Energy Footprint Project

Final Steering Group Meeting

7th April 2005

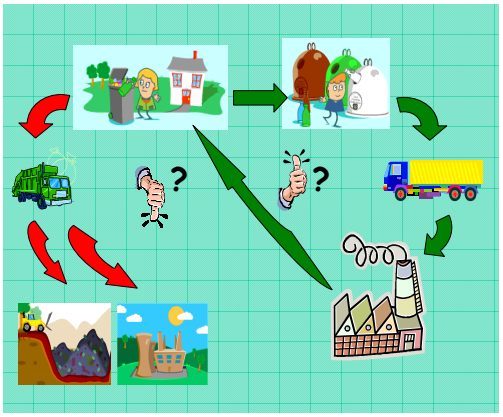
Paul Dacombe

Outline

- Details of model
- Some results
- Conclusions
- Future work

Waste Management Options

More traditional, but less favoured option of landfill & incineration



More favoured option of recycling

....but which is better in terms of energy consumption?

Acknowledgements: Rockware Glass

Energy Footprint Model

- Phase One (Biffaward)
  - data collection
  - framework model development
  - analysis and interpretation
- Phase Two (SUE)
  - further model development
  - filling in the gaps!
    - mass/energy data from other SUE Waste Projects
  - extensive simulations and interpretation analysis
  - development of user-friendly interface

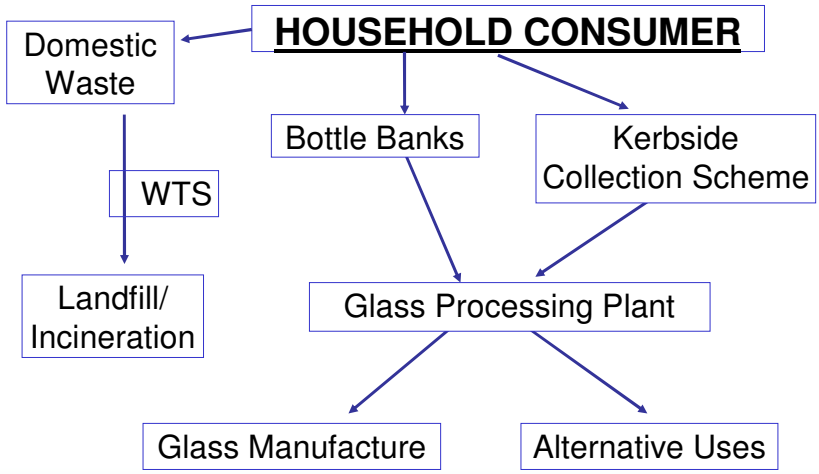
Principals of EFP Model

- Based on the city of Southampton
- Starts from the point where material becomes "waste"
- Energy consumption associated with disposal/processing, including transportation stages
- Recycling via bring-sites, HWRC and kerbside collection
- Disposal via landfill, thermal recovery of heat
- Comparison of different waste management options

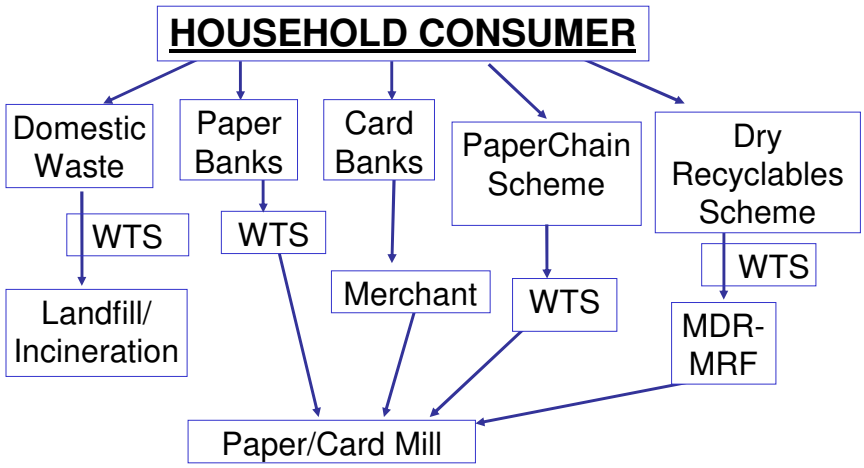
Structure of EFP Model

- Split up into inter-linked sub-models
  - Stage 1 transport (household to banks)
  - Stage 2 transport (banks to WTS)
  - Dry Recyclables Kerbside Collection Scheme
  - Materials Recovery Facility
  - Stage 3 transport (WTS/MRF to various locations)
  - Manufacturing Plant/Processing Facility
  - Refuse collection
  - Landfill transfer
  - Incineration
  - Various material-specific sub-models
    - e.g. plastics sort MRF, glass crushing/sorting plant at Docks

