



Presentation to Smart Future Cities Conference

Stephen Bygrave
CEO, Beyond Zero Emissions



beyond
ZERO
emissions

The ZCA Project



Australian
National
University



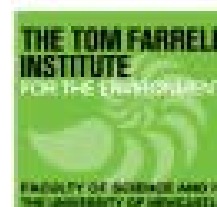
UNSW
AUSTRALIA



INSTITUTE OF
ENVIRONMENTAL
STUDIES



MELBOURNE SUSTAINABLE
SOCIETY INSTITUTE



The ZCA Project



1. Energy

2. Buildings

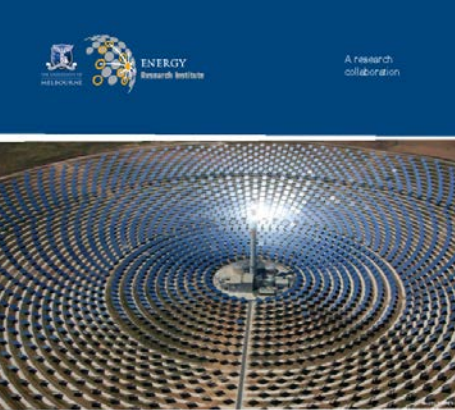
3. Transport

4. Land Use

5. Industrial processes

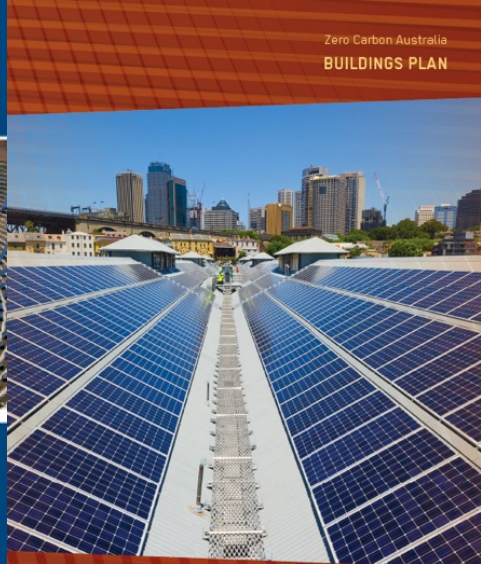
6. Renewable energy superpower



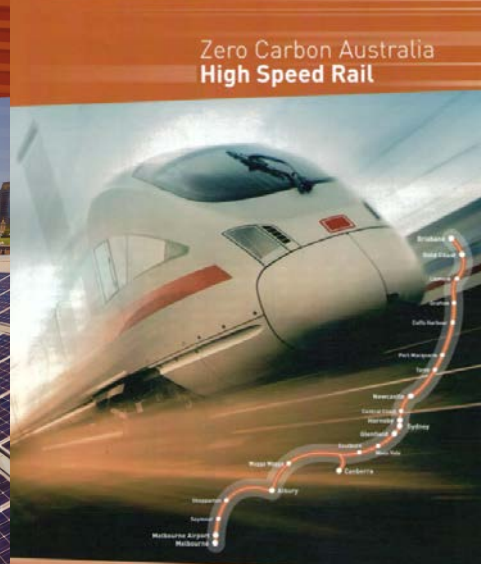


Australian Sustainable Energy Zero Carbon Australia Stationary Energy Plan

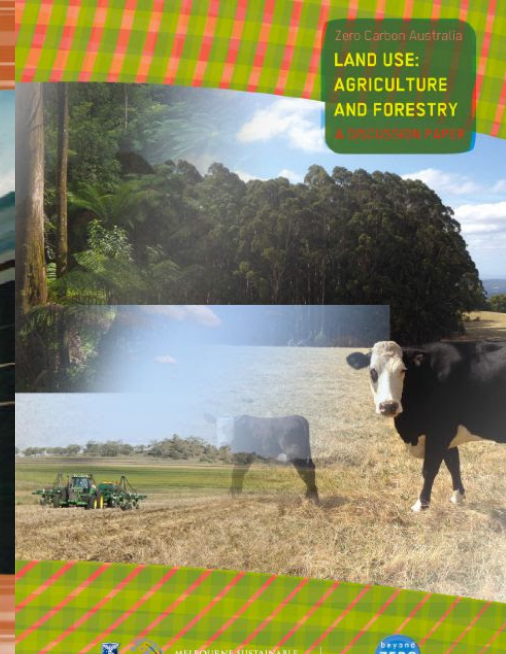
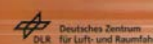
- > A ten year roadmap for 100% renewable energy
- > Baseload energy supplied by renewable sources
- > Affordable at \$5 per household per week



Zero Carbon Australia BUILDINGS PLAN



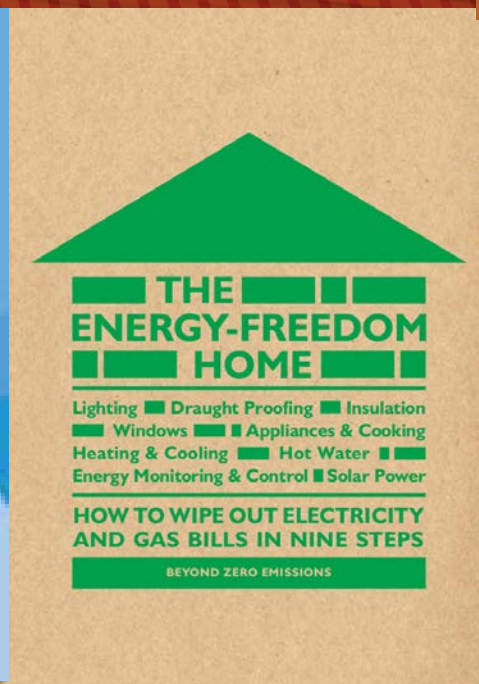
Zero Carbon Australia High Speed Rail



Zero Carbon Australia LAND USE: AGRICULTURE AND FORESTRY & DISCUSSION PAPER



Fossil economy



THE ENERGY-FREEDOM HOME

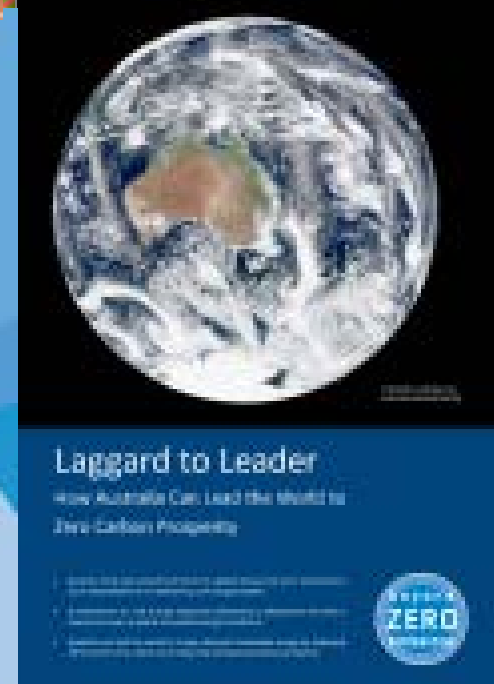
Lighting ■ Draught Proofing ■ Insulation
■ Windows ■ Appliances & Cooking
Heating & Cooling ■ Hot Water ■
Energy Monitoring & Control ■ Solar Power

HOW TO WIPE OUT ELECTRICITY
AND GAS BILLS IN NINE STEPS

BEYOND ZERO EMISSIONS



Carbon crisis Systemic risks to our carbon emissions reductions



Laggard to Leader

How Australia Can Lead the World to
Zero Carbon Prosperity

- Australia's leadership in the global energy transition
- Australia's leadership in the global energy transition
- Australia's leadership in the global energy transition

