

EMSD Symposium 2011
Symposium on Electrical and Mechanical Safety &
Energy Efficiency
- Engineering a Safe and Low-carbon Environment

**DECOMPOSING RESIDENTIAL
ENERGY USE IN HONG KONG**

by

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Background (1)

- Asia-Pacific Economic Cooperation Leaders' Declaration in Climate Change, Energy Security and Clean Development
- to reduce energy intensity (TJ/GDP) by at least 25% by 2030 (with 2005 as the base year)
- Energy Intensity Model of HK (LEAP) has been developed in 2010.

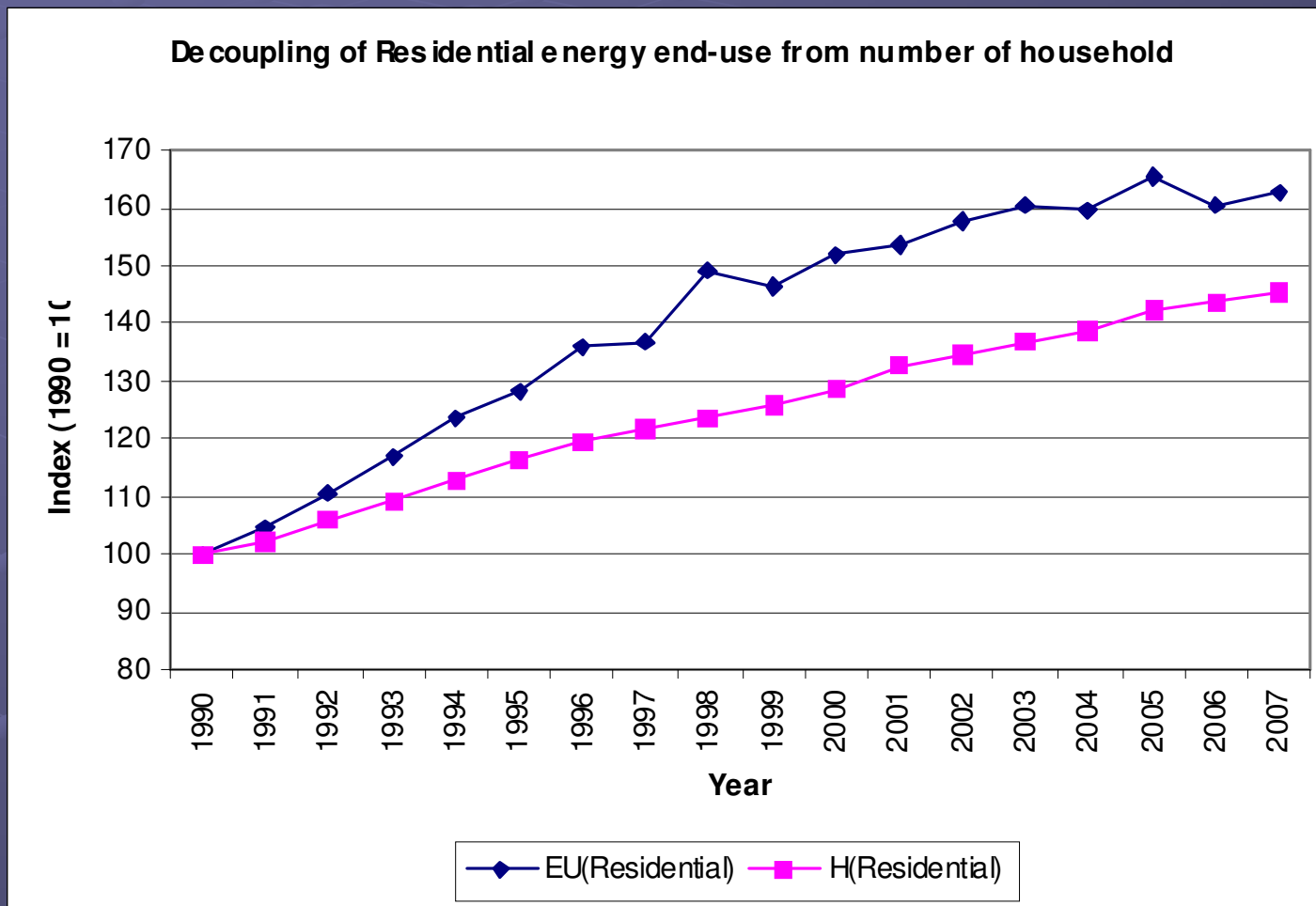
Background (2)

