STIRLING CITY CENTRE

URBAN RENEWAL PROJECT

The resilient, distributed and sustainable city template?

Our Context

- Closest major centre to CBD – 7 minutes
- 2nd largest employment area – 35,000 jobs
- Freeway and rail links to CBD
- Between CBD and Ocean

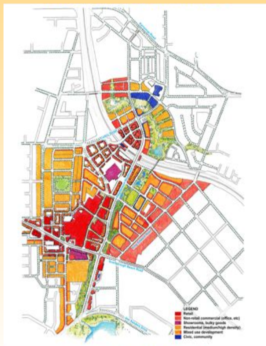
The issues…

- No formal *sustainability impact assessment* has been undertaken of the region.
- The City, DPI and partner agencies identified a number of problem areas including:

- **Macro issues**
- Car dependency (high GHG emissions per capita; vulnerability to peak oil)
- Low rates of social capital formation in dormitory suburbs; no sense of place
- Sprawling fringe development = loss of bio-diversity, productive farmland, water catchments, etc

- **Micro issues**
- Severe traffic congestion and high levels of through traffic
- Transit *proximate* development but no Transit *Oriented* Development
- Land uses incompatible with regional centre and rail/bus station (i.e. bulky goods retailing)
- Contamination of former landfill (leachate spreading to residential areas)
- Acidification of soils and groundwater in region, and risk in the area
- Pressure on the aquifer (2m declines in last 30 years)
- Poor visual amenity
- Community severance; dangerous walking/cycling environment

Our Goals



To create a sustainable community

- Environmental restoration;
- Green Corridor;
- Compact, mixed use transit-oriented;
- Distributed, green infrastructure;
- Affordable housing and living;
- Deliberative democracy and PPCP partnerships

Structure Plan Framework

Adopted by Council November 2008

Sets the following Targets:

- 30 000 jobs and;
- 12,500 dwellings within Structure Plan Area;

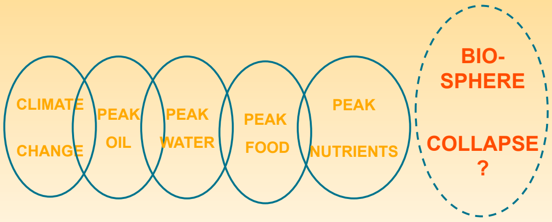
- **30% of dwelling stock will be 'affordable';**
- 20% of dwelling stock will be single bedroom;
- 25% of dwelling stock will be suitable for families.

"the great disruption"

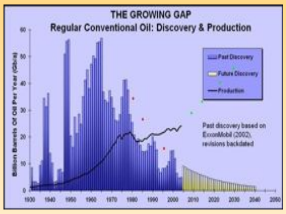
"the whole growth model we created over the last 50 years is simply unsustainable economically and ecologically and that 2008 was when we hit the wall -- when Mother Nature and the market both said: "No more."

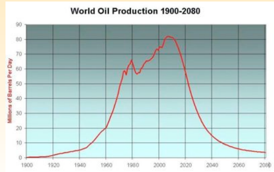
- Thomas Friedman - New York Times 7 March 2009

The emerging peaks…



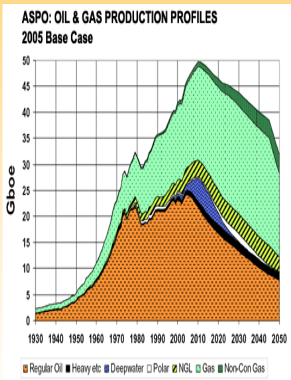
Peak Oil

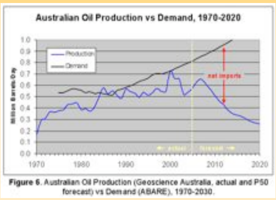


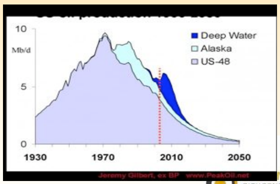


- "**Peak oil** is the point in time when the maximum rate of global petroleum extraction is reached, after which the rate of production enters terminal decline."
- **"Current global trends in energy supply and consumption are patently unsustainable – environmentally, economically, socially. Securing energy supplies and speeding up the transition to a low carbon energy system both call for radical action by governments – at national and local levels"** ***IEA 2009***
- Professor Peter Newman.. said that Peak Oil has happened. It occurred in 2008 and was directly linked to the GFC. As oil and therefore petrol became more costly, so those stretched by mortgages that they couldn't pay, went broke. The Global Financial Crisis, says Professor Newman, had an oily origin. *Countercurrents.org, 3 May 2010*

