

Interpreting LCIA results: development of Canadian normalization factors, from individual consumption and national statistics

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INTERNATIONAL CHAIR
IN LIFE CYCLE ASSESSMENT

A research unit of the



CIRAIG™

Presentation outline

Introduction

- What is normalization?
- Why calculate specific normalization factors for Canada?
- Bottom up and top down approaches

1 – Bottom up approach (consumption based)

- Methodology
- Results

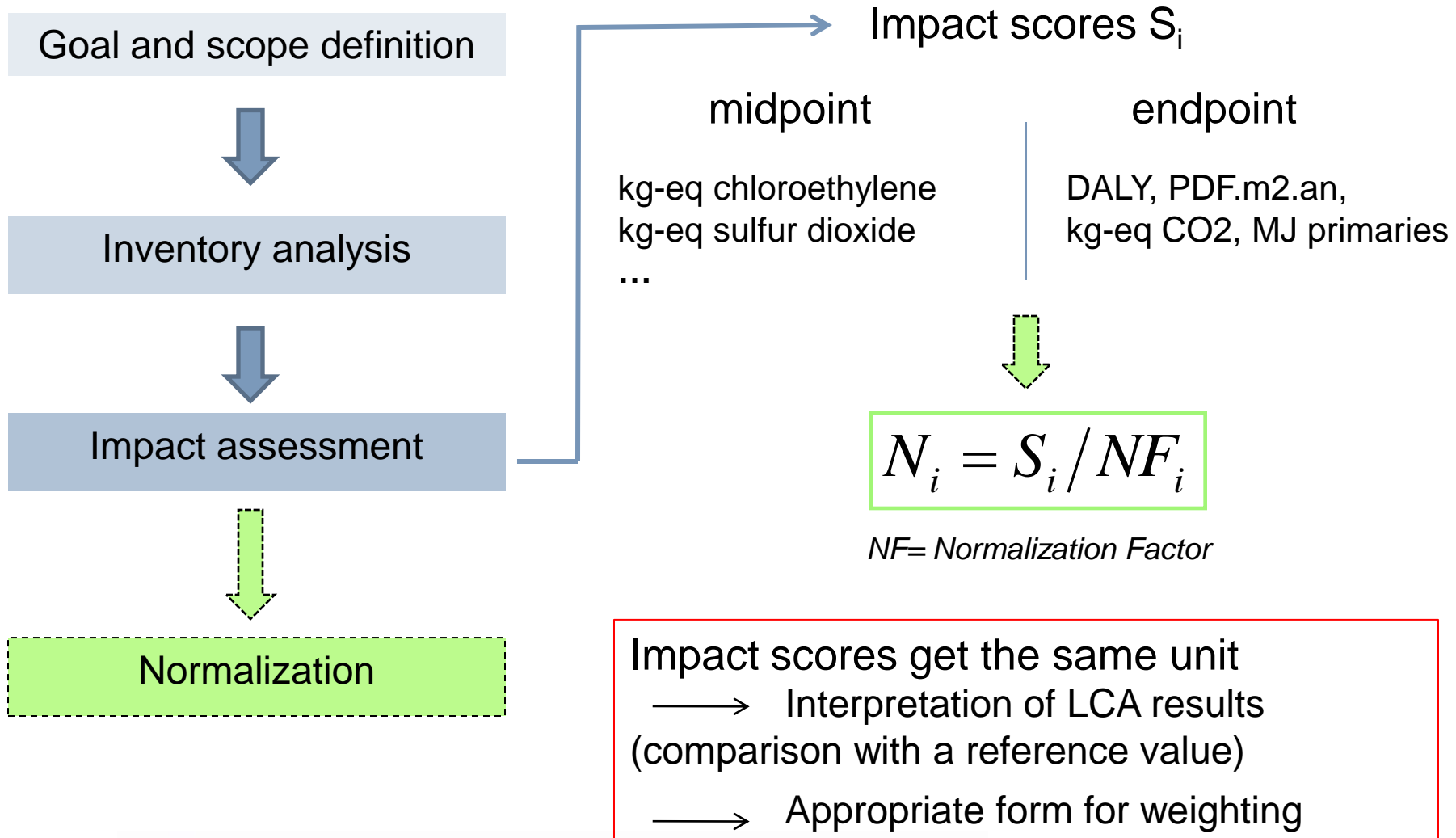
2 – Top down approach (production based)

- Methodology
- Results

3 – Comparison of bottom up and top down approaches

4 – Current work

What is normalization?



Existing and missing NF



Canada....

No Canadian NF



Europe

NF from Impact 2002+,
Ecoindicator 99, CML
2000...



United States

NF from TRACI

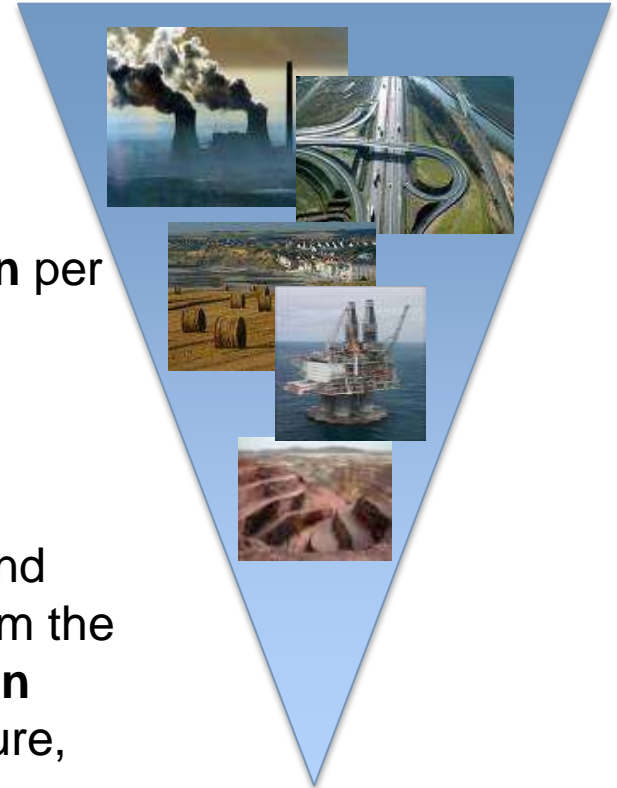
$$NF_i = \frac{\sum CF_s \times E_s}{P}$$

