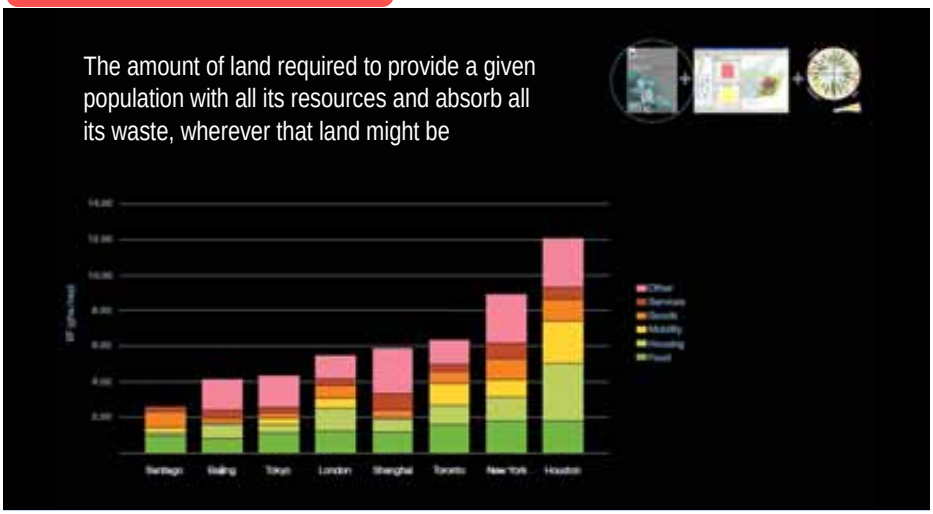
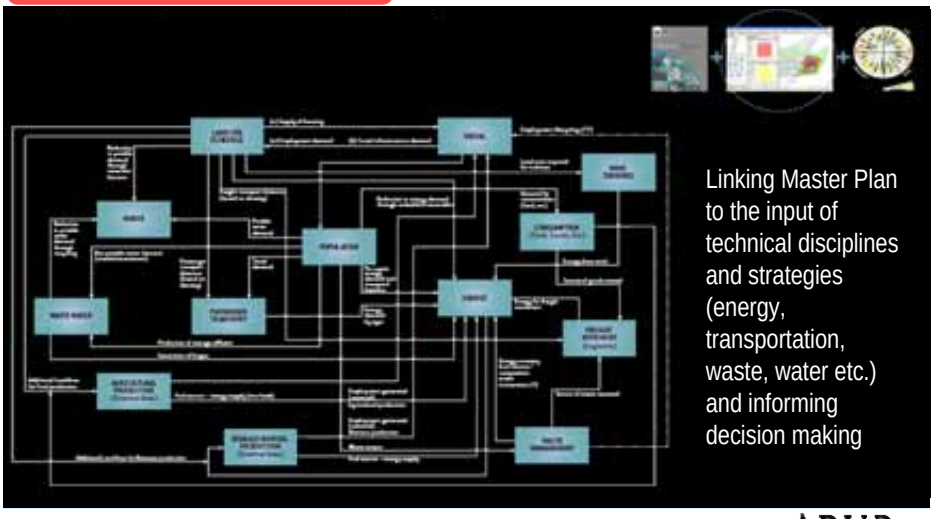
Eco-Footprint

The amount of land required to provide a given population with all its resources and absorb all its waste, wherever that land might be

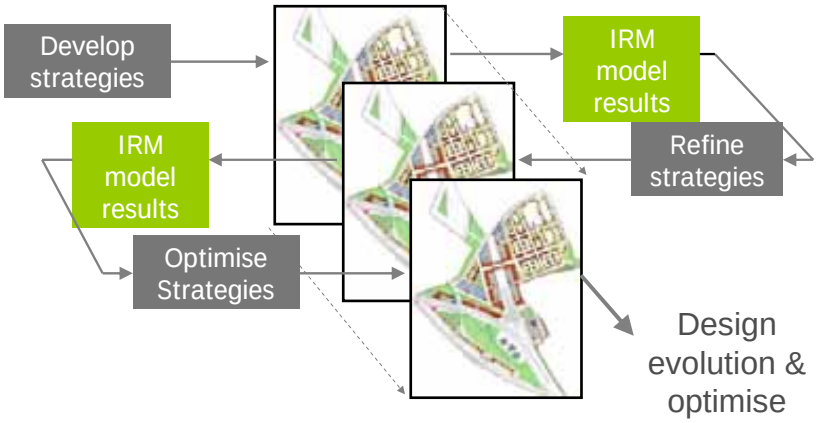


Integrated Resource Management Model (IRM)

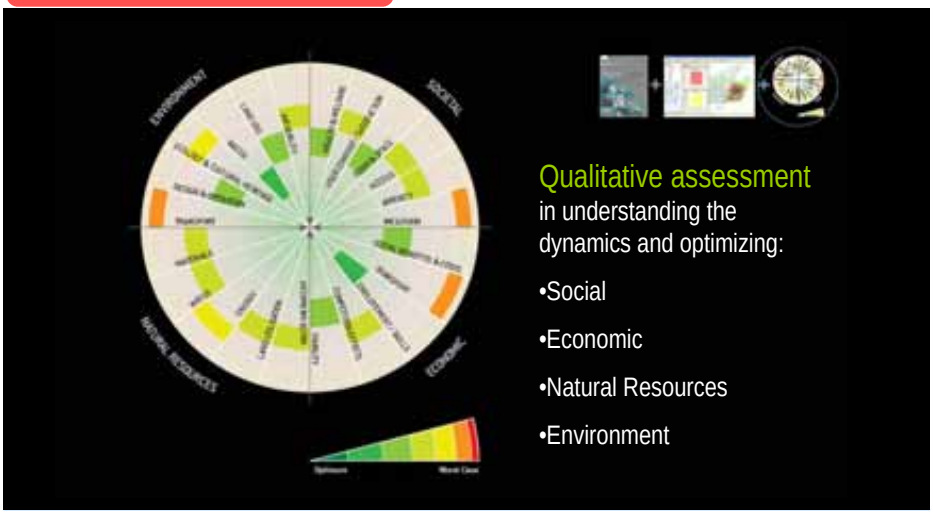


Linking Master Plan to the input of technical disciplines and strategies (energy, transportation, waste, water etc.) and informing decision making

Facilitating iterative testing and refinement of design solutions



SPeAR (Sustainability Project Appraisal Routine)

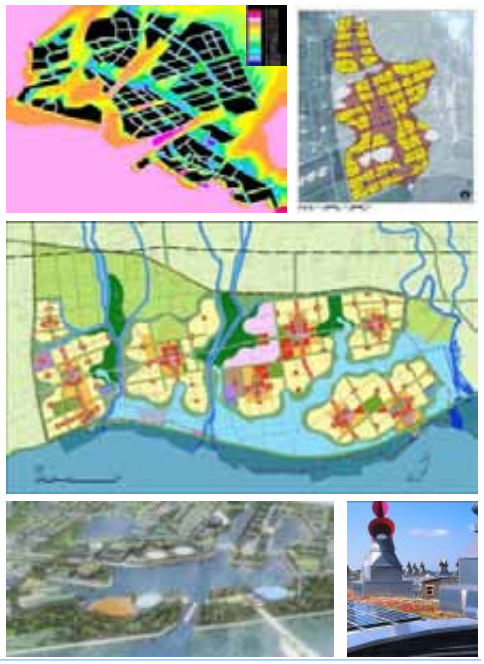


Qualitative assessment in understanding the dynamics and optimizing:

- Social
- Economic
- Natural Resources
- Environment

Project Integration

- Ensure KPI's and targets decided upon at the start of the project are incorporated into the Master Plan.
  - Energy (& Carbon)
  - Water
  - Materials & Waste
  - Human & Environmental Health
  - Density & Housing
  - Mobility & Accessibility
- Selected technologies are suitable, locally available etc.
- Economically viable
- Implementable (regulatory plans, infrastructure providers, management etc.)