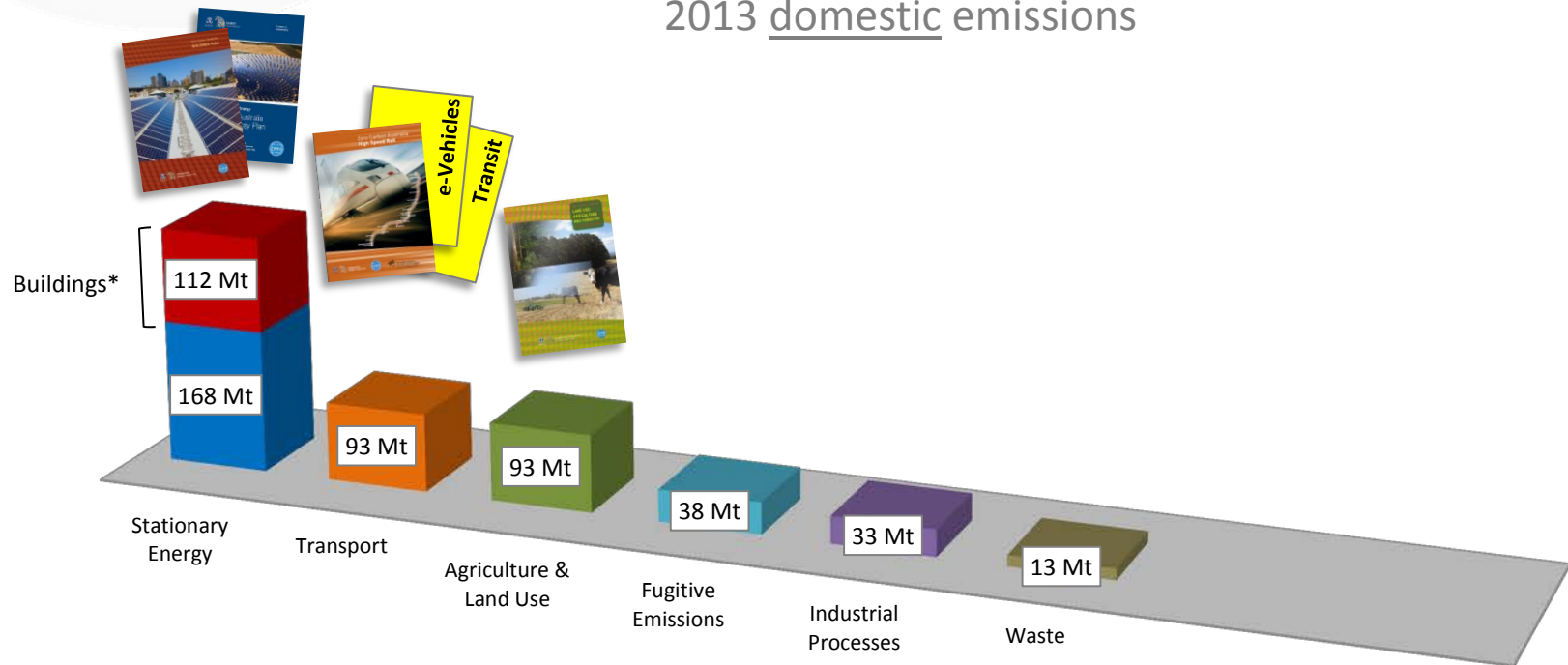


beyond
ZERO
emissions

Australian GHG footprint

549 Mt $\text{CO}_2\text{-e}$

2013 domestic emissions

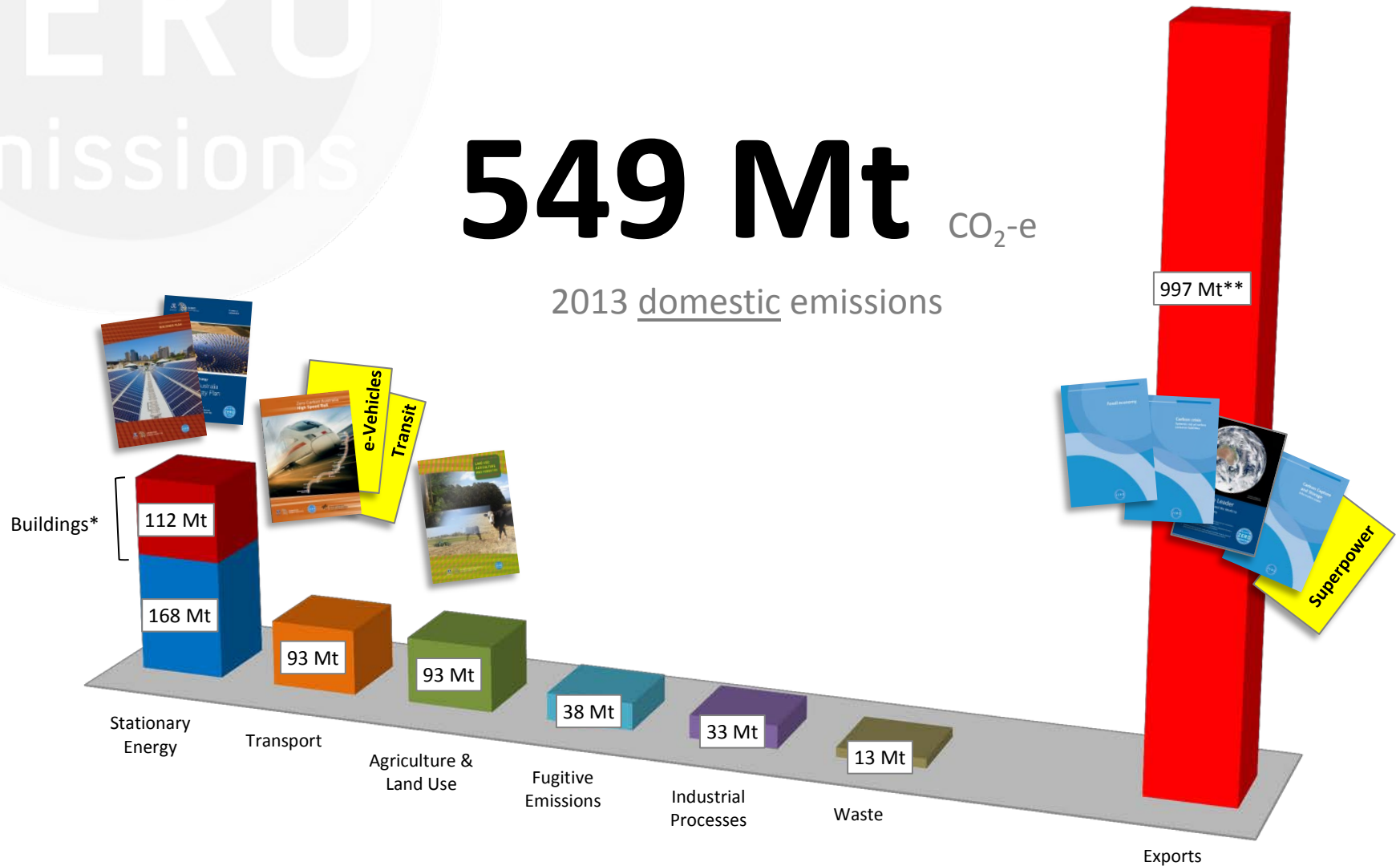


Key to
ZERO
emissions

Australian GHG footprint

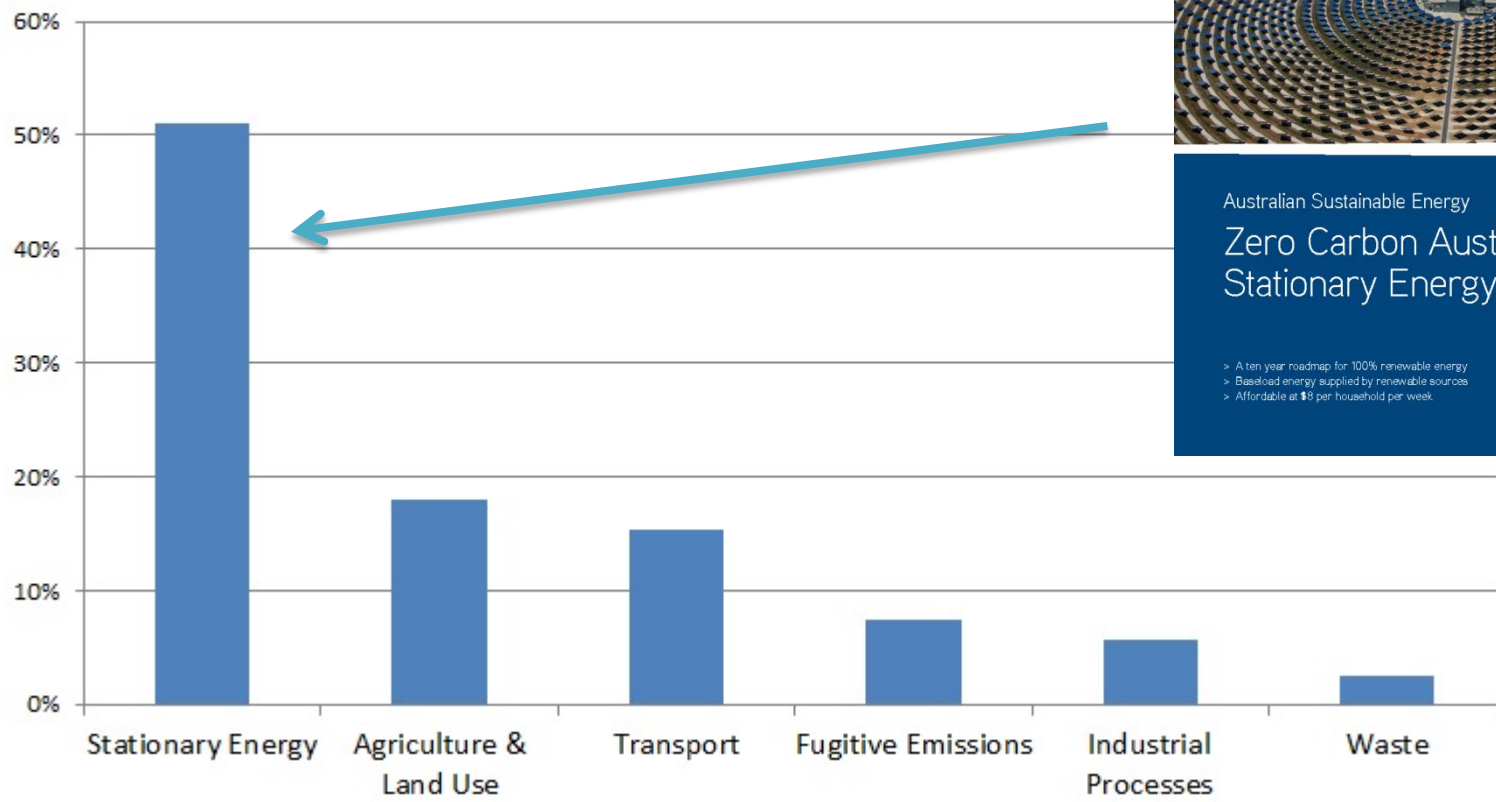
549 Mt $\text{CO}_2\text{-e}$

2013 domestic emissions




Energy

Australian CO2-e Emissions Sectors



UNIVERSITY OF MELBOURNE ENERGY Research Institute

A research collaboration



Australian Sustainable Energy
Zero Carbon Australia
Stationary Energy Plan

- > A ten year roadmap for 100% renewable energy
- > Baseload energy supplied by renewable sources
- > Affordable at \$8 per household per week.

beyond
ZERO
emissions



Energy



Published in 2010

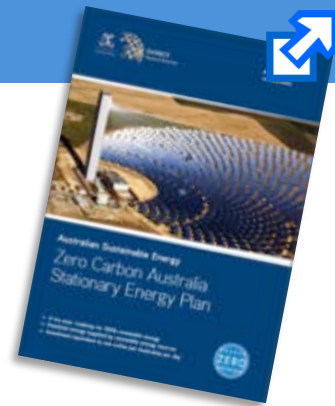


How to get to 100%
renewables
24/7 power
Baseload generation

Key to
ZERO
emissions

Energy

Bloomberg New Energy Finance
– “New wind and new solar
cheaper than new coal and new
gas”

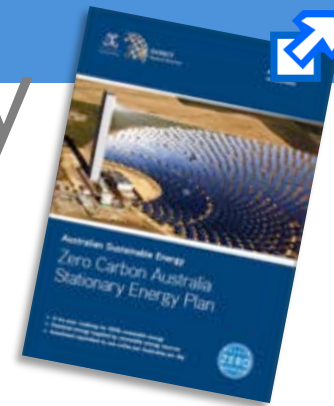


Published in 2010



Key to
ZERO
emissions

Energy



Published in 2010

Renewable Energy Targets

ACT 90% by 2020
SA 50% by 2025
QLD 50% by 2030
Fed Labor 50% by 2030
Vic 20% by 2020



100% renewables developed countries

Europe:

- Reykjavik, Iceland (achieved in community wide electricity)
- Linköping, Sweden (achieved in municipal/public transport)
- El Hierro, Canary Islands (achieved in community wide electricity)
- Barcelona, Spain
- Malmö, Sweden
- Munich, Germany
- Stockholm, Sweden (has a fossil fuel free target)

