



Green infrastructure

DECARBONISING URBAN REDEVELOPMENT



Curtin University

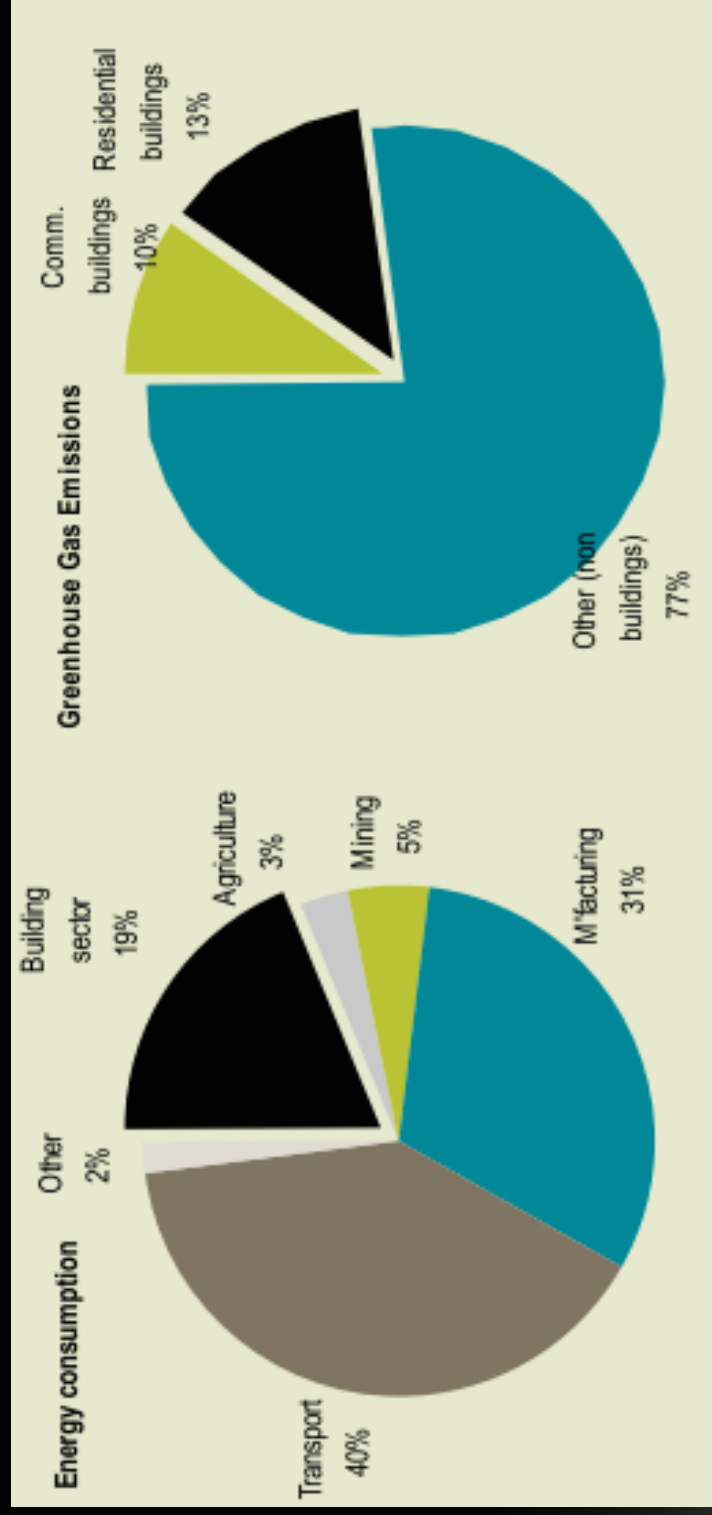
Decarbonising Cities & Regions

- Australian Research Council Linkage Grant
- Four Western Australian Examples
 - Urban “Fringe” Developments
 - **Urban Redevelopment**
 - Mining Camps
 - Indigenous Settlements
- And an Accreditation Analysis



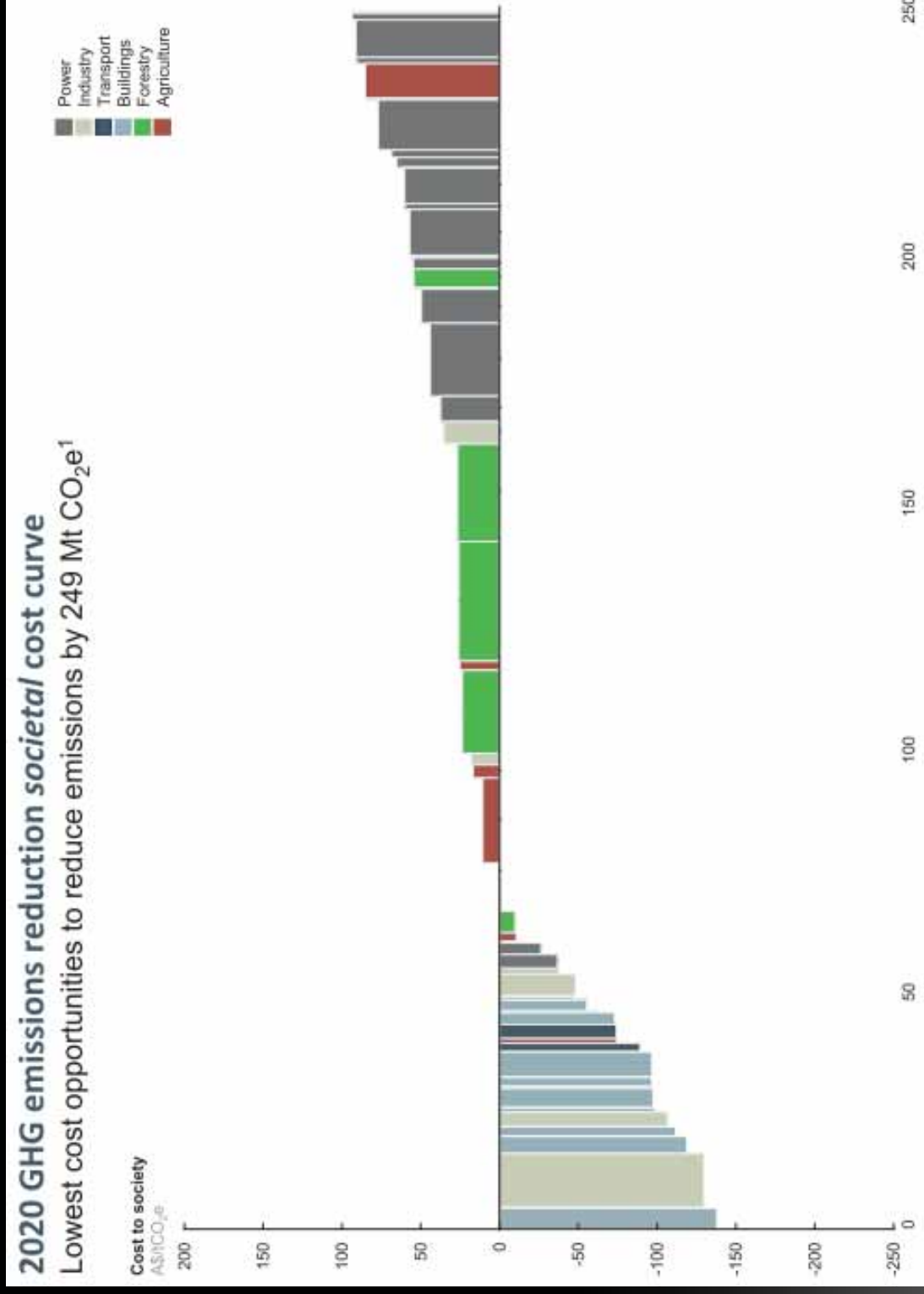
Climate Change in Context

- Why Urban Redevelopment?



