Survey of Dunedin Housing and Heating Practices

- Energy Studies / Economics Study
  - Colin Smithies, Paul Thorsenes (Economics)
  - Bob Lloyd, Tim Bishop (Energy Studies)
- Survey of 65 Dunedin Houses Purchased in 2005
  - Physical Inspection
  - Model to estimate Heat Loss, Annual Net Heating Energy Requirements

Study Aims

- Characterise heating requirements and practices for Dunedin Single Family Homes
- This is part of a larger study to investigate preferences for energy efficient housing as indicated by effects on purchase price.

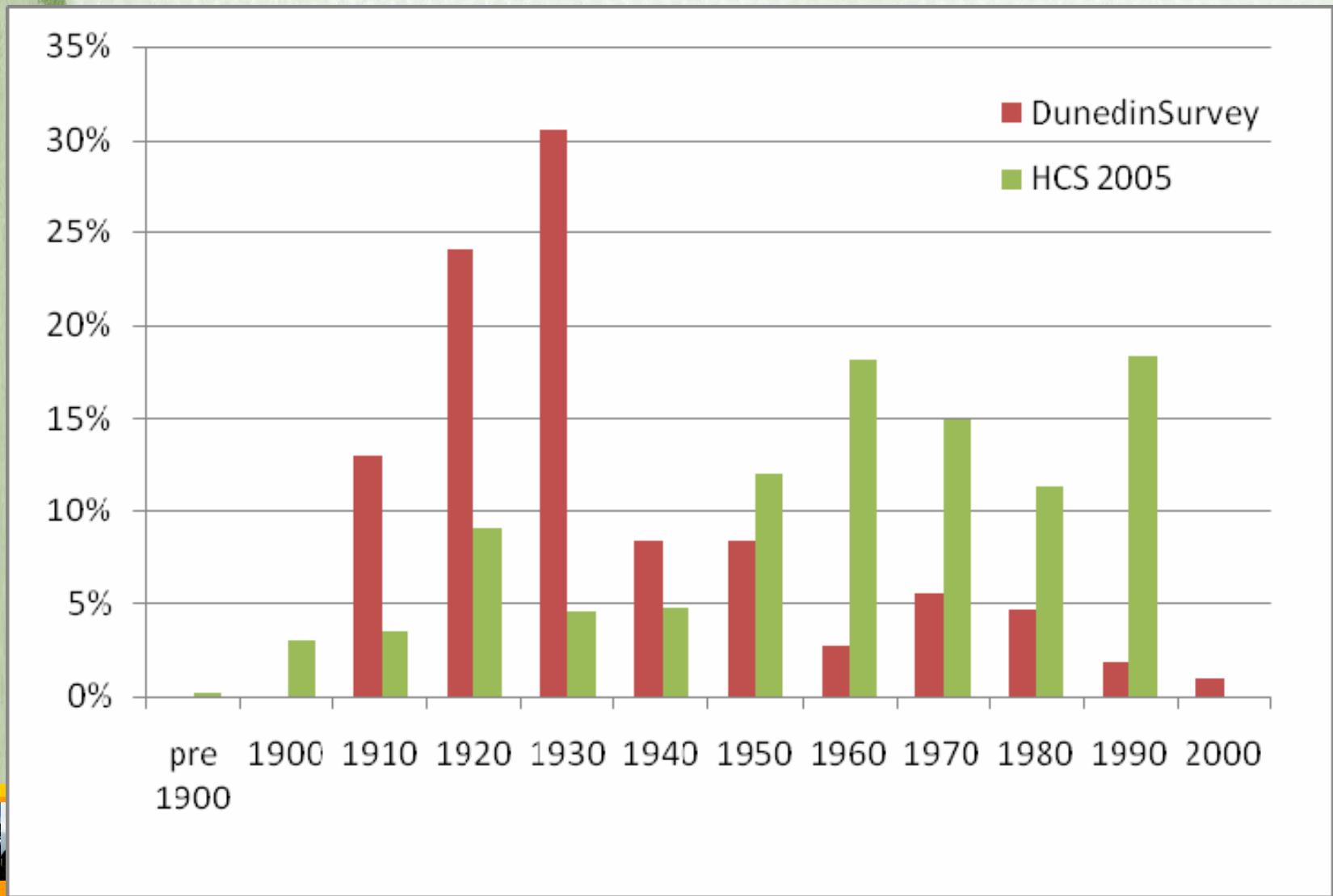
Research Questions

- Characterise Heating Energy Requirements
  - What Levels of Insulation and construction are observed?
  - What Heating Schedules and Temperatures are Reported
  - What areas of houses are heated

