Life Cycle Assessment of the Australian Building Material Requirement - Identifying Potential for Reducing Impacts.

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Project Background

- National government project to investigate how sustainability of materials may be addressed in the Australian building codes
- Project included
  - Materials flow of current buildings construction
  - Projection of future building demand and consequent material requirements
  - LCA of building requirements now and from future demand
  - Recommendation and testing (though the LCA) of tools and strategies for increasing sustainability of building materials

Inclusions and exclusions

- Data included quantities of building elements used in each building sector in a year.
- Cradle to grave impacts for building elements has been included.
- Floor coverings and paints are included.
- Plumbing and electrical is included
- Energy in construction and construction waste included

- Not included
- Operational energy
- Furniture and fit out
- Site excavation
- Indoor air quality issues
- Transport to site

Data flows

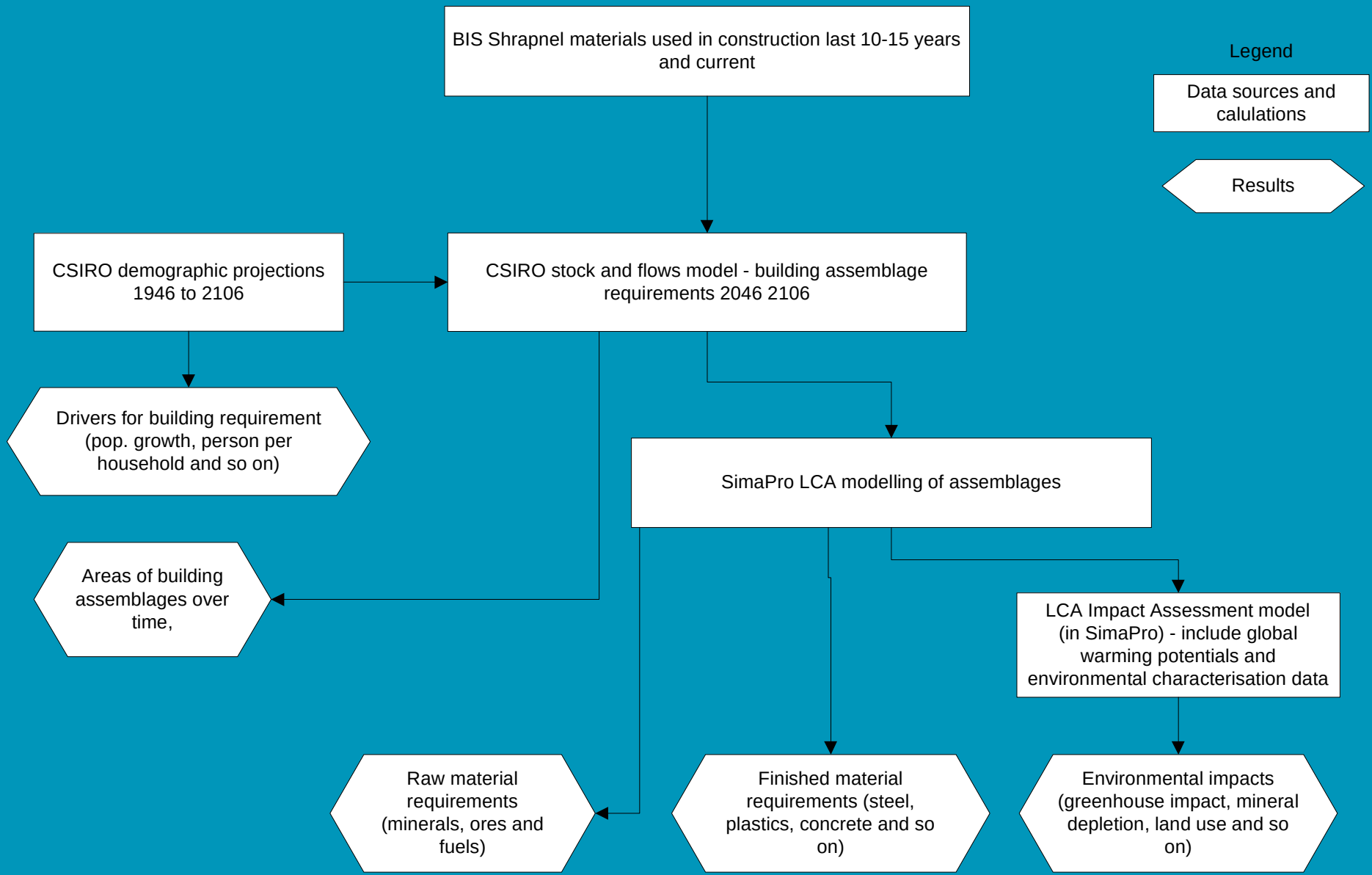
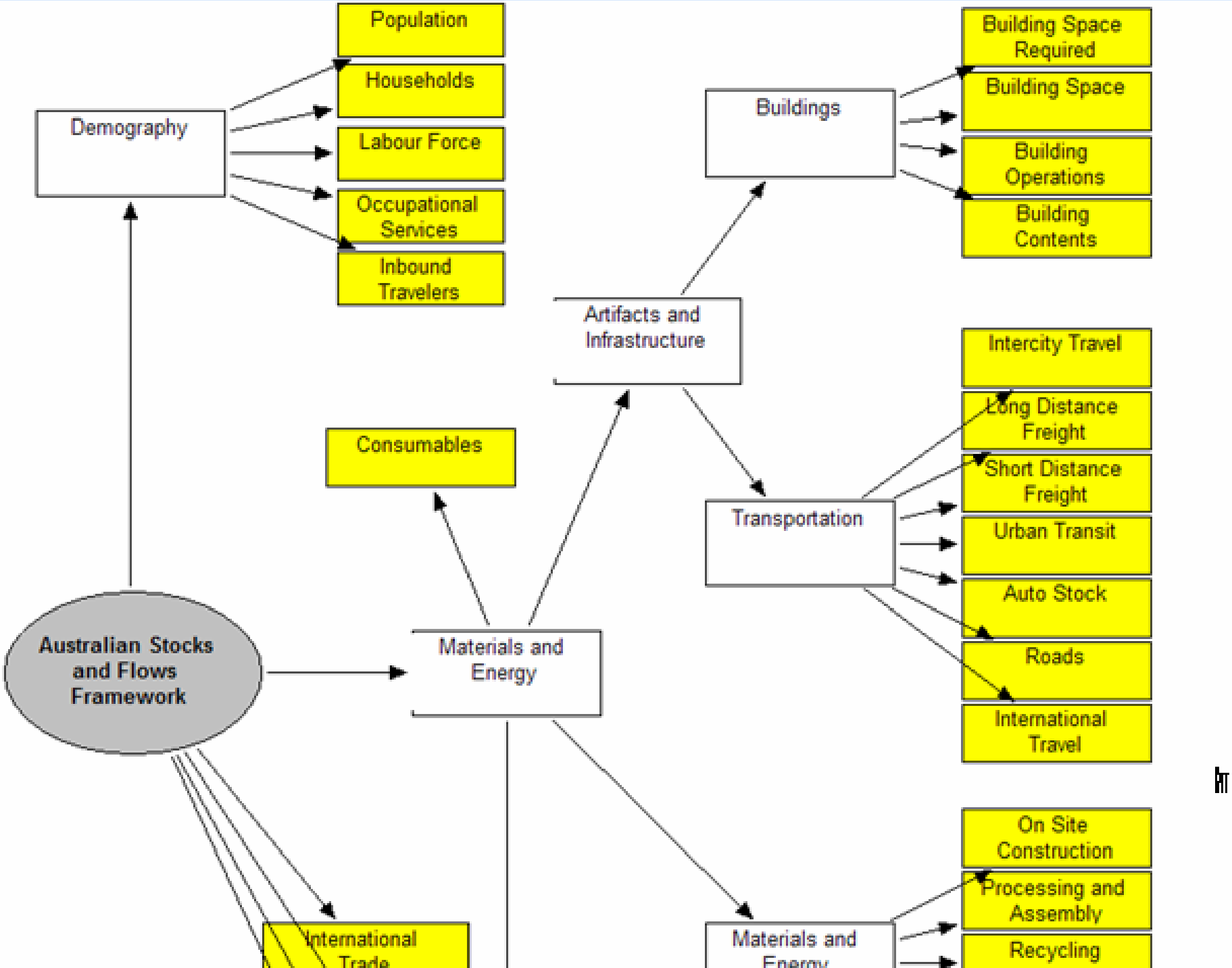

BIS Shrapnel materials used in construction last 10-15 years and current
Legend
Data sources and calulations
Results
CSIRO demographic projections 1946 to 2106
CSIRO stock and flows model - building assemblage requirements 2046 2106
Drivers for building requirement (pop. growth, person per household and so on)
SimaPro LCA modelling of assemblages
Areas of building assemblages over time,
LCA Impact Assessment model (in SimaPro) - include global warming potentials and environmental characterisation data
Raw material requirements (minerals, ores and fuels)
Finished material requirements (steel, plastics, concrete and so on)
Environmental impacts (greenhouse impact, mineral depletion, land use and so on)

Table 2.2: Total external cladding materials in total houses, Australia, 1995-2004/05

Cladding material		*1995*	*1998*	*2001*	*2004/05*
Total houses commenced	'000	91.95	100.4	92.8	101.2
Average floor area	m²	200.7	221.0	232.0	256.9
Full/double brick	'000m²	1,272.6	1,321.3	1,739.7	946.2
(exposed/face brick)	%	12	10	13	6
Full/double brick	'000m²	311.9	665.7	878.6	1,643.2
(rendered/painted)	%	3	5	7	10
Full/double brick - total	'000m²	1,584.5	1,987.0	2,618.3	2,589.4
	%	15	15	20	16
Brick veneer - total	'000m²	-	-	-	6,674.2
(exposed/face brick)	%	-	-	-	42
Brick veneer - total	'000m²	-	-	-	3,539.9
(rendered/painted)	%	-	-	-	22
Brick veneer - total	'000m²	7,316.6	8,729.0	8,674.2	10,214.1
	%	71	66	65	64
Concrete block	'000m²	191.4	90.3	228.1	85.3
	%	2	1	2	1
Lightweight concrete block	'000m²	35.3	31.7	1.0	136.8
	%	*	*	*	1
Concrete brick	'000m²	-	-	-	251.6
	%	-	-	-	2

