Energy, Transport and Sustainable Urban Form : Outline of OECD's Upcoming Projects

Yasushi YOSHIDA

Head of Division
Regional Policies for Sustainable Development

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US Department of Housing and Urban Development;
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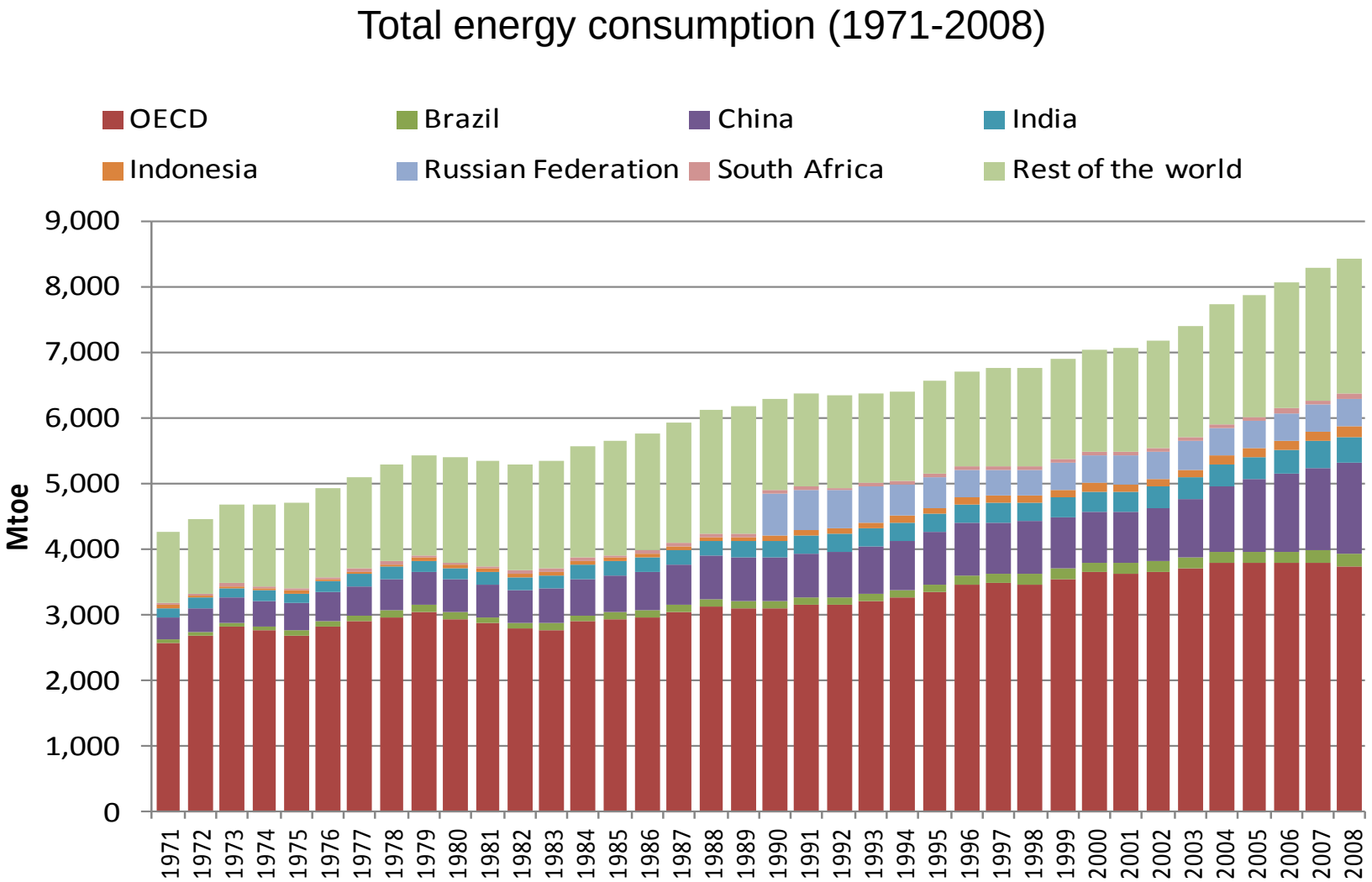
Why Energy?