100% renewables developed countries

North America:

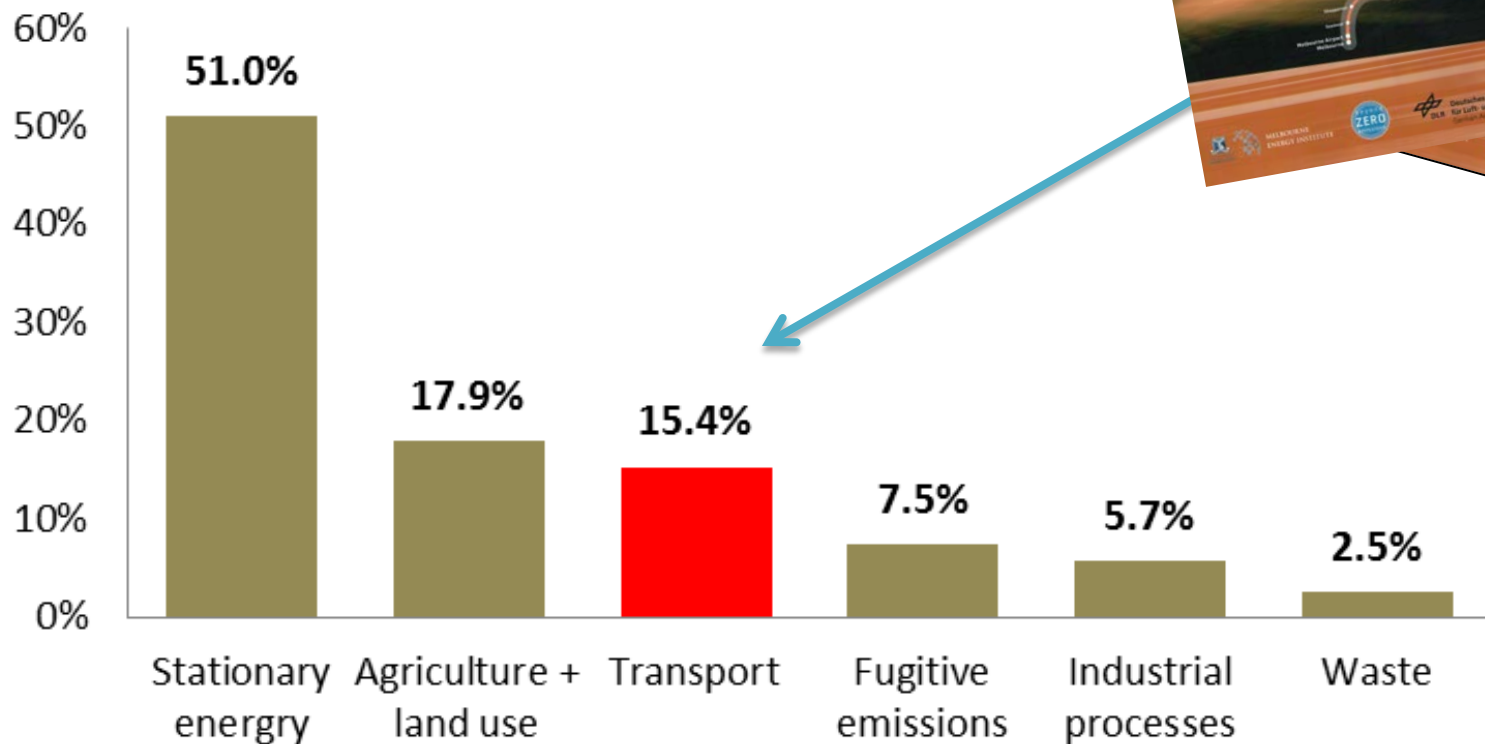
- Burlington, Vermont (achieved in community wide electricity - first in N.A.)
- San Diego, California
- San Francisco, California
- Palo Alto, California
- Lancaster, California
- Greensburg, Kansas
- Georgetown, Texas
- Aspen, Colorado
- Vancouver, Canada (target is community wide for all three sectors: electricity, heating/cooling, transportation)
- Oxford County, Canada

100% renewables developing countries

- Costa Rica: <http://go100re.net/properties/costa-rica/>
- Cape Verde, Africa: <http://go100re.net/properties/cape-verde/>
- District of Kasese in Uganda: <https://go100re.net/properties/kasese-uganda/>
- Agadir, Morocco: <https://go100re.net/properties/agadir-morocco/>
- Island of Bozcaada, Turkey: <https://go100re.net/properties/island-of-bozcaada-turkey/>
- Island of Sumba, Indonesia: <http://go100re.net/properties/sumba/>
- Tuvalu: <http://go100re.net/properties/tuvalu/>
- Tokelau: <http://go100re.net/properties/tokelau/>
- El Hierro, Canary Islands: <http://go100re.net/properties/el-hierro-canary-islands/>
- Palawan, Phillipines: <http://go100re.net/properties/palawan/>
- Cook Islands: <http://go100re.net/properties/cook-islands/>

Transport

Australian CO₂-e Emission Sectors



- High Speed Rail a zero emissions transport solution
- Faster, cheaper, cleaner form of transport
- A sound investment, achieving full capital replacement

Zero Carbon Australia High Speed Rail



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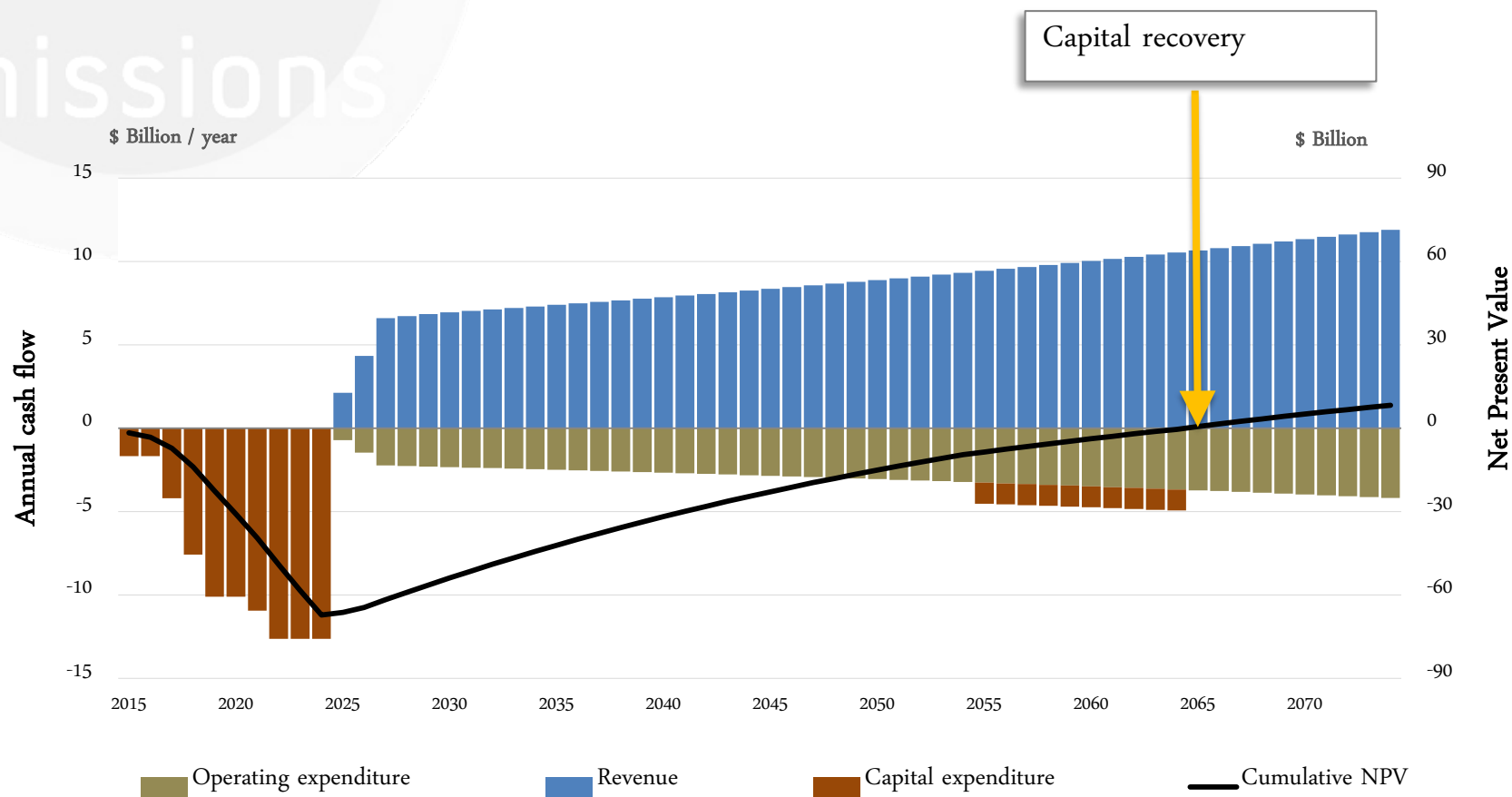
Deutsches Zentrum
für Luft- und Raumfahrt
German Aerospace Center

City centre to city centre



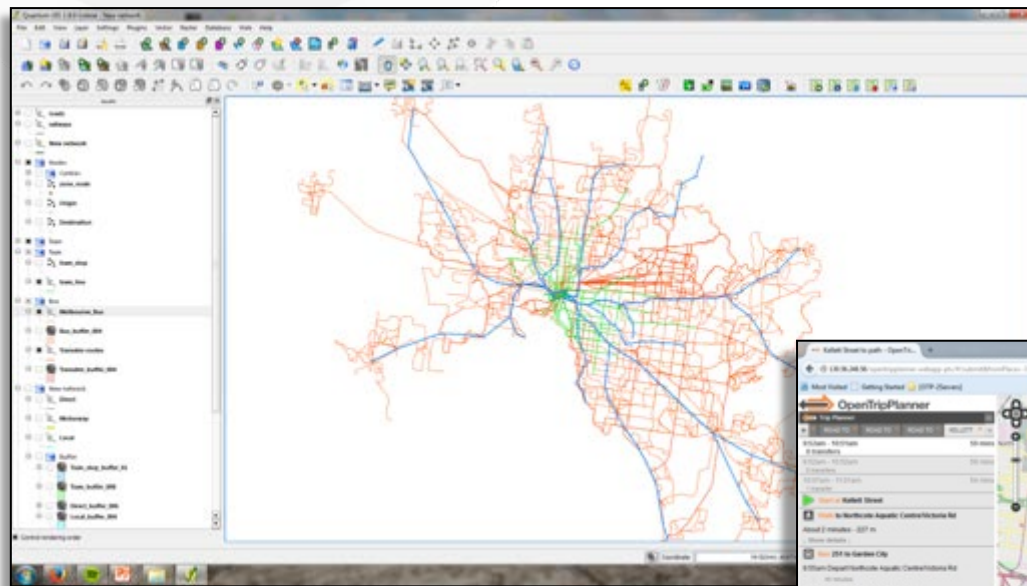
Connecting regional towns to urban centres