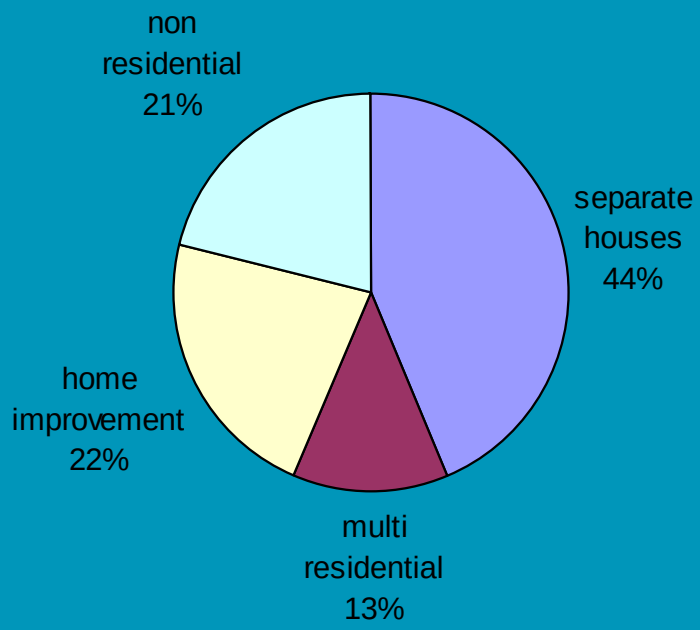
Table 2.3: Total windows by type in total houses in Australia, 1995-2004/05

Window type		*1995*	*1998*	*2001*	*2004/05*
Total houses commenced	'000	92.0	100.4	92.8	101.3
Average number of windows per house		15.7	14.8	16.3	17.5
Sliding	'000	1,091.2	1,166.5	1,032.8	1,025.6
	%	75	78	68	58
Awning/hopper/wind-out	'000	137.7	148.3	230.7	252.3
	%	10	10	15	14
Double hung/sash	'000	110.7	87.2	129.9	158.1
	%	8	6	9	9
Casement	'000	9.8	24.4	62.9	90.2
	%	1	2	4	5
Bay windows	'000	56.0	28.0	5.6	34.2
	%	4	2	*	2
Arched	'000	-	-	-	43.5
	%	-	-	-	2
Fixed/non-opening	'000	31.6	25.1	36.0	103.9
	%	2	2	2	6
Louvre	'000	-	4.3	14.3	65.0
	%	-	*	1	4
Other+	'000	9.2	2.4	-	2.7
	%	1	*	-	*
Total	'000	1,446.2	1,486.2	1,512.2	1,775.5
	%	100	100	100	100


Population
Households
Labour Force
Occupational Services
Inbound Travelers
Demography
Building Space Required
Building Space
Building Operations
Building Contents
Buildings
Artifacts and Infrastructure
Intercity Travel
Long Distance Freight
Short Distance Freight
Urban Transit
Auto Stock
Roads
International Travel
Transportation
Consumables
Australian Stocks and Flows Framework
Materials and Energy
On Site Construction
Processing and Assembly
Recycling
Materials and Energy
International Trade

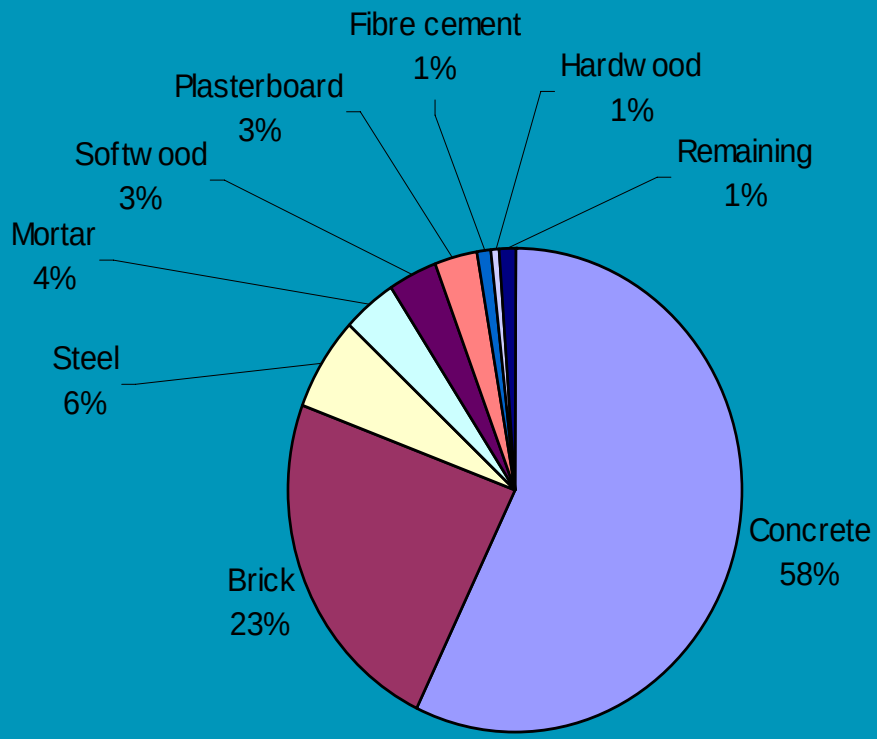
Building demand

24,035,000 M2 of separate houses residential construction
7,120,000 M2 of multi residential construction
12,340,000 M2 of home improvement
11,660,000 M2 of non residential construction



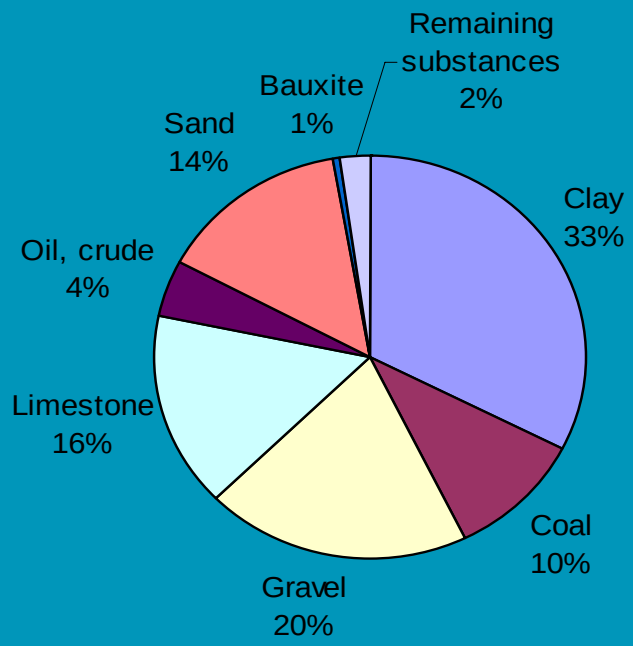
Finished materials

26.7Mt of finished materials



Raw Materials

34.2Mt of raw materials
0.6Mt recycled materials
51,000 ML of water
570,000 Ha of Land



Material production inventories

- Developed from a mix of local and overseas data.
- Steel and concrete sectors provided LCA data.
- PVC and Aluminium had prior LCA data developed in Australia.
- Recycling and landfill data from prior work developed for EcoRecycle Victoria
- Other material developed from public data published in Australian or data adapted from European inventories to Australian technologies.

Steel production

- Three grades used in Study
  - Beams
  - Sheet
  - Reinforcing steel.

  - Recycling allocation set to maximum of input and output (so based more on output which is higher than input).
  - Economic allocation being undertaken as sensitivity on major materials.

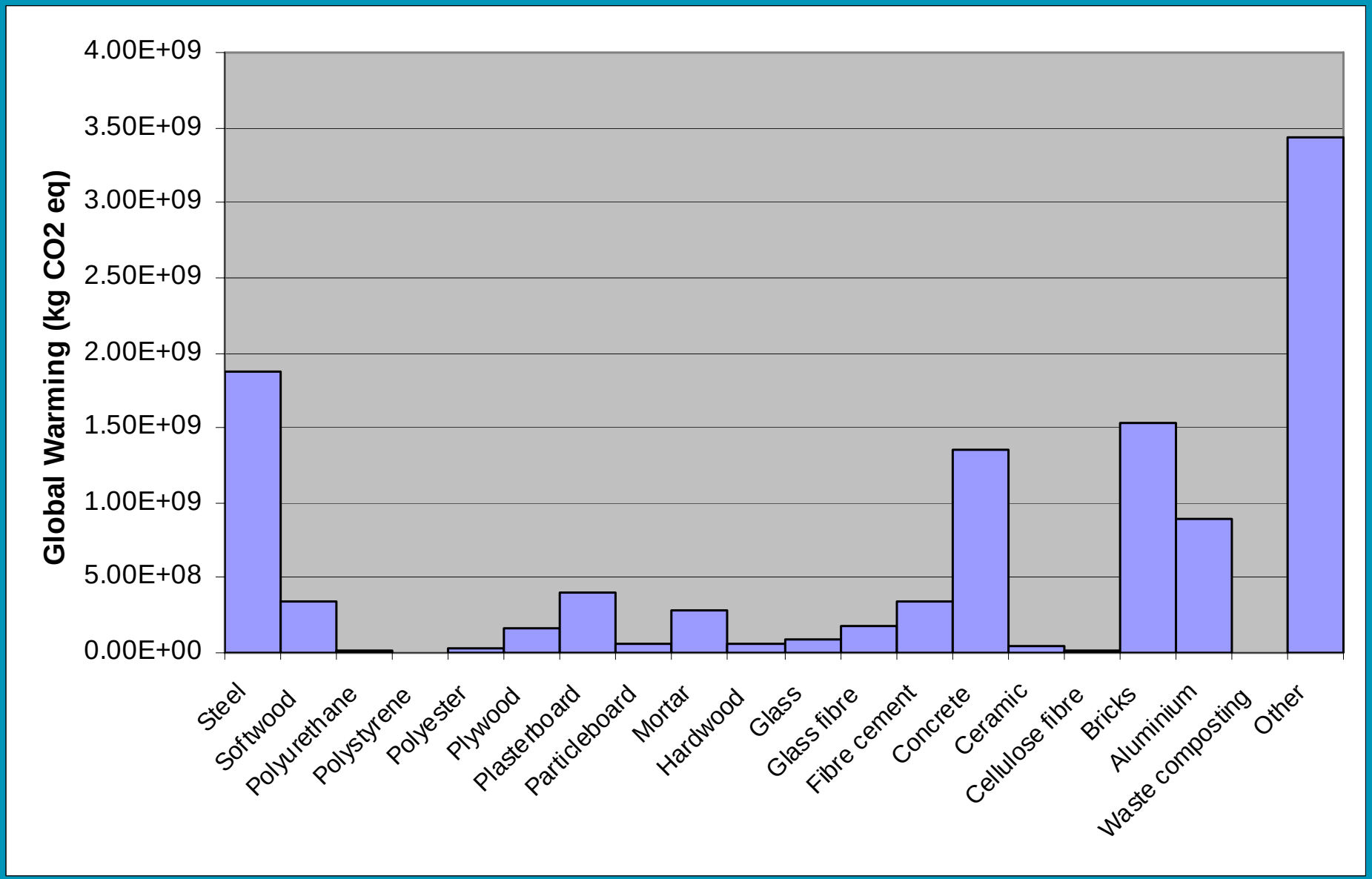
Concrete production

- Baseline of cement supplements (slags as fly ash) included with sensitivities for increasing amounts.
- High rise, low rise and concrete block applications differentiated