Total energy consumption (1971-2008)
OECD
Brazil
China
India
Indonesia
Russian Federation
South Africa
Rest of the world
Mtoe
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1971
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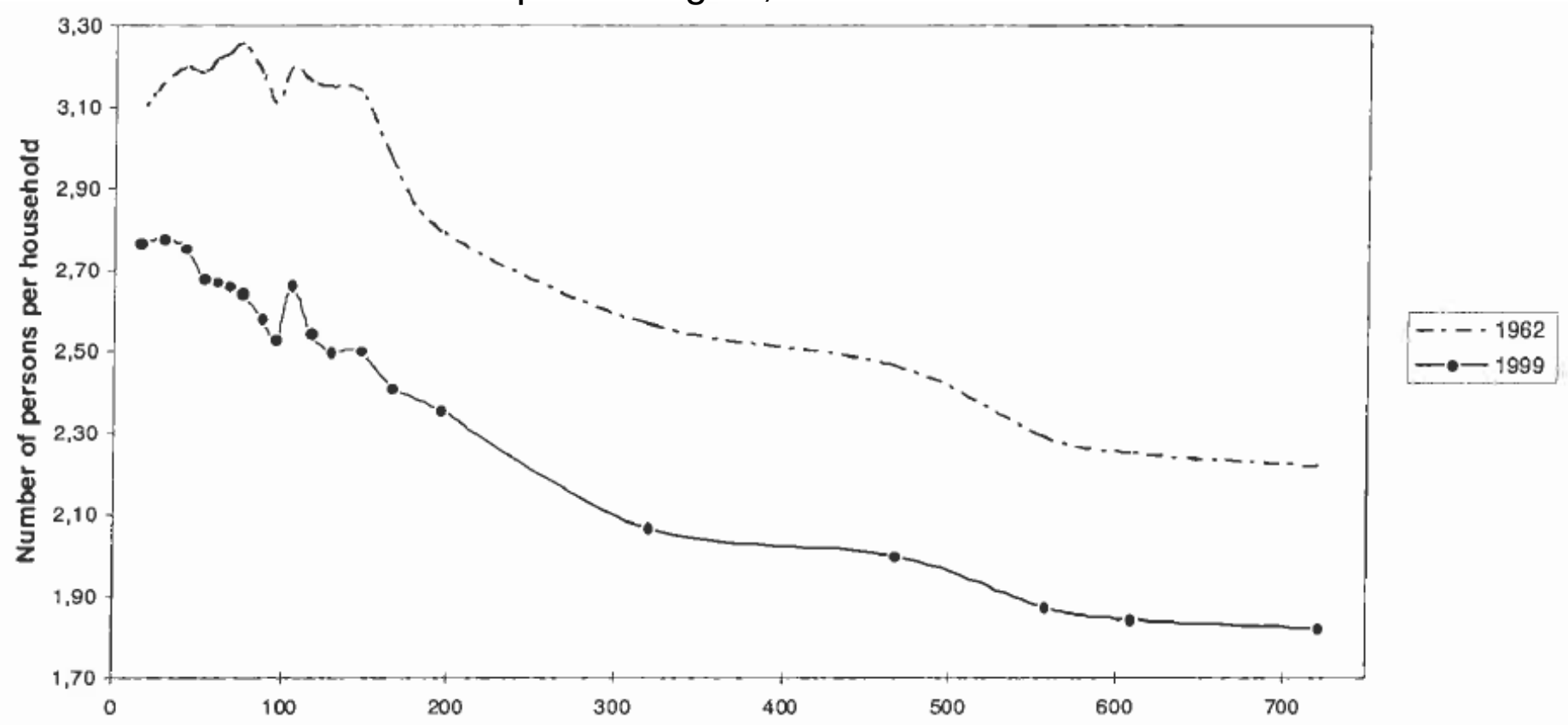
Why Energy?

Average household size by density areas
Paris metropolitan region, 1962 and 1999



- Decrease in household size
- Increase in house size

→ Inefficient energy use in the developed countries

Why Energy?

From Fossil Fuel /Nuclear to Renewable Energy?