Declining output…







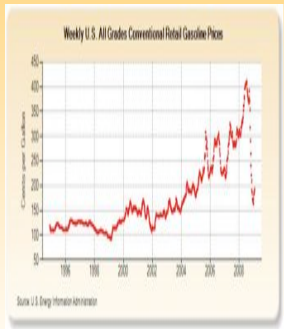
Non linear impacts…

Demand for oil is price *inelastic*

During the second oil shock in 1979, a 9% decrease in world oil output translated into a **trebling of prices**.
Australian Senate Report, 2007

Oil drives our farming equipment and is an essential feedstock for:

Pesticides and herbicides
Lubricants
Dyes and paints
Pharmaceuticals
Synthetic fibres
Plastics



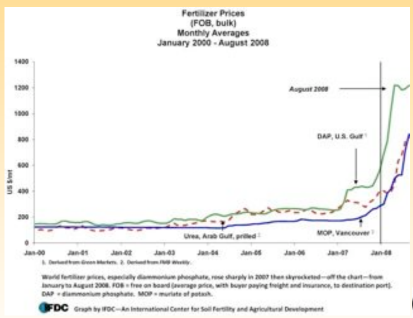
Energy vulnerability

- Kwinana BP refinery supplies almost 90% of refined fuels in WA and is sourced from:

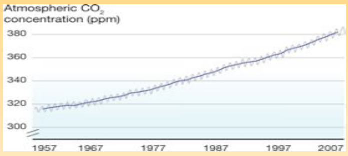
North West Shelf:	32%
Other WA oil fields:	12%
Total WA:	**44%**
SE Asia* & West Africa:	29%
Middle East:	27%
Total Offshore:	**56%**

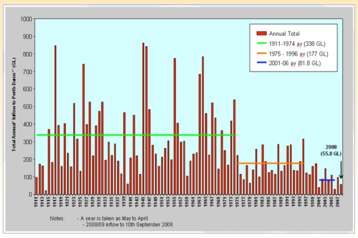
- **Max potential 2 Weeks Storage**
- *Malaysia, Indonesia, Vietnam, PNG

Peak nutrients??



Peak Climate Stability?





Keeling Curve

"Magic Gates"
1975
1998
2010??

Non linear impacts
(runoff into Perth's dams has declined much faster than winter precipitation

Peak Water

We've lately raised the Earth's average temperature by .74°C (1.3°F), a number that sounds inconsequential. But these words do not: flood, drought, hurricane, rising sea levels, bursting levees. Water is the visible face of climate and, therefore, climate change.

The results are in plain sight along pummelled coasts from Louisiana to the Philippines as super-warmed air above the ocean brews superstorms, the likes of which we have never known. *In arid places the same physics amplify evaporation and drought, visible in the dust-dry farms of the Murray-Darling River Basin in Australia. On top of the Himalaya, glaciers whose meltwater sustains vast populations are dwindling.*

http://ngm.nationalgeographic.com/2010/04/water-is-life/kingsolver-text/3

Perth's potable water supplies

- **Gnangara water mound 137GL**
- Stream flow into dams: 55.8GL
- **Kwinana Desalination Plant: 45GL**
- Yarragadee (deep aquifer): 15GL
- **Jandakot water mound: 10GL**

- *Proposed* Binningup plant: 50GL (100GL potential)

Gnangara Aquifer may never recover…

WA NEWS / SHARON SMITH ©

THE STATE GOVERNMENT HAS CONCEDED THAT WATER LEVELS IN THE GNANGARA MOUND MAY NEVER FULLY RECOVER, SPARKING CLAIMS THAT MANY OF PERTH'S LAKES AND WETLANDS ARE AT SERIOUS RISK. IN THE WAKE OF PERTH'S DRIEST SUMMER AND YEARS OF BELOW-AVERAGE RAINFALL, THE DEPARTMENT OF WATER SAID THE WATER TABLE IN THE GNANGARA HAD FALLEN TO ITS SECOND LOWEST POINT SINCE RECORDS WERE KEPT. WATER LEVELS HAD DROPPED 3.61M, OR MORE THAN 500 BILLION LITRES, BELOW THEIR HISTORICAL AVERAGE.

