CENTRAL TO EVELEIGH

SUSTAINABILITY STRATEGY REPORT

PREPARED BY KINESIS FOR URBANGROWTH NSW

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Note: This report is provided subject to some important assumptions and qualifications:

The results presented in this report are modelled estimates using mathematical calculations. The data, information and scenarios presented in this report have not been separately confirmed or verified. Accordingly, the results should be considered to be preliminary in nature and subject to such confirmation and verification.

Energy, water and greenhouse consumption estimates are based on local climate and utility data available to the consultant at the time of the report. These consumption demands are, where necessary, quantified in terms of primary energy and water consumptions using manufacturer's data and scientific principles.

Generic precinct-level cost estimates provided in this report are indicative only based on Kinesis's project experience and available data from published economic assessments. These have not been informed by specific building design or construction plans and should not be used for design and construct cost estimates.

The Kinesis software tool and results generated by it are not intended to be used as the sole or primary basis for making investment or financial decisions (including carbon credit trading decisions). Accordingly, the results set out in this report should not be relied on as the sole or primary source of information applicable to such decisions.

CONTENTS

EXECUTIVE SUMMARY

PURPOSE

This report provides an assessment of the potential of the C2E Framework Plan (May 2015) and identifies key sustainability and infrastructure interventions that will deliver C2E as world class urban renewal.

OUR APPROACH

The analysis and strategies outlined in this report expand on and seek to measure the following components of the C2E Framework Plan (see Figure 1):

1. Ten Areas of Consideration
2. Four Themes
3. Ten Key Moves

In order to assess the success and benefits of C2E, Kinesis identified four criteria and measures of success against which the C2E Framework Plan was measured:

1. **Accessible and Connected** (measured through car use, walkability and public transport access, highlighting the population's access to employment and services).

2. **Environmentally Sustainable and Responsive** (measured through greenhouse gas emissions, energy consumption and water use).

3. **Affordable Housing and Living** (measured by taking a holistic view of both the cost of housing and cost of living associated with transport and utilities costs).

4. **Resilient Community** (measured through household cost of living which reflects an individual's adaptive capacity, urban heat island which can be minimised to reduce heat waves and climatic changes, and infrastructure delivery to ensure resilience to changing climates).

While C2E is in the early stages of planning, it is critical that key interventions are identified and documented at this stage to ensure they are incorporated through the next phases of planning, design and delivery. Analysis was undertaken using the UrbanGrowth NSW's integrated sustainability, infrastructure and design tool, PRECINX. PRECINX provides a basis from which UrbanGrowth NSW can measure the potential of the C2E Framework Plan.

Analysis of C2E's measures of success was analysed using the land use and development inputs provided by ARUP and Grimshaw Architects. The performance of this was analysed under:

1. **Business as Usual C2E Scenario** which assumes development under existing planning and development controls.

2. **Optimised C2E Scenario** which incorporates several key interventions that will optimise and outcomes sought under the Framework Plan and deliver C2E as world class urban renewal.

Analysis and results of these four criteria and associated measurables are documented in this report.
Finally, to establish whether or not C2E will, at a metropolitan level, have a positive or negative impact on the city, the results of each scenario were benchmarked against the **Sydney Metropolitan Average** (average transport, energy, water and cost of living profiles of all existing residents in Metropolitan Sydney).

ANALYSIS AND OPTIMISATION OF C2E FRAMEWORK PLAN

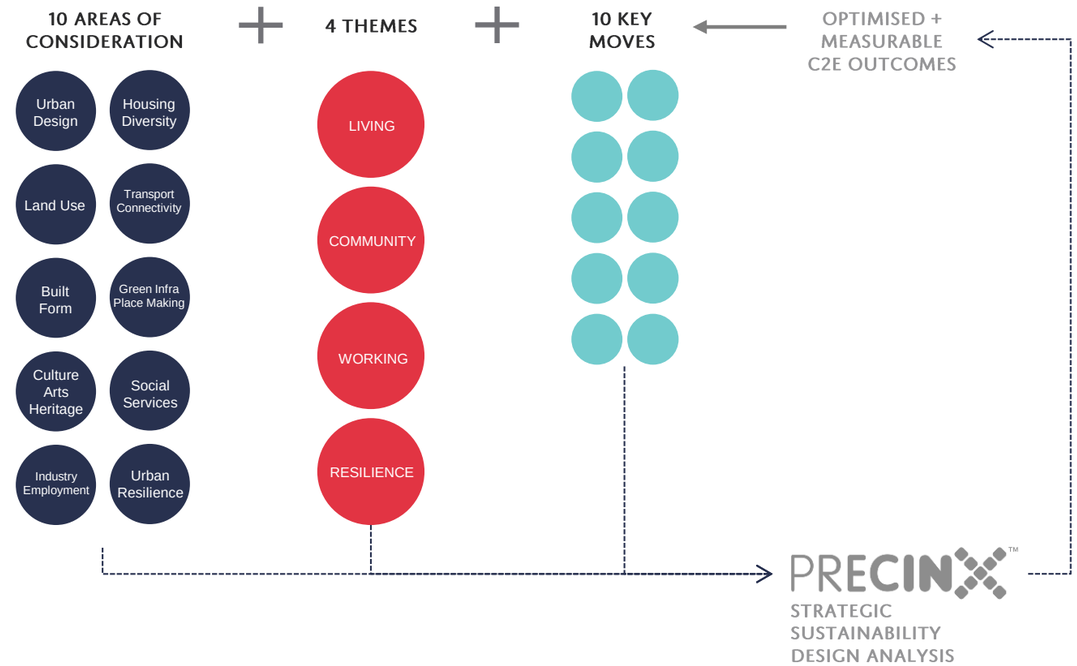


Figure 1: Relationship of this report to the C2E Framework Plan.

KEY FINDINGS OF THIS REPORT

MESAURES OF SUCCESS

The findings of this report demonstrate that C2E will add significant value to the future development of Sydney. Under the Base Case C2E, the project delivers the following:

1. ACCESSIBLE + CONNECTED

- Over 90% reduction in car dependence and use when compared to the Sydney Metropolitan average.
- Over 60% reduction in household car ownership when compared to the Sydney Metropolitan average.
- All residents within a 15 min walk of heavy rail.
- All residents within 5 mins or 400 metres of public open space.

2. ENVIRONMENTALLY SUSTAINABLE + RESPONSIVE

- 40% reduction in resident water consumption when compared to the Sydney Metropolitan average.
- 2% reduction in resident stationary emissions when compared to the Sydney Metropolitan average.

3. AFFORDABLE HOUSING + LIVING

- 45% reduction in household cost of living from energy, water and transport costs when compared to the Sydney Metropolitan average. Equivalent to over $6,000 saving per household per year.
- 3% of dwellings are expected to deliver sales prices that would be considered affordable for moderate income of the local housing submarket.

4. RESILIENT COMMUNITY

- Affordability outcomes achieved at C2E provide key resilience and adaptive capacity outcomes for residents.
- Increased open space, green infrastructure and networks provides the potential to improve resilience against a changing climate and the effects of urban heat island.
- When compared to an un-vegetated public domain, a well-managed, lush tree canopy can reduce land surface temperature by up to 15 degrees on a 35 degree day.

Key interventions were identified to build on and support the C2E Framework Plan and improve on the measures of success achieved by C2E under the Base Case.

KEY INTERVENTIONS TO DELIVER WORLD CLASS URBAN RENEWAL

There are a number of emerging trends that need to be considered and transferred to the thinking, design, development and infrastructure briefs for creating world class urban regeneration at C2E. While C2E is in the early stages of planning, it is critical that key interventions are identified and documented to ensure they are incorporated through the next phases of planning, design and delivery.

1. DESIGNING FOR 21ST CENTURY MOBILITY + SHARED URBAN EXPERIENCE

WHAT - Low and alternative car ownership and parking models are recommended to ensure C2E is designed to meet affordability, mode split, car ownership and private car share investment criteria.

WHY - There is a mobility revolution occurring globally that is fuelled by technological change, collaborative consumption and a new approach to how we engage in the workplace. If you add to this the disruption posed by the emergence of the autonomous vehicle, C2E must be agile and respond to a cities agenda that is unlike anything Sydney has ever faced before. As a first step to deliver on this, **the Optimised C2E Scenario** proposes significantly lower parking rates, coupled with car share and decoupled parking strategies.

KEY OUTCOMES ACHIEVED

- Leverages the accessibility of the corridor to deliver low car dependence and car ownership rates
- Further reduces energy consumption, greenhouse gas emissions and car use
- Delivers a more affordable housing and affordable living community
- Linked to affordability, increases the adaptive capacity and resilience to future changes in climate and economic systems.

2. ENHANCE URBAN RESILIENCE THROUGH INTEGRATED RECYCLED WATER

WHAT - Recycled water is enabled throughout the precinct and linked to public domain design and management to both mitigate local climate challenges and off-set potential urban heat island impacts.

WHY - While water reuse has traditionally been considered as a water conservation objective, recycled water from black and grey wastewater provides the opportunity to flip this goal on its head. Increased open space, green infrastructure and networks provides the potential to improve resilience against a changing climate and, furthermore, the effects of urban heat island. To deliver on this, **the Optimised C2E Scenario** proposes to link the inevitably higher irrigation demands from broad leaf canopy, soft surfaces and green walls and roofs to recycled water to ensure an unlimited supply of water for this public and private domain.

KEY OUTCOMES ACHIEVED

- Significantly reduces potable water consumption for public space irrigation.
- Reduces electricity consumption and peak infrastructure demands from air conditioning through cooler streets.
- Significantly reduces sewer infrastructure requirements to the corridor.
- Recycled water ensures the public domain irrigation demand is not reliant on rainfall patterns and is resilient to future variations in rainfall.
- Reduces the heat island effect and the impact of heat waves.

3. ENVIRONMENTAL OUTCOMES THROUGH HIGH PERFORMANCE BUILDINGS

WHAT - Higher environmental standards are established for all new development at C2E.

WHY - Coordinated urban renewal at C2E presents a unique opportunity to potentially optimise the performance of this new development.

OUTCOMES - Based on a review of recent developments adjacent to C2E (such as Green Square and Central Park), **the Optimised C2E Scenario** incorporates strategies to achieve BASIX Energy 45 (125% higher than current compliance) and BASIX Water 60 (50% higher than current compliance).