Sustainable Buildings

Sustainability Strategy – Six Objectives

Carbon neutral

Self-sufficient by collecting and re-using water

Built using sustainable materials

Able to cope with future climate change

A positive contribution to society and the built environment

Sustainable in operation

Research & Education

Foresight and Innovation team to help Arup and clients understand the future of the built environment

Rating Tools

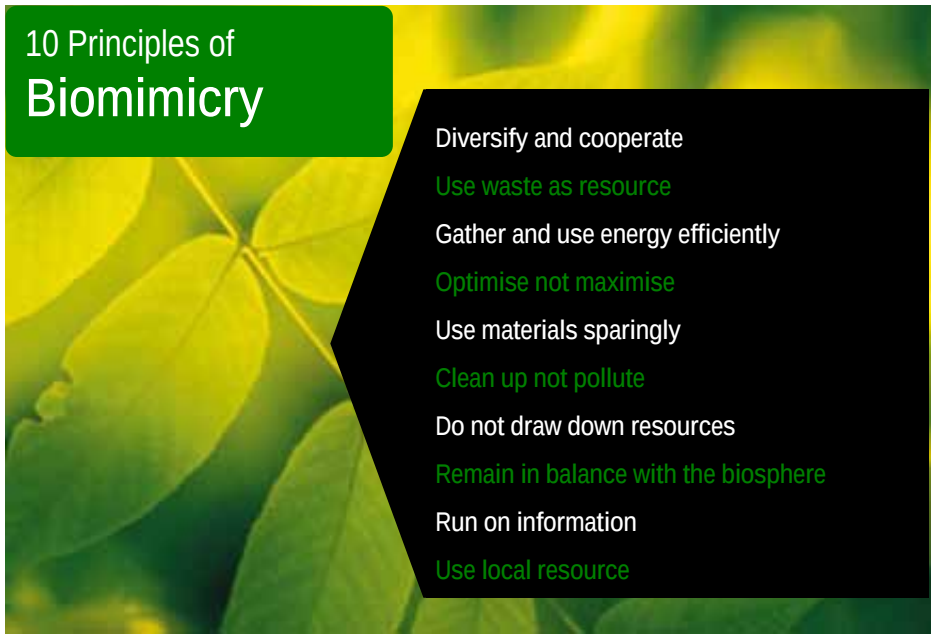
green building index

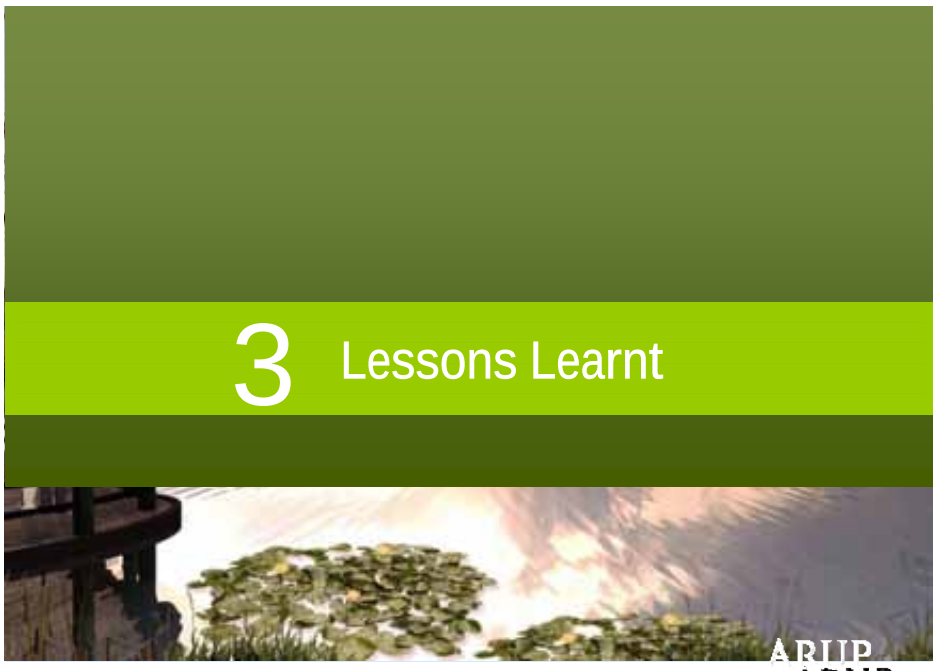
www.greenbuildingindex.org

green star

breglobal

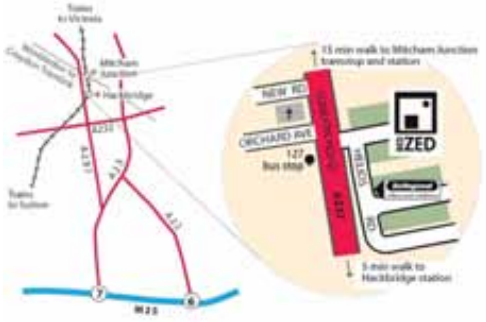
Creating Sustainable Communities


10 Principles of
Biomimicry
Diversify and cooperate
Use waste as resource
Gather and use energy efficiently
Optimise not maximise
Use materials sparingly
Clean up not pollute
Do not draw down resources
Remain in balance with the biosphere
Run on information
Use local resource


3 Lessons Learnt
ARUP

BedZED - 1999

- Beddington Zero (fossil) Energy Development (BedZED) located near Sutton to the south of London.
- Peabody Trust , one of the largest housing associations in London, is a long-established and forward-thinking social housing provider.
- Culmination of many years of ideas testing between Arup and the architect Bill Dunster,



BedZED

- BedZED is a zero energy development designed to produce at least as much energy as it consumes.
- Brownfield site consists of 83 mixed tenure flats, maisonettes, and townhouses; approximately 2500m2 of work/office space; and community uses.
- The village incorporates sustainable material sourcing, a renewable energy supply, a total water strategy, and an integrated transport system.

- Powered by a biomass CHP plant (110kWe) running on tree surgery waste to give overall net zero CO2 emissions.
- The village's water consumption is reduced by the use of low flush WCs and spray taps.
- Rainwater is collected from the uppermost parts of roofs and stored in tanks below ground for non-potable use in dwellings and for irrigating the landscape.
- On-site natural waste water treatment and recycled into rainwater storage tanks.