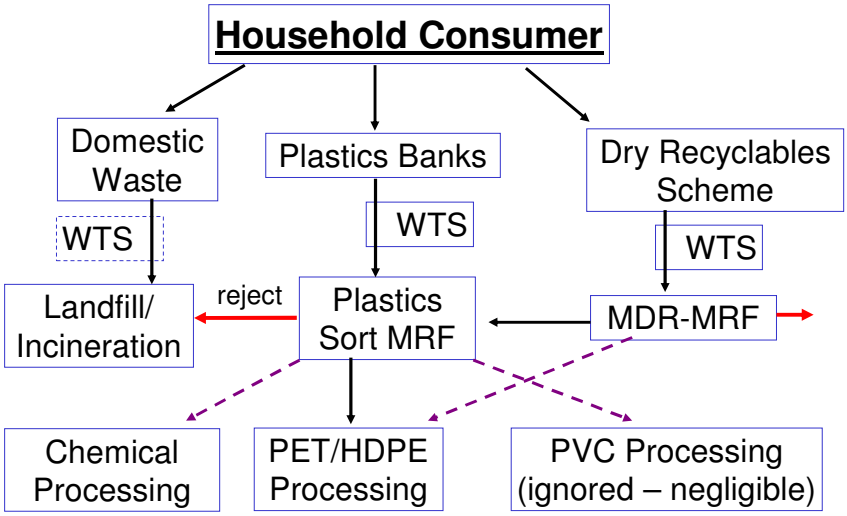
Glass Waste Management



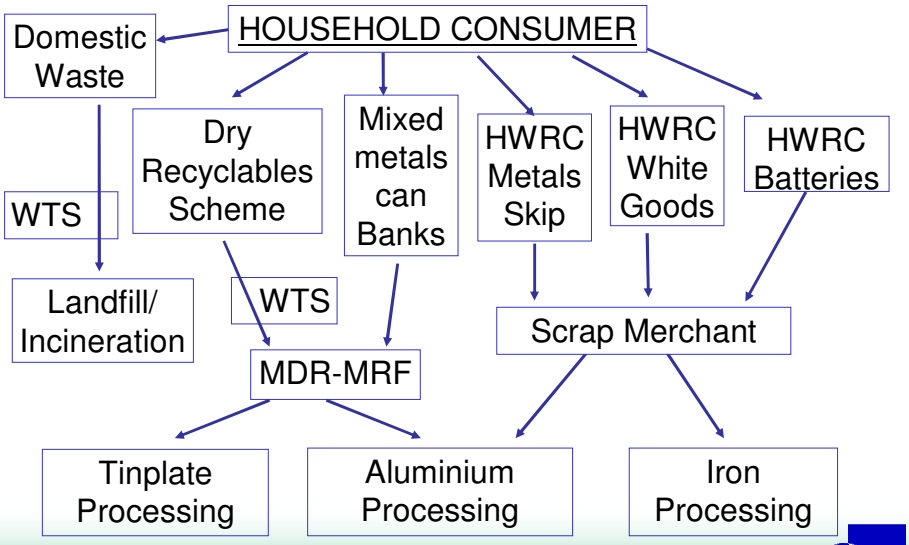
Paper/Card Waste Management



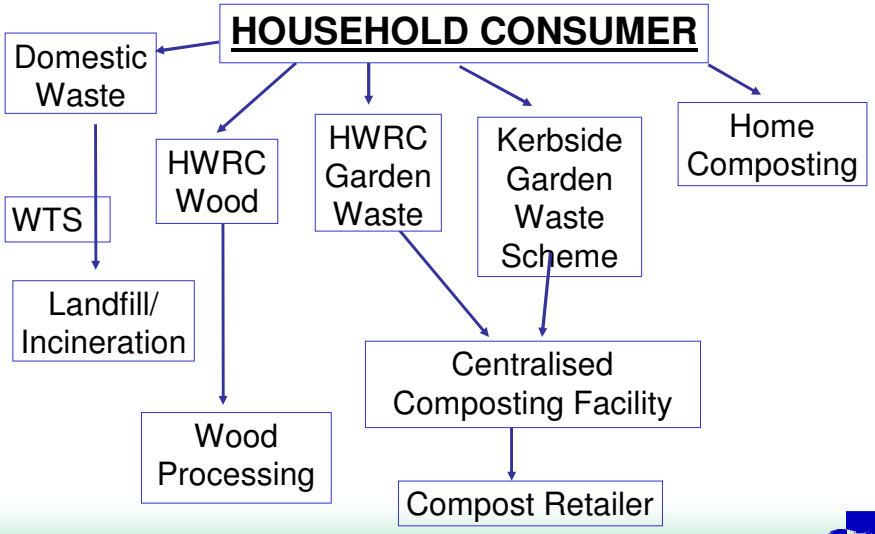
Plastics Waste Management



Metals Waste Management



Organics Waste Management



Stage 1 Transport

- Includes only trips by car made specifically for recycling
  - For bring-sites the percentage is dependent upon the site density (as is the distance travelled)
  - For HWRC site, assumed all trips are specifically for recycling (distance = 2.5miles)
- Assumed mass of material per trip
  - Bring-sites: 0.75 kg for plastics, 4.5 kg for all other materials
  - HWRC: assume 20kg total load; amount of each material variable depending on composition of material going through site

Stage 2 Transport

- Transfer to WTS
  - from the material banks to next stage
    - For glass = processing plant at Docks
    - All other material goes to WTS (assumed Otterbourne) by skip lorry (average distance 8.57 miles for bring-site; HWRC = 9.6 miles)
  - 20 minute handling time for loading/unloading/emptying banks

Kerbside Collection

- PaperChain scheme
  - Newspapers/magazines/leaflets
  - 3.5 tonne truck
  - Fortnightly collection
- Glass kerbside collection
  - Glass bottles/jars
  - 10 tonnes truck
  - Fortnightly collection

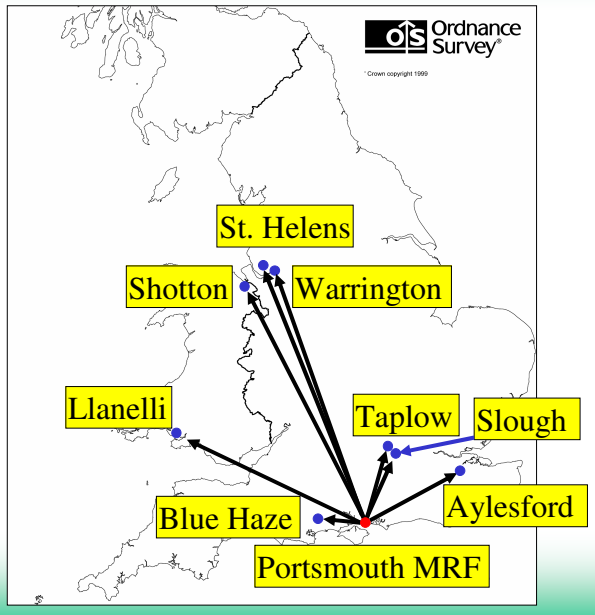
Kerbside Collection

- Dry Recyclables Scheme:
  - Modelling of new scheme being phased in throughout Southampton
  - Paper/card, plastic bottles/containers, metal cans
  - Use of RCV (11.5t capacity limit)
  - Fortnightly collections
  - via WTS (Otterbourne) to MRF

