looped water cycles, allow for urban food production, increase local biodiversity, integrate with the local economy, use materials that are local, low in embodied energy and safe for all species through time.
Cogeneration in large developments.	Commercial and residential buildings.	Land management.
Electricity consumption reduction	Electricity generation methods	Transport
Assisting clients align their policies/practices with the need to form/lead/monitor integrated project teams	Solar photovoltaic	
Assist clients to align their policies/practices with the need to form /lead/monitor collaborative integrated teams for retrofit and new projects.	Facilitate integrated team building.	Engaging with local communities and businesses
HVAC	Street Lighting	Cogeneration at precinct scale
Uptake of low carbon technologies in our property portfolio.	Planning and development control	Education of the existing resources available in the architectural profession through CPD and access to a knowledge base such as our EDG notes.
Energy efficient building design	HVAC systems	Passive design strategies for a changing climate

The successful implementation of a market leading development of a carbon neutral new 22 level state office building covering the carbon footprint of embodied energy, operation energy, waste and transport over a thirty-year life cycle as a demonstration project	Lobbying for good government policy in response to evidence provided by the Industry of low cost carbon abatement available in buildings	Thermal efficiency using properties of materials
Modelling	Land management	Focus on renewable technologies in the medium term.
Cogeneration in large developments (water heating, water recycling, and energy waste reduction)	Integration of renewable energy technologies	Street lighting
Re-use of waste and by-products	Low carbon footprint products	Celebrate the delight that can be found in such a direction and promote widely.
Mandatory use of LCA in design and decision making	Focus on energy efficiency in the short term.	Less Carbon and greenhouse gas emission (GGE) intensive solutions in delivering quality affordable housing options especially for Medium density development
Commercial and Residential buildings	Solar PV	HVAC
domestic water heaters	disclosure of energy efficiency information to prospective residential tenants	3. Hydraulic Engineering and Plumbing: Plumbing generally is a resource intensive industry that is moving towards a more energy and water efficient performance. Like electrotechnology, legislative requirements and increasing resource costs underpin the demand for implementation of LCL in the BE.
Design great buildings that are delightful to live in because they are naturally cooled and heated.	Find productive ways to close loops that traditionally result in waste to deliver even greater outcomes—such as water, sewerage and food.	Waste management: Closing the loop, including biomass and recycling
Reduction in barriers to power solutions that are less GGE intensive, and smart grid technology that allows for lower costs to developers, owners and tenants and can be operationally managed	Reduction in costs for products that are less GGE through joined up supply chain approaches across Government and the construction and development industry	Biomass for heat and electricity production
Energy waste reduction	Lighting	Land use & urban planning
1. Electrotechnology: Training in photovoltaics, wind turbines, lighting and HVAC drive engineering are all addressed in vocational and higher education courses. Increasing energy costs, requirements for trades upgrading, registration and industry requirements are creating a greater demand to improve energy efficiency—LCL.	2. Building Design and Construction: These courses obviously directly impact carbon performance for participants in new and refurbished residential, industrial and commercial construction and building operations. Passive design and efficient resource use are featured in these courses.	
Good design (designing our way out of the problem; e.g. building and precinct design based on holistic principles)	Retrofitting packages for entire districts	Supporting the use of renewable energy including solar photovoltaic on a large scale with industry, finding a use for the considerable roof space available
Carbon neutral engineered wood products e.g. CLT	Natural solid wood products e.g. flooring, architraves	Encouraging builders to adopt LCL techniques and building practices
Clean technology	Re-use of waste and by-products	Improving power use efficiency

Commercial and residential buildings.	design of low carbon communities and precincts	Industrial energy efficiency
design of low carbon buildings	Supporting the transition to energy efficiency primarily in the area of lighting and the use of LED technology with our business partners	Land management
Supporting the use of appropriately sourced wood as low carbon, renewable construction material through our work with industry and consumers	Members of ABSA advising building designers and clients of LCL opportunities before they build	Research into low carbon urban infrastructure (power, water, sewerage)
Enforcing minimum energy efficiency building standards.	HVAC efficiency	Reduced volume of fly-ash placed in ash dams
Improving transportation to and from work	Land management	Use of LED lighting 4. Install solar photovoltaic (again, with incentive)
Re-use of waste and by-products	Cogeneration in large developments	
Commercial and residential buildings (retrofit and new)	Research into low carbon impact urban transport and travel behaviour, and transit-oriented development	
Research into planning and land management	Development of new materials/products incorporating fly-ash	
Target standards to be revised to accommodate renewable materials	Properly detailing the building envelope seal—sealing the structure as well as the openings (properly sealing openings is costly requiring thermal breaks and double/triple glazing—it should have some type of incentive)	
Concept stage using new tools like ArchiCad 16's integrated energy evaluation tool: Building Energy Model (BEM). This energy evaluation tool will achieve optimum modelling (abate need for HVAC)		