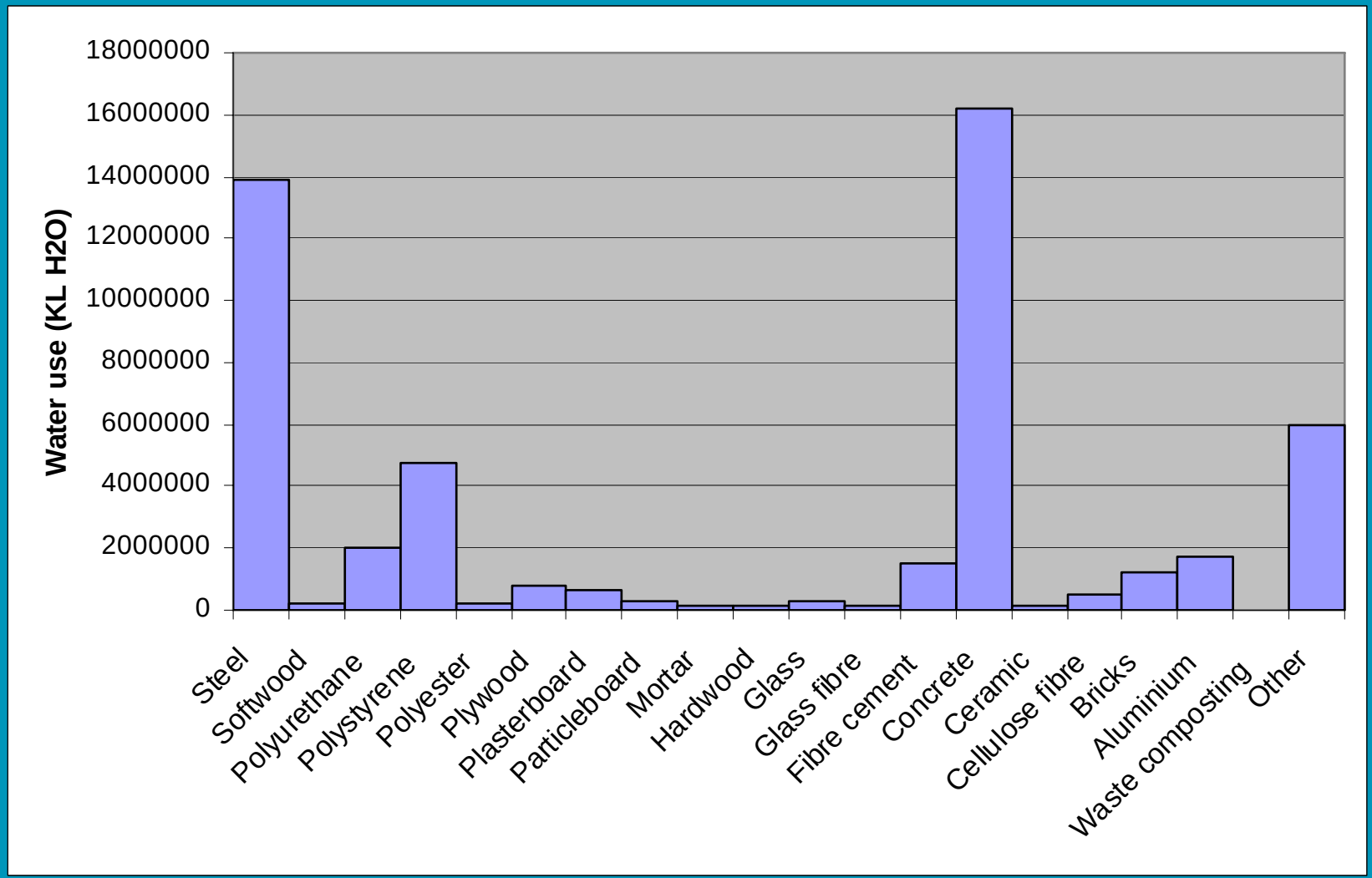
Impacts 2006

Impact category	Unit	Impact value	Percent of annual Australian impact in 2006	Equivalent to
Global warming	Mt CO2 eq	12.04	2.13	18.07 million trees planted
Photochemical oxidation (smog)	Kt C2H2 eq	19.46	2.13	63.2 million kilometres of car travel or 400,000 cars driving around the earth at the equator.
Eutrophication (surplus nutrients)	Kt PO4--- eq	8.38	2.43	7.48 million households' sewage (after treatment)
Carcinogens	DALY	439.80	0.13	112.6 million terawatt hours of electricity
Land use	000 Ha years	561.00	0.11	756.9 thousands of soccer fields or equivalent to Greater Melbourne area.
Water use	GL H2O	37.09	0.05	416.2 million showers or 100,000 Olympic sized swimming pools
Solid waste	Mt	9.82	35.37	90. million 240-litre bins

Greenhouse contribution per material



Embodied water contributions



So what are the trends in these impacts?