Materials Recovery Facility

- Currently assumed to be located at Portsmouth
- Processing of paper/card, plastic bottles/containers & metal cans
- Estimation of energy consumption from electrical usage, and on-site vehicle fuel consumption
- Model accounts for material losses during recovery and actual transport distances

Materials Recovery Facility



Stage 3 Transport

- Transfer from WTS and other locations to next stage
  - to MRF
  - Various other locations on to the next stage in the recycling chain/cycle
    - e.g. paper bank material from WTS to Aylesford paper mill; plastics bank material from WTS to St. Helens (plastic sort MRF)

Manufacture/Processing Facility

- Energy Consumption to produce virgin material
- Energy Consumption to produce material from recyclate
- Calculate energy consumption required to produce material within Southampton
- Determine energy savings from use of recycled material

Refuse Collection

- 11.5t max. capacity truck, weekly collection
- No. of collection rounds estimated from amount of household waste generated (15.66kg/hh/week) and capacity of truck
- Weekly or fortnightly collection (depending on whether Dry Recyclables scheme in operation or not)
- Collection round distance estimated from length of city's roads (571km) & no. of weekly collections
- Currently assumes transport to WTS

Landfill Transfer

- Currently assumes transfer from WTS to landfill site (assumed 15 miles)
- Does not include on-site vehicle fuel consumption

Incineration

- Energy generated through incineration of the residual waste
- Based on specifications for Marchwood EfW facility
- Transfer of incinerator residues to landfill or for recycling

Waste Generation/Recycling

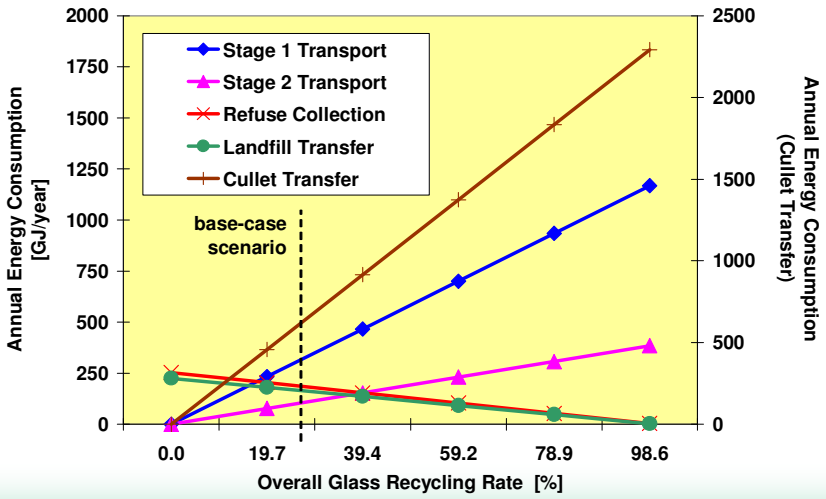
Waste Category	generated [tonnes/yr]	wt %	recycled [tonnes/yr]	recycling rate [%]
Paper & card	23562	26.02	4265	18.1
Plastic Film	6658	7.35	0	0.0
Dense Plastic	4981	5.50	53	1.1
Textiles	4538	5.01	213	4.7
Misc. Combustibles	5370	5.93	142	2.6
Misc. non-Comb.	1707	1.89	729	42.7
Glass	5326	5.88	1376	25.8
Ferrous Metals	3792	4.19	1047	27.6
Non-ferrous metals	876	0.97	49	5.6
putrescibles	24187	26.71	1543	6.4
fines	3235	3.57	0	0.0
Sub-Total	**84232**	**93.01**	**9417**	**11.2**
Miscellaneous	6335	6.99	177	2.8
TOTALS:	**90567**	**100.00**	**9594**	**10.6**

Waste Generation/Recycling: 5 main waste fractions modelled

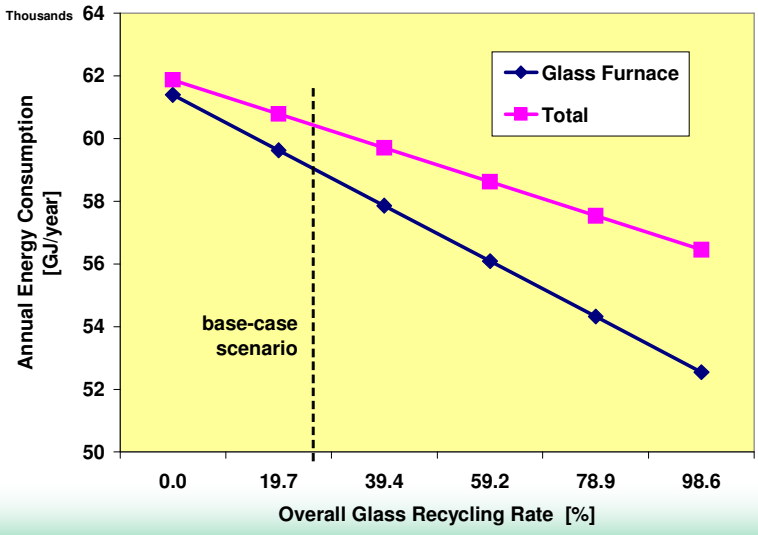
Waste Fraction	generated [tonnes/yr]	wt %	recycled [tonnes/yr]	recycling rate [%]
Glass	5326	5.88	1376	25.8
Paper & card	23562	26.02	4266	18.1
Plastics	11638	12.85	53	0.5
Metals	4669	5.16	1095	23.5
Organics	25001	27.61	1680	6.7
TOTAL	**70196**	**77.52**	**8471**	**12.1**