Cash flow



key to the
ZERO
emissions

Transport transit

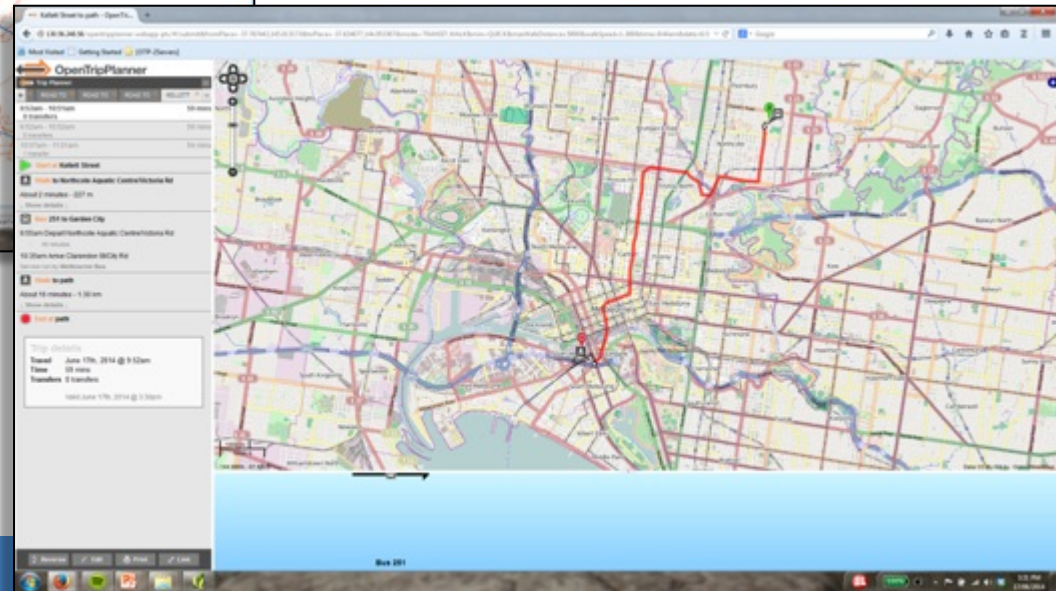


- Standardised platform
- Rapid concept development
- Public interaction



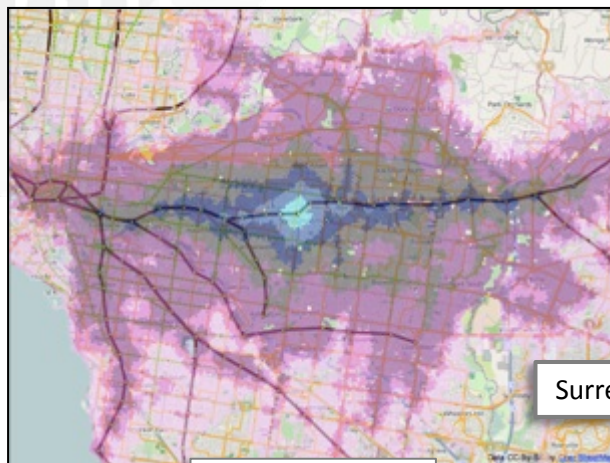
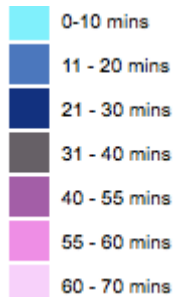
QUANTUM GIS

GTFS

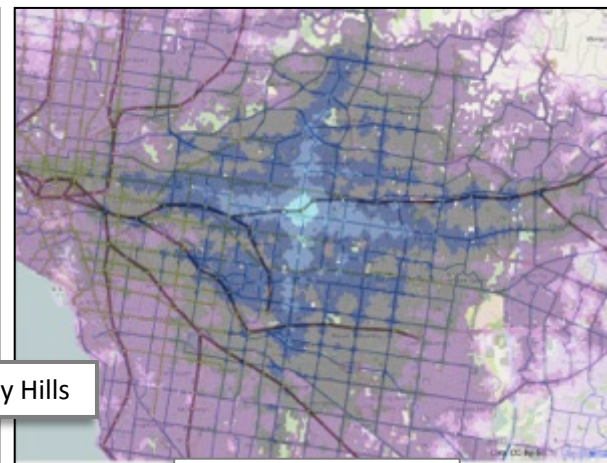


beyond
ZERO
emissions

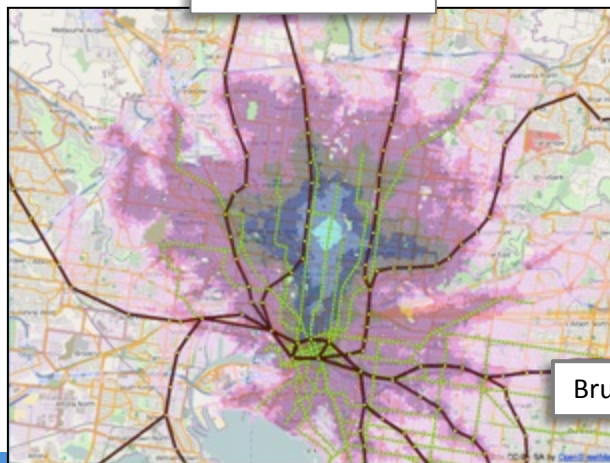
Transport transit



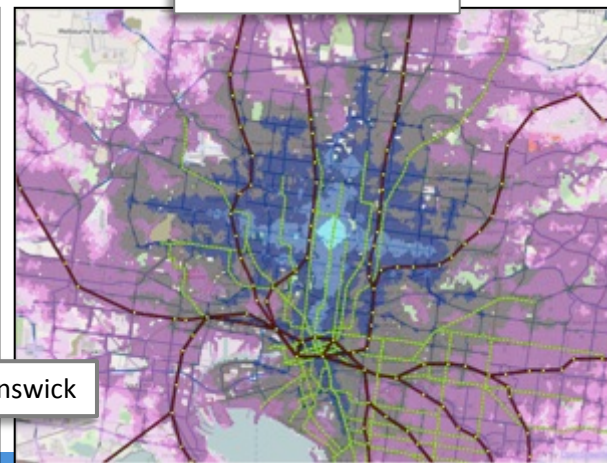
2013 PTV schedule



BZE Version 1 network



Brunswick



Electric vehicles





Australian Transport

In 2011

Consumed
49 Billion
Litres oil based fuel



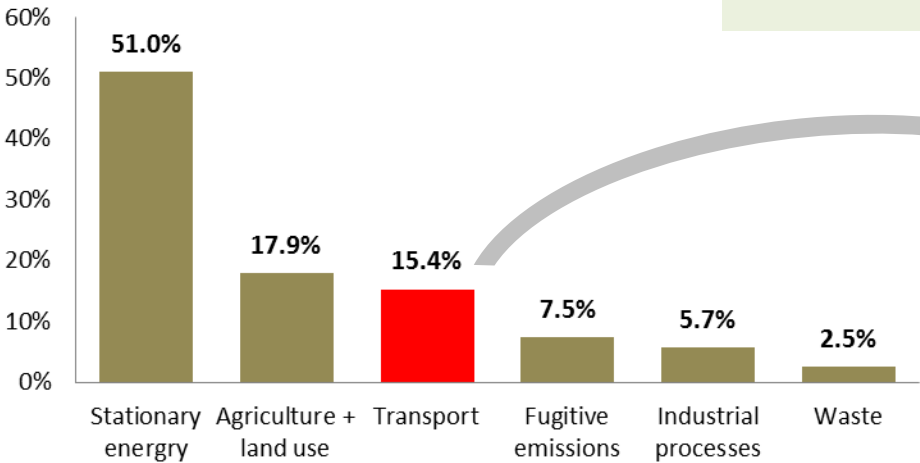
Australian Government
Department of Resources, Energy and Tourism