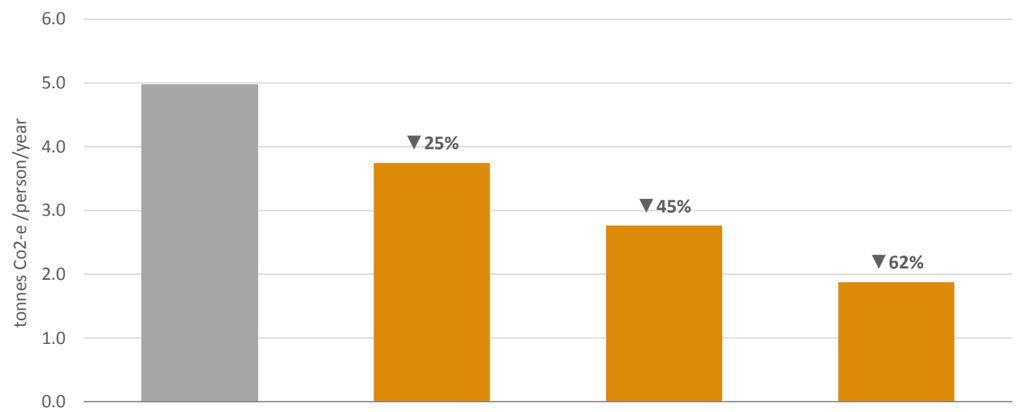
KEY OUTCOMES ACHIEVED

- Further reduces energy consumption, water consumption and greenhouse gas emissions.
- Reduces electricity consumption and peak infrastructure demands.
- Delivers a more affordable living outcomes, ensuring residents and business are more resilient to future utility prices changes.

The performance of these outcomes is quantified by PRECINX in this report.

DELIVERING A LOW CARBON PRECINCT

The accessibility and location of C2E provides significant low carbon outcomes through reduced car use and transport related greenhouse gas emissions. Combined with the building level strategies proposed above, C2E is expected to achieve up a 62% reduction in total greenhouse gas emissions compared to the Sydney Metropolitan Average.



In addition, the consideration of building materials through detailed building design could further reduce the carbon embodied in the materials used in the construction of development at C2E to achieve improved greenhouse gas emission results.

UNDERSTANDING C2E

Development along the C2E corridor and study area (see Figure 2) should be designed to respond to and build on the existing and future patterns and demographics of the area. For the purpose of this report, existing car ownership rates, travel patterns, household expenditure and local climate was examined to help establish the basis for interventions which optimise the C2E transformation.

TRANSPORT + CAR OWNERSHIP

- Across the City of Sydney LGA households own, on average, less than 1 vehicle (0.8 cars per household). This pattern of low car ownership is present along the C2E corridor (see Figures 3 and 4).
- While car ownership patterns in and around the C2E corridor can be correlated to household income, the car ownership is reflected in existing travel patterns. Figures 5 and 6 highlight areas of high journey to work public transport mode split and high journey to work walk and cycle mode splits.

COST OF LIVING

- Both car ownership rates and travel patterns are a strong indicator of cost of living.
- Analysis of the contribution of cost of housing, transport and utility expenditure previously undertaken by Kinesis for a number of local government areas highlights the contribution of transport to household expenditure and extent to which high accessibility and low transport costs can offset housing costs.
- Figure 7 outlines the average household expenditure for a number of Sydney local government areas, based on the median house and unit sales price of the last 12 months and existing car ownership and travel patterns.
- While C2E is located within an area with high cost of housing, a component of these costs can be offset by the relatively low cost of living, in particular transport costs.

URBAN HEAT ISLAND

- Major heat waves are Australia's deadliest natural hazards. Major heat waves have caused more deaths since 1890 than bushfires, cyclones, earthquakes, floods and severe storms combined[1].
- People living in urban environments can be more susceptible than non-urban dwellers to the effects of heatwaves as a result of the urban heat island. The urban heat island is effectively the difference between the land surface temperature and the average air temperature. This is caused by the prevalence in cities of heat-absorbing materials such as dark coloured pavements and roofs, concrete, urban canyons trapping hot air, and a lack of shade and green space in dense urban environments.
- Studies undertaken by the City of Sydney highlight a strong correlation between surface types and vegetation with lower land surface temperatures. Figure 8 outlines the land surface temperature in and around the C2E corridor, highlighting the corridor (in particular the existing roads) as a high temperature area, lacking local vegetation for shade.

C2E CORRIDOR AND STUDY AREA

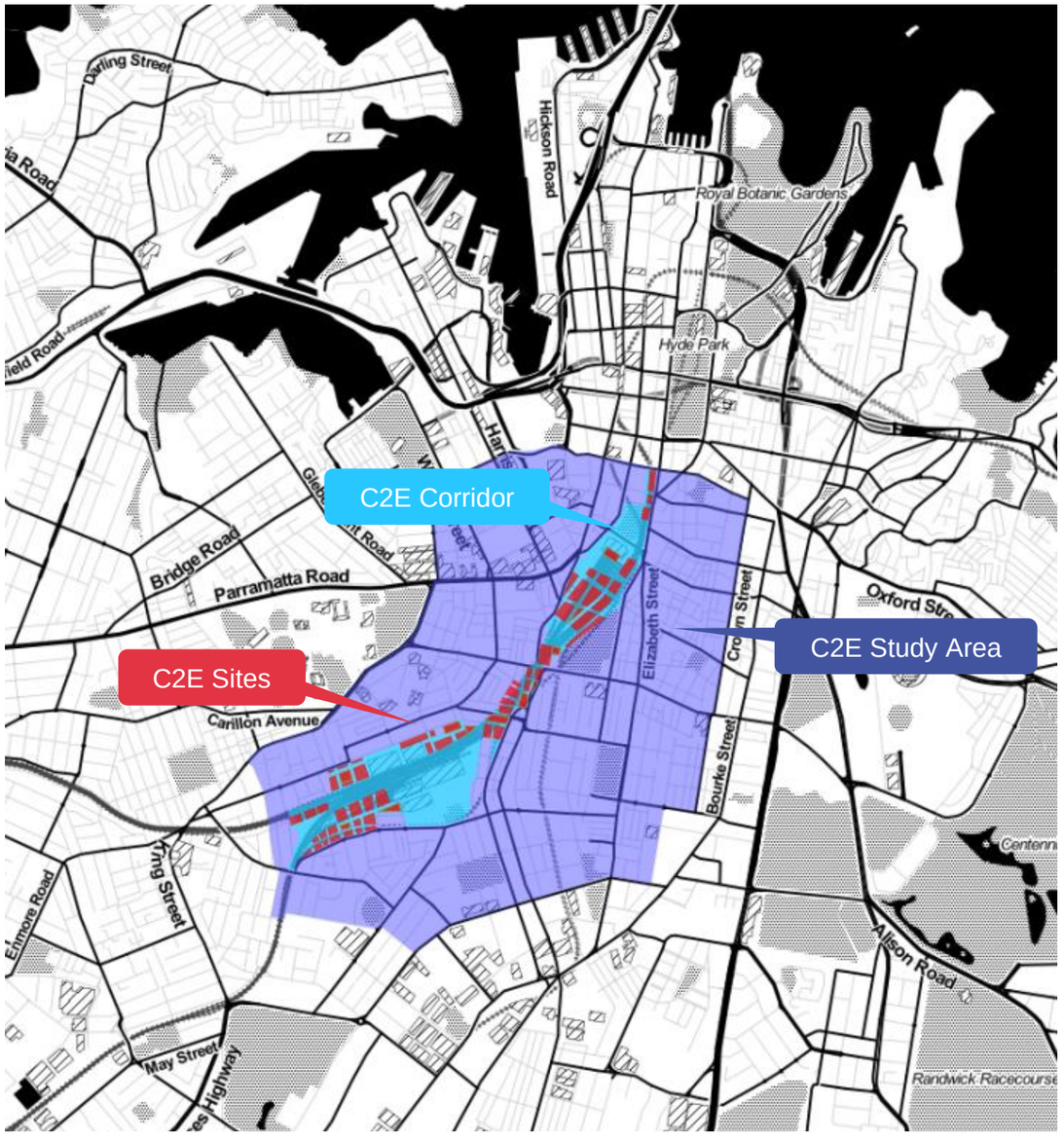


Figure 2: C2E Corridor and Study Area, corridor and sites.

[1] Department of Infrastructure and Regional Development (2013) State of Australian Cities.

EXISTING CAR OWNERSHIP

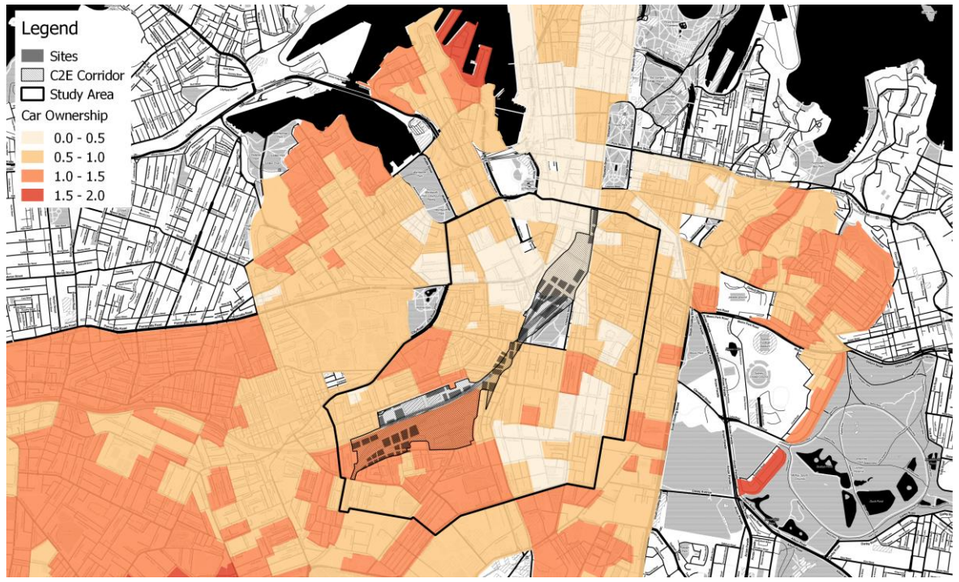


Figure 3: Average car ownership rates (source: ABS Census 2011)

HOUSEHOLD WITH NO CARS

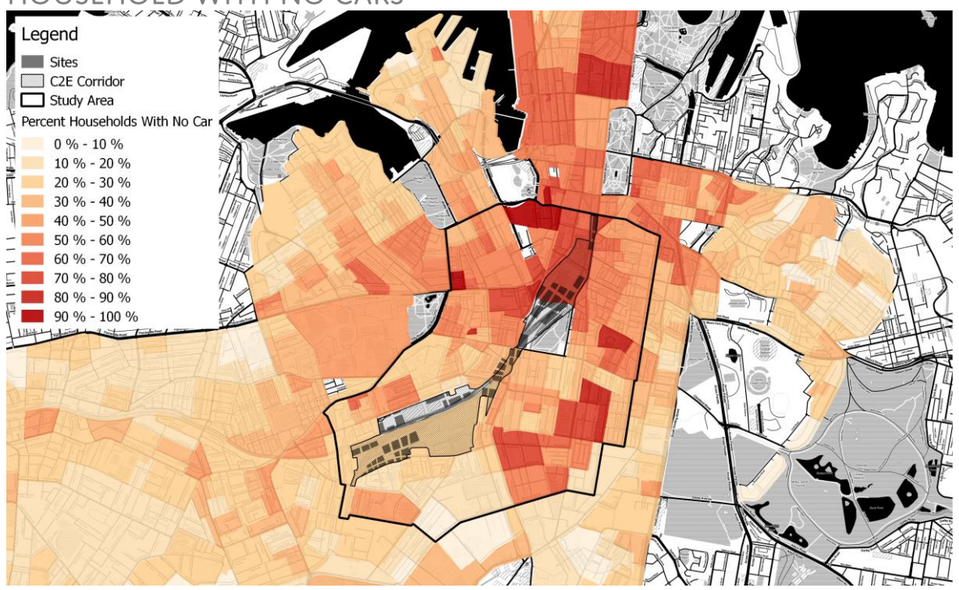


Figure 4: Percent of housing with no vehicles (source: ABS Census 2011)