overall recycling rate for these 5 fractions

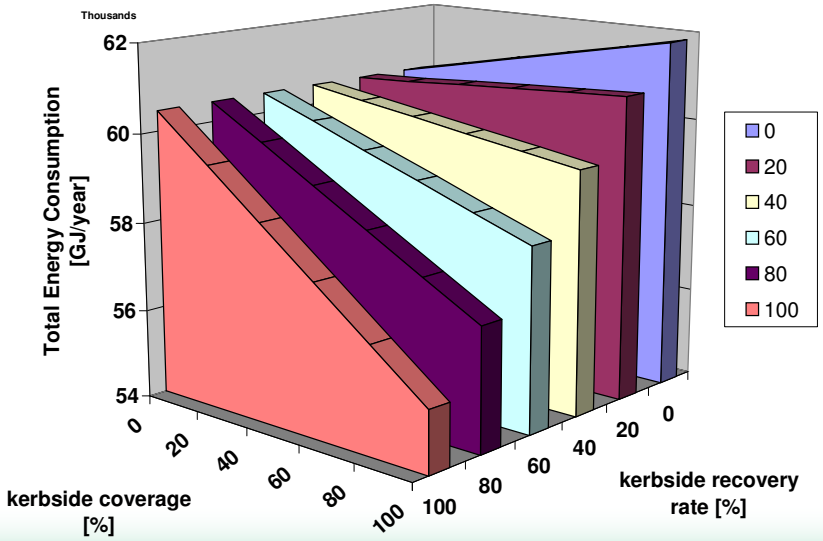
Energy Consumption (minor components)



Energy Consumption (major components)



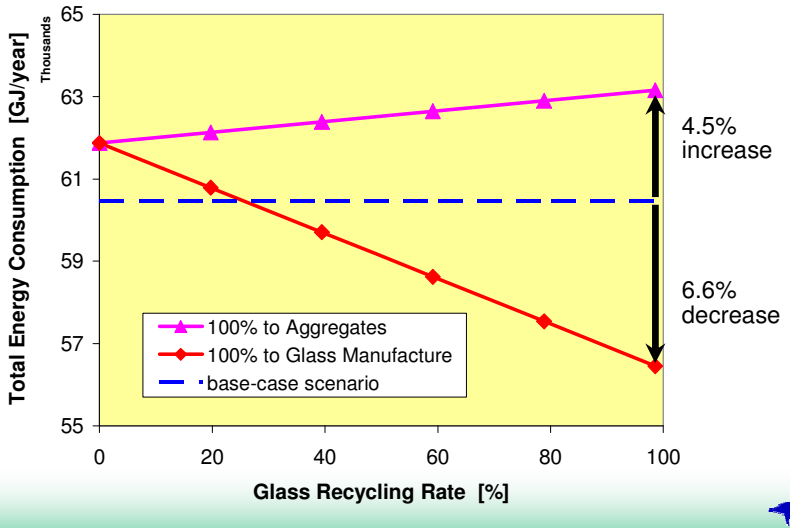
Bottle Banks or Kerbside?



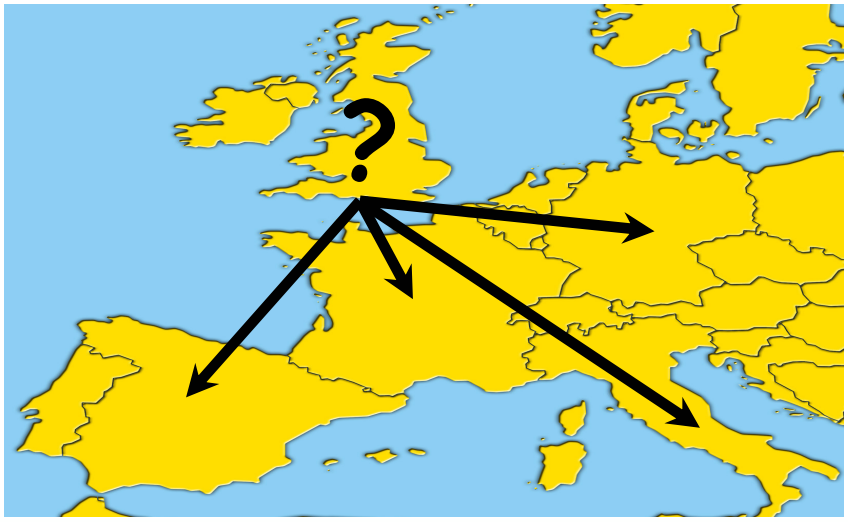
Comparison of Recycling Schemes

- **Bottle Banks:**
  - 6.6% maximum savings compared to base-case scenario
    - 4000GJ or ~1.03GJ/tonne recycled
- **Kerbside Recycling:**
  - 8.4% (base-case scenario)
    - 5065GJ or ~1.31GJ/tonne recycled

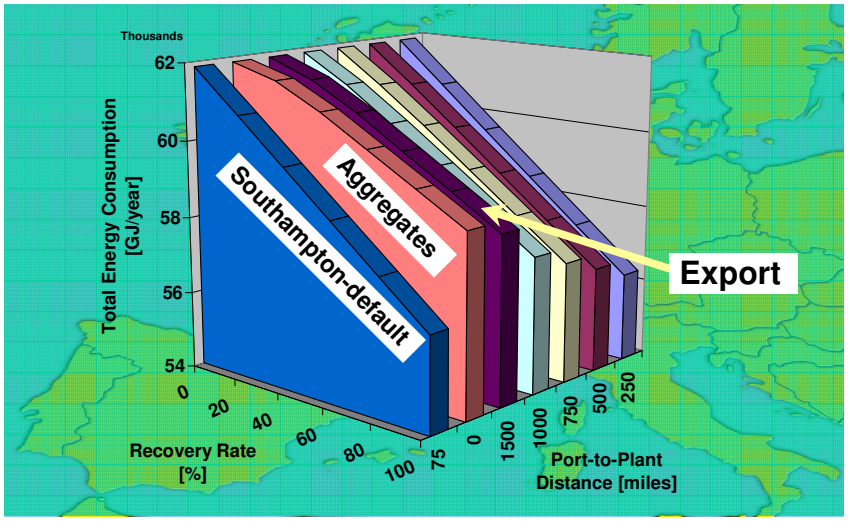
Glass Manufacture or Aggregates



Export of Green-Glass Cullet?



