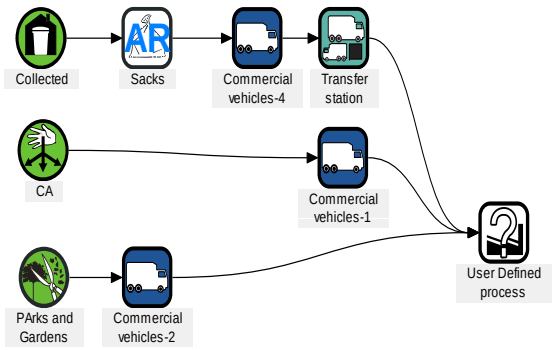
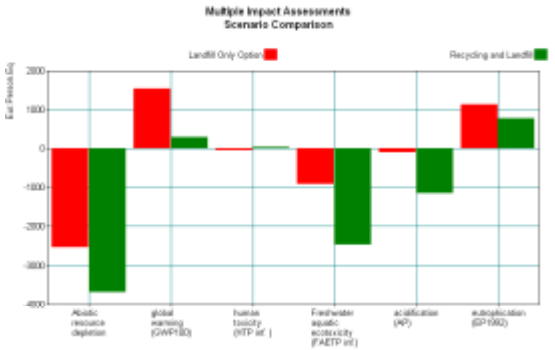
Presented by David Hall, to IAIA conference in Aalborg 2010
dhall@golder.com

Examining and assessing GHG emissions from Waste Management activities using the Environment Agency's WRATE model

Golder Associates

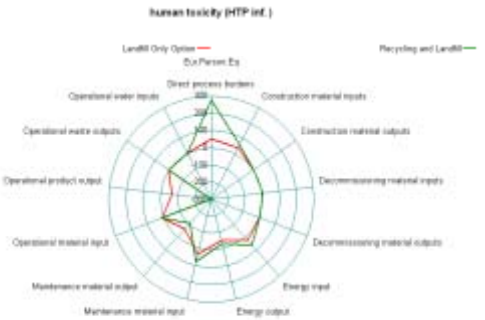
What is the WRATE model

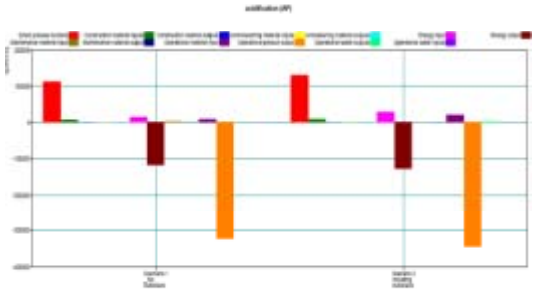




- **W**aste and **R**esources **A**ssessment **T**ool for the **E**nvironment
- WRATE is a Life Cycle Assessment tool to allow **waste managers** and those involved in waste strategy to become **LCA experts overnight**!
- It is owned by the **Environment Agency**, **written by Golder**, and developed by Golder and ERM, and peer reviewed by AEAT.
- Its **focus is MSW**, but it can be used for commercial and industrial wastes – but the heart of the model is populated with data such as the elemental composition of MSW.
- The original version was released in 2007
- The first major upgrade was released in 2010

