The energy effect of urban water security, lessons from the Australian Millennium Drought, and related analysis

Asian Development Bank

Manilla, 3:00pm

Tuesday 8 December 2015

Dr Steven Kenway
Research Group Leader, Water-Energy-Carbon
The University of Queensland

The University Of Queensland
AUSTRALIA

Water-Energy-Carbon Research Group

Overview

Emerging interrelated problems – water- energy security and resilience.

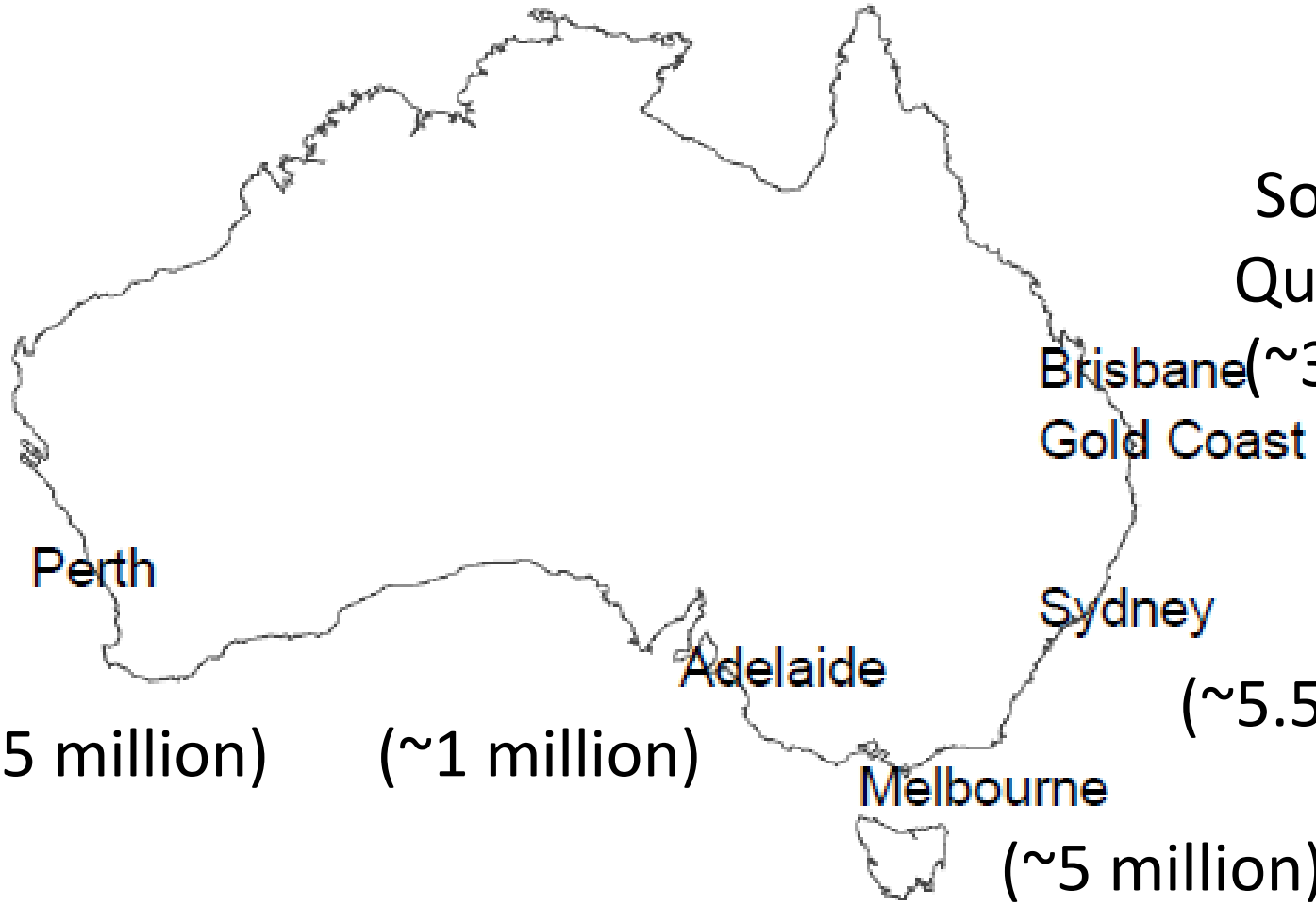
Overview of Current Water-Energy Research (UQ).

- Integrated planning, city-benchmarking, tools and decision-support
- Frameworks to support decision-making
- Training and capacity-building

Energy implications of water security strategies:

- Systemic analysis of energy use in urban water in Australia
- Impact and uptake of the work and its direction

Location of cities described



South East Queensland (~3 million)

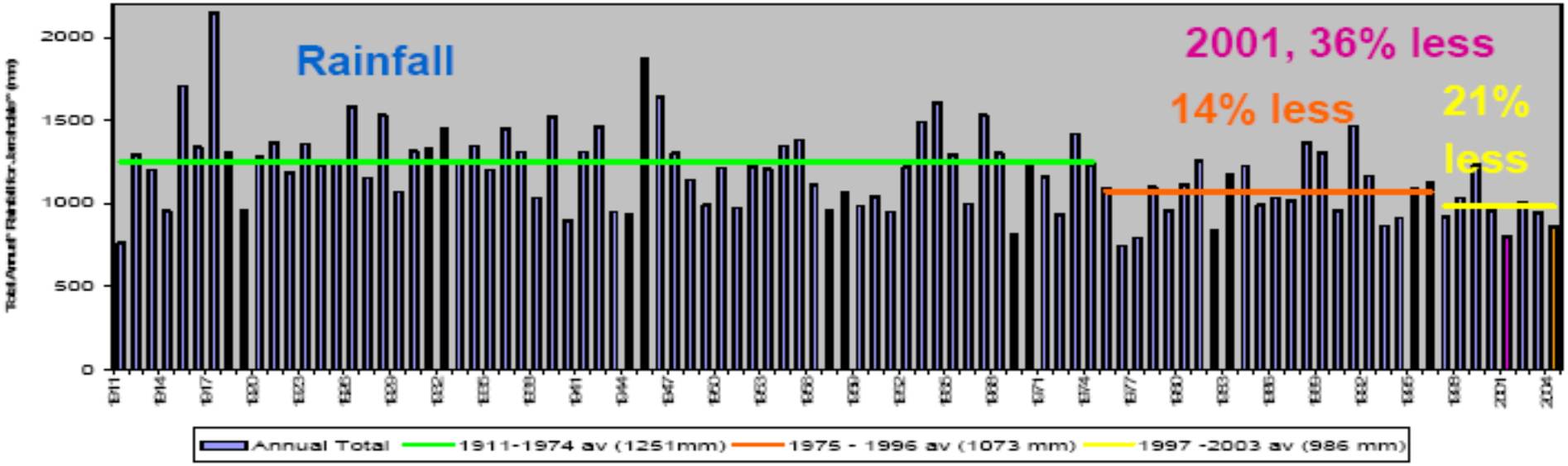
(~1.5 million)

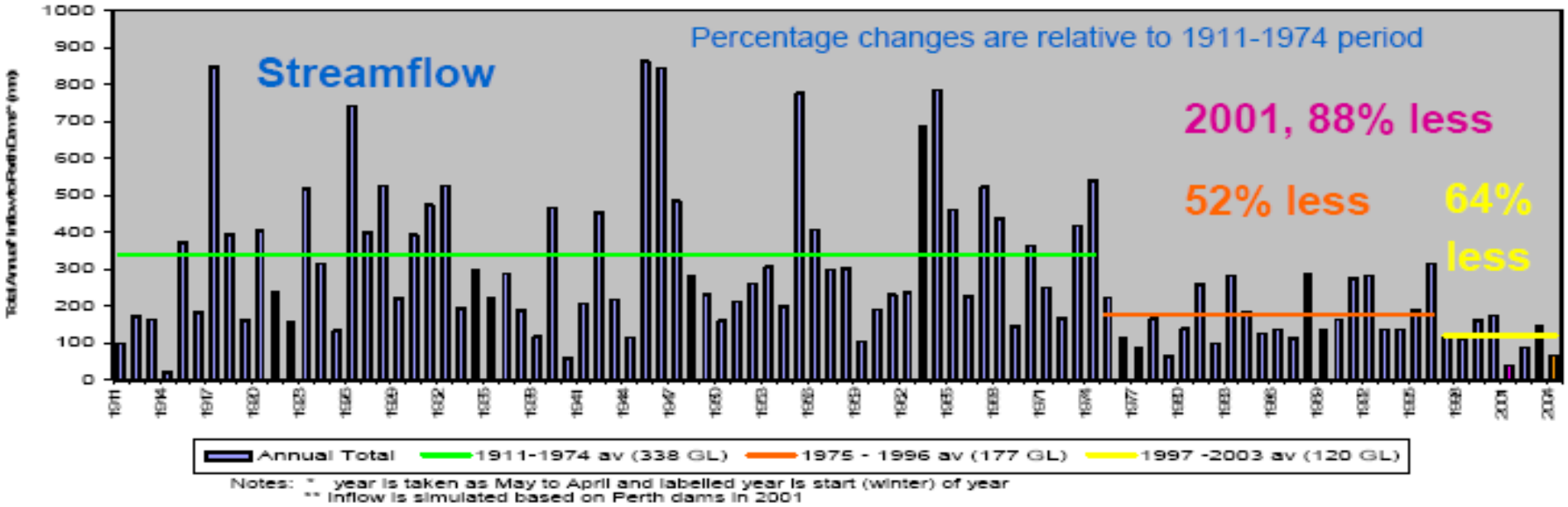
(~1 million)

(~5.5 million)

(~5 million)

An emerging problem climate-change driven rainfall and stream flow reductions (Perth, Australia - 1917-2005)





Courier Mail Feb 1 2007

It's desalinate or die

Greg Stolz
GOLD COAST BUREAU CHIEF

PEOPLE will die unless the State Government rushes through the Gold Coast desalination plant, claims Premier Peter Beattie.

Visiting the Gold Coast yesterday, Mr Beattie brushed off a lone anti-desalination protester who gate-crashed his media conference and a Labor caucus retreat.

He also dismissed concerns about a French water giant's high-priced involvement in the desalination plant and defended the Government's decision to push ahead with the controversial

VOILA! ... how *The Courier-Mail* revealed the story yesterday.

$1.3 billion project without an environmental impact study.

At a media conference at Tugun near the desalination plant site, Mr Beattie was collared by protester Inge Light who slipped through a security detail and a gaggle of government officials to complain about the project's financial and environmental costs.

"I've got to be honest with you, we're going to build it (the plant), we've got no choice — unless you go up there and play God and make it rain for me," Mr Beattie said.

Ms Light asked Mr Beattie what she should tell her children when they were paying high costs and a heavy environmental price to drink desalinated water.

"Tell them we've got water because if you don't allow us to get desalinated water, frankly no-one's going to be alive," the Premier retorted.

"If we don't have desal, we're not going to have any water. If you don't have water, you're dead."

Mr Beattie also rejected concerns about the involvement of French giant Veolia Water, which *The Courier-Mail* revealed yesterday stood to make hundreds of millions of dollars from building and operating the desalination and western corridor recycled water project.