PUBLIC TRANSPORT TO WORK

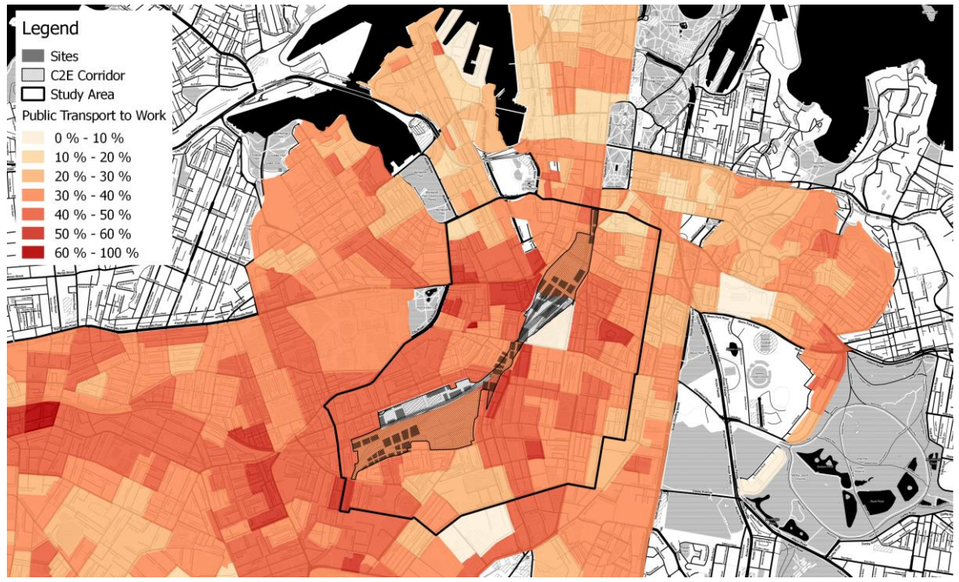


Figure 5: Percent of persons who travel to work by public transport (source: ABS Census 2011)

WALK + CYCLE TO WORK

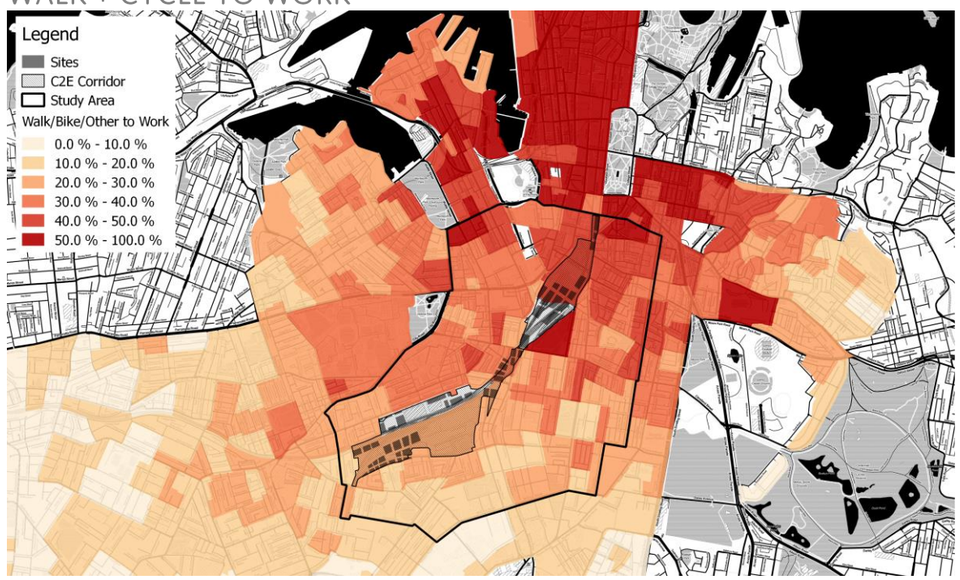


Figure 6: Percent of persons who walk or cycle to work (source: ABS Census 2011)

HOUSEHOLD EXPENDITURE BY LOCAL GOVERNMENT AREA

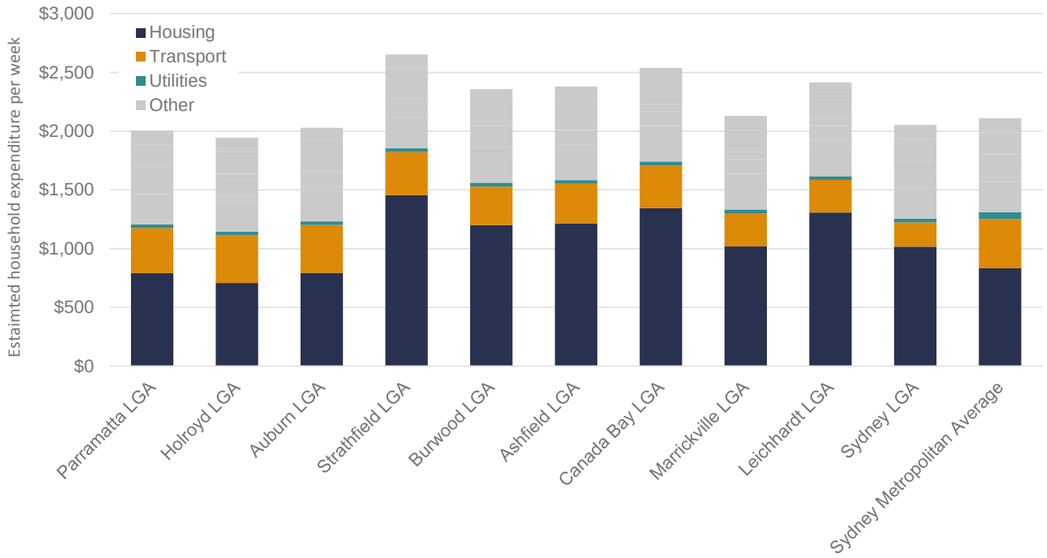


Figure 7: Estimated household expenditure highlighting housing, transport and utility costs compared to other expenses.

NOTES:

- Housing costs are based on the median house and unit sales price of the last 12 months, assuming 5% deposit, 30 year loan, 5% interest rate.
- Transport costs are based on existing car ownership and travel patterns (car use and public transport use).
- Other refers to all other household expenditure including food, clothing, household items, medical and recreation. This is assumed to be the same across all areas (based on ABS Household Expenditure Survey).

LAND SURFACE TEMPERATURE AT C2E

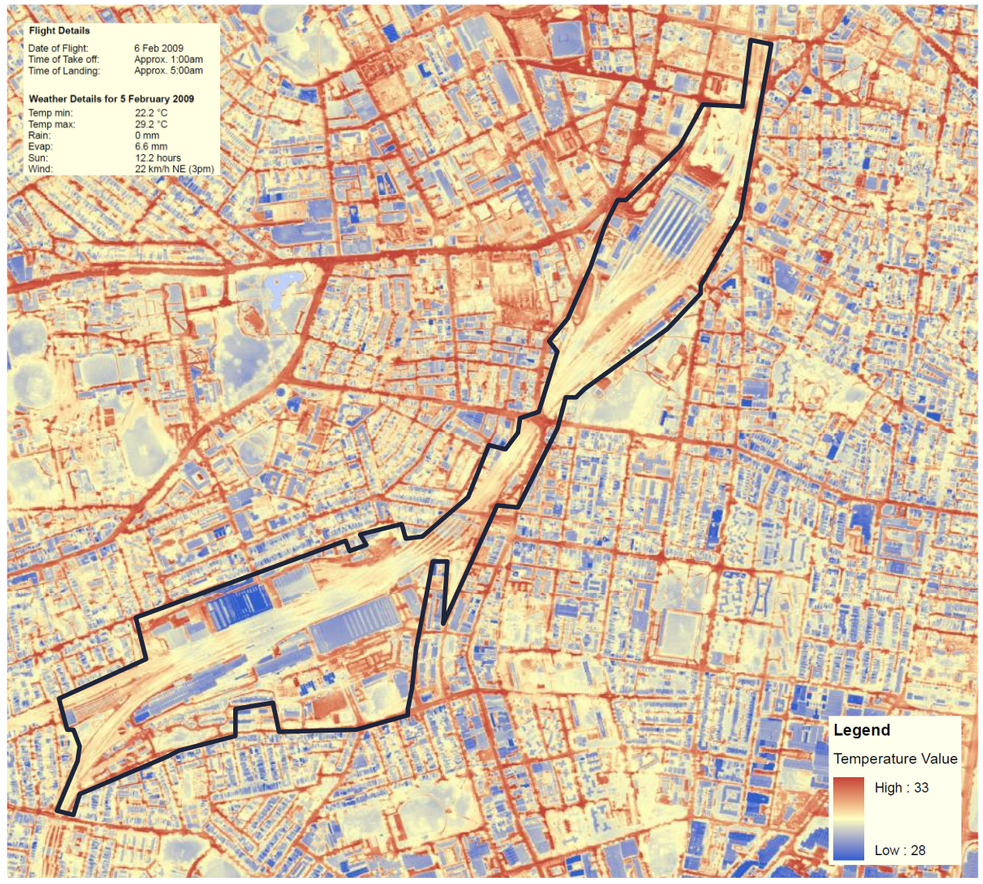


Figure 8: Land surface temperature from thermal imagery taken on day with max temp 29.2 ^{O}C

ESTABLISHING MEASURES OF SUCCESS

The Framework Plan identifies ten key areas of consideration which emerged from early engagement key stakeholders and the community. These areas are summarised around 10 key themes of:

1. Urban design
2. Land use
3. Housing diversity
4. Transport and Connectivity
5. Built form
6. Green infrastructure and place making
7. Culture, arts and heritage
8. Social facilities and services
9. Industry and employment
10. Urban resilience

In addition, the Framework Plan outlines four themes to guide the transformation of C2E:

1. **Living** – a place with broad supply and choice of homes and active and attractive place to support social diversity and community connections.

2. **Community –**a place that celebrates our rich diversity and heritage and gives everyone easy access to community and cultural facilities.

3. **Working** – a dynamic and population place to work – a place that connects many types of businesses and offers the right balance and diversity of service, trade, digital, education, innovation and creative industries.