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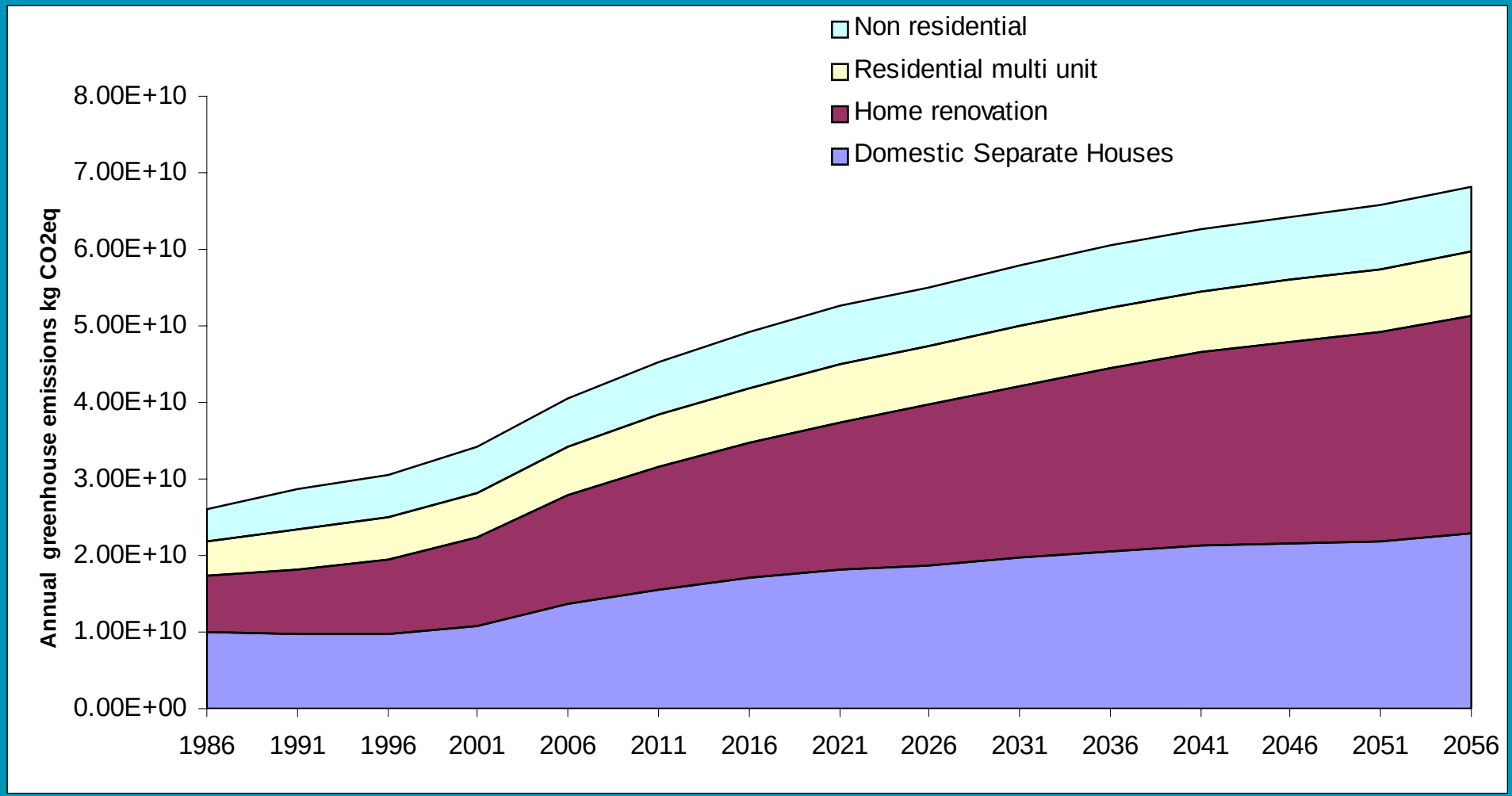
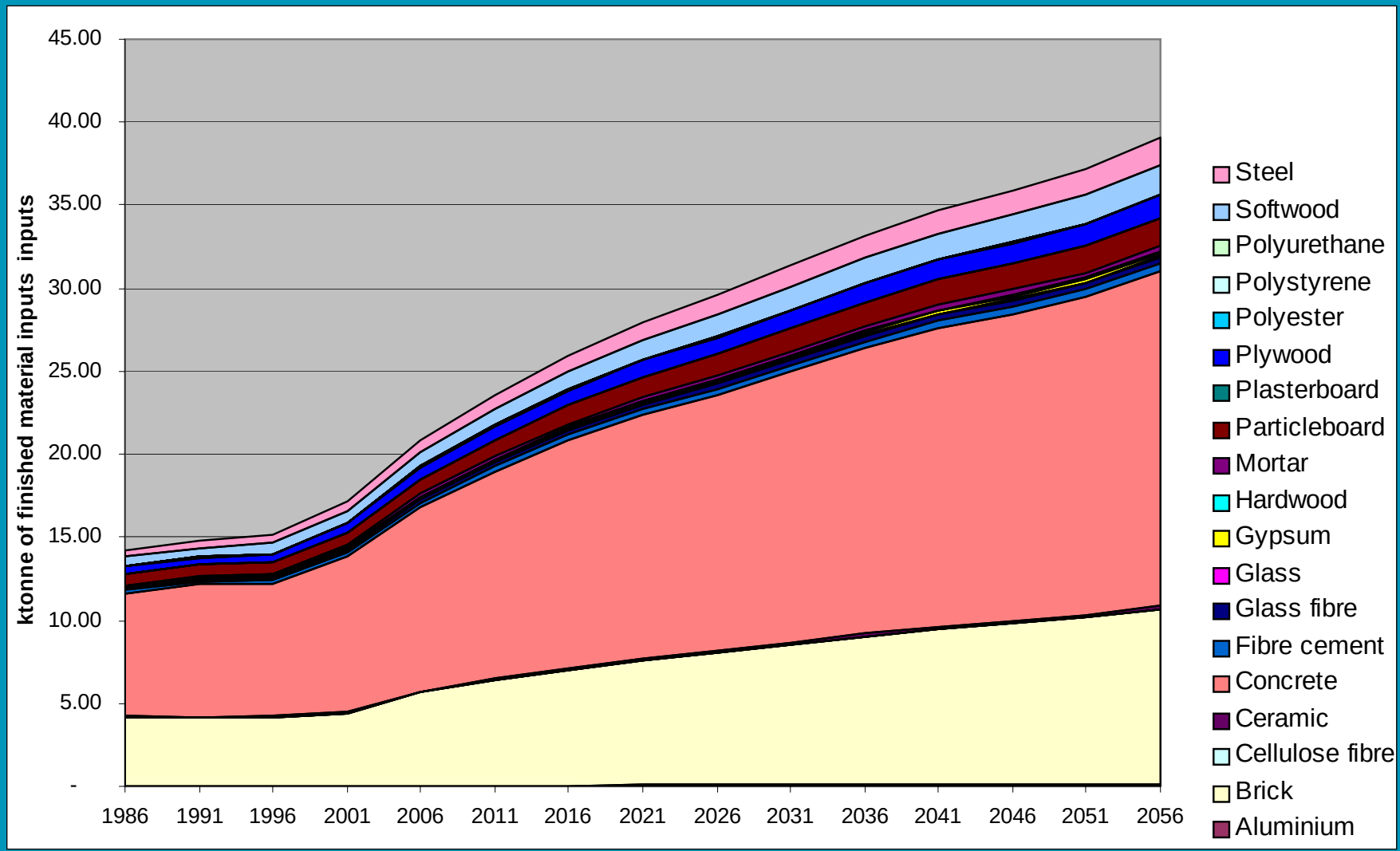
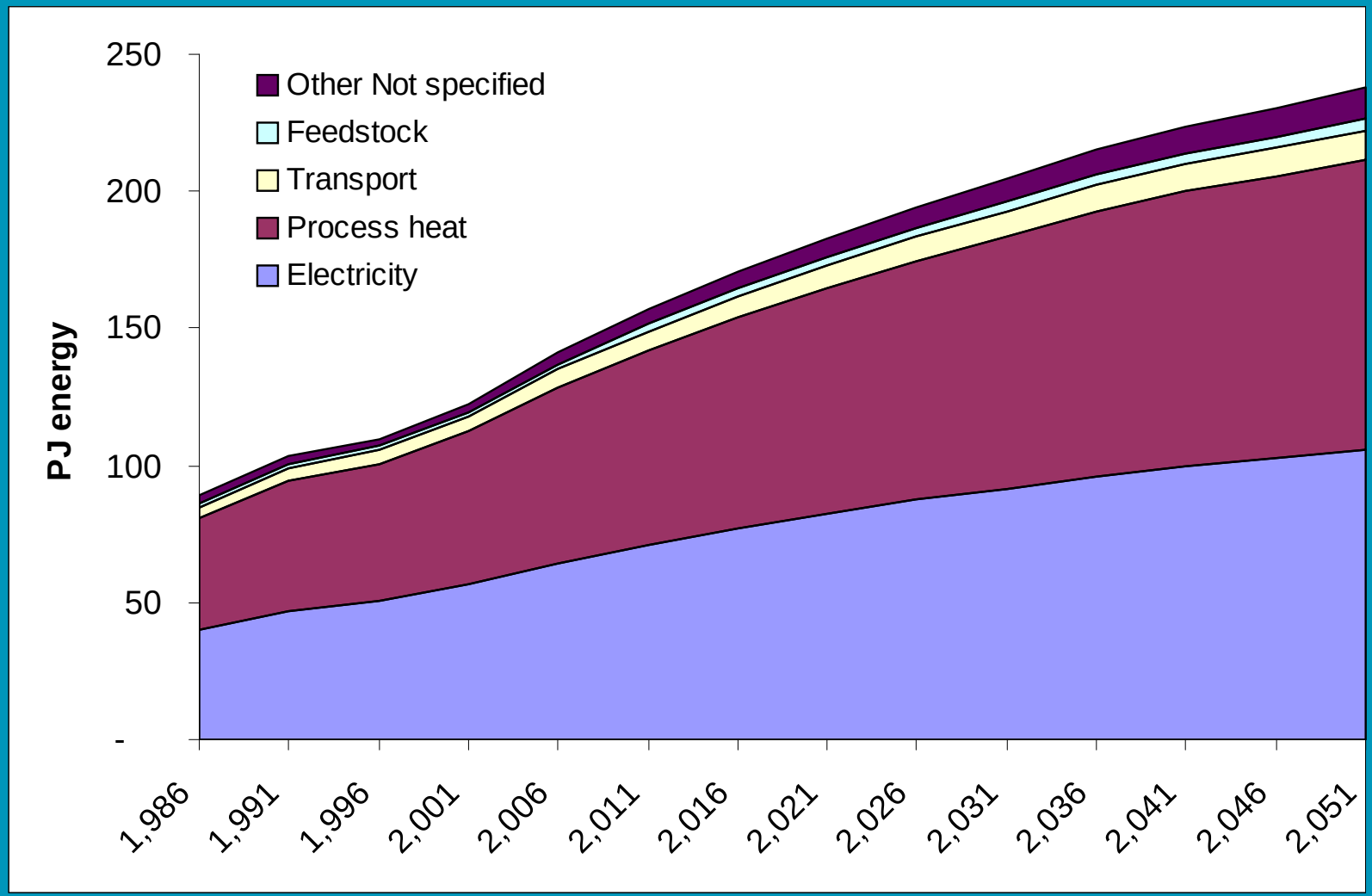
Greenhouse gas trend over next 50 years



