



Institiúid Teicneolaíochta Chorcaí  
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# SUSTAINABILITY AND THE IRISH CONSTRUCTION SECTOR

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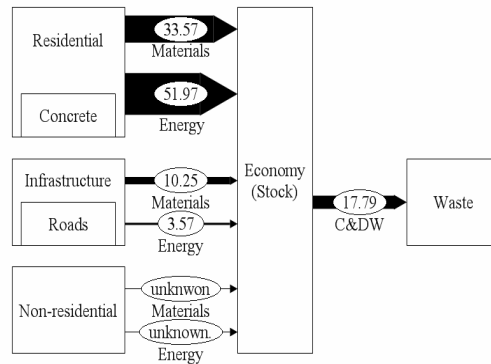
Dept of Chemical & Process Engineering, [www.cit.ie/chemeng](http://www.cit.ie/chemeng)

## Introduction

- Results of a MSc research project:  
    **“Material and energy flow analysis of the  
    Irish construction sector”**  
focusing on new concrete built dwellings  
constructed in Ireland in 2007
  - Materials
  - Energy
  - Construction & Demolition (C&D) waste

## Irish construction sector

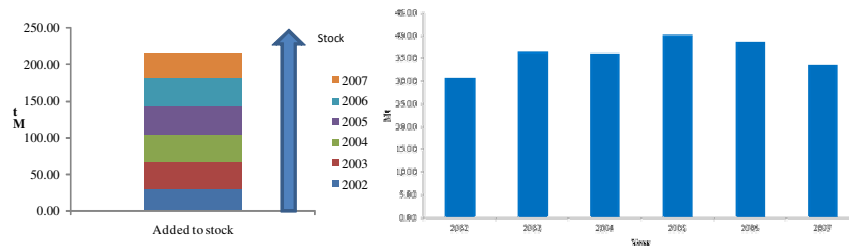
- In 2007 the construction of new concrete built dwellings consumed:
  - 34Mt materials
  - 52PJ (1.24Mtoe) energy
  - 68% of construction concrete produced in Ireland



Construction sector flow for 2007. Units for materials, Mt and units for energy, PJ.

## Materials in residential sector

- Consumption of natural resources is tied to economic growth and to the growth of the construction sector

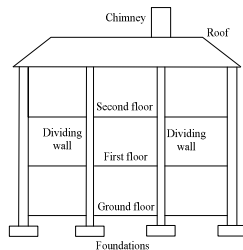


Materials stocked in the residential sector from the construction of concrete dwellings

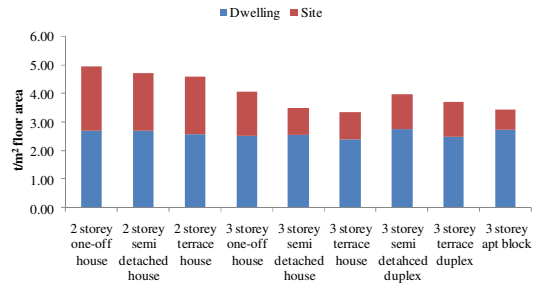
# Design affects material consumption

➤ Typical 2 storey semi-detached concrete dwelling consumes

- 627t of materials
- 4.72t/m<sup>2</sup> floor area



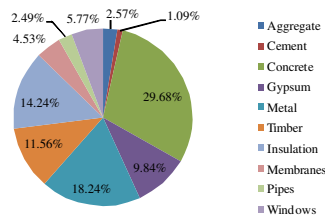
Example of 3 storey semi-detached and terrace dwellings



Dwelling and site material requirement per m<sup>2</sup> floor area

# Embodied energy

➤ Embodied energy: energy consumed over the life cycle of the material composing the building



Proportion of embodied energy of materials of 2 storey semi-detached dwelling and site

Examples of embodied energy of materials per kg material (Hammond & Jones, 2010)

<u>Material</u>	<u>MJ/kg</u>
Aggregate	0.083
Cement render	1.33
Concrete	0.75
Gypsum	6.75
Metal	20.1
Timber	10
Insulation	45
Membranes	134
Pipes	67.5
Windows	1604.17MJ/ m <sup>2</sup> window