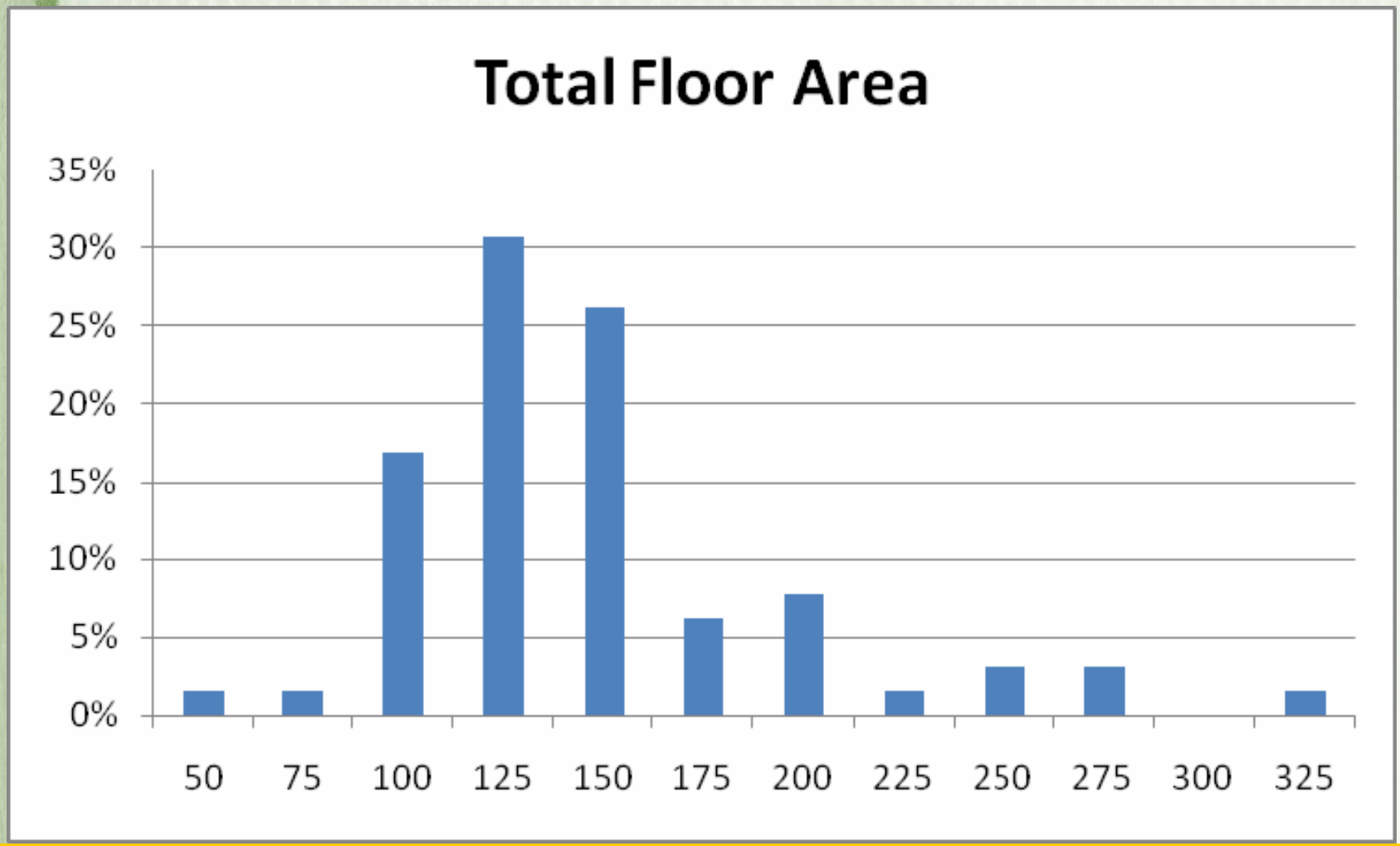
Details

- Sample Selection
  - Obtain list of 2005 House Sales in Dunedin from Quotable Value
  - Randomly select houses to participate in survey
- Survey
  - Visit and Interview about heating preferences and habits, conduct physical inspection of house to model in ALF3

