Greenhouse Gas Mitigation from Waste Materials Recycling

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Question

Carbon credits have not been realised from recycling projects.

Why?

Literature

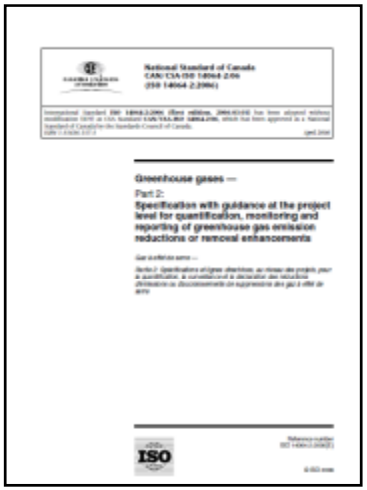
- Recycling avoids processes of mining, drilling, mineral processing, smelting and refining
  - GHG emissions benefits are quantified (USEPA 1998, 2006)
  - Based on life cycle assessment (ISO 14040:2006)
- Future opportunities for increasing recycling are tremendous (UNEP 2011)

- Previous work done on municipal waste, metals, construction materials, plastics
  - USA (Weitz et al 2002)
  - Canada (ICF 2005, Mohareb 2008)
  - China (Zhao 2009)
- CDM method exists
  - UNFCCC Clean Development Mechanism. *AMS-III.AJ.: Recovery and recycling of materials from solid wastes*

Methods

International standards

- Life cycle assessment



ISO 14064-2:2006
Project quantification

- GHG quantification of projects

ISO 14040:2006
ISO 14044:2006
Life Cycle Assessment

Data set

- Four “Enhanced Recycling” projects
- Government of Canada *Action Plan 2000 on Climate Change*
  - Five-year (2001-2006)
  - $3.4 million
  - Minerals and Metals Program
- Projects selected for activities and available data

Measurement

- ISO 14064 Part 2
- Baseline vs. project on life-cycle basis
- Low, medium, high scenarios to 2010
- Emissions factors from GoC (ICF 2005)
  - “GHG savings” for recycling, reuse, etc.
- Also provided “Measurement and reporting plans” to serve as basis for expanded or replicated enhance recycling

Project 1: Construction waste recycling

- *"Let's Climb Another Molehill"*
- Recycling Council of Ontario
- Greater Toronto area

- Focused at on-site WMAPs resulting in waste diversion activities
  - Waste Management Action Plans
  - Data, issues, barriers and opportunities to applying progressive 3Rs on-site