4. **Resilience** – a place that responds to economic, social and climatic changes in ways that benefit our quality of life and the quality of our environment – a place that harnesses new opportunities to enrich the community.

PRECINX is used as a basis from which UrbanGrowth NSW can measure key components of the C2E Framework Plan and identify whether or not C2E is delivering on these themes (Figure 9). Drawing on this, four criteria and associated measures of success were determined for analysis and measurement through PRECINX, these are:

1. **Accessible and Connected** (measured through car use, walkability and public transport access, highlighting the population's access to employment and services).

2. **Environmentally Sustainable and Responsive** (measured through greenhouse gas emissions, energy consumption and water use).

3. **Affordable Housing and Living** (measured by taking a holistic view of both the cost of housing and cost of living associated with transport and utilities costs).

4. **Resilient Community** (measured through household cost of living which reflects an individual's adaptive capacity, urban heat island which can be minimised to reduce heat waves and climatic changes, and infrastructure delivery to ensure resilience to changing climates).

Analysis and results of these four criteria and associated measurables are documented in this report.

C2E MEASURES OF SUCCESS

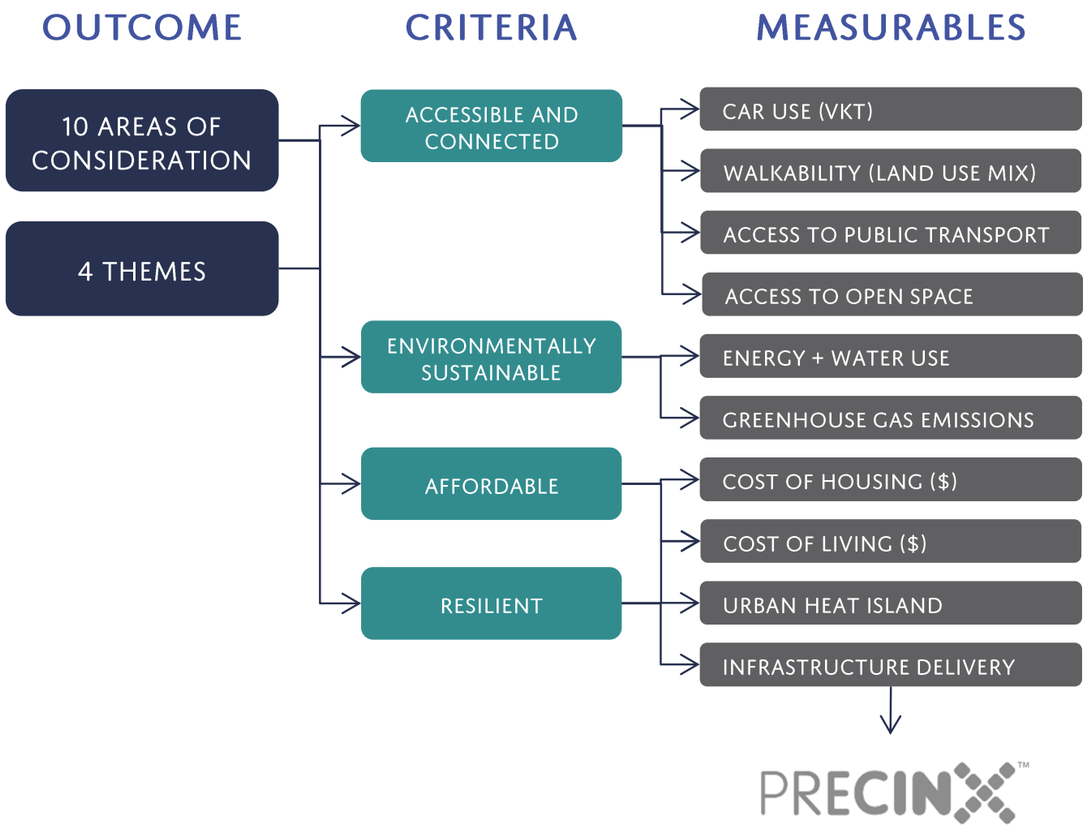


Figure 9: Established measures of success for C2E based on key elements of the Framework Plan.

DEVELOPMENT SCENARIO FOR C2E

Scenario analysis was undertaken using PRECINX, a strategic infrastructure and urban design tool, used in the analysis of key performance metrics of precincts, integrating land use and development inputs with demographic, utility, transport and affordability models.

The land use and development scenario was developed and provided by ARUP and Grimshaw Architects[2]. This information was provided on a block by block basis and grouped into 7 precincts (see Table 1 and Figure 10). This land use and development information included the following:

- Lot area
- Non-residential floor space
- Residential floor space and dwelling count
- Building height and storeys

In order to better understand the outcomes of the proposed C2E development scenario, the following additional information was estimated by Kinesis and the urban design consultant team. These assumptions are documented below for each scenario. Please note that these were incorporated for modelling purposes and will not have a significant impact on the strategies or results outlined in this report. Using this information, the two scenarios were modelled in PRECINX:

C2E Base Case Scenario

- Estimated dwelling and floor space as provided by ARUP and Grimshaw Architects.
- Non-Residential floor space mix of 20% retail, 80% commercial
- Assumed dwelling mix of 10% 3-bedroom, 45% 2-bedroom, 30% 1-bedroom and 15% studios.
- Parking rates based on City of Sydney LEP 2012 and existing land category A, B and C.
- All new development was modelled to meet BASIX and Section J building compliance.

C2E Optimised Scenario

- Estimated dwelling and floor space as provided by ARUP and Grimshaw Architects.
- Non-Residential floor space mix of 20% retail, 80% commercial
- Assumed dwelling mix of 10% 3-bedroom, 45% 2-bedroom, 30% 1-bedroom and 15% studios.
- Parking rates aligned to the City of Sydney LEP 2012 for the most accessible sites (Category A land).
- Development, infrastructure and public domain is optimised with recommended strategies. The details of these strategies are outlined in the following section, and include:
  - Building level energy and water efficiency
  - Building level renewable and low carbon energy supply
  - Precinct scale recycled water supply
  - Reduced parking supply and car share

Modelling was analysed for each of the 7 precincts but is reported for the C2E Corridor as a whole.

[2] Land use and development figures were provided to Kinesis on 20 May 2015 and were current at the time of this report. Includes development potential over rail corridor. These figures are subject to change as detailed precinct planning continues.

C2E CORRIDOR AND PRECINCTS

	Lot Area (m2)	Non-Residential GFA (m2)	Residential GFA (m2)	Dwelling Number
To C2E Corridor*	**199,965**	**504,898**	**812,228**	**10,685**

Table 1: Land use and development details for C2E (source: ARUP and Grimshaw Architects).
***Note –** figures were provided to Kinesis on 20 May, 2015 are were current at the time of this report. Includes development potential over rail corridor. These figures are subject to change as detailed precinct planning continues.

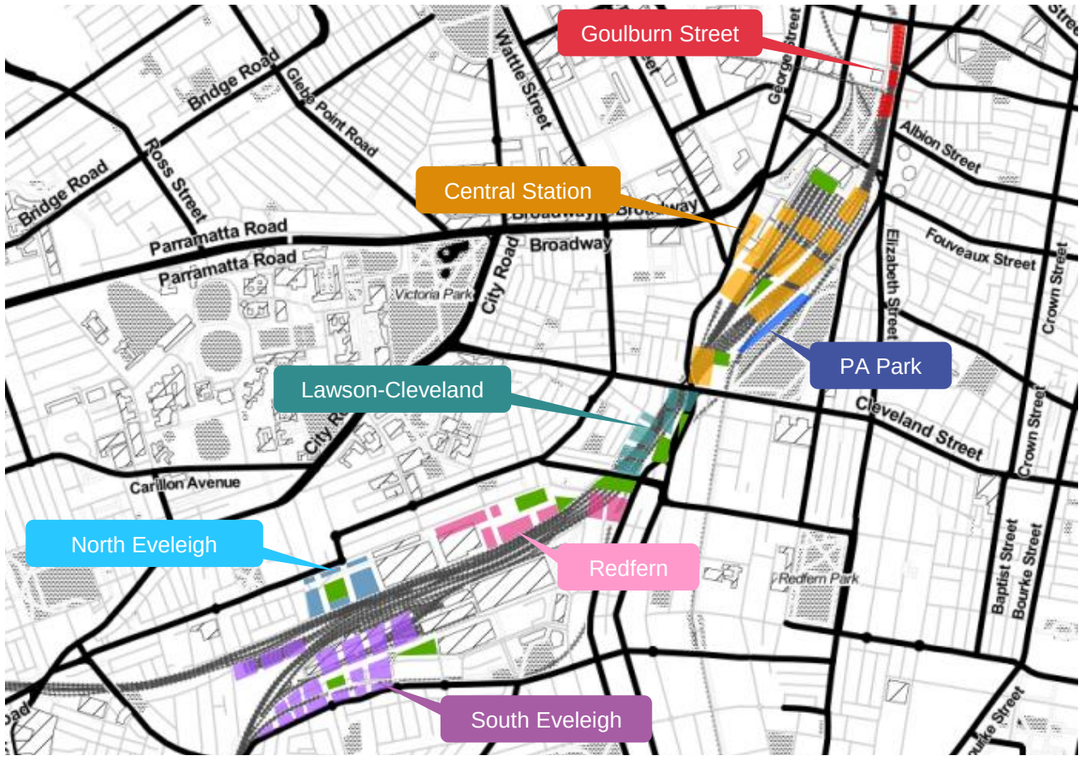


Figure 10: C2E Corridor and Precinct locations (open space areas shown in green)

INTERVENTIONS FOR WORLD CLASS URBAN RENEWAL

There are a number of emerging trends that need to be considered and transferred to the thinking, design, development and infrastructure briefs to ensure world class urban regeneration at C2E. These trends are based on the best available data and respond to changing preferences around the urbanity, affordability, equity and resilience of cities.

While C2E is in the early stages of planning, it is critical that key interventions are identified and documented to ensure they are incorporated through the next phases of planning and design.

C2E was modelled under a Base Case Scenario which assumes compliance with current planning and development controls. A suite of strategies were explored in order to identify key interventions that deliver on the four themes and measures of success for C2E. The details of the strategies identified and analysed under each scenario. Key interventions are discussed below.

KEY C2E INTERVENTIONS EXPLORED

Scenario	Energy	Water	Transport
C2E Base Case	• BASIX Compliance • Section J Compliance	• BASIX Compliance • Section J Compliance	• City of Sydney LEP 2012 Parking Rates
C2E Optimised	• Improved thermal performance. • Improved A/C efficiency • Improved appliance efficiency. • Renewable Energy (building scale Solar PV). • Cogeneration (Mini CHP for hot water).	• Improved fixture and appliance efficiency. • Recycled water for internal and external uses coupled with significant public and building level green infrastructure.	• Reduced parking rates from 0.55 per dwelling (average based on LEP 2012) to 0.25 per dwelling. • Car share provision (approx. 20% take-up).