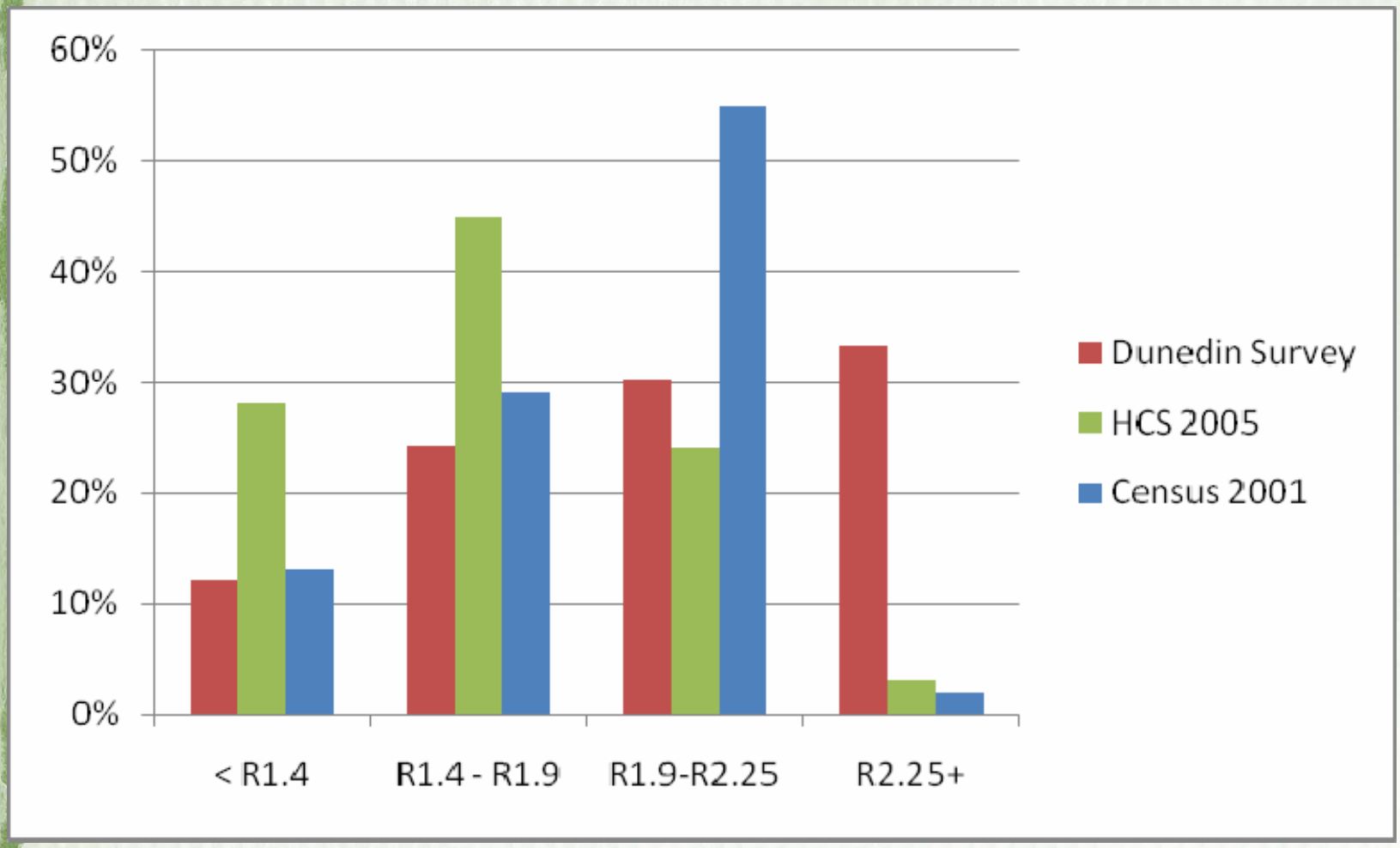
House Age


35%
30%
25%
20%
15%
10%
5%
0%
DunedinSurvey
HCS 2005
pre 1900
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000