"You're not going to build pipelines for nothing, this is an expensive exercise," he said.

"We're spending something like $7 billion building a water grid.

"This is about giving people wate — we make no apology for it."

Mr Beattie again ruled out privat ising water assets and promise higher water revenue would be re invested in infrastructure rather tha go into government coffers.

"This is not about making money we won't make money out of water, he said.

The Premier said the Governmen did not have time for an environ mental impact study on th desalination plant because of th water crisis. "From our point of view we're going to provide water and we'r not going to compromise," he said.

Dry Downs to tap into Wivenhoe, says report

Amanda Gearing

GOVERNMENT bureaucrats want to let another 130,000 people tap into Wivenhoe Dam's dwindling supplies.

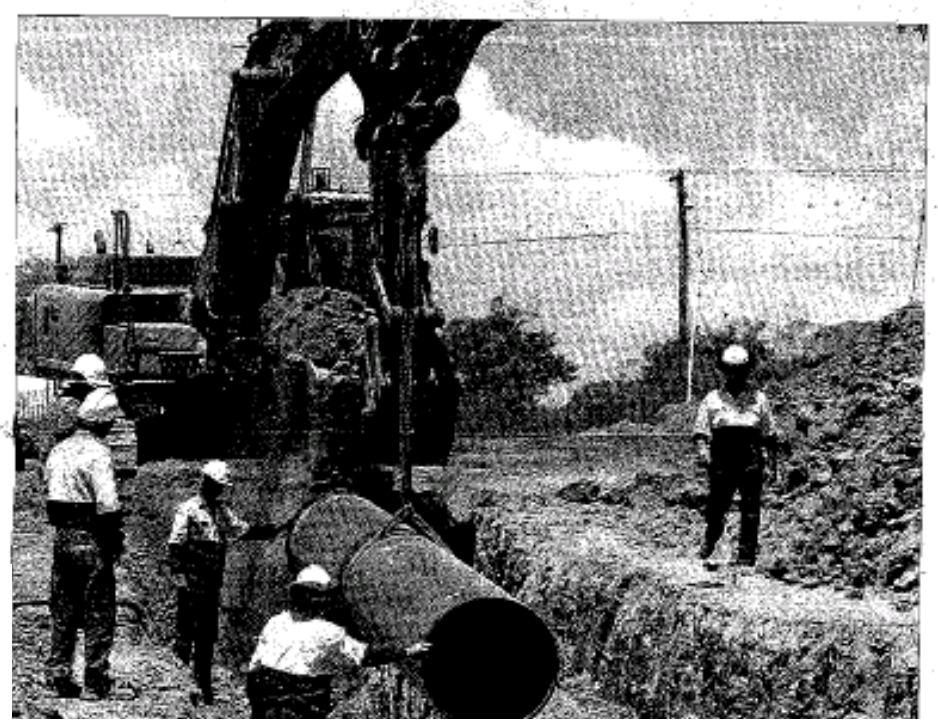
A yet-to-be-released report recommends linking Toowoomba and surrounding shires via a pipeline from Wivenhoe Dam to Perseverance Dam.

The pipe will take up to 9500 megalitres of water a year — more than a fortnight's supply for Brisbane.

The pipeline was recommended as the only viable solution to Toowoomba's water shortage by a taskforce of state and local government bureaucrats and Toowoomba business people.

The pipeline is designed to provide long-term water security and will be fast-tracked to allow it to provide emergency water supplies if Toowoomba's dams run dry, as predicted, in early 2009.

Progress of pipeline strikes rock bottom



Tuck Thompson

CONSTRUCTION of the pipeline which will deliver recycled water to Brisbane's parched dams is moving a snail's pace, having progressed on 500m of its 200km journey in the past fortnight.

The Government, however, remains optimistic that the pipeline will be constructed on time — despi the rate of progress having to be increased ten-fold if it is to be finished by the due date.

Infrastructure Minister Anna Bligh, who reviewed the digging and pipe laying outside Bundamba yesterday, said she was "very pleased" with the progress, which is already two months behind schedule.

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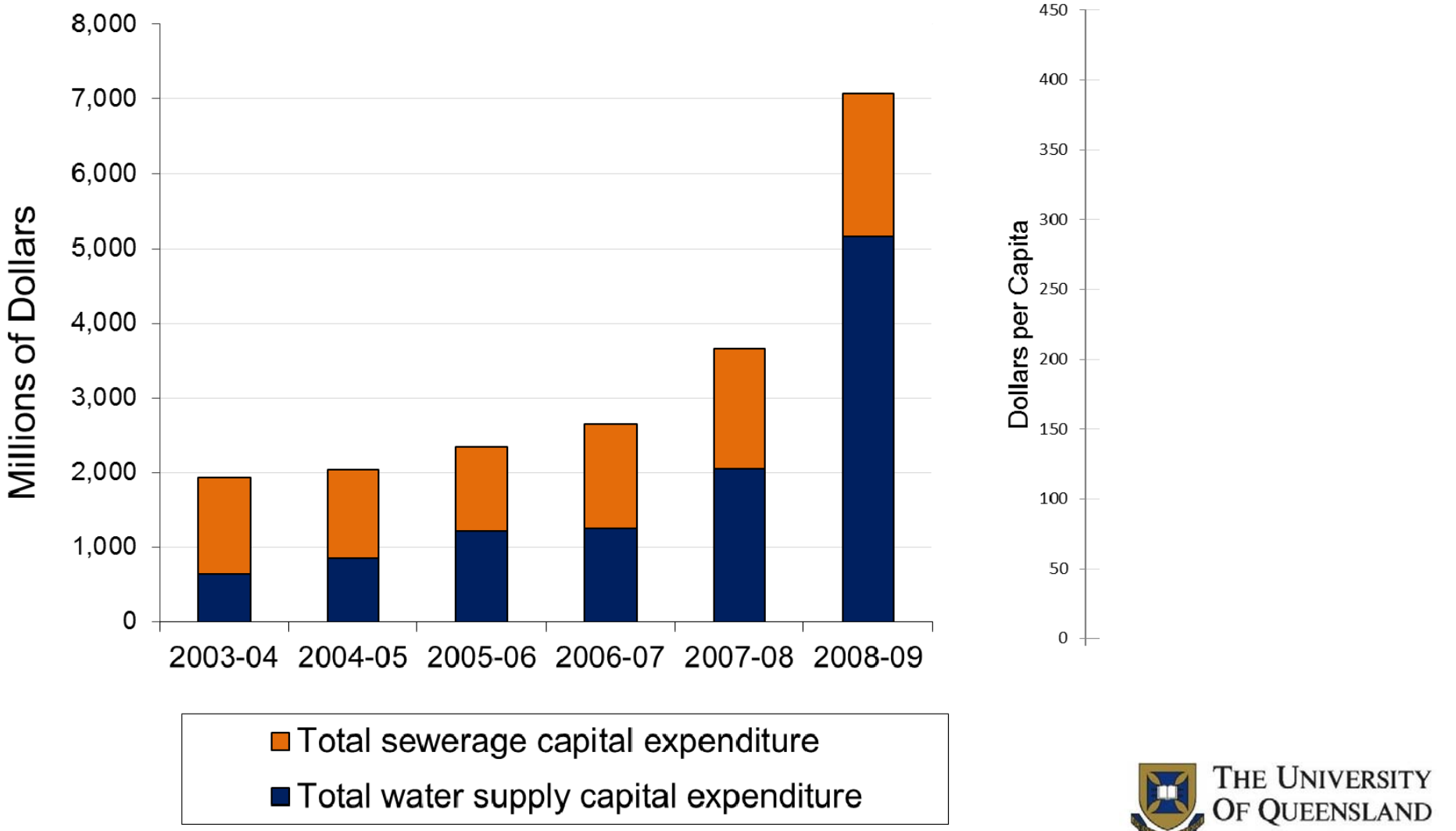
Australian urban water capex – major cities



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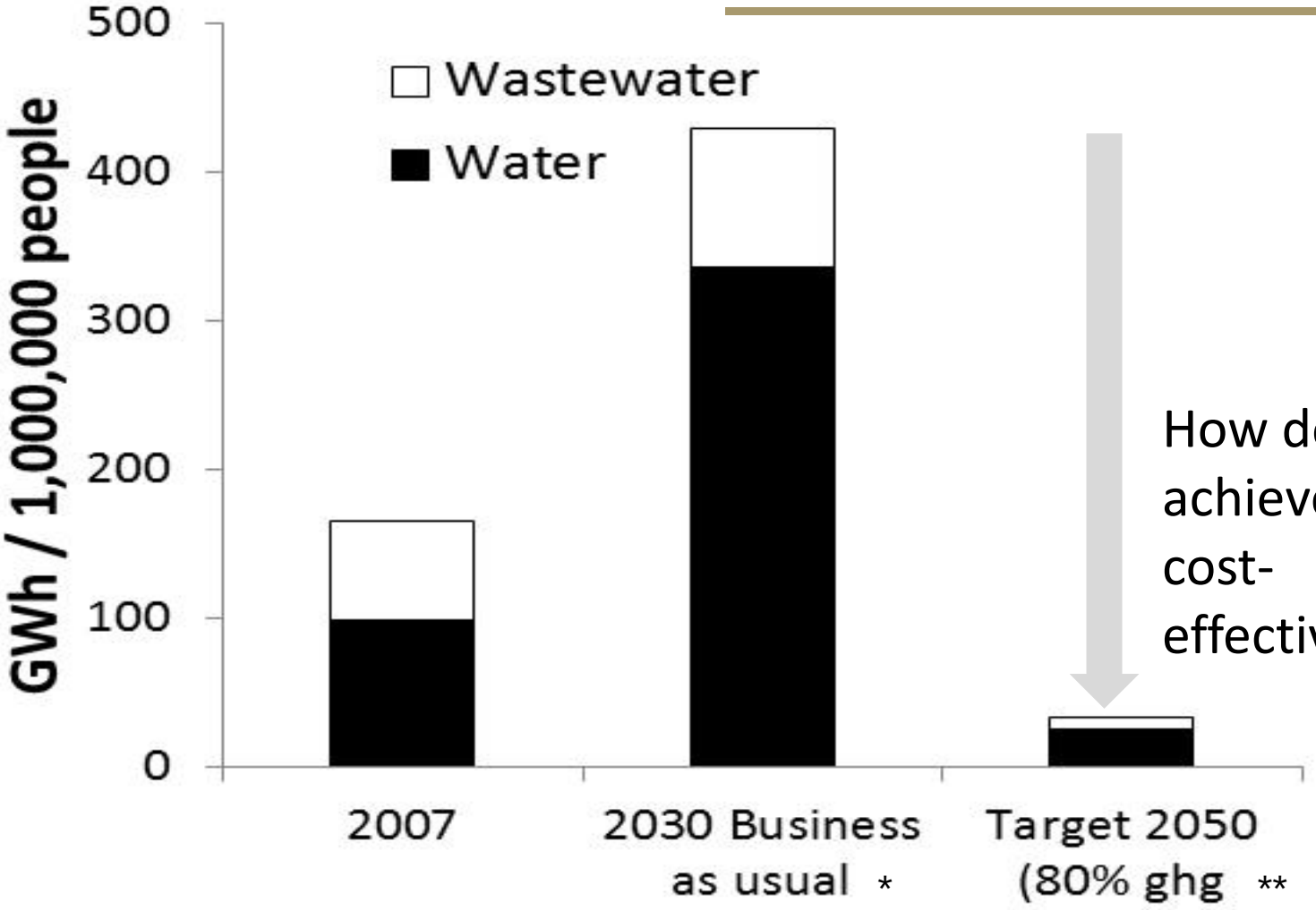
Challenge for Australia (and elsewhere) ….