➤ Every building has a large embodied energy associated with its materials

## Design affects embodied energy

- Typical 2 storey semi-detached dwelling consumes
  - 735GJ (17.6toe) embodied energy in materials
  - 5.53GJ/m<sup>2</sup> floor area (0.13toe/m<sup>2</sup> floor area)
- Factors such as:
  - Material choice
  - Amount of specific material

Embodied energy per average floor area

Dwelling	GJ/m <sup>2</sup>
2 storey one-off	5.69
2 storey semi-detached	5.53
2 storey terrace	5.19
3 storey one-off	5.60
3 storey semi-detached	5.52
3 storey terrace	5.13
Semi-detached duplex	5.82
Terrace duplex	5.27
Apartment	5.47
Average	5.47
Standard deviation	0.23

## Embodied energy and operational energy

- Irish homes consume a quarter of the energy used in Ireland (SEAI, 2011)
- 122 PJ (2.9Mtoe) of energy used by residential sector in 2007 (SEAI, 2011)
- 23,136 kWh (1.99toe) operational energy required for an average dwelling in Ireland (SEAI, 2010)
  - 9 years for operational energy to overtake embodied energy
- Low embodied energy buildings can have high energy usage arising from operational needs
- Insulation – an example of achieving lower operational energy by increasing the embodied energy



## Surplus or incomplete dwellings



50,000 concrete built dwellings

- If for example 50,000 concrete dwellings are vacant
  - 32Mt of material
  - 49PJ of embodied energy
- Approx. 15Mt of potential C&D waste of which 7Mt of potential concrete waste

	<u>Dwelling</u>	<u>Dwelling and site</u>
<b>Mt</b>		
Houses	17.02	27.89
One-off houses	8.45	14.30
Multi-development houses	8.58	13.59
Apartments	2.48	3.47
<b>Total</b>	<b>19.50</b>	<b>31.36</b>

	<u>Dwelling</u>	<u>Dwelling and site</u>
<b>PJ</b>		
Houses	36.32	43.07
One-off houses	18.34	23.27
Multi-development houses	17.98	19.80
Apartments	5.17	5.52
<b>Total</b>	<b>41.48</b>	<b>48.60</b>

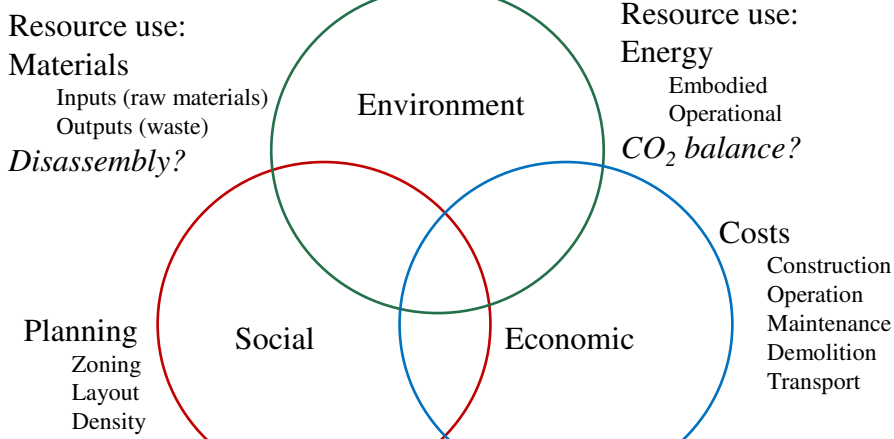
## C&D waste – potential for material substitution

- Materials stocked in the economy represent a reserve for future wastes
- 97% recovery rate of concrete in 2007
- Demand for recovered concrete has little effect on cement demand
- Road sector has lead the way in accepting secondary aggregates

# Road construction

- If all recovered concrete waste in 2007 were used in new road construction it would have displaced:
  - 36% of sub-base material
  - 3% of imported fill material
- Demolition of the 50,000 dwellings would exceed the requirements of the road sector and factors to be considered are:
  - Distance of waste origin to desired final location
  - Transport cost and CO<sub>2</sub> balance
  - Provision of landfill facility
  - Stockpiling

# Sustainable construction



## Ensuring sustainability in the construction sector

- Monitor and predict environmental impacts of materials and energy usage to:
  - Achieve optimum material and energy usage
  - Enable the development of policies on sustainable use of natural resources, on waste management and for effective sustainable construction practices
- Data reliability is of ultimate importance



Thank you for your attention!

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