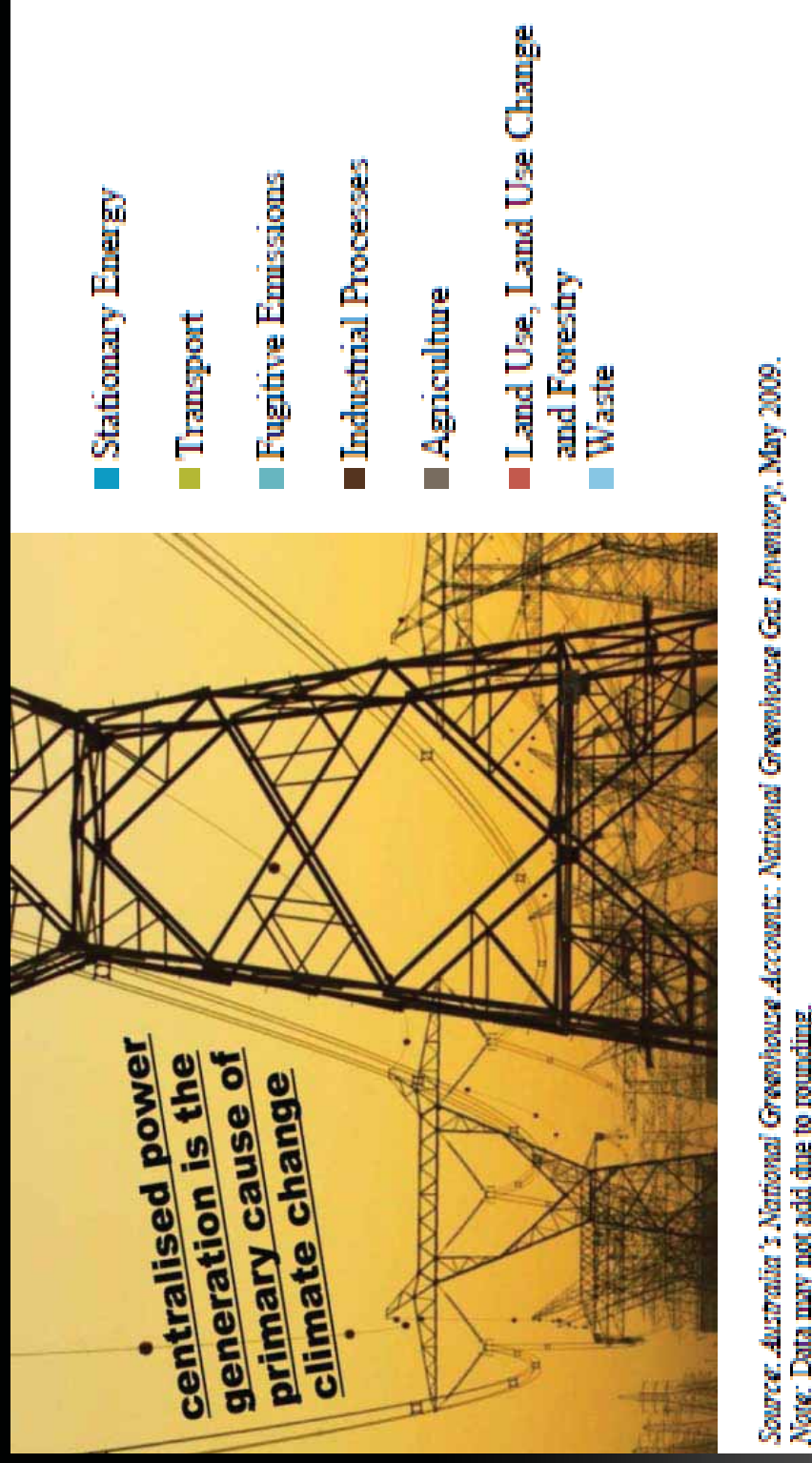
- The built environment has great potential to reduce emissions cost effectively (McKinsey Report)

Climate Change in Context



Climate Change in Context

- Contribution to CO₂-e: Emissions by sector



Green Infrastructure...

“the substructure or underlying foundation especially the basic installations and facilities on which the continuance and growth of a community depends.”

Ref: Webster's New World Dictionary

The following could be considered “green” or sustainable urban infrastructure :-

- Distributed Energy and integrated energy demand management initiatives and programs
- Energy efficient buildings
- Public transport networks
- Localised water and waste management systems
- Connected green spaces and wildlife corridors
- Water sensitive urban design