Table 2: Key interventions explored by Kinesis for C2E to deliver on the measures of success.

C2E KEY INVERVENTIONS

In order to optimise the significant benefits afforded by C2E, three key "thematics" have been identified to further support and enhance the C2E Framework Plan.

1. DESIGNING FOR 21ST CENTURY MOBILITY + SHARED URBAN EXPERIENCE

There is a mobility revolution occurring globally that is fuelled by technological change, collaborative consumption and a fresh approach to how we engage in the workplace. Already we can see within the C2E corridor local evidence of these trends:

- The average City of Sydney household owns, on average, less than 1 vehicle.
- Across the Sydney Metropolitan Area, 1 in 4 people aged 18 to 35 do not have a license or own a car.
- Currently, approximately 8% of City of Sydney residents are car share members. This is as high as 20% in high density, highly accessible locations such as Darlinghurst and Surry Hills.
- Across the City of Sydney LGA, bike trips increased 113% between 2011 and 2013.
- Almost one in five City of Sydney residents (19 per cent) ride a bike each week.

If you add to this the disruption posed by the emergence of the of the autonomous vehicle within the development timeframe of C2E, it is clear that our planning has to be agile and respond to a cities agenda that is unlike anything Sydney has ever faced before.

The thinking for C2E should not be limited to an anti-car agenda, but rather focus on mobility and accessibility. By designing for outcomes that deliver against the trends outlined above, we are likely to achieve a regeneration corridor that delivers urbanity which can be embraced by those that reside within and pass through C2E.

The key strategy to achieve these outcomes is delivered first by establishing low parking rates. Under the Base Case scenario modelled for this report (i.e. current planning controls), the City of Sydney LEP 2012 will deliver an average 0.55 parking spaces per dwelling or approximately 6,500 new local vehicles. The **Optimised C2E Scenario** we have modelled delivers approximately new 3,000 local cars, less than half of what is required under a BAU approach to urban regeneration.

It is suggested decoupled, adaptable and temporary car parking strategies could offset any risk associated with predicting the diminishing value of private parking provision within the corridor.

The immediate benefits of lowering parking rates are significant:

- Lower construction costs associated with excavation and construction of underground parking.
- Lower housing costs - reducing parking by 1 space could equate to approximately $100,000 off the sales price of a new apartment.
- Improved street level public domain outcomes
- Lower compliance costs with BASIX Energy Targets
- Lower energy costs and associated strata fees.

Components of these outcomes for C2E are shown in Figure 11.

KEY OUTCOMES ACHIEVED

- **Accessible and Connected**
- **Environmentally Sustainable and Responsive**
- **Affordable Living**
- **Resilient Community**

RECOMMENDATION - Low and alternative car ownership and parking models are recommended to ensure C2E is designed to meet affordability, mode split, car ownership and private car share investment criteria.

A note on the Proposed Waterloo SRT Station

The proposed Waterloo SRT Station is an additional catalyst to design for and achieve the accessibility and mobility outcomes outlined above. With the proposed Waterloo SRT Station, public transport accessibility is increased by over 40% within the 10 minute walk catchment of the station, further providing accessibility outcomes that can deliver low parking, car ownership and affordability outcomes.

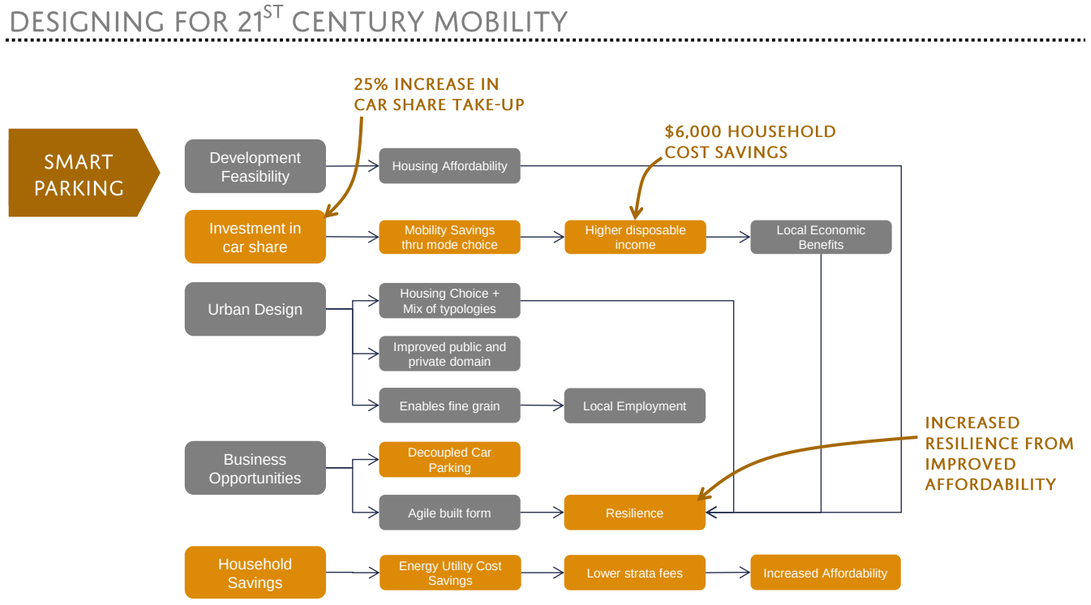


Figure 11: The quantified benefits of smart parking strategies for C2E.

2. ENHANCE URBAN RESILIENCE THROUGH INTEGRATED RECYCLED WATER

While water reuse has traditionally been considered as a water conservation objective, recycled water from black and grey wastewater provides the opportunity to flip this goal on its head. In addition, urban renewal should seek to deliver a resilient and cool urban environment and public domain – an urban oasis that is cooler, more comfortable and more walkable on hot summer days.

Climate projections from CSIRO and the Bureau of Meteorology (BOM) highlight the need to build climate resilience into sustainable communities. For the Sydney climate zone, these projections estimate:

- Average temperatures will continue to increase in all seasons (very high confidence).
- More hot days and warm spells are projected with very high confidence.
- Fewer frosts are projected with high confidence.
- Decreases in winter rainfall are projected with medium confidence.
- Increased intensity of extreme rainfall events is projected, with high confidence.
- A harsher fire-weather climate in the future (high confidence).
- On annual and decadal basis, natural variability in the climate system can act to either mask or enhance any long-term human induced trend, particularly in the next 20 years and for rainfall.

Increased open space, green infrastructure and networks provides the potential to improve resilience against a changing climate and, furthermore, the effects of urban heat island. When compared to an un-vegetated public domain, a well-managed, lush tree canopy can reduce land surface temperature by up to 15 degrees on a 35 degree day.

The Framework Plan outlines a series of green spaces, infrastructure and networks that will seek to deliver this. To deliver on this plan, **the Optimised C2E Scenario** proposed to link the inevitably higher irrigation demands from broad leaf canopy, soft surfaces and green walls and roofs to recycled water to ensure an unlimited supply of water for this public and private domain.

Further, linking recycled water systems to public domain management enables a liveable, walkable, urban oasis. This is evident at Central Park where the green wall is part of the recycled water system, allowing constant irrigation and high use of treated recycled water on-site (further reducing sewer infrastructure requirements).

Components of these outcomes for C2E are shown in Figure 12.

KEY OUTCOMES ACHIEVED

- **Environmentally Sustainable and Responsive**
- **Affordable Living**
- **Resilient Community**

RECOMMENDATION - Recycled water is enabled throughout the precinct and linked to public domain design and management to both mitigate local climate challenges and off-set potential urban heat island impacts.

ENHANCING URBAN RESILIENCE THROUGH RECYCLED WATER

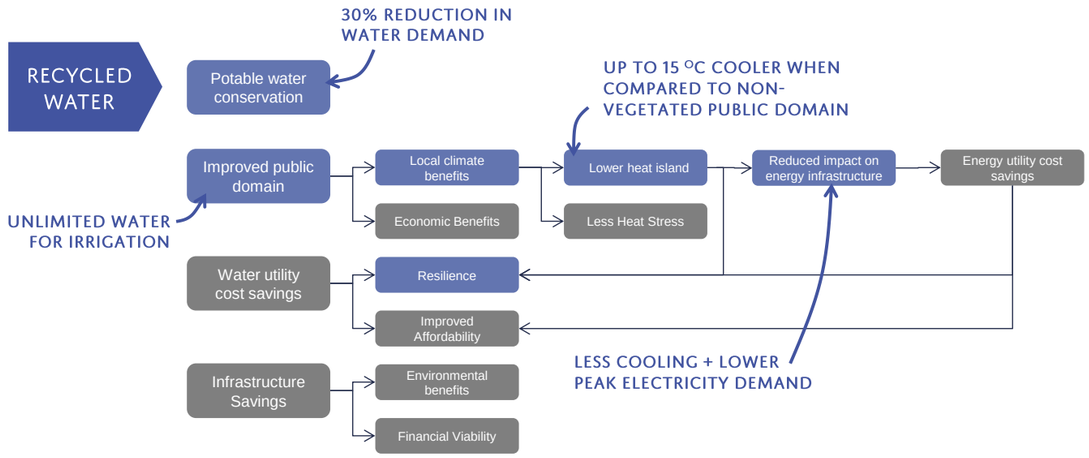


Figure 11: The quantified benefits of recycled water coupled with public domain management for C2E.

3. ENVIRONMENTAL OUTCOMES THROUGH HIGH PERFORMANCE BUILDINGS

The Base Case assumes current new building standards (BASIX, the Building Code of Australia compliance and City of Sydney LEP 2012 parking rates). However, coordinated urban renewal at C2E presents a unique opportunity to potentially optimise the performance of this new development.

Furthermore, trends in energy consumption show that new development is longer improving on existing housing stock. The current Sydney Metropolitan average greenhouse gas emissions from electricity and gas is equivalent to achieving a BASIX target of 20 (which is the target for high rise apartment development at C2E).

