

Infrastructure Sustainability
Version 1.2



START2SEE
LIFE CYCLE ASSESSMENTS



ISCA MATERIALS CALCULATOR UPDATE V1.2

NZ VERSION SUMMARY REPORT

ISCA
31 MARCH 2017
S1611

Infrastructure Sustainability Materials Calculator
Version 1.2



ISCA

Infrastructure
Sustainability
Council of Australia



Infrastructure Sustainability Materials Calculator
Version 1.2



ISCA

Infrastructure
Sustainability
Council of Australia



Infrastructure Sustainability Materials Calculator
Version 1.2



ISCA

Infrastructure
Sustainability
Council of Australia



Infrastructure Sustainability Materials Calculator
Version 1.2

Project Details

Project Title

ISCA – Update of Materials Calculator to v1.2 NZ version

Client Details

Infrastructure Sustainability Council of Australia (ISCA)

Client Contacts

start2see Project Manager

Jessica Cairns, Hayley Jarick

Rob Rouwette

Report version

Author(s)

Date

Final report V1.0

Rob Rouwette

31 March 2017

If you would like to discuss any of the topics or have any questions please feel free to contact start2see (Rob Rouwette) on mobile +61 403 834 470.

© start2see Pty Ltd
Melbourne, Australia
ACN: 143 127 315

Table of Contents

1	Project Brief	4
1.1	Deliverables.....	4
2	Developing a NZ specific calculator	5
2.1	Update LCI factors.....	6
2.2	Update weighting factors.....	6
2.3	Review of updated calculator by start2see	7
	References	8
	Appendix A. Changes to processes.....	9
	Appendix B. New Zealand electricity mix	12

1 Project Brief

The Infrastructure Sustainability Council of Australia (ISCA) has asked start2see to adjust the 'IS Materials Calculator version 1.2' for use on New Zealand (NZ) projects. The Scope of Works includes:

1. Analyse the existing 2014 review of emission factors (by URS) for applicability to the LCI factors in the existing version 1.2. Document recommendations for change.
2. Adjust LCI data in line with the recommendations. Where relevant:
 - a. Update electricity generation to the latest available NZ data
 - b. Adjust diesel used in transport to NZ fuel specification
 - c. Adjust natural gas data to NZ specifications
3. Adjust weighting data (for calculating IS EnviroPoints) based on the NZ weighting set.
4. Update the generic descriptions on the "Instructions" worksheet.
5. Add the changes to the "Changelog" worksheet.

1.1 Deliverables

start2see is to deliver:

- A revised IS Materials Calculator including New Zealand appropriate factors, checked and debugged and ready for ISCA review.
- A brief summary report of the changes implemented into the calculator.

2 Developing a NZ specific calculator

The steps taken by start2see in adjusting the existing IS Materials Calculator v1.2 into a New Zealand specific calculator are outlined in this section.

2.1 Analyse existing review of LCI factors

start2see has analysed the existing review of emission factors [URS 2014]. Based on this review and our own analysis of the LCI data used in version 1.2 of the IS Materials calculator, we have adjusted the key energy processes:

- Energy inputs to materials have been revised as per Appendix A.
 - Only first order electricity inputs have been adjusted. This means electricity used further into the supply chain is still based on AusLCI data. The only exception is aluminium, where primary aluminium production was also adjusted because of its large electricity input.

The influence of leaving higher order electricity inputs untouched is expected to be minimal (<5%).
 - For plastics, only the final production process has been adjusted with NZ electricity data. We have maintained the assumption (from [URS 2014]) that plastics raw materials are imported.
 - The steel data in the version 1.2 calculator are based on Worldsteel data. These are aggregated LCI data and therefore cannot be altered.
 - Where electricity inputs constitute less than 1% of the ISEnviroPoints, they have not been adjusted.
- Diesel inputs to transport processes have been revised as per Appendix A. IS Materials Calculator.
- Data for water treatment chemicals have not been adjusted. Investigating whether these chemicals are manufactured in New Zealand or not is outside the scope of this update.

2.2 Update LCI factors

- a. Update electricity generation to the latest available NZ data

start2see has used the latest five-year average (2012-2016) electricity mix data for New Zealand to determine the average grid mix for use in the IS Materials Calculator. The data were sourced from [MBIE 2017] and are included in Appendix B.
- b. Adjust diesel used in transport to NZ fuel specification

start2see has used the New Zealand diesel characteristics (energy content: 38.4 MJ/L; GHG emissions 82.06 g CO₂e/MJ)
- c. Adjust natural gas data to NZ specifications¹

Natural gas data have not been adjusted. AusLCI does not contain country-specific natural gas data. Any changes to natural gas impacts would mainly be due to differences in scope 3 emissions (exploration, production, transmission, distribution). In the Australian National Greenhouse Accounts [NGA 2016], scope 3 emissions contribute 7 - 21% to the life cycle GHG emissions of natural gas. It is not clear how a 33% reduction could be achieved. Not updating natural gas data could influence the performance of materials that are relatively gas-intensive, such as asphalt. start2see recommends ISCA communicates that natural gas data have not been adjusted.