New residential construction

Photo credit: Molehill report, RCO

15 sites sampled in total

Wood
Framing

Component
reuse

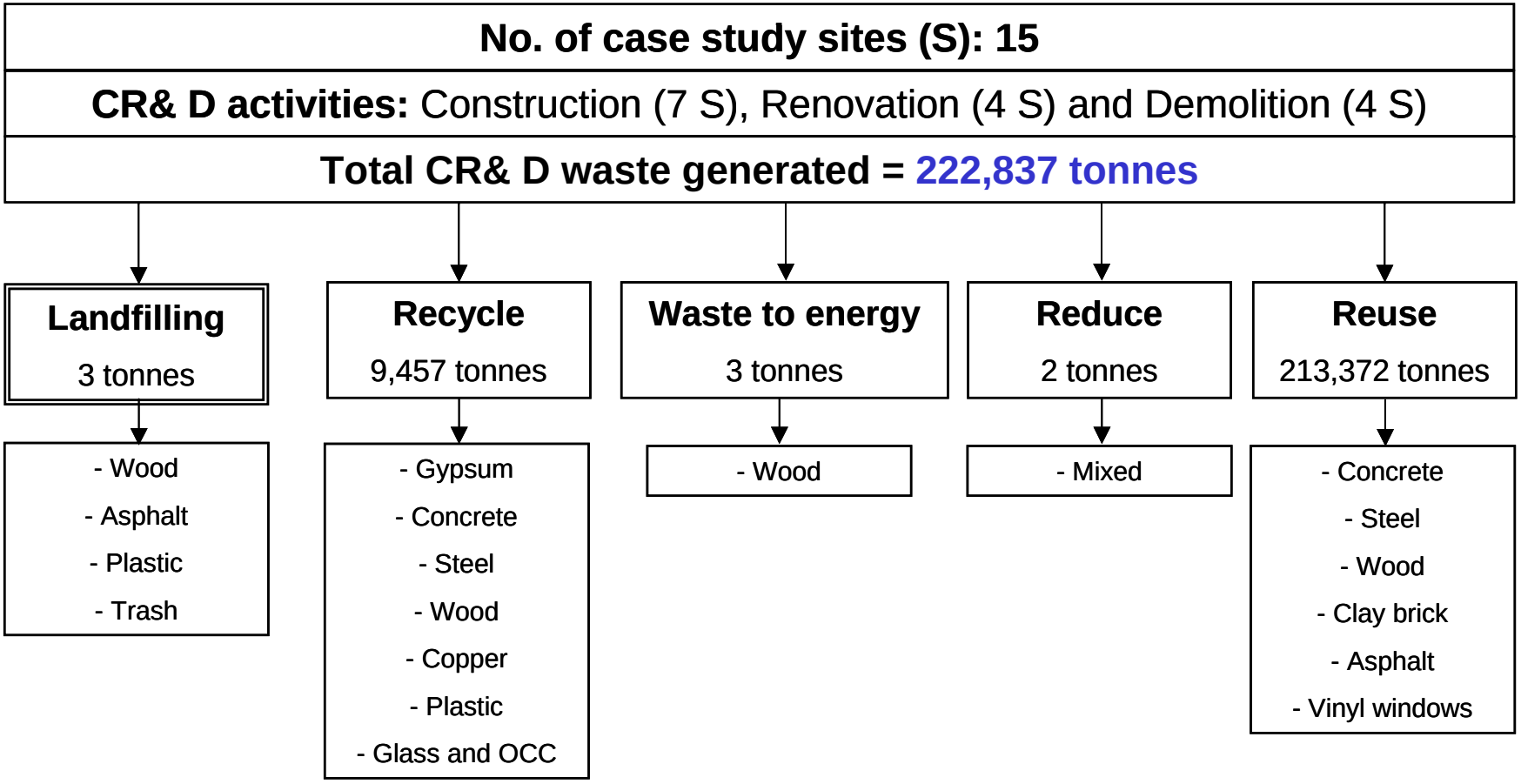
Gypsum recycling

Concrete recycling: major demolition

Pearson International Airport,
Toronto, ON

Photo credit: Molehill report, RCO

Molehill overview of materials



Project 2: Adding residential scrap metal to municipal recycling programs

- Ottawa Valley Waste Recovery Centre
- Small metal items collected with traditional recyclables
- Sort at MRF, sell to dealer
- 19,040 kg of metal
- Operates today and expanded in scope – appears economically viable

Photo credit: OVWRC

Project 3. Cost-effective ways of recycling scrap metal from Northern communities