Based on a review of recent developments adjacent to C2E (such as Green Square and Central Park), **the Optimised Scenario** incorporates strategies to achieve BASIX Energy 45 (125% higher than current compliance) and BASIX Water 60 (50% higher than current compliance):

- Further reductions in parking rates (0.25 spaces per dwelling on average), off-set with car share.
- Efficient building design, fixtures and appliances
- Building level solar PV and combined heat and power (CHP) for residential hot water
- Precinct level recycled water for irrigation, toilet and laundry

KEY OUTCOMES ACHIEVED

- **Environmentally Sustainable and Responsive**
- **Affordable Living**

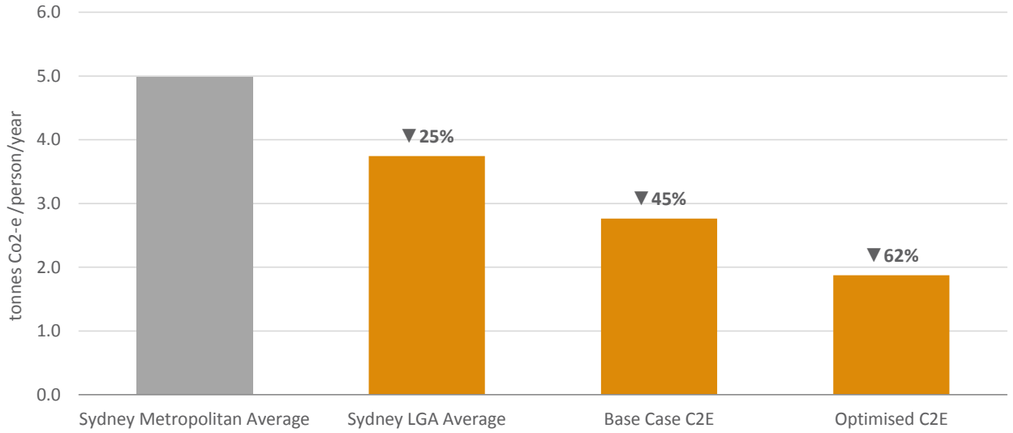
RECOMMENDATION - Higher environmental standards are established for all new development at C2E.

A Note on District Energy

PRECINX provides detailed analysis of district energy and Kinesis has investigated district energy at scale throughout the City of Sydney. In highly residential areas, district energy for heating and cooling is difficult to manage due to the intermittent and 'peaky' nature of residential air conditioning. As a result, the key interventions outlined for C2E does not rely on district energy. However, the energy strategies and performance outcomes can be delivered and achieved either at the building scale or through localised district infrastructure if feasible and appropriate for the development along the corridor. The incorporation of district energy should be included as part of the infrastructure delivery considerations for C2E.

DELIVERING A LOW CARBON PRECINCT

The accessibility and location of C2E provides significant low carbon outcomes through reduced car use and transport related greenhouse gas emissions. Combined with the building level strategies proposed above, C2E is expected to achieve:



In addition, the consideration of building materials through detailed building design could further reduce the carbon embodied in the materials used in the construction of development at C2E to achieve improved greenhouse gas emission results.

The performance results of these key opportunities are reported in **Performance Outcomes** below.

PERFORMANCE OUTCOMES

PRECINX is used as a basis from which UrbanGrowth NSW can measure key components of the C2E Framework Plan. Drawing on the areas of consideration and principles, four criteria and associated measures of success were determined for analysis and measurement through PRECINX:

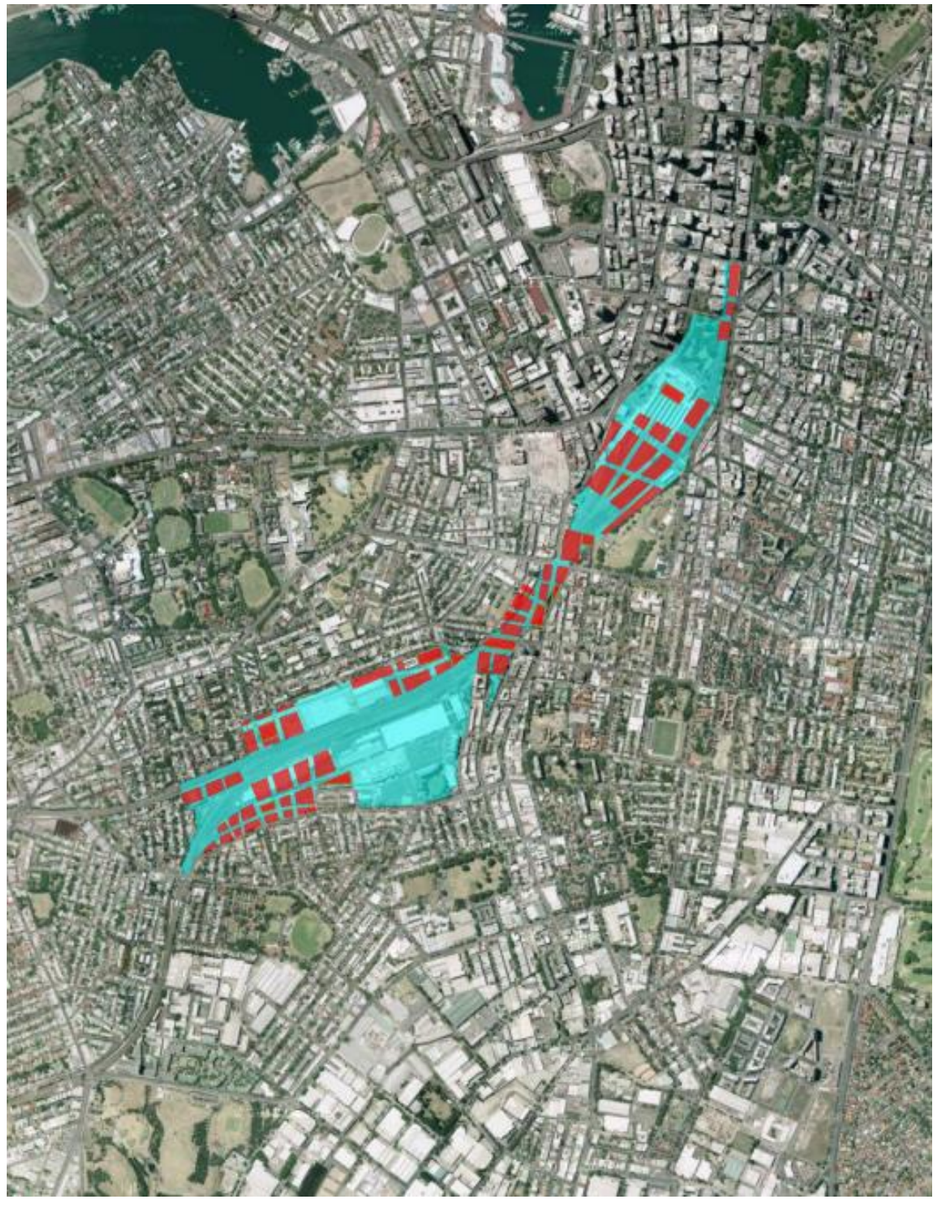
1. **Accessible + Connected** (measured through car use, walkability and public transport access)
2. **Environmentally Sustainable** (measured through energy and water use and greenhouse gas emissions)
3. **Affordable** (measured through household cost of housing and cost of living)
4. **Resilient** (measured through household cost of living, urban heat island and infrastructure delivery)

A summary of these results for both Base Case and Optimised scenarios are document in Table 2 and discussed further below.

MEASURES OF SUCCESS

Estimated results of the Base and Optimised Scenario	Sydney Metro Average	Sydney LGA Average	Base Case C2E	Optimised C2E
Accessible + Connected				
Car Use (km per person/day)	20.0	7.4	1.8	0.8
Average car ownership rate	1.6	0.8	0.6	0.3
Car share take-up (%)	1%	8%	19%	23%
Access to public transport (average walk, wait time – mins)	n/a	n/a	9 mins	9 mins
Access to open space	n/a	n/a	400m / 5mins	400m / 5mins
Environmentally Sustainable				
Water Consumption (kL per person/year)	87	81	53	31
Stationary GHG Emissions (tonnes CO2-e per person/year)	2.6	2.9	2.5	1.8
Affordable + Urban Resilience				
Household Costs ($ per household per year)	$14,850	$10,800	$8,230	$5,030
Peak electricity demand	n/a	n/a	48	31
Peak sewer loads	n/a	n/a	447	357

Table 2: Performance results for key measures of success for C2E



ACCESSIBLE + CONNECTED

Base Case C2E

- Under the Base Case, development at C2E is expected to deliver accessible housing with per person car use estimated to be over 90% lower than the Sydney Metropolitan average, at less than 2 km per person per day (see Figure 13).

- This low car use is achieved due to the following characteristics of C2E:

    - Access to public transport
    - Access to open space
    - Access to local employment and the Sydney CBD
    - Access to local amenity and services
    - Low car ownership rates (on average approximately 0.6 vehicles per household) when compared to the Sydney Metropolitan Average (on average approximately 1.6 vehicles per household) – see Figure 14.

Optimising C2E

- City of Sydney LEP 2012 delivers low parking rates under the Base Case of approximately 0.55 spaces per dwelling on average. Kinesis explored further lowering these parking rates with the aim of designing C2E for 21st Century mobility, incorporating low car ownership, high car share, decoupled parking and the emergence of the autonomous vehicle.

- Under the Optimised scenario parking rates were reduced by over 50% from (on average) 0.55 spaces per dwelling to 0.25 spaces per dwelling. Under this scenario, Optimised C2E is expected to further reduce car use by 60% when compared to the Base Case to less than 1 km per person per day (see Figure 13).

- This strategy is coupled with car share as an alternative to private car ownership. The reduction in parking provides a business case for private capital investment in the provision of car share. Under the Optimised scenario, expected car share take-up rates are expected to increase by 25% compared to the Base Case and 300% compared to the current Sydney LGA membership rates (see Figure 15).

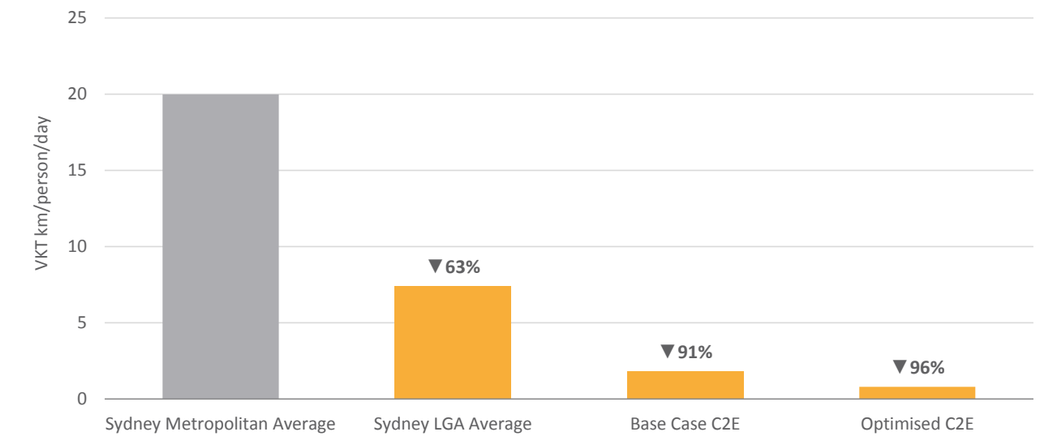


Figure 13: Estimated per person car use under the Base Case and Optimised scenarios

*Note: Percent reductions are shown as a reduction against the Metropolitan Average

