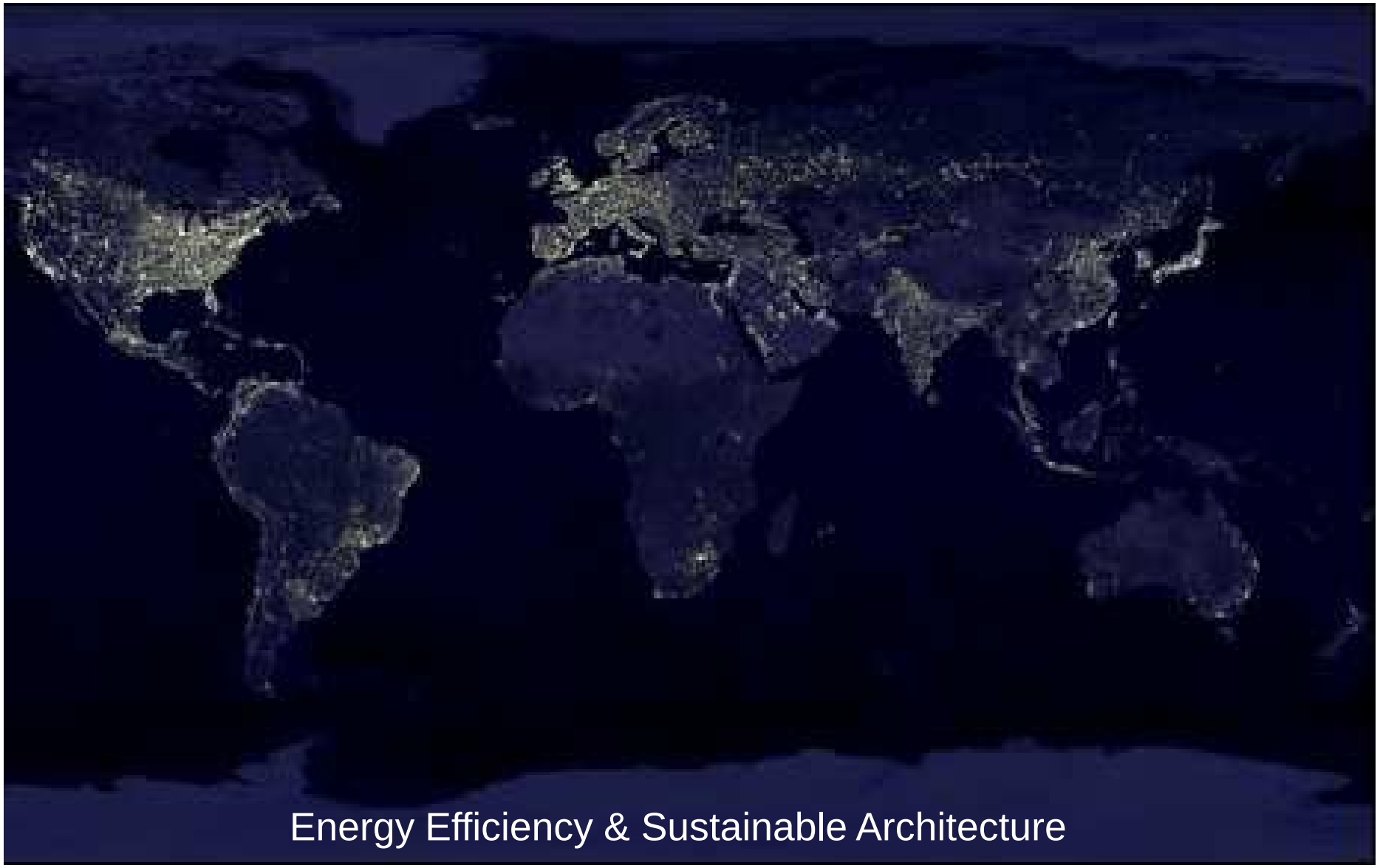