Emitted
87.6 Million
Tonnes CO₂-e

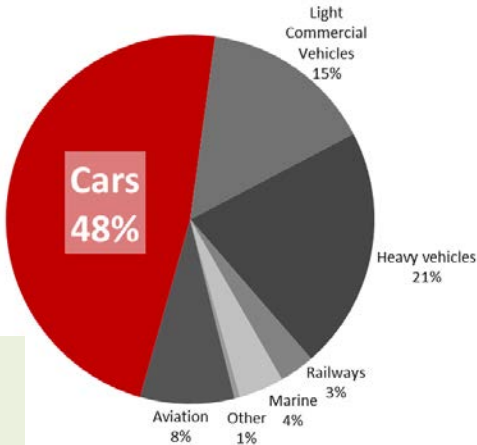


Australian Government
Department of Climate Change

Australian CO₂-e Emission Sectors



7.4% of total emissions



Electric Vehicles: economic transition

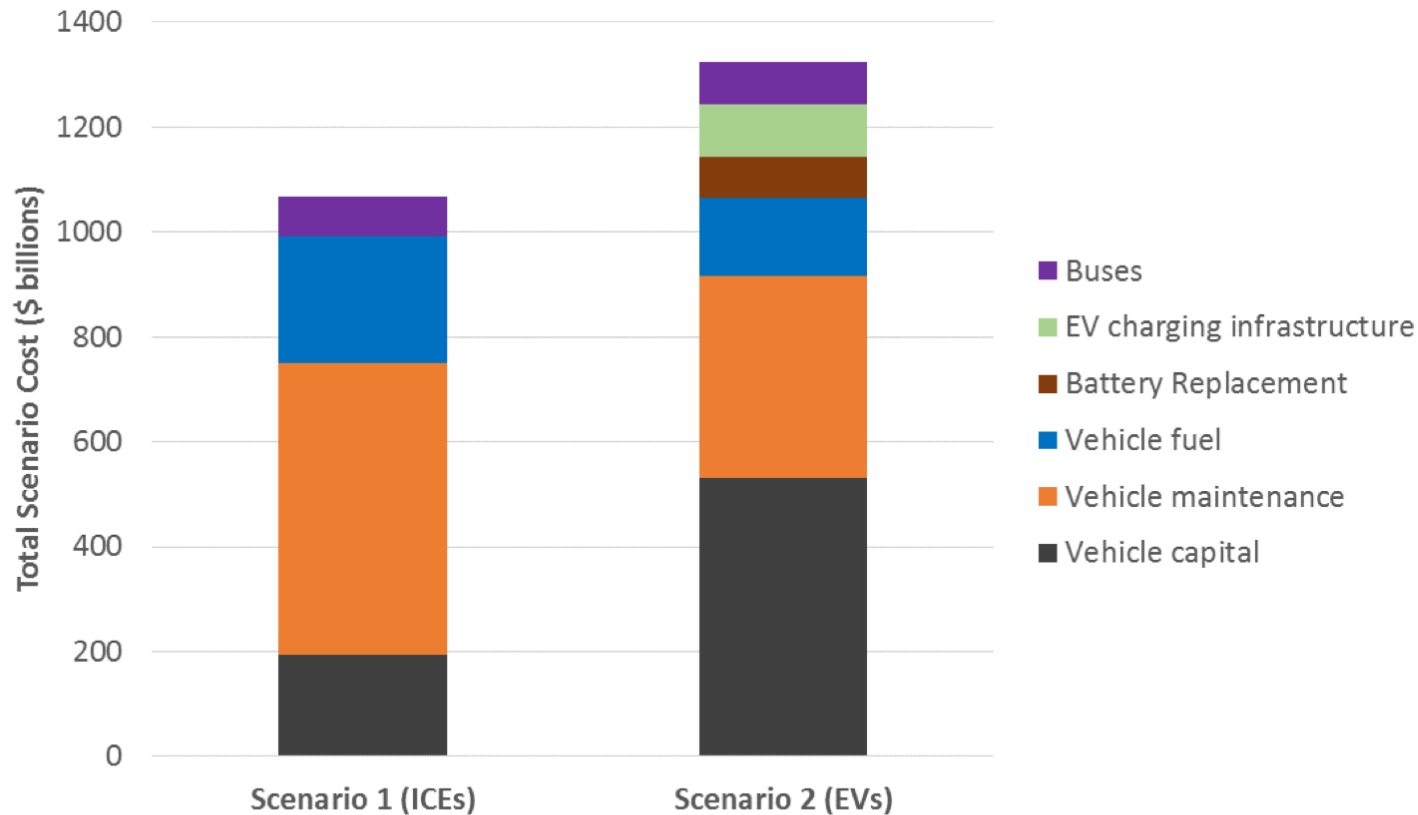


Figure 1 - Summary of Scenario costs (Net Present Value of total cost between 2015 and 2035) in the Conservative Sensitivity

Electric Vehicles: economic transition

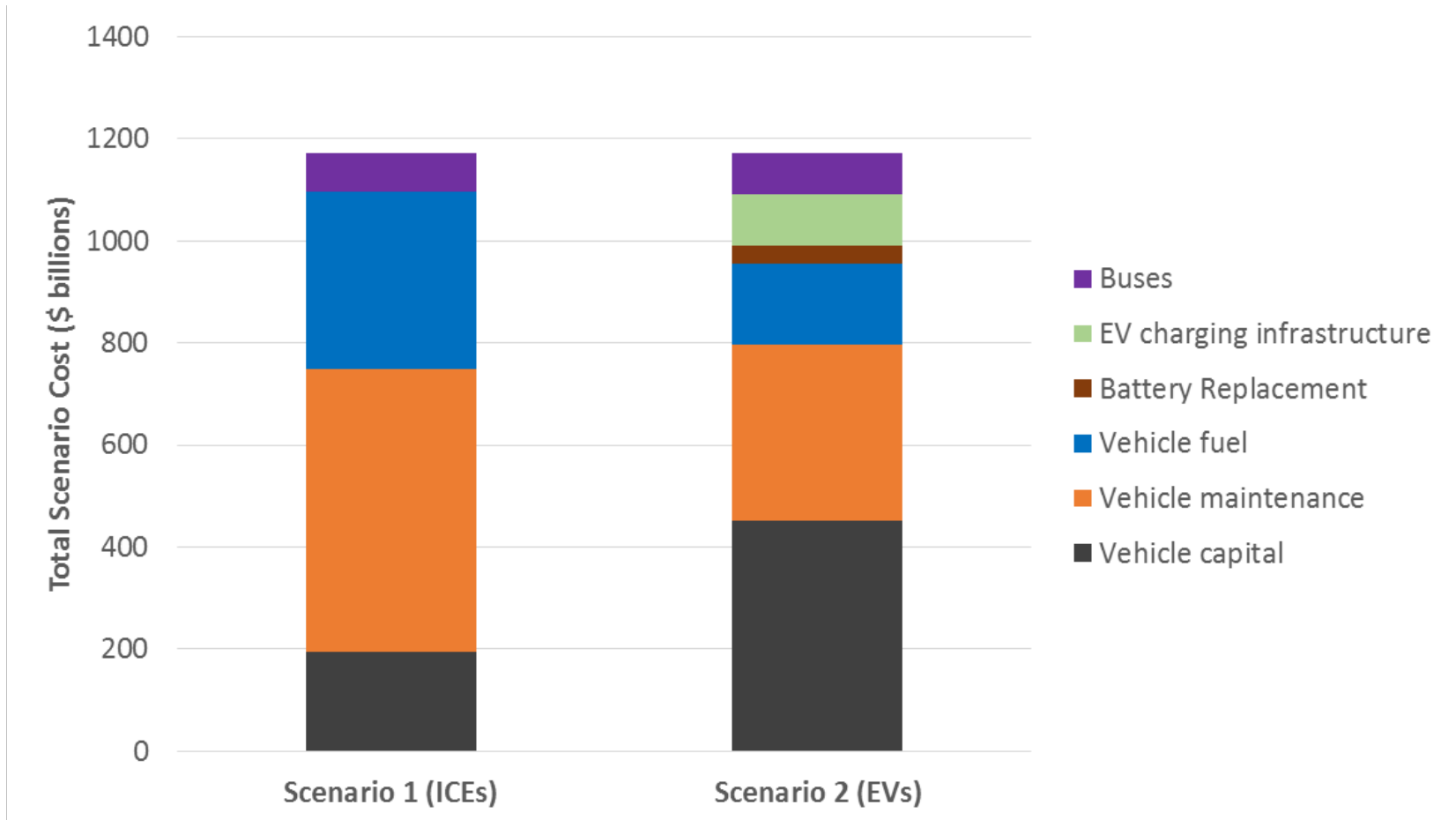


Figure 2 - Summary of Scenario costs (Net Present Value of total cost between 2015 and 2035) in the Low Cost Sensitivity

Zero Emissions Communities

Working with Mayors and local communities in Victoria and NSW



Zero Emissions Byron

Mayor has announced intention for Byron Shore to move to zero emissions over 10 years

- Steering committee Council, BZE
- Community working groups
 - Energy
 - Buildings
 - Transport
 - Land use
 - Waste



Zero Emissions Byron

Adapting BZE's research / Community driven

- 100% renewable energy (Enova, COREM)
- zero emissions buildings (Energy Freedom)
- sustainable transport (EV,s, public transport, car sharing)
- waste (organics diversion)
- land use (organic farming, local food, permaculture)

What did we find out?



- 53% reduction in residential energy use
- 44% non-residential energy use
- 33,000MW of rooftop solar
- Initial investment offset by savings on energy bills



Buildings



Brick Veneer

Heating dominant climates

-75% Energy use



Lighting

- Replace all linear fluorescents and halogen downlights with LED alternatives
- Assumed efficacy of LEDs = 150 lm/W



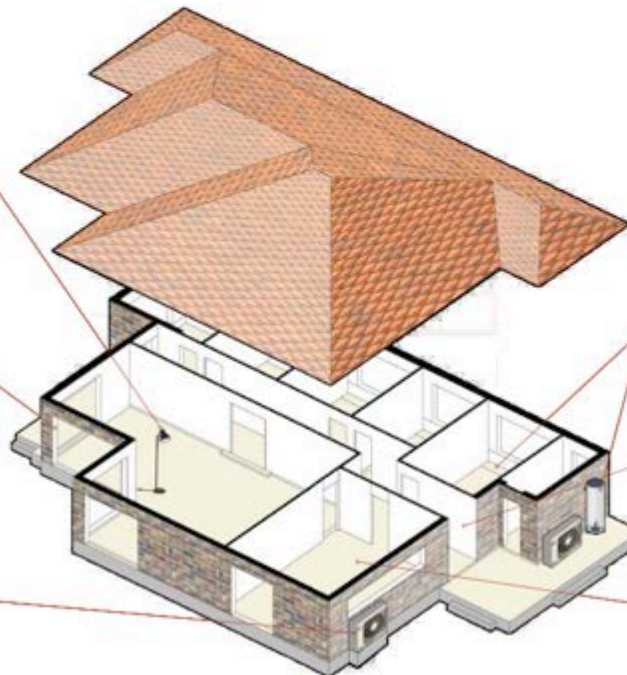
Fabric Upgrades

- Insulate roof to R6, insulate walls to R2.5
- Replace windows with thermally broken double glazed units
- Install curtains and pelmets on all windows
- Ventilated downlights to be eliminated; install self sealing exhaust fans
- Full weather sealing on external windows and doors
- External awnings on east and west windows



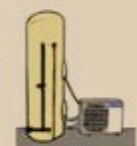
Space Conditioning

- Best on the market split system reverse cycle air-conditioners to replace all gas heaters and old air-conditioners. COP >4.6
- 2.5kW for bedroom, 4.5kW for living room
- Wood heating maintained on downward trend



Hot Water

- Heat pump to replace all gas instantaneous gas tank, and electric tank unit
- Heat Pump: COP 4
- Water efficiency measures, e.g. low flow shower head



Cooking

- Replace gas cooktops with induction electric
- Replace small amount of gas ovens with electric. (Electric is dominant type on market.)



Energy Monitoring

- Installation of Smart Meter
- Installation of In Home Display or web portal for real time monitoring of energy consumption
- Meters/switches on individual appliances



Appliances

- New replacement appliances must meet best practice energy performance e.g. LED displays, best available fridge, washer, etc.