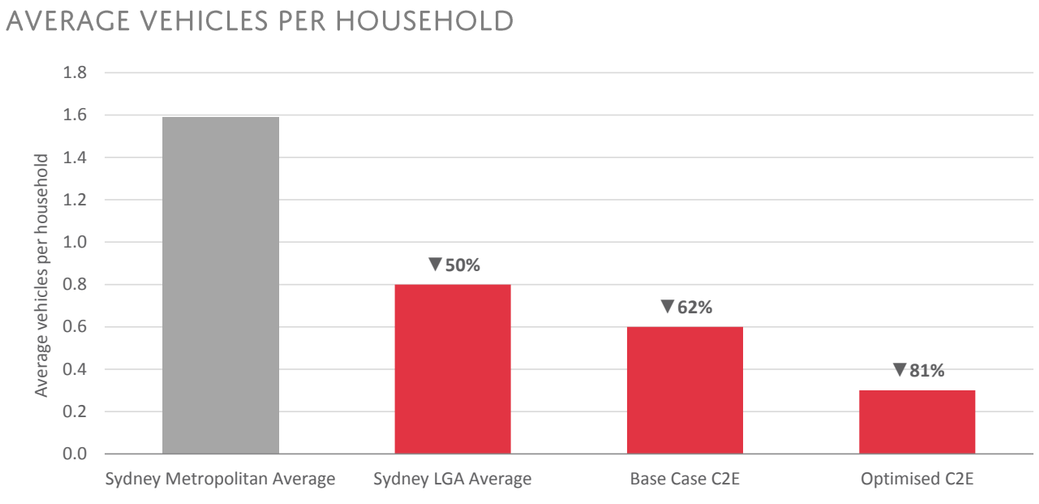


Figure 14: Estimated vehicle ownership under the Base Case and Optimised scenarios

*Note: Percent reductions are shown as a reduction against the Metropolitan Average

ENVIRONMENTALLY SUSTAINABLE

Base Case C2E

- High density development provides a significant opportunity for low energy use buildings. However, poor management of common area energy demands associated with underground parking, lighting and ventilation can have a significant impact on energy use, energy costs and strata fees.

- Under the Base Case, despite BASIX compliance, per person building energy related greenhouse gas emissions are similar to the current Sydney Metropolitan average. This is due primarily to the low BASIX requirements for high rise development (BASIX Energy 20) and general reductions in energy use across the Sydney Metropolitan area. However, when combined with transport emissions, C2E's per person emissions are expected to be 45% lower than the Sydney Metropolitan Average (Figure 16).

- Under the Base Case, per person water consumption is expected to be 39% lower than the Sydney Metropolitan average. Lower water consumption is due to lower irrigation demands associated with apartment development and BASIX requirements for new dwellings.

Optimised C2E

- Kinesis explored a range of strategies to improve the performance of both dwelling design and infrastructure delivery to achieve higher environmental performance and lower household operating costs. Strategies proposed are based on best practice examples in sites adjacent to C2E, including Central Park and Green Square Town Centre, and include:

    - High building efficiency
    - Solar PV
    - Cogeneration for hot water supply
    - District level recycled water for internal and external uses

- When compared to the Sydney Metropolitan average, the Optimised scenario can achieve a 62% reduction in per person greenhouse gas emissions (from energy use and transport emissions) and a 64% reduction in water consumption (see Figures 16 and 17).

- These energy and water results are approximately equivalent to the following BASIX targets:

    - BASIX Energy 45 (125% improvement on current requirements)
    - BASIX Water 60 (50% improvement on current requirements)

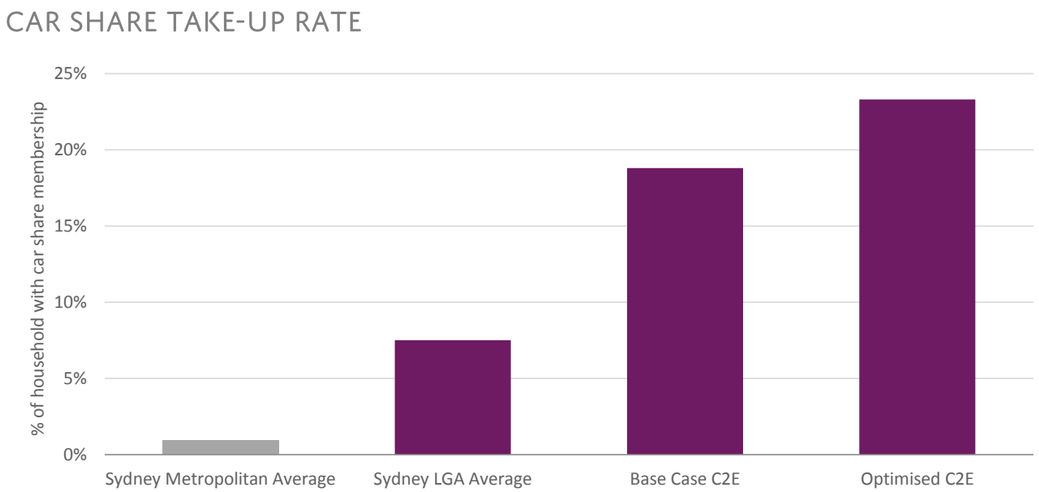


Figure 15: Estimated car share take-up rate under the Base Case and Optimised scenarios

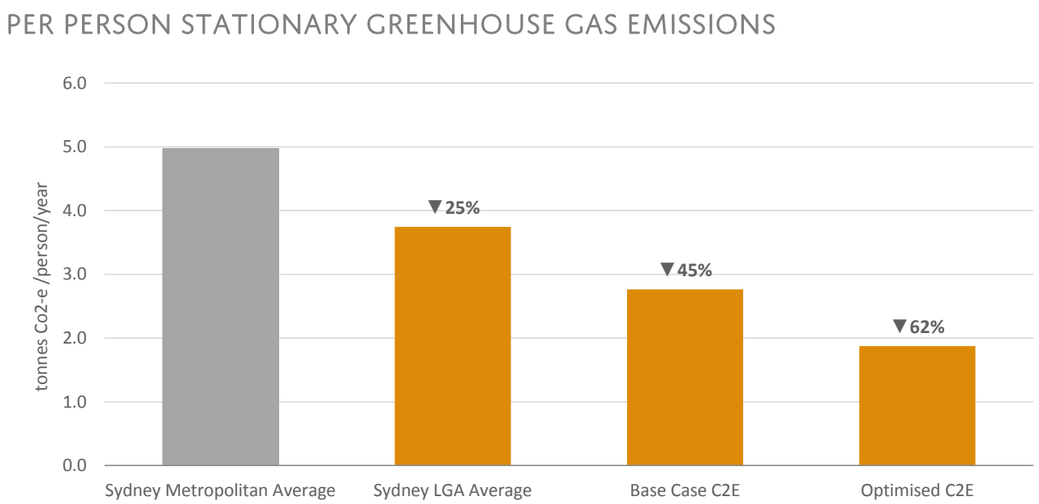


Figure 16: Estimated stationary emissions under the Base Case and Optimised scenarios

*Note: Percent reductions are shown as a reduction against the Metropolitan Average

AFFORDABLE HOUSING FOR MODERATE INCOME HOUSEHOLDS

- **Affordable housing** is housing that is appropriate for the needs of a range of very low to moderate income households and priced so that these households are also able to meet other basic living costs such as food, clothing, transport, medical care and education. Housing is usually considered "affordable" if it costs less than 30 percent of gross household income. While this figure provides a useful benchmark of housing affordability, the definition of affordability varies according to a household's individual circumstances. Demands on the same gross income may differ significantly.

- UrbanGrowth NSW's objective is to improve the supply of housing for moderate-income households. **Moderate-income housing** is defined as housing that is made available for sale at a price affordable to households on moderate incomes. Moderate income is defined as between 80% and 120% of the combined per annum median income.

- Based on current median household income for the C2E local housing submarket (ABS Census 2011 projected to 2015) the **Moderate Income Housing price point for C2E is approximately $585,000**. This figure represents the affordable price point of the median household income and is based on:

  - Gross median weekly household income of $1,900
  - 5% deposit, 30 year loan and 5% interest rate

- Recent sales data (Dec 2013 to Nov 2014) of apartments within the local housing submarket was analysed to understand sales price points for apartments in and around the C2E corridor. In addition, information provided by UrbanGrowth NSW and developed by Colliers analysed the expected sales price points for new dwellings at C2E. Both data sets were compared to the Moderate Income Housing price point (see Figure 18).

- Based on this analysis, approximately 7% of dwellings in C2E are expected to meet the affordable housing price point for moderate income households (Figure 18).

- Due to the prime location of C2E, housing costs are expected to be significantly higher than other parts of Sydney and the delivery of affordable housing would require market intervention. However, if total cost of living are taken into account, the cost of transport can partly off-set the higher cost of housing (see Total Affordability below).

- In addition, the sales price figures are based on an average parking rate of 0.55 spaces per dwelling (C2E Base Case). Optimised C2E reduces this to 0.25 spaces per dwelling, potentially reducing housing costs for a proportion of the dwellings at C2E.

- Finally, alternative housing supply models can be employed to assist in the delivery of MIH, such as value capture and floor space bonus provisions in exchange for the delivery of moderate-income housing.

PER PERSON WATER CONSUMPTION

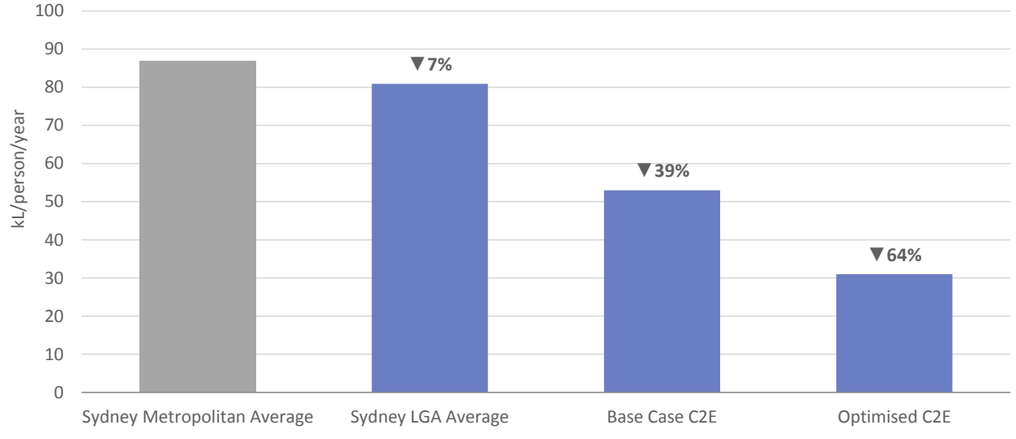


Figure 17: Estimated per person water use under the Base Case and Optimised scenarios
*Note: Percent reductions are shown as a reduction against the Metropolitan Average