DIRECTOR-GENERAL KIM TAYLOR ATTRIBUTED THE DRAMATIC FALL TO PERTH'S DIMINISHING RAINFALL AND SAID THE DEPARTMENT HAD TAKEN STEPS TO EASE PRESSURE ON THE VITAL RESOURCE. THESE INCLUDED CUTTING THE WATER CORPORATION'S ANNUAL TAKE FROM THE MOUND BY MORE THAN 30GL, IMPOSING A PERMANENT WINTER SPRINKLER BAN, INTRODUCING WATER EFFICIENCY MEASURES FOR AGRICULTURE AND INCREASING THE LEVEL OF MONITORING.

MR TAYLOR SAID A PROMISING, BUT STILL UNPROVED, PLAN TO REPLENISH THE MOUND WITH TREATED SEWAGE ALSO WOULD BE CRUCIAL TO ITS FUTURE. BUT HE OFFERED A SOBERING OUTLOOK FOR THE GNANGARA'S PROSPECTS, SAYING THAT WHILE WINTER RAINFALLS WOULD ALWAYS PARTIALLY RECHARGE WATER LEVELS, A FULL RECOVERY WAS UNLIKELY.

"SIGNIFICANT RECOVERY IN LEVELS IS ONLY POSSIBLE IF WE HAVE A SUSTAINED PERIOD OF SIGNIFICANTLY ABOVE-AVERAGE RAINFALL," MR TAYLOR SAID. "RECENT WORK FROM THE CSIRO WOULD SUGGEST THAT THIS IS NOT LIKELY."

EDITH COWAN UNIVERSITY ASSOCIATE PROFESSOR PIERRE HORWITZ, AN AQUATIC ECOLOGIST, SAID IT WAS DISINGENUOUS OF THE DEPARTMENT TO ASSERT THAT LOWER RAINFALL WAS THE ONLY CAUSE BEHIND THE GNANGARA'S PREDICAMENT. HE SAID THERE WAS TOO MUCH WATER BEING TAKEN FROM THE MOUND AND THIS WAS LEADING TO THE COLLAPSE OF A NUMBER OF LAKE AND WETLAND SYSTEMS. HE SAID LOCH MCNESS, A LARGELY DEPLETED NATURAL LAKE SYSTEM NEAR YANCHEP, WAS TYPICAL OF THIS.

CONSERVATION COUNCIL EXECUTIVE DIRECTOR PIERS VERSTEGEN SAID PERTH'S WETLANDS WERE AN IMPORTANT BREEDING GROUND FOR MANY DIFFERENT SPECIES OF MIGRATORY BIRDS AND WA HAD AN INTERNATIONAL OBLIGATION TO MAINTAIN THEIR VITALITY. He acknowledged the Government had introduced measures to protect the Gnangara Mound but accused it of not acting quickly enough.

Transformational Change is occurring

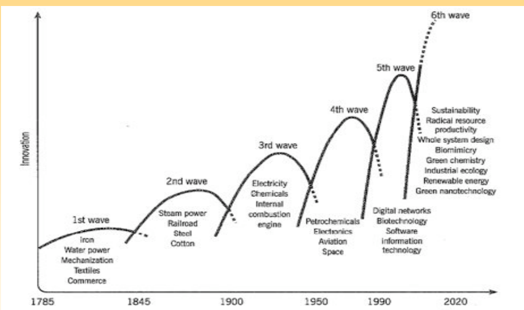


Figure 1.1 *Waves of innovation of the first and the next industrial revolution*

Hargroves & Smith 2005 – The Natural Advantage of Nations

Resilient Cities

- **Renewable energy city**
- **Carbon neutral city**
- **Distributed city**
- **Photosynthetic city**
- **Eco – efficient city**
- **Place base city**
- **Sustainable transport city**

- Newman, Beatley. Boyer 2009

Our journey towards the vision of a distributed, green city…

- Environmental Workshop – May 2009
- Water and Energy Workshops – October 2009
- Energy & Water Barriers Papers – Completed Feb 2010
- Green Infrastructure Study awarded to PB-CUSP Alliance – March 2010
- Technology Options Workshop 13th April 2010

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What the Stirling City Centre Alliance Green Infrastructure Study Proposes

- 1 Technology Review & Evaluation Criteria
- 2 Conceptual Design Scenarios/Governance models
- 3 Identification of next steps

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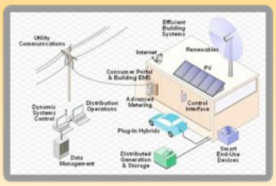
What we mean by green or distributed infrastructure?