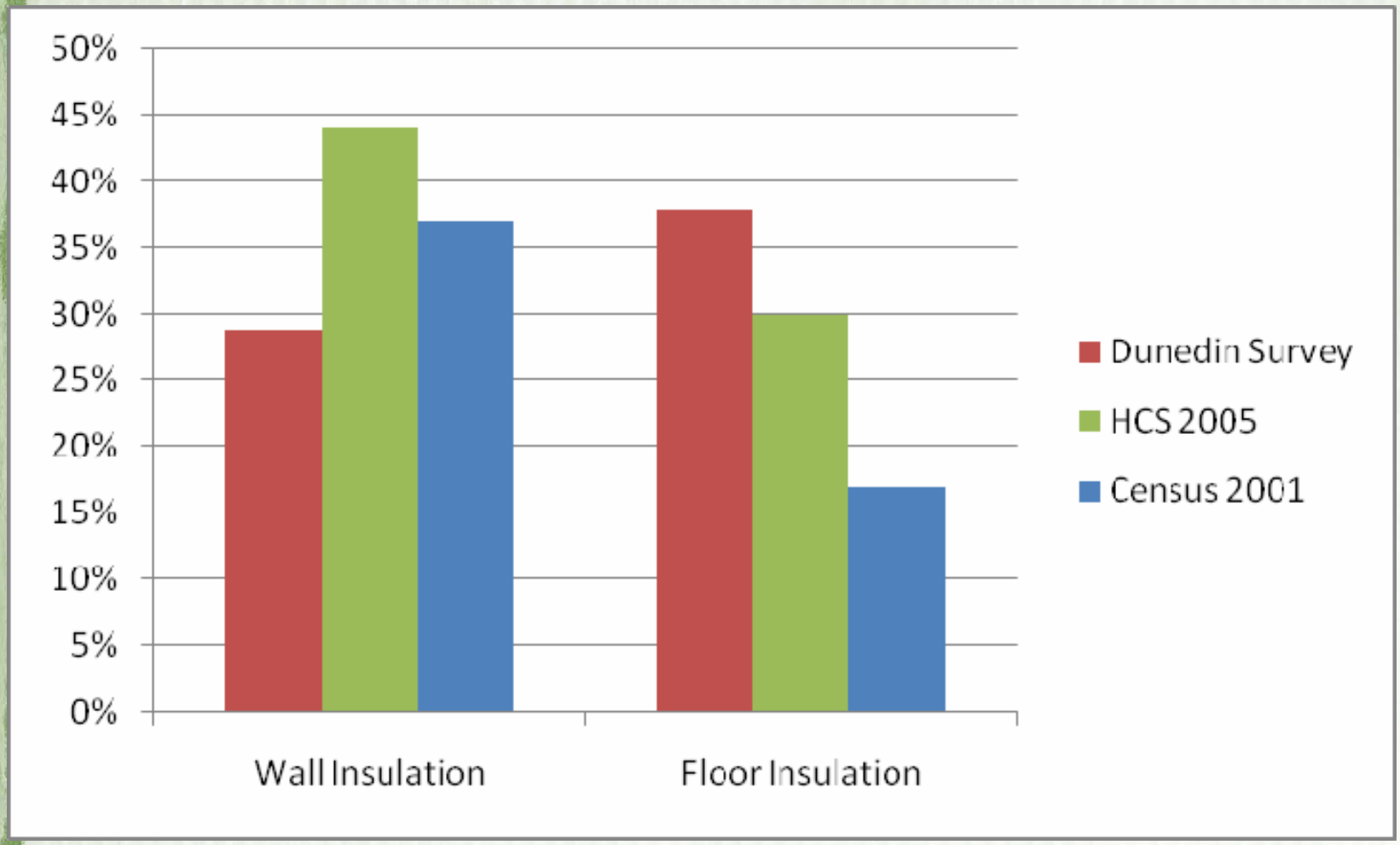
Floor Area

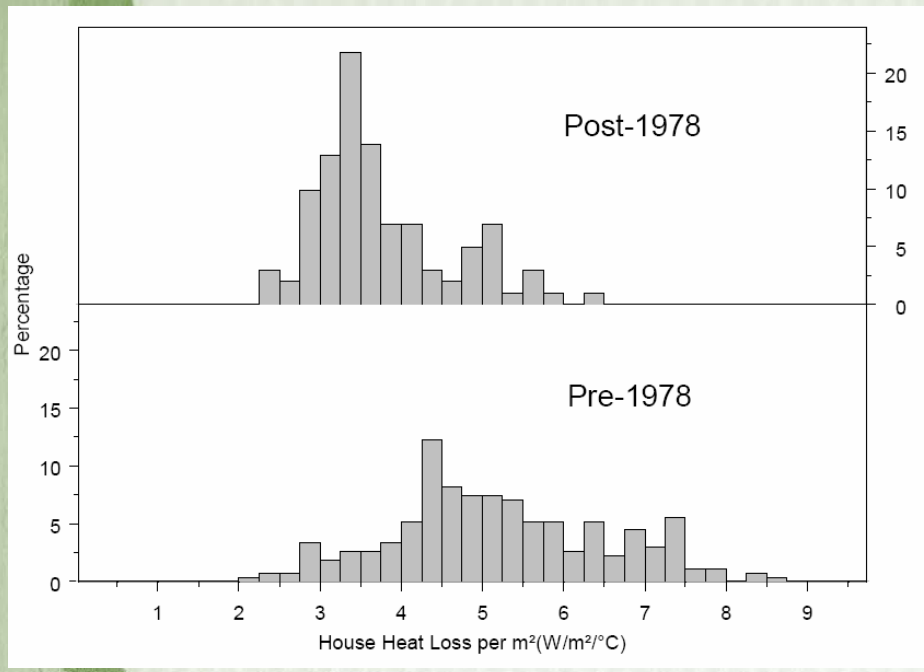

Total Floor Area
35%
30%
25%
20%
15%
10%
5%
0%
50
75
100
125
150
175
200
225
250
275
300
325