RECENT SALES, EXPECTED C2E SALES AND MIH PRICE POINT

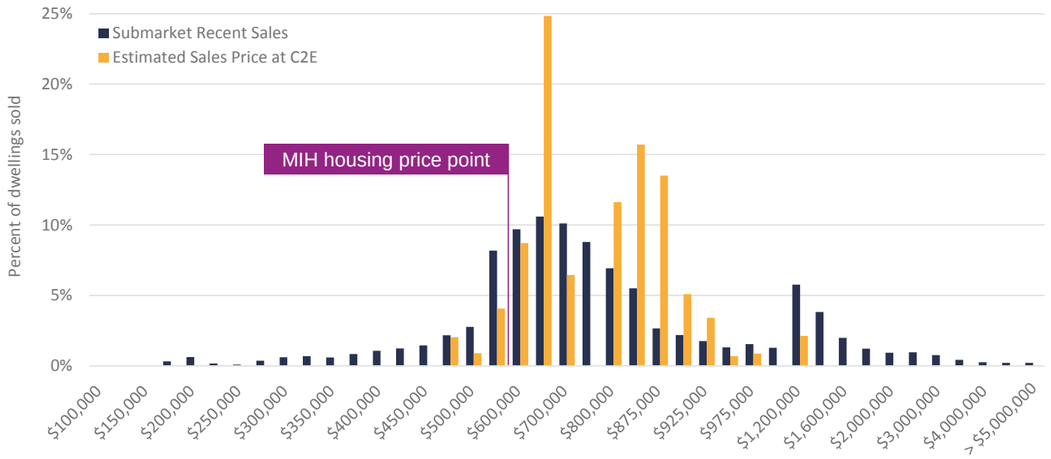


Figure 18: Apartment sales within C2E housing submarket (Dec 2013 to Nov 2014) compared to expected sales prices for new apartments at C2E. The Moderate Income Housing price point for the C2E housing submarket is also shown. (Sources: ABS Census household income, APM Research and Colliers International)

AFFORDABLE LIVING

Base Case

- Under the Base Case, development at C2E is expected to deliver housing with significantly lower cost of living expenses associated with transport, energy and water, equivalent to approximately $6,500 a year in household savings when compared to the Sydney Metropolitan average (Figure 19).
- Household cost savings under the Base Case are primarily driven by the expected lower car use and vehicle ownership characteristics of C2E.

Optimising Urban Renewal

- Lower car ownership, car share, improved energy and water efficiency and smart precinct infrastructure delivery proposed under the Optimised scenario, is expected to deliver an additional $3,000 per household per year.

Total Affordability

- In terms of a total affordability, under the Base Case C2E, the average household at C2E could be expected to spend approximately $53,000 on total housing, transport and utility costs, of which $45,000 would be on housing costs and $8,000 on transport and utility costs. This equates to a 13% reduction in total weekly household expenditure when compared to the Sydney Metropolitan Average (see Figure 20).
- The Optimised scenario is expected to reduce housing, transport and utility costs further, equating to a 18% reduction in total weekly household expenditure when compared to the Sydney Metropolitan Average (see Figure 20).

URBAN RESILIENCE

Resilience can be defined as an individual or urban system's ability to adapt and respond to changing environments over time. For C2E, urban resilience analysis has focused on addressing:

- Changes in energy prices and economic systems
- Changes in local climate and associated urban heat island
- Changes in household expenditure requirements

Studies have identified a strong link between household income, expenditure and resilience or adaptive capacity. In effect, higher income households have a higher ability adapt to increasing energy price increases, increased heat waves and higher insurance premiums expected under future climate changes scenarios. The affordability outcomes achieved at C2E provide a key resilience and adaptive capacity outcomes for residents.

Increased open space, green infrastructure and networks provides the potential to improve resilience against a changing climate and, furthermore, the effects of urban heat island. When compared to an un-vegetated public domain, a well-managed, lush tree canopy can reduce land surface temperature by up to 15 degrees on a 35 degree day.

COST OF LIVING

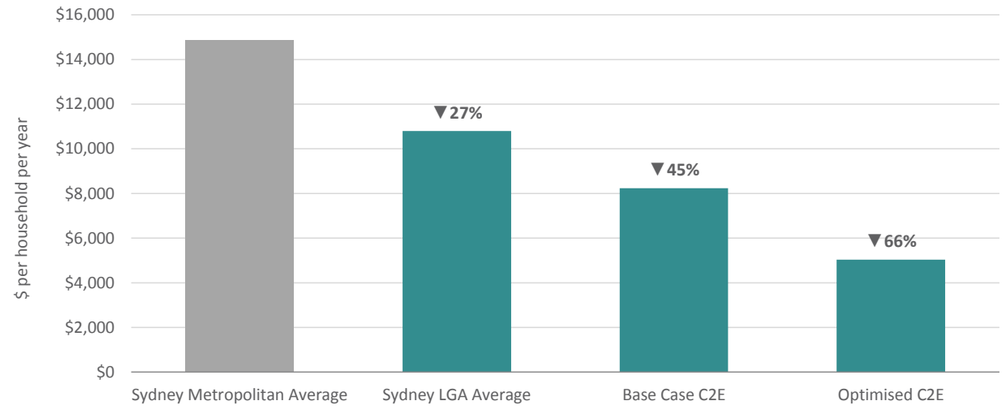


Figure 19: Estimated household expenses for transport and utilities under the Base Case and Optimised scenarios

*Note: Percent reductions are shown as a reduction against the Metropolitan Average

TOTAL ESTIMATED AVERAGE HOUSEHOLD EXPENDITURE

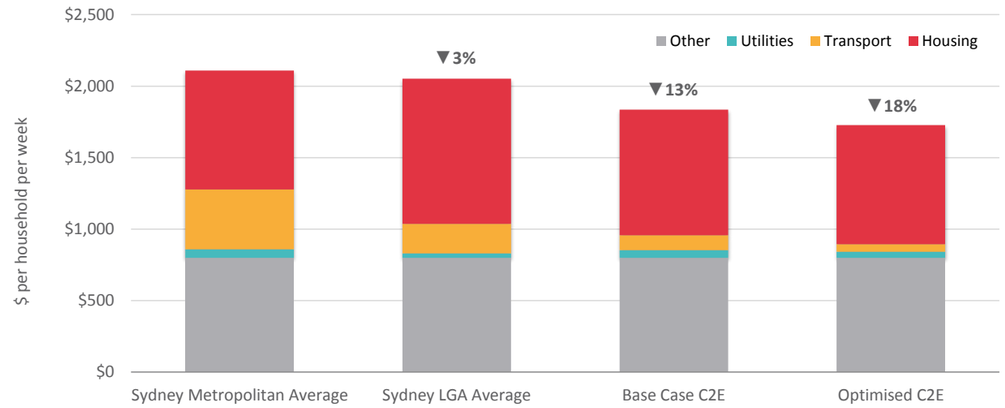


Figure 20: Estimated weekly total household expenses

NOTES:

- Percent reductions are shown as a reduction against the Metropolitan Average
- Housing costs are based on the median house and unit sales price of the last 12 months, assuming 5% deposit, 30 year loan, 5% interest rate.
- Transport costs are based on existing car ownership and travel patterns (car use and public transport use).
- Other refers to all other household expenditure including food, clothing, household items, medical and recreation. As not analysis was undertaken on this area, this cost is assumed to be the same across all areas (based on ABS Household Expenditure Survey).
- Comparisons can be made with Figure 7 of this report.

KEY ASSUMPTIONS

Metropolitan Sydney average benchmarks

Electricity	2,132 kWh per person/year
Gas	3,888 MJ per person/year
Water	237.8 L per person/day
Transport	19.98 km per person/day

Tariffs and rates

Household cost savings outlined in this report are based on current tariffs outlined below:

Residential Water	**Rate**	**Unit**
Mains tariff	2.232	$/kL
Recycled water tariff	2.068	$/kL
Service charge per dwelling	765	$/yr
Recycled water service charge	0	$/yr

Residential Grid Electricity	**Rate**	**Unit**
Applied tariff	0.2514	$/kWh
Solar feed-in tariff	0.06	$/kWh
Service charge per dwelling	289.16	$/yr

Residential Gas	**Rate**	**Unit**
Gas (first 3,775 MJ per qtr/remaining)	0.040964/0.023452	$/MJ
Service charge per dwelling	207	$/yr

Residential Transport	**Rate**	**Unit**
Fuel	1.50	$/L
Annual capital costs (devaluation)	6,642	$/yr
Annual registration/insurance	2,172	$/yr

KEY DATA SOURCES

- ACADS-BSG Australian Climatic Data (Reference Meteorological Year, RMY) for hourly temperature, insulation and humidity.
- Bureau of Meteorology local rainfall and evaporation data
  - Data is from the representative weather station for the local climate zone
  - The RMY (Representative Meteorological Year) is synthesized from a composite of 12 typical meteorological months that best represent the historic average of the specified location using post-1986 data in addition to the earlier weather data for each of the 69 climate zones in Australia.
- Sydney Water (2009) Rouse Hill 15 minute and daily demand profiles (Kinesis request, unpublished)
- Department of Resources, Energy and Tourism, 2010, Energy in Australia – 2010, ABARE, Canberra
- Kinesis 2014, Additional water end use breakdowns derived from first principle analysis of residential and non-residential building types.
- National Water Commission, 2011, National performance report 2009-2010: urban water utilities, National Water Commission, Canberra
- NSW Department of Planning, BASIX Residential Water Consumption Data (2010)
- Sydney Water Best Practice Guidelines for water conservation in commercial office buildings and shopping centres (2007), http://www.sydneywater.com.au/web/groups/publicwebcontent/documents/document/zgrf/mdu0/~edisp/dd_054580.pdf
- Sydney Water Best Practice Guidelines for holistic open space turf management (2011), www.sydneywater.com.au/web/groups/publicwebcontent/documents/document/zgrf/mdq1/~edisp/dd_045253.pdf
- Water Corporation. (2014). Mapping water use at school. from https://www.watercorporation.com.au/home/teachers/lesson-plans-and-teaching-resources/lesson-plan-search/lesson-plan/?id=%7BD9516524-4A2C-4B98-A113-3891D59F1AAA%7D
- Department of Resources, Energy and Tourism, 2010, Energy in Australia – 2010, ABARE, Canberra
- Department of Infrastructure and Transport, 2011, Road vehicle kilometres travelled: estimations from state and territory fuel sales, Australian Government, Canberra
- Department of the Environment, 2014, National Greenhouse Accounts Factors, http://www.environment.gov.au/system/files/resources/b24f8db4-e55a-4deb-a0b3-32cf763a5dab/files/national-greenhouse-accounts-factors-2014.pdf
- Energy Use in the Australian Residential Sector, 1986 – 2020, Australian Government Department of the Environment, Water, Heritage and the Arts (DEHWA), 2008.
- Energy Efficient Strategies (2009), Appliance Energy Consumption in Australia: Equations for Appliance Star Ratings
- Building Code of Australia (2007) Energy Efficiency Requirements in Commercial Buildings
- Transport Data Centre (2006) The Development of a Sydney VKT Regression Model
- ABS (2010) 'Household Expenditure Survey, Australia: Summary of Results', catalogue number 65300DO001_200910, Australian Bureau of Statistics, Canberra.