- Green or Distributed Infrastructure systems are decentralised systems providing key utility services (electricity, potable and waste water, gas/bio-gas, solid waste, ICT, etc)
- They are designed to reduce our ecological footprints (impacts on the natural environment). E.g. reduce carbon emissions, protect natural environments, conserve precious resources such as fresh water.

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Australian Green Infrastructure Council (AGIC) Green Infrastructure Rating Tool

1. Project Management & Governance	1.1 Purchase & Procurement 1.2 Reporting & Responsibilities 1.3 Climate Change Vulnerability 1.4 Making Decisions 1.5 Knowledge Sharing & Capacity Building
2. Economic Performance	2.1 Value for Money 2.2 Due Diligence 2.3 Economic Life
3. Using Resources	3.1 Energy Use 3.2 Water 3.3 Material Selection & Use
4. Emissions, Pollution & Waste	4.1 Greenhouse Gas Management 4.2 Discharges to Air, Water & Land 4.3 Land Management 4.4 Waste Management
5. Bio-diversity	5.1 Functioning Ecosystems 5.2 Enhanced Biodiversity
6. People & Place	6.1 Health, Wellbeing, Safety 6.2 Natural & Cultural Heritage Values 6.3 Participatory Processes 6.4 Positive Legacy for Current & Future Generations 6.5 Enhanced Urban & Landscape Design & Aesthetics 6.6 Knowledge Sharing, Shared Intellectual Property
7. Workforce	7.1 Safety, Health & Wellbeing of Workforce 7.2 Capacity Building 7.3 Increased Knowledge of Applied Sustainability 7.4 Equity

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Learning's from 'cutting edge' case studies

- Armstrong Creek
- Bedzed
- Masdar City
- Hammerby Sjostad


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Armstrong Creek

South of Geelong, Victoria
▪2687 hectares
▪22 000 homes
▪22 000 jobs
▪54 000 people

Sustainability Victoria funded a *Business Case* demonstrating benefits of sustainable infrastructure

Regional 3rd pipe option favoured – centralised wastewater recycling; re-use for POS irrigation and non-potable applications including toilet flushing

Energy supply & Demand
▪7 star homes + efficient appliances/lighting
▪Gas fired co-generation for electricity and district heating = 10 tCO_2 - e/year

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BedZed Beddington Zero Energy Development

UK's largest carbon neutral development

- Completed in 2002
- 100 eco-homes & offices (80 homes)

Project Benefits:

- Space heating reduction 88%
- Fossil fuel consumption for private car use down 65%
- Hot water reduction 57%
- Mains water reduction 50%
- Electricity reduction 25%

Design Elements

- *The buildings* have 300mm insulation; south facing terraces; efficient appliances; smart meters
- *Combined heat & power* plant fuelled by timber (cut offs from tree surgery) and provides electricity and hot water (super-insulated pipes)
- *Green transport plan* – encourage use of transit, provides a car club, free parking for EV's
- *Water conservation, treatment & recycling* including low flow tabs & dual flush toilets; biomembrance reactor for on-site recycled-water
- *Materials and resources* – 15% of materials reclaimed or recycled; 52% sourced from 32 mile radius;

Masdar City, UAE

17km from Abu Dhabi

- Site area of 6 km2
- Home to 50,000 people and 1,500 businesses.
- 40,000 workers will commute to the city daily.

Project Benefits:

Carbon emissions zero
Zero waste
Water consumption 50% reduction
Water recycling 80%
Mobility: A fossil-fuel-free, solar-powered personal rapid transit system

Hammerby Sjostad

Stockholm, Sweden

- Former industrial site located next to lake Hammerby Sjo;
- 9,000 apartments for approximately 20,000 residents;

Urban Design

- Mixed use developments; restricted building depths & setbacks for sunlight & views; balconies/terraces; green roofs; light rail

Energy and waste

- Henriksdal sewage plant treats wastewater;
- Heat is recovered for space heating of apartments;
- Solid waste converted into biogas.
- Plans to extract nutrients from sewage and wastewater via new technology for use on farmland.
- Surface water treated locally to avoid overloading the sewage works.
- Combustible waste in the area is recycled as heat and food waste is composted into soil.

Multi-Modal Center

Lake View

The Stirling City Centre Context

Towards sustainable re-development

- The goal of the Stirling City Centre Alliance is to become *"the world's most sustainable city by 2031"*. There will be a need to incorporate "cutting edge" initiatives in water and energy supply and demand management.
- It is also believed that there are strong potential links with waste management and related information and communication technologies.