Bottom up and Top down approaches

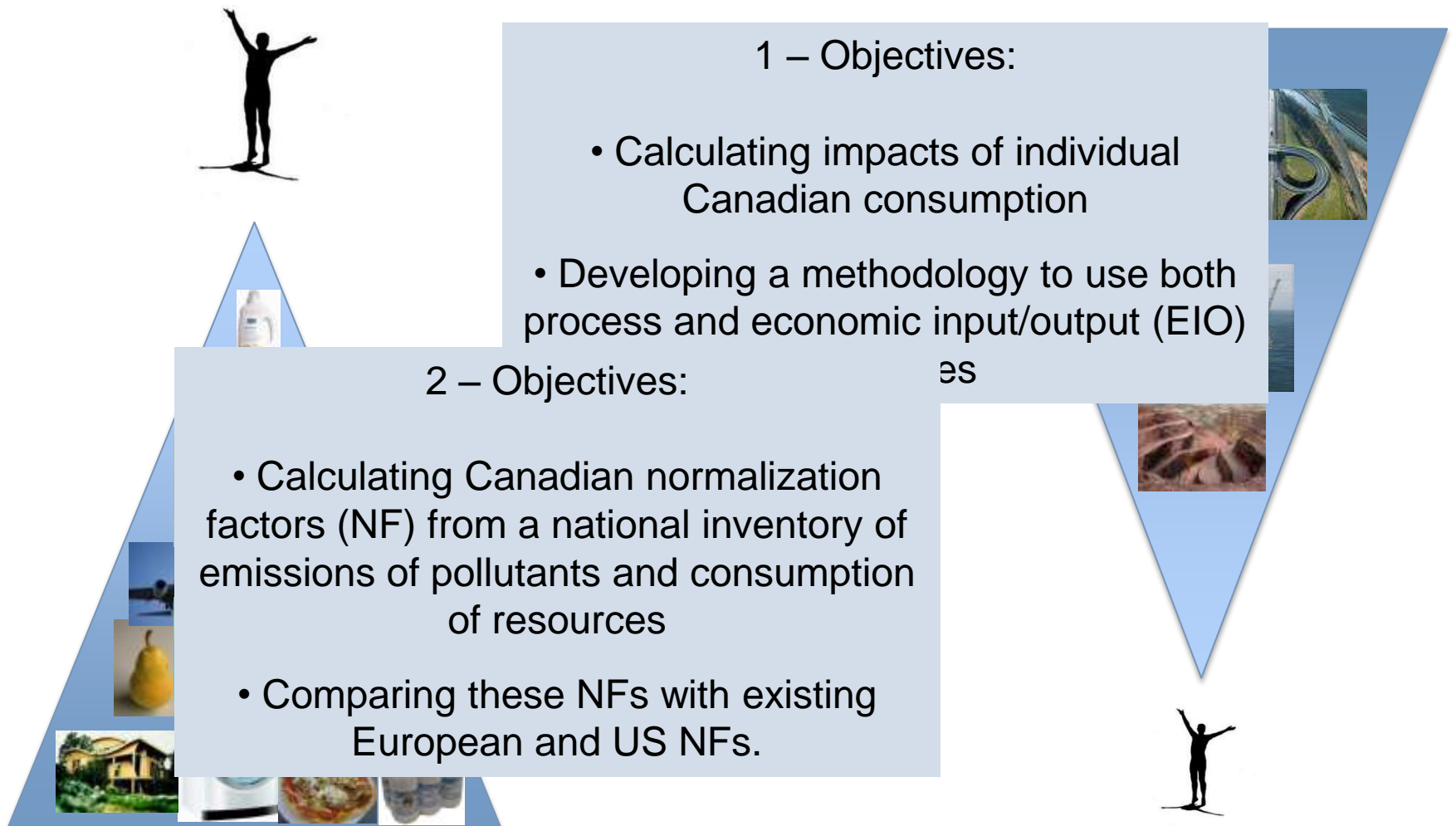


1- Bottom-up:
Reference = total **consumption** per
canadian citizen

2 – Top-Down:
Reference = Emissions and
consumption of resources from the
whole national **production**
activities (Industry, agriculture,
etc..)



Bottom up and Top down approaches



Bottom up and Top down approaches



1- individual Canadian consumption

Physical data (kg, km...)

Monetary data (\$CAN)

Food

Transport

Housing

Consumption goods

Public services

Data sources: official
canadian websites:

*Statistics canada,
environment canada...*

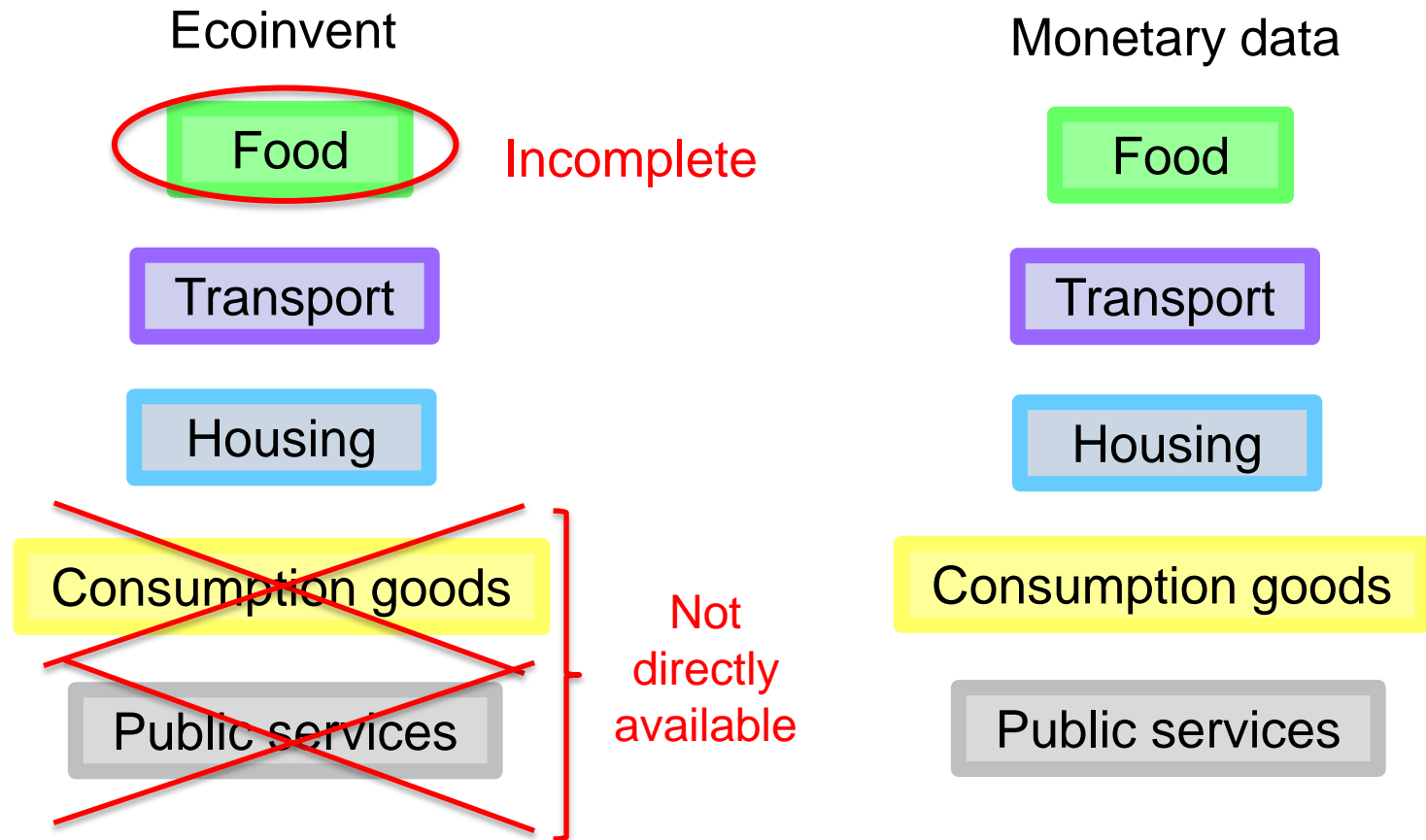
Process LCA

Economic Input/output
(EIO) LCA

Ecoinvent database

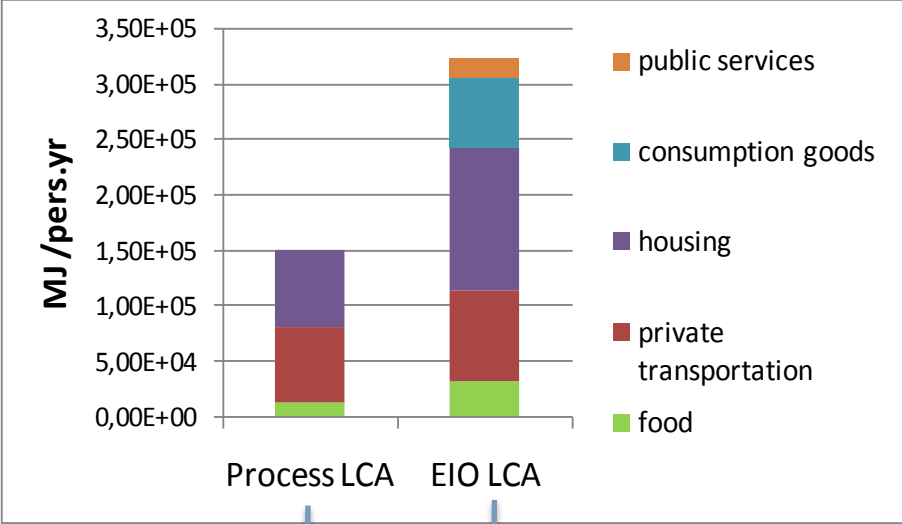
US Input/output 98 database₈

1- 1st iteration



1 - Results

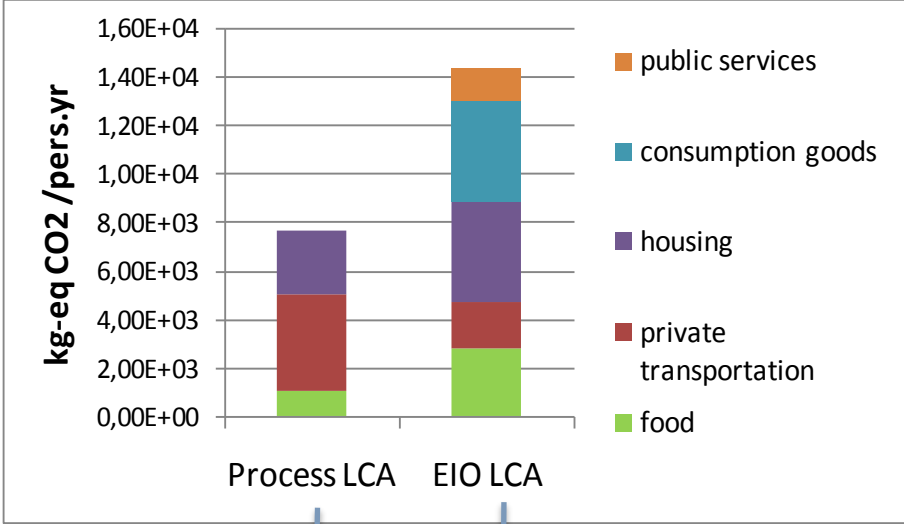
Non renewable energy



150 GJ/pers.yr

323 GJ/pers.yr

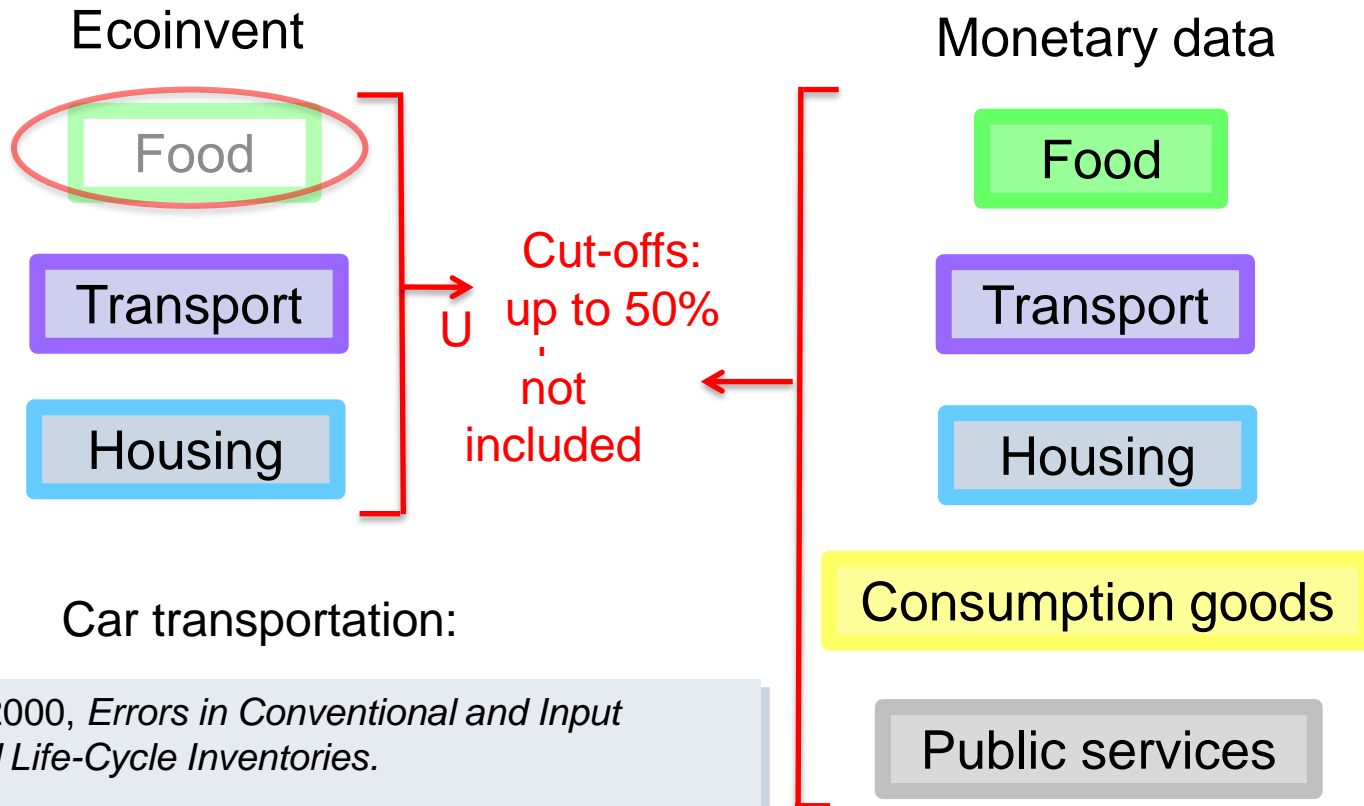
Global warming



7,7 t CO2 /pers.yr

14,3 t CO2/pers.yr

1- 2nd iteration



Car transportation:

- Lenzen, M. 2000, *Errors in Conventional and Input Output-based Life-Cycle Inventories*.