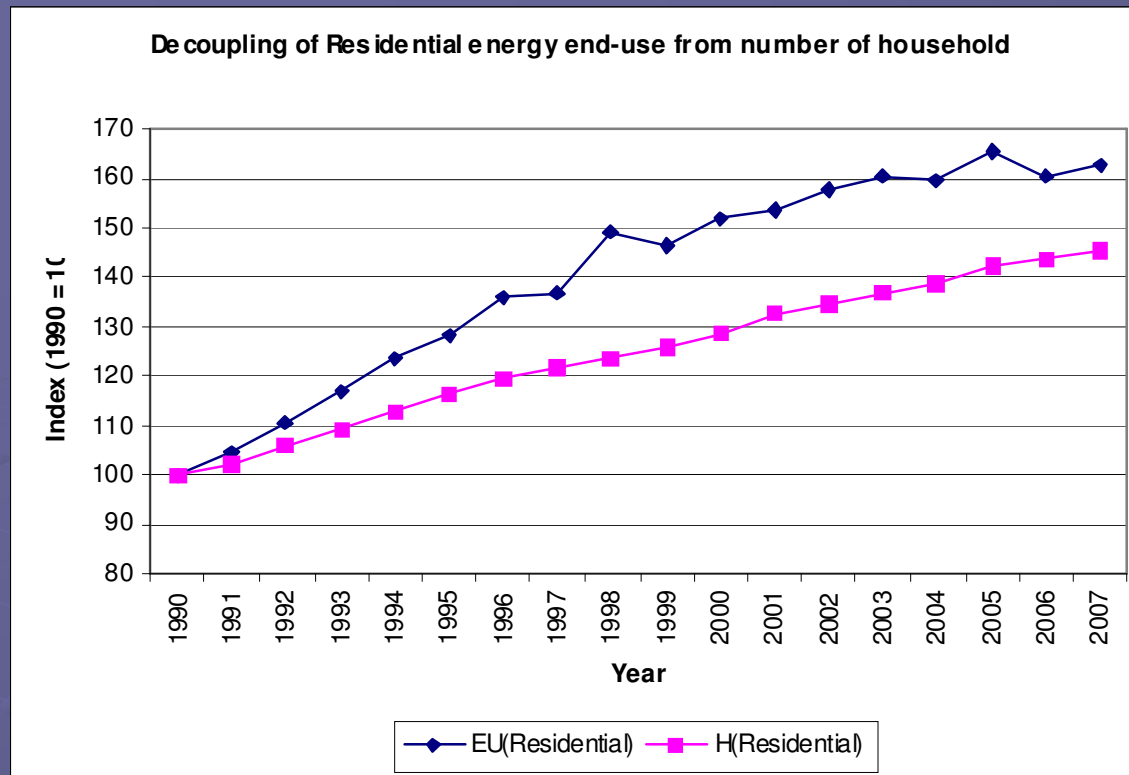
- Energy Intensity & Decomposition Analysis
- Four sectors
 - Residential (TJ/number of household)
 - Commercial (TJ/floor area(m²))
 - Industrial (TJ/value-added (HK\$))
 - Transport (TJ/passenger-km)

Residential Sector

Energy Use TJ (E)		Number of Households (H)	
E (1990)	32,327	H (1990)	1527863
E (2007)	52,667	H (2007)	2220288
ΔE	20,340	ΔH	692425
$\Delta E (\%)$	62.9%	$\Delta H (\%)$	45%

Decoupling of Energy End-use from Number of Households





Residential segments:

- Public Housing (Public)
- HA Subsidized Sales Flats (HASS)
- Private Housing (Private)
- Other Housing (Others)