Cullet Export or Aggregates?



"The UK's new rubbish dump: China"

The Guardian, September 20, 2004

"The UK's new rubbish dump: China"

"….exports to China are running at 200,000 tonnes of plastic rubbish…a year…"

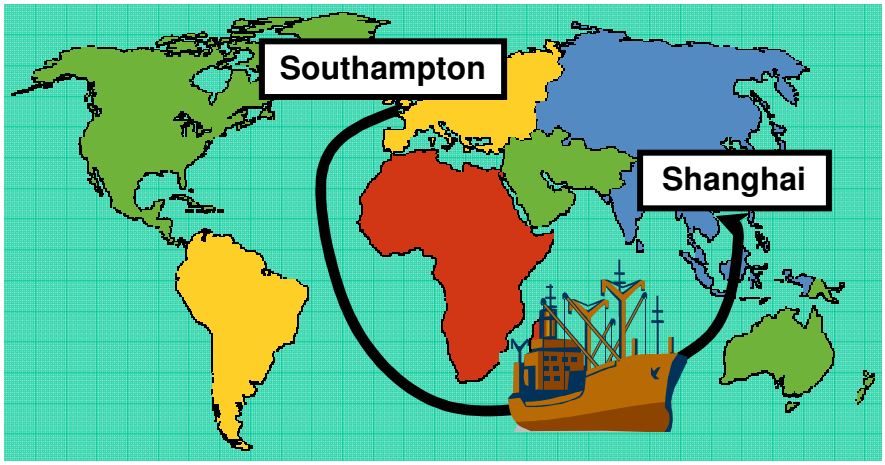
"The UK's new rubbish dump: China"

"Sending plastic bottles to China is 'barmy'…'we should be dealing with the stuff here' "

"The UK's new rubbish dump: China"

"….better to send rubbish to China to be recycled than to put it in landfill in Britain…the environmental cost of sending bottles thousands of miles was negligible compared with making 'virgin' plastic bottles from oil…"

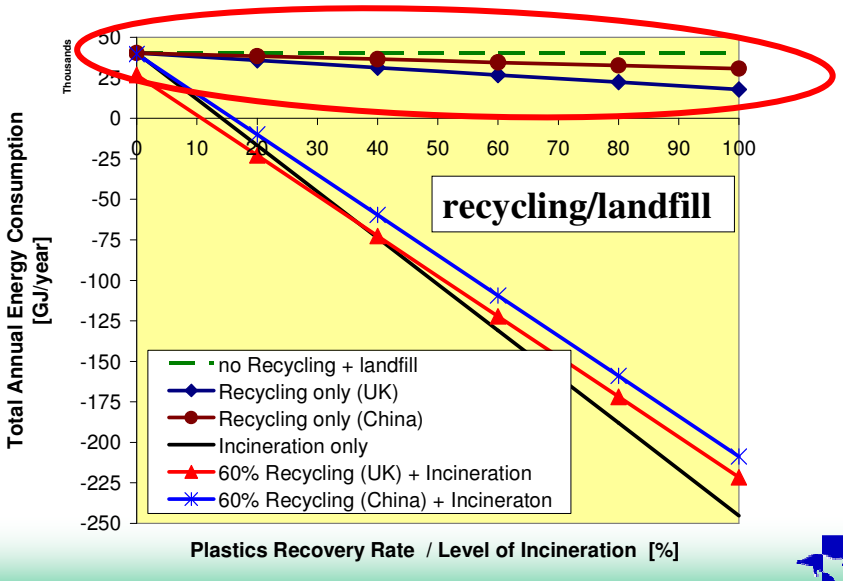
Export to China



Assumptions, etc….

- Only variable changed in model is the transfer distance to processing plant
  - Southampton to Shanghai one-way = 10308 nautical miles (via Suez Canal)
- Ship load = 1200 tonnes
  - assume ship fully loaded
    - part-loaded with plastics (bottles/containers)
    - energy consumption associated with shipping plastics is proportional to amount of plastics shipped

Comparison of Scenarios



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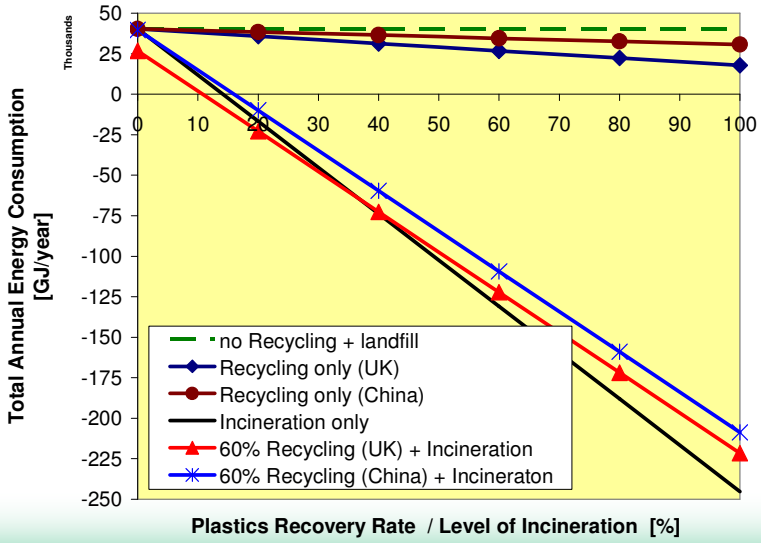

