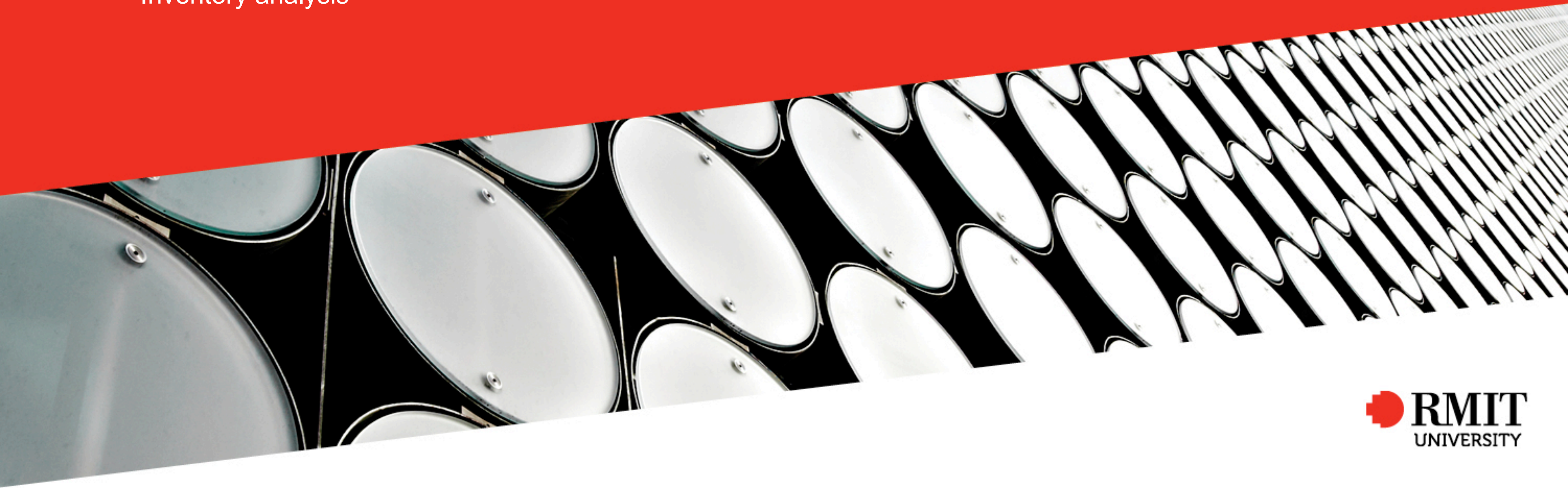
OENG1118 Sustainable engineering practice and design

Week 6: Life cycle assessment

Inventory analysis



RMIT UNIVERSITY

LCA: inventory analysis

Skills – LCA: inventory analysis

Design and compile **inventory data tables** of materials, energy, emissions, and other releases

Set **cut-off criteria** for materials, energy, emissions, and other releases

Design and compile **data quality assessment tables** for materials, energy, emissions, and other releases

Inventory analysis: take-home message

We collect enough good-quality data to meet the goal.

Inventory data

Inventory data

Quantify the flows

- Measure
- Calculate
- Estimate
- Database

explain procedure

Consider cut-off criteria for:

- mass
- energy
- environmental relevance/impact

Maki, SJ 2006, *Jeans infographic*, Coroflot. viewed 14 April 2004, <www.coroflot.com/sjmaki/Jeans-Infographic>.