Ceiling Insulation



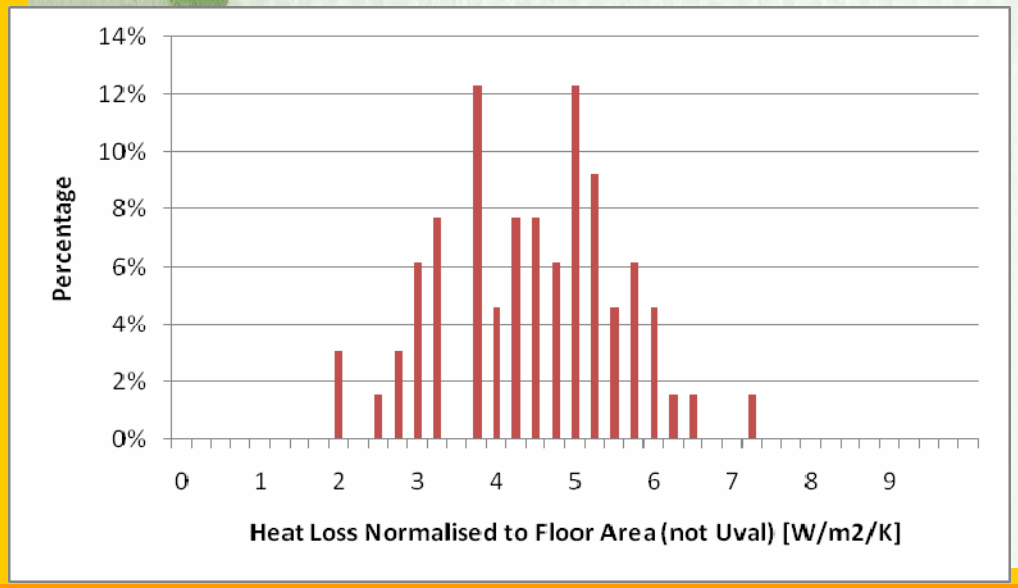
Wall and Floor Insulation



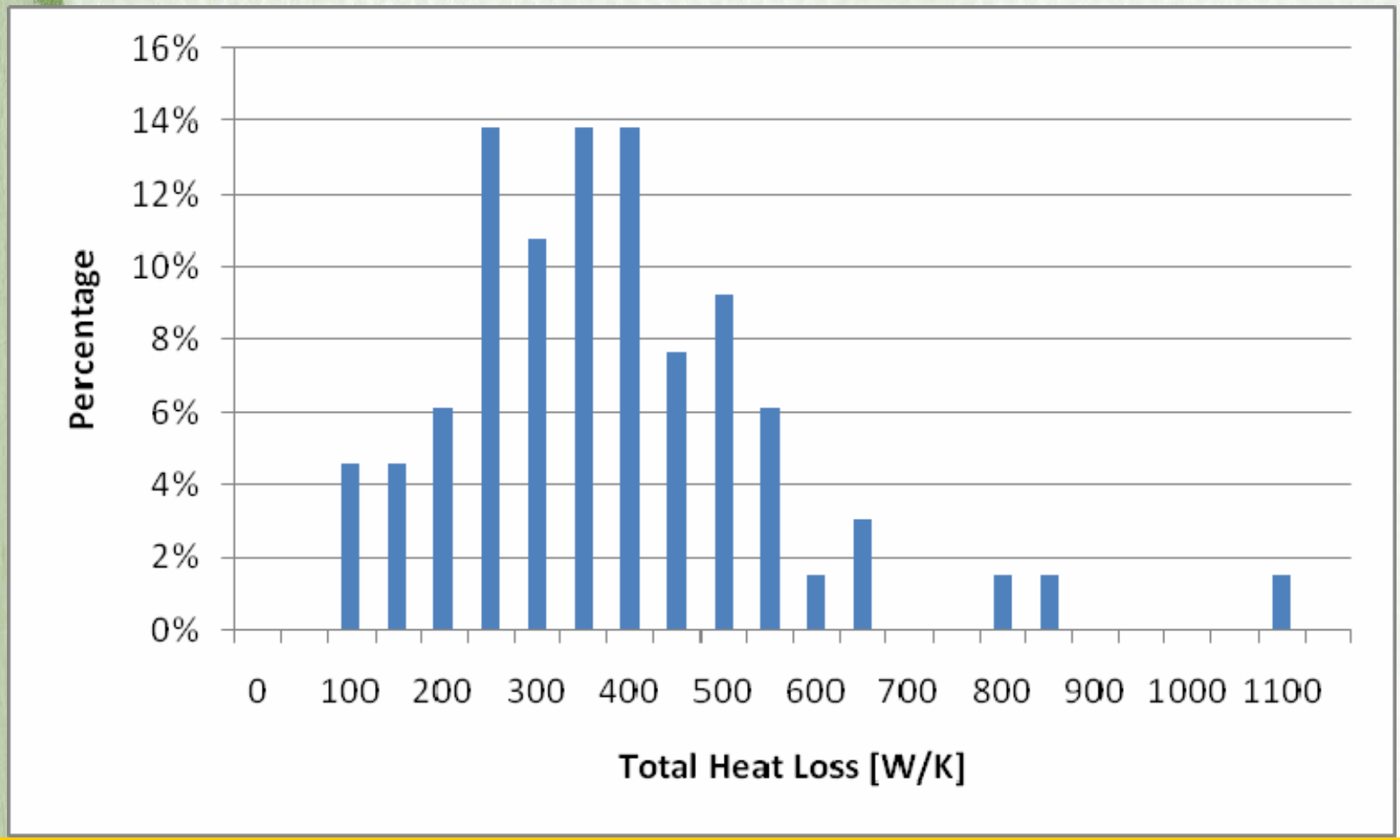


Heat Loss

- Power needed to raise temperature by 1 degree