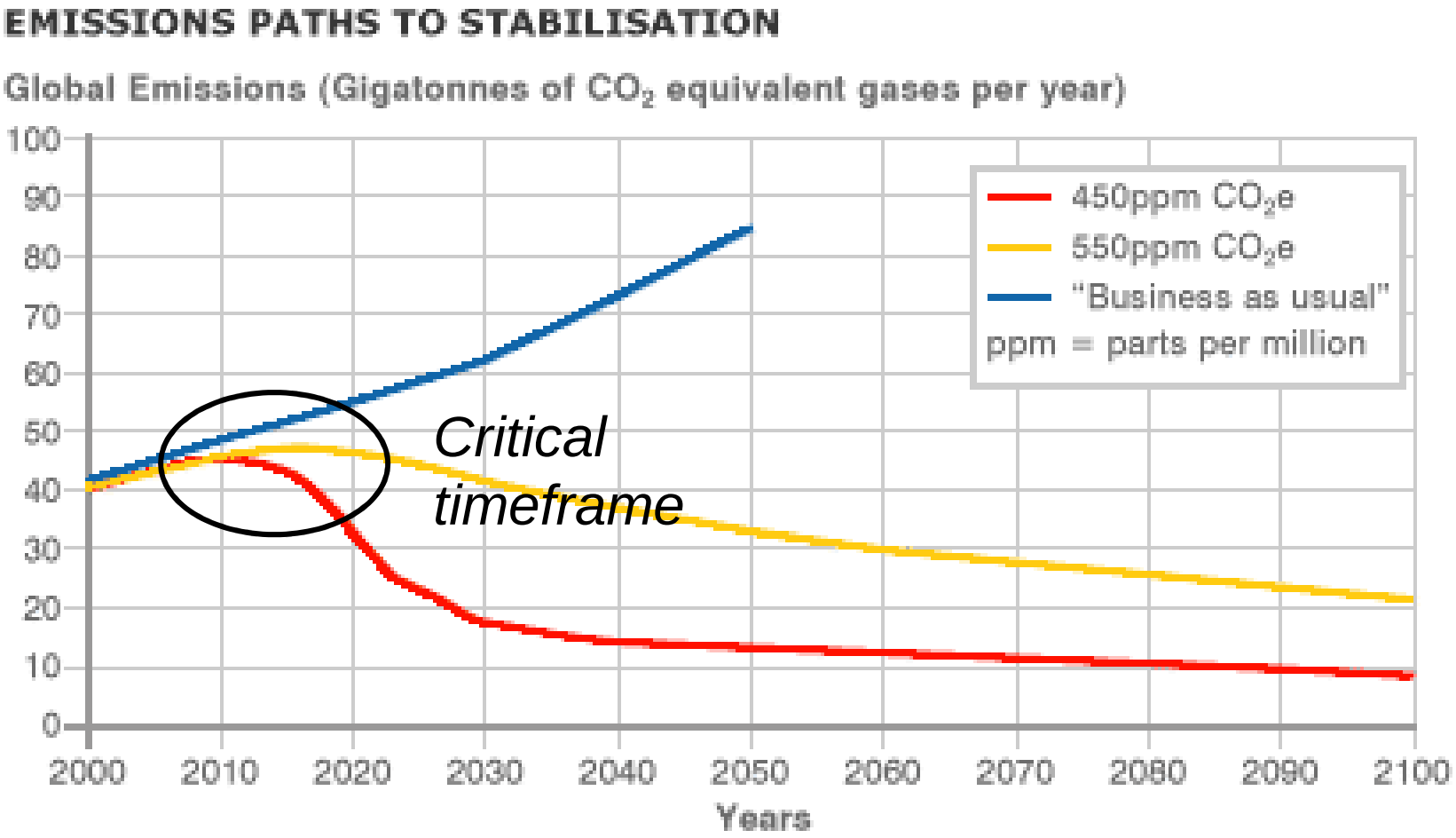