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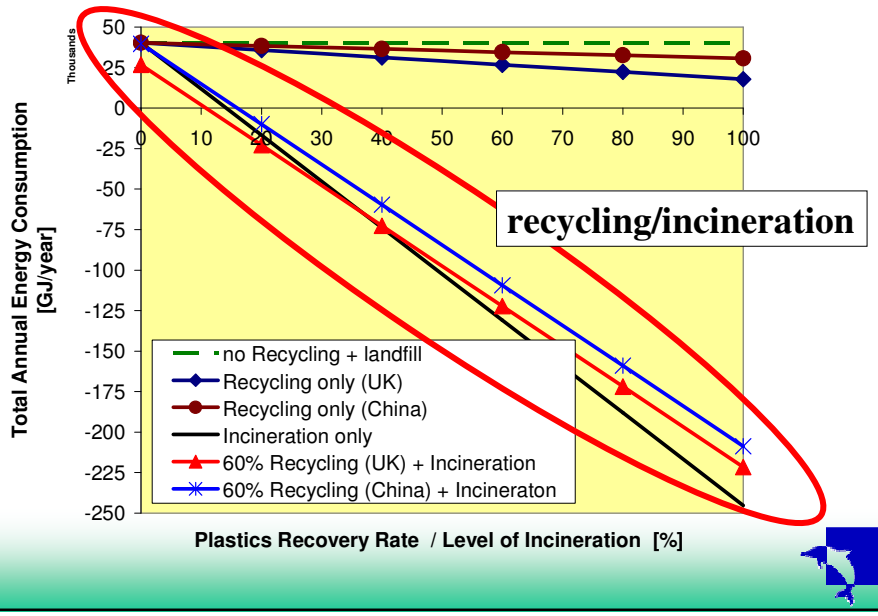

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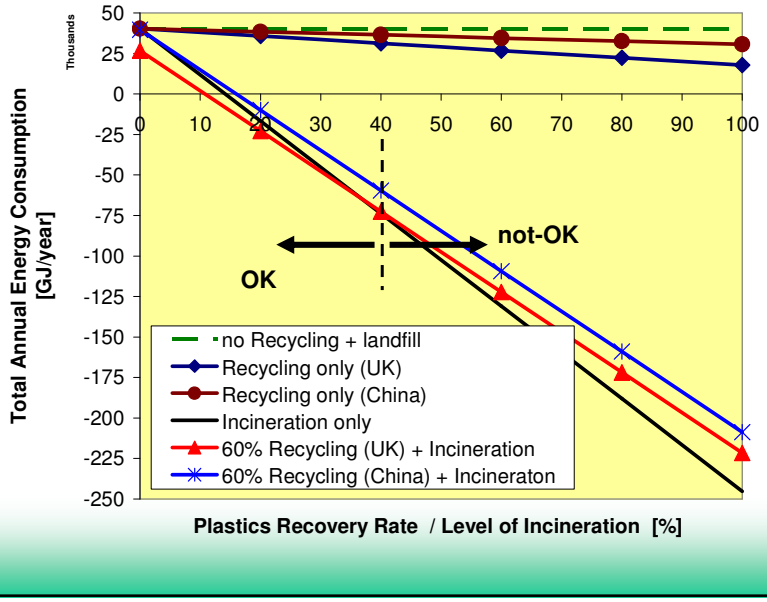

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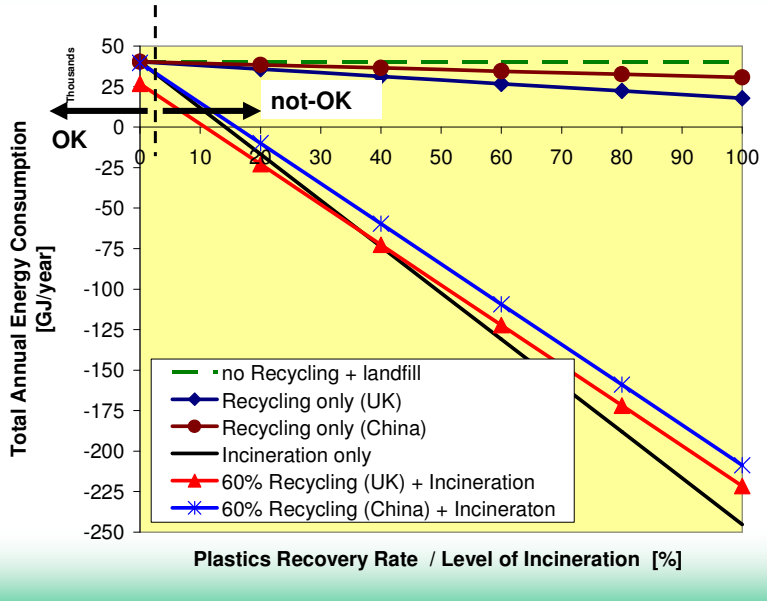
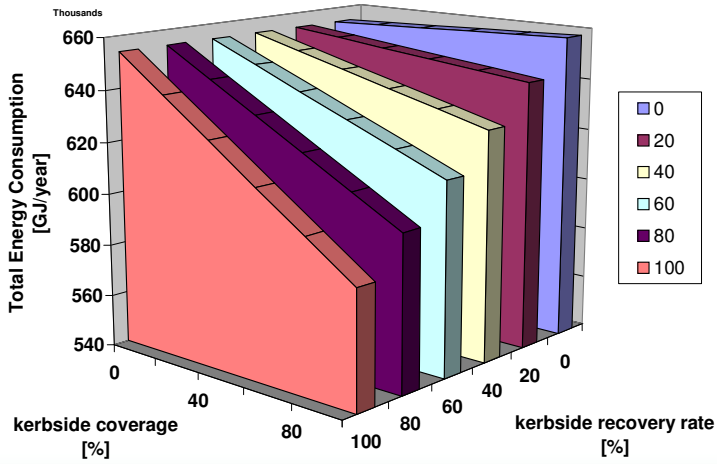
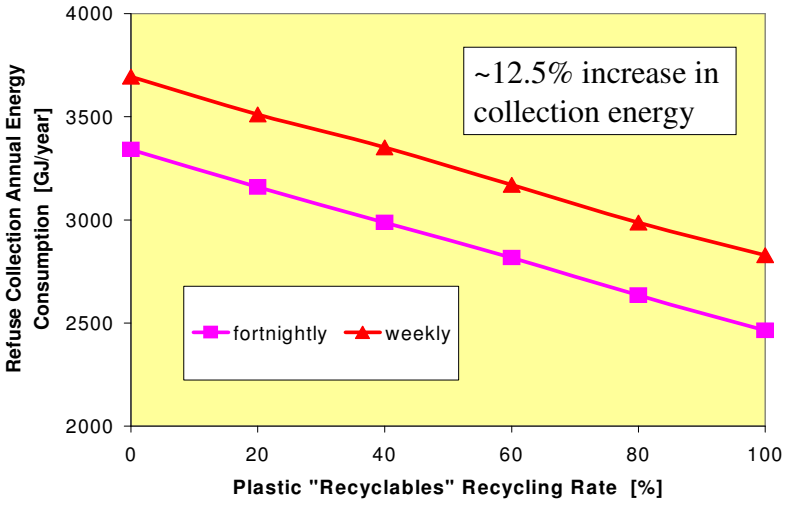


