Integrated Carbon Metrics – Project Goals

- Enable the analysis of the 'carbon fabric' of the built environment
- Provide **data** and **tools** to
- Assess the carbon performance of **precincts, projects, sectors** and **cities**
- Quantitatively evaluate low-carbon **scenarios**
- **Cooperate** between researchers, industry, local and state authorities
C embodied in electricity
C embodied in services
C embodied in materials
C embodied in equipment (capital goods)
Operational C
C embodied in transport
Life cycle carbon emissions (of a building)

Levels of Carbon Emissions and ICM Tools

- Industry sectors
- Precinct, city
- Buildings
- Building materials

- Hybrid LCA Database
- Product Explorer
- Life cycle cost and carbon analysis
- Precinct Carbon App
- PIM Scenario Model
- Sector Carbon Map
Levels of Carbon Emissions and ICM Tools

Hybrid approach: Process LCA + IOA + MFA

Examples for Building Materials and Elements:
- Gravel
- Doors, wooden
- Plywood
- Glued laminated lumber
- Plastic pipes
- Clay bricks
- Ready mixed concrete and mortar
- Alloy steel flat-rolled products
- Iron or steel rails, rail fastenings or other rail accessories
- Cast iron tubes, pipes and hollow profiles
- Aluminium roofing and guttering
- Iron or steel window-frames
- Nails, tacks, staples, spiked cramps, studs, spikes & pins

Industry sectors

Precinct, city

Buildings

Building materials

Hybrid LCA Database

kg CO₂e / $ (or kg, m² etc.)
Levels of Carbon Emissions and ICM Tools

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Sustainability Assessment Program
UNSW Australia
Low Carbon Living CRC
ICM Tool > Product Explorer

Select sector: Plywood

Major contributors to the footprint of the 'Plywood' sector (kg/yr):
1. 'Electricity generation'
2. 'Other wooden builders joinery and carpentry'
3. 'Other wood product manufacturing'
4. 'Particle board (incl laminated) and similar board of wood or other materials'
5. 'Road transport'
6. Other
   TOTAL

Major contributors to the footprint of the 'Road transport' sector (kg/yr):
1. 'Road transport'
2. 'Electricity generation'
3. 'Oil and gas extraction'
4. 'Other petroleum and coal product manufacturing'
5. 'Postal and courier pick-up and delivery service'
6. Other
   TOTAL
Case study on cement and concrete
Decomposition of life-cycle GHG emissions for types of concrete

- Ordinary Portland Cement
- Other iron and steel manufacturing
- Other basic chemical manufacturing
- Oil and gas extraction
- Road transport
- Electricity transmission
- Electricity generation
- Other types of concrete
- 100% OPC 25MPa concrete
- 25% Fly ash 25MPa concrete
- 25% Fly ash 40MPa concrete
- 40% GGBFS 25MPa concrete
- 40% GGBFS 40MPa concrete
- Geopolymer concrete 100% slag 40 Mpa
- Geopolymer concrete 100% fly ash 40 Mpa
- Others

TIMs (kgCO2e/m3)
**IS Materials Calculator – based on LCA**

### Infrastructure Sustainability Materials Calculator

**Version 1.1**

**Release date:** 20/02/2015

**Original release date:** 20/02/2015

**Level Achieved:** 2

<table>
<thead>
<tr>
<th>Component Type</th>
<th>GHG (tCO2-e)</th>
<th>Ecopoints</th>
<th>Actual Case</th>
<th>GHG (tCO2-e)</th>
<th>Ecopoints</th>
<th>Reductions</th>
<th>GHG (tCO2-e)</th>
<th>Ecopoints</th>
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</thead>
<tbody>
<tr>
<td>Total</td>
<td>5,454</td>
<td>7,957</td>
<td></td>
<td>3,793</td>
<td>5,668</td>
<td>1,661</td>
<td>2,289</td>
<td>29%</td>
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<tr>
<td>1 Component type: Wastewater Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>854</td>
<td>1,161</td>
<td>22%</td>
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<tr>
<td>Sub-component type: Municipal Sewage works</td>
<td>3,584</td>
<td>5,253</td>
<td></td>
<td>2,730</td>
<td>4,092</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Capacity of treatment facility: 1,825,000 m3/yr</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Component 1:

- **Component:** Wastewater Treatment
- **GHG (tCO2-e):** 2,730
- **Ecopoints:** 4,092
- **Total per m3/yr of wastewater treated:** 0.00150 / 0.00224