F - Junnila, S. 2006. *Empirical comparison of process and Economic Input/output LCA in services Industry*

EIO LCA	74	1,6
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1- 2nd iteration

Ecoinvent

Active = Impacts mainly attributed to use phase

Passive = Impacts mainly attributed to production phase

Housing

HYBRID

- Active
- Passive

- Active
- Passive

Monetary data

Food → EIO LCA

Transport

→ Process LCA

→ EIO LCA

Housing

→ Process LCA

→ EIO LCA

Consumption goods → EIO LCA

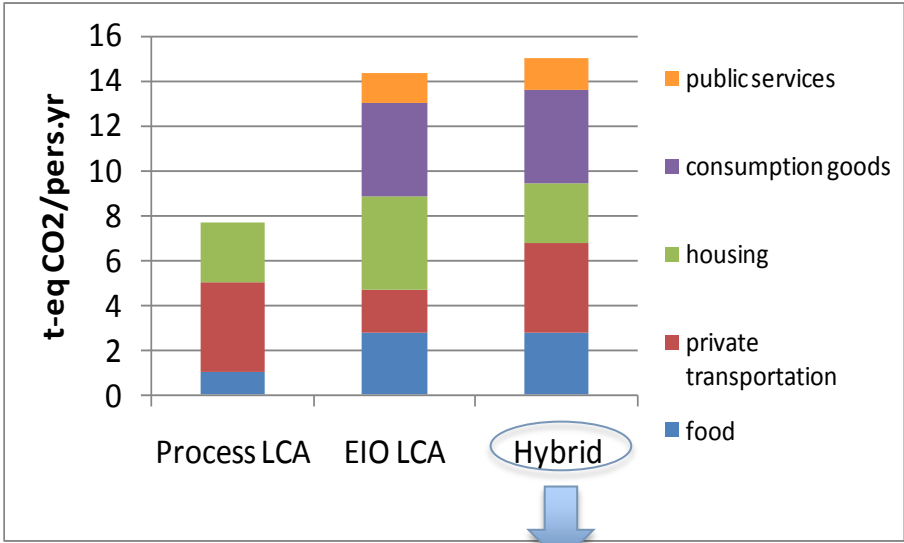
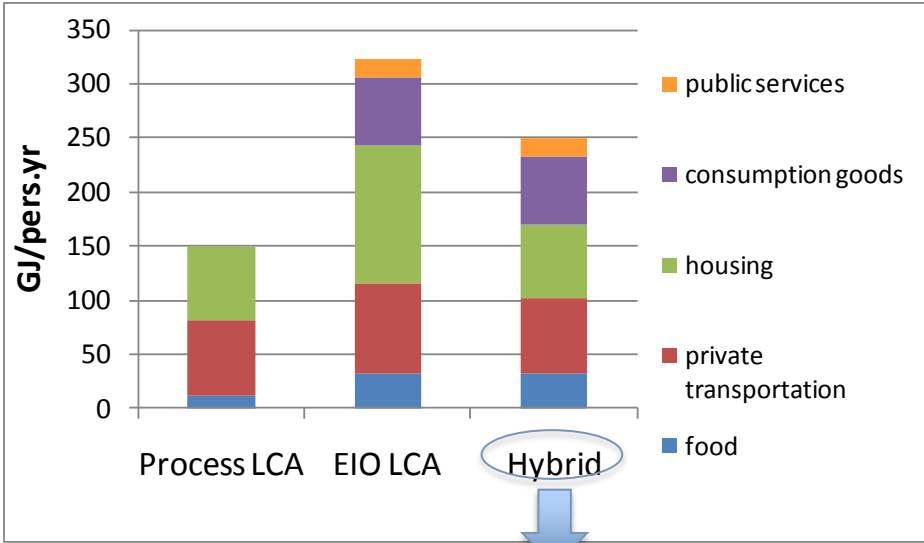
Public services → EIO LCA

1 - Results

Non renewable energy

HYBRID

Global warming



250 GJ/pers.yr

15 t-eq CO₂/pers.yr

Transport 28%

Housing 27%

Consumption goods 25%

Food 19%

Transport 27%

Consumption goods 28%

2 – Impact at national scale

1

Data collection of Canadian emissions of pollutants and consumption of resources

2

Calculation of Canadian NF

$$NF_i = \frac{\sum CF_s \times E_s}{P}$$

Life Cycle Impact Assessment (LCIA)
Methodologies
Impact 2002+, TRACI, LUCAS

Geographical zones:
Europe, Canada, US

3

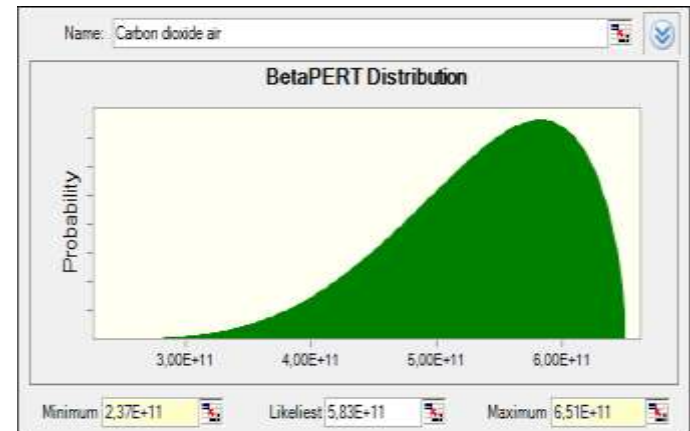
Validation of Canadian results

- *Identification and comparison of Canadian, European and US main contributors (substances)*
- *Extrapolation of some European emission values to complete Canadian Inventory (on Gross Domestic Product and population basis)*

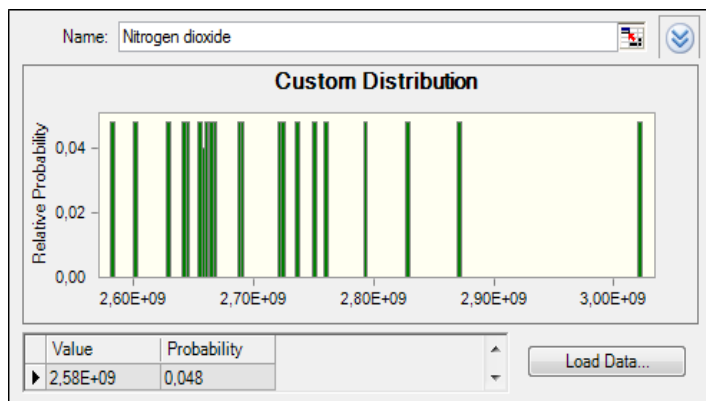
2- Uncertainty and temporal variability

1. Uncertainty on canadian normalization factors calculation

- *Data collection from different canadian inventories and extrapolated values from European and US inventories*
- Crystal Ball software
- **Input parameters: chosen value; min; max**