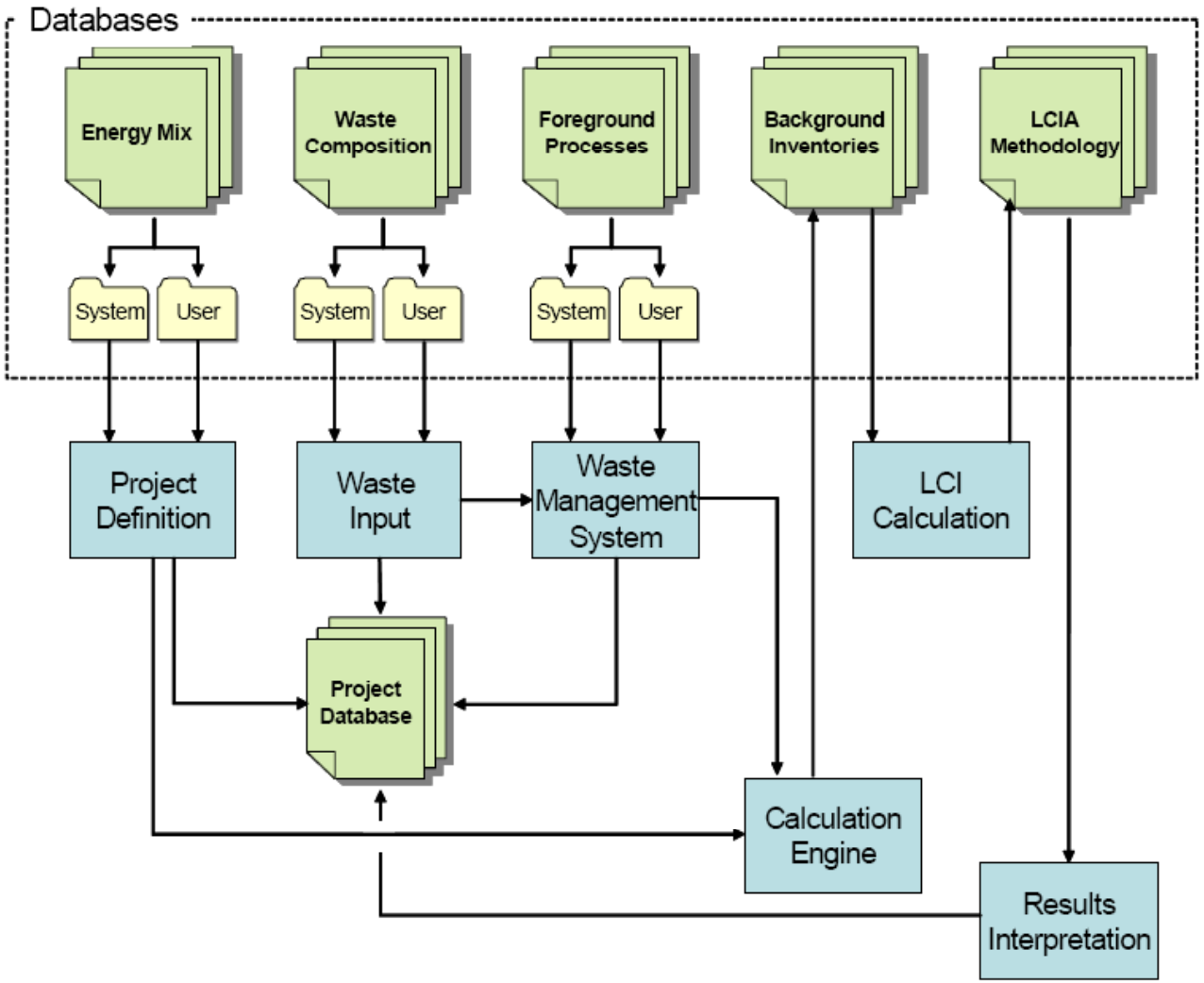
Some Facts and Figures on WRATE





- WRATE “monitors” some 1000 environmental burdens (raw materials, emissions, land-use, off-sets and energy)
- It contains over 300 different Environmental Impact Assessment models (GWP, Ac, Htox, Aqtox, OzDP etc)
- It contains virtually every advanced waste treatment, disposal, recycling, recovery, composting process know – and if its not included in the software you can build your own waste process.
- It is a 140 Mb install (mainly supporting information)
- It **is easy** to use at the Standard Level
- It is **as complex** as you want to make it at the Expert Level

Basic Structure of the Databases



Drivers for WRATE's Development

- Landfill Directive diversion targets for the UK represent a huge challenge as in the 1990's the majority of MSW was disposed of to Landfill.
- This is changing, and I have seen investment estimates of between £13 and £20 Billion to update the UK's waste infrastructure to meet the Directive targets.
- If the UK is spending that sort of money – it would be best if we can optimise the outcome and get it right first time – while ensuring that other divers – the UK's commitment to carbon reduction (from waste), recycling targets, etc are also met.
- Defra (our environment ministry) needed to develop a waste strategy for the country that was based on sound science and now requires the use of LCA in any public investment in waste infrastructure.
- The model is transparent – with great majority of equations and most data both visible and editable.

Features

- It tracks waste (and it properties) from one process to another and is “mass” aware – you cannot “loose waste” in a process.
- Uses different CV (net), moisture contents & ash contents (as well as elemental compositions) for different waste fractions (both primary and secondary – i.e. paper is primary and newspaper, office paper, cardboard etc are secondary waste fractions).
- Waste flows can be divided or merged together from one process to the next.
- Many processes have restrictions on incoming wastes (i.e. IBA cannot be moved in a RCV or stored in a refuse bin).
- The model tracks key elemental compositions (heavy metals, total sulphur, total chlorine, total fluorine) and most of the equations are scalable – so increasing the sulphur content of the waste will result in higher sulphur emissions or higher use of consumable materials in air scrubbing technology.
- Changing the waste make-up by minimisation, or by pre-treatment is reflected in how much gas is generated in a landfill and will change the leachate composition/emissions to groundwater and surface water.

Processes included

- Collection
  - Sacks 6
  - Bins 12
  - Skips 8
  - Bring banks 8
- Transport
  - Trucks 19
  - Ships 3
  - Trains 1
  - Cars 3
- Intermediate
  - Transfer stations 4
  - MRFs 6
  - Household waste recycling 5
- Recycling – 24
- Treatment
  - Autoclave 2
  - EfW/CHP 9+
  - Pyrolysis 2
  - Gasification 3
  - AD 4
  - MBT 15 (including 4 extra AD)
  - Composting 10
- Landfill 6
- All “Scalable” to the waste that is passed to the process.
- 150 system process in total.
- Plus User Defined Processes for any amendments or additions

Golder Associates

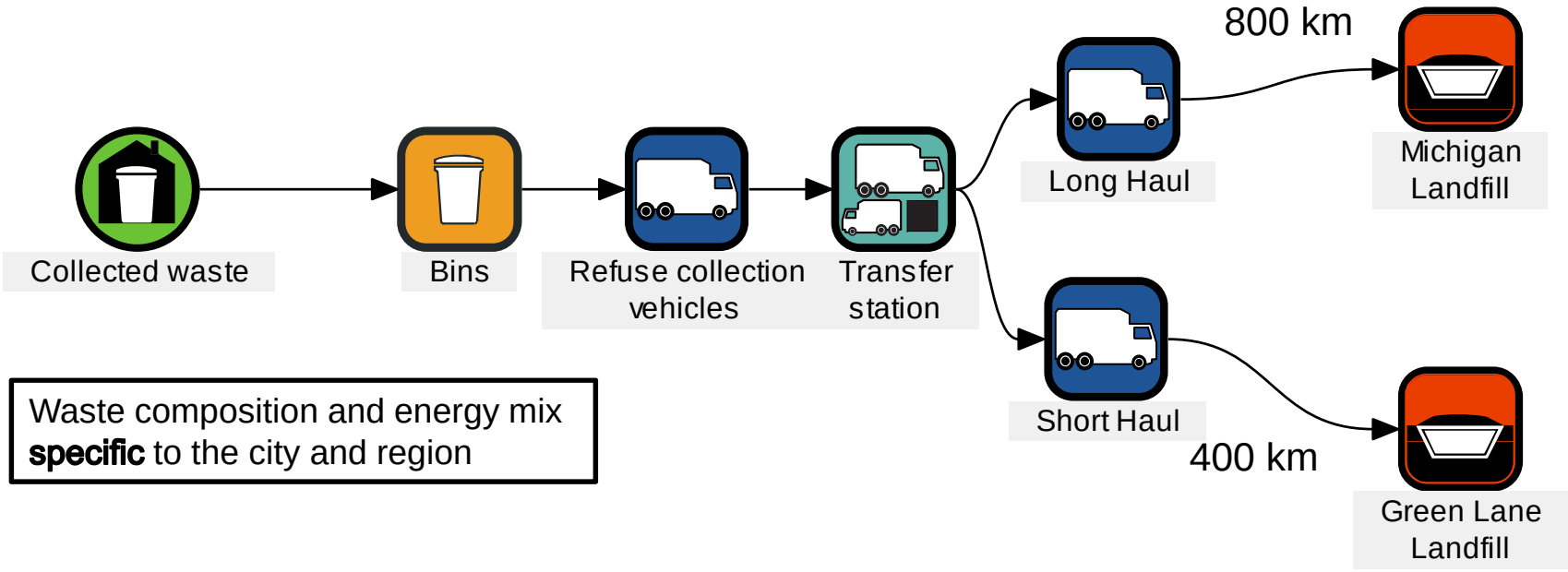
Let's look at an example – Greater Toronto Area