**Asphalts**

- **Select Asphalt:** Hot Mix Asphalt
- **Amount:** - tonnes
- **Transport mode:** None, On-Site
- **Transport distance:** 0 km

**Concretes**

- **Select Concrete 1:** Concrete Strength Grade 20 Mpa 30% SCM
  - **Amount:** 1,125 tonnes
  - **Transport mode:** Rigid Truck
  - **Transport distance:** 0.2 km
  - **GHG (tCO2-e):** 104
  - **Ecopoints:** 111

- **Select Concrete 2:** Concrete Strength Grade 32 Mpa 20% SCM
  - **Amount:** 280 tonnes
  - **Transport mode:** Rigid Truck
  - **Transport distance:** 0.2 km
  - **GHG (tCO2-e):** 36
  - **Ecopoints:** 38

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**Sustainability Assessment Program**

**UNSW Australia**

**Low Carbon Living CRC**
Levels of Carbon Emissions and ICM Tools

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This framework, called the **Life Cycle Optimisation Model**, will be achieved by:

1. Determining the base case life cycle GHG emissions and net cost of two typical Australian building typologies in two different climate zones.

2. Identifying the key passive building elements (and their alternatives) used to lower operational GHG emissions in these buildings.

3. Determining the implications on the life cycle GHG emissions and net cost of using these alternative elements.
Embodied vs operational energy

Levels of Carbon Emissions and ICM Tools

Industry sectors

Precinct, city

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Life Cycle Optimisation Model

PIM Scenario Model

City Carbon Map

SUSTAINABILITY ASSESSMENT PROGRAM

UNSW AUSTRALIA

LOW CARBON LIVING CRC
Outputs from Precinct Carbon App

The results of a precinct assessment of Fisherman’s Bend.
Levels of Carbon Emissions and ICM Tools

Industry sectors

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Life Cycle Optimisation Model

Precinct Carbon App

PIM Scenario Model

Sector Carbon Map

Low Carbon Living CRC

UNSW Australia

Sustainability Assessment Program
Precinct Information Modelling - Scenarios

Precinct (Re)Development Scenarios & Data

- Urban densification
- Mixed use (retail, car parking, offices, apartments)
- New Development
- Old Site
- Inner-city renewal (utilising existing buildings)
- Transport-oriented development

Precinct Life-cycle Energy & Emission Modelling Tool

Precinct Scenario Analysis and Planning

- Precincts Annual Capita Energy Consumption
- Precincts Annual Energy Off-set

Graphs showing energy consumption and emissions for different scenarios.
Levels of Carbon Emissions and ICM Tools

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SUSTAINABILITY ASSESSMENT PROGRAM
UNSW AUSTRALIA
LOW CARBON LIVING CRC
Industry sector ‘carbon map’ of direct and embodied emissions

<table>
<thead>
<tr>
<th>Industries (origin) v</th>
<th>Products (destination) &gt;</th>
<th>Residential building construction</th>
<th>Non-residential building construction</th>
<th>Road and bridge construction</th>
<th>Non-building construction nec</th>
<th>Total emissions embodied in construction activities per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, Food &amp; Fibre</td>
<td></td>
<td>783</td>
<td>2,199</td>
<td>218</td>
<td>901</td>
<td>4,101</td>
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<tr>
<td>Mining</td>
<td></td>
<td>2,550</td>
<td>2,191</td>
<td>795</td>
<td>3,190</td>
<td>8,725</td>
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<tr>
<td>Material manufacturing</td>
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<td>3,147</td>
<td>2,090</td>
<td>657</td>
<td>2,115</td>
<td>8,009</td>
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<tr>
<td>Cement &amp; concrete</td>
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<td>454</td>
<td>330</td>
<td>112</td>
<td>339</td>
<td>1,235</td>
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<tr>
<td>Metal production</td>
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<td>1,365</td>
<td>1,036</td>
<td>344</td>
<td>952</td>
<td>3,696</td>
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<tr>
<td>Equipment manufacturing</td>
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<td>838</td>
<td>808</td>
<td>291</td>
<td>866</td>
<td>2,804</td>
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<tr>
<td>Electricity</td>
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<td>4,277</td>
<td>3,951</td>
<td>1,405</td>
<td>16,925</td>
<td>26,558</td>
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<tr>
<td>Gas &amp; water supply, waste</td>
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<td>1,959</td>
<td>1,388</td>
<td>467</td>
<td>1,962</td>
<td>5,776</td>
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<tr>
<td>Residential building construction</td>
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<td>822</td>
<td>190</td>
<td>13</td>
<td>49</td>
<td>1,074</td>
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<tr>
<td>Non-residential building construction</td>
<td></td>
<td>208</td>
<td>466</td>
<td>27</td>
<td>32</td>
<td>733</td>
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<tr>
<td>Road and bridge construction</td>
<td></td>
<td>15</td>
<td>32</td>
<td>73</td>
<td>129</td>
<td>249</td>
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<tr>
<td>Repair and maintenance - road and bridge</td>
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<td>2</td>
<td>4</td>
<td>9</td>
<td>16</td>
<td>31</td>
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<tr>
<td>Non-building construction nec</td>
<td></td>
<td>49</td>
<td>107</td>
<td>243</td>
<td>429</td>
<td>828</td>
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<tr>
<td>Repair and maintenance - non-bldg constr.</td>
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<td>2</td>
<td>4</td>
<td>9</td>
<td>16</td>
<td>31</td>
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<tr>
<td>Trade &amp; transport services</td>
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<td>2,994</td>
<td>2,262</td>
<td>759</td>
<td>3,049</td>
<td>9,063</td>
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<td>Public services</td>
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<td>16</td>
<td>14</td>
<td>5</td>
<td>14</td>
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<tr>
<td>Business services</td>
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<td>606</td>
<td>529</td>
<td>187</td>
<td>565</td>
<td>1,887</td>
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<tr>
<td><strong>Total Carbon Footprint</strong></td>
<td></td>
<td><strong>20,087</strong></td>
<td><strong>17,602</strong></td>
<td><strong>5,613</strong></td>
<td><strong>31,547</strong></td>
<td><strong>74,849</strong></td>
</tr>
</tbody>
</table>