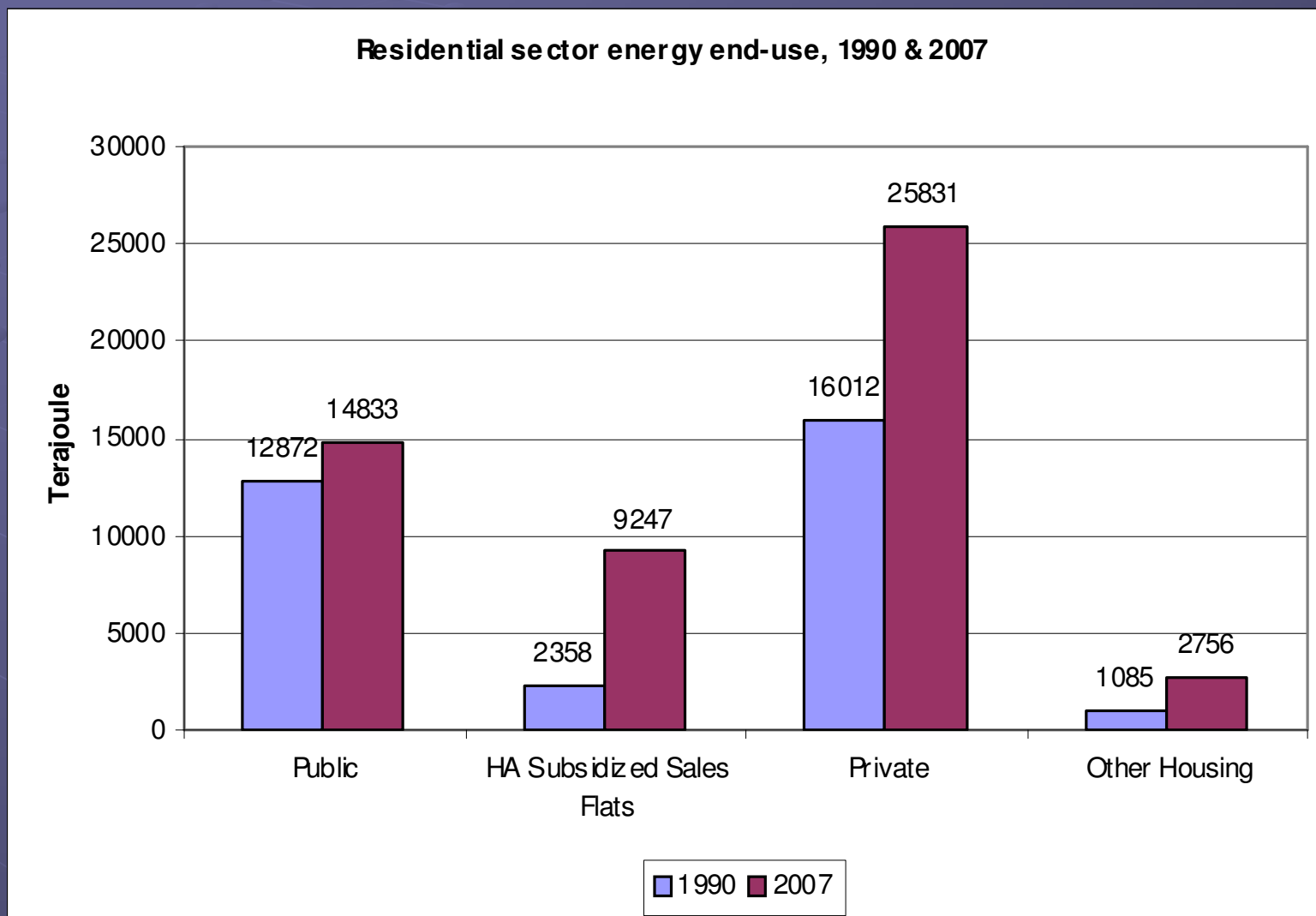


**Is the energy use increasing trend due to
(1) the changes in the proportion of different segments