Rising Urban Water Energy Use, Costs and GHG Targets



*Most future water supplied from desalination and reuse

** Target in 2011, has shifted now to 40-60 per cent below 2000 levels by 2030.

Kenway, S. J., Priestley, A., Cook, S., Seo, S., Inman, M. and Gregory, A. (2008) *Energy use in the Provision and Consumption of Urban Water in Australia and New Zealand, CSIRO and Water Services Association of Australia.* ISBN 978 0 643

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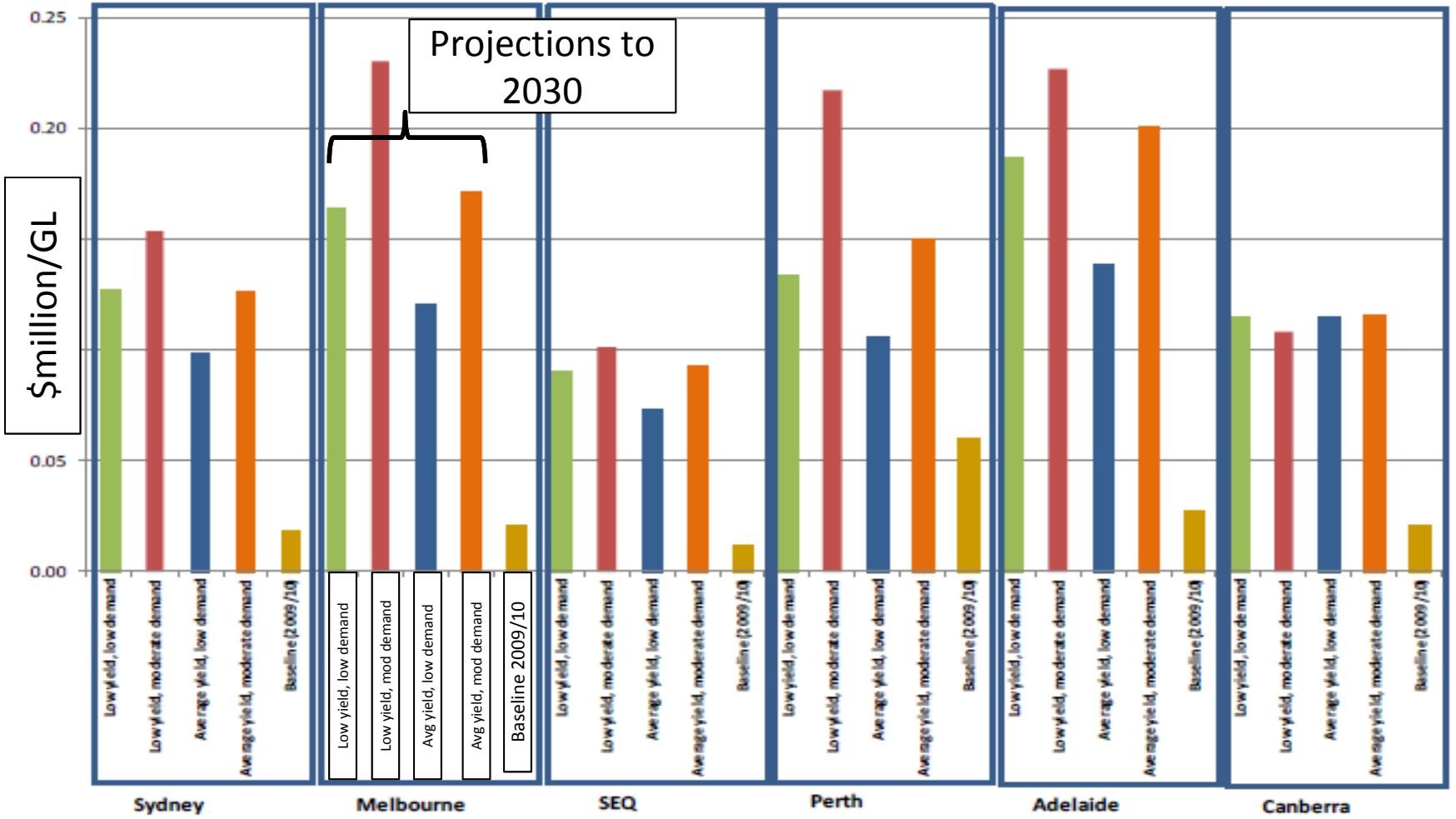
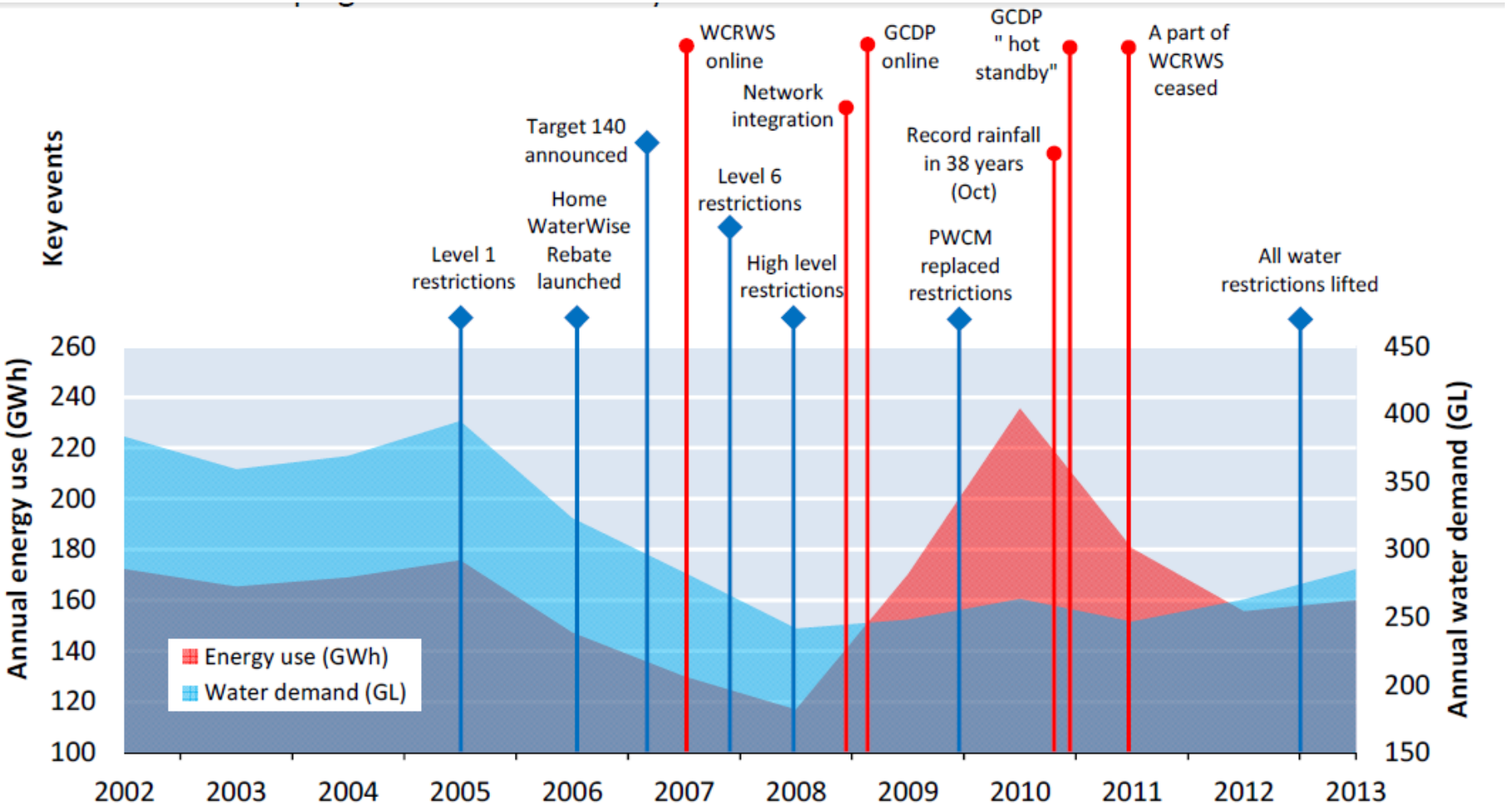
Cost per Unit of Water Supplied ($millions/GL) 600% increase by 2030