Green infrastructure vision

- Low to zero footprint
- Reduce need for centralised services
- Optimum use of local services
- Reduce life-cycle costs
- Improve liveability

- Can we become a net exporter of energy, water and waste?

SUSTAINABILITY ASSESSMENT FRAMEWORK

Footprint					
Metabolism	% Carbon in electricity *Zero to low*	% Scheme water supply *Zero to low*	% Main drainage of total storm water *Zero to low*	% Main sewerage of human waste *Zero to low*	% Solid waste to tip *Zero to low*
Reducing need for centralised services					
Systems operations – temporal	Peak power from grid *Zero to low*	Draw on summer reserves (local & bioregional) *Zero to low*	Storm water in flood times *Zero to low*	Discharge at peak times *Zero to low*	Need for extra garbage trucks *Zero to low*
Optimum use of localised services					
Systems design – local	Optimum use of local sun, wind and geothermal energy sources *% local to central*	Optimum use of local rain and ground water (shallow and deep). *% local to central*	Optimum use of local biophilic elements and soil (sand and peat). *% local to central*	Optimum use of local people's waste *% local to central*	Optimum use of household and business waste *% local to central*
Reduced costs					
Systems design – cost	Least use of grid power charges *% cf to grid* Least substation power charge. *% cf to grid* Most use of on-going power production revenue *$ gained*	Least use of scheme water charges *% cf to grid* Least use of headworks water charge *% cf to grid* Most use of on-going water supply revenue *$ gained*	Least use of main drainage charges *% cf to grid* Least use of drainage charge *% cf to grid* Most use of on-going stormwater revenue *$ gained*	Least use of sewerage charges *% cf to grid* Least use of headworks sewerage charge *% cf to grid* Most use of on-going sewerage revenue *$ gained*	Least use of solid waste tip site charges *% cf to present system* Least use of solid waste levy *% cf to present system* Most use of on-going solid waste recycling revenue *$ gained*
Improved Liveability whilst Reducing Footprint					
Systems design and operations – human	Reliable power *% cf to grid* Contribution to	Clean and reliable water supply *Days meeting standard cf grid*	Creeks rather than drains. *% reduction*	Safe disposal of sewage *Days meeting standard cf grid*	Safe disposal of garbage *Days meeting standard cf present system* Contribution to recycling

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Opportunities identified at workshop

- **Promote efficiency first: green buildings, social marketing**
- **Reduce electricity demand: district heating & cooling**
- **Flatten the peak: smart meters & appliances, smart grids, thermal cooling**
- **Find alternative sources: solar PV, water (rain & stormwater harvesting, grey water re-use), geo-thermal (offset electric demand and/or generate power) bio-gas from solid waste & waste water**
- **Energy Storage: lithium batteries in EV's and buildings (recycled from EV's)' water pump stations**

- **Will feed into 3 design scenarios:**
- **Conventional or BAU;**
- **Stretched target;**
- **World's best practice**

- **It was noted that visibility of infrastructure would celebrate sustainability as a place theme and that setting our sights higher would position us well for Commonwealth funding support**

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The challenge

- Each year, the average Perth house uses around: 276kL of water; 6,500kWh of power; 1 tonne of waste

- Using these rates, the Stirling City Centre growth of 15,000 new households will equate to an additional 4GL of water (mostly scheme) and 97.5GWh of power. The peak electricity generation at current usage rates is expected to be close to 150 MW.

- *Providing this much energy and water at these rates is unsustainable and puts too much strain on existing infrastructure.*

- Further constraints for Stirling City Centre include:
- A lack of electricity, gas, water and sewer distribution and reticulation infrastructure
- Capacity constraints on upstream electrical infrastructure requiring expensive upgrades, which are usually passed onto consumers as headworks charges
- Downstream sewerage treatment pond at capacity

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The Opportunity

- **Demand side management** including:
- Buildings design with good thermal performance
- Using energy efficient appliances, smart meters and smart appliances;
- Grey water reuse within the building

- **Locally generated supply** including:
- Bio-gas power generation using waste organics (kitchen scraps, garden clippings, sewerage, etc.)
- Rain water capture, treatment and storage
- Solar energy for electricity generation and hot water heating
- Ground source heat exchange

- Two green infrastructure scenarios have been developed:

- One to address the short-term problems of peak electricity, sewer load limits and increased scheme water using local best practice techniques

- One to achieve world's best practice of becoming a net energy and water exporter and a net waste importer.