- Historically, Toronto has disposed of virtually of all its waste to landfill
- Only 2.7% of this was landfilled in Ontario
- The remainder was sent to Michigan (USA) by truck (800 km round trip).
- Even the "local" landfill was a 400 km round trip by truck.
- By the turn of the millennium, the city began to realise that its waste management system was not sustainable.
- Their objective was to remove organic waste from MSW, reduce the amount sent to landfill and to achieve a better GHG emission profile for their waste management system.
- We used WRATE to benchmark their existing scheme, and investigated alternatives.
- **Disclaimer** – the actual models presented here are not those used in the project – they were developed pre-proposal (in around 2 hours) and are schematic at best – but serve to demonstrate the power of the tool.

Golder Associates

Base Case

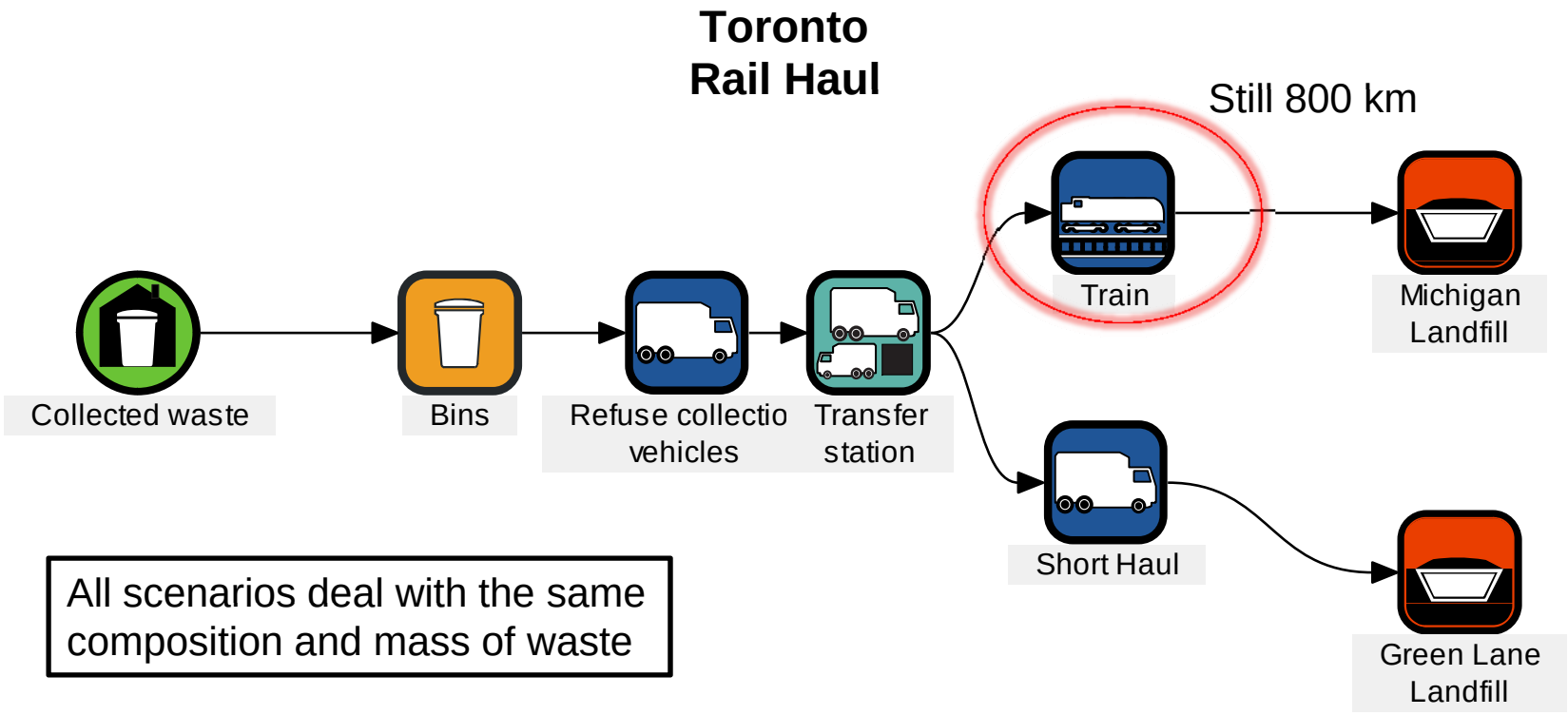
Toronto
Base Case Road Haul



Waste composition and energy mix **specific** to the city and region

Date 01/10/2010