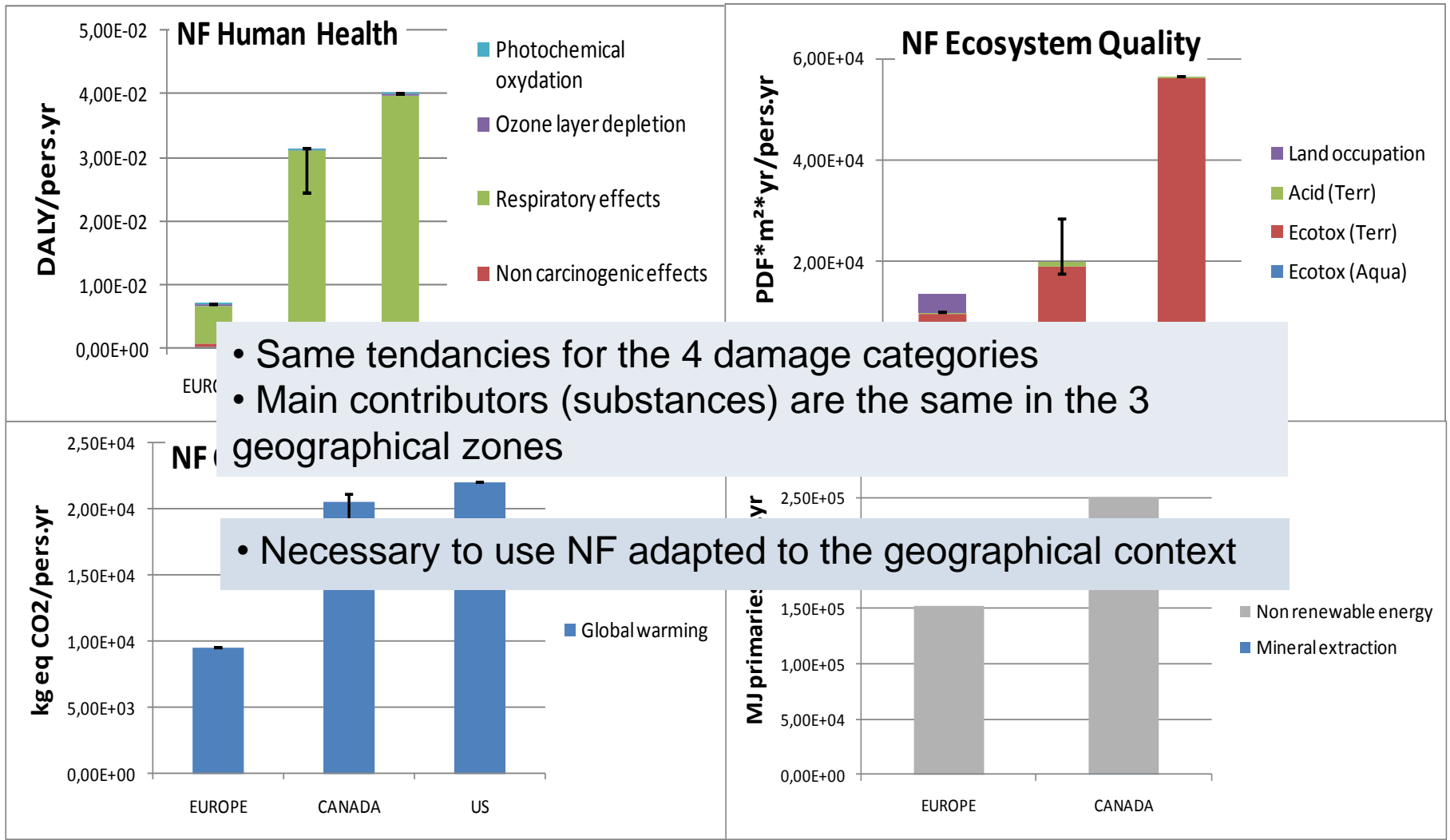


2. Temporal variability of canadian normalization factors

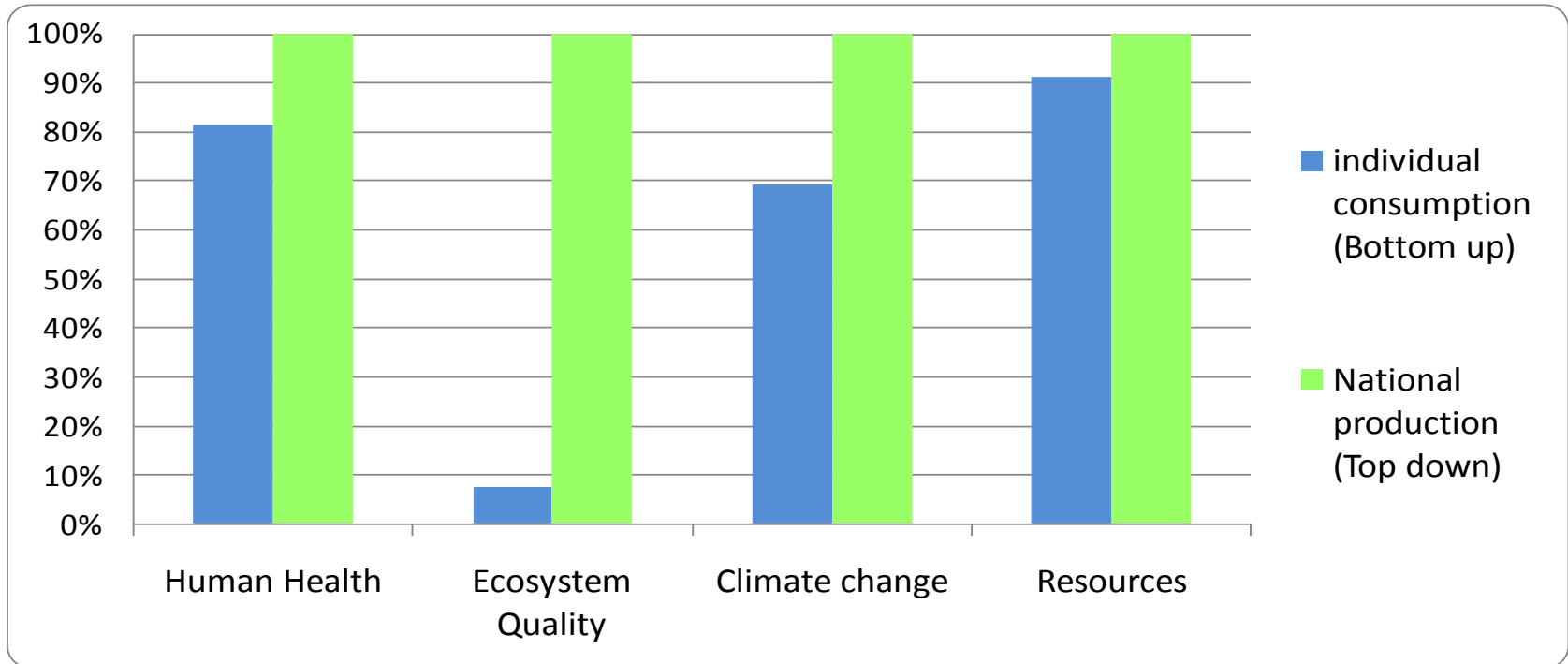


- *Data collection of canadian emissions and consumption of resources from 1976 to 2005*
- Crystal Ball software
- **Input parameters: same probability for each annual emission values**