Cook et al 2012

Water use and energy use of SEQ system



Lam, Lant, Kenway 2015

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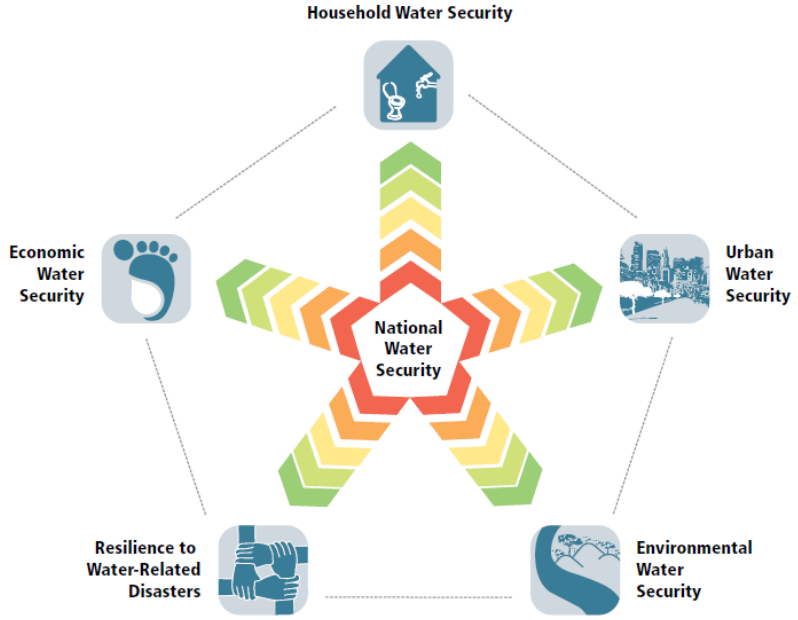
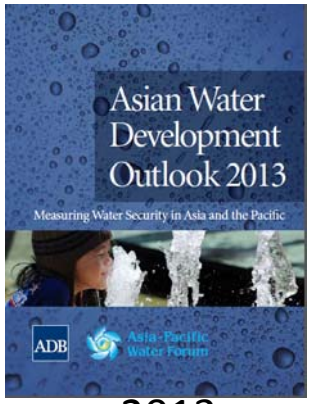
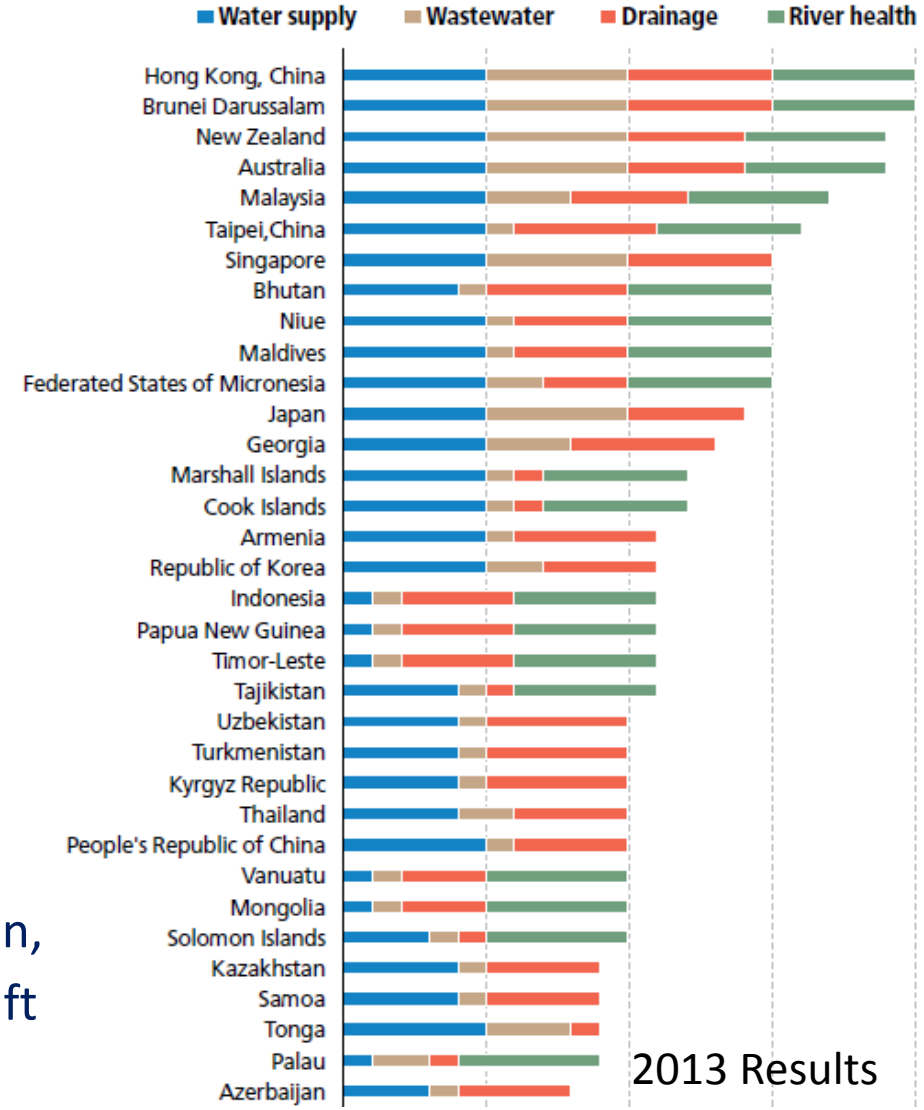
Asian Water Development Outlook 2016- Urban Water Security Index (48 Countries)





2013

2016 (higher resolution, more data, indicators, shift towards city scale)

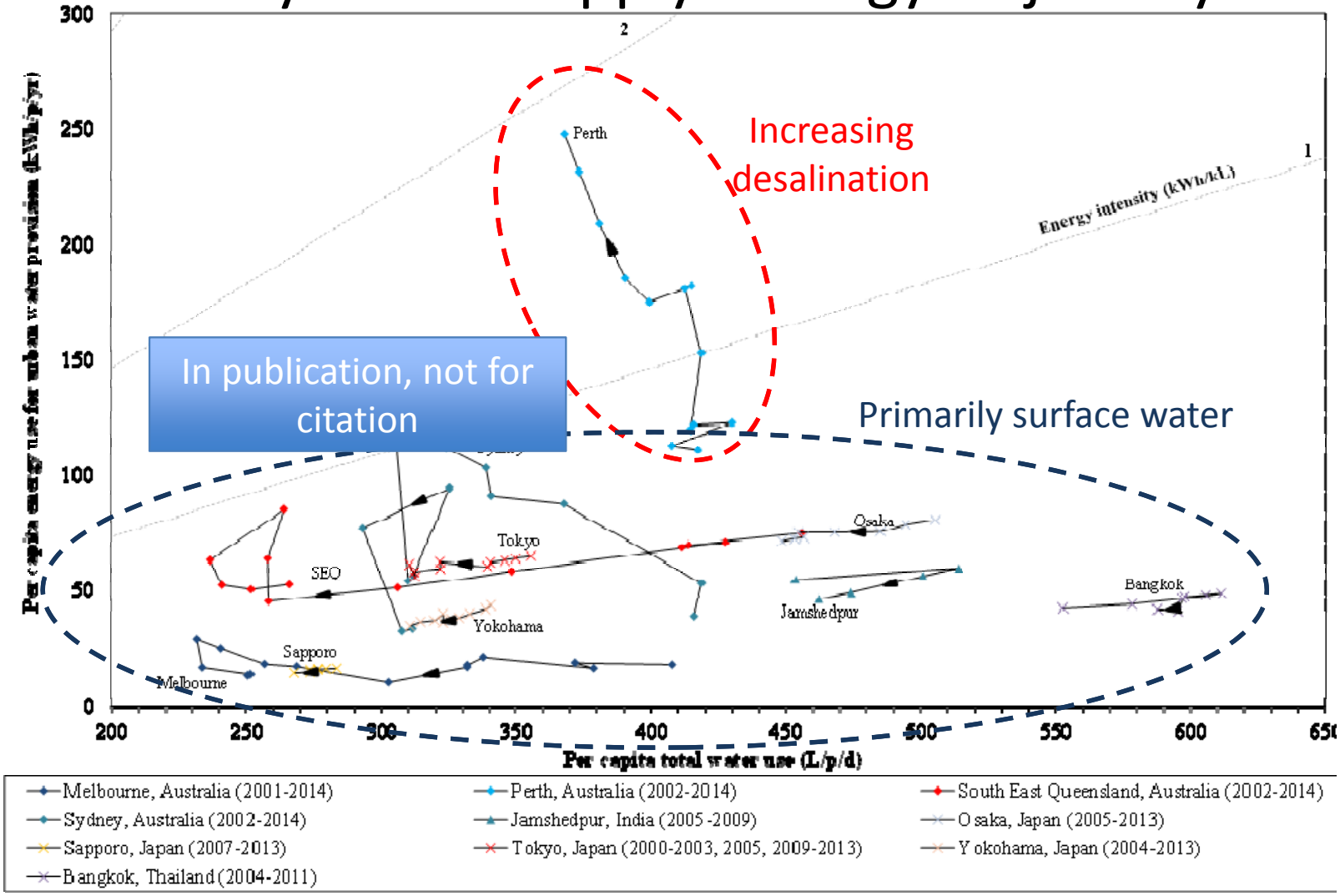


2013 Results

AWDO Case study: water supply "energy trajectory"

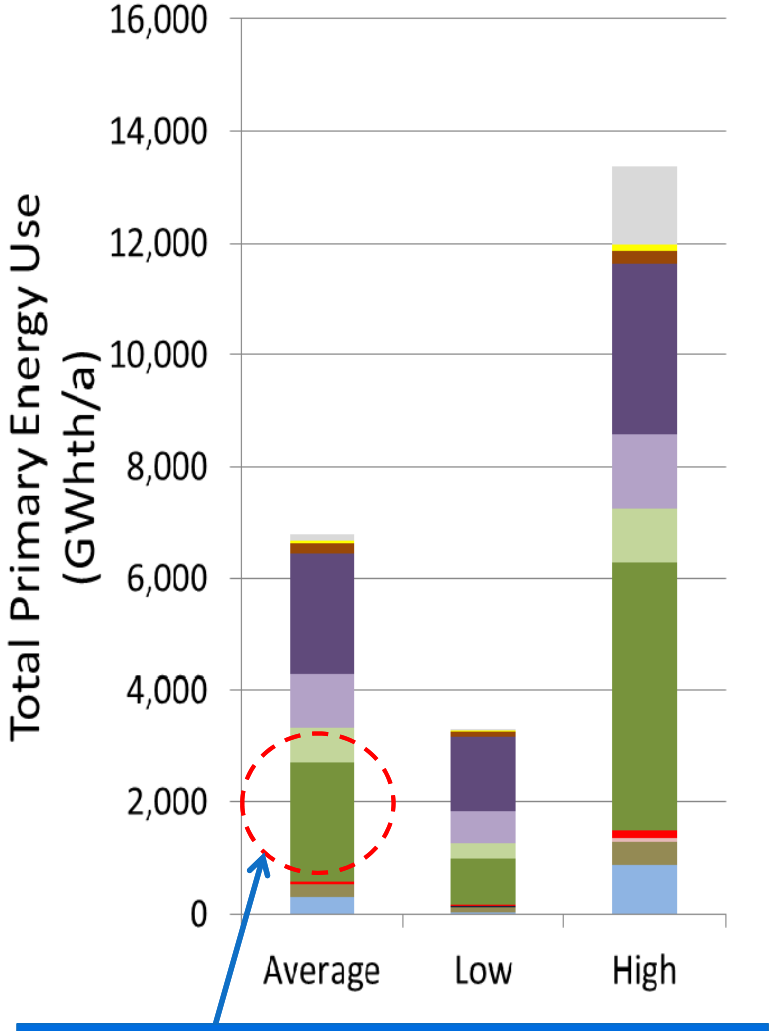
Context: Shifting to climate-resilient sources is often energy intensive. Energy is a major cost component of urban water supply.

Recommend: Develop indicators and include energy in AWDO 2016.



Based on Lam et al submitted papers 2015.

Urban water *indirectly* influences 13% of Australia's electricity, 18% of Australia's natural gas use (8% primary energy, 9% ghg emissions) in the average case.