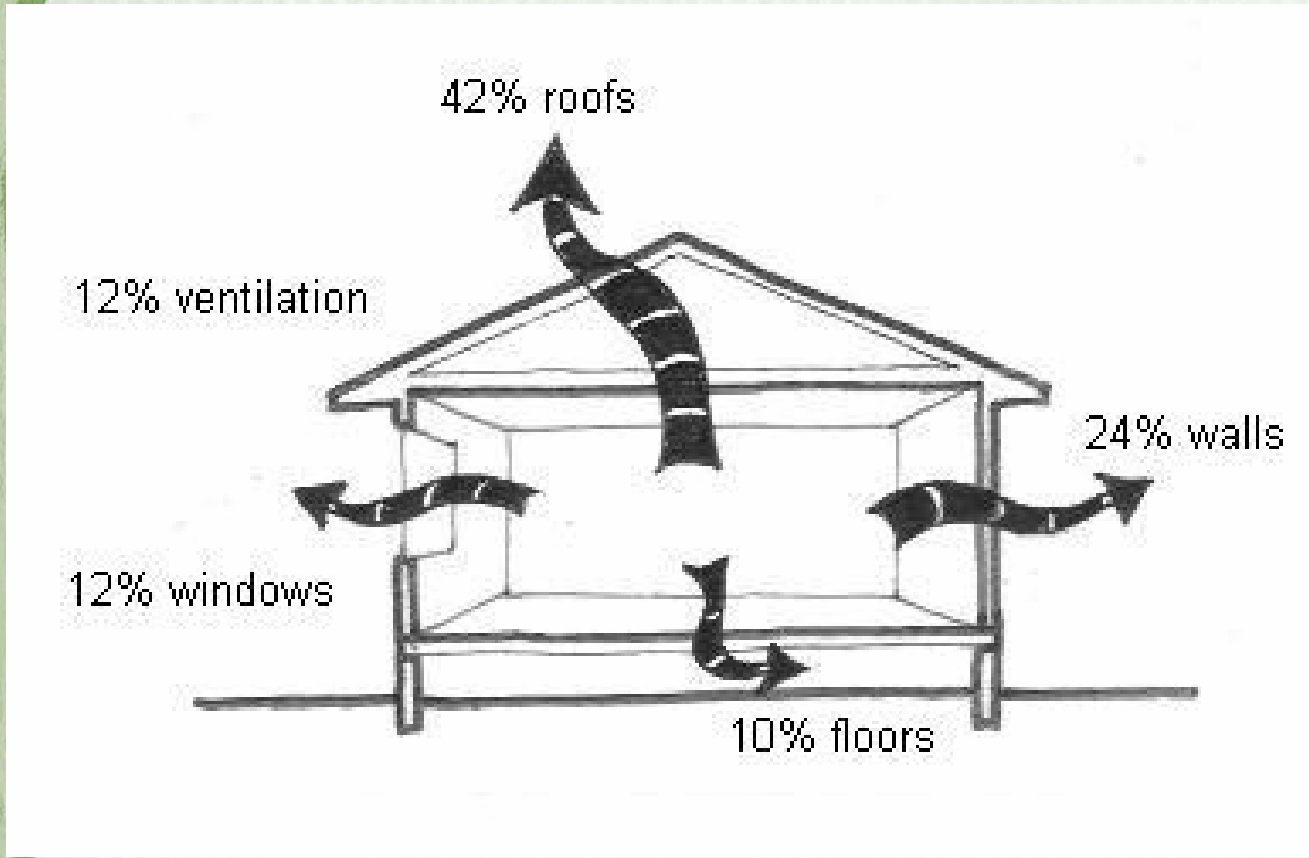


Heat Loss

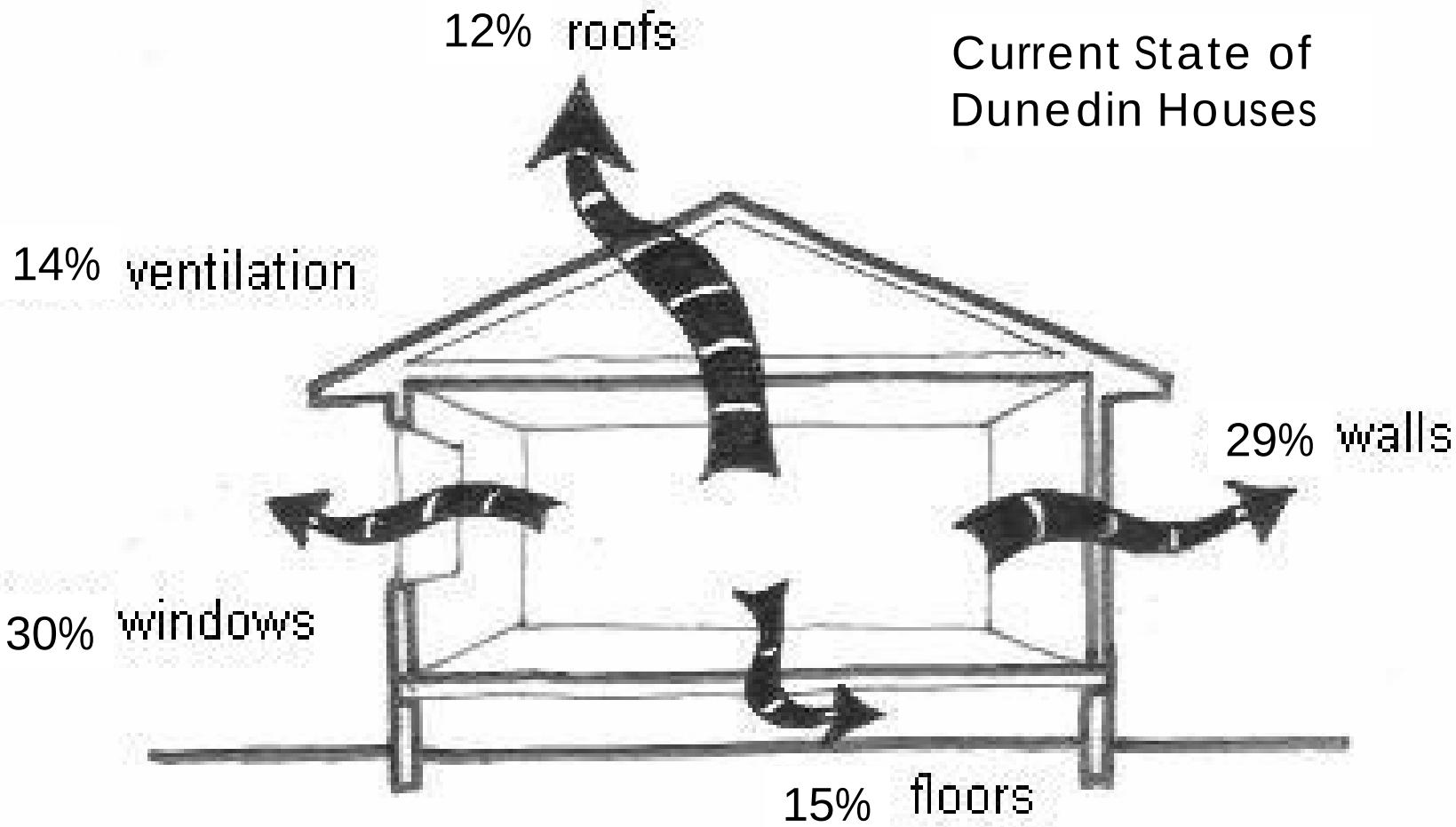

16%
14%
12%
10%
8%
6%
4%
2%
0%
Percentage
0
100
200
300
400
500
600
700
800
900
1000
1100
Total Heat Loss [W/K]