Inventory data

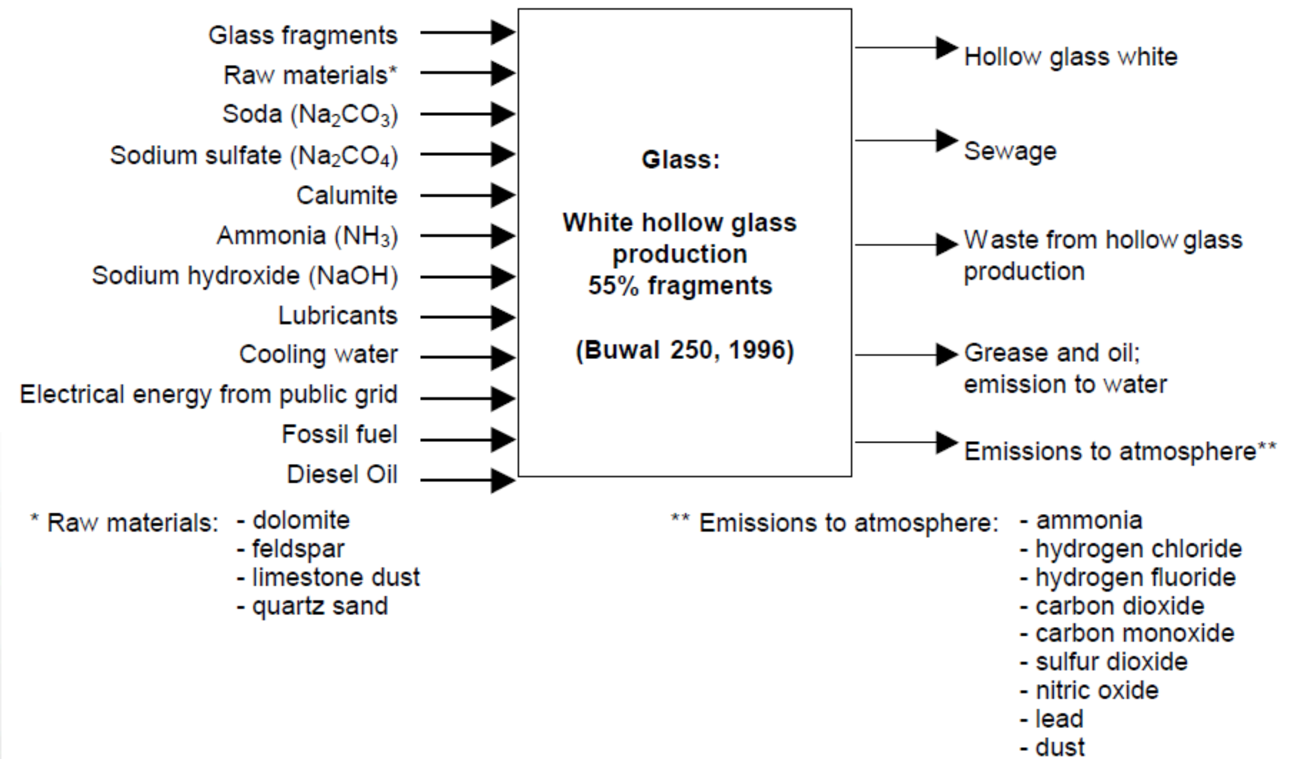
Foreground data is data on the product-system of study

- Mass of packaging
- Energy inputs for a process
- Solid waste flows
- Transport distances
- Etc.

Background data is ‘substitute’ data on other product-systems

- Electricity generation
- Transport impacts
- Recycling rates
- Landfill models
- Etc.

Inventory data



BSI 2000, *PD ISO/TR 14049:2000: Environmental management – Life cycle assessment – Examples of application of ISO 14041 to goal and scope definition and inventory analysis*, BSI.

Inventory data tables

Quantify the flows

Module: Glass: white hollow glass production, 55 % fragments (Buwal 250, 1996)
Section: packaging production