Opportunity – residential water use – water and energy efficiency

- Heat Island (H) - water component
- N, P, K loss (resynthesis) (Rn + Rp + Rk)
- Carbon loss (not captured) (Rc)
- Industrial water use (Ui)
- Commercial water use (Uc)
- Residential use (non hot water) (Uro)
- Residential use (hot water) (Urhw)
- Bottled water (Pb)
- Highrise basement pumps (Ph)
- Rainwater tank pumps (Pd)
- Energy use - utilities - wastewater (Pww)
- Energy use - utilities - water (Pw)

INDIRECT ENERGY

- *resource loss*
- *water use*
- *water supply*

DIRECT ENERGY

Kenway , Lant, Priestley (Journal of Wate and Climate, 2011)

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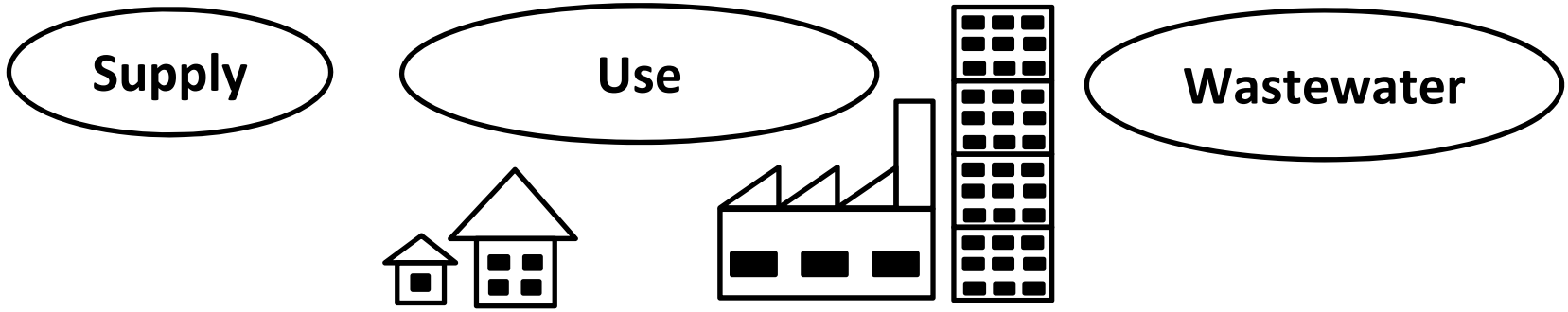
Energy Influenced by Urban Water

South East Queensland - 2011-12



	Supply	Residential (water-related energy)	Industrial & Commercial (water-related energy)	Wastewater treatment
Energy (GWh)	150	3,200*	2,300*	250*
Energy ($ million)	20	800*	300*	25*

(93%)

(96%)

Collectively:
- 13% of all electricity use in South East Queensland +
- 18% of all natural gas use
- 4% all other energy use

Source: Kenway, S., et al. (2015). A systemic framework and analysis of urban water energy (*Environmental Modelling and Software*)

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The overall water-energy landscape

Sources: Californian Energy Commission (2005); Wolff et al 2011, Kenway et al 2015.

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Integrated Water and Electric Utility Planning

Water Sector Drivers:

- Rising energy costs and dependency

Energy Sector Drivers:

- Energy demands exert pressure on water supplies
- Solar and wind power generation (while reducing demand will not reduce pressure on water resources for some time)

Mutual Drivers:

- Climate Change, Population growth
- Restrictive Standards
- Extreme Weather Events
- Water Scarcity
- Infrastructure Renewal and Replacement
- Revenue Fluctuations
- Overall Uncertainty for the Future

Project 4469 – Water Research Foundation (USA)

- Case-Studies
- Survey
- Utility guidebook
- Integrated Planning Tournament

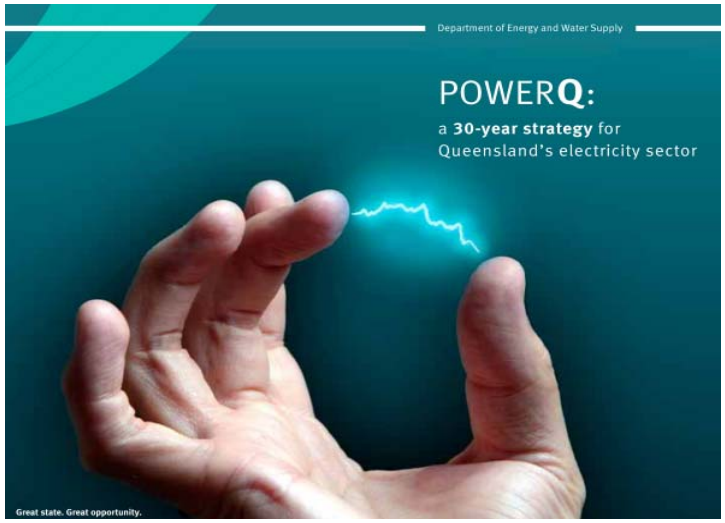
Water-Energy in Future

Current situation (2013)	Anticipated future (2030)
Water and energy funding and regulation and policy undertaken in isolation.	Comprehensive simultaneous policy, regulation and funding.
Water and energy utilities funded based on volumetric sales (GWh/ML).	Decoupling / Partial Decoupling of revenues from volumetric sales.
Reactive, unplanned trading. Problem-shifting.	"Systemic" planning and efficiency via design.
Scattered data and reporting making trends difficult to see.	Interlocking and co-ordinated data and reporting.
Unquantified urban performance.	Quantified performance underpinned by a clear metabolic boundaries.
Optimisation studies absent.	Optimisation guiding urban blueprints (regional and city plans).
No targets for water-related energy management.	Targets drive co-ordinated action across government and industry.
Isolated research and industry effort.	Co-ordinated research and action.

Kenway, S. J. 2013. The Water-Energy Nexus and Urban Metabolism - Connections in Cities. Brisbane: Urban Water Security Research Alliance. Technical Report 100.

Complementary Water and Energy Strategies (Minister for Water and Energy)

DEWS, 2014. **WaterQ:** 30-year strategy for QLD's water sector.



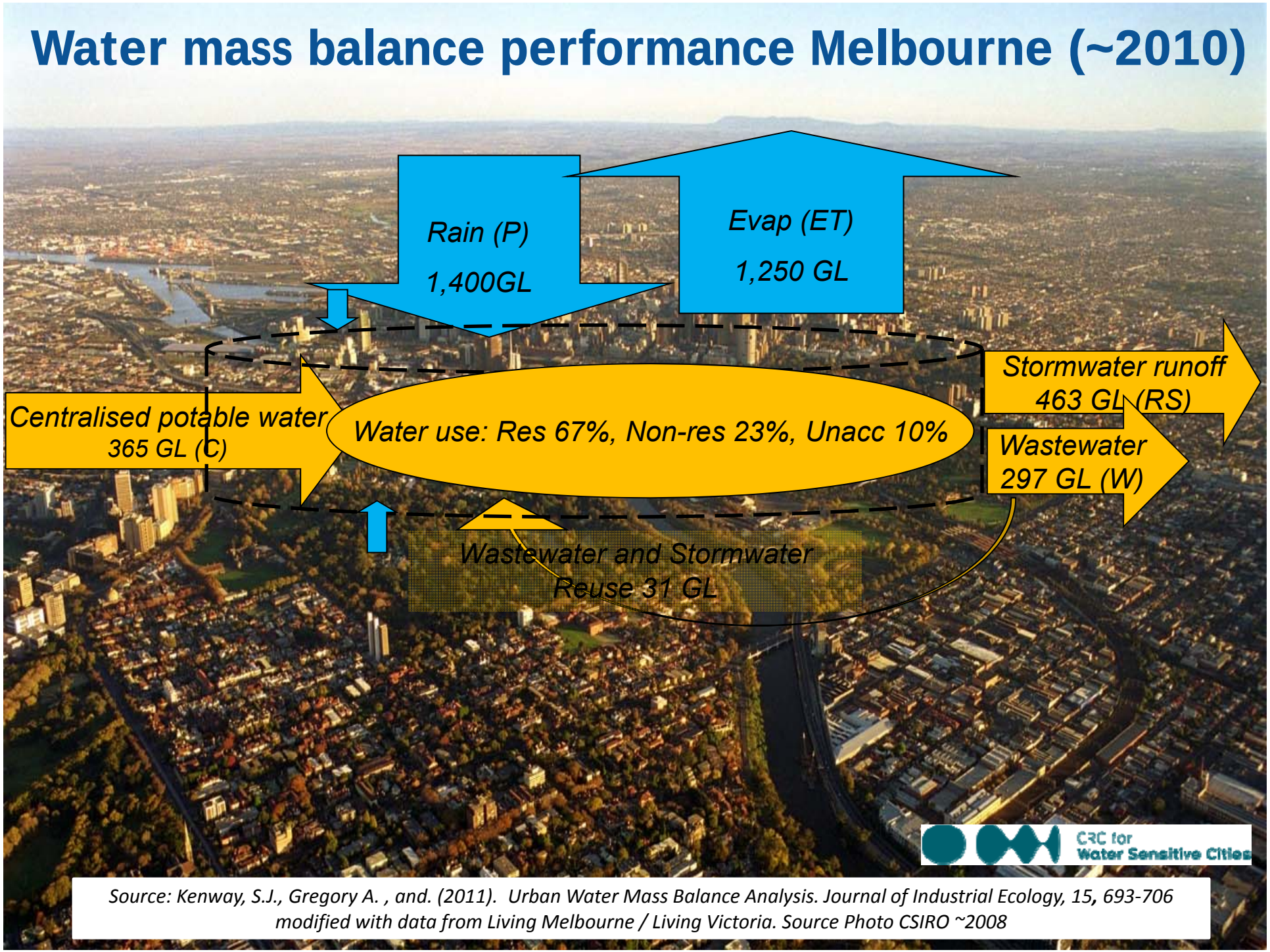
DEWS, 2014. **PowerQ:** 30-year strategy for QLD's electricity sector.

30-year plans with opportunities to achieve synergies between water and energy

Short video by former
Minister for Water and Energy 2013-2015
for integrated planning Tournament
(Water Research Foundation Project)

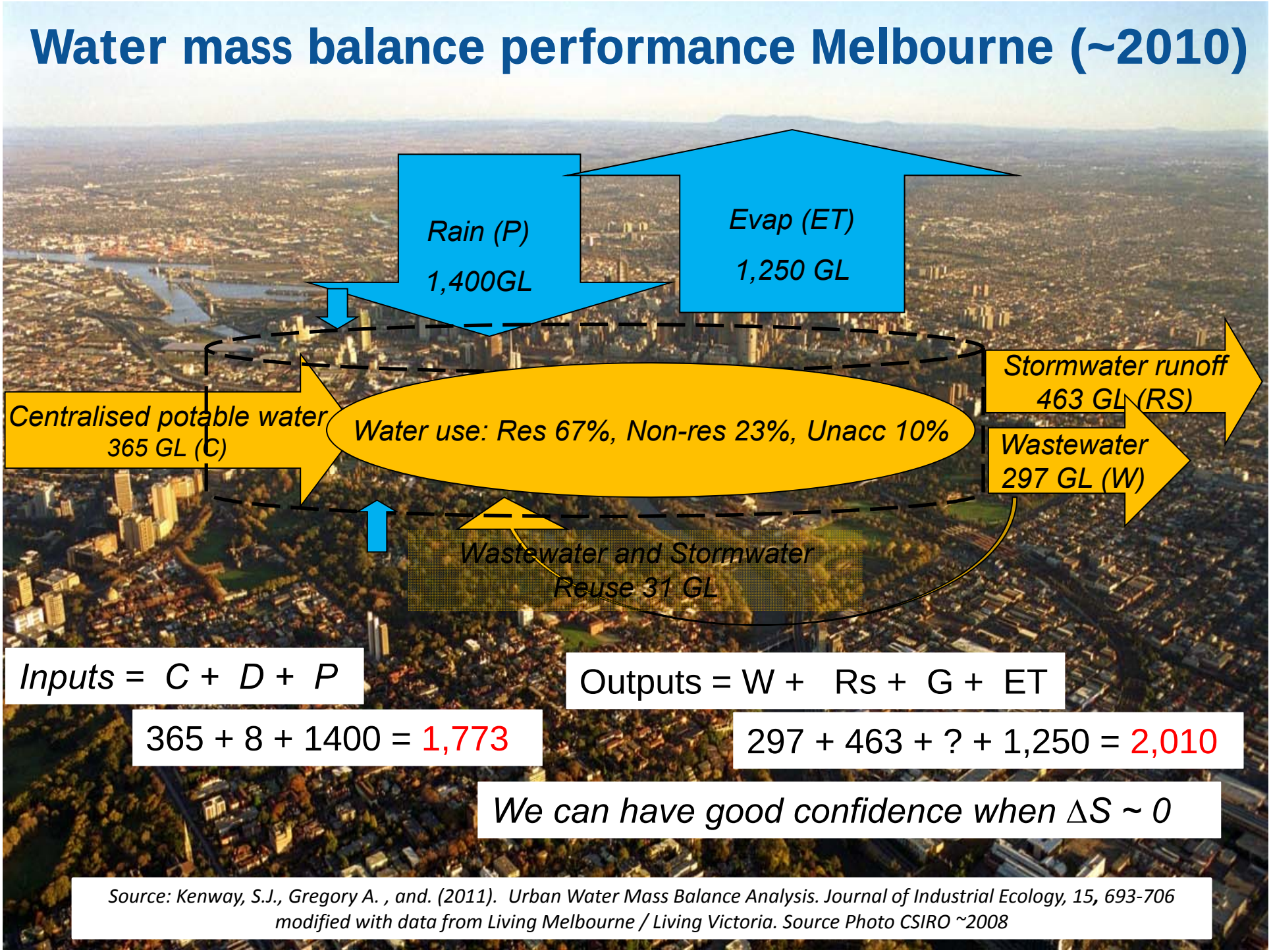
https://www.dropbox.com/sh/sfaov7j71sdlnnw/AAAdqU8K0HI3uirWuUpmk5a?dl=0