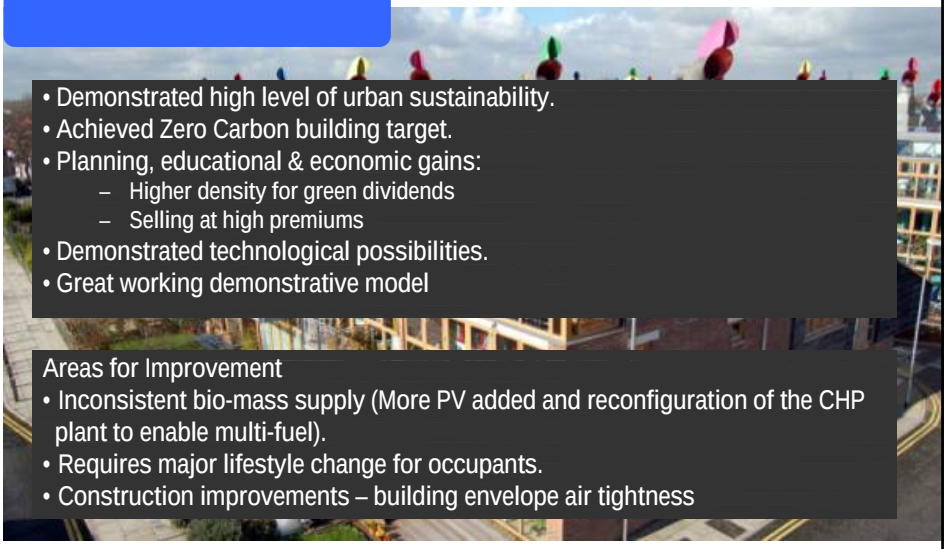
- **Environmental** – low-energy and renewable fuel, including biomass combined heat and power (CHP) and photovoltaics (PVs), zero net carbon emissions, water saving, reclaimed materials, Green Travel Plan, biodiversity measures, and private gardens for most units
- **Social** – mixed tenure, two-thirds affordable or social housing, lower fuel costs, healthy living centre, community facilities, sports pitch and 'village square', café
- **Economic** – locally sourced materials, workspace for local employment and enterprise, locally available renewable energy sources.

3. Ecological footprint for UK lifestyle in ha/person, based on a four-person household (data source: BioRegional).

		Car mileage	Car manufacture, repair, maintenance, road infrastructure	Public transport	Air travel	Electricity and gas	Water	Domestic waste	Office footprint: energy and waste	Food: production, distribution, packaging	Overall eco-footprint	
Typical UK lifestyle	Owns car Yearly holidays by plane Recycles 11% Eats out of season, highly packaged, imported food	0.60 10 000 km/yr	0.41	0.00	0.30	0.45 22 100kWh/yr electric and gas	0.002 140 litres/day	1.70	0.80 Brown energy and virgin paper	1.63	6.19	
BedZED Conventional lifestyle	Owns car and commutes to work by public transport Yearly holidays by plane Recycles 60% Moderate meat eater and some imported food	0.40 5000 km/yr	0.32	0.30 4000 km/yr	0.30	0.10 Waste wood CHP inc landfill diversion credit	0.001 91 litres/day	1.02	0.80 Brown energy and virgin paper	1.00	4.36	
BedZED Ideal	Lives and works at BedZED Recycles office paper No car - ZEC car member Two yearly holidays by plane Recycles 90% at home Low meat diet with local fresh food	0.09 1000 km/yr	0.04 20 people per club car	0.30 4000 km/yr	0.15	0.10 Waste wood CHP inc landfill diversion credit	0.001 91 litres/day	0.34	0.16 Closed-loop office paper scheme	0.72	1.90	
Global Average											2.40	
Global Available	Leaving 10% of bio productive land for wildlife										1.90	

BedZED

Lessons Learnt



- Demonstrated high level of urban sustainability.
- Achieved Zero Carbon building target.
- Planning, educational & economic gains:
  - Higher density for green dividends
  - Selling at high premiums
- Demonstrated technological possibilities.
- Great working demonstrative model

Areas for Improvement

- Inconsistent bio-mass supply (More PV added and reconfiguration of the CHP plant to enable multi-fuel).
- Requires major lifestyle change for occupants.
- Construction improvements – building envelope air tightness

Dongtan - 2004

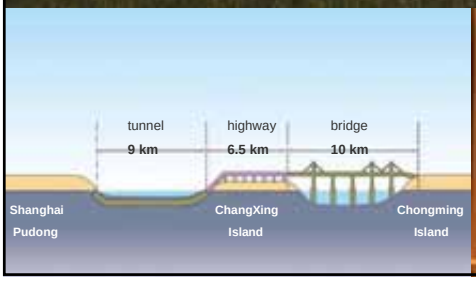
Dongtan

Location

Opened 31st October, 2009. World's largest tunnel diameter and is "the fifth largest cable-stayed bridge in the world".

Chongming Island Bridge

October 2007



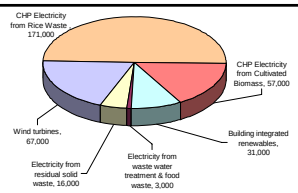
October 2009

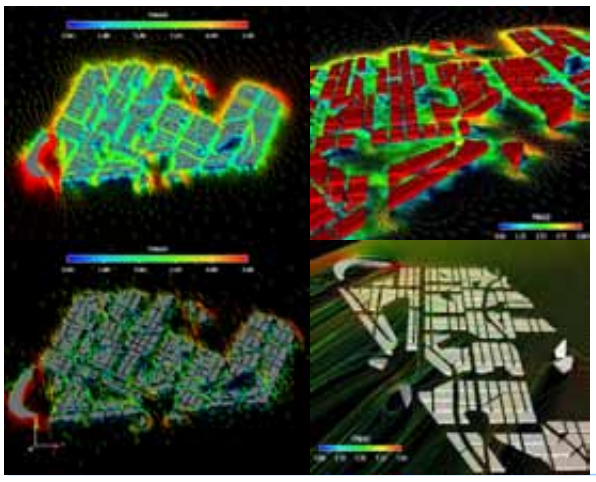
1. Dongtan

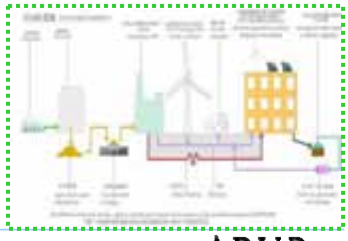
- Prepared Masterplan and sustainability guidelines
- Completed this work and our client originally intended to have the first phase of development completed in time for the 2010 Shanghai Expo.
- Start date for the construction of the first phase of Dongtan has been held up.
- While planning agreement for the project has been obtained, the client is still awaiting for planning permissions to be fully confirmed.