Buildings

Timber weatherboard

Cooling dominant climates

-29%

Energy use



Lighting

- Replace all A19 incandescent, CFL, halogen, linear fluores, halogen downlights with LED alternatives
- Assumed efficacy of LEDs = 150 lm/W



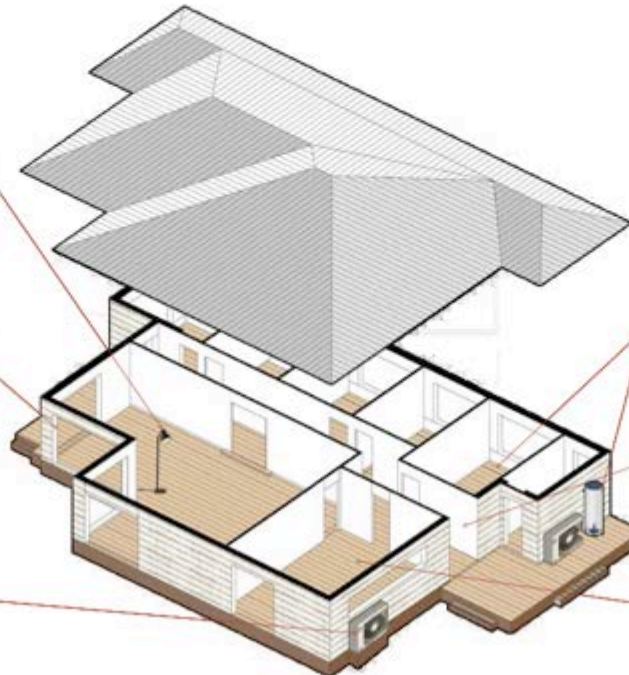
Fabric Upgrades

- Insulate roof to R6, insulate walls to R2.5, floors R2
- Replace windows with single glazed low-emissivity IGUs with larger openings
- Ventilated downlights to be eliminated; install self sealing exhaust fans
- Full weather sealing on external windows and doors
- External awnings on east and west windows, plus north in tropical climate zones



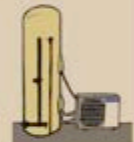
Space Conditioning

- Best on the market split system reverse cycle air-conditioners to replace all gas heaters and old air-conditioners. COP >4.6
- 2-3kW for bedroom, 4-5kW for living room
- Ceiling fans for improved air circulation without air conditioner
- Wood heating maintained on downward trend



Hot Water

- Heat pump replace all gas instantaneous, gas tank units
- Heat Pump: COP 4
- Water efficiency measures, e.g. low flow shower head



Cooking

- Replace gas cooktops with induction electric
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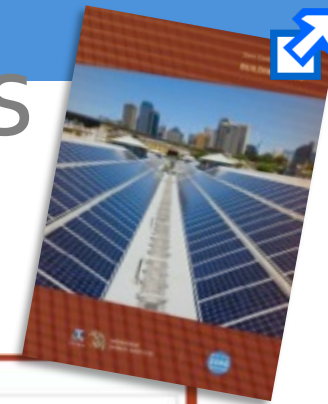
Buildings



Masonry clad tower

-80%

Energy use



Lighting

- Replace all A19 incandescent, CFL, halogen, linear fluores, halogen downlights with LED alternatives
- Assumed efficacy of LEDs = 150 lm/W



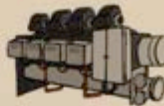
Fabric Upgrades

- Replacement Double Glazed windows; $U = 2$; SHGC = 0.64
- Insulate roof to R4 and walls to R2.5
- Draught proofing/air locks reduce air-infiltration: 1 ACH to 0.1 ACH



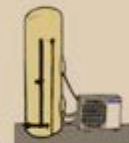
Space Conditioning

- Air cooled chiller upgrade: COP ~ 4 (halve energy consumption)
- Boiler replacement with heat pump: COP ~ 4
- Variable speed drives and controls on pumps and fans
- Night purge



Hot Water

- Heat pump to replace all gas instantaneous, gas tank, and electric tank units
- Heat Pump: COP 4
- Water efficiency measures, e.g. low flow shower head



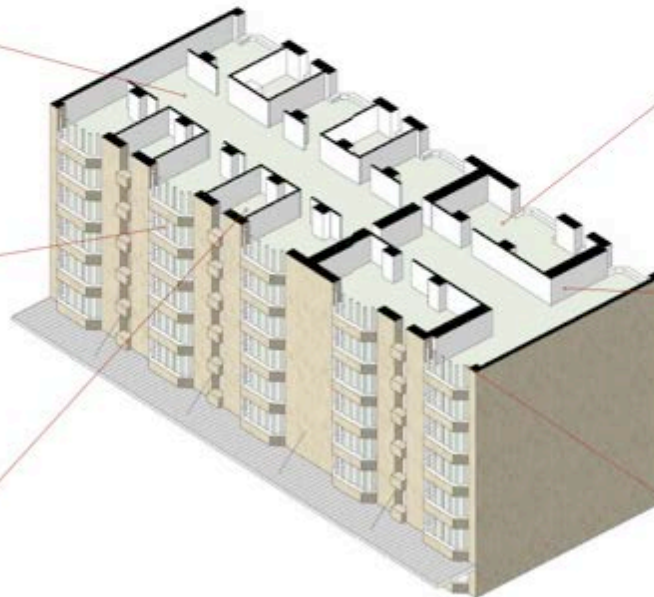
Energy Management

- Installation of Energy Management System with sub-metering
- Provide on-site Facility Managers trained in energy efficiency



Appliances

- New replacement appliances must meet best practice energy performance e.g. LED displays, low wattage PCs
- Equipment load reduction: 15 W/m^2 to 5 W/m^2
- Gas cooking replaced with high efficiency electric (where applicable)

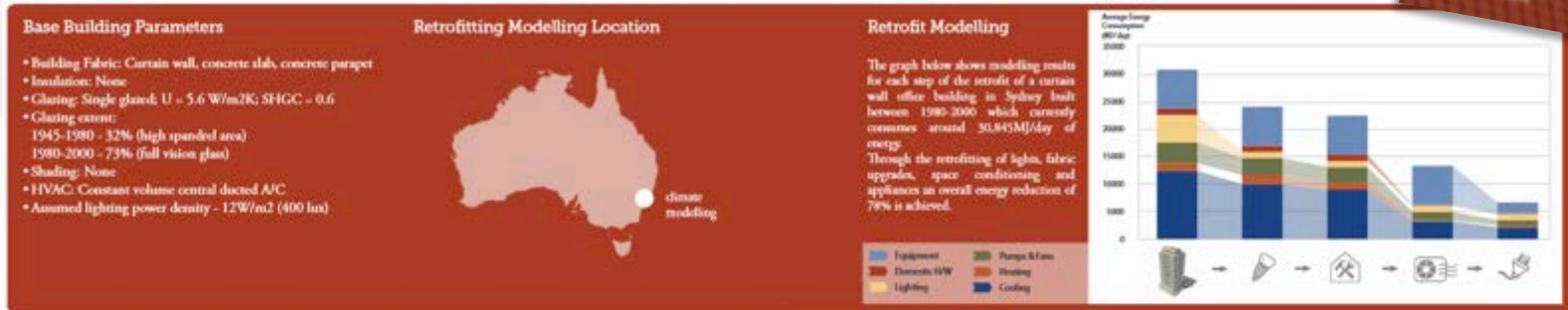


Buildings



Curtain wall tower

-78% Energy use



Lighting

- Replace all A19 incandescent, CFL, halogen, linear fluores, halogen downlights with LED alternatives
- Assumed efficacy of LEDs = 150 lm/W



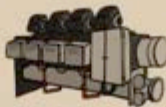
Fabric Upgrades

- Apply solar control film. This will have solar heat gain
- Insulate roof to R4.5 and walls to R2.5
- Draught proofing/air locks reduce air infiltration: 1 ACH to 0.1 ACH



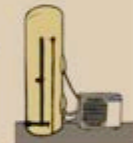
Space Conditioning

- Water cooled chiller upgrade: COP = 6 (halve energy consumption)
- Boiler replacement with heat pump: COP = 4
- Replace constant air volume AHU with variable air volume system.
- Variable speed drives and controls on pumps and fans.
- Economy cycle (temperate climates only)
- Night purge



Hot Water

- Heat pump to replace all gas instantaneous, gas tank, and electric tank units
- Heat Pump: COP 4
- Water efficiency measures, e.g. low flow shower head



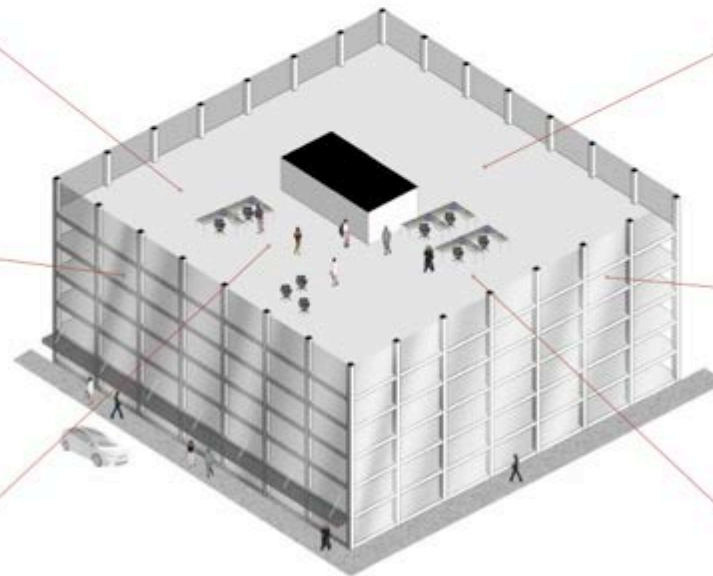
Energy Management

- Installation of Energy Management System with sub-metering
- Provide on-site Facility Managers trained in energy efficiency



Appliances

- New replacement appliances must meet best practice energy performance e.g. LED displays, low wattage PCs
- Equipment load reduction: 11 W/m^2 to 3 W/m^2
- Gas cooking replaced with high efficiency electric (where applicable)



Buildings



Shopping centre

-63% Energy use



Lighting

All areas:

- Replace all A19 incandescent, CFL, halogen, linear fluorescent, halogen downlights with LED alternatives
- Assumed efficacy of LEDs = 150 lm/W



Fabric Upgrades

Common areas:

- Apply solar control film. This will halve solar heat gain
- Insulation - Roof R4, Wall R2
- Cool Roof paint
- Draught proofing/air locks to reduce air infiltration