Software Version 2.0.1.4
Database Version 2.0.1.4

One “instant” improvement suggested

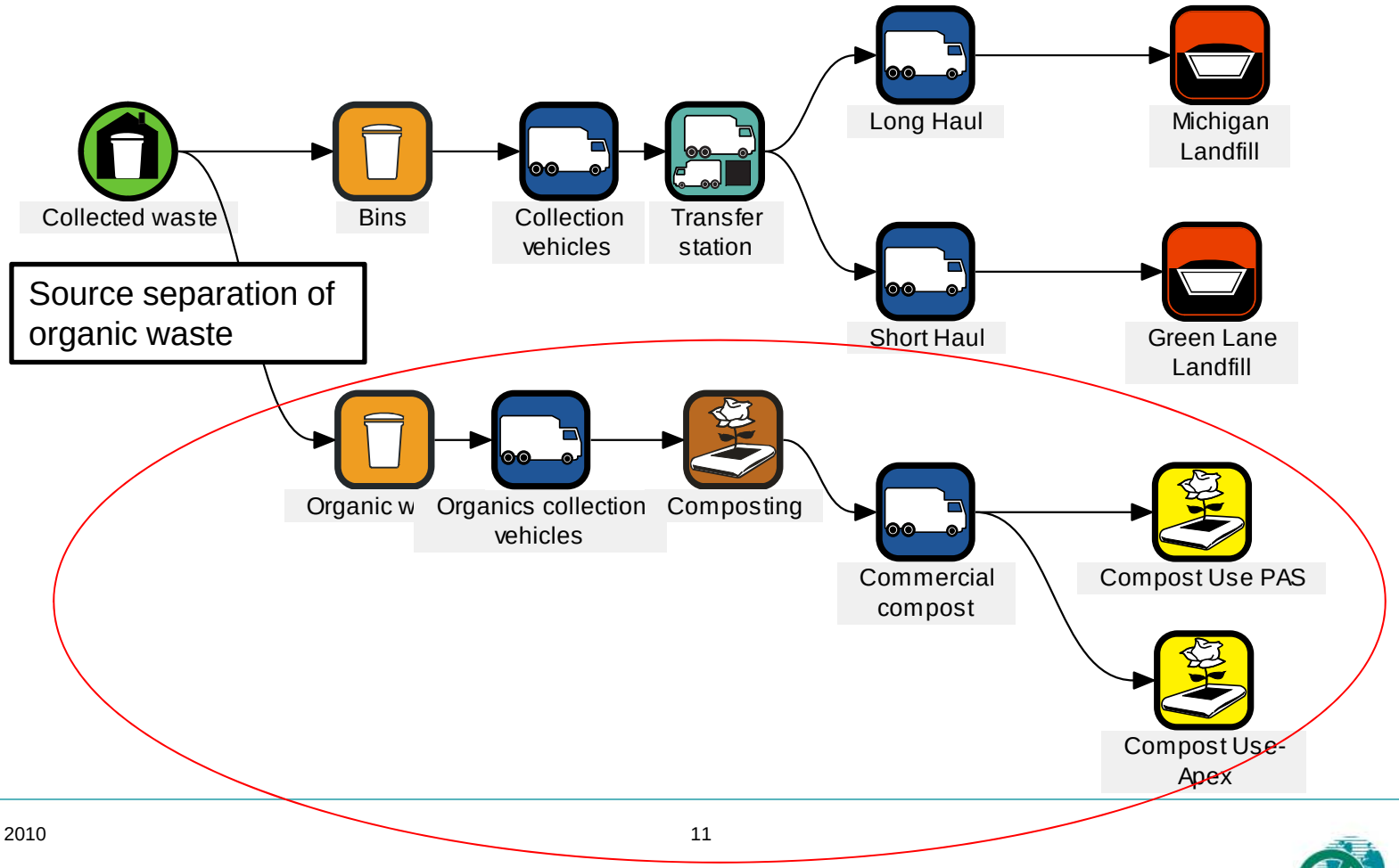


All scenarios deal with the same composition and mass of waste

Date 01/10/2010
Software Version 2.0.1.4
Database Version 2.0.1.4

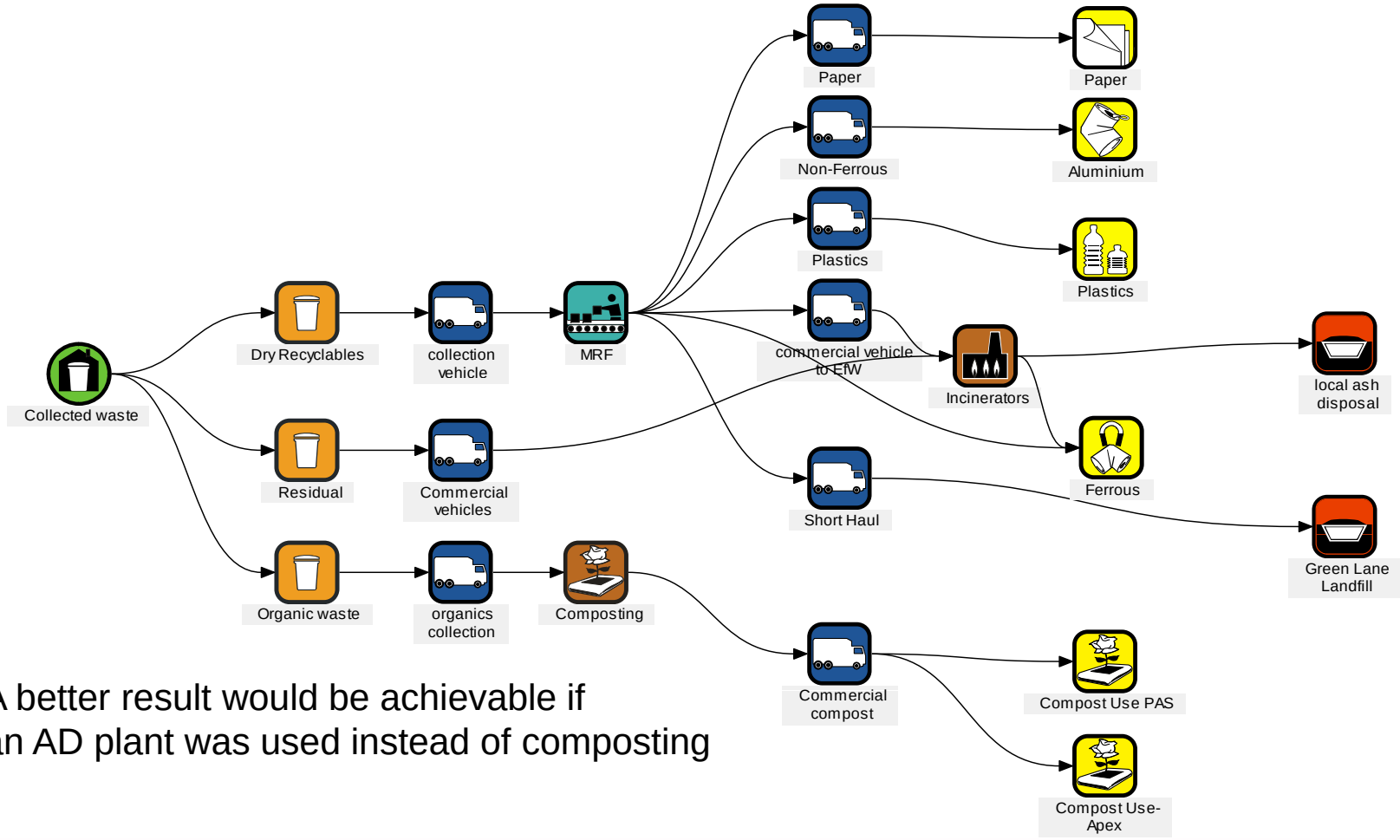
GTA's original prime option

Toronto
Organics collection and residual landfill



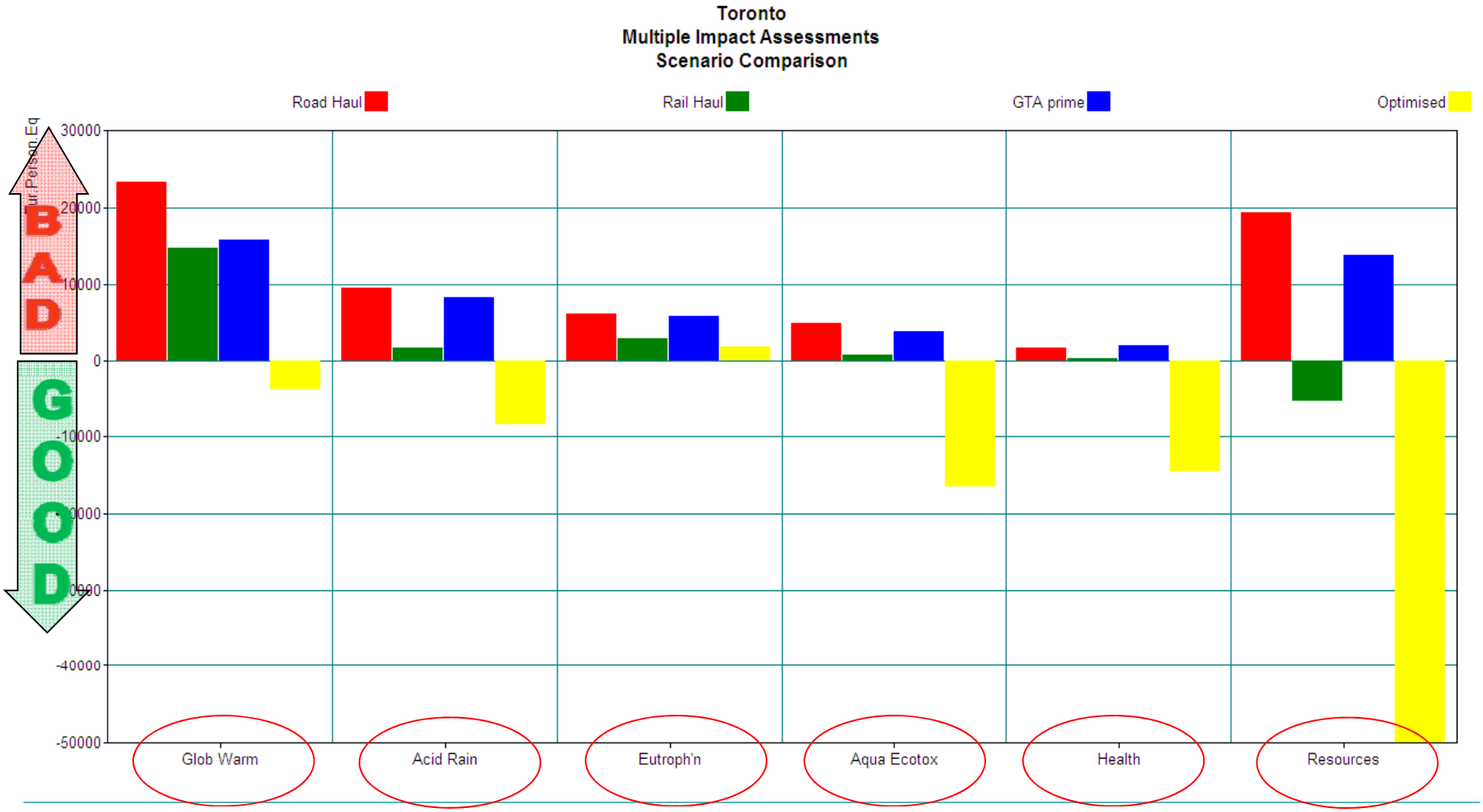
Partially Optimised – purely a figment of my imagination of what might be achievable