and/or**

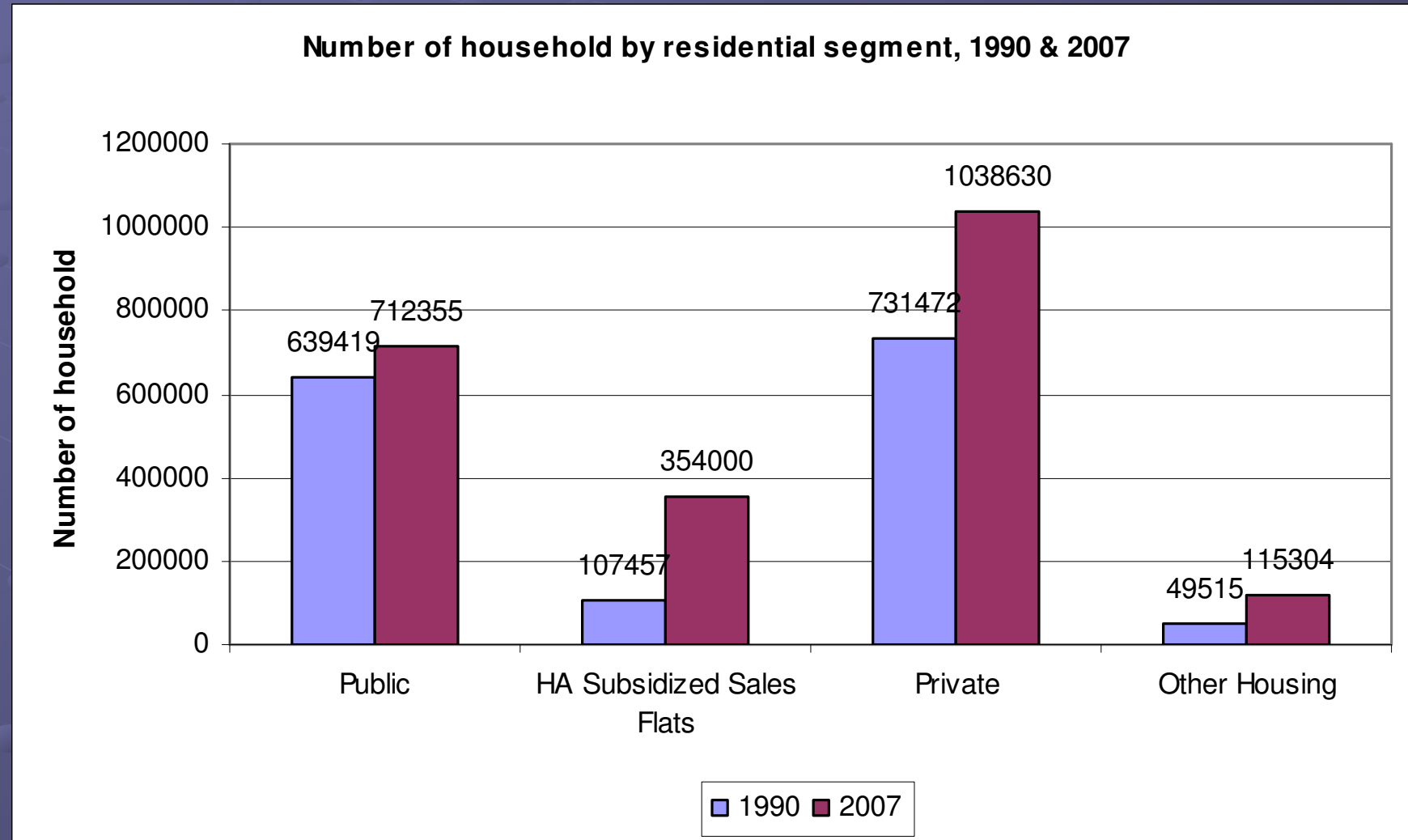
(2) the energy intensity itself getting worst?

Which segment contributes more in (1) and/or (2)?