Water mass balance performance Melbourne (~2010)



Source: Kenway, S.J., Gregory A. , and. (2011). Urban Water Mass Balance Analysis. Journal of Industrial Ecology, 15, 693-706 modified with data from Living Melbourne / Living Victoria. Source Photo CSIRO ~2008

Water mass balance performance Melbourne (~2010)



Inputs = C + D + P

365 + 8 + 1400 = 1,773

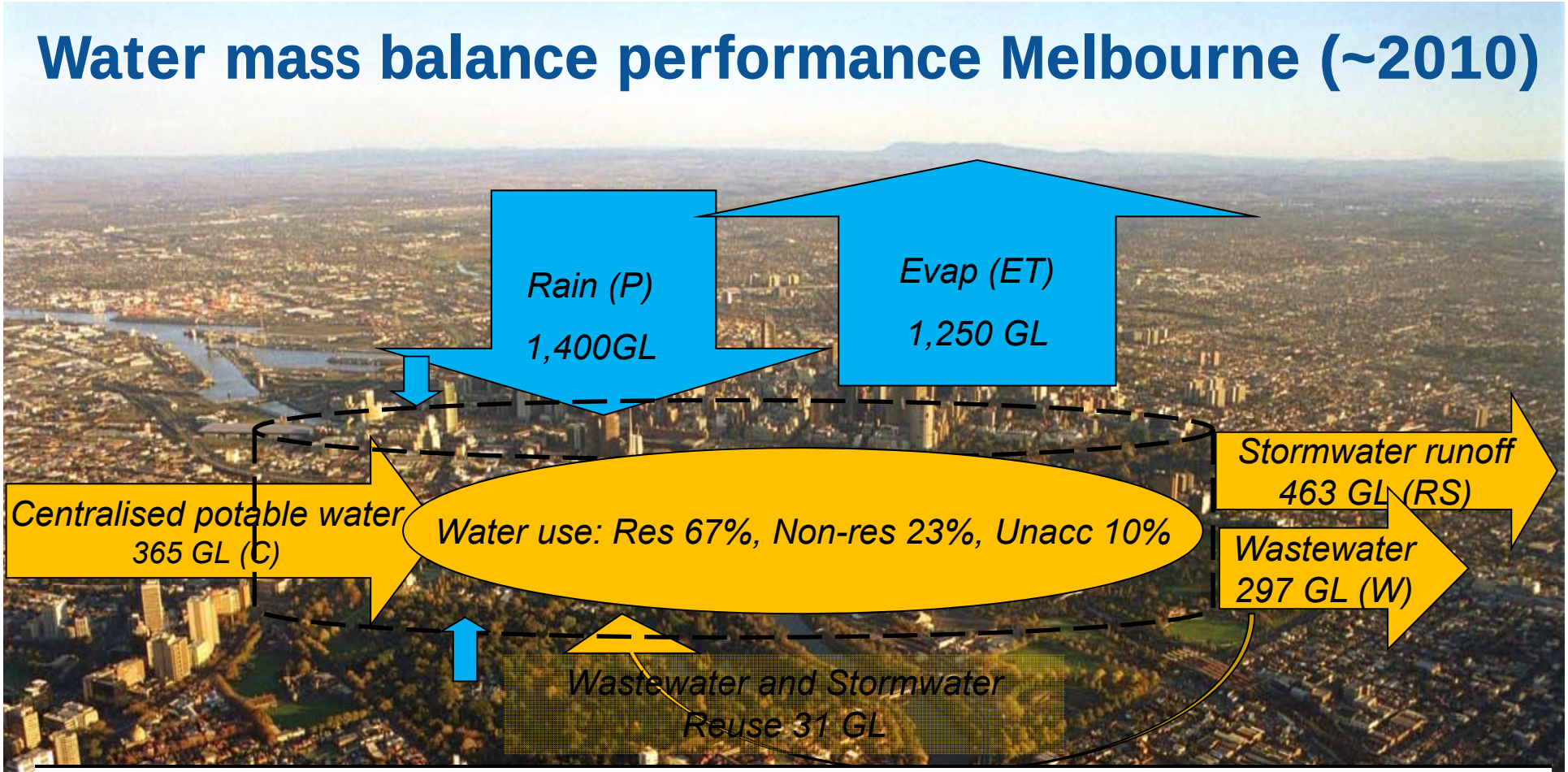
Outputs = W + Rs + G + ET

297 + 463 + ? + 1,250 = 2,010

We can have good confidence when $\Delta S \sim 0$

Source: Kenway, S.J., Gregory A. , and. (2011). Urban Water Mass Balance Analysis. Journal of Industrial Ecology, 15, 693-706 modified with data from Living Melbourne / Living Victoria. Source Photo CSIRO ~2008

Water mass balance performance Melbourne (~2010)

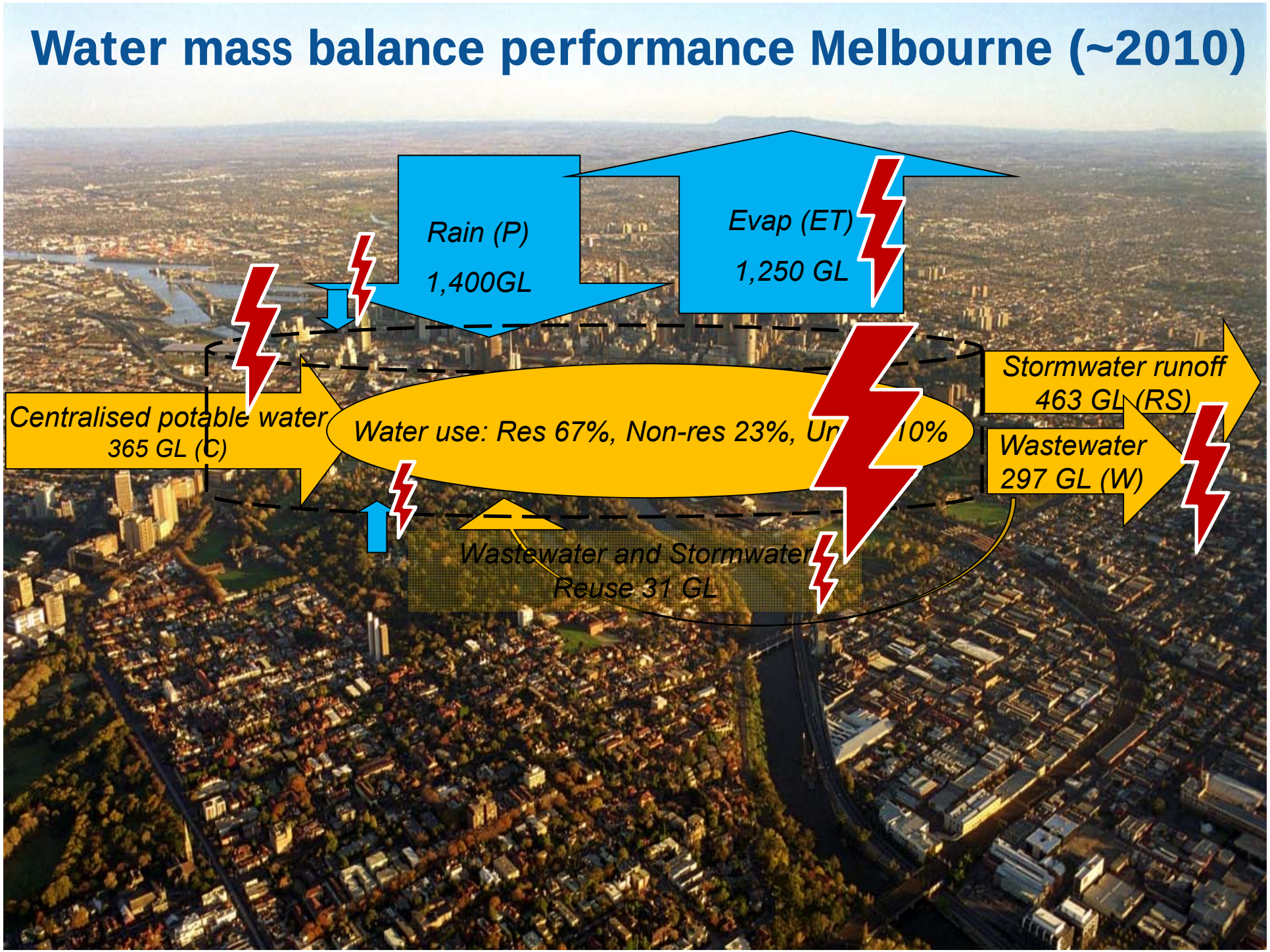


	Potential to meet centralised demand from			Current use of available resource		
	Rainfall	Wastewater	Stormwater	Rainfall (D/P)	Wastewater (Re/W)	Stormwater (Re(s)/Rs)
Melbourne	384%	81%	127%	0.5%	7%	2%

CRC for Water Sensitive Cities

Source: Kenway, S.J., Gregory A. , and. (2011). Urban Water Mass Balance Analysis. Journal of Industrial Ecology, 15, 693-706 modified with data from Living Melbourne / Living Victoria. Source Photo CSIRO ~2008

Water mass balance performance Melbourne (~2010)