Toronto
Organics and Incineration

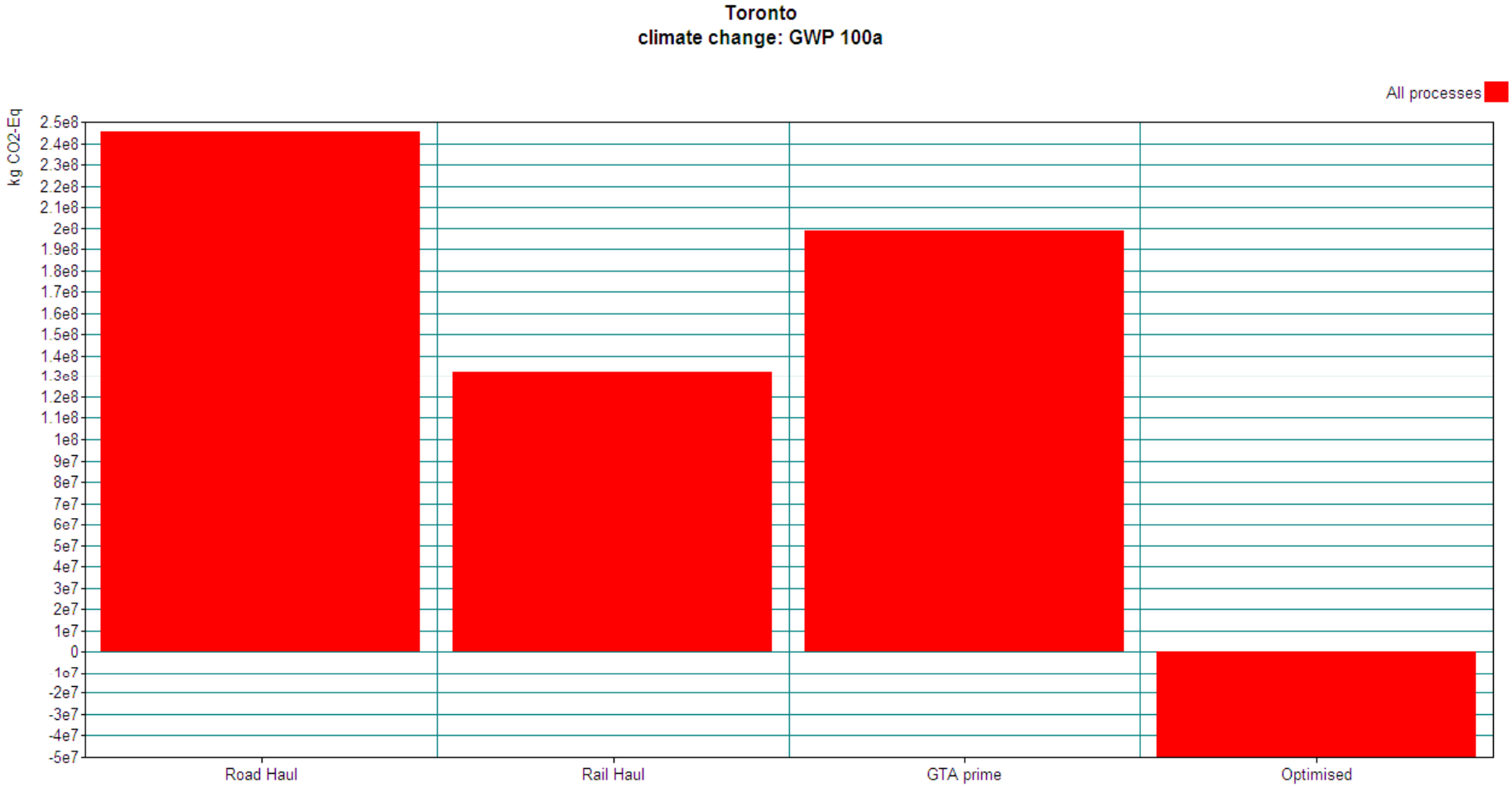


A better result would be achievable if an AD plant was used instead of composting

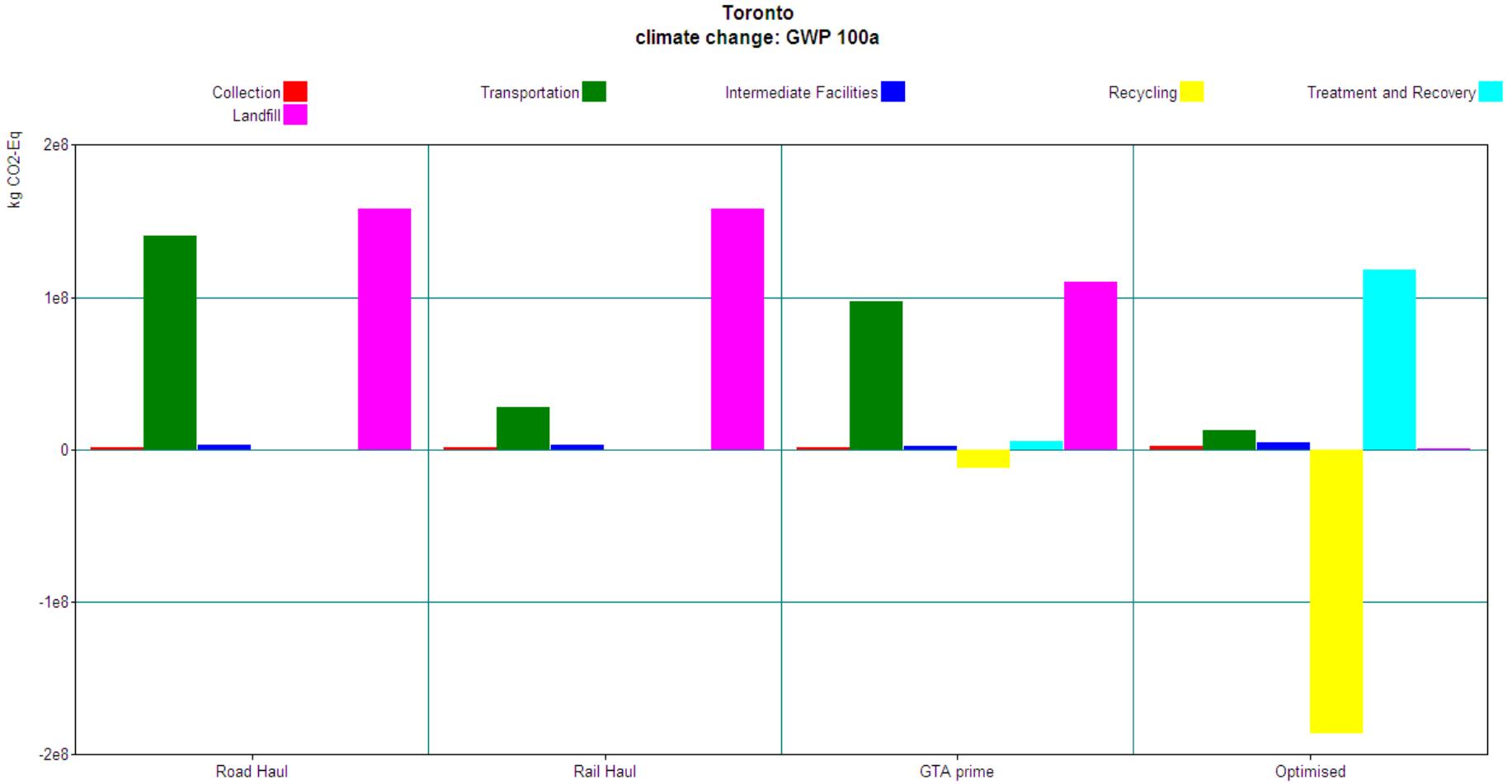
And the Results…..