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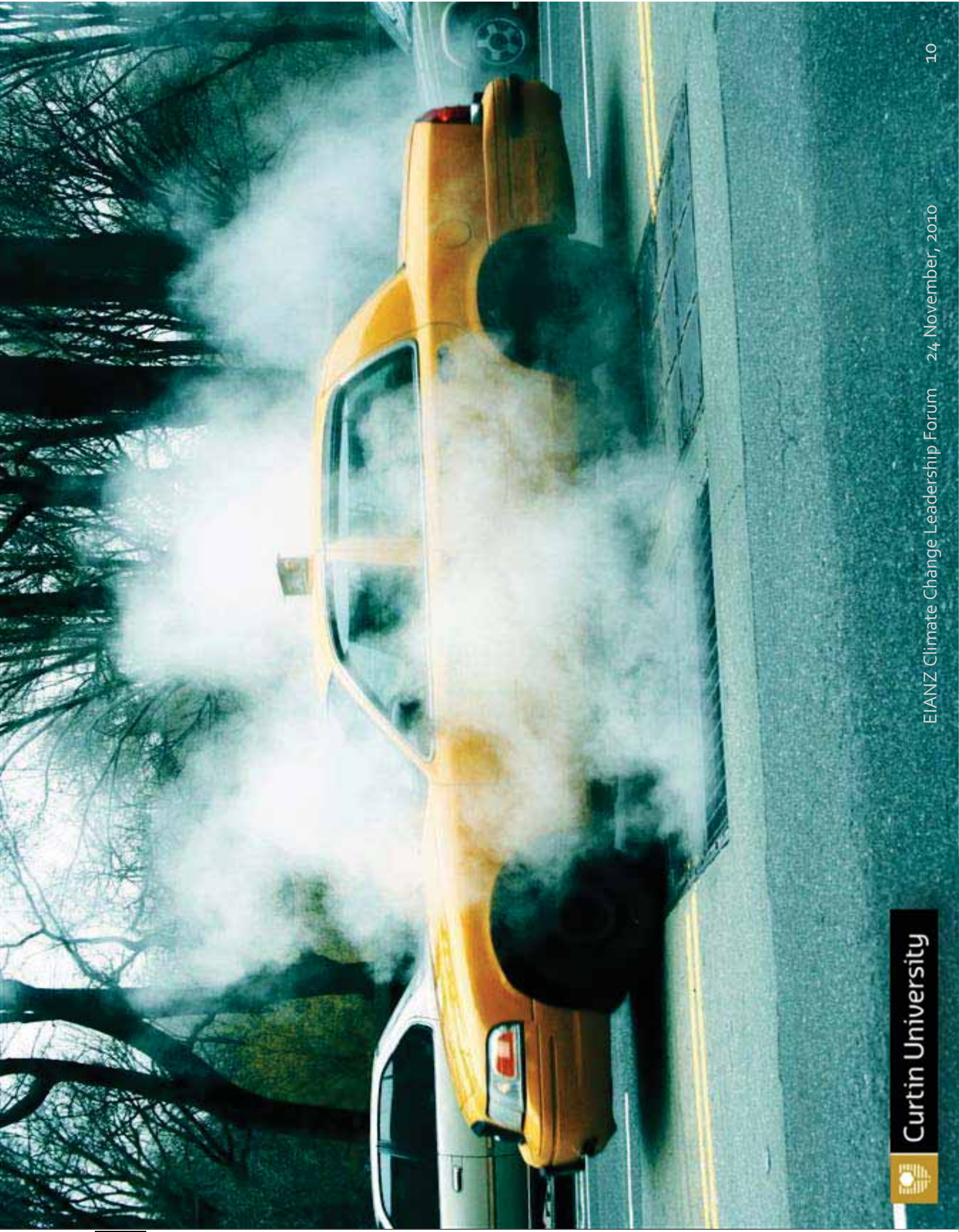
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- **Distributed Energy** and integrated energy demand management initiatives and programs
- **Energy efficient buildings**
- Public transport networks
- Localised water and waste management systems
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Distributed Energy

Distributed generation systems are small-scale power generation technologies (typically in the range of 3 kW to 10,000 kW) used to provide an alternative to or an enhancement of the traditional electric power system.

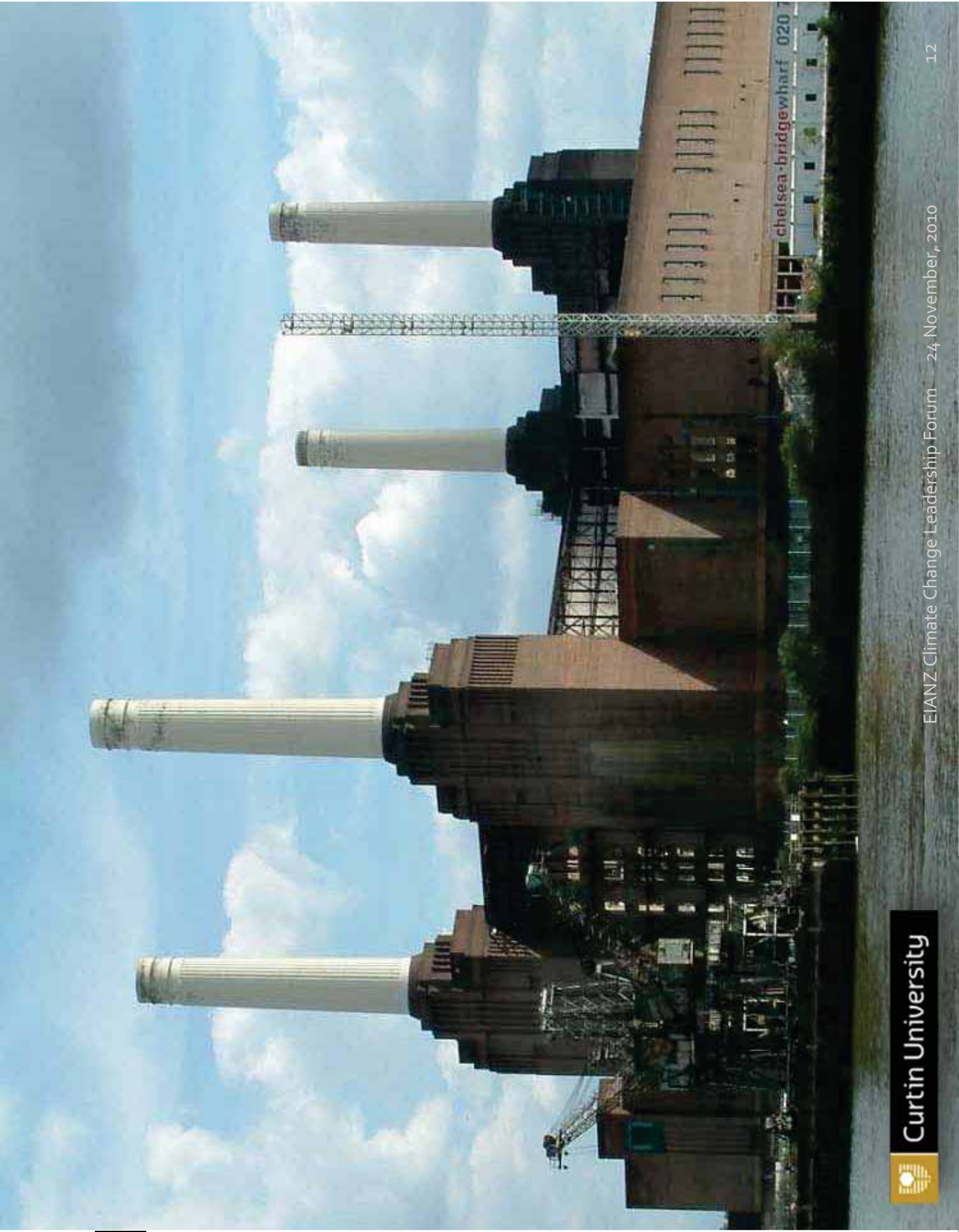
- Cogeneration; an obvious choice...
 - or combined heat and power (CHP) is a plant that simultaneously generates both electricity and useful heat.
- Embedded renewables have a role to play
 - Electrical Energy
Eg. Photovoltaic's, wind turbines
 - Thermal Energy
Eg. Solar thermal, Geothermal



A photograph of a yellow taxi cab parked on a city street. The scene is hazy, with a thick layer of white steam or smoke rising from the ground, partially obscuring the taxi and the background. The taxi is a classic yellow cab with a black roof rack. The background shows a street with trees and a building. The overall atmosphere is misty and urban.