Dongtan

Strategies – Energy, Water, Waste, ICT, Cultural, Transport



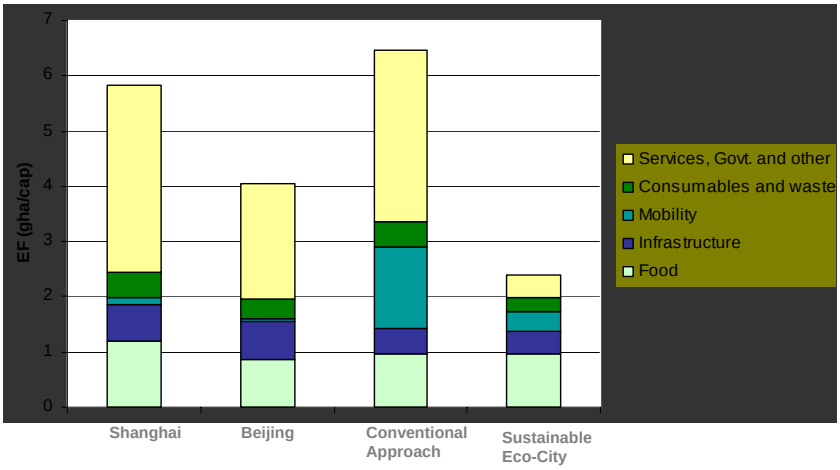




Dongtan

Eco-Footprint

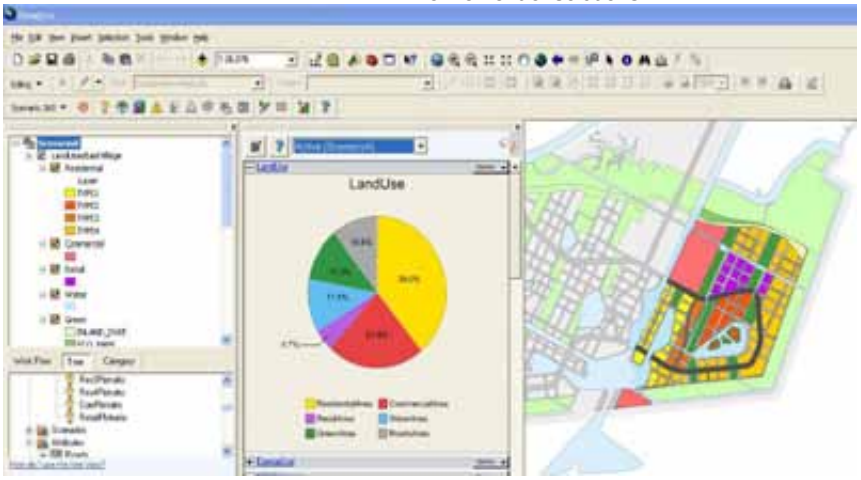
Eco-City Footprint 2.3 gh/person
Conventional Approach Footprint 5.8 gh/person

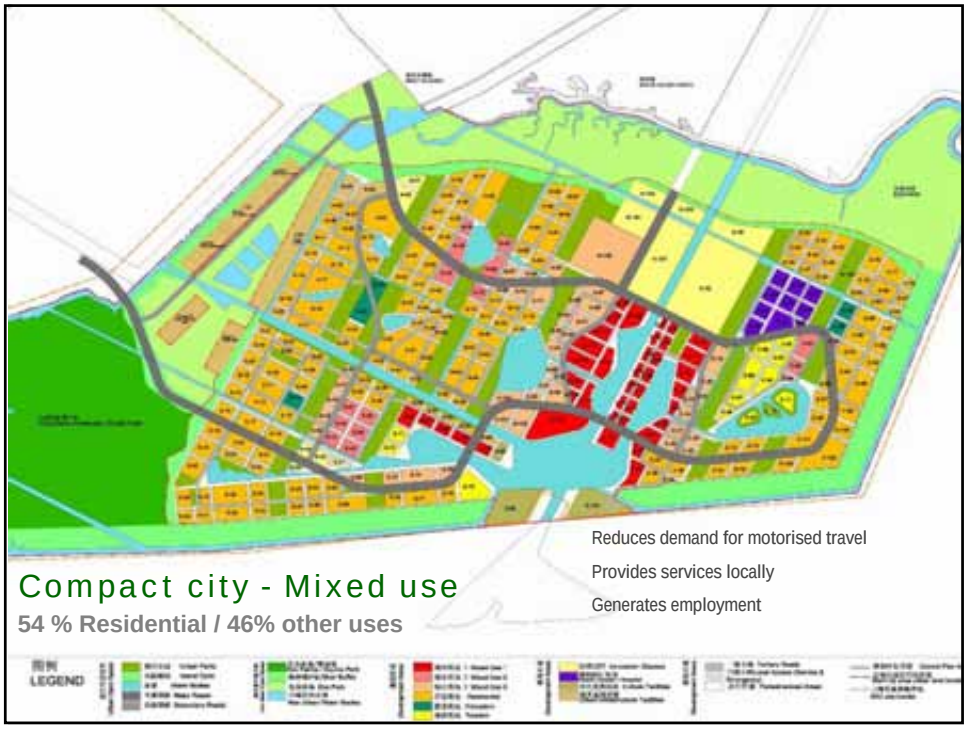


Dongtan

Integrated Resource Management Model - IRM

- Support decision making (options & scenarios).
- Coordinate technical sector inputs (i.e. transport, waste management, energy, social infrastructure, etc);
- Facilitate iterative process of testing and refinement of solutions





Compact city - Mixed use

54 % Residential / 46% other uses

Reduces demand for motorised travel

Provides services locally

Generates employment

Masterplan

Clusters and Centres

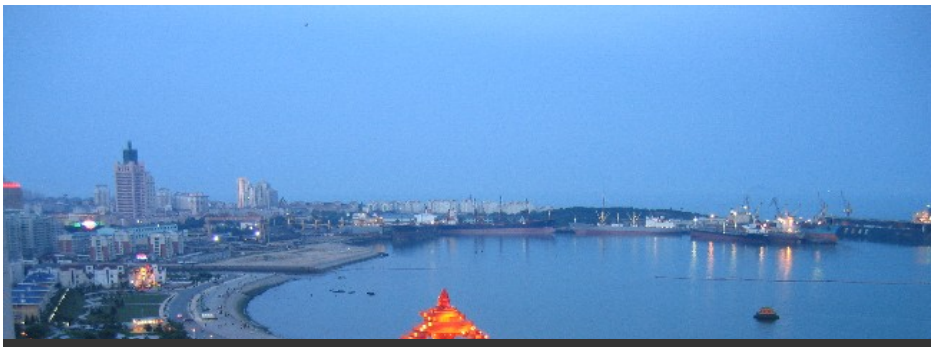
Dongtan

Lessons Learnt

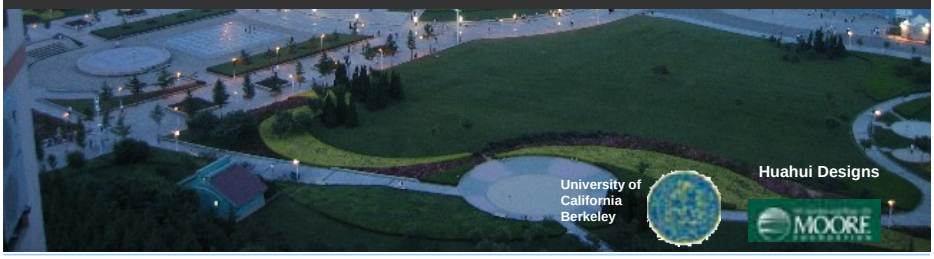
- Created a methodology & model for sustainable masterplanning that is now being used to inform numerous other planning projects in China and across the globe:
- Our vision with our client was to share this 'integrated urbanism' approach with academic centres, research programmes and design institutes.
- Supporting an extensive programme of research into eco-city design funded by the UK and Chinese governments and carried out in Chinese and UK universities in order to help build a broader understanding of sustainable development.