Paper Banks or PaperChain?

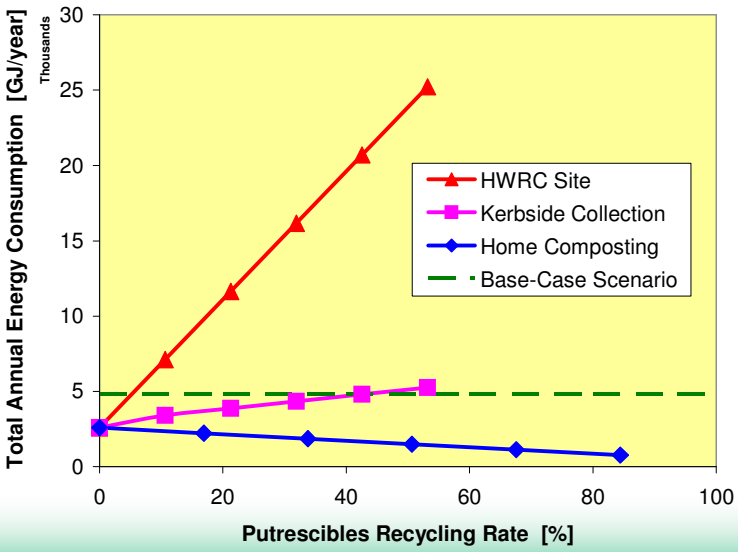


Frequency of Refuse Collection

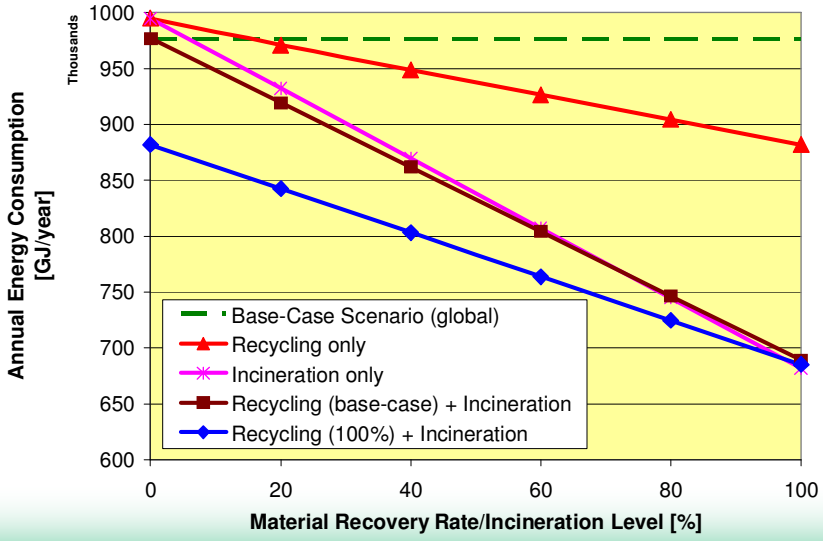


100% coverage of dry recyclables scheme; no bank tonnages

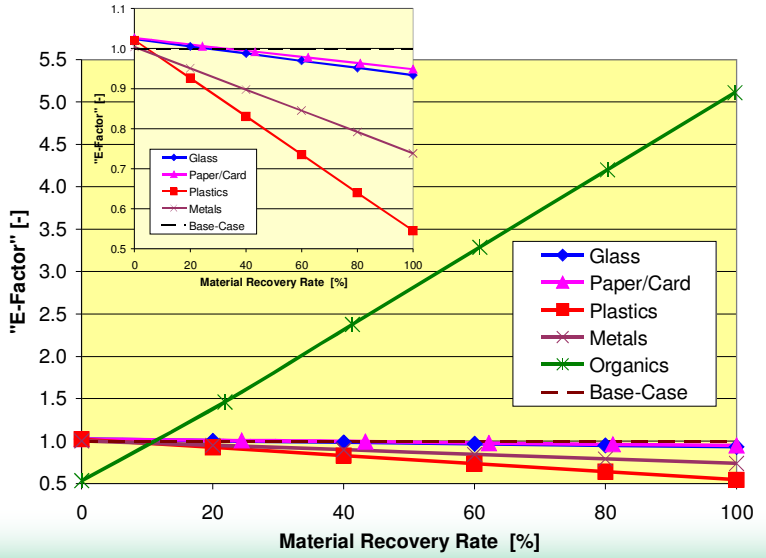
Centralised or Home Composting?