Energy Efficiency & Sustainable Architecture

outline

- Energy Efficiency – ‘low hanging fruit’
- Decentralised (on-site) energy generation
- Low-e buildings - TAMM*
- Urban regeneration + Retrofitting

*Targets, Analysis, Measurement and Monitoring

2007-2015



Urgent - act NOW!

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Building Energy Efficiency

20-30% efficiency increase NOW

- Upgrade building services technology
  - Motors, drivers & ballast
  - Sensors and control systems
- Dynamic (AI +NN) BEMS (Building Energy Management Systems)
- ~3yr Pay-back on ESCO's (Energy Service Companies) Retro-fit
- Future innovations + technology upgrades

Decentralised energy

- Localised energy generation
  - Make it where its used & needed
  - Avoid T&D losses (7-10%)
- Local DC grid (mini-grid)
  - Most equipment & electronics (semi-conductors) operate on Direct Current (DC)
  - Avoid conversion losses (DC-AC-DC) (10-20%)
- CHP (Combined Heat & Power) + Cooling (Tri-generation) achieves ~80%+ efficiency (best available centralised electricity plant = 52%)

On-site generation

Building integrated:

- Solar electric (PV) - electricity
- Vertical axis wind turbines (VAWT) – electricity
- Solar thermal – hot water/air conditioning
- Ground source cooling – air conditioning
- Wastewater recycling (generates biogas)
- Waste-to-energy (organic waste to biogas)
- CHP - Gas/LNG/Biogas (links intermittent RETs)

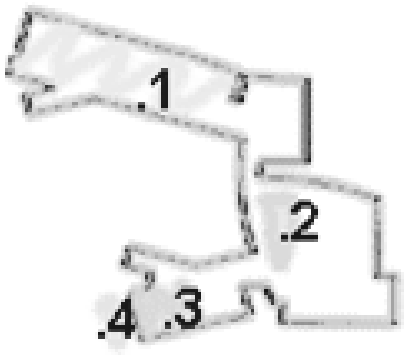
Available + cost effective NOW

- Fuel cells (also CHP) – natural gas/biogas/hydrogen

Presently maintenance costs high

Promotes better energy supply security

Hong Kong School 2004



1 Deck-shading (CIS)
2 Rooflight (Poly-si)
3 S.SE facing Canopy (A-si)
4 Vertical façade (omitted)

View from residential tower (south)

40kW PV array (~ 65% roof cover) generates 9% annual electricity need, (target 10%) PV system costs within standard government budget for schools.

School design by Architectural Services Department, HK Government;
PV systems design, installation supervision, monitoring & data acquisition by HKU PV Research
Cost Analysis by DLS Management International.

HK Office Tower

PV-generated electricity powers window shades to prevent interior heat build-up(not grid-tie application)

One Peking Road, Hong Kong
Rocco Design & Partners for Glorious Sun

Case study

Wal-Mart Store, Aurora, Colorado, USA Reported (February 2006)

- 3-on-site generation technologies
  - 50kW wind turbine
  - 134kW solar electric installation
  - 60kW gas-fired micro-turbines
- Evaporative cooling including
  - Low-flow displacement ventilation
- Energy-saving:
  - Daylighting and EE lighting technologies
  - Solar wall pre-heats ventilation air
  - Waste-oil boilers heat water for underfloor heating

Property

Responsible for ~70%* of total energy use

60+ years operational life

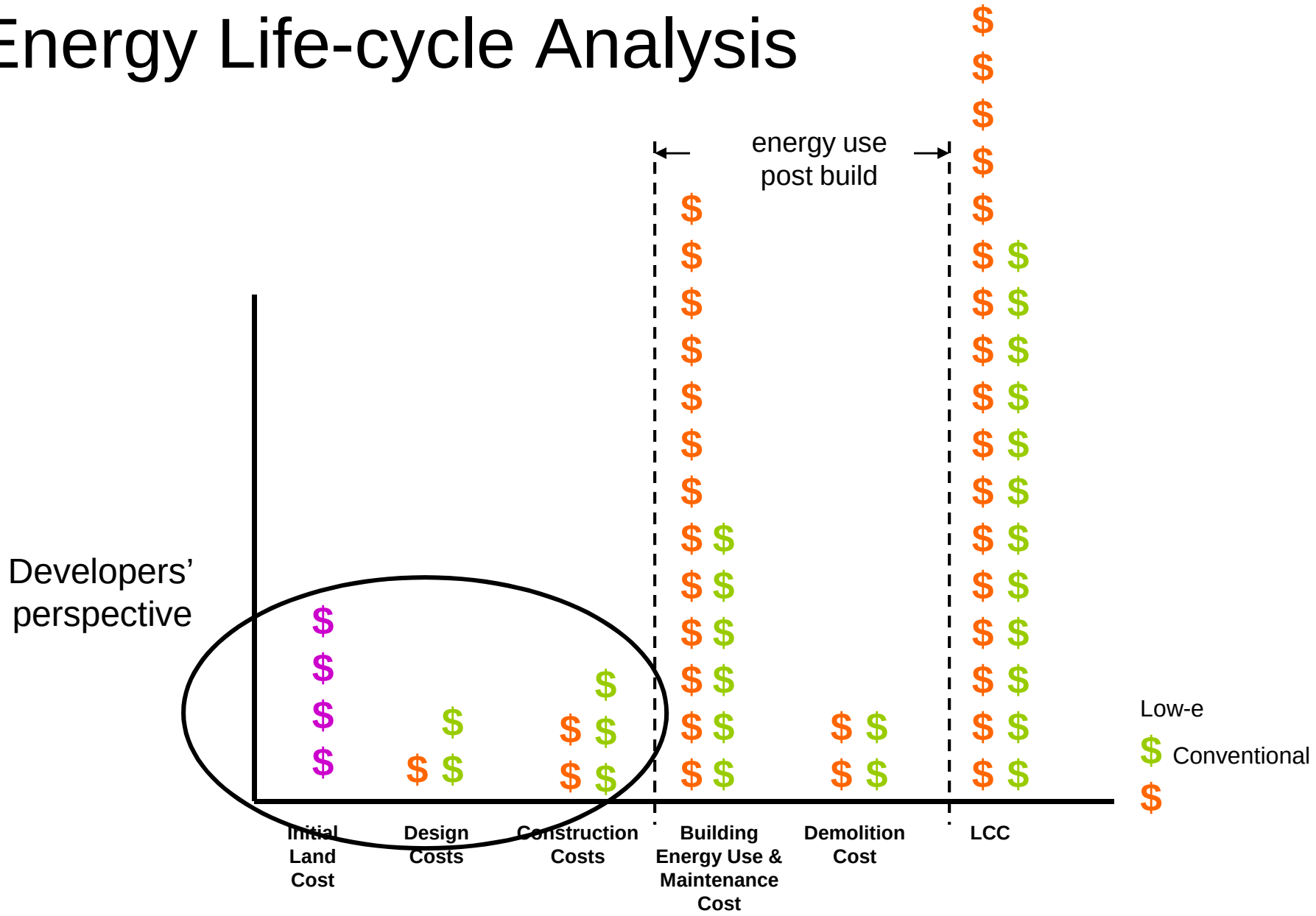
A project developed today will impact well into 2080