**Power to 1800 Buildings in Manhattan
50% of steam from cogeneration
plants provides heating & cooling
Offsets 350MW_e of power from grid**

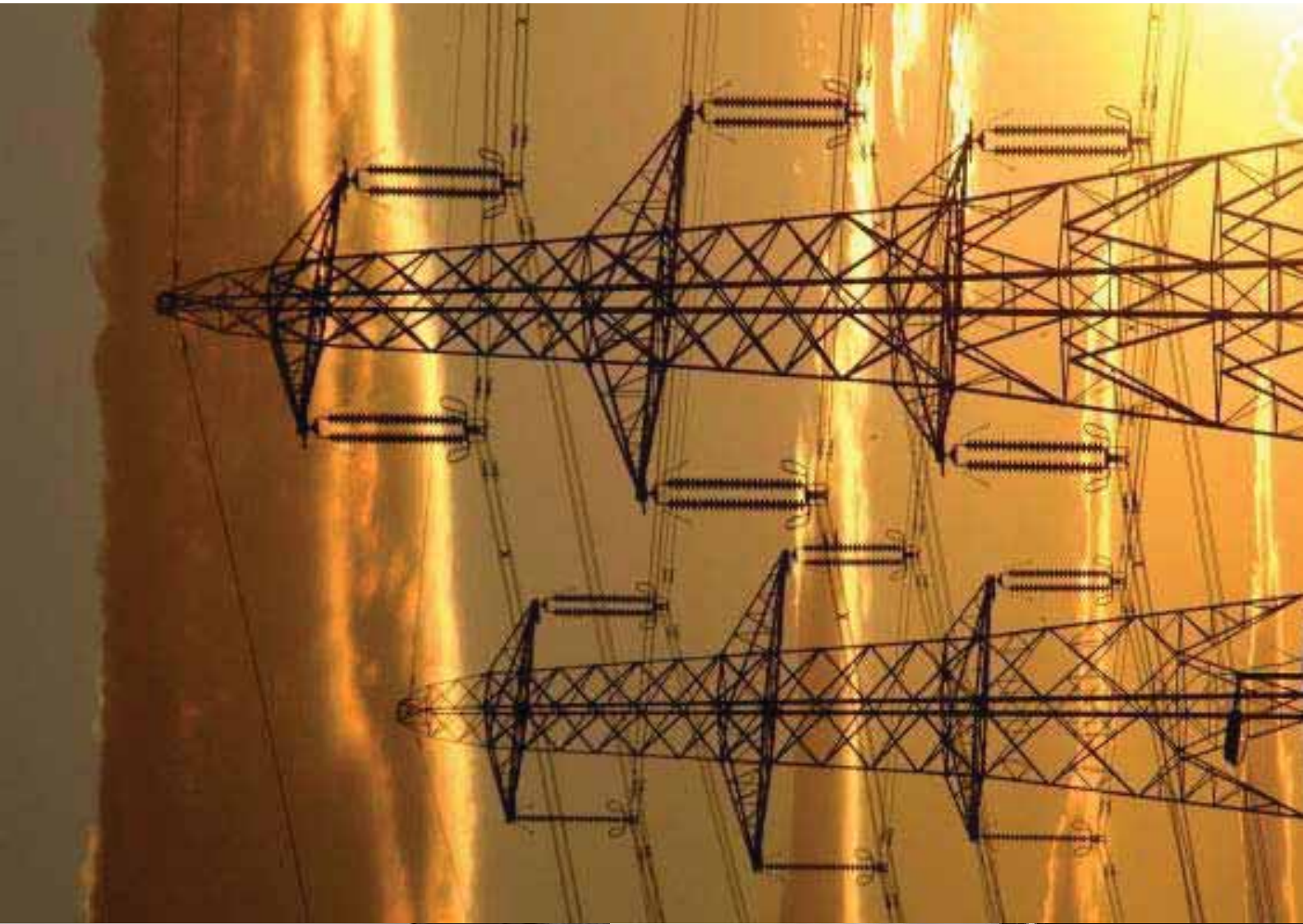






**Cogeneration scheme introduced
benefitted some 10,000 people.**

- **hot water and central heating to Pimlico
on the North side of the river**



Improve System Efficiencies

GHG/Energy Relationship

- Emissions depend on:-
 - The amount of energy used
 - The source of the energy
- Fossil fuel fired power stations
 - Thermal efficiency around 33%
 - Further 10 to 15% lost to transmission and distribution inefficiencies
 - Water
- Cogeneration/Trigeneration
 - Heat recovery can push efficiency up to about 85%
 - **Locate where the recovered energy can be put to good use....**

	Renewable electricity	Natural gas*	Grid electricity**
kgs of GHGe emitted per unit of heat produced	0	0.33	1
* LPG is approximately 0.4 ** National average. For electricity generated in Victoria this figure is 1.4. In Tasmania it is very low due to use of hydro. In the NT it is about 0.75 due to use of gas for electricity generation.			



The Return of Energy Generation_(th + e) to the City

- At a small scale
 - Anything from building to precinct scale to suit the local environment
- Extremely Efficient

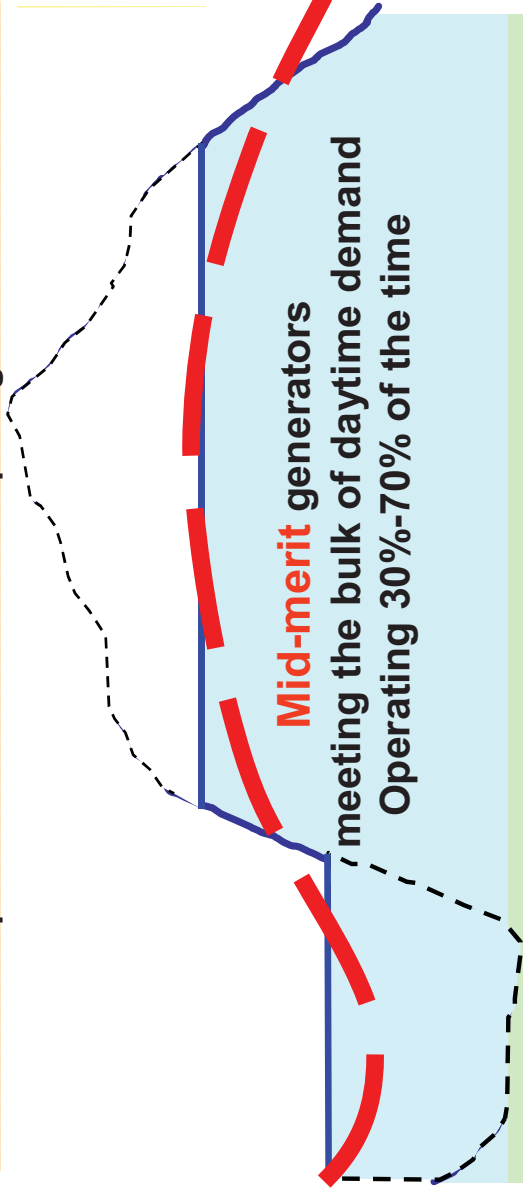


The Grid in WA

- South West Integrated System (SWIS)
 - Largest islanded network in the world
 - 6,000km TX; 85,000km DX; serving 5,047MW installed generation capacity and 860,000 customers
 - 10% of system capacity is used for less than 48 hours / year
 - 20% of system capacity is used for less than 10 days / year