2 – Comparison of canadian, european and US NF



3 – Comparison of bottom-up and top-down approaches



- **Differences Bottom-up/Top down:**

- Missing parts in bottom-up assessment
- Differences between production and consumption activities

- **Ecosystem quality:** difference = copper and zinc refineries

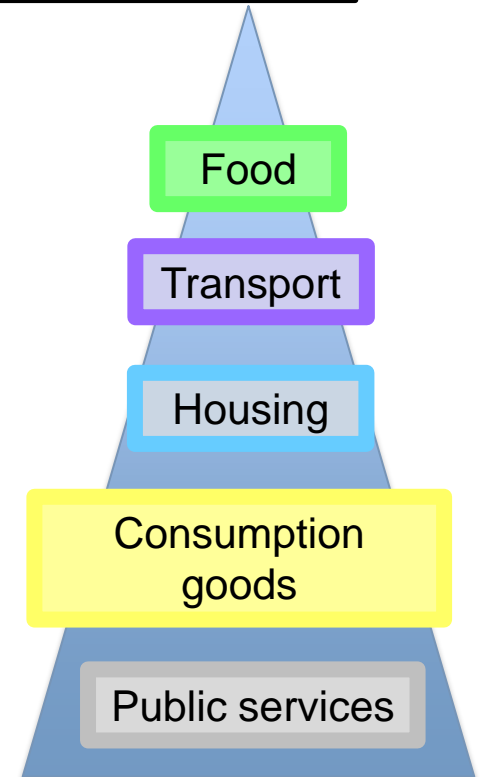
Canada = one of the first five world producers of copper and zinc

1 – Current work

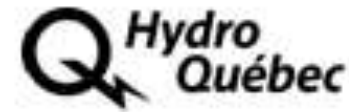
Tiered hybrid analysis utilizes **process-based** analysis for the **use** and **disposal phase** as well as for several important upstream processes, and then the **remaining input requirements** are imported from **an IO-based LCI**.

Suh & Huppes, 2003, *Methods for Life Cycle Inventory of a product*

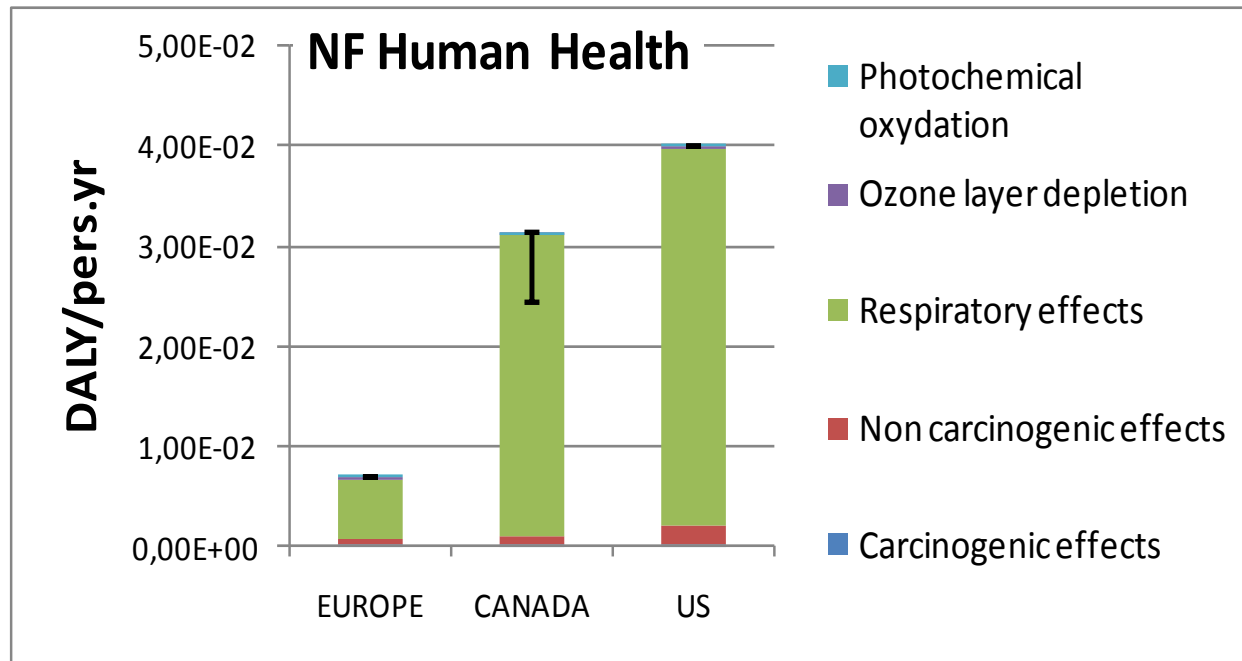
- ➔ Identifying and understanding the differences between process LCA and EIO LCA
- ➔ Realizing a complete Tiered hybrid analysis for Individual Canadian consumption