4.8% 4.2% 1.4% 7.6% 18% of all industry emissions
Integrated C Metrics for Adelaide: "City Carbon Map"

### Carbon Map of the City of Adelaide

#### ORIGIN: Emissions from industries

<table>
<thead>
<tr>
<th>ORIGIN Industries</th>
<th>kt CO2e per year</th>
<th>Agriculture</th>
<th>Goods</th>
<th>Energy</th>
<th>Food</th>
<th>Construction</th>
<th>Electricity</th>
<th>Waste</th>
<th>Transport</th>
<th>Services</th>
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</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>Adelaide City</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Goods</td>
<td>Adelaide City</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
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<tr>
<td>Energy</td>
<td>Adelaide City</td>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
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<tr>
<td>Food</td>
<td>Adelaide City</td>
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<td>3</td>
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<td>0</td>
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<td>1</td>
</tr>
<tr>
<td>Construction</td>
<td>Adelaide City</td>
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<td>0</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Electricity</td>
<td>Adelaide City</td>
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<td>3</td>
<td>0</td>
<td>8</td>
<td>20</td>
<td>38</td>
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<td>1</td>
<td>21</td>
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<tr>
<td>Waste</td>
<td>Adelaide City</td>
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<td>0</td>
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<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Transport</td>
<td>Adelaide City</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Services</td>
<td>Adelaide City</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
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</table>

#### DESTINATION: Emissions embodied in products

<table>
<thead>
<tr>
<th>DESTINATION Industries</th>
<th>kt CO2e</th>
<th>Agriculture</th>
<th>Goods</th>
<th>Energy</th>
<th>Food</th>
<th>Construction</th>
<th>Electricity</th>
<th>Waste</th>
<th>Transport</th>
<th>Services</th>
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</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>Rest of World</td>
<td>7</td>
<td>14</td>
<td>0</td>
<td>3</td>
<td>30</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Goods</td>
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<td>1</td>
<td>32</td>
<td>0</td>
<td>5</td>
<td>6</td>
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<tr>
<td>Food</td>
<td>Rest of World</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Construction</td>
<td>Rest of World</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>53</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<td>Rest of World</td>
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<td>Waste</td>
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<td>0</td>
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<tr>
<td>Transport</td>
<td>Rest of World</td>
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<td>0</td>
<td>2</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>75</td>
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</tr>
<tr>
<td>Services</td>
<td>Rest of World</td>
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<td>17</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

#### Total carbon footprint of Adelaide City:

1.1 Mt CO₂e
Suite of ICM Tools as output

- Industry sectors
- Precinct, city
- Buildings
- Building materials
- Life Cycle Optimisation Model
- Hybrid LCA Database
- Product Explorer
- PIM Scenario Model
- Precinct Carbon Map
- Sector Carbon Map
- Click-b4u-build portal

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ICM Tools for Infrastructure Planning – THANK YOU