Table 15: Key opportunities to support low carbon living in the built environment

Key Job Roles	Knowledge and Skill Gaps	Supporting Programs
The job role gap is that we do not have (enough) people who can rigorously analyse policy propositions, or if we do, they do not get enough say in decision making.	There is a knowledge gap on genuine long-term performance data of designs, devices and behaviour.	And then there is a gap in turning this into policy, regulations and incentives to achieve the best outcomes.
Education is crucial and it's not being addressed.	More needs to be known about social, behaviour change and the role that it plays in getting people to transition to a low carbon environment.	The gaps are significant, far greater than the coverage at present.
Facility managers have a critical job role.	All people involved in procurement of services for construction need to understand their role of becoming sustainable procurers.	Please note a lot of work has already been done on the skills agenda: http://eex.gov.au/business-support/energy-efficiencyskills-and-training/ .
Builders and tradespeople have a low level of knowledge about low carbon approaches and the benefits of implementing low carbon strategies.	People need training in use of life cycle assessment as part of procurement of goods.	Professional bodies (associations) are all doing something, but quality is usually low.

The real estate/marketing sectors are the key to increasing the uptake and demand for sustainable, low carbon building stock. Currently, training and knowledge are virtually non-existent.	Knowledge about indirect/embodied carbon emissions (full carbon footprint) is needed.	
There is a need for marketing, educational awareness to prove the financial relevance and benefits of LCL.	Carbon accounting knowledge and skills are needed.	
	There are needs to show productivity gains in people's time. People are short of time. If we can give back time in today's busy world, then we will encourage adoption of LCL.	
	The main gap is the underpinning understanding of sustainability. Each sector sees itself in isolation and misses the broader application of the sustainability principles and therefore the LCL implications. Good underpinning knowledge and systems thinking is needed.	
Connecting individuals creating the tools, systems, etc. with those actually using them	At university we learned a lot about generics and theory but less about practical applications.	As in Europe and the US, perhaps a comprehensive energy certificate should be required for the sale of properties.
Development of the databases for finding green will assist this.	We need builders to adopt a comprehensive, integrated approach to building LCL housing products.	There are very few short courses / training opportunities for energy and carbon accounting in WA.
	Just as engineering disciplines require a level of knowledge in humanities subjects, non-science/engineering courses should contain a certain amount of science-based curriculum, especially in relation to developing analytic skills.	
	This would require identifying products needed and the skills and technical knowledge needed to introduce those products.	
	The key to senior roles is usually to see the financial benefits of change.	
	The key to mid-level roles is to know the materials and construction techniques that are most efficient.	
	Construction workers they need to know why things are being done and the consequence of their actions. The construction workers tend to have no knowledge of cause and effect and treat the environment as a massive waste dump.	