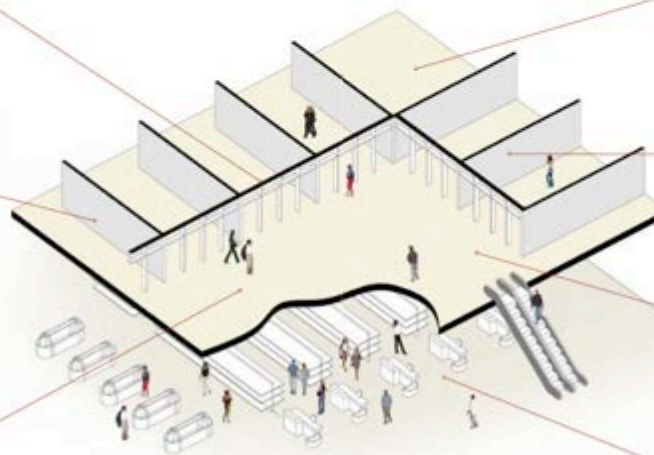
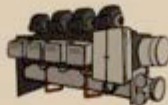
Space Conditioning

Small retail:

- Replacement high efficiency air-conditioner, COP 4.6

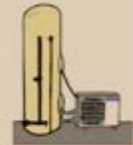
Common areas:

- New air-cooled packaged chiller COP 4 (halve energy consumption)
- Boiler replacement with heat pump COP 4
- Variable speed drives and controls on pumps and fans
- Economy cycle (temperate climates only)



Hot Water

- Heat pump to replace all instantaneous and tank units
- Heat Pump: COP 4
- Water efficiency measures, e.g. low flow shower head



Energy Management

- Installation of Energy Management System with sub-metering
- Provide on-site Facility Managers trained in energy efficiency



Appliances

- New replacement appliances must meet best practice energy performance e.g. LED displays, low wattage PCs
- Gas cooking replaced with high efficiency electric (where applicable)



Supermarkets

- Fit doors on display cases - triple glazed with controls to minimise anti-sweat heater energy demand
- All other cost effective measures already implemented in best performing 20% of large supermarket chains
- Total energy demand reduction from 820 kWh/m² to 500 kWh/m²

Key to
ZERO
emissions

Retrofit

+



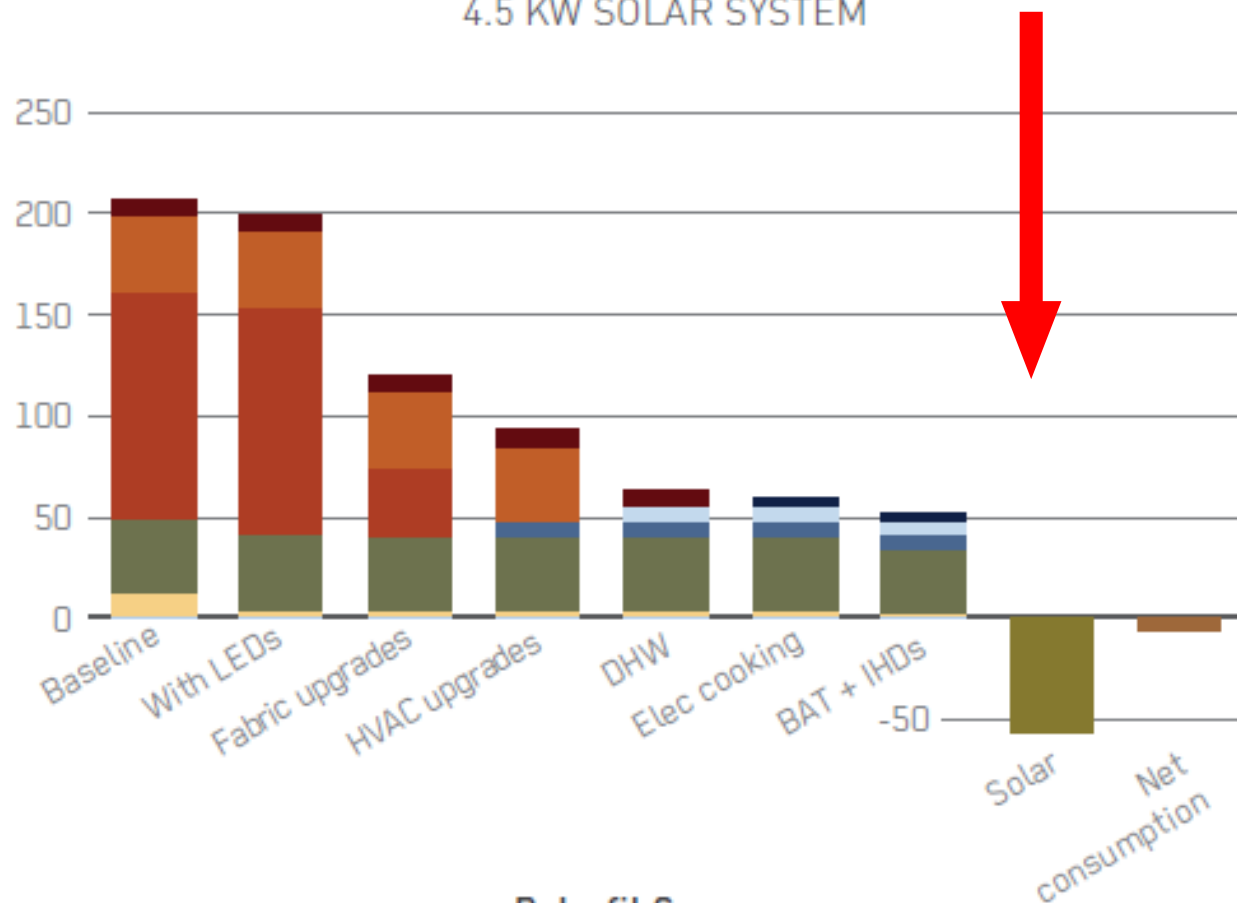
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Net generating
houses

REDUCTION IN ENERGY CONSUMPTION RESULTING FROM RETROFIT

4.5 KW SOLAR SYSTEM

Energy Consumption (MJ per day)



- Cooking (Gas)
- Domestic Hot Water (Gas)
- Heating (Gas)
- Cooking (Electric)
- Domestic Hot Water (Electric)
- Heating (Electric)
- Equipment
- Lighting
- Cooling
- Solar
- Net Consumption

Energy Surplus (MJ per day)

Retrofit Sequence

\$1 trillion of jobs and investment

- Stationary Energy - \$370bn
- Buildings Plan - \$270bn
- Electric Vehicle - \$200bn

Also reduces oil imports

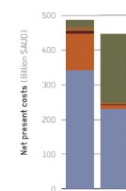
- Land Use - \$100bn
- High Speed Rail - \$84bn

Combined benefit – some costs reduced

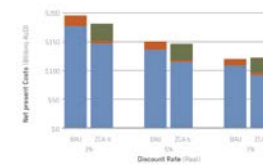
Total around \$1,024bn

Component	\$AU,Bn
CST	\$175
Backup Heaters	\$8
Bioenergy supply	\$6
Wind	\$72
Transmission	\$92
TOTAL	\$353
Off-grid CST + Backup	\$17
TOTAL + Offgrid	\$370

Stationary
Energy
Plan
Costs



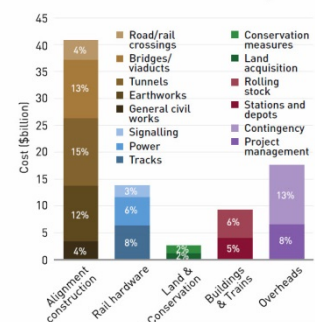
Residential



Non-Residential

Buildings
Plan
Costs

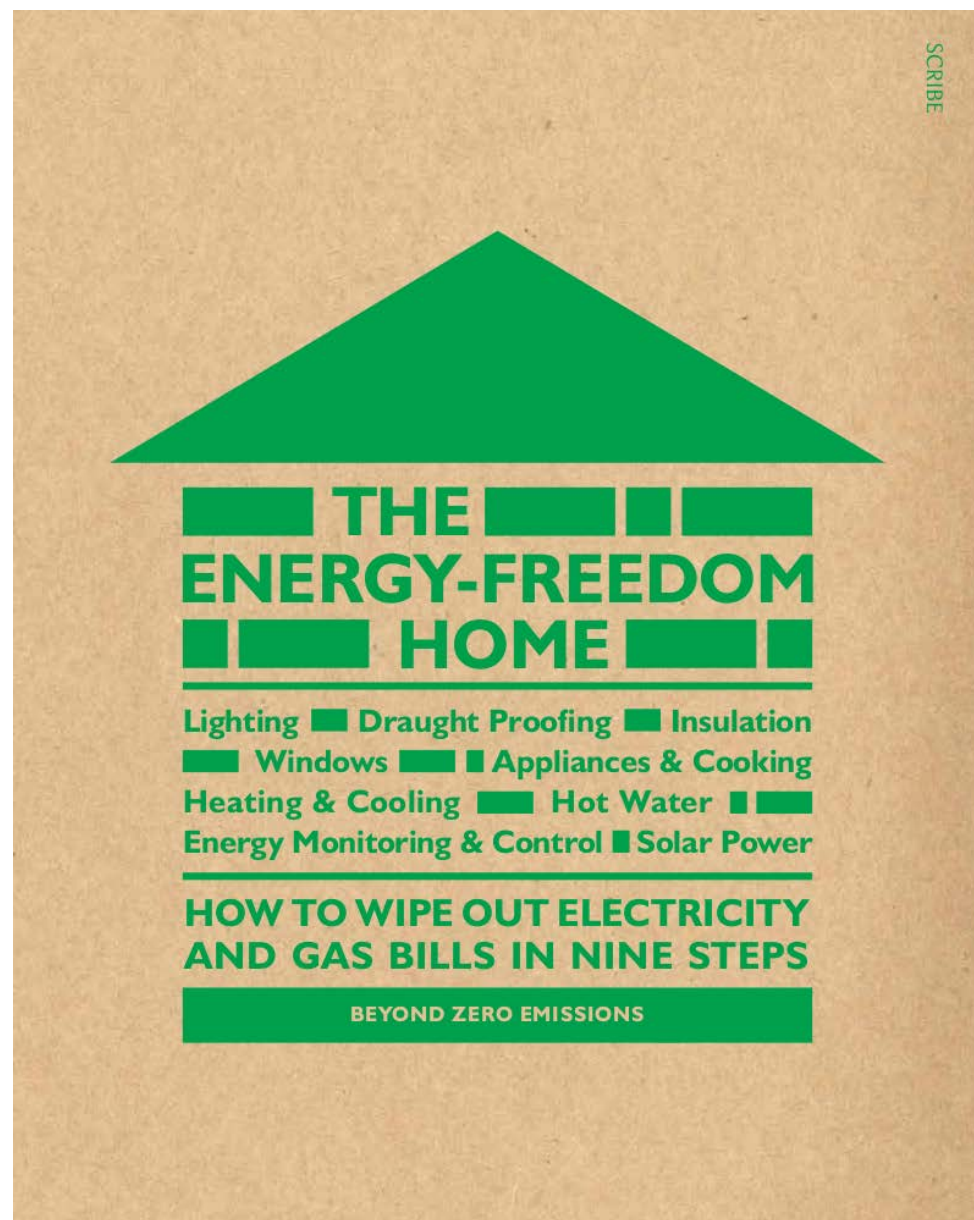
FIGURE VII Breakdown of \$84 billion capital cost estimate for Melbourne-Brisbane HSR system