But

Property developers *used to* have short-term focus

*Normally referenced as 40-50% but higher when embodied energy included
See Building Energy Efficiency, Asian Business Council, October 2007

Energy Life-cycle Analysis



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TAMM*

Building Energy Performance

- BECS (Building Energy Codes & Standards) government tools
- Assessment tools (construction industry) adopted by governments
  - US Green Buildings Council (LEED) widely applied
  - UK BREEAM
  - Japan CASBEE
  - Australia Green Star
- Benchmark building sectors, certification & labelling
  - peer pressure + market leadership

Mandatory/Voluntary

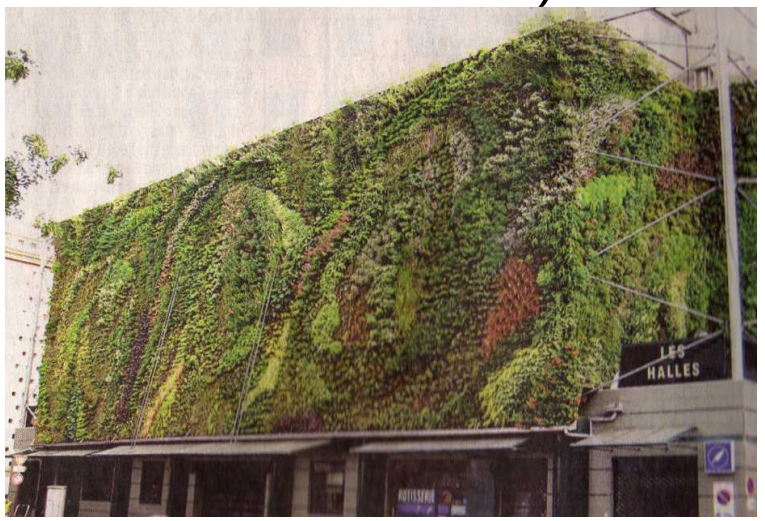
- Enforcement
  - Government or self-assessment
- Market forces
  - easy finance, faster sales, leverage on price
- Non-fiscal tools/CSR
  - awards, publicity, prestige, share value

***Targets, Analysis, Measurement & Monitoring**

Urban regeneration

Developers, Design Professionals & Clients

- Raised awareness (Building Performance Assessment tools)
- Corporate Social Responsibility
- Don’t knock down – retro-fit
- Appreciative of $ savings (time)
- Market advantage in ‘green’ features
  (Green Roof [HSBC] + Planted Walls)



Retro-fitting

- Saves embodied energy
- Cultural heritage
- Saves construction time($)
- Retrofit with RETs
  - PV installation
  - Ground source cooling
  - Ground source heating

‘Brown’ Sites

New-build on ‘brown sites’:

- Passive design principles – climate responsive
- ‘Long-life, low-energy, loose-fit’ for future adaptability
  (Note bedroom-size restricts Hotel upgrade results in demolition)
- Integrated RETs – on-site generation for energy security
- Recycling waste-water (irrigation/flushing) + MSW on-site (biogas)
- EE awareness raised with localised generation