Baseload Generation

Reserve generators and **Demand Management** supplying only extreme peak demands and backup for generator failure



Base load generators supplying the underlying demand
Operating near continuously

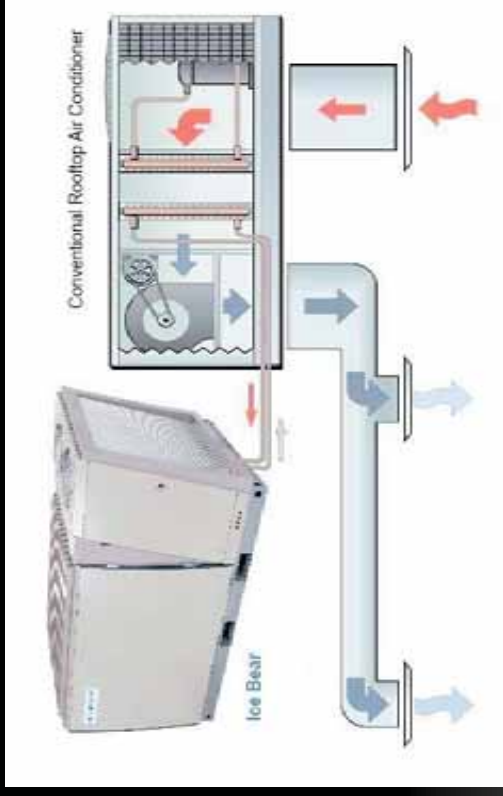
Midnight

Noon

Midnight

Demand Management

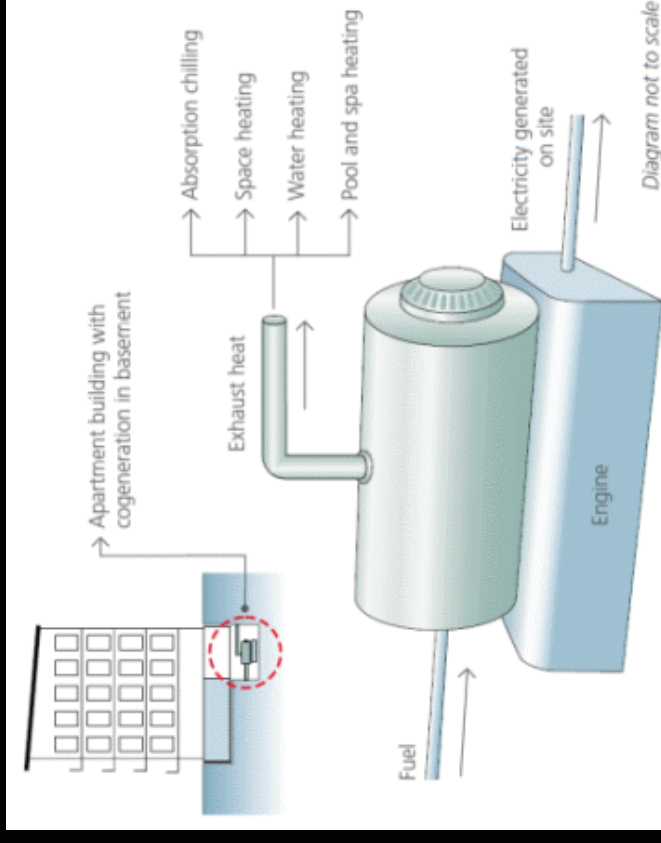
- Smart Grids and Meters
- Thermal Energy Storage
- User behaviour



Cogeneration

Gas Turbines

- CCGT
- Micro
- Reciprocating Engines
- Fuel Cells
- A modular system
 - Can provide efficient power and heat for anything from a single building to a complete neighbourhood
- Flexible fuels

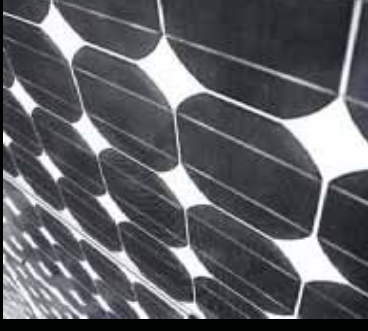


Wind...

- Outputs from 2 – 15kW
- Inconsistent wind patterns



Solar . . .



- Photovoltaic
 - Crystalline, thin film
 - From 1.5 kW....
- Thermal
 - Hot Water Service
 - Space Heating



What is Australia doing?

■ Decarbonising Cities and Regions.....