2.3 Update weighting factors

start2see has updated the weighting factors in line with the NZ average weighting factors [URS 2014]. The IS EnviroPoints factors have been updated accordingly (see Table 1).

¹ The 2014 adjustment of the calculator included a revision of natural gas data. The URS report states “The NZ natural gas process in GaBi has a significantly lower impact than the Australian equivalent, e.g. 32.8% and 66% reduction in global warming potential and abiotic depletion potential respectively.”

Table 1. Weighting factors

Indicator	Relative Weight - IS EnviroPoints	Relative Weight - BPIC ecopoints	Relative Weight - IS EnviroPoints NZ	Relative Weight - BPIC NZ ecopoints
Global Warming	47.5%	19.0%	45.2%	19.0%
Abiotic depletion	20.0%	8.0%	14.3%	6.0%
Land use	0.0%	20.0%	0.0%	13.0%
Water Use	0.0%	6.0%	0.0%	5.0%
Eutrophication	7.5%	3.0%	14.3%	6.0%
Acidification	7.5%	3.0%	7.1%	3.0%
Fresh water aquatic ecotox.	0.0%	10.0%	0.0%	12.0%
Marine aquatic ecotoxicity	0.0%	10.0%	0.0%	11.0%
Terrestrial ecotoxicity	0.0%	6.0%	0.0%	7.0%
Photochemical Smog	7.5%	3.0%	7.1%	3.0%
Ozone depletion	10.0%	4.0%	11.9%	5.0%
Ionizing radiation	0.0%	2.0%	0.0%	2.0%
Human toxicity	0.0%	3.0%	0.0%	5.0%
Respiratory effects	0.0%	3.0%	0.0%	3.0%
TOTAL	100.0%	100.0%	100.0%	100.0%

2.4 Review of updated calculator by start2see

start2see has undertaken a brief review of the updated NZ calculator. This showed the NZ calculator's results are different from the Australian calculator's results in line with expectations.

References

- MBIE 2017 NZ Ministry of Business Innovation and Employment (MBIE), Data tables for electricity, <http://www.mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/statistics/electricity>; accessed 31-03-2017
- NGA 2016 Commonwealth of Australia - Department of the Environment, National Greenhouse Accounts factors, August 2016
- NZGA 2017 New Zealand Geothermal Association, Geothermal Emissions, <https://nzgeothermal.org.nz/emissions/>; accessed 31-03-2017
- URS 2014 Barry M., Materials Calculator Review for New Zealand, Letter from URS New Zealand to Rick Walters (ISCA), 12 August 2014

Appendix A. Changes to processes

The following table lists all the materials and processes that are included in the IS Materials Calculator version 1.2. Where electricity, natural gas and diesel inventory data have been adjusted to New Zealand factors, this is indicated by "yes" in the respective columns.

Product group	Name	Electr.#	Gas	Diesel
Aggregates	Crushed Blast Furnace Slag			
	Crushed Rock	Yes		
	General Fill			
	Gravel	Yes		
	Crushed Limestone	Yes		
	Recycled Crushed Concrete/Masonry	Yes		
	Recycled Crushed Glass	Yes		
	Sand	Yes		
Bitumen Products	Asphalt, <2.5% virgin bitumen	Yes		
	Asphalt, 2.5-3.4% virgin bitumen	Yes		
	Asphalt, 3.5-4.4% virgin bitumen	Yes		
	Asphalt, 4.5-5.4% virgin bitumen	Yes		
	Asphalt, standard mix, 5.5% virgin bitumen	Yes		
	Bitumen			
Concrete Components	Additives			
	Cement	Yes		
	Coarse Aggregates	Yes		
	Concrete production process	Yes		
	Fine Aggregates	Yes		
	Flyash			
	GGBF slag	Yes		
	Mains water	Yes		
	Manufactured sand	Yes		
	On-site recycled & captured water			
Recycled Aggregates	Yes			
Cement Products	Lime (hydraulic)	Yes		
	Portland Cement	Yes		
Coatings & Finishes	Immersion Zinc coating	Yes		
	Paint - solvent based	Yes		
	Paint - water based	Yes		