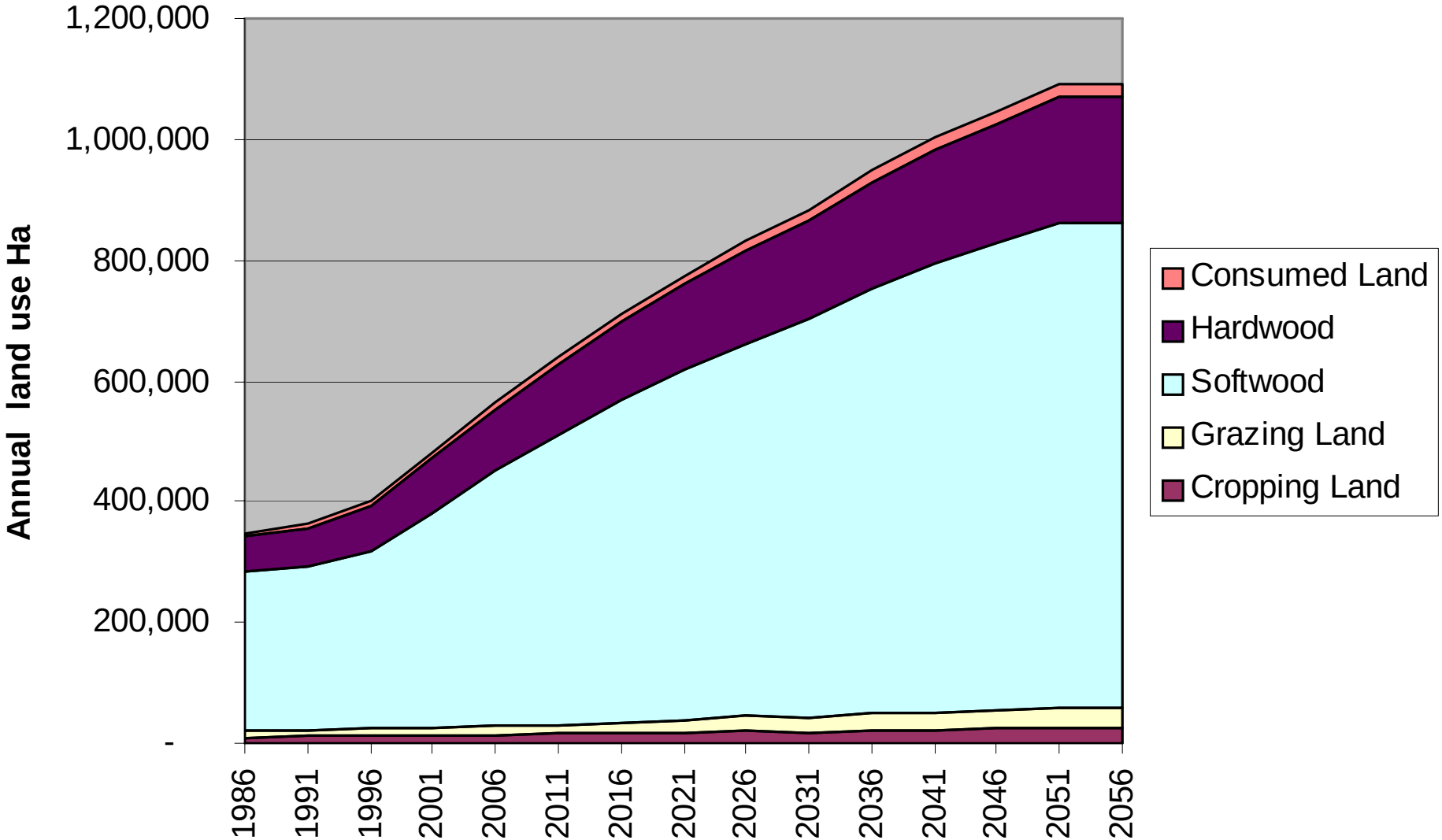
Material flows to 2056



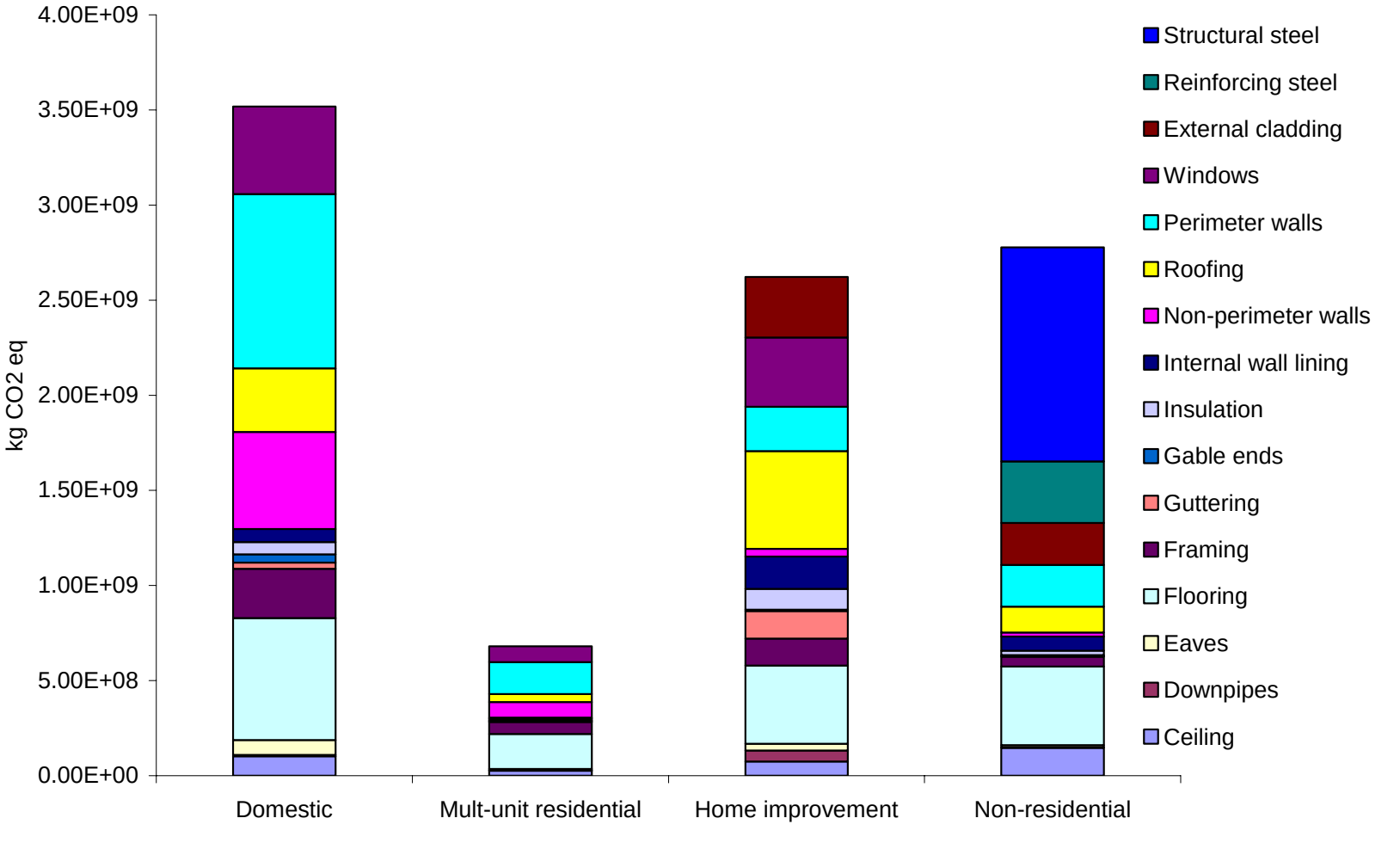
Energy use projected from building materials