C40

climate leadership
group climate
change action plans
by city leaders

London

60% reduction in
emissions from 1990
by 2025

25% decentralised
energy by 2025,
53% by 2050

NY

30% reduction in
emissions from 2007
by 2030

800mwe
decentralised
energy by 2030

Paris

75% reduction in
emissions from 2004
by 2050

Toronto

80% reduction in
emissions from 1990
by 2050

LA

35% reduction in
emissions from 1990
by 2030

35% renewable
energy by 2020

Decarbonising Cities & Regions

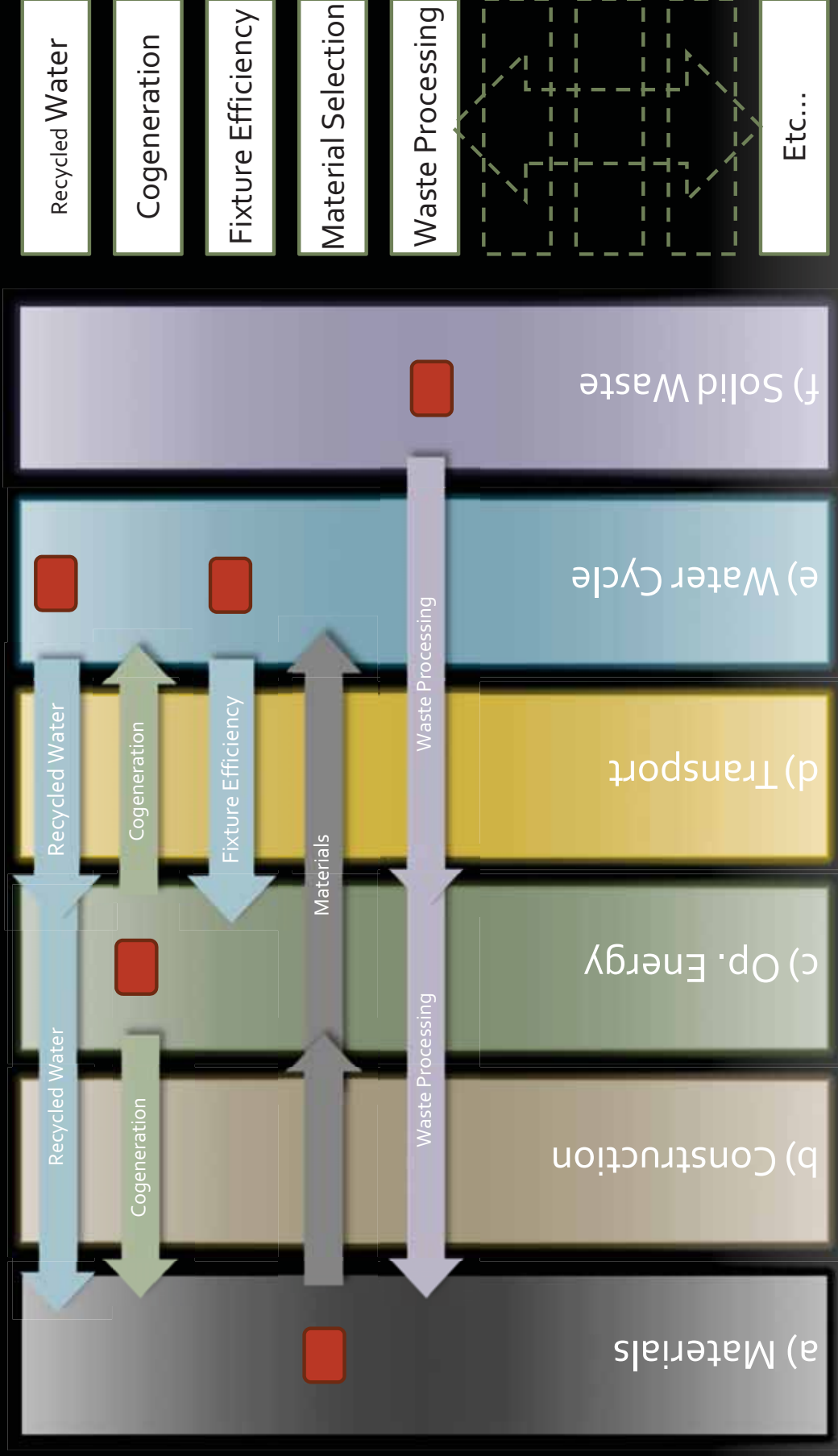
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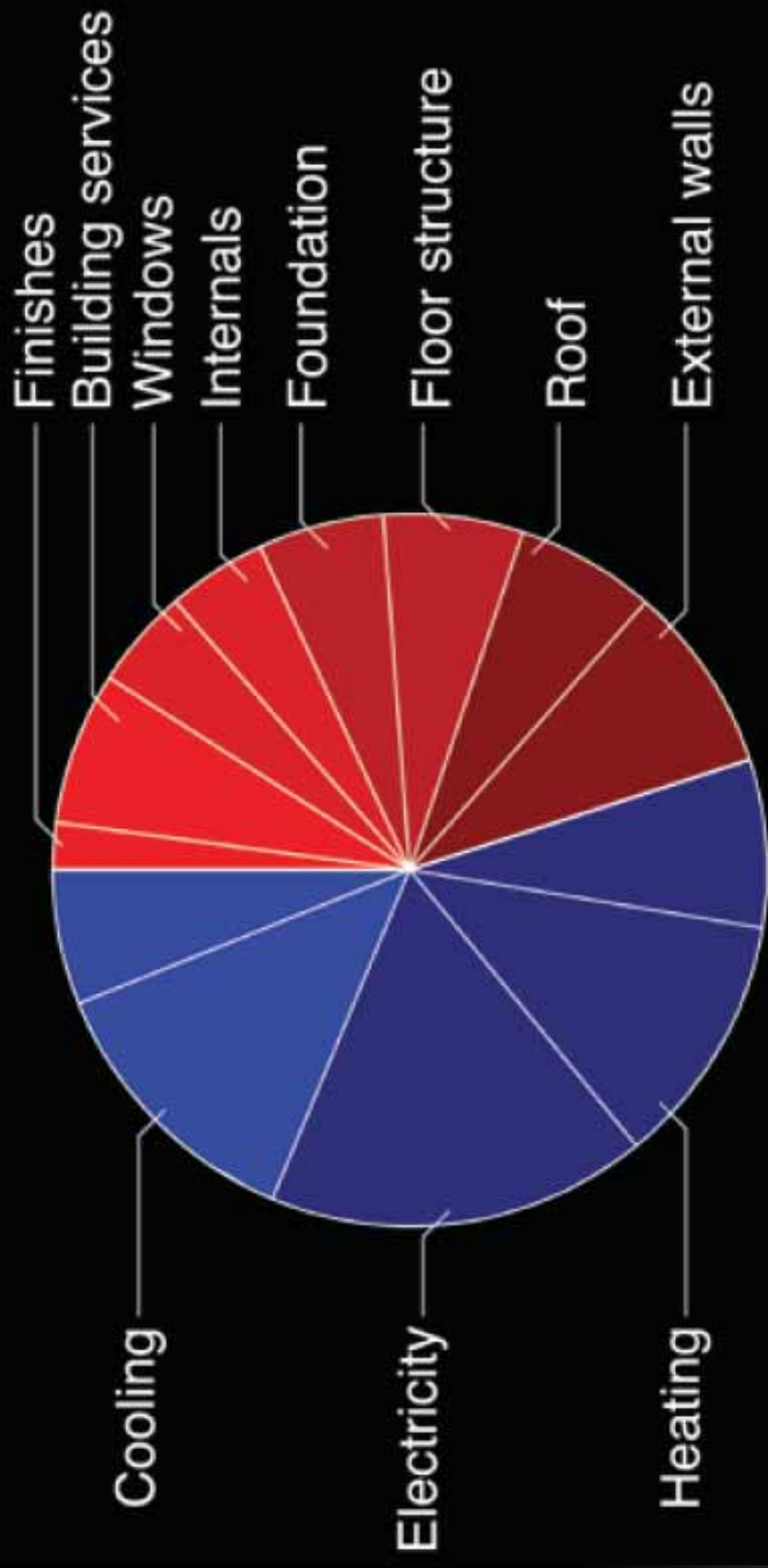
A Framework

- a) **The GHGe used in the materials** of the buildings and the infrastructure including the variations when regional and recycled materials are used;
- b) **The GHGe used in the construction/deconstruction process** and how this varies with different approaches;
- c) **The electrical power and natural gas** used in the buildings including the differences with different building types and variations when provided from centralised or distributed sources;
- d) **The transport fuels** used in the construction and the on-going use of the area by residents including the variations with different urban area designs;
- e) **The GHGe produced in the full water cycle** (pumping water) including GHG linked to different forms of water infrastructure (centralised or distributed); and
- f) **The GHGe associated with the solid waste** generated by the community and its variations when there is more re-use and recycling.