Areas for Improvement

- Feasibility of some of the recommended technologies (non-fossil fuel cars, consistent large scale bio-mass supply, large scale wind farms etc.)
- Costs and economic model
- Implementation into local statutory control process.



Qingdao Eco-Block - 2007

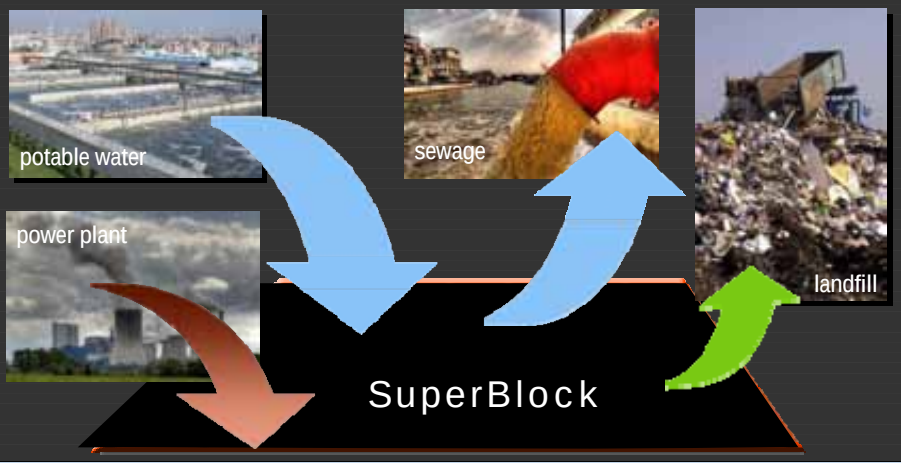


Qingdao Eco-Block

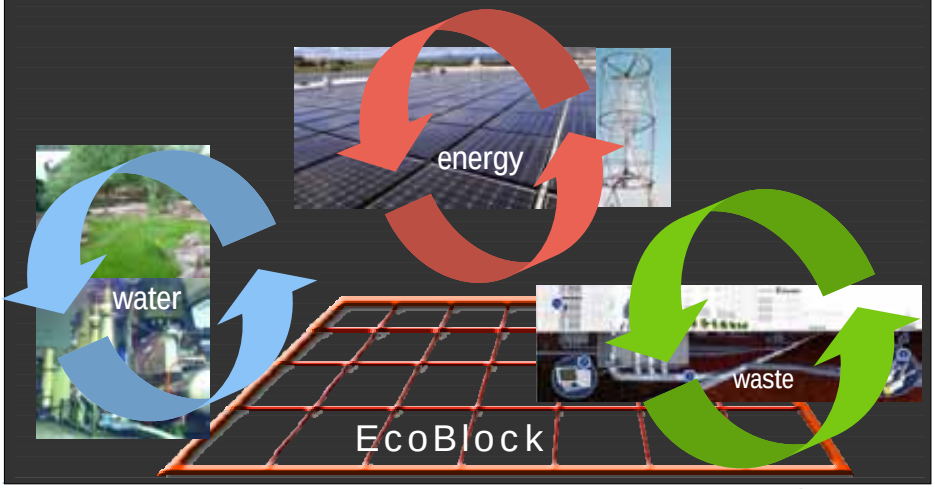
- China is efficient at building housing on a mass scale to meet its rate of growth
- Everyday 10-15 Superblock developments are built.
- Superblocks are typically 1 km2 in size
- Every year > 11 million new Superblock apartments are built.

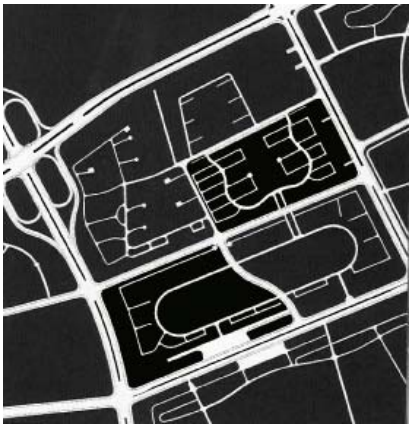
Qingdao Eco-Block

The mass-replicated SuperBlocks place significant demands on China's infrastructure



If SuperBlocks could be self-sufficient [energy, water & waste], then demand on China's infrastructure & natural resources could be significantly reduced





SuperBlock

Places huge demands on natural resources and infrastructure

Eco-Block

Mass replicable EcoBlocks - are self-sufficient with respect to energy, water and waste, significantly reducing demand on China's infrastructure and natural resources.

Qingdao Eco-Block

Qingdao Site

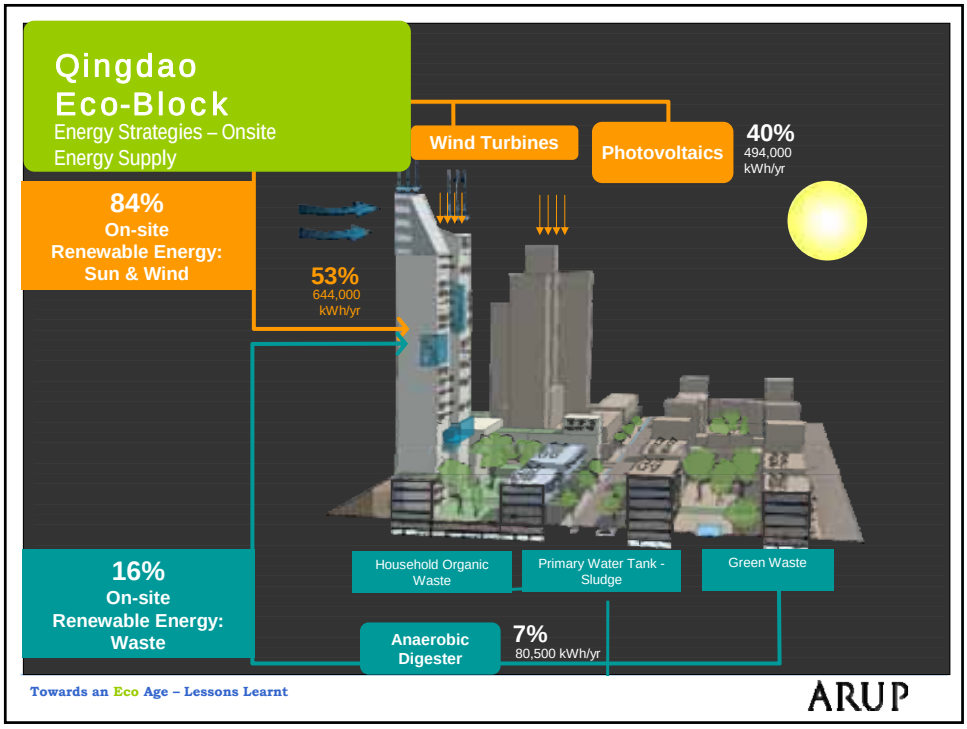
- 8 replicated EcoBlocks
- 5,100 units total
- Increasing density towards transit

GOALS:

Mass replicable

- Resource self-sufficient (water, waste, energy)
- 100% waste water recycled on site
- 75%+ reduced potable water demand
- 100% on-site renewable energy generation
- Encourage journeys by foot, bicycle and transit
- 40% to 60% site area to be green space