EECA Heat Loss

Heat Loss for an Un-insulated House



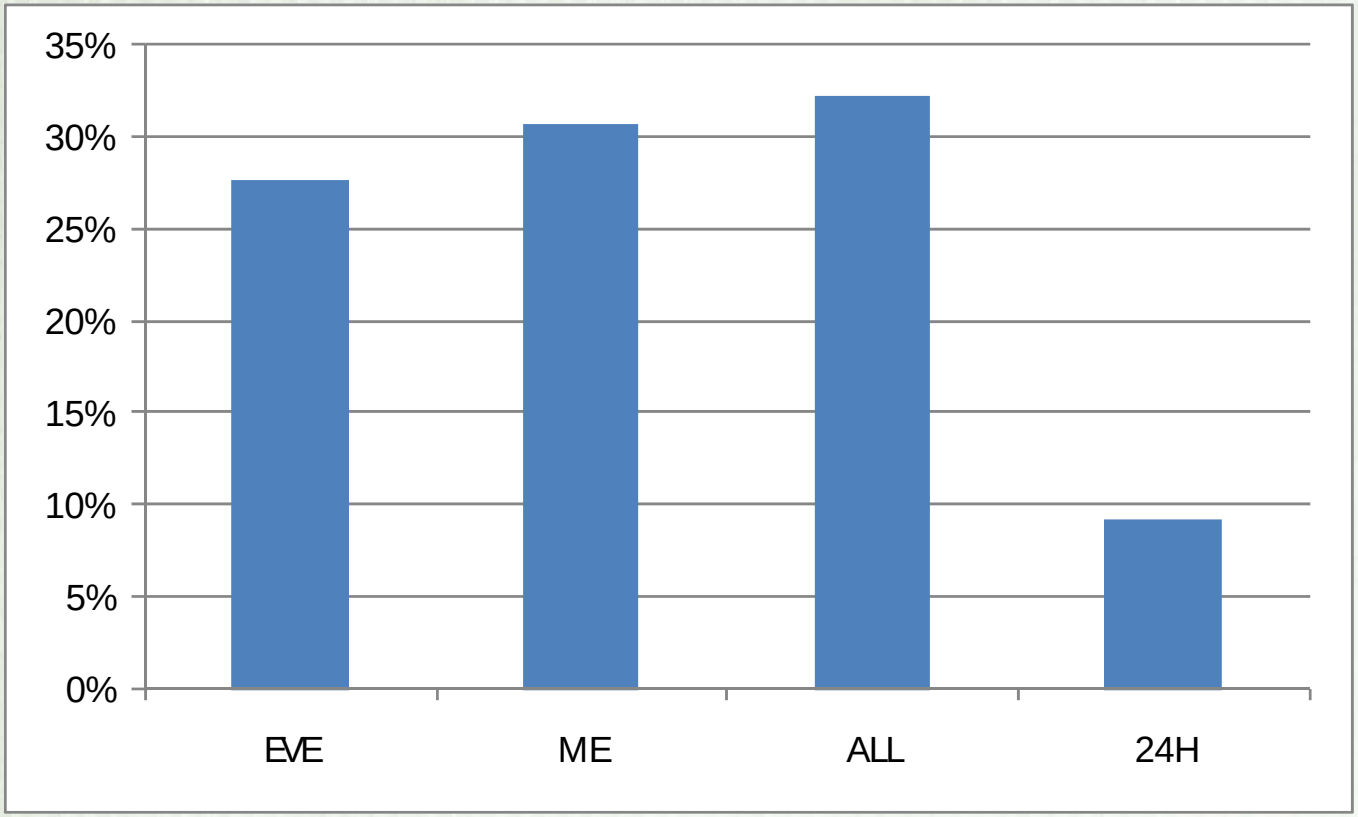
Dunedin Housing Heat Loss



ALF3 Model

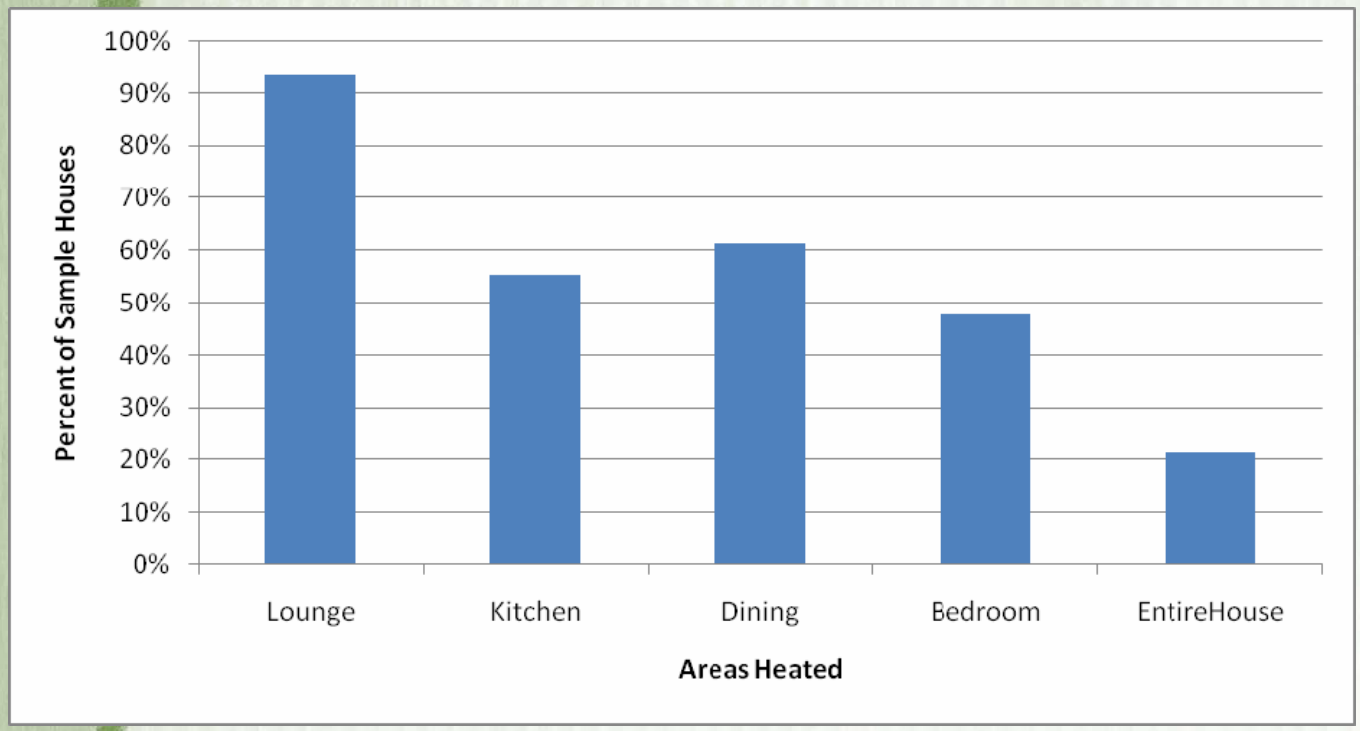
- Model Inputs
  - Heat Loss
  - Climate
  - Heat Gains from Sun into windows
  - Heating Schedule (Evening, Morning, All Day, 24Hours) and Temperature 16,18,20
- Outputs:
  - Predicts Annual Heating Energy (Net kWh/year)
  - Usually Assumes entire house heating.

Heating Schedule Chosen



Heated Area Chosen

- Average ~60% of house is heated



Predicted Annual Energy Use

	Data						
Sched	Average	HeatedAreaEng	f House	as Pump	s Burner	las Open	s Gas LPG
24H	16,516	13,974	6	6	1	1	1
ALL	17,127	11,162	21	10	12	5	4
ME	13,678	7,850	20	13	12	4	4
EVE	8,024	3,676	18	12	7	6	3
Grand Total	13,489	8,329	65	41	32	16	12

- Compare with Dunedin/Invercargill Average Heating Energy 7,100 kWh/year measured by HEEP Study

First Conclusions

- New Zealand Houses are not designed to efficiently hold onto available heat
- House Size, Heated Area Chosen, Heating Schedule chosen, and insulation affect heating Energy Requirements
- Can we
  - Increase temperatures to improve comfort and health,
  - Without increasing carbon emissions?

Current Research

New Question: What are good upgrade options for Dunedin Housing Stock?

Assume Zoned Heating.