Pioneer BIPV

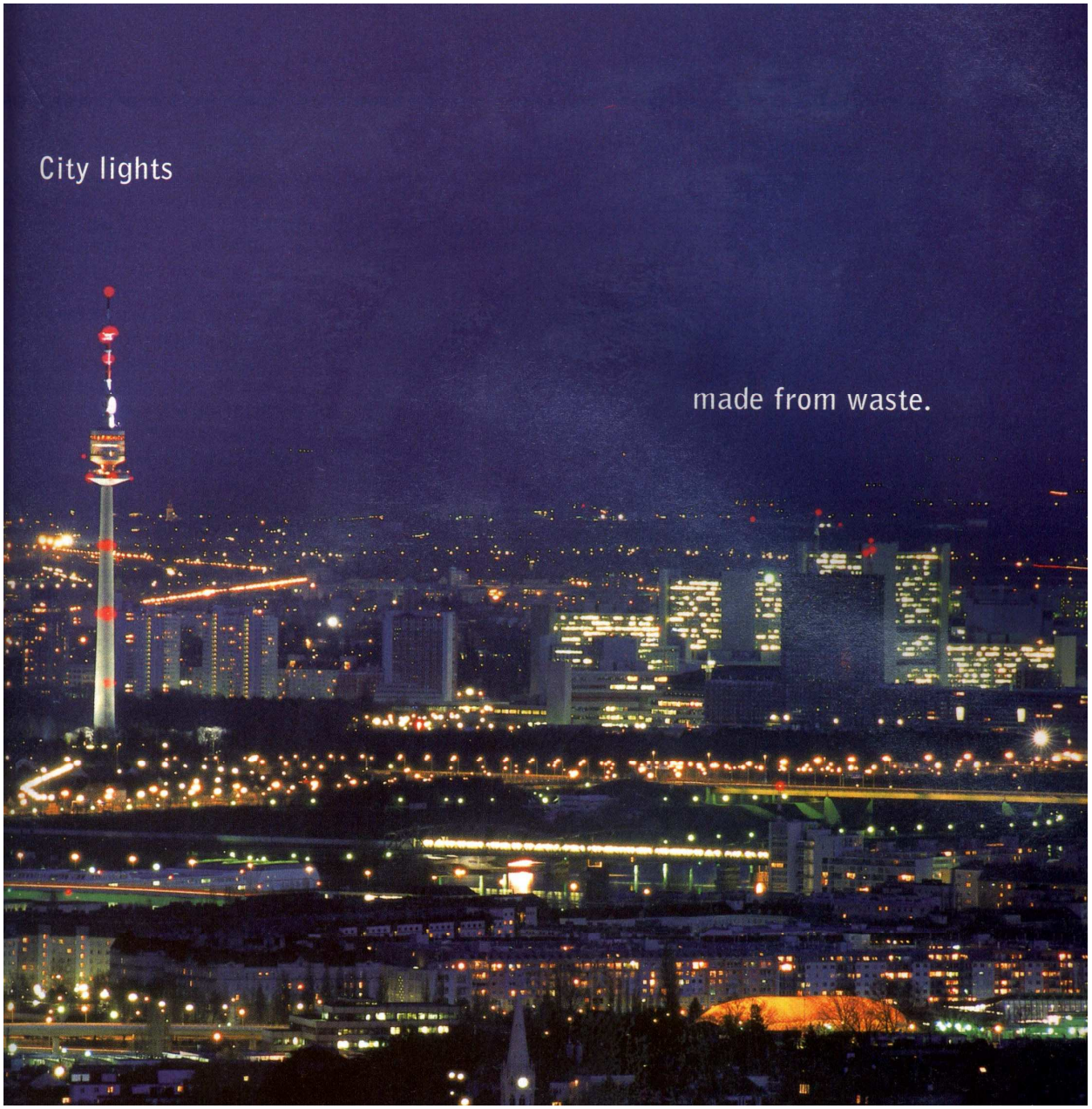
Fuel cell in the basement
+ PV on the facades

4 Times Square New York, 1998

Shanghai’s Dongtan Eco-city (Zero carbon emissions) city of the future : Arups

Conclusion

- Energy efficiency
  - Targets and goals for EE + RETs
  - Building design from passive design principles
  - Design quality + time on system analysis & sizing
- On site generation + energy efficiency
  - CHP + RETs with BEMS
  - Savings from fossil fuel costs + energy security
- Benchmarks through Green Buildings ratings
  - Market forces + peer pressure
  - Building performance rating against competitors
  - Maximum advantages – CSR, sales, awards, publicity



Energy security

Domestic solid waste + anaerobic digester = Biogas

Thank you

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