Acknowledgements

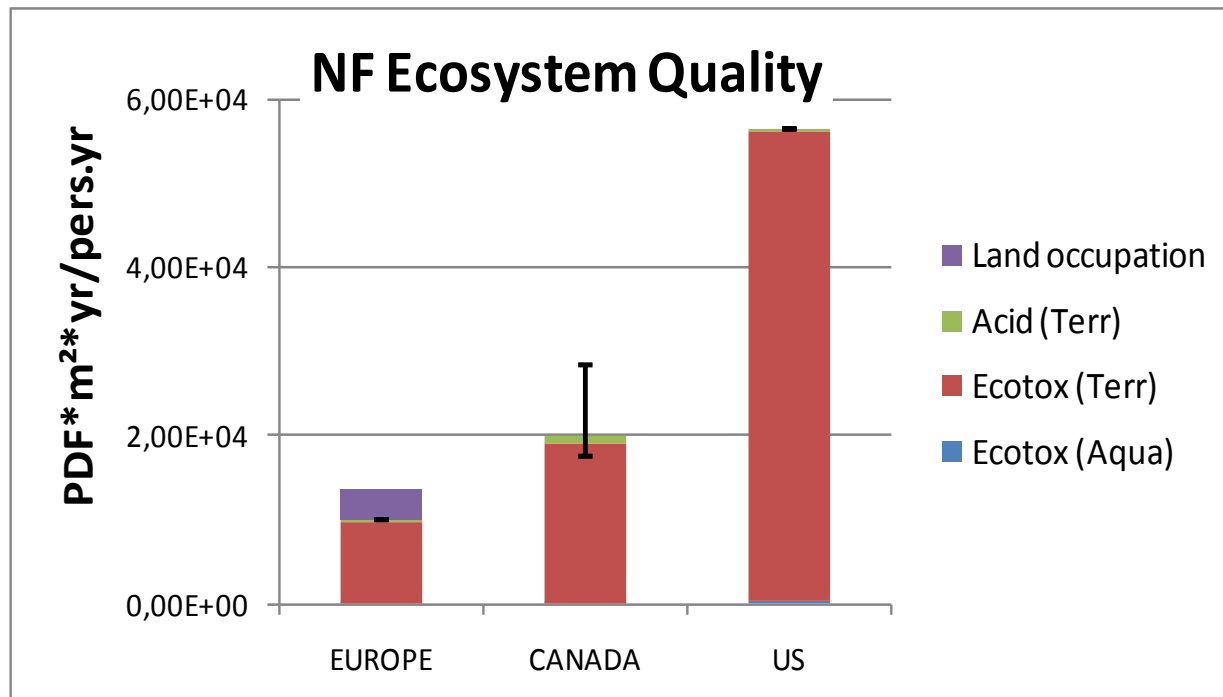


2 – NF: Human Health



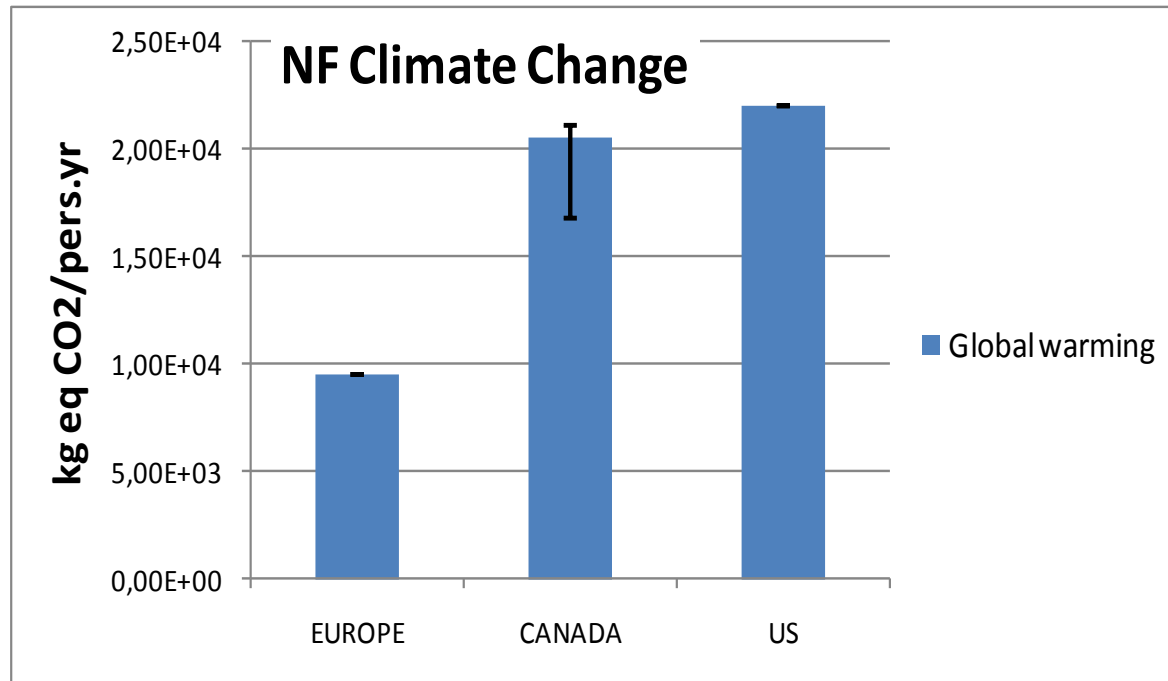
- Respiratory effects: more than 90% of the NFs (3 geographical zones)
- Main contributors in Europe, Canada and US: Nox, Sox and PM10
- Canadian NF = 0,8 US NF
Canadian NF = 4 European NF
- Uncertainty: the chosen emission values are the maximum of available data

2 – Ecosystem quality



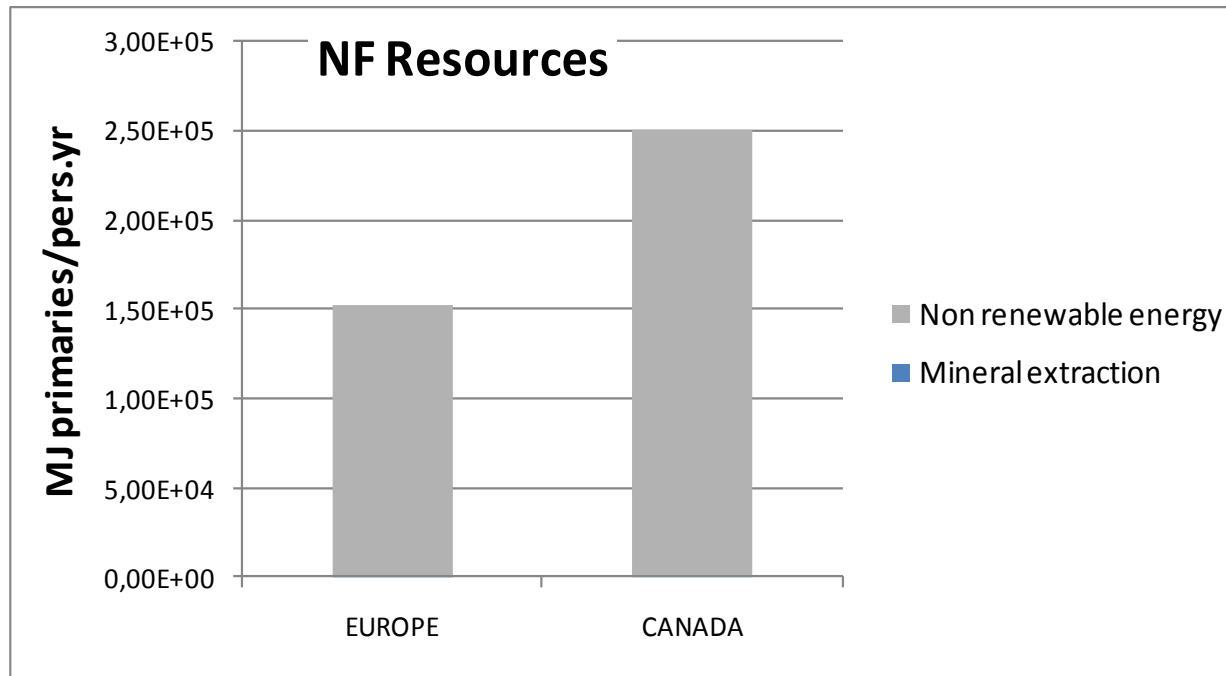
- Ecotoxicity in soil: 90% of Canadian and US NFs.
- Zinc in soil = 75% of Canadian NF, 67% of European NF, 57% of US NF.
- Canadian NF = 0,3 * US NF,
Canadian NF = 1,5 * European NF.
- An extrapolated European value was used for copper emissions in soil

2 – Climate change



- Carbon dioxide > 80% of the impact (3 geographical zones)
- Canadian NF \approx US NF
Canadian NF = 2* European NF
- Transport, energy production and industrial activities = more important in North America than in Europe (on yearly person basis).