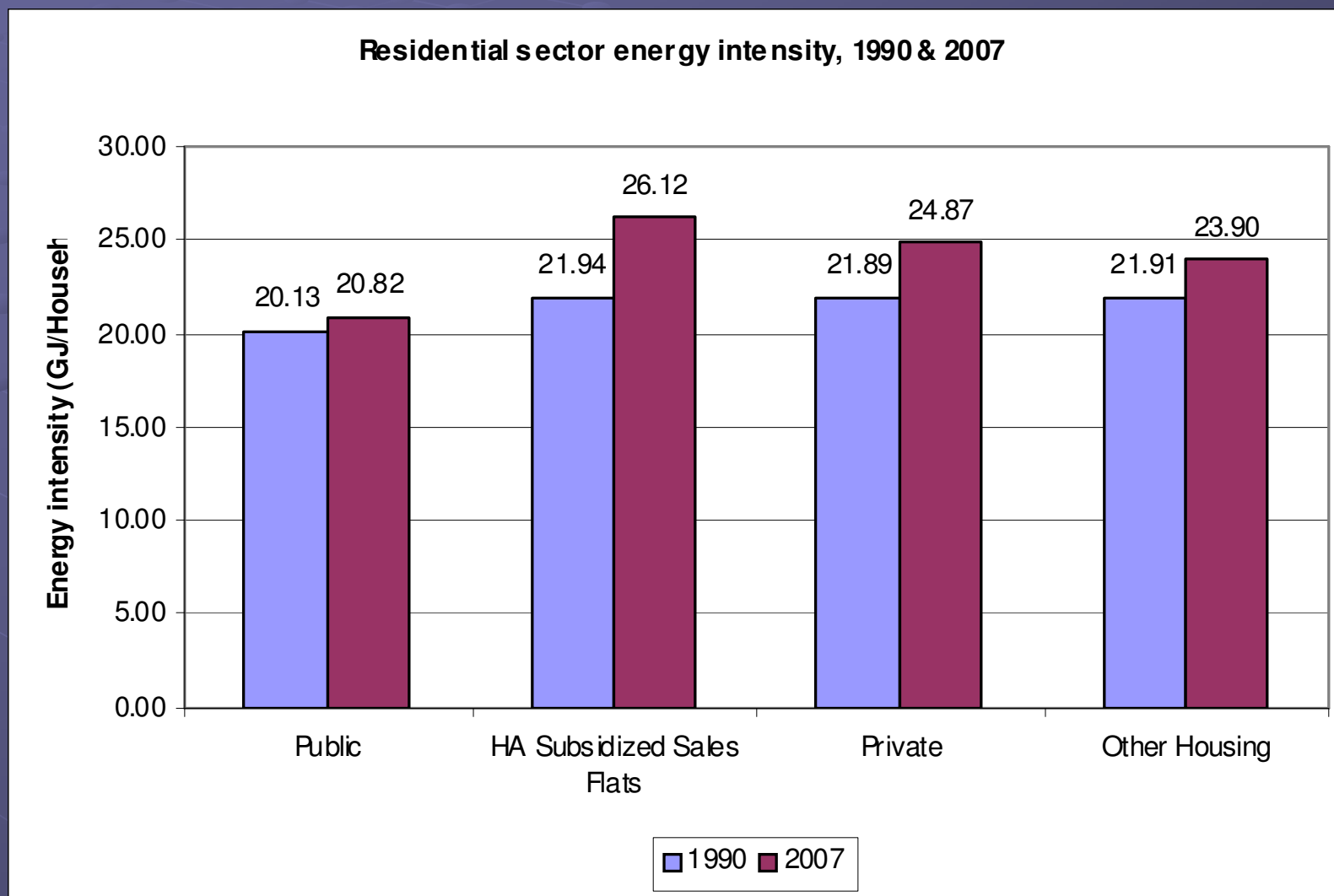
Energy End-use by Residential Segment (TJ), 1990 and 2007



Number of Households (H) by Segment, 1990 and 2007



Energy Intensity (GJ/H) by Segment, 1990 and 2007



Methodology – Decomposition Analysis

● Logarithmic mean Divisia index (LMDI)

$$D_{Tot,2007} = \frac{E_{2007}}{E_{1990}} = D_{act,2007} \times D_{str,2007} \times D_{int,2007} \times D_{Wea,2007}$$

Activity
effect

Structural
effect

Intensity
effect

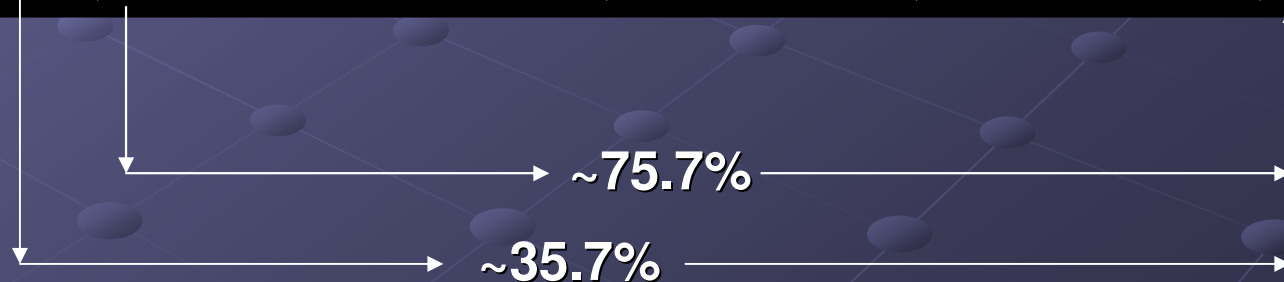
Weather
effect

$$\Delta E_{x,T} = \left(\frac{E_T - E_0}{\ln E_T - \ln E_0} \right) \ln D_{x,T}$$

$$\begin{aligned} \Delta E_{Tot,2007} &= E_{2007} - E_{1990} \\ &= \Delta E_{act,2007} + \Delta E_{str,2007} + \Delta E_{int,2007} + \Delta E_{Wea,2007} \end{aligned}$$