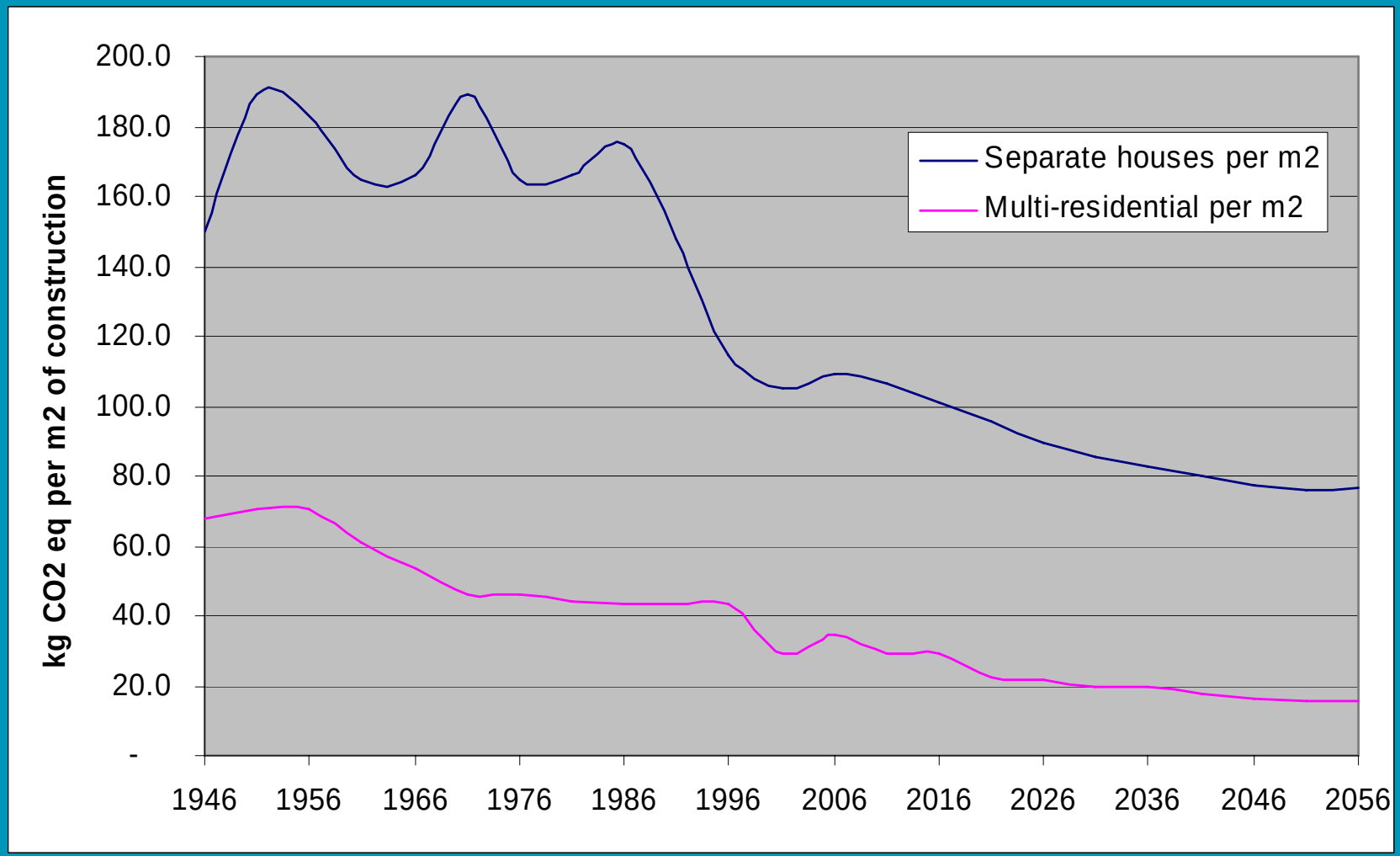
Land use trends from building materials



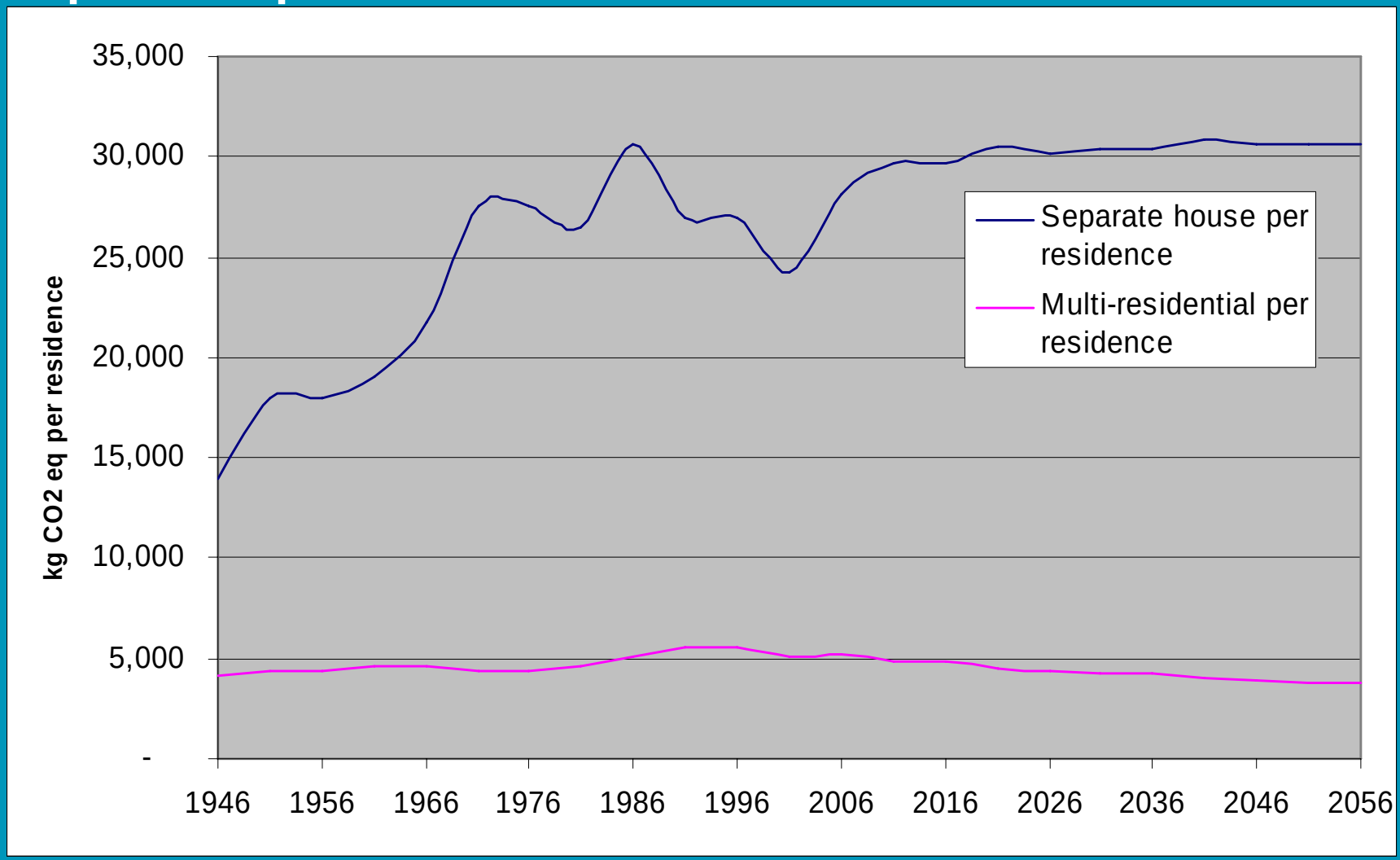
Embodied impacts by application



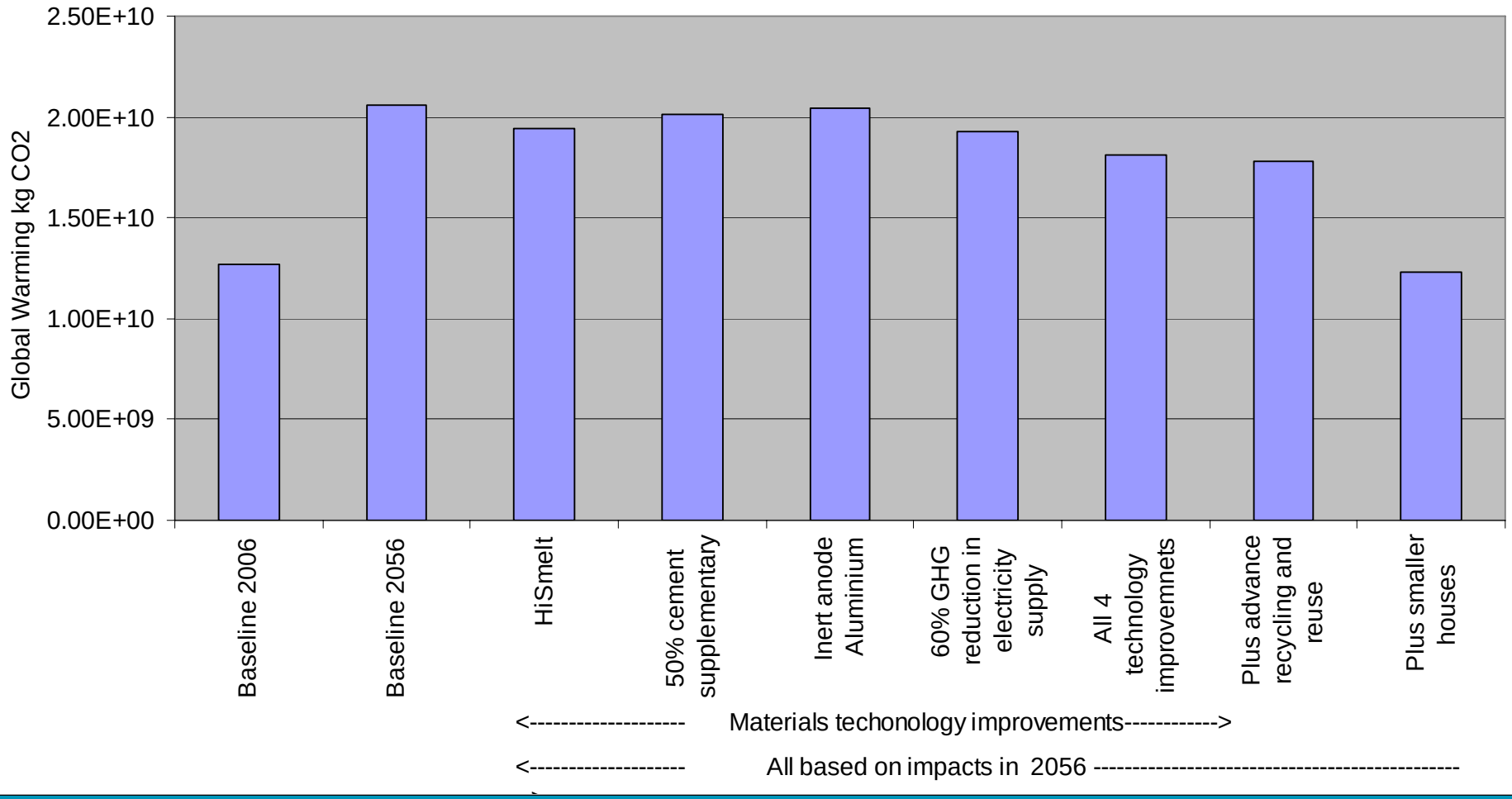
Impacts per m2 of construction



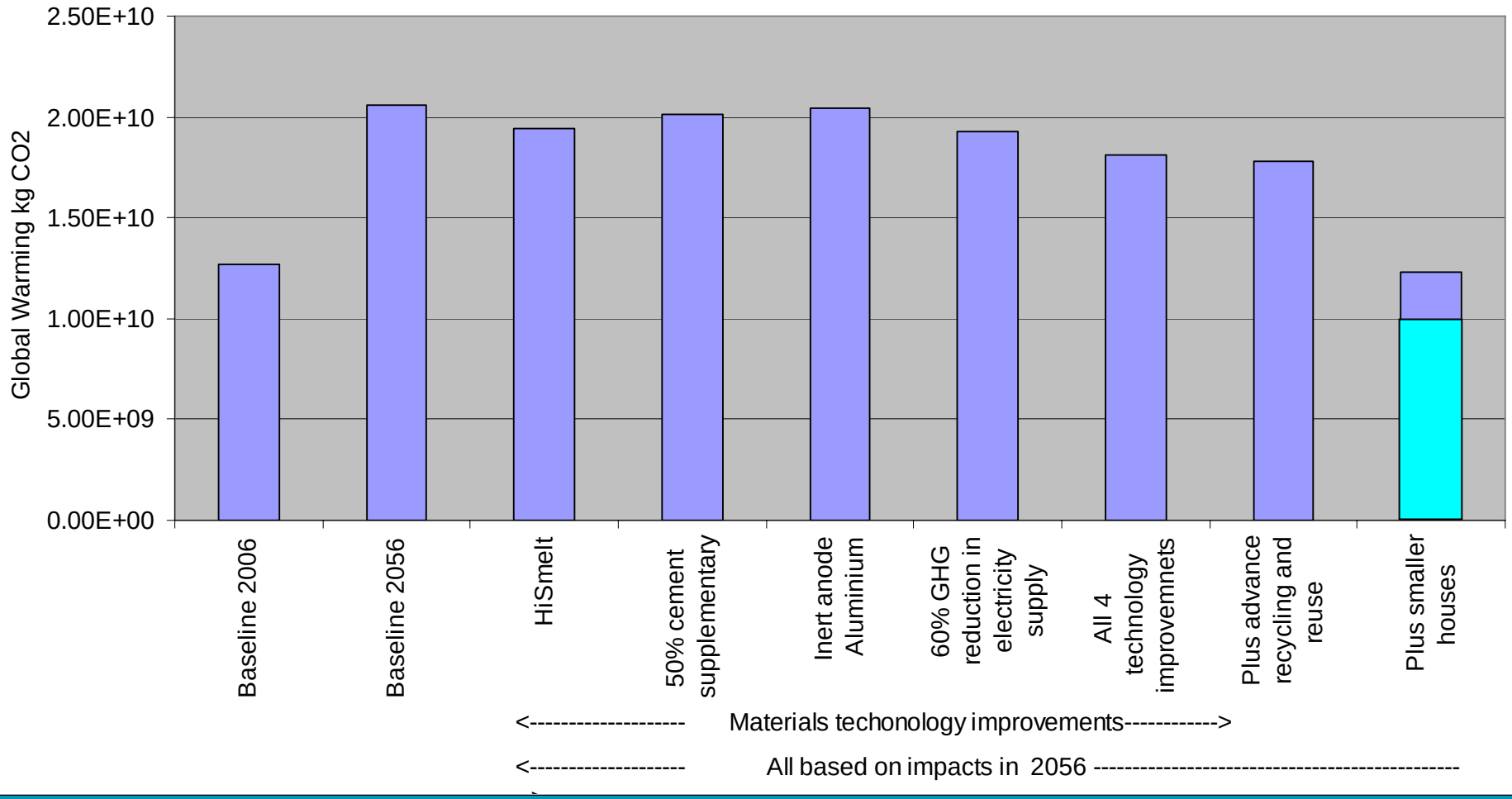