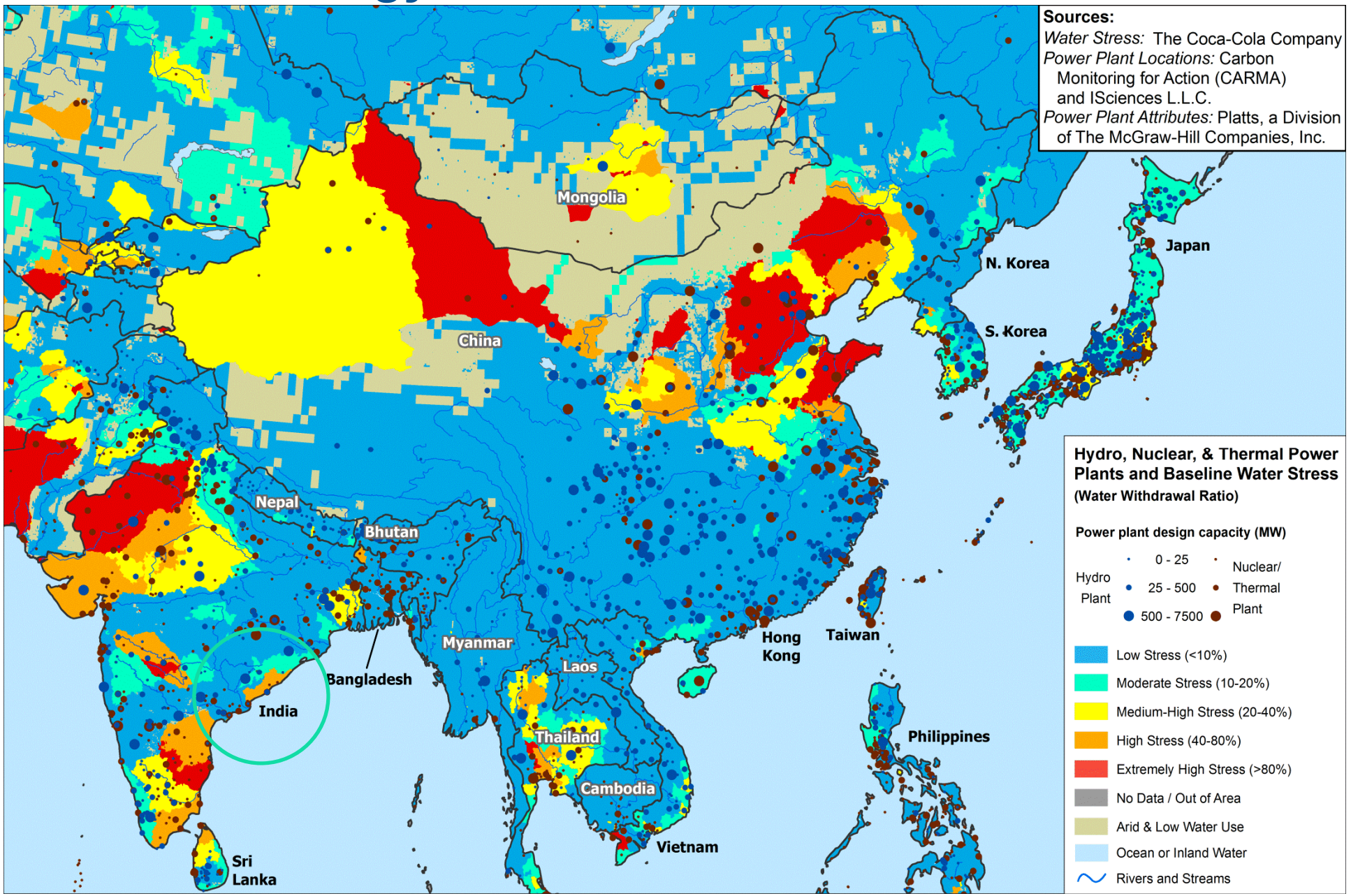


Master of Integrated Water Management Urban Metabolism Design module – build sustainable cities

Features:

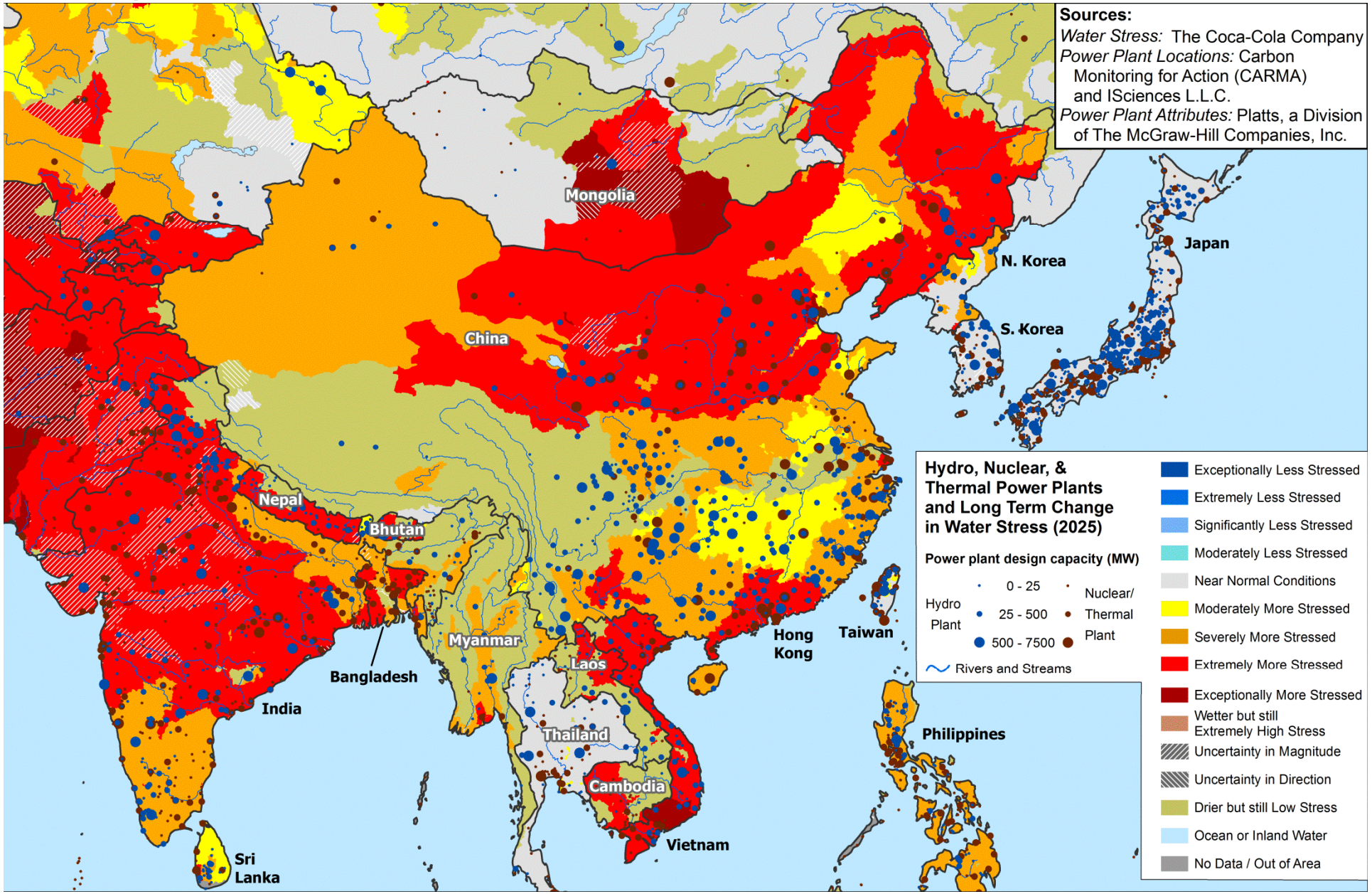
- Green buildings (rooftop cooling and stormwater management);
- Stormwater potable use and retention for habitat creation;
- Wastewater reuse for horticulture and energy generation

Water for energy? Baseline Water Stress



Source: James Dalton, World Water Forum 2015, Korea

Long Term Water Stress (and power plants, based on 2025 IPCC Scenario A1B)



Source: James Dalton, World Water Forum 2015, Korea

What will be the water/energy impact of emerging technologies at household scale?