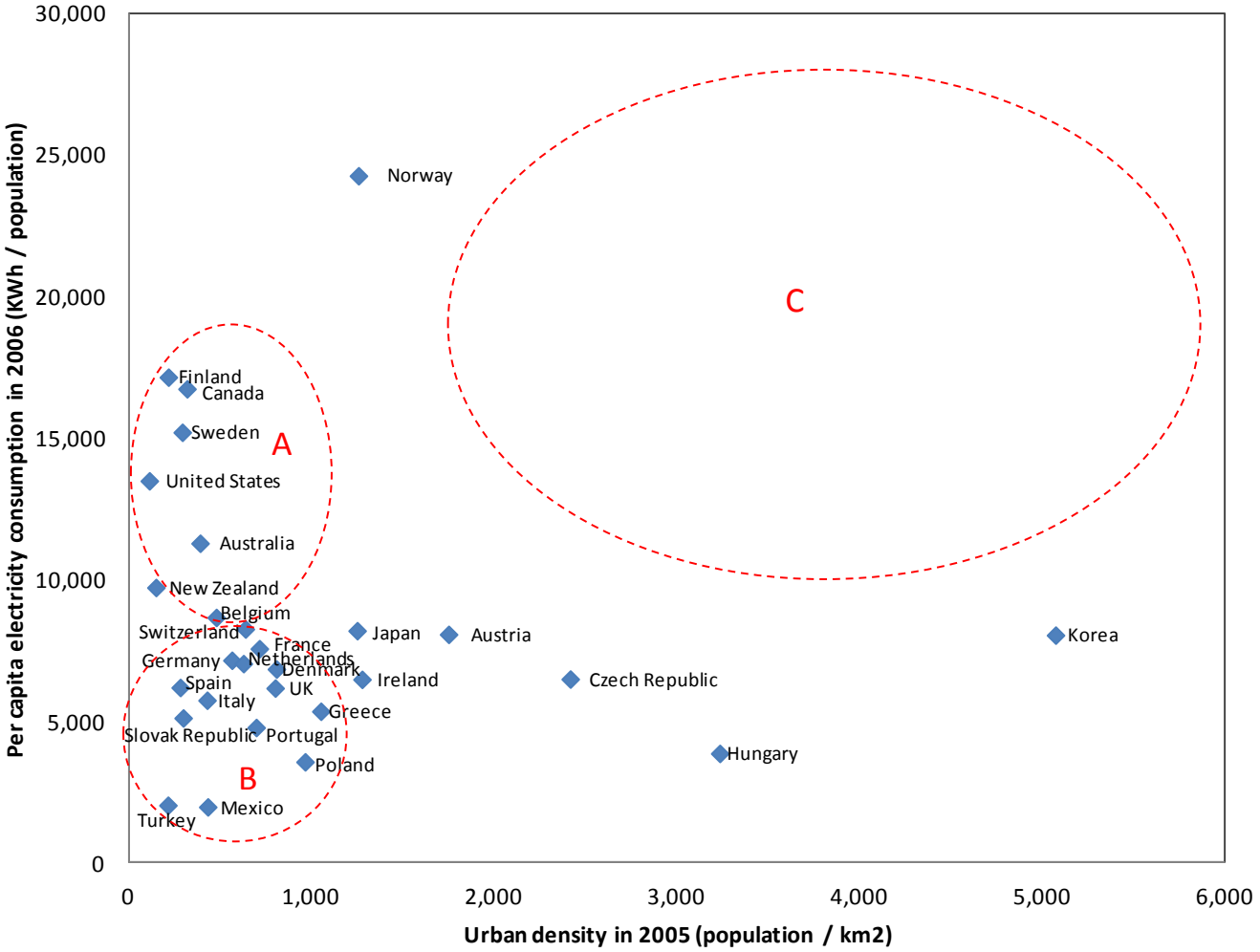
From Centralized Energy System to Decentralized one?