Global Waste Management



"Energy Factor"



Energy Savings

Material	Total Energy Consumption [GJ/year]			E-Factor (max. recovery)
	base-case	max. recovery	difference	
Glass	60454	56455	4000	0.93
Paper & card	640943	608064	32879	0.95
Plastics	39609	21595	18015	0.55
Metals	229710	169614	60096	0.74
Organics	4831	24694	-19863	5.11
TOTAL	975547	880422	95125	0.90

Energy Savings

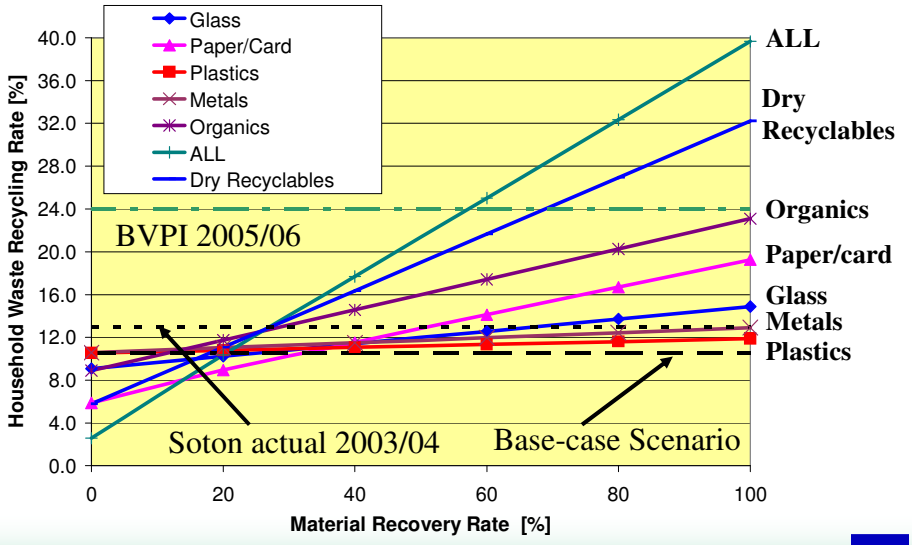
- Max. energy savings from recycling (compared to base-case scenario)
- Average domestic household electricity consumption 11.9 GJ/year (3300kWh*)
- Savings can provide how many households in Southampton with electricity?
- Scale up to whole of UK

* Source: www.CO2.org

Energy Savings

- Glass: 26778 households
- Paper/Card: 220106 hh
- Plastics: 120600 hh
- Metals: 402309 hh
- Organics: **-132972 hh**
- Total (global): **636808** hh (~1.5 million people, or a population greater than that of Hampshire)

Household Waste Recycling Rate



CONCLUSIONS

- The major source of energy savings from recycling is through increased use of recycled material in the manufacturing process
- Generally, recycling via kerbside collection is better than via bring-sites
- Incineration of the residual waste stream (rather than landfilling) has a lower energy footprint than recycling (with landfill)
  - However, a combination of recycling plus incineration generally gives the lowest energy consumption (particularly at low-medium incineration levels)

CONCLUSIONS (cont.)

- The choice of the best waste management option (in terms of energy footprint) is dependent on collection method, types of plastics recycled and level of incineration

Further Work (Phase Two)

- further model development
- filling in the gaps!
  - mass/energy data from other SUE Waste projects
- extensive simulations & interpretation analysis
- development of user-friendly interface

Further Work (Phase Two)

- further model development
  - re-calculation of refuse composition
    - tracking changes since 1999 analysis
  - enhance flexibility of model
    - allow possibility to send material to multiple locations simultaneously
      - e.g. different landfill sites, WTS, MRF
      - use of EPA data to achieve this
    - expand to include, e.g., mining & transportation of raw material
    - incorporate databases into model

Further Work (Phase Two)

- filling-in the gaps
  - Seek to replace assumptions with actual data
    - Incorporate mass/energy data from other SUE Waste projects
  - Organics model
    - A.D and other technologies for processing organics
    - Date from bioprocessing project
  - Incineration sub-model
    - Enhance, plus include other thermal treatment technologies
    - Data from thermal processing project

Further Work (Phase Two)

- **filling-in the gaps**
  - Expand to cover C&I wastes
    - Incorporate data from C&I Waste project
  - Metals model
    - Expand to include bulky waste (project 6)
    - Greater detail for, e.g., scrap metal recycling
  - Examine re-use & waste minimisation aspects (projects 6 & 7)
  - End-markets for recyclate
    - More detailed examination of options for use of recyclates
  - Hope to predict/determine downstream waste generation & composition from upstream resource flows (with project 1)

Further Work (Phase Two)

- **extensive simulations & interpretation analysis**
  - Sensitivity analysis
    - Determine the importance of different parameters (particularly those where an assumed value has been used)
    - Relative effect of varying the parameters
    - Which values to keep as default and which to be input by the user (minimise amount of data required from the user)
  - Re-run previous scenarios using new data
  - Run scenarios incorporating technologies not examined before

Further Work (Phase Two)

- **Develop user-friendly interface**
  - **Two options for user**
  - OPTION ONE:
    - Present model with base-case refuse & recycling amounts
      - Compare scenarios to the base-case
        - » Examine the impact of different waste management strategies compared to the base-case scenario
      - Useful for local authorities – should have data available

Further Work (Phase Two)

- **Develop user-friendly interface**
- OPTION TWO:
  - Start with amount/composition of "waste" generated by households
    - Decide what and how much of each material goes where
    - Useful for strategic planning at local and Government level
      - Examine the impact that different waste management options have with regard to achieving recycling targets; or impact of E.U/Government waste strategies
      - Particularly useful when considering waste management plan for new-build, e.g new town/large housing estate

Further Work (Phase Two)

- **Develop user-friendly interface**
  - User-interface
    - Drop-down menus where appropriate
      - For location of facilities, etc.
        - » e.g. list of WTS, MRF, EfW facilities in Hampshire
        - » In-built databases with details of facilities, distances from various cities, etc.
      - Option to choose city/town/district from list
        - » Populate with, for example, districts and U.As in Hampshire; major cities/towns in UK
        - » Database for each containing information about each, e.g. demographics and waste management infrastructure

THANKS TO:

- Biffaward
- BOC Foundation
- Hampshire County Council
- Onyx Environmental
- Southampton City Council

www.suewaste.soton.ac.uk