Recirculating shower

amphiro

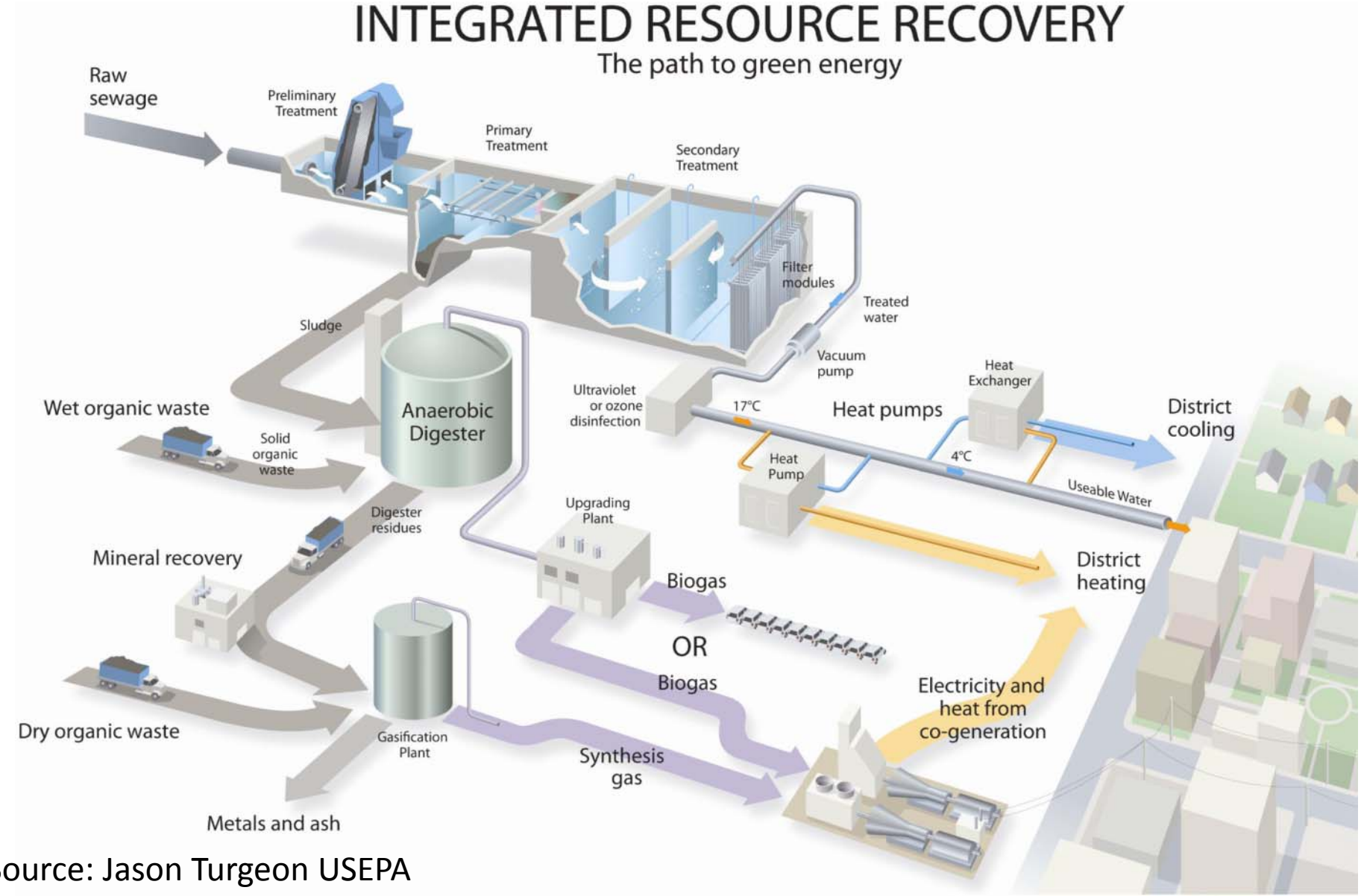
Airshower

Waterless or ionising clothes washers

Waterless dishwashers

Not a product endorsement

Technologies for city-scale



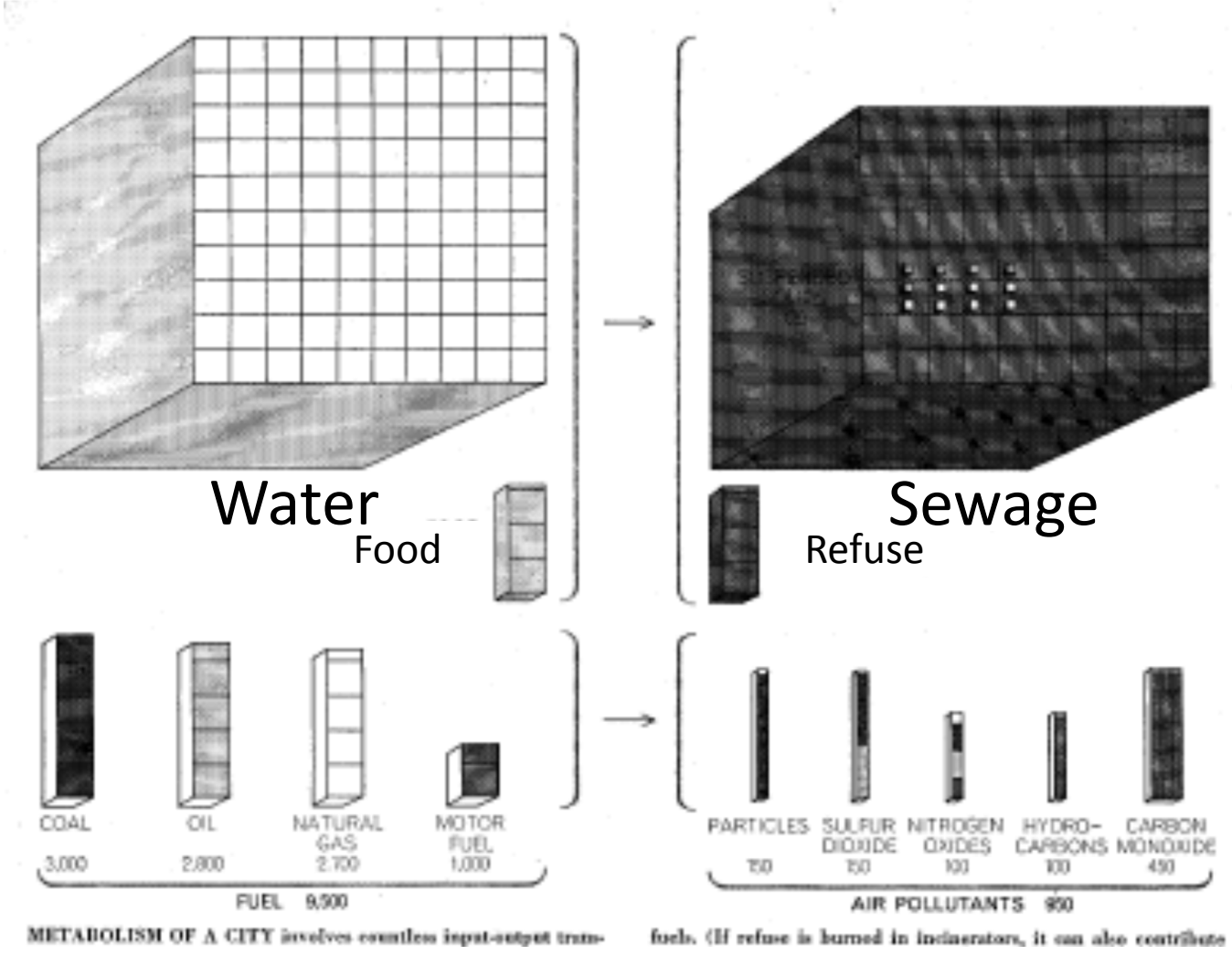
Source: Jason Turgeon USEPA

Literature examples

- "Rising energy costs and use, is a significant risk to the water sector" *Vicwater 2011.*
- "Water security underpins energy and economic security". *Sandia National Laboratories, US 2009.*
- "Sustainable solutions must address water, energy and climate change holistically." *World Business Council for Sustainable Development, 2009.*
- "Resilient pathways reduce GHG emissions, lowers water demand, maintain environmental quality and allow living standards to continue to improve" *Prime Minister Science Eng. and Innovation Council 2011, Australia.*

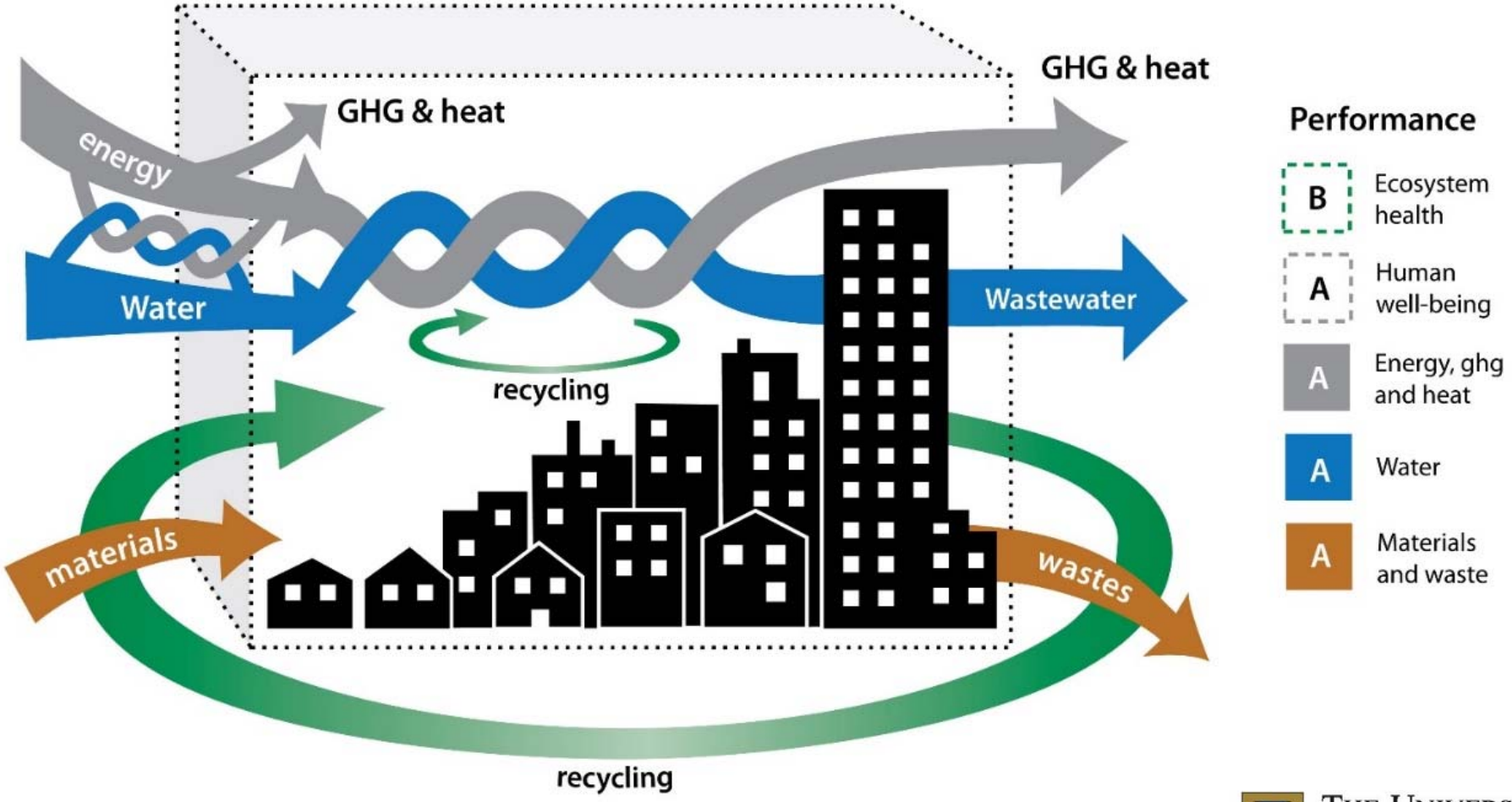
In 1965, Abel Wolman, AWA president, used metabolism as a concept to simultaneously deal with shortages of water, pollution of water and air… and public economic decisions

He concluded *"there is no shortage of water, however, there is a need for long-term thinking".*



Wolman, 1965, The Metabolism of Cities (Scientific American)

Research interest area – water, energy, GHG and urban performance



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Implications for cities in Asia

There is a need for forward-looking, scenario-based assessment at city-scale. For example, building on AWDO (and IAASA Water Futures) to consider high risk cities:

- Rapidly growing
- Reliant on diminishing (or impacted) water resources
- Likely to be increasingly dry in future

(ADB study (IIASA 2015) indicates 88% of Asian population with high water scarcity/complexity by 2050)

And then assess opportunities:

- What is the overall water balance – including opportunities from stormwater and wastewater flows.
- What is the right mix of supply-side and demand-side solutions.

Main messages

1. Achieving Water and Energy Security and Resilience needs all systems considered simultaneously.
2. Urban water supply and use has a large energy impact~ 10% of national primary energy use in Australia excluding Agriculture.
3. Much can be done to improve security and productivity – and reduce GHG emissions.

Whole of system understanding (including water-energy-economy links), solutions and technology, governance and institutions, collaboration and community engagement, financing mechanisms.

4. Understanding and managing water-energy links is important for economic and resource strategies.

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Selected References

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Acknowledgements

Thanks to various research sponsors, colleagues and collaborators:

Smart Water Fund
Australian Research Council
Seqwater
CRC Water Sensitive Cities
Water-Research Foundation
Jemena
Envestra
South East Water
Yarra Valley Water
City West Water
Eawag / ETH Zurich Bits to Energy

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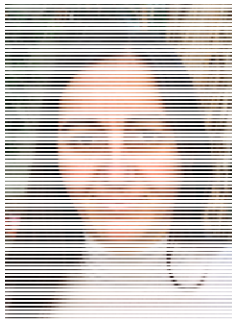
Thanks also to the contributing Water-Energy-Carbon team and supporters

Amanda Binks

Marguerite Renouf



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