Decomposition Results by Segment, 1990 and 2007

Residential Segment	<i>Activity effect</i> (ΔE_{act})	Structural effect (ΔE_{str})	Intensity effect (ΔE_{int})	Weather effect (ΔE_{wea})	Total effect (ΔE_{tot})
Public	5,169	-3,675	-327	795	1,961
HASS	1,884	4,126	589	290	6,889
Private	7,674	-476	1,440	1,180	9,819
Others	670	845	53	103	1,671
All	15,397	820	1,754	2,369	20,340



- measures how the relative changes of the number of households in a segment (household number in the segment vs. household number in the sector) contribute to the energy end-use in the sector

Residential Segment	Activity effect (ΔE_{act})	Structural effect (ΔE_{str})	Intensity effect (ΔE_{int})	Weather effect (ΔE_{wea})	Total effect (ΔE_{tot})
Public	5,169	-3,675	-327	795	1,961
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Private	7,674	-476	1,440	1,180	9,819
Others	670	845	53	103	1,671
All	15,397	820	1,754	2,369	20,340

~ 20.3%

~ - 18.1%

Intensity effect (TJ/household)

Residential Segment	Activity effect (ΔE_{act})	Structural effect (ΔE_{str})	Intensity effect (ΔE_{int})	Weather effect (ΔE_{wea})	Total effect (ΔE_{tot})
Public	5,169	-3,675	-327	795	1,961
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~ 7.1%

- ve value

Weather effect

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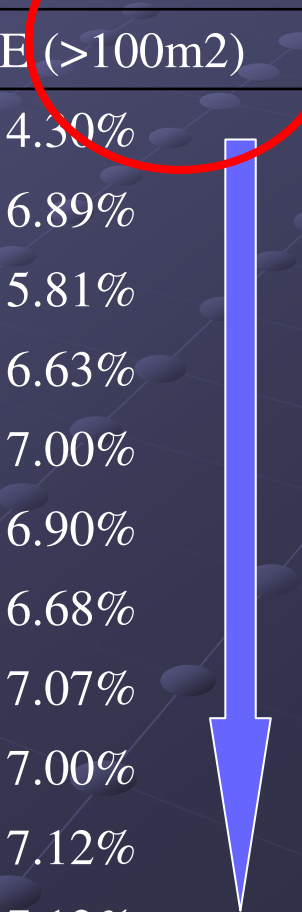
↓ ~ 11.6% ↑

Discussion

● Intensity effect +7.1% (Private segment)

Cumulative Percentage of Completions by Class

Year	A & B (<70m ²)	C (<100m ²)	D & E (>100m ²)
1997	82.24%	13.45%	4.30%
1998	79.56%	13.55%	6.89%
1999	79.76%	14.43%	5.81%
2000	76.67%	16.70%	6.63%
2001	76.36%	16.65%	7.00%
2002	75.17%	17.93%	6.90%
2003	76.68%	16.64%	6.68%
2004	76.87%	16.06%	7.07%
2005	76.80%	16.20%	7.00%
2006	76.61%	16.27%	7.12%
2007	76.68%	16.20%	7.12%