Qingdao Eco-Block
Energy Strategies to Reduce Demand
Passive Solar heating
High performance glazing
Efficient lighting
Natural Ventilation
Energy efficient equipment
Daylighting
Shaded walkways
Shared Plug-In Hybrids
Building shading
Reflective pavement
Towards an Eco Age – Lessons Learnt
ARUP


Qingdao Eco-Block
Energy Strategies – Onsite Energy Supply
Wind Turbines
Photovoltaics
40%
494,000 kWh/yr
84%
On-site Renewable Energy: Sun & Wind
53%
644,000 kWh/yr
Household Organic Waste
Primary Water Tank - Sludge
Green Waste
16%
On-site Renewable Energy: Waste
Anaerobic Digester
7%
80,500 kWh/yr
Towards an Eco Age – Lessons Learnt
ARUP

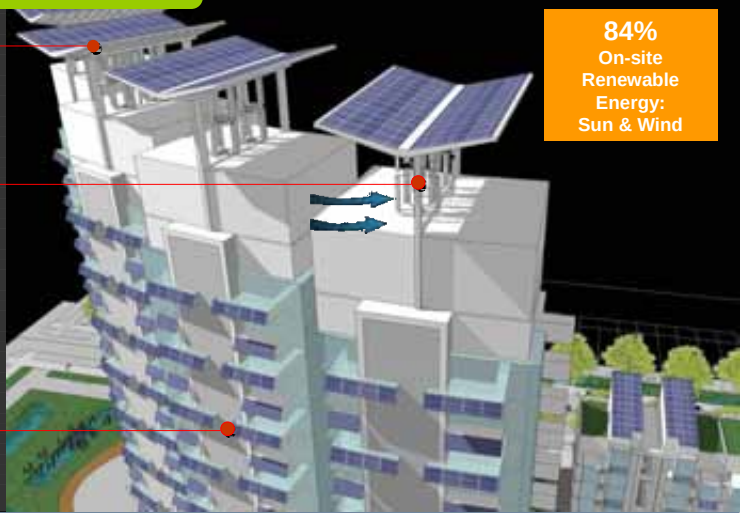
Qingdao Eco-Block

Energy Strategies – Onsite Energy Supply

Roof mounted photovoltaics

Building integrated wind turbines

Canopy integrated photovoltaics



84%
On-site Renewable Energy: Sun & Wind

Qingdao Eco-Block

Water Strategies to Reduce Demand

Xeriscaping

Recycled water for irrigation

Low flow equipment

Low flow fixtures & fittings

Qingdao Eco-Block

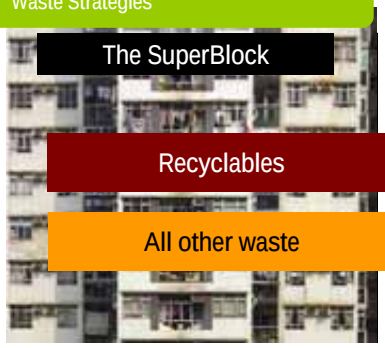
Water Strategies for Alternative Supply

Qingdao Eco-Block

Water Strategies for Alternative Supply

Qingdao Eco-Block

Waste Strategies



The SuperBlock

Recyclables

All other waste

1465 kg/day
76%
填土掩埋
to Landfill

455 kg/day
24%
回收
to be Recycled

The EcoBlock

green and organic waste

Recyclables

All other waste

339 kg/day
17%
to Landfill

550 kg/day
29%
to be Recycled

1032 kg/day
54%
Waste to energy

Towards an Eco Age – Lessons Learnt

ARUP

Qingdao Eco-Block

Waste Strategies

Each residential unit linked direct to automated system

Street waste collection linked to automated system

Off-site recycling from central point

Anaerobic digester

Underground automated waste management system

Towards an Eco Age – Lessons Learnt

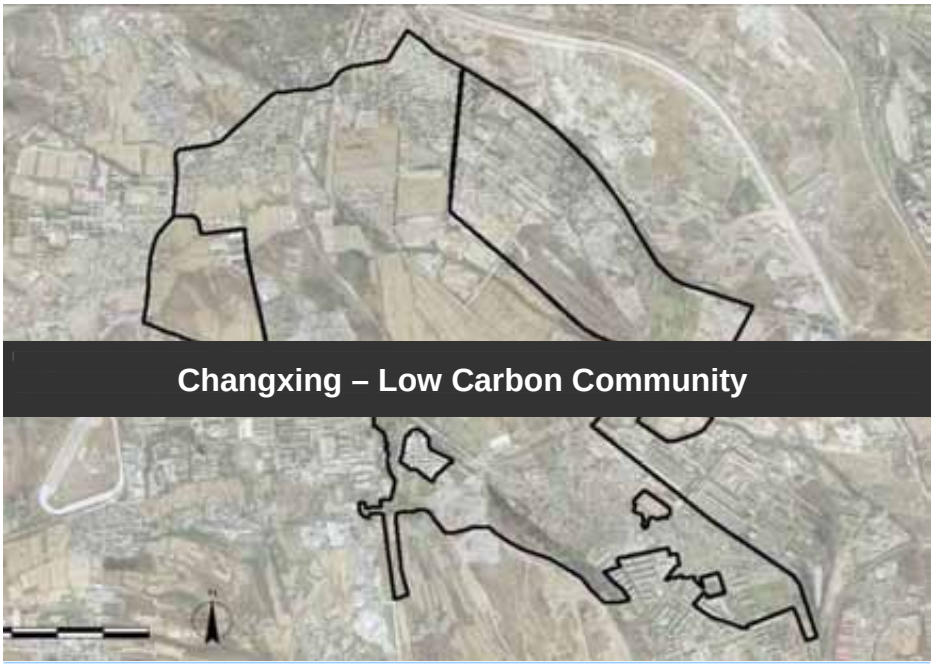
ARUP

Qingdao Eco-Block

Lessons Learnt

- Technologically possible.
- Created a development model which significantly reduces pressures on the natural resources and environment.
- Good political support.

- Financial constraints resulting in low take-up from the private sector.
- Difficulties in implementation under current statutory conditions without subsidies.



Changxing – Low Carbon Community

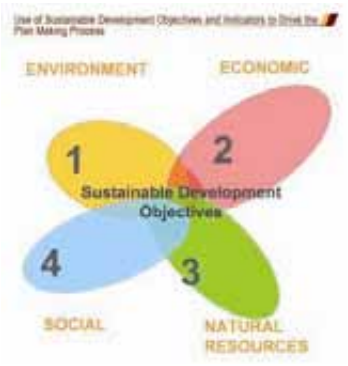
Changxing

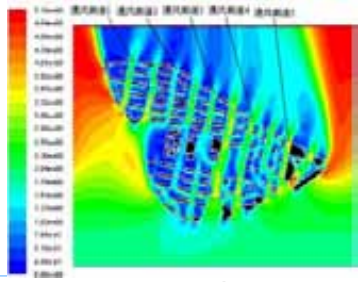
Location

- Located in Fengtai's Hexi District, within the south-western region of Beijing.
- The project site is approximately 17 km from the center of Beijing.
- One of the most important development areas along the south-western corridors of Beijing city, to accommodate the city's growth.
- Won ISOCARP 2009 Award

Changxing

- Based on a Sustainability Framework which clearly sets out the Vision, Objectives and measurable Performance Indicators.
- Energy, Water, Waste, Environmental, Ecology and Transportation strategies to achieve low carbon targets.
- Developed a total of 19 quantitative performance indicators to compare the master plan with conventional city development/ "*Business as Usual"* (BAU) mode.