A Model Houses with New Heating System

Upgrade Cost, Heating Cost, and Carbon emissions

B Model Houses upgraded with insulation

Upgrade Cost, Heating Cost, Carbon emissions

Thank You!

- New Zealand Houses are cold

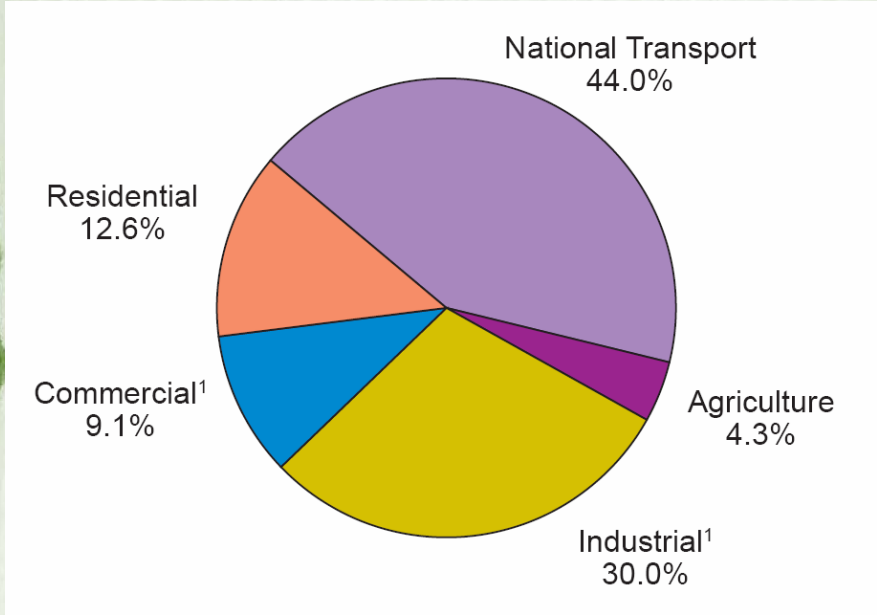


Figure G.5a: Electricity Consumption by Sector (GWh)

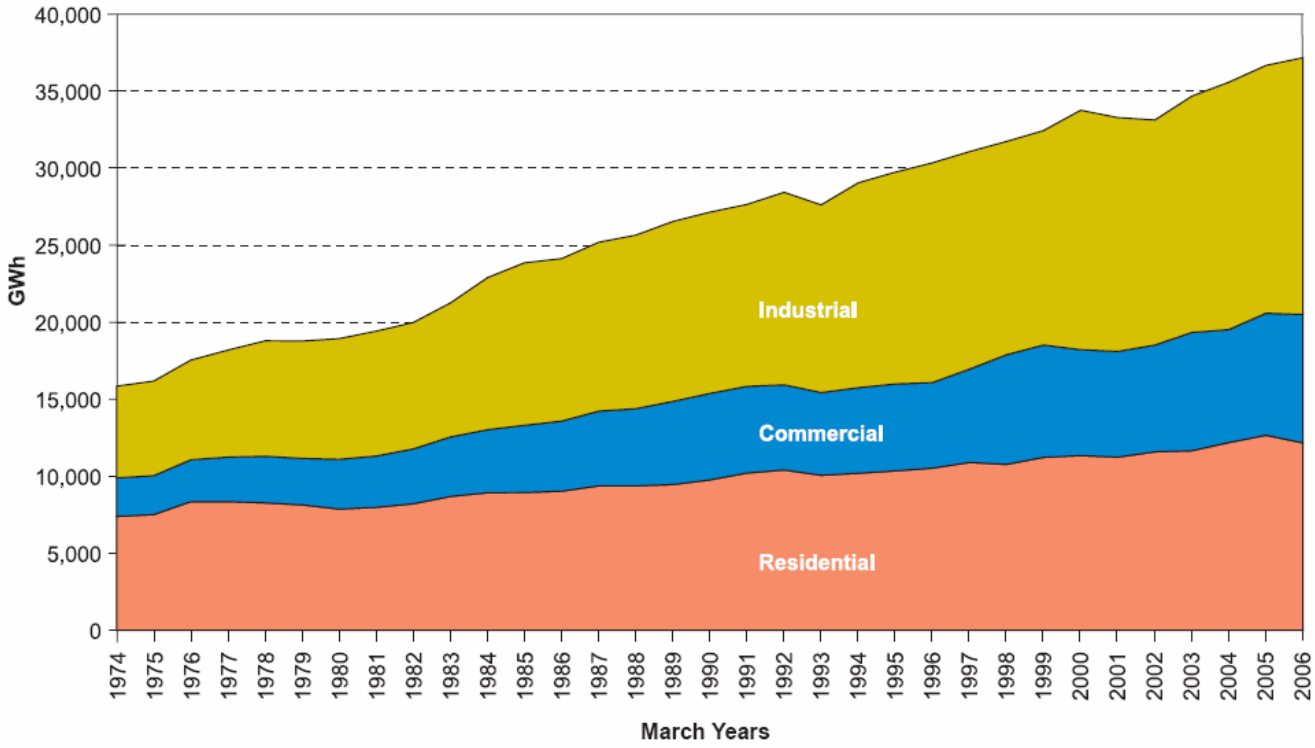


Table J.7: International Consumption of Energy for 2005

	Oil Products Tonnes/person	Gas m^3/person	Electricity kWh/person
India*	0.10	26	579
China*	0.18	33	1,445
Russia*	0.65	2,940	6,740
UK	1.25	1,654	6,330
Germany	1.36	1,238	7,478
France	1.43	765	8,299
New Zealand	1.63	1,004	10,351
Australia	1.79	1,081	12,296
Japan	1.78	631	8,463
Chinese Taipei*	1.92	385	9,103
Canada	2.71	2,839	18,191
USA	2.95	2,090	14,470

* 2003