Impacts per household



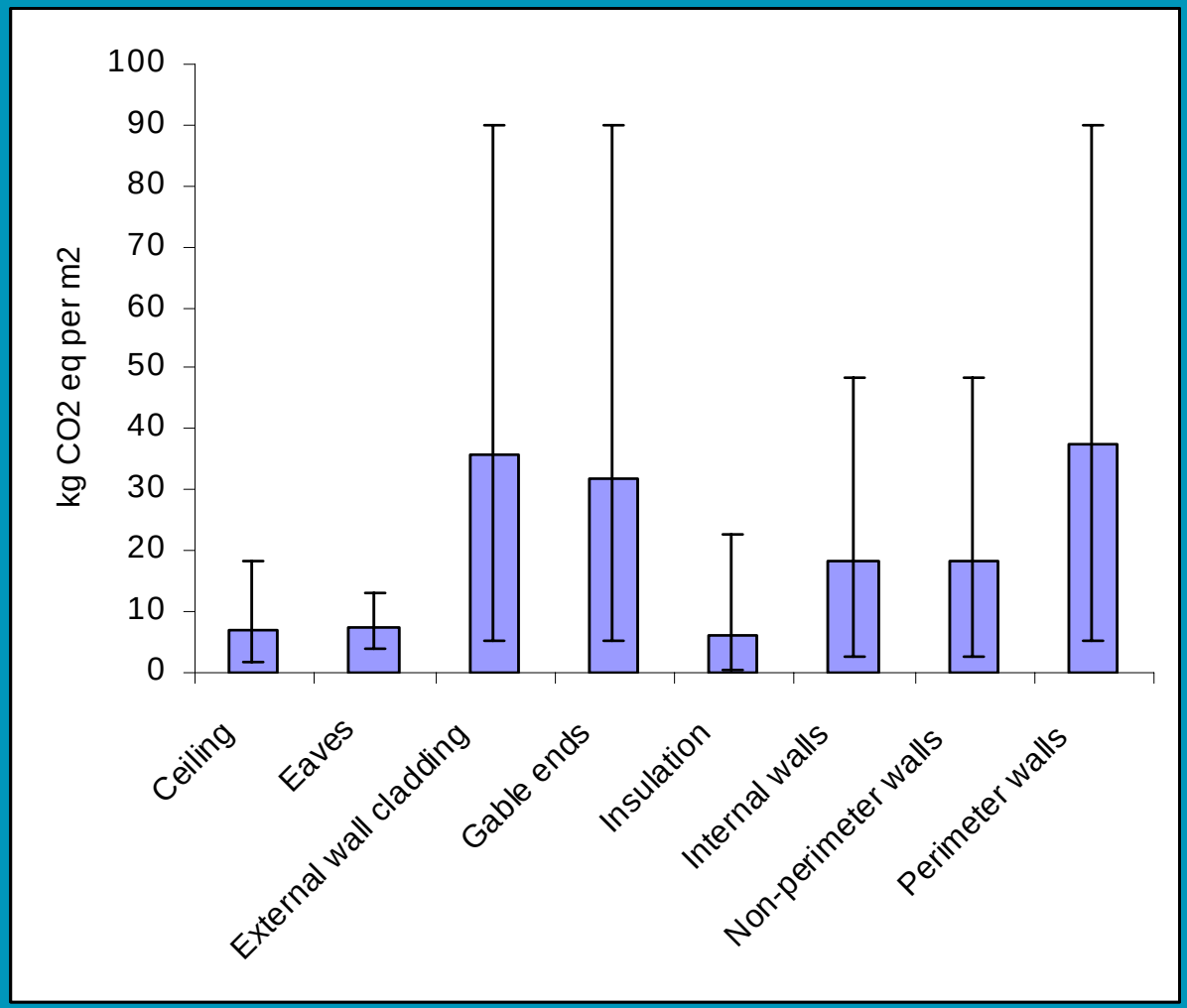
Reduction in house size – global warming



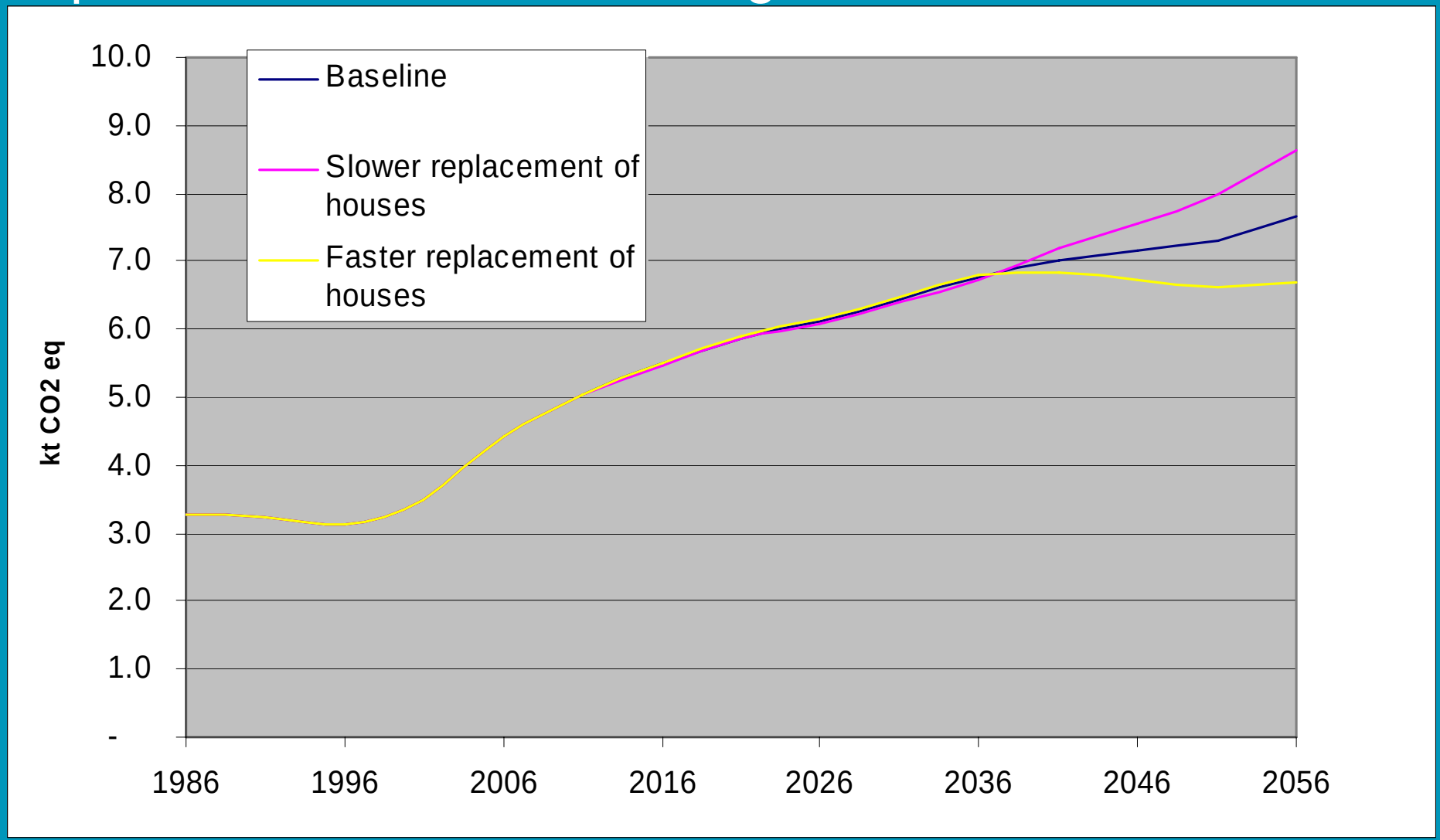
Reduction in house size – global warming



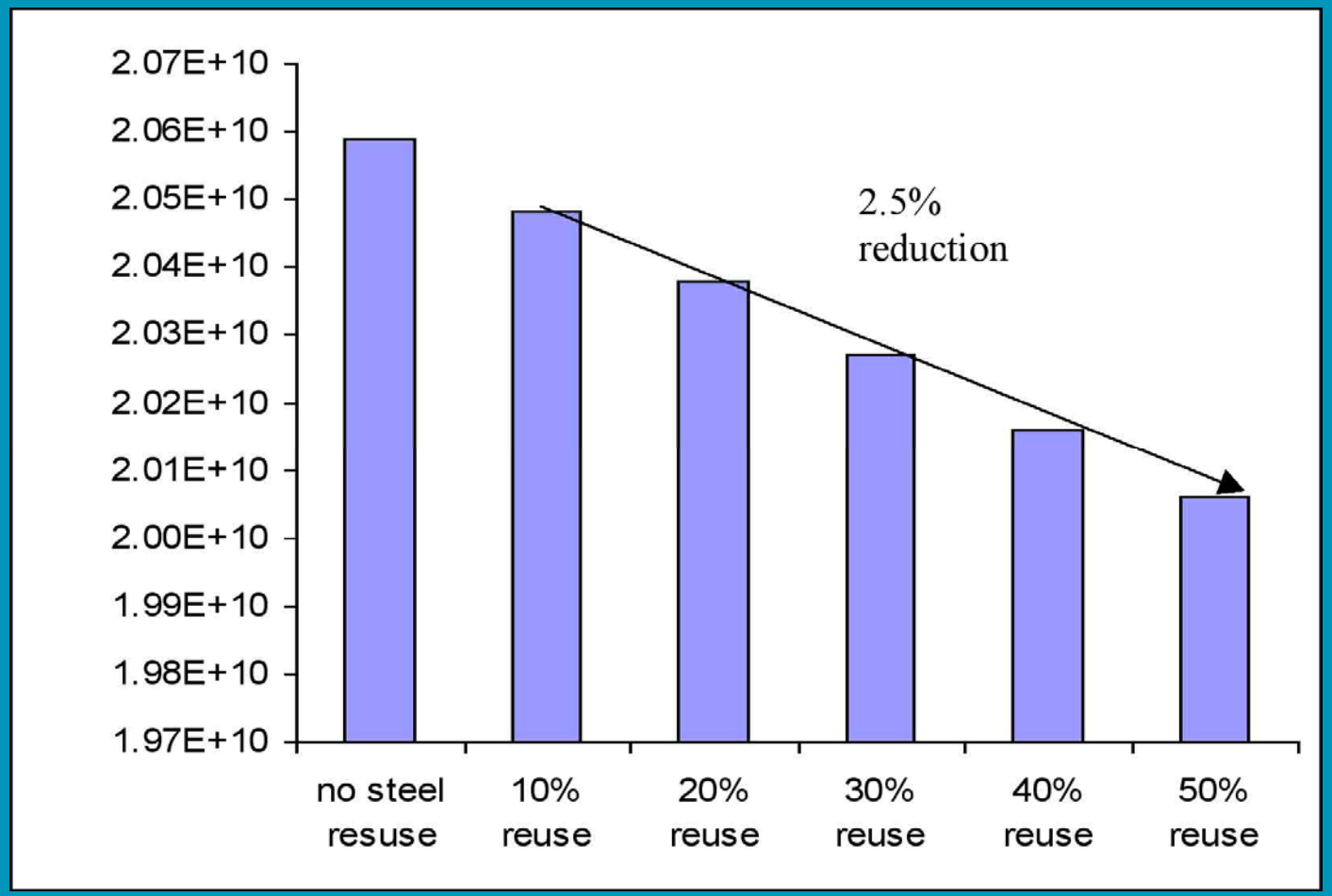
Variation in building assemblage impacts per m2