Input	Material categories	Unit	Quantity
Glass fragments; secondary raw material	Product from other systems	kg	601,30
Dolomite; raw material	Elementary flow	kg	72,50
Feldspar; raw material	Elementary flow	kg	31,10
Limestone dust; raw material	Elementary flow	kg	27,00
Quartz sand; raw material	Elementary flow	kg	253,10
Soda (Na_2CO_3)	Intermediate product	kg	62,80
Sodium sulfate (Na_2SO_4)	Intermediate product	kg	3,20
Calumite	Intermediate product	kg	6,50
Ammonia (NH_3)	Intermediate product	kg	0,30
Sodium hydroxide (NaOH 50%)	Intermediate product	kg	21,40
Lubricants	Intermediate product	kg	0,662
Cooling water	Elementary flow	m^3	1,70
Electrical energy from public grid (Swiss)	Intermediate product	kW·h	291,00
Diesel oil (production)	Intermediate product	kg	0,14
Fuel (integrated incineration)	Intermediate product	kg	152,4
Output			
Hollow glass white	Intermediate product	kg	1 000,00
Sewage	Intermediate product	m^3	1,68
Waste from hollow glass production	Intermediate product	kg	4,44
Special waste from hollow glass production	Intermediate product	kg	0,65
Ammonia; emission to atmosphere	Elementary flow	g	0,72
Hydrogen chloride; emission to atmosphere	Elementary flow	g	53,3
Hydrogen fluoride; emission to atmosphere	Elementary flow	g	14,80
Carbon dioxide; emission to atmosphere	Elementary flow	kg	521
Carbon monoxide; emission to atmosphere	Elementary flow	g	27,80
Sulfur dioxide; emission to atmosphere	Elementary flow	g	1 292,00
Nitric oxide; emission to atmosphere	Elementary flow	g	1 158,80
Lead; emission to atmosphere	Elementary flow	g	44,60
Dust; emission to atmosphere	Elementary flow	g	589,60
Grease and oil; emission to water	Elementary flow	g	42,00

BSI 2000, *PD ISO/TR 14049:2000: Environmental management – Life cycle assessment – Examples of application of ISO 14041 to goal and scope definition and inventory analysis*, BSI.

Inventory data tables

Inputs & product outputs

Description of unit process: (attach additional sheet if required)			
Material inputs	**Units**	**Quantity**	**Description of sampling procedures**
Water consumption[a]	**Units**	**Quantity**	
Energy inputs[b]	**Units**	**Quantity**	**Description of sampling procedures**
Material outputs (including products)	**Units**	**Quantity**	**Description of sampling procedures**

Emission outputs

Unit process identification:			**Reporting location:**
Emissions to air[a]	**Units**	**Quantity**	**Description of sampling procedures** (attach sheets if necessary)
Emissions to water[b]	**Units**	**Quantity**	**Description of sampling procedures** (attach sheets if necessary)
Emissions to land[c]	**Units**	**Quantity**	**Description of sampling procedures** (attach sheets if necessary)
Other releases[d]	**Units**	**Quantity**	**Description of sampling procedures** (attach sheets if necessary)
Describe any unique calculations, data collection, sampling, or variation from description of unit process functions (attach additional sheets if necessary)			

measurement, calculation, estimation, database

AS/NZS 1999, *AS/NZS ISO 14041:1999: Environmental management – Life cycle assessment – Goal and scope definition and inventory analysis*, AS/NZS, pp. 17-18.

Inventory data tables

External transport

Name of intermediate product	Road transport			
	Distance km	Truck capacity tonnes	Actual load tonnes	Empty return (Yes/No)

Internal transport

	Total amount of input transported	Total consumption of fuel
Diesel oil		
Gasoline		
LPG[a]		

[a] Liquified Petroleum Gas.

AS/NZS 1999, *AS/NZS ISO 14041:1999: Environmental management – Life cycle assessment – Goal and scope definition and inventory analysis*, AS/NZS, pp. 16-17.

Inventory data tables

In compiling inventory tables, we:

1. favour *foreground* data (from the manufacturer, surveys, etc.), especially for parameters:
   - with high contributions to environmental impacts
   - that define a special feature of the LCA study
2. fill data gaps with *background* data (from the LCA inventory databases and other sources)

If we still have data gaps, then we do *all* of the following:

- Exclude that data
- Change the goal and scope
- Address the gap in the *interpretation* phase

Cut-off criteria

Cut-off criteria

When we have expected but unknown flows, or too many flows:

1%

- Mass: Exclude flows that are < X% of the cumulative mass of all the inputs and outputs

1%

- Energy: Exclude flows that are < Y% of the cumulative energy of all the inputs and outputs
- Environmental relevance: Include flows that potentially have a significant environmental impact, even if they meet the above criteria