Compact City to Save Energy

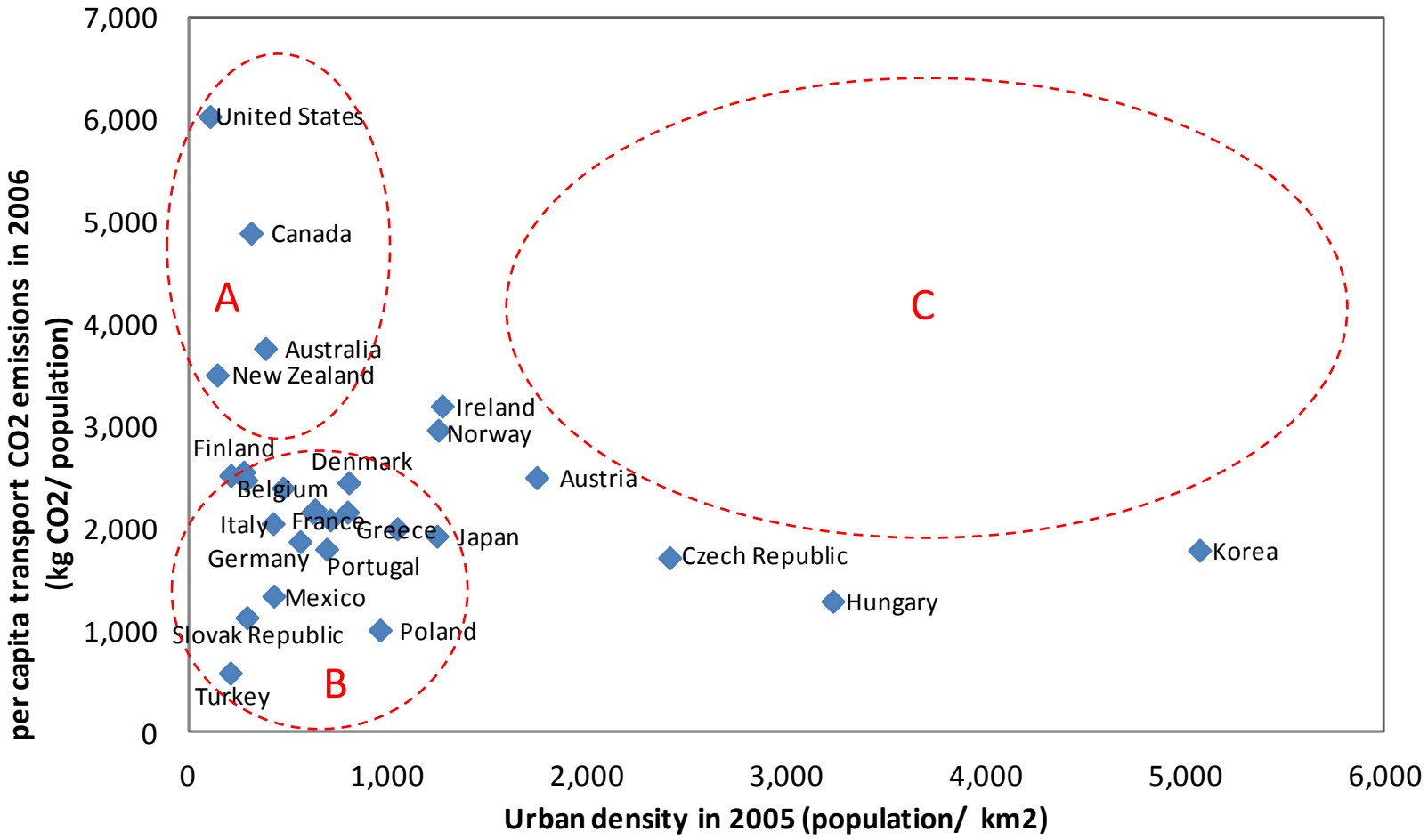
- Explosive development in the developing countries
- Growing inefficiency in the developed world city
- Newly recognized risks around the conventional energy policy