REFERENCE

- ⁱ Energy Efficiency Council, <http://www.eec.org.au/node/247>
- ⁱⁱ AIRAH,
http://www.airah.org.au/iMIS15_Prod/AIRAH/Careers/Careers%20Resources/AIRAH/Navigation/Careers/Careers%20Resources/Careers_Resources.aspx?hkey=2438f5d3-10b0-4446-93ab-812a003a46a9
- ⁱⁱⁱ Mulgan, Geoff (2013) Joined-Up Innovation: What is systemic innovation and how can it be done effectively? Leadbeater, Charles (2013) The Systems Innovator: Why successful innovation goes beyond products? <http://www.nesta.org.uk/library/documents/Systemsinnovationv8.pdf>, accessed 28 May 2013. Shove, Elizabeth (2010) Beyond the ABC: Climate change policy and theories of social change. Environment and Planning A, 42, 1273–1285. Shove, Elizabeth, Pantzar, Mika and Watson, Matt (2012) The Dynamics of Social Practice: Everyday Life and How It Changes. London: Sage.
- ^{iv} AIRAH Building Simulation Workshop committee chair Paul Bannister, M.AIRAH, AIRAH Press Release 2013
- ^v Ben Liley, New Zealand's National Institute of Water and Atmospheric Research, AIRAH Press Release 2013.
- ^{vi} AIRAH CEO Phil Wilkinson, M.AIRAH, AIRAH Press Release 9 Apr 2013.
- ^{vii} DCCEE, 2010 <http://www.climatechange.gov.au/what-you-need-to-know/buildings/publications/greenhouse-gas-emissions.aspx>.
- ^{viii} ClimateWorks Low Carbon Growth Plan, 2011
http://www.climateworksaustralia.org/commercial_buildings_emission_reduction_opportunities.pdf
- ^{ix} Energy Efficiency Council, <http://www.eec.org.au/node/247>
- ^x AIRAH,
http://www.airah.org.au/iMIS15_Prod/AIRAH/Careers/Careers%20Resources/AIRAH/Navigation/Careers/Careers%20Resources/Careers_Resources.aspx?hkey=2438f5d3-10b0-4446-93ab-812a003a46a9
- ^{xi} Project consultation quotation 2013
- ^{xii} See Naga and Consumption Atlas, Northern Alliance For Greenhouse Action (NAGA), <http://www.naga.org.au/>
- ^{xiii} ICA-OSGeo, Open Source Geospatial Lab: <http://www.osgeo.org/node/1230>.
<http://www2.warwick.ac.uk/fac/sci/lifesci/research/facilities/geolab/>.
- ^{xiv} Sydney Coastal Councils Group, About, http://www.sydneycoastalcouncils.com.au/About_SCCG.
- ^{xv} See Solar Cities examples supported by the Commonwealth Department of Innovation
<http://www.climatechange.gov.au/energy-efficiency/solar-cities>
- ^{xvi} Energy Start, US Environmental Protection Agency and the Department of Energy
https://www.energystar.gov/index.cfm?c=new_homes.hm_index&s=m

ADDITIONAL REFERENCES

ACF and ISA. Consumption Atlas. 2007; Available from: <http://www.acfonline.org.au/sites/default/files/resource/index67.swf>.

Commonwealth Department of Industry, Innovation, Science, Research and Tertiary Education, *Education Review of Energy Efficiency Skills Demands and Training Provision Across the Trades and Professions*, April 2012, Unpublished Report by Allen Consulting Group and the National Centre for Sustainability, Swinburne University of Technology.

Victorian Skills Commission, *Skills for Carbon Abatement*, October 2011, Unpublished Report by Allen Consulting Group and the National Centre for Sustainability, Swinburne University of Technology.

Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCSRTE), Professional development programs for VET Practitioners 2013
<http://www.innovation.gov.au/Skills/SkillsTrainingAndWorkforceDevelopment/ClimateChangeAndSkillsForSustainability/Pages/ProfessionalDevelopmentProgramsForVETPractitioners.aspx>, 22 June 2013.

DIICCSRTE, Skills for the carbon challenge, 2013

<http://www.innovation.gov.au/Skills/SkillsTrainingAndWorkforceDevelopment/ClimateChangeAndSkillsForSustainability/Pages/SkillsForTheCarbonChallenge.aspx>, 21 June 2013.

DIICCSRTE, Clean Energy Skills, 2013

<http://www.innovation.gov.au/Skills/SkillsTrainingAndWorkforceDevelopment/ClimateChangeAndSkillsForSustainability/Pages/CleanEnergySkills.aspx>, 21 June 2013.

Energy Education and Workforce Development, U.S. Department of Energy (US DOE), Office of Energy Efficiency and Renewable Energy (EERE) http://www1.eere.energy.gov/education/educational_professional.html, 21 June 2013.

Energy Education and Workforce Development, US DOE, EERE

http://www1.eere.energy.gov/education/colleges_universities.html.

European Centre for the Development of Vocational Training, Green Skills and environmental awareness in vocational education and training: Synthesis Report, no. 24, 2012, http://www.cedefop.europa.eu/EN/Files/5524_en.pdf, 22 June 2013.

McGraw Hill Construction & United Technologies, World Green Building Trends SmartMarket Report, 2013

<http://www.construction.com/about-us/press/world-green-building-trends-smartmarket-report.asp> 21 June 2013.

O*Net OnLine, American Job Center Network, U.S. Department of Labor, 2013 <http://www.onetonline.org/find/green?i=47-3012.00&n=0&q=Go>, 23 June 2013.

Built Environment Industry Innovation Council, Report to the Government 2012

<http://www.innovation.gov.au/industry/buildingandconstruction/BEIIC/Pages/default.aspx>.