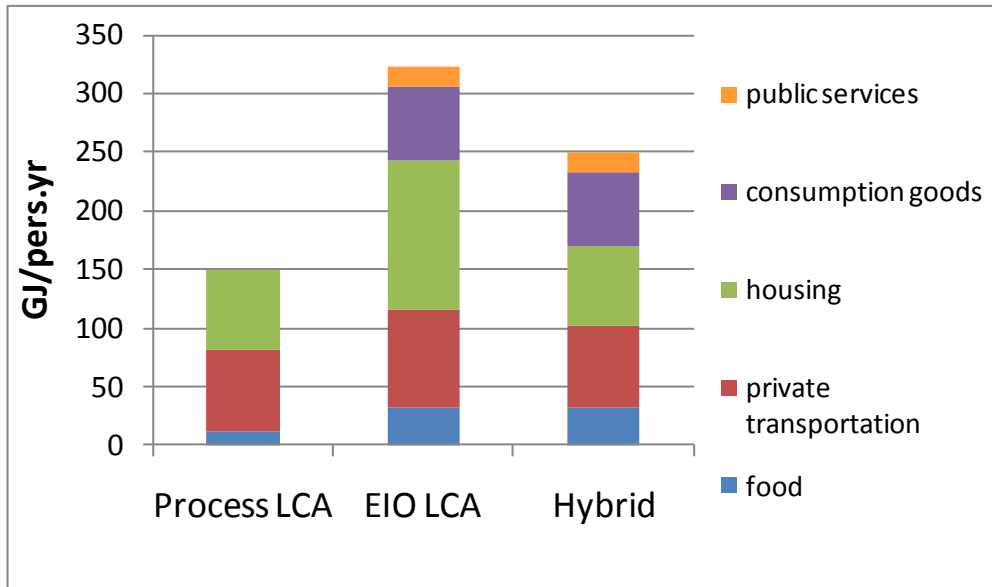
2 - Resources



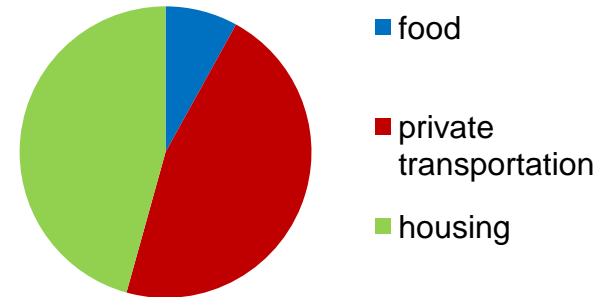
- Canadian NF = consumption of energy within Canadian borders.
 - Canadian NF = 1,6 * European NF
 - Canada = important producer of energy (natural gas, oil sands...) and minerals
- Canadian consumption = 60% of Canadian production

Individual consumption – Process, EIO and Hybrid LCA

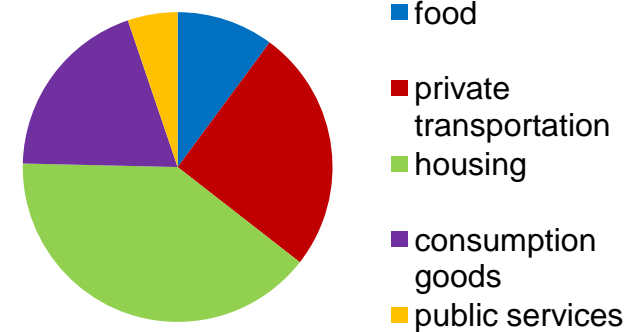
Non renewable energy



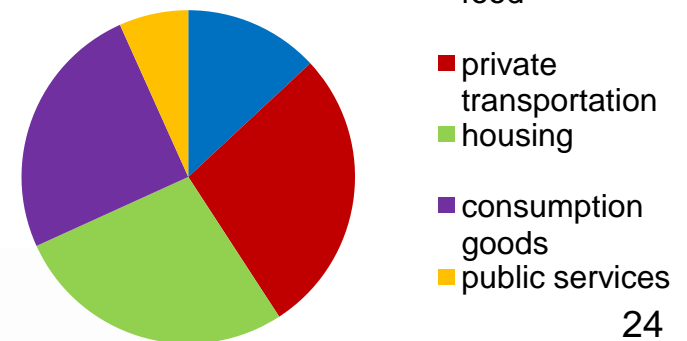
Process LCA



EIO LCA

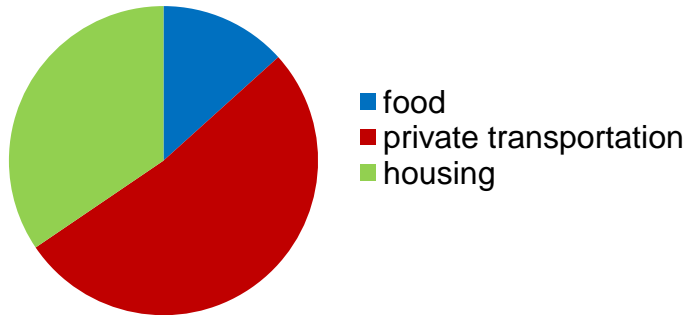


Hybrid

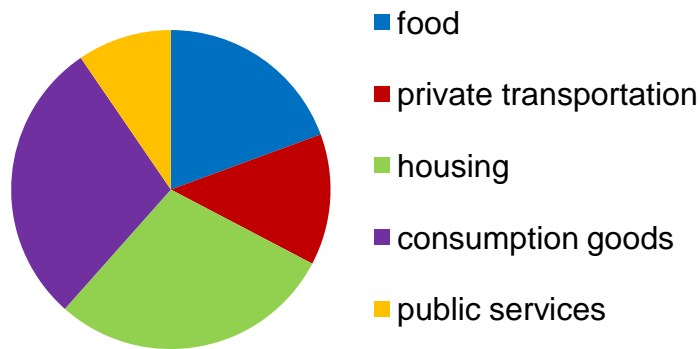


Individual consumption – Process, EIO and Hybrid LCA

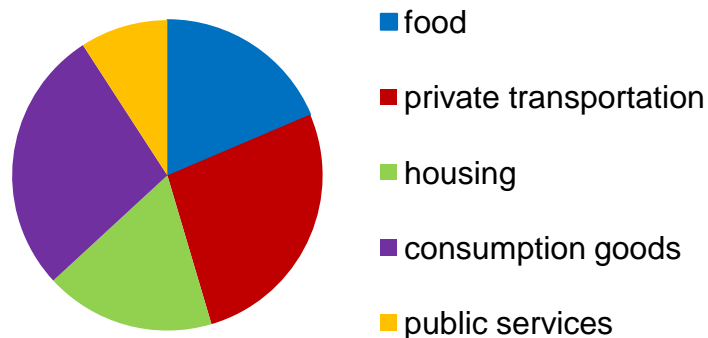
Process LCA



EIO LCA



Hybrid



Global warming