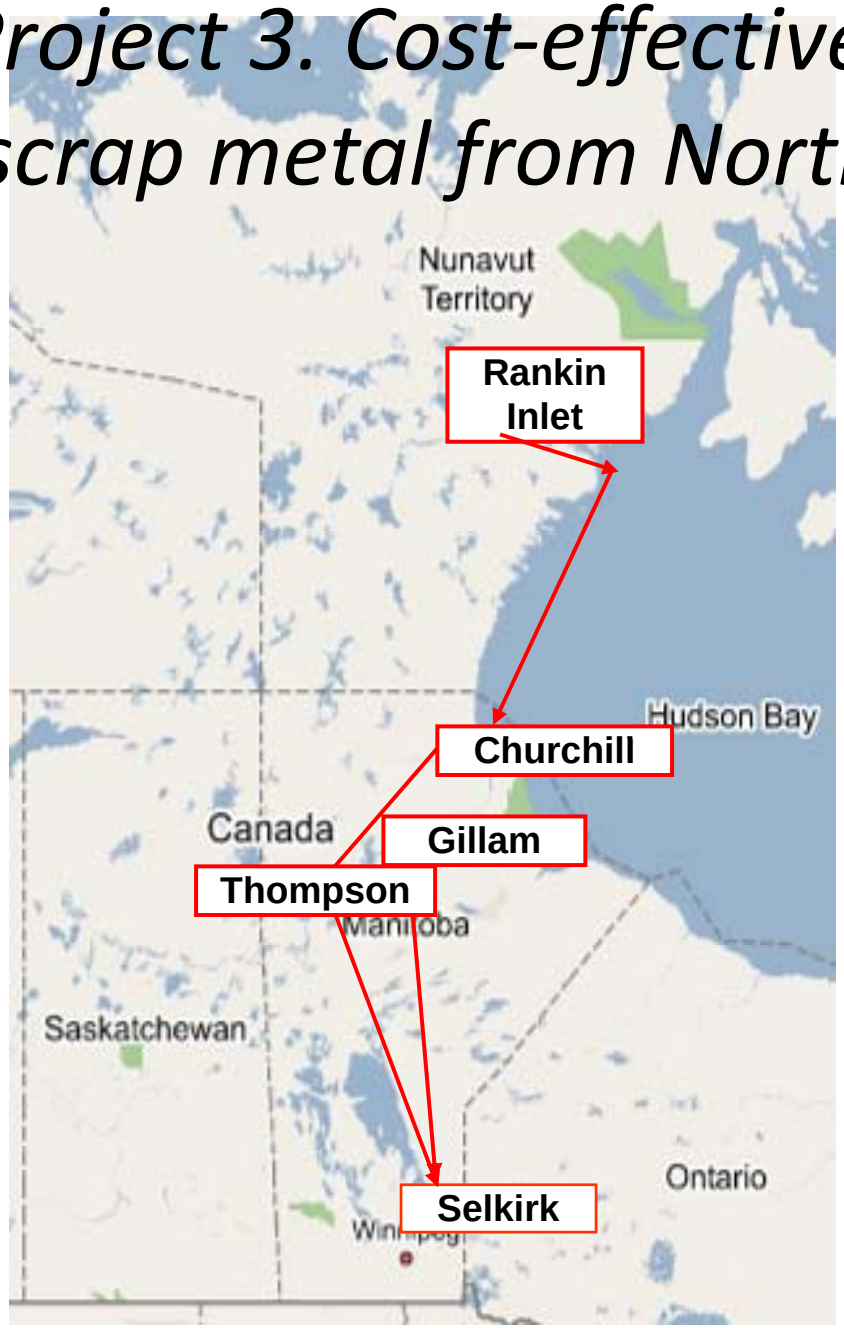


Photo credits: North Central Development

Scrap metal recovery from Northern communities

Photo credits: North Central Development

Northern: transportation routes

Rankin Inlet, NU (498 km)

Via Kivalliq Marine → Churchill, MB

Churchill, MB (547 km)

Via HBR/Omni Trax → Thompson, MB

Thompson, MB (770 km)

Rightway Recyclers; Gardewine → **Selkirk**, MB
"Mandak Metal Processors", Scrap Broker

Gillam, MB (1072 km)

Gardewine → **Selkirk**, MB
"Mandak Metal Processors", Scrap Broker

Northern scope of analysis

Quantification:
∑ (emission factors x activity levels)

PROJECT													
SSR identifier	SSR name	Input (material, fuel, electricity etc.)	Amount	Unit	GHG factors (in kg CO2e/unit)				Net GHG emissions savings (in tonnes CO2e)	UA	UE	UT	Comments
					CO2	CH4	N2O	CO2e					
E1	Production of metal products	N/A			N/A								SSR excluded (see Criteria B)
E2	Use of metal products	N/A			N/A								SSR excluded (see Criteria B)
E3	Scrap pre-processing at sites	Scrap	2004	tonnes	0.005	0	0	0.005	-10	medium	high	high	National emission factor for landfilling is applied here. Source: ICF Consulting Final report 2005, P. 28, Net recycling emissions: Steel.
E4	Sorting scrap metal	Electricity	29690	kWh	3.6E-02	2.0E-06	4.8E-05	3.6E-02	-1.1	medium	medium	high	Amount of electricity and natural gas are based on national activity levels for Material Recovery Facilities processes. Source: EPIC/CSR 2002: Integrated Waste management Tool: Environmental Analyses Model . Source of emission factor for electricity and natural gas: ICF Consulting Final report 2005, P. 88, Net recycling emissions: Steel.
		Natural gas	314	m3	2.24	0	0	2.24	-0.7	medium	medium	high	
E5	Recycling ferrous metal	Ferrous metal	1964	tonnes	1.18	0	0	1.18	2317	medium	high	high	Source: ICF Consulting Final report 2005, P. 88, Net recycling emissions: Steel.
E6	Recycling nonferrous metal	Non-ferrous metal	40	tonnes	5.295	0	0	5.295	212	medium	high	high	Source: ICF Consulting Final report 2005, P. 88. Net recycling emissions: Aluminium, Copper; Assumed 50% Al and 50% Copper.
E7	Transport	Road, diesel	13046	liter	2.73	0.003	0.02	2.76	-36	low	low	medium	Source: Greenhouse Gas Division, Environment Canada, August 2004: Canada's Greenhouse Gas Inventory 1990–2002, P.173
		Rail, diesel	2782	liter	2.73	0.003	0.34	3.074	-9	low	low	medium	
		Marine, diesel	383	liter	2.83	0.01	0.02	2.86	-1	low	low	medium	