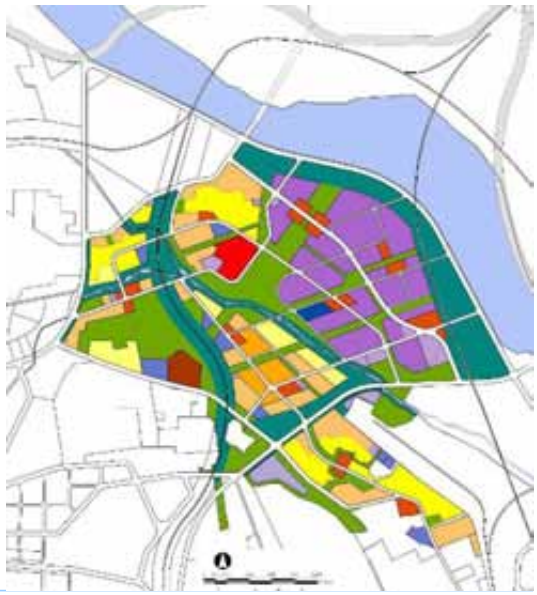
Changxing

Sustainable Development Indicators

Sustainability Indicators (19 indicators)

Natural Resources

•50% reduction in CO2 emission compared to BAU including carbon neutralization through tree planting standards.
•At least 15% of energy supply from renewable energy.
•20% reduction in energy demand compared to BAU.
•600persons/ hectare density for Residential land.
•100% waste collection and classification and reduce domestic waste generation to 0.8kg/p/day.
•70% of domestic waste to be recycled and reused
•Construction materials recycled and use of local materials.
•Domestic water use per resident to be less than 110 litres/ day
•100% of buildings to have rainwater collection facilities and stormwater detention facilities in public areas.
•80% of water use from non-conventional/ recycled means.



Changxing

Sustainable Development Indicators

50% reduction in CO_2 emission compared to BAU

Domestic water use to be less than 110 litres/ person/ day

Reduce domestic waste generation to 0.8kg /person/day

100% of residents within 400m of public transport stops

At least 15% of energy supply from renewable energy

At least 15% of residential development for social housing

Changxing

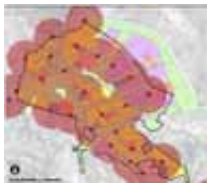
Setting Targets & Benchmarking

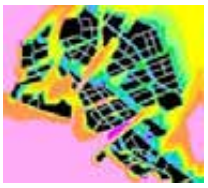
类别 Category	长兴生态城 Changxing Eco-City	北京政策/指示/标准 Beijing Policies/ Directives/ Standards	国家政策/指示/标准 National Policies/ Directives/ Standards	国际最佳 International B
Renewable Energy	**20%** Note: Ratio of renewable energy use in the model area can be higher	**4%** Source: Up to 4% by 2010 *("Beijing City Energy Development and Conservation Plan for the '11th Five-Year Plan' Period"—released by the Beijing Municipal Development and Reform Commission on December 11, 2006)*	**10%** by 2010 **16%** by 2020 Source: 10% by 2010 *("Outline of the 11th Five-Year Plan for National Economy and Social Development of The People's Republic of China"—released by the Central Government of China on March 16, 2006)* 16% by 2020 *("Mid-to-Long Term Development Plan for Renewable Energies"—reviewed and approved in principle by the State Council Executive Meeting)* More than 10% of total energy consumption in the buildings will be renewable energy *("GB/T 50378-2006 Green Building Evaluation Standards"—released by the Ministry of Construction of The People's Republic of China on March 7, 2006, effective June 1, 2006)* 10% of total energy consumption in sub-districts will be renewable energy *("Main Construction Points and Technical Guidelines for Green Eco-Residential Sub-Districts"—released by the Ministry of Construction of The People's Republic of China in May 2001)*	LEED ND – GCT Credit 13: Desig shared on-site nonpolluting renewa technologies such as solar, wind, g hydroelectric, and biomass with pe capacity of at least 5% of the proje load or of the project's annual elec consumption. European Union – 12% of total EU from renewable energy by 2010. South Australia, Australia – 20% o renewable by 2014. Tokyo, Japan – 20% of energy pro by 2020. BEDZED development, UK – 100 on-site Biofuel and PV. Western Harbour-City of Tomorro from renewable energy including w
Carbon Emission	Reduce a minimum of 50% of yearly carbon dioxide emission relative to the regular plan Note: Carbon dioxide emission reduction indicator for the model area can be higher	No specific indicators Reference: CO2 emission per unit of electricity in China: 0.785kg *(Conservation International website: http://www.conservation.org.cn/cn/co2.asp)* British BP China website: http://www.bp.com/sectiongenericarticle.do?categoryId=9011336&contentId=7025421 Fuel / Carbon concentration coefficient Coal / 0.92kg CO2/unit of electricity Natural gas / 0.52kg CO2/unit of electricity Nuclear Energy / 0.0kg CO2/unit of electricity Renewable energy / 0.0kg CO2/unit of electricity	China does not commit to quantified emission reduction indicators	LEED ND – GCT Credit 12: For system, the total CO2 emissions sh national average of CO2 emissions Ottawa, Canada – 20% reduction o levels. Lund, Sweden – 75% reduction of 2050. UK – 60% reduction of CO2 emiss BEDZED development, UK – carb Munkesoegaard Eco-Village, Cope emission is 60% less than the Dani
✱ Water				
Water Consumption	**150L**/person/day 37% reduction relative to Beijing data at year-end 2005 Note: 2005: Household water usage: 238L/person/day—*("Beijing City Water Resource*	**185-300L**/person/day Source: 185-300L/person/day by 2020 *("Beijing City Master Plan (2004-2020)")*	**240L**/person/day Source: National average urban water consumption per person per day by 2010: 240L *("Outline of National Water Conservation Plan*	LEED ND – GCT Credit 3: Reduc strategies that in aggregate use 20% water use baseline. Singapore - target <155l/p/day and Queensland, Australia - Reduce de to 84% to 165l/p /day

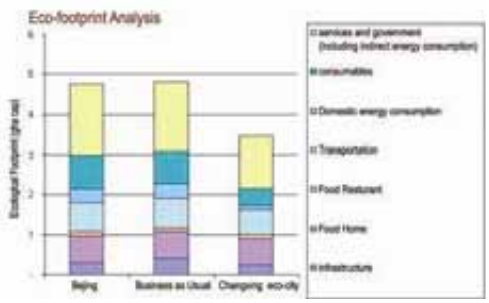
Changxing

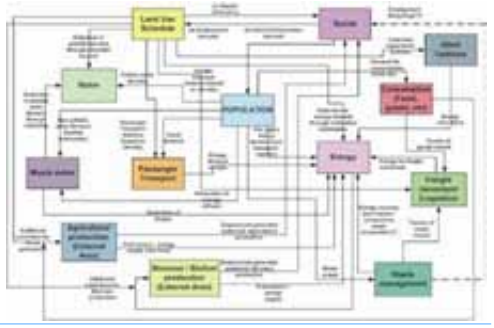
Performance Assessment Tools

- Integrated Resource Management (IRM) Model;
- Eco-Footprint;
- G.I.S;
- Computation Fluid Dynamics (CFD) Micro-climate Modelling