High
Speed
Rail
Costs

beyond
ZERO
emissions

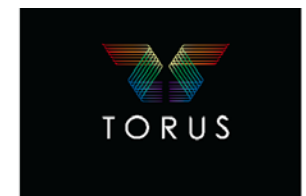
Energy Freedom Home Book Launch



energyfreedom.com.au

1. LED lighting upgrades
2. Insulation upgrades
3. Efficient electrical appliances
4. Induction cooktops
5. Double glazing
6. In-home displays
7. Heat pump space conditioners
8. Heat pump hot water
9. Rooftop solar

Plus energy retailer switch



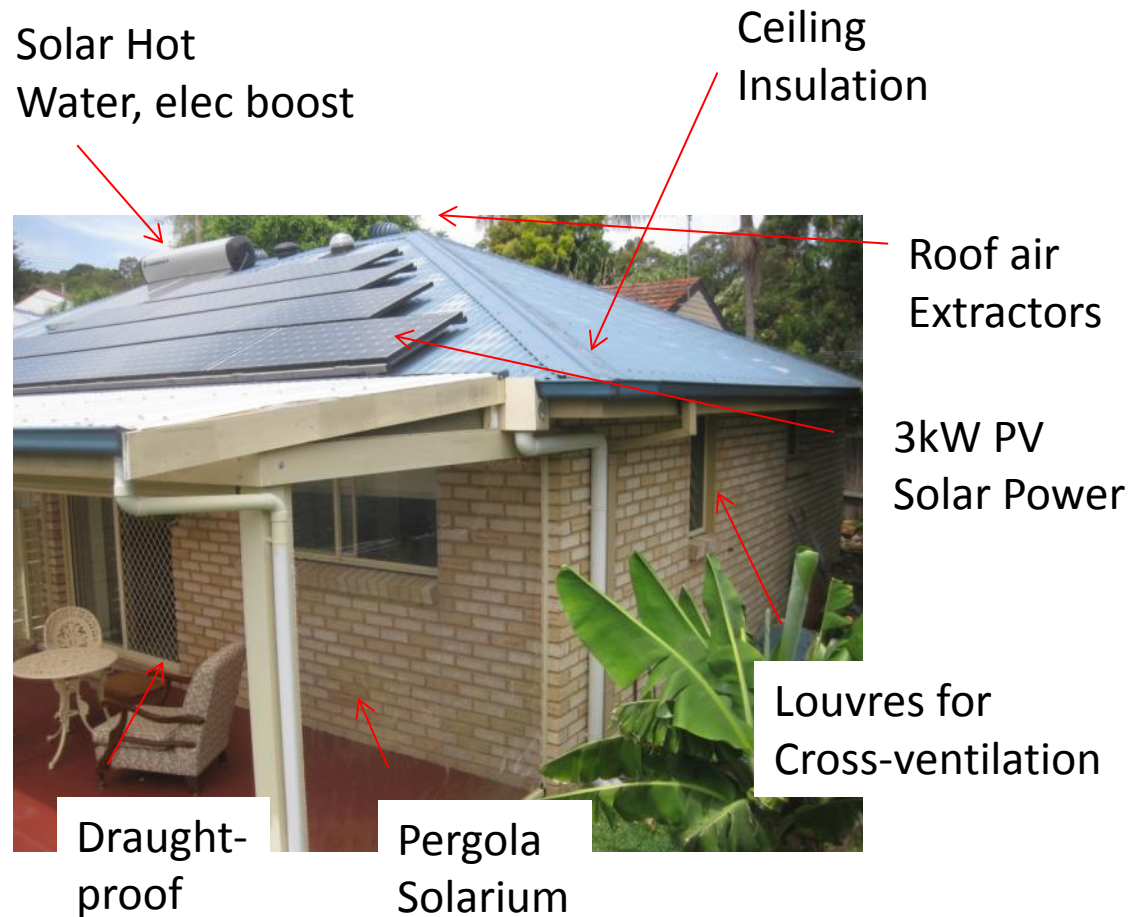
9 steps and Newcastle Home

Step	Newcastle Brick Veneer 2BR Home with 2 adults
1. Lighting - LEDS	Mostly CFLs, some LEDS
2. Draught Proofing	Extensive, back door but not front door base - debate re health and ACH
3. Insulation – ceiling, walls, floor	R4 in ceiling, left walls alone (already energy positive)
4. Windows – shading, curtains, tints, dbl glaz	Sealed and thermally lined curtains and boxed-in Roman blinds - closed at sunset and on hot days, Large Pergola shading - mainly lifestyle addition & to dry clothes in wet weather
5. Appliances and Cooking – high star	Removed gas stove/cooktop, Microwave, high star fridge, 1 small TV, front load washing machine, never use dryer, no dish washer
6. Heating and Cooling – high COP/EER air con	Large ceiling fans, Louvre window X-vntln, purge fan from ceiling/ roof, roof extractors 1kW radiant panel heater with thermostat, 120W desk panel heater, convection heater in bedroom, heat globe in ensuite
7. Hot Water – heat pump/ solar	Removed gas hot water; New solar with electric boost with switch - rarely used
8. Energy Monitoring and Control - BMS	Powerboards with light in each room, read meters manually each month (awaiting IP monitoring & control – like Eddy)
9. Solar Power – PV	3 kW system, generating 12 kWh per day
Summary	House uses 7 kWh per day - net energy positive over 1 year (5kWh/d)

Newcastle Brick Veneer Home

Retrofit Improvements

Year	Improvement
2009	Added ceiling insulation, improved lights
2010	Panel heaters, ceiling fans, roof-mounted air extractors, solar power
2011	Draught proofing, electric cooking
2012	Solar hot water, curtains, louvres
2013	Pergola solarium, blinds



Newcastle Brick Veneer Home

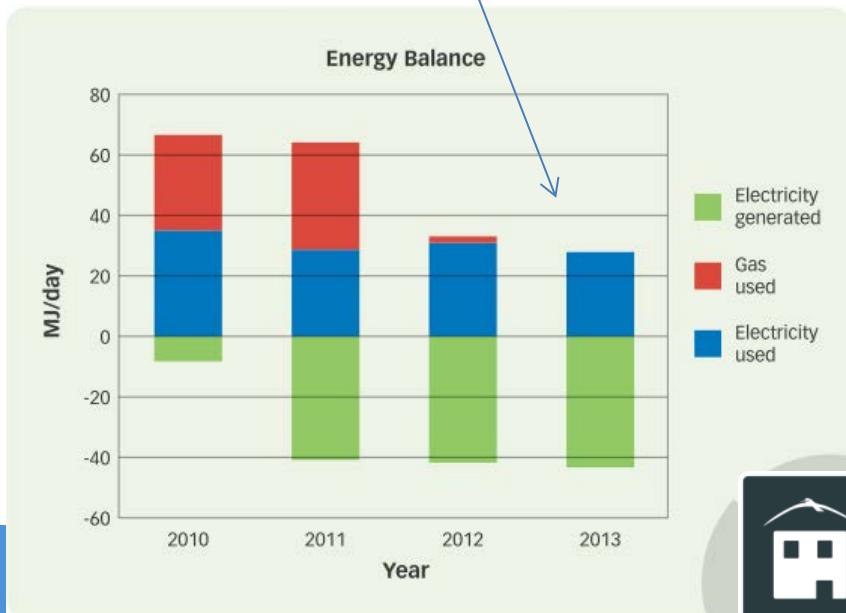
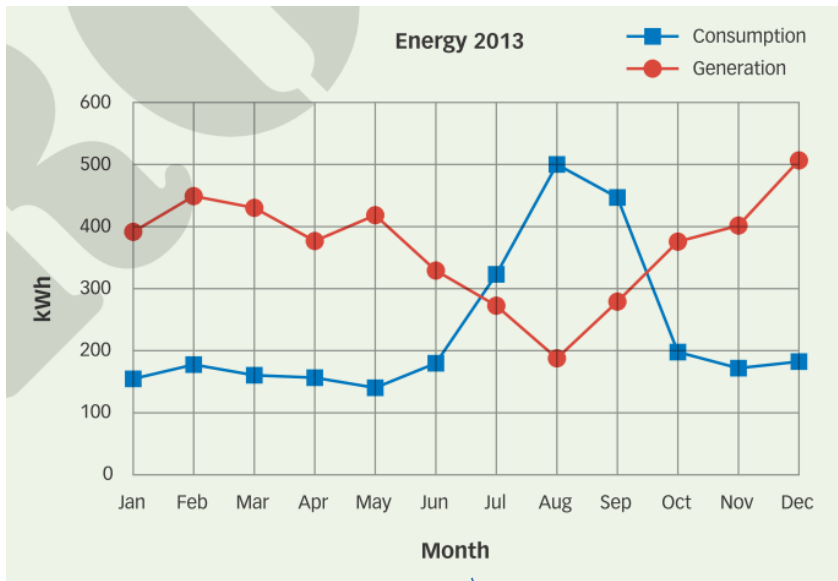
Retrofit Improvements



- Experimental curtains
 - Thermal lined
 - Sealed at edges in middle
 - Improved liv. Rm by 2°C
- Louvre window
 - cross-ventilation,
 - boxed-in roman blinds
- 160 W panel heater
 - Heats occupant, not whole space



Results



- Net energy positive over 12 months
- Sometimes get \$400/qrtr from retailer
- Removing gas halved energy used
- NatHERS stars went from 0 to 4 (80% improvement in energy)
- NABERS stars went from 3.5 to 4, with a 60% improvement

What would an Energy Freedom Australia look like?

- 8 million homes in Australia could harvest energy from the sun and be high performing and energy efficient
- 31,000MW of electricity could be generated from rooftop solar (for houses with sufficient sunlight)
- Rooftop solar could generate more than enough energy for every house
- **Meaning.. every home in Australia can achieve energy freedom**



Homes become solar power stations
energyfreedom.com.au





More information / get involved / visit BZE stand

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