And concentrating solely on GHG emissions…..



More detail


Toronto
climate change: GWP 100a
Collection
Landfill
Transportation
Intermediate Facilities
Recycling
Treatment and Recovery
kg CO2-Eq
2e8
1e8
0
-1e8
-2e8
Road Haul
Rail Haul
GTA prime
Optimised

The outcome (Political and Societal issues)

- What is best for the environment may not be socially acceptable and Ontario still has a great deal of opposition to waste incineration.
- So, the optimal solution is not being followed, but organic waste treatment (composting), as well as residual waste treatment (MBT) is now being implemented.

- One day…..perhaps…

You develop multiple scenarios all dealing with the same waste and see which is best

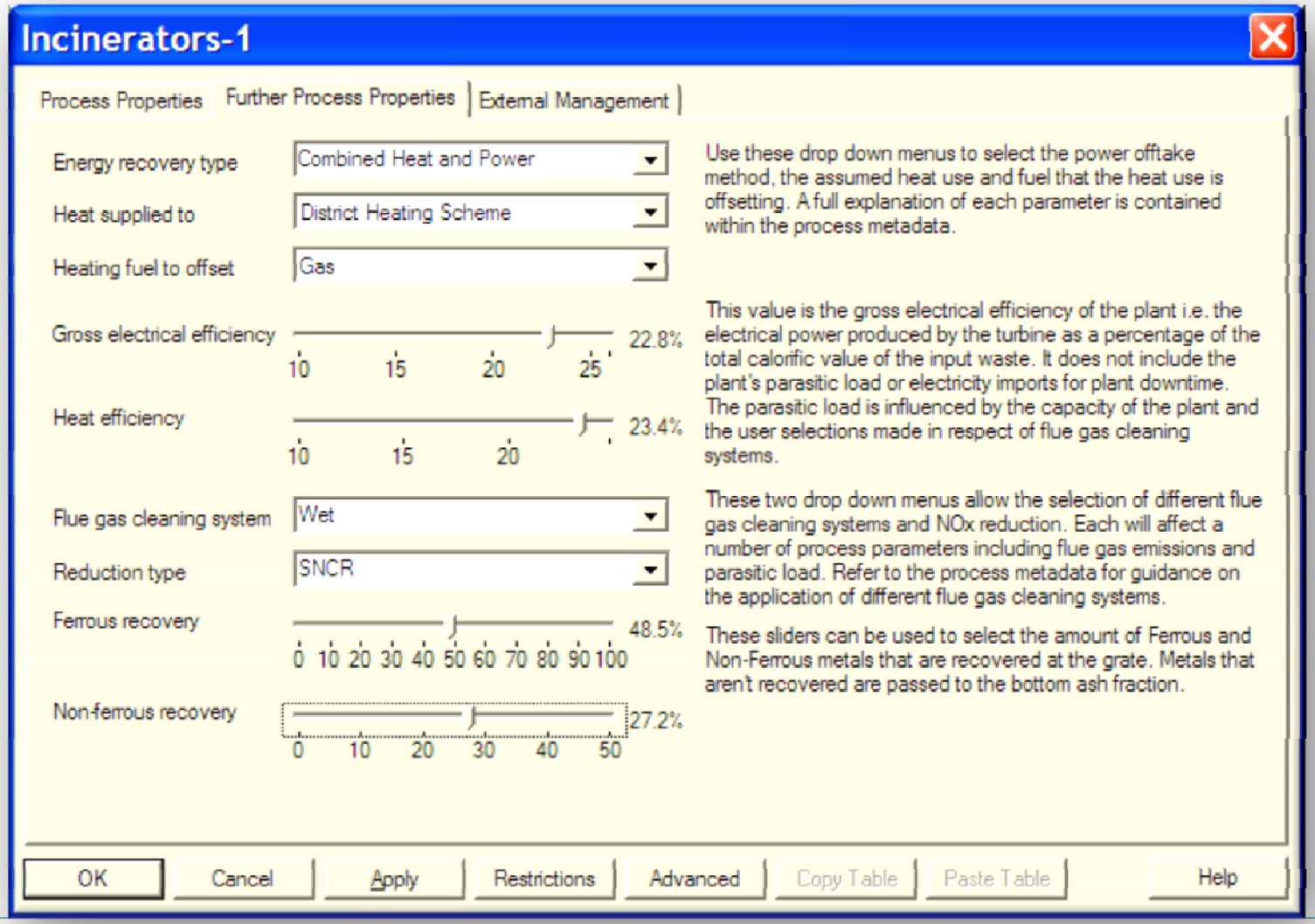
- While you can simply assess the environmental burdens of a single scenario to develop an understanding of its performance, the real power of the model comes from examining (and comparing) multiple scenarios.
- It allows the “What if” questions within the Waste Strategy to be addressed in a matter of minutes! For example:
  - What is better for my waste stream – Landfill or MBT or Incineration?
  - Is there an advantage to use AD derived Bio-Gas (as CNG) to power my collection vehicles or should I generate electricity from it?
  - If I can invest in plant that will use more energy in recovering an additional 15% of non-ferrous metal from the waste stream, will there be an environmental pay-back?
  - Which Public/Private funded offering (PFI) has a better environmental footprint.