The Framework as a Model

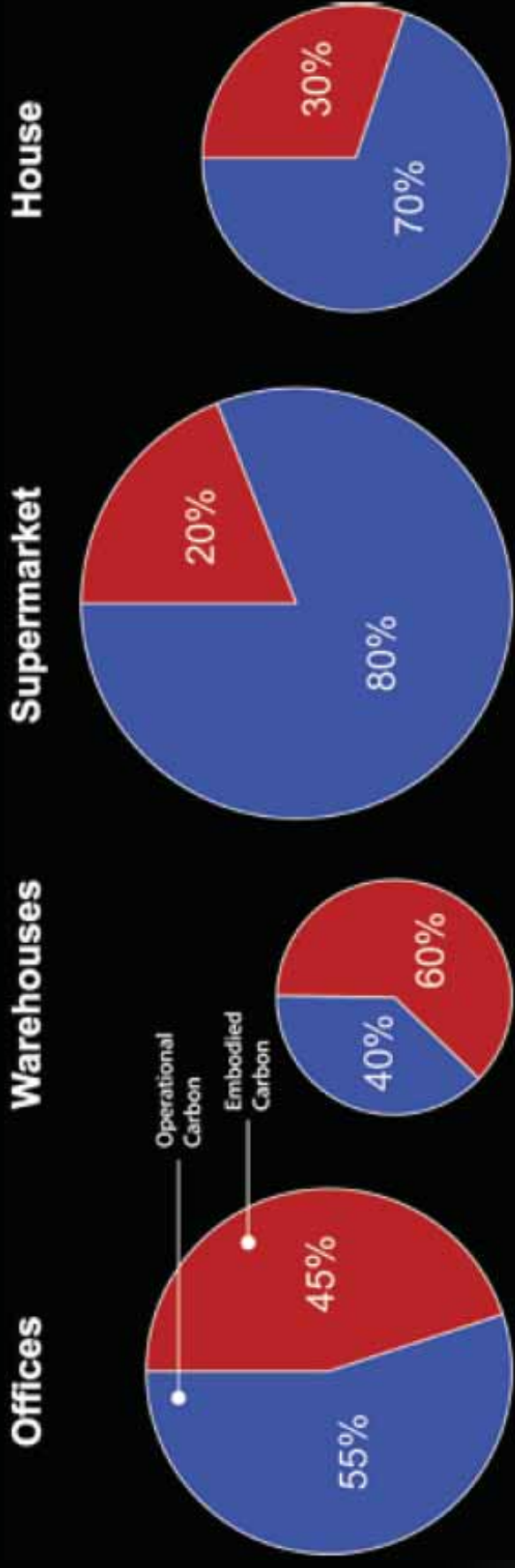


Whole Life Carbon



Source: Sturgis Associates LLP Indicative Whole Life Carbon Emissions

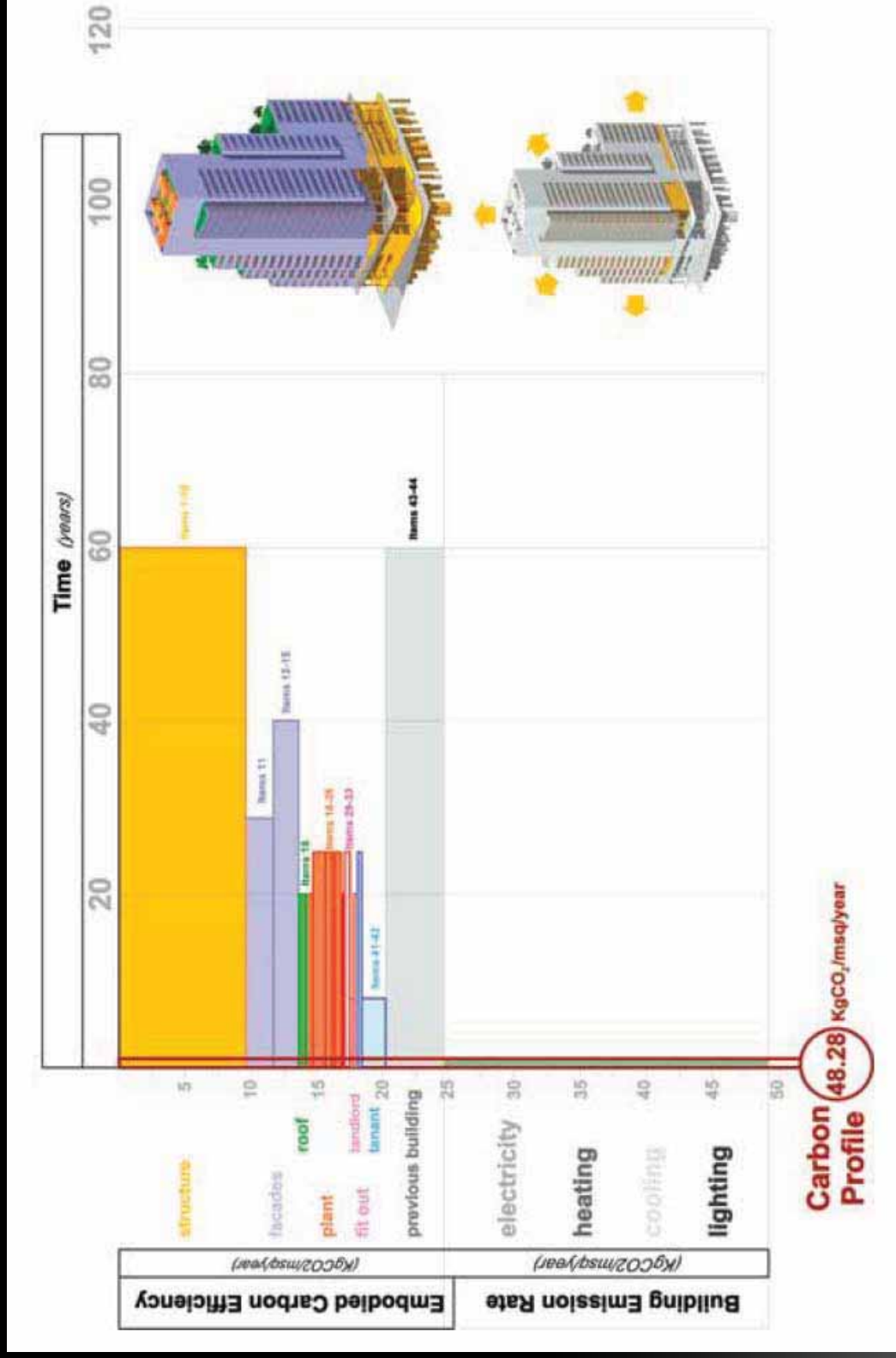
Whole Life Carbon



Carbon Profiling

- **Responsibility**
 - Legal
 - Physical
- **Component Lifespan**
 - Weakest link is the component with the shortest lifespan in an 'assembly'
- **Temporal Model**
- **Metric – kg CO₂-e/m²/year**