Compact City

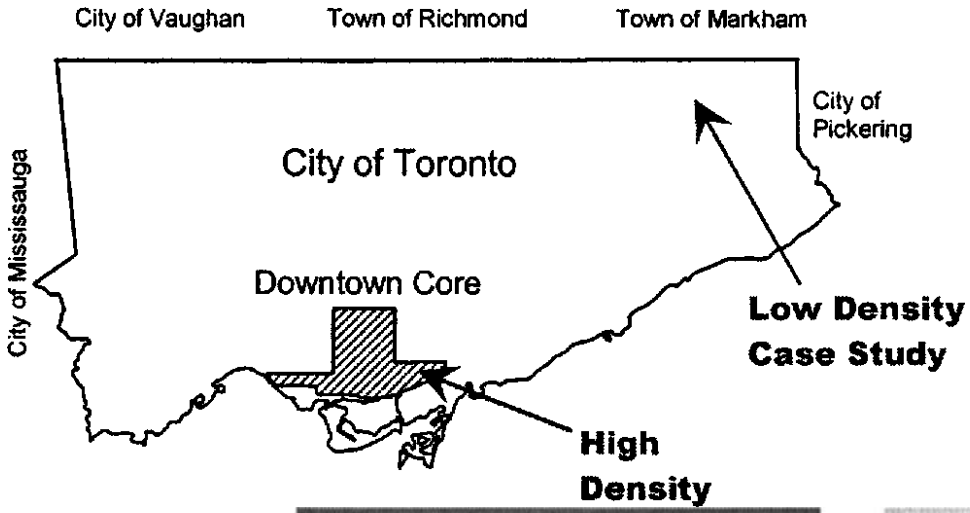
Electricity consumption per capita and density in predominantly urban areas, 2005-06



CO_2 emissions per capita in transport and density in predominantly urban areas, 2005-06



Case studies (1) :Norman, J. et al. (2006)



High Density Case-Study Building

Low Density Case-Study Typical Dwelling

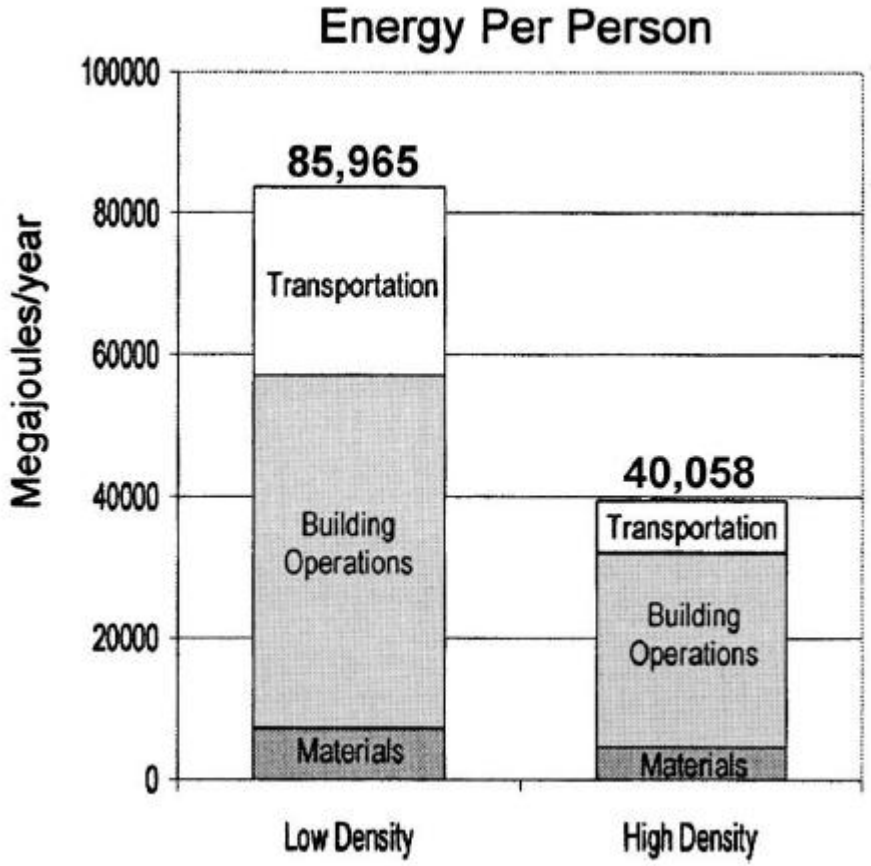
Case studies (1) :Norman, J. et al. (2006)

Three major elements of urban development are considered.