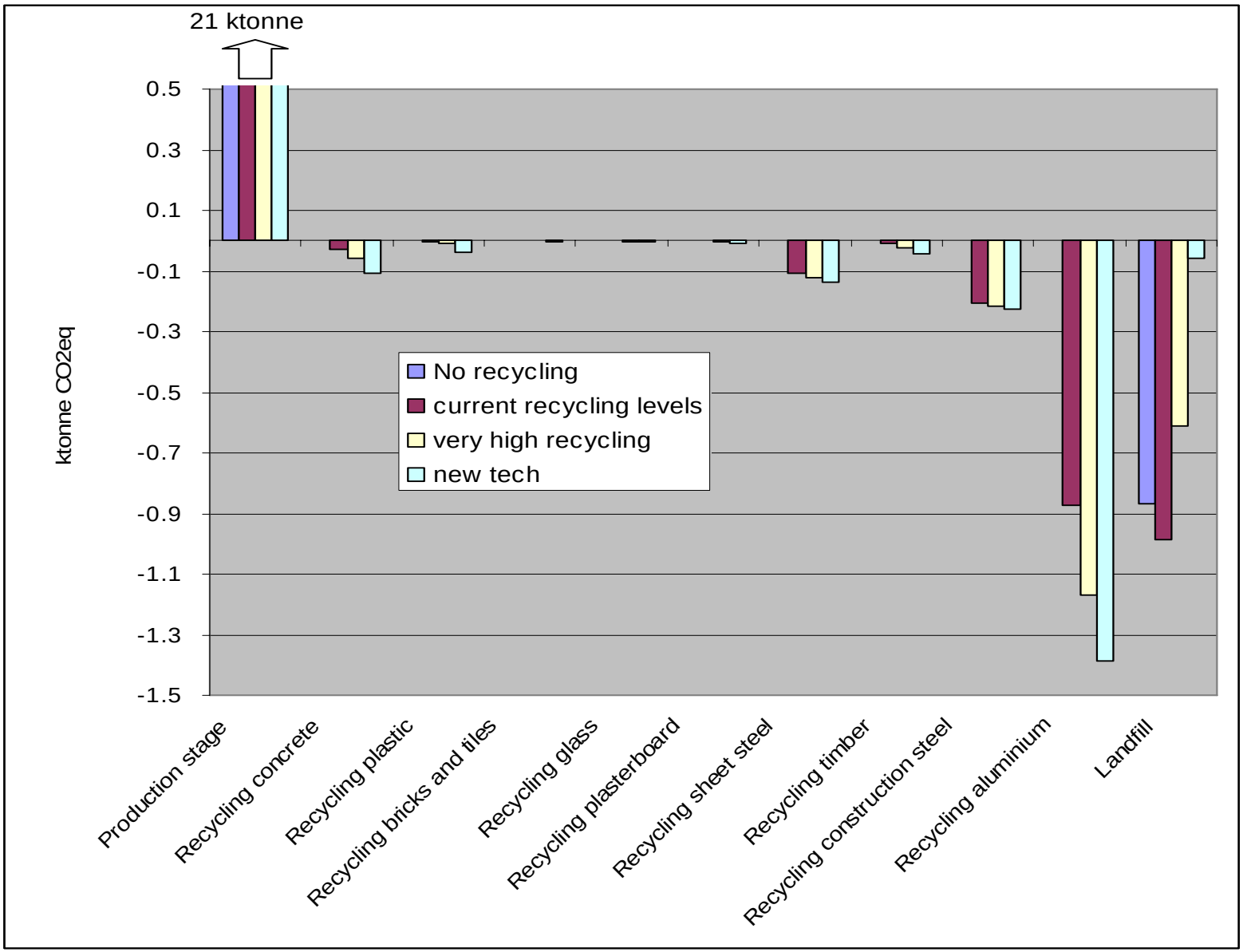
House replacement and its effect on operational improvements in total housing stock



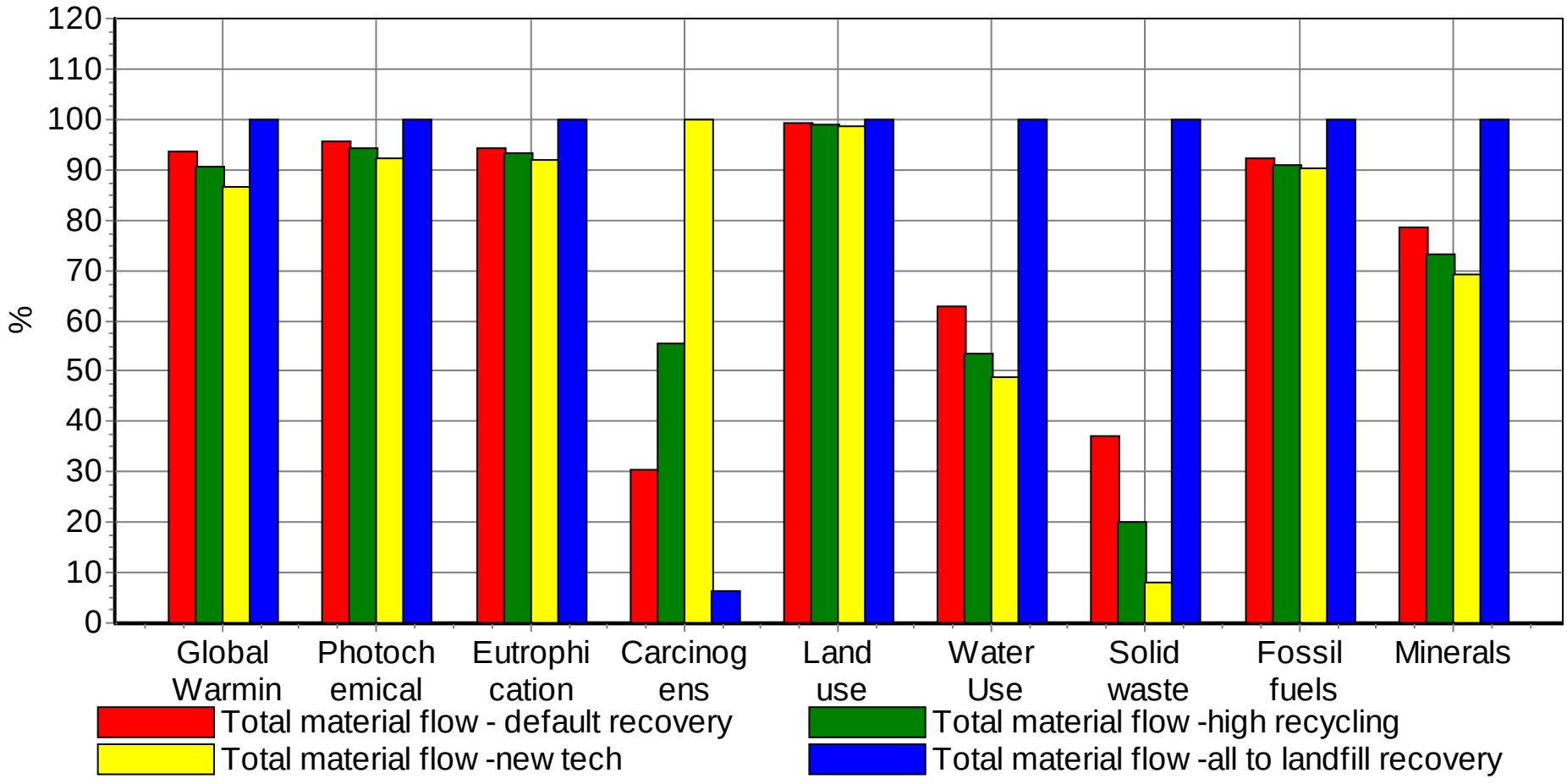
Steel beam reuse - benefits



End of life recovery - benefits



Solid waste indicators



Conclusions

- Impact of building materials are increasing due to population growth and growth in the size of building and reduction in the number of occupants per house.
- Technology improvements alone will not be sufficient to counteract this growth in impacts.
- End of life recovery in high already but the recovery of environmental value is limited from concrete which makes up a major mass component of the material recycles.
- While building materials vary in impacts any links to building operational impacts such as thermal performance, needs to be considered.
- Reducing building space demand has the potential to reduce the impacts of the built environment.
- There is a need to improve LCI development in Australia through a national LCI project.