1%

- The sum of the excluded flows shall not exceed Z% of mass, energy, or environmental relevance

Data quality assessment

Data quality assessment

We consider the following criteria to choose the most appropriate data:

- Representativeness: time coverage, geography coverage, technology coverage
- Precision, completeness, consistency, reproducibility

We may use rating scales such as:

- high/medium/low
- good/average/poor
- percentage
- uncertainty

Data quality assessment tables

Table 4-41: Data quality assessment (very good, good, average, poor, very poor)

Inventory Item	Time related coverage	Data type (Background, foreground, mixed)	Geographical coverage	Technology coverage	Foreground precision (Good to poor, based on worst quantified data quality, refer Section 4.36)	Completeness	Representativeness (minimum of time period, geographical coverage)	Consistency	Reproducibility	Main data source(s)
Crude oil production	Very poor – data relates to past or present, not reference year (2034-35)	Background	Very good	Very good	-	Very good	Very poor	Very good	Very good	Ecoinvent
Sea freight of crude oil		Mixed	Very good	Very good	Average	Very poor	Very poor	Very good	Very good	Ecoinvent, searates.com
Refining of Jet A-1		Mixed	Very good	Very good	Average	Very poor	Very poor	Good	Good	(BP 2009; Grant et al. 2008b), AUPLCI
Jet-fuel transport to Perth airport		Mixed	Very good	Very good	Triangle distribution	Very good	Very poor	Very good	Good	(BP 2009), estimate, AUPLCI
Fertiliser production		Background	Very good	Very good	-	Very good	Very poor	Very good	Good	Ecoinvent, AUPLCI
Pesticide and herbicide production		Background	Very good	Very good	-	Very good	Very poor	Very good	Good	Ecoinvent
N_2O emissions from fertilisers		Foreground	Good	Very good	Good	Average	Very poor	Very good	Very good	NGGI, IPCC, Barton *et al.* (2008),
CO_2 emissions from urea		Foreground	Good	Very good	Good	Average	Very poor	Very good	Very good	(IPCC 2006c).
Farming enterprise mix		Foreground	Very good	Very good	Good	Good	Very poor	Very good	Very good	FFICRC
Wheat farming		Foreground	Very good	Very good	Average	Good	Very poor	Very good	Good	Department of Ag.

Quiz

Inventory data: getting appropriate numbers

Consider the *process* of making plain pancakes.

Product flow

Input		Output	
Flour	____g	Pancakes	____g
Eggs	____g	Char	____g
Milk	____g		
Butter	____g		
Natural gas	____g	Carbon dioxide	____g
Oxygen	____g	Water vapour	____g
Nitrogen	____g	Nitrogen	____g
		Heat	____W

Product flow

Emissions to ____

- How do we determine the values?
- What about the pan and stove?

Inventory data: getting appropriate numbers

Consider the use stage of a shower.

Give an example of data you might acquire through:

- measurement
- calculation
- estimation

Inventory data: types of data

Where might we find foreground data?

Inventory data: types of data

Where might we find background data?

Inventory data: gaps

If our data collection results in insufficient data to map the whole life cycle, then we:

A. invent data to fill the gaps

B. adjust the goal and scope of the study to match available data

C. ignore the gaps and hope that nobody notices

D. communicate the gaps and uncertainty in the interpretation phase

Data quality assessment: types of data

Which type of data is generally of higher quality?

A. Foreground data

B. Background data

C. Neither type

Data quality assessment tables

In designing a data quality assessment table, which of the following might we include as assessment criteria?

reproducibility

functional unit

technology coverage

intended audience

geographical coverage

precision

component price

completeness

consistency

representativeness

reference flow

time coverage

Data quality assessment tables

In designing a data quality assessment table, which of the following might we include as assessment criteria?

reproducibility

functional unit

technology coverage

intended audience

geographical coverage

precision

component price

completeness

consistency

representativeness

reference flow

time coverage

RMIT UNIVERSITY

Data quality assessment: purpose

Data quality assessment helps us to check whether:

A. the LCA is complete enough to meet the aims (goal & scope)

B. the data quality is sufficient to meet the aims (goal & scope)

C. the data quality is sufficient to draw conclusions

D. all of the above

Skills – LCA: inventory analysis

Design and compile **inventory data tables** for materials, energy, emissions, and other releases

- descriptions of unit processes; foreground and background data; measurement, calculation, and estimation of data; LCA databases & software

Set **cut-off criteria** for materials, energy, emissions, and other releases

- decision rules for mass, energy, environmental relevance, and economic value

Design and compile **data quality assessment tables** for materials, energy, emissions, and other releases

- time, geography, and technology coverage; type of data source; precision, completeness, (representativeness), consistency, reproducibility

Inventory analysis: take-home message

We collect enough good-quality data to meet the goal.

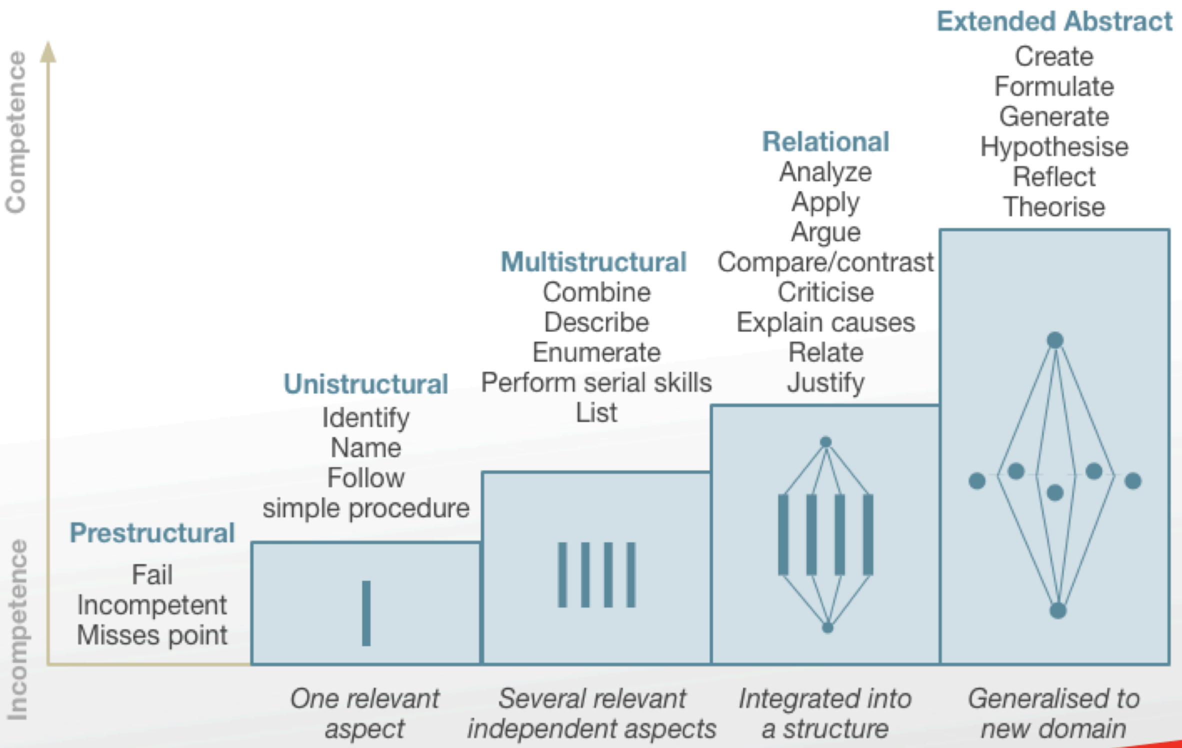
Thanks!

Assessment standards

SOLO taxonomy

[Video](#) (4 min)

[Text](#) (100 words)



Source: The Australian National University 2014, *Unravelling Complexity*, The Australian National University, Canberra. http://vc-courses.anu.edu.au/uc/home, viewed 4 March 2014.