(1)Construction materials for infrastructure (including residential dwellings, utilities and roads)
(2) Building operations, and
(3)Transportation (Private automobiles and public transit)

Estimate life-cycle energy consumption per capita

Case studies (1) :Norman, J. et al. (2006)



Case studies (2) : Cheng, V. et al (2011)

Gross density : 18 dph (UF2) – 523 dph (UF5)

Case studies (2) : Cheng, V. et al (2011)

Urban Form	1	2	3	4	5	6
Gross Density (dph)	55	18	33	27	523	100
Energy per Dwelling (kWh)	14,163	15,571	13,327	13,400	9,457	10,050

Negative correlation between “gross density “and “energy per dwelling” (r_S = -0.829, $p < .05$).

dph : dwellings per hectare

Case studies (2) :Cheng, V. et al (2011)

Table 3. Low carbon technologies and their requirements

Technology	Requirements	
Photovoltaics	Roof or space facing SE/SW	Can export electricity if connected to grid, more cost effective if high on-site demand
Solar thermal	Roof or space facing SE/SW	Hot water demand on-site
Ground Source Heat Pump	Land area for ground collector or a water source	Building with a space heating (and possibly cooling) demand and low temperature heating system (e.g. under-floor)
Micro-CHP and CHP	Domestic or communal space	Proportional heat and electricity demand, scope for heat network

Case studies (2) :Cheng, V. et al (2011)

Urban Form	1	2	3	4	5	6
Water Heating Demand (kWh)	Solar thermal: 437 panels of 100 (lit) capacity	Solar thermal: 148 panels of 100 (lit) capacity	Micro-CHP: 488298	Micro-CHP: 340400; GSHP: 133274	CHP: 1965438	CHP: 781755
Space Heating Demand (kWh)	GSHP: 4158000; electricity required: 864000	GSHP: 1663200; electricity required: 345600	Micro-CHP: 1746072	GSHP: 2195206; electricity required: 483840	CHP: 3197088	CHP: 1288043; GSHP: 1663200; electricity required: 345600
Electricity Demand (kWh)	PV: 1026205	PV: 720804	Micro-CHP: 744790	PV: 691619; Micro-CHP: 113467	CHP: 2868070	CHP: 1149888
Renewable/ low carbon supply	6017498 kWh	2691716 kWh	2979160 kWh	3473966 kWh	8030596 kWh	4823977 kWh
Other supply (kWh)	Grid elect.: 1118901	Grid elect.: 101543	Gas: 4232007	Grid elect.: 399961 Gas: 533961	Gas: 20399786	Grid elect.: 345600 Gas: 6431969
Renewable/ low carbon	84%	96%	41%	79%	28%	42%

CHP: combined heat and power,
GSHP: ground source heat pump
PV: photovoltaic panel

Centralized vs. Decentralized Resource Management Systems

Characteristics of centralized systems;

(1)They tend to function in isolation, ignoring important synergy

(2)They allow resources to flow through cities in a linear fashion, not circular flows

(Rauland, V and Newmann, P.(2011))

How can we introduce decentralized system (ex. renewable power generation) into existing cities?

How can we benefit from the synergy between different systems?

Is high density a good condition for the introduction of decentralized system?

EV?

http://www.paris.fr/pratique/voitures-deux-roues-motorises/autolib/quels-trajets-faire-avec-autolib/rub_10055_actu_107631_port_25190

Thank you.

Cheng, V. et al. (2011), **A Study of Urban Form and the Integration of Energy Supply Technologies, World Renewable Energy Congress 2011-Sweden 8-13 May 2011, Linkoping, Sweden**

Norman, J. et al. (2006), **Comparing High and Low Residential Density: Life-Cycle Analysis of Energy Use and Greenhouse Gas Emissions,** ***Journal of Urban Planning and Development, Vol.*** 32, No. 1, March 1, 2006.

Rauland, V. and Newman, P.(2011) **Decarbonising Australian cities: A new model for creating low carbon, resilient cities,** 19th International Congress on Modelling and Simulation, Perth, Australia, 12–16 December 2011 http://mssanz.org.au/modsim2011