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Water

- A target of *50 KL/person per year total water use* (currently 97KL) is being set as the "best practice scenario" will be achieved through:

- A requirement for better than 5 star green ratings for all dwellings which will mandate water wise fittings and fixtures

- On site rainwater capture, treatment and use in potable and hot water applications

- On site capture of all bathroom hot water sources as grey-water and treatment to a standard for reuse in toilet flushing, washing machines and garden irrigation

- Application of very low water use toilets and insinkerators, and collection of black-water and organic household waste through a vacuum transfer system to a centralized treatment facility

- Re-supply of centrally treated water back to environmental flows (stream/green corridor)

- Minimal use of bore-water

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Load reduction

- *Energy load reduction* using high thermal performance design in the built environment reducing energy load (up to 40%).

- Developers will need to exceed the current regulatory requirements by looking to a 7-Star building rating. The high residential density of the Stirling City Centre development will reduce the residential energy load. One option is for a 'low cooling' 7-Star home, which places the emphasis on improving cooling performance as opposed to heating performance and correlates well with Perth's critical peak summer load.

- Further energy demand reduction comes from efficient lighting and smart appliances that can have their load deferred to off-peak times. The installation of a smart meter will also allow users to monitor their usage and modify as required.

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Peak electricity load reduction

Limits on electricity capacity from the grid

- It is proposed that a 2kVA After Diversity Maximum Demand (ADMD) be used as the target demand for residential developments (currently ADMD is 4.6kVA for Stirling). Additional amps can be allowed for households with direct feed renewable energy, such as solar PV or on-roof wind generators.

Embedded generation and district supply

- Tri-generation technology generates electricity, heating and cooling energy using gas fuel. The fuel can be either natural gas or renewable sources, such as bio-gas from anaerobic digestion of organics or syn-gas from gasification of organics. The heat energy can be used as direct heat for space heating and water heating or can be put through an absorption chiller, which provides the cooling component.
- This technology can be deployed at a district level with electrical, heating and cooling energy being piped to buildings via a centralised generation plant.
- An alternative to this approach is locating the tri-generation units within the buildings themselves and have a distribution system between buildings to effectively share the loads.
- A sophisticated demand management system or 'Smart Grid' would be required to manage such a system.

Shifting the peak (storage and deferred load)

- Peak loads can be shifted to off-peak times.
- Short term storage technologies include phase change materials, ground heat exchange, thermal heat reservoirs, or chilled water storage.
- Deferred load also applies to appliances. A new generation of 'smart' appliances can be set to run during off-peak times or controlled remotely to defer their load. Smart grid would be required here.

Renewable energy substitution

Immediate technologies

- *Geothermal heat exchange* – shallow geothermal heat exchange (down to 30 m) can be used for heating and cooling of space and water
- *Combined Photovoltaic Thermal (PVT)* – used for water heating and power generation where CPVT can't be used and space is limited
- *Photovoltaic (PV)* – electrical power only – ideal for large roof space areas such as carparks (shading), and retail facilities
- *Wind pods* – roof mounted horizontal axis wind pods couple effectively with PV (can be mounted together)
- *Bio Gas* – methane gas produced from Anaerobic Digestion of organic waste – can be scaled with increasing volume of feedstock will substitute for natural gas over time

Emerging technologies

- *Concentrating Photovoltaic and Thermal (CPVT)* – high power density and can meet electrical, heating and cooling demands – uses absorption cooling and electrically driven chillers – will substitute natural gas tri-generation – can be used at district level
- *Syngas* – gas produced from the gasification of dry organic waste (timber, dried sewer waste) –feedstock can be imported to make a net waste importer –can be scaled with increasing volume of feedstock
- *Electric vehicles* – can provide storage and peak lopping capability – would require infrastructure for grid connection

Waste (including waste water)

Collection

- *Sewerage waste* – Vacuum system which by-passes existing sewerage main and stores at centralized site to be used as a bio-gas feedstock
- *Municipal waste* – Vacuum system to a centralized site – system allows for multiple waste streams (pre-sorting by disposer) to ease downstream sorting

Recovery/reuse

- After collection, the waste is required to be stored at a centralized site
- This may be a staging point for further collection/ transfer to another recovery facility (this site could be small and even underground).
- If some recovery is to be done on site, then a larger recovery centre would be required.
- Some materials recovery could be achieved at the centralized site; another option is to store only sewerage waste and have organic materials returned (after sorting off-site) for bio-digestion or gasification.

Thank you

Questions?