Discussion

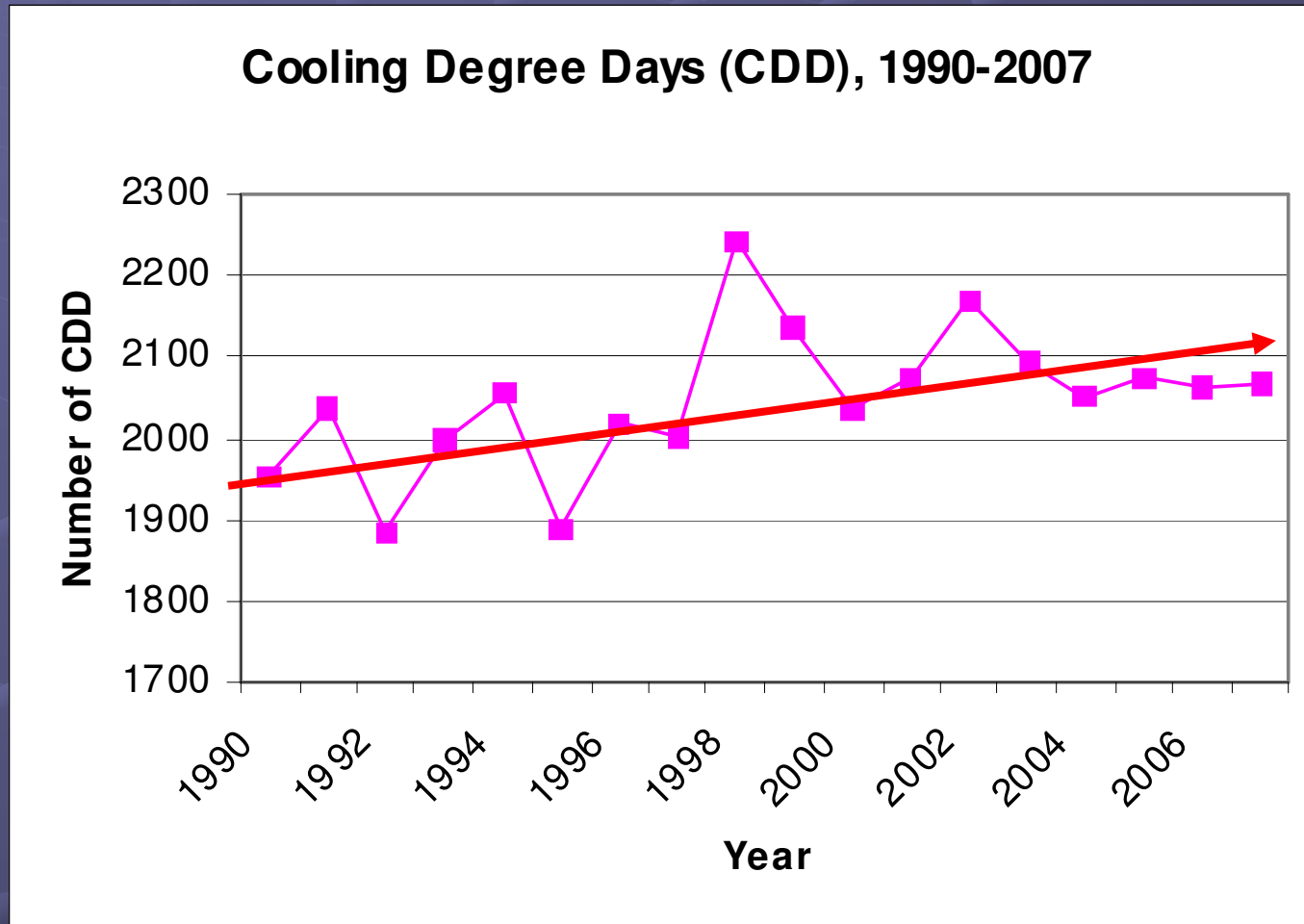
● Intensity effect -327TJ (Public segment)

Domestic Households by Monthly Domestic Household Income, 1996, 2001, and 2006

	1996		2001		2006	
Monthly Domestic Household Income (HK\$)	Number	% of total (1996)	Number	% of total (2001)	Number	% of total (2006)
< 2,000	55 597	3.0	65 855	3.2	86 736	3.9
2,000 - 3,999	61 573	3.7	97 568	4.8	118 573	5.3
4,000 - 5,999	75 595	4.1	93 018	4.5	121 665	5.5
6,000 - 7,999	105 639	5.7	116 340	5.7	146 010	6.6
8,000 - 9,999	136 577	7.4	120 721	5.9	147 081	6.6
10,000 - 14,999	324 001	17.5	318 623	15.5	339 469	15.2
15,000 - 19,999	269 694	14.5	262 086	12.8	279 217	12.5
20,000 - 24,999	210 926	11.4	223 708	10.9	225 292	10.1
25,000 - 29,999	147 295	7.9	159 470	7.8	162 783	7.3

Discussion

- Weather effect 11.6%



Conclusions

- Decomposition analysis (1990, 2007)
- Activity effect is the key driver
- Intensity effect of Private is getting poor.
 - use more energy per household in this segment
- Intensity effect of Public is improved, ie, use less energy per household
- Mandatory Energy Efficiency Labelling (MEEL) scheme.