Emissions factors as “GHG savings” ICF (2005) report for NRCan

Project 4: Electronics waste recycling

- Quebec CFER Network
- Demonstrating a comprehensive treatment and recycling of E-waste:
  - Cathode Ray Tube (CRT)
  - Glass
  - Plastic
  - ferrous
  - nonferrous metals other materials

Photo : CFER

Electronics recycling: emissions factors

- Used ICF report factors
- Complexities
- E.g.: computer reuse "GHG savings"
  - Recycling factor 1.61 t CO_2e/t of computer (ICF)
  - Reuse factor of 59 t CO_2e/t of computer (from USA source)
    - A significant contributor
    - 4249 of the 4578 t CO_2e in Low scenario (93%)
- What values to use? What confidence is needed?

Results

	Project 1: Construction wastes	**Project 2: Residential scrap metal**	**Project 3: Northern recovery**	**Project 4: Electronics recycling**
Waste collected	222,837 t across 15 sites	19 t for 3,927 households in eight months (6.06 kg/house/ year)	2,004 t at five remote sites in northern Canada	294 t obsolete computers and electronics (25,470 pieces)
Baseline activity	Landfill of construction waste	Landfill via residential stream	Dumping in open sites	Landfill and hazardous disposal
Project activity	Reuse: 213,372 t Recycle: 9,457 t	Recycling: 15 t ferrous, 4 t non-ferrous metals	Recycle: 1,964 t ferrous, 40 t non-ferrous. Transport 500-1000 km	Reuse: 72 t Recycling: ferrous 84 t, non-ferrous metals 57 t, plastics/glass 60 t
GHG reduction (t CO2e)	0.21-0.36 t per tonne recovered. **Total: 222,000 t**	2.0 t per tonne urban scrap metal collection. **Total: 38 t**	1.2 t per tonne metal collected. **Total: 2,000 t**	15 t per tonne reused or recycled. **Total: 4,600 t**

Discussion

- *Why have carbon credits have not been realised from recycling projects?*

Conclusions

- GHG benefits to recycling
- Carbon offsets may be wrong mechanism

- Additionality
  - Economic additionality was likely in projects 1, 3 and 4
- Magnitude
  - Full-scale is indeed small
  - Construction waste >100,000 t
    - Over 15 sites
    - vs. CDM typically 25,000-200,000 t
  - Scale up, aggregation challenging
- Ownership
  - Location remote to baseline
  - Projects – (urban) reuse & recycling activity
  - Baselines – distant, primary material production, large (capped) facilities
    - Regulatory additionality (?)

Full reference: Young, S. B. (2011). "Greenhouse Gas Mitigation from Waste Materials Recycling." Greenhouse Gas Strategies in a Changing Climate Conference. AWMA. November 16-17, 2011. San Francisco, CA.

Acknowledgements

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AWMA 2011: GHG Strategies Conference

Abstract #31: Lessons Learned from GHG Measurement and Reporting of Technologies with ISO 14064: Part 2

Abstract #32: Greenhouse Gas Mitigation from Waste Materials Recycling

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Scholarly and professional communities

Images: sourced as cited