Golder Associates

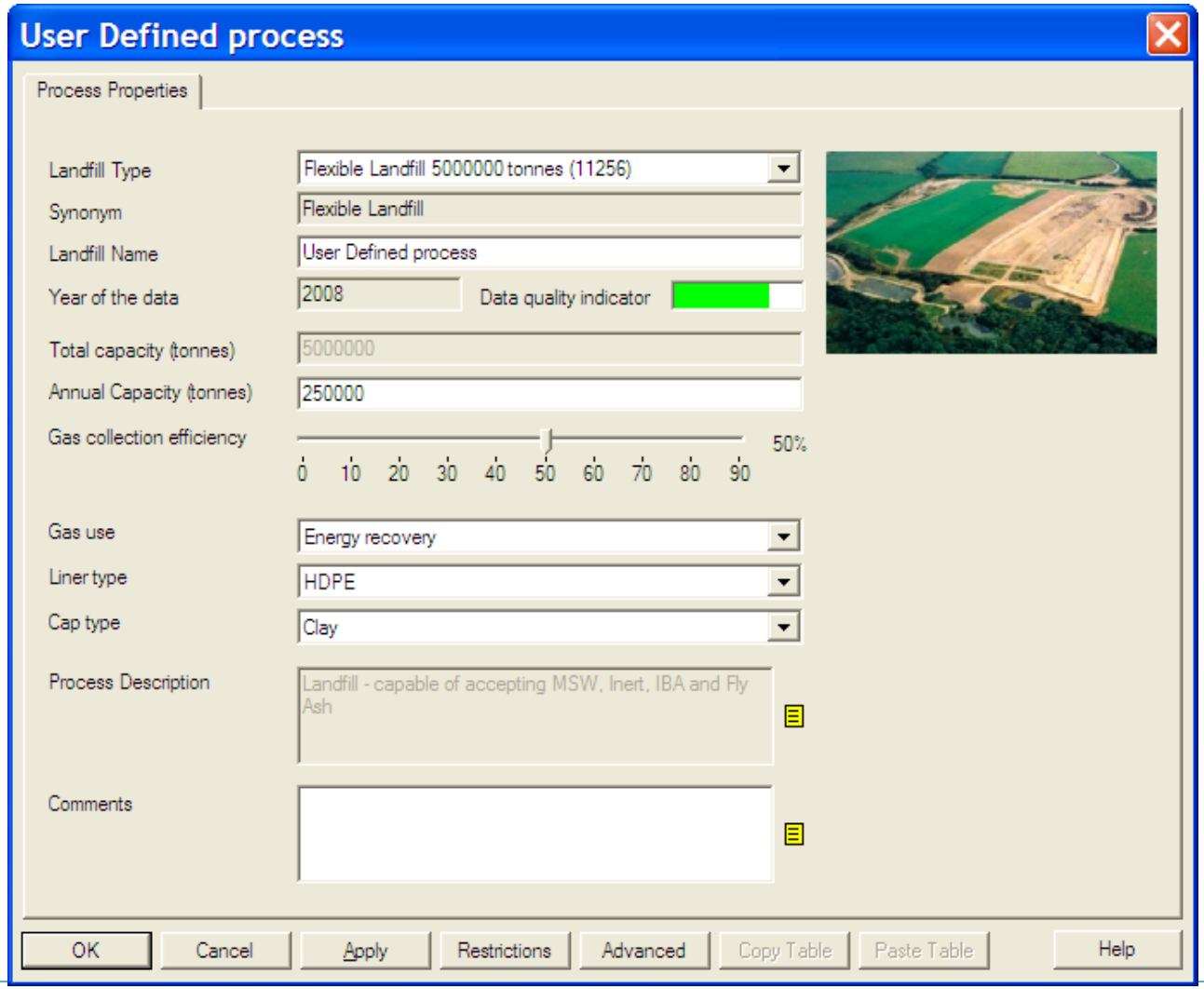
A new “Breed of Processes”

- WRATE allows Expert Licence holders to edit process, or to write new processes from scratch.
- These User Defined Processes (UDP) generally require peer review to ensure they have been properly constructed and adhered to ISO 14040, and are mathematically valid.
- Most EfW plants have different efficiencies, use different scrubbing and pollution abatement methods, and some export heat.
- The latest version of the model has a Flexible EfW process that allows general changes in a system process without the need to edit the process or move away from a peer approved system process……

Flexible EfW plant user interface



Flexible Landfill model on the way



Allows energy production, flaring, or venting.

Will ultimately permit export of gas as a product for use elsewhere.

Data Improvements for the latest release

- Use of ecoinvent data v2.01 (version 1 used v1.2)
- New default waste composition for England added
- Energy mix updated
- Additional Impact assessments added – now 311 impact assessments (up from 103)
- A few new processes and a large number of updates to the existing processes (especially EfW, MBT, and other treatment technologies) and brings the total number of waste processes within the model to150.

The Real Advantage of the Model

- Assessing the difference between current and future waste strategies should aim to improve GHG emissions.
- Typically, a Landfill based strategy can be significantly improved by recycling certain waste streams, treating residuals, and recovering energy from that stored within the waste stream.
- On two significant city/county wide PFI contract bids that we have evaluated, savings of between 130 to 420 kg CO_2 eq per tonne of waste can be achieved.
- You can determine the best strategy (per $) for reducing the carbon emissions from waste
  - Some developing countries would do well if they simply collected their landfill gas and flared it, generated electricity or utilised the gas in transport.

Conclusions

- WRATE, as a modern tool specifically designed for waste managers, it can rapidly assess the carbon emissions, and other impact assessments related to waste management activities.
- It can be used or adapted to suit most countries (especially those in Europe as the background database is of European origin).
- It is clear to me that…..

Thank you for your attention

David Hall
Golder Associates (UK) Ltd
Nottingham, UK
dhall@golder.com