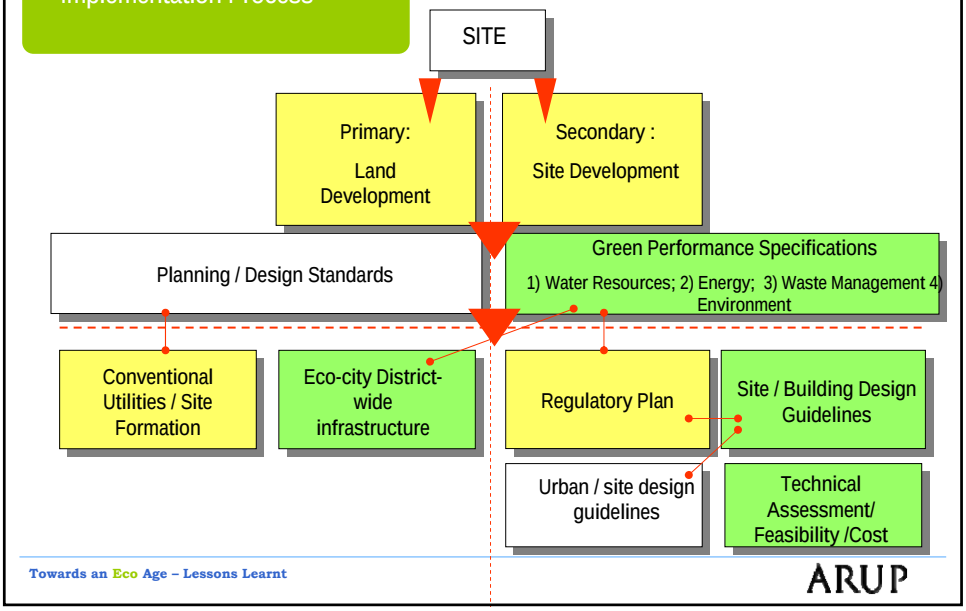


Changxing

Statutory Guidelines and Plans

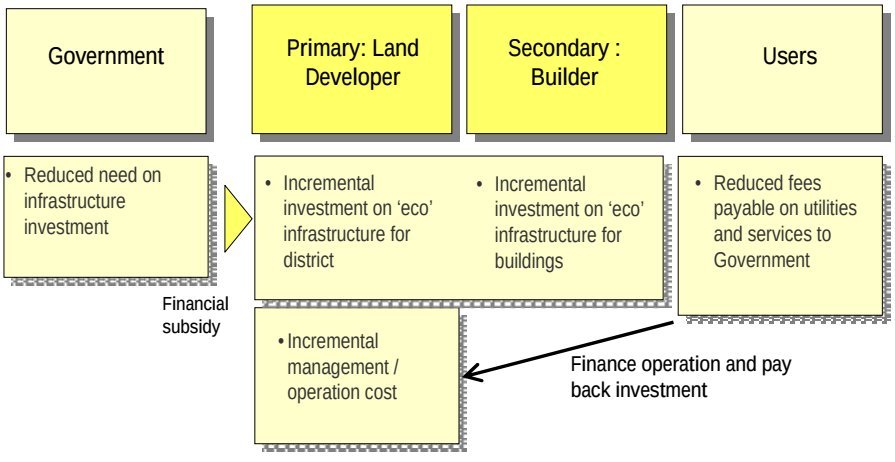
Changxing

Implementation Process



Economic Model

Cost/ Benefit Redistribution



4 Conclusion

Conclusion

Challenges

China's growth target - Quadrupling per capita GDP by 2020.

1 billion people will live in urban centres by 2030.

40 billion m2 of floor space will be built – in five million buildings

Climate Change and Natural Resource Consumption

Conclusion

- **Replicable**

  Not only meeting local domestic demand or requirements but benchmarks well against international best practices

- **Market- driven/ support**

  Must be resilient and economically viable with or without government incentives/ support

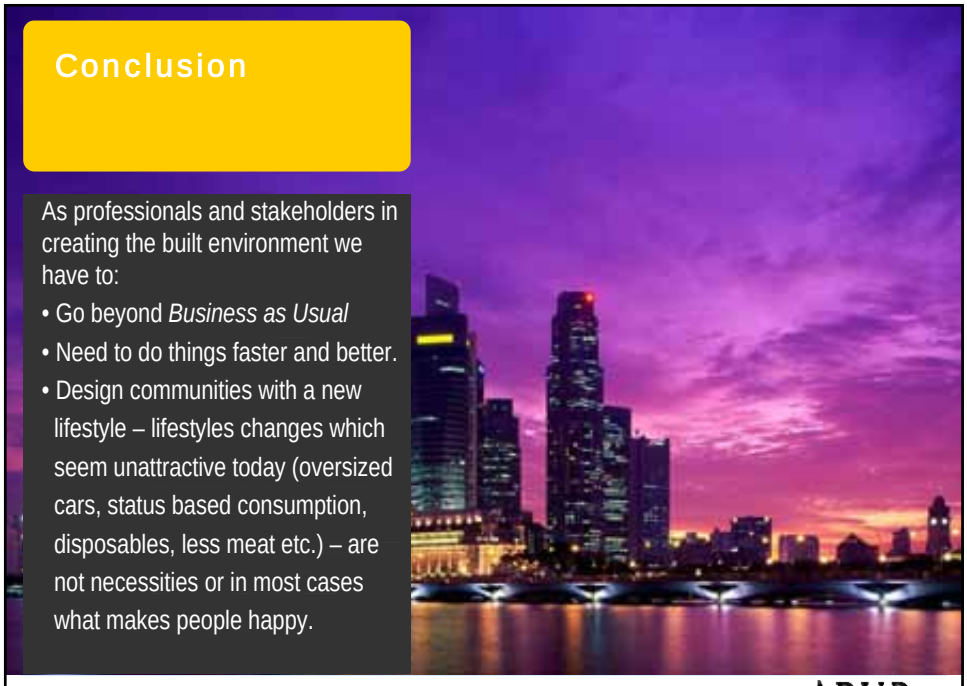
- **Scalable**

  Consider the functional & implementation scale from masterplans to primary land development and secondary site development & building levels.

- **Enforceable**

  Must have the clear implementation framework for the developer & different government departments to successfully implement and enforce the various sustainable elements of the plan.

Conclusion



As professionals and stakeholders in creating the built environment we have to:

- Go beyond *Business as Usual*
- Need to do things faster and better.
- Design communities with a new lifestyle – lifestyles changes which seem unattractive today (oversized cars, status based consumption, disposables, less meat etc.) – are not necessities or in most cases what makes people happy.

Promising Change – amongst governments, professionals and general public.

New political climate

- Host of new green legislations
- Commitments by EU to reduce emissions to 20 % below 1990 level by 2020 and up to 30% if other industrialised nations join them.
- By end of 2008, 29 states in the US have adopted climate plans.
- National Climate Change Strategy, BCA Green Mark Scheme and Sustainable Singapore Blueprint 2009.
- Malaysia – Green Technology Policy, Green Building Index.

Start of a journey – long and arduous one nonetheless, but challenges we must all rise up and face.

Which future?

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