Product group	Name	Electr.#	Gas	Diesel
Composites	Cement Fibreboard	Yes		
	Glass fibre reinforced plastic (FRP)	Yes		
Glass	Glass	Yes		
Metals	Aluminium	Yes		
	Steel Galvanised Coil - Steel BMT (per mm) only*			
	Steel Galvanised Coil - Zinc coating (per g/m2 zinc) only	Yes		
	Steel Angle*			
	Steel fibres for concrete reinforcement*			
	Steel Galvanised Coil*			
	Steel Hot Rolled*			
	Steel Hot Rolled Metal Coated*			
	Steel Hot Rolled Powder Coated*			
	Steel Plate*			
	Steel Rail Lines*			
	Steel Reinforcing Bar*			
	Steel Round and Square Sections*			
	Steel Slab*			
	Steel Universal Beams & Columns*			
Steel Welded Reinforcement Mesh*				
Pipes	Ductile Iron Pipes	Yes		
	Fibreglass Pipe & Tube	Yes		
	Geopolymer pipes			
	PE Pipes	Yes [†]		
	PVC Pipes	Yes [†]		
	Reinforced Concrete Pipes	Yes		
	Steel Black Pipe & Tube			
	Steel Galvanised Pipe & Tube			
Plastics	ETFE film			
	HDPE film	Yes [†]		
	PC sheet (e.g. danpalon)	Yes [†]		
	LDPE film	Yes [†]		
	PTFE (teflon) film			
	uPVC sheet	Yes [†]		
Timber	Sawn Hardwood			
	Structural Pine			
Transport	Articulated Truck			Yes

Product group	Name	Electr.#	Gas	Diesel
	Concrete Agitator Truck			Yes
	Light Commercial Vehicles			
	None, On-Site			
	Rail, Bulk Transport			Yes
	Rigid Truck			Yes
	Shipping, Domestic Freight			
	Shipping, International Freight			
Water Treatment	Alum (aluminium sulfate)			
	Carbon dioxide			
	Caustic soda			
	Citric acid			
	Ethanol			
	Ferric chloride			
	Ferric Sulphate			
	Ferrous chloride			
	Hydrated Lime			
	Hydrochloric acid			
	Liquid sugar			
	Methanol			
	Molasses			
	Poly aluminium chlorohydrate			
	Polyelectrolyte			
	Potassium permanganate			
Sodium bisulphite				
Sodium hypochlorite				

* The steel data in the version 1.2 calculator are based on Worldsteel data. These are aggregated LCI data and therefore cannot be altered.

NZ electricity data are based on the most recent 5 year average NZ grid mix (see Appendix B)

‡ Plastic products: The final processing step uses NZ electricity data. The raw materials have not been adjusted

Appendix B. New Zealand electricity mix

The following table outlines the average New Zealand grid mix that has been applied in order to adjust the LCI factors in the tool. Source: MBIE 2017

Calendar year	2012	2013	2014	2015	2016	Average
Net Generation (PJ)^{1,2}	154.31	150.92	152.23	154.76	153.33	153.11
Hydro	81.60	82.19	86.84	87.68	92.62	86.19
Geothermal	21.22	21.86	24.73	26.68	26.76	24.25
Biogas	0.80	0.79	0.87	0.91	0.92	0.86
Wood	1.29	1.30	1.27	1.25	1.20	1.26
Wind	7.41	7.21	7.89	8.43	8.29	7.85
Solar ³	0.02	0.03	0.06	0.123	0.19	0.08
Oil	0.01	0.01	0.00915	0.01	0.02	0.01
Coal	11.94	8.06	6.59	6.32	3.55	7.29
Gas	29.88	29.30	23.77	23.18	19.58	25.14
Waste Heat ⁴	0.13	0.17	0.19	0.19	0.19	0.17

1. These fuels include generation from cogeneration plants.
2. 1 Gigawatt Hour (GWh) = 0.0036 Petajoules (PJ).
3. Distributed Solar PV Generation has been estimated using Electricity Authority data.
4. Waste heat includes heat from chemical processes - e.g. fertiliser industry.

AusLCI does not contain any data on geothermal electricity generation. Therefore, start2see has developed a proxy estimate for the impacts of geothermal electricity generation.

First, a hydro-electric power plant² was selected to simulate embodied emissions of a geothermal power plant. Secondly, as geothermal power plant do have additional emissions associated with gases released with geothermal fluids, an estimate of these emissions was included.

[NZGA 2017] indicates “The largest proportion of gases is CO₂ with lesser amounts of hydrogen sulphide and methane.” Only CO₂ emissions have been reported (see table below). start2see has added the average CO₂ emissions to complete the proxy process for geothermal electricity in New Zealand.

Gas Contents And CO₂ Emissions From New Zealand Geothermal Developments (Source: NZGA 2017)

Field	Gas %	CO ₂ (kt/year)	CO ₂ (g/kWh)
Ohaaki	2.86	86	249
Wairakei	0.59	44	32
Poihipi Road	0.43	7	35
Rotokawa	2.00	22	105
Mokai	1.30	28	66
Kawerau	2.82	59	226
Ngawha	1.32	46	597
Average	1.62	42	100

The electricity production mix as modelled by start2see results in the following emission factors:

- GHG intensity: 0.137 kg CO₂e/kWh
- ISEnviroPoints: 0.348 mPt/kWh

For consumers, distribution losses of 6.8% are added to these factors.

² AusLCI process: *Electricity, hydropower, at reservoir power plant, non alpine regions/RER U/AusSD U*