Carbon Profiling



The Toolbox

- What tools are there available that have an actual metric of 'CO₂-e' as a result?
- Not Many!
 - Joint paper produced by the author together with "Decarb Team"

- | |
|--|
| a) CO ₂ -e used in the materials |
| b) CO ₂ -e used in construction |
| c) CO ₂ -e in Operational Use |
| d) CO ₂ -e in Transport fuels |
| e) CO ₂ -e produced in full water cycle |
| f) CO ₂ -e associated with solid waste |

The Toolbox

- What tools are there available that have an actual metric of 'CO₂-e' as a result?
- CCAP PRECINCT™
 - Greenhouse Gases (kg CO₂/person/year)
 - Potable Water (kL /person/year)
 - VHT (hrs/person/week)
 - Total Affordability (\$/household/year)



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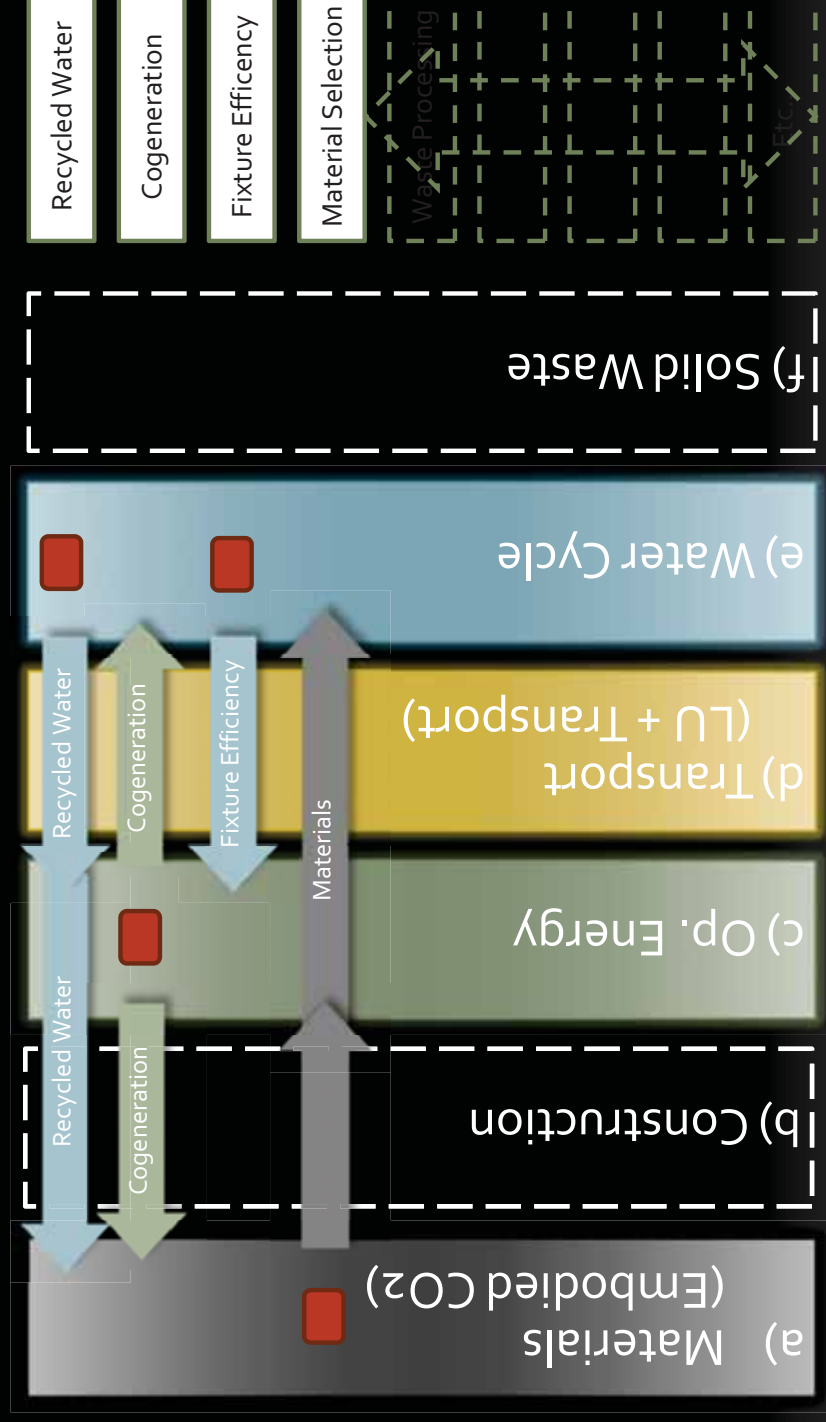
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How the CCAPrecinct tool fits into the framework model...

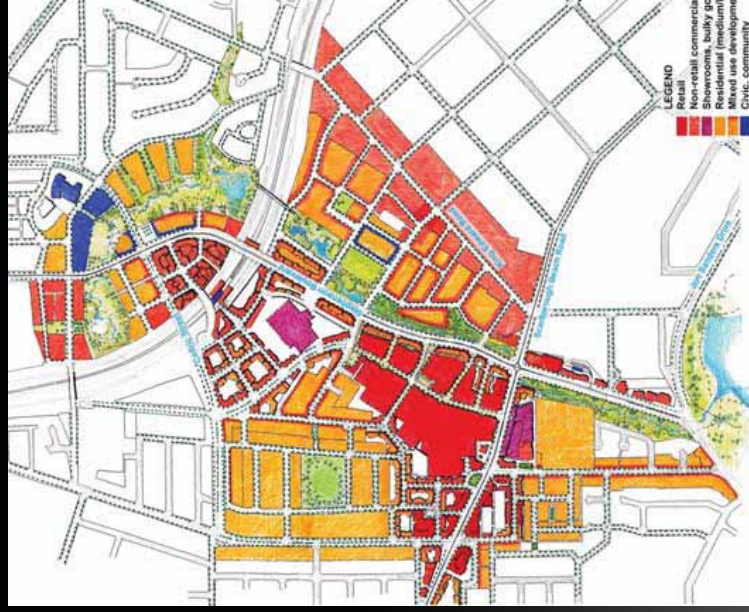


CCAPPrecinct + X_{cons} + Y_{waste} = "complete model"

Case Studies

Stirling City Centre

- 328ha
- 12,500 new dwellings
- 30,000 jobs in total within 800m of station



Cockburn Coast

- 330ha
- 5,000 new dwellings
- 7,000 job



Carine

- 8ha
- 261 new dwellings
- Retirement Village and aged care centre



What do you need?

- More efficient buildings
 - Pixel Building
 - CH₂
- Combination of co/trigen, solar, wind to meet demand in various combinations
- Smart grids and metering
 - Demand-side Management
 - Thermal Energy Storage
 - User behaviour



...provides an assortment of tools that can make a development “net zero” or “carbon +ve”

Questions...

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