Program Carbon Emission Scorecard Technical Document

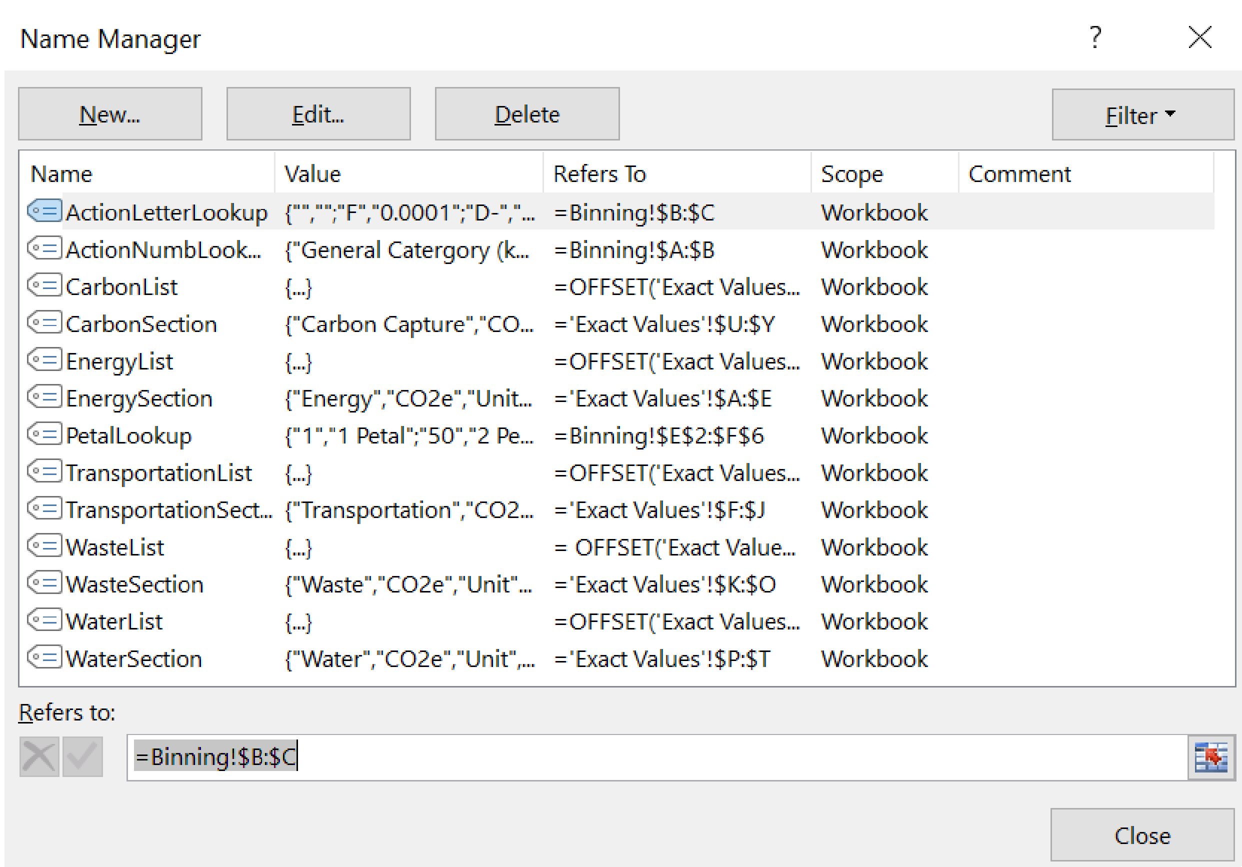
By: Brigitte Lefebvre

Excel Formulas

These formulas are the basis for how the scorecard works, while the original Excel file is in protected mode to prevent formulas from being disrupted while the scorecard is used, it is not password protected so anyone can enter the excel review tab and unprotect the sheets to make changes. If this occurs, these formulas can be put back into the scorecard in their indicated squares if an original version of the scorecard can't be recovered.

Defined Names and Ranges

The name manager can be found using the search bar in Excel and searching for "Name Manger". The defined names and ranges are used throughout the formulas in the excel sheet.

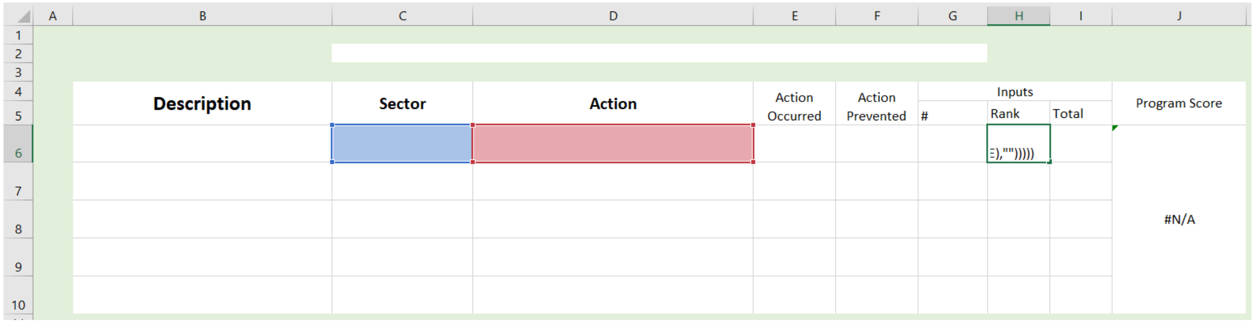


Name	Value	Refers To	Scope	Comment
ActionLetterLookup	{"","";"F","0.0001";"D-","...	=Binning!$B:$C	Workbook	
ActionNumbLook...	{"General Catergory (k...	=Binning!$A:$B	Workbook	
CarbonList	{...}	=OFFSET('Exact Values...	Workbook	
CarbonSection	{"Carbon Capture","CO...	='Exact Values'!$U:$Y	Workbook	
EnergyList	{...}	=OFFSET('Exact Values...	Workbook	
EnergySection	{"Energy","CO2e","Unit...	='Exact Values'!$A:$E	Workbook	
PetalLookup	{"1","1 Petal";"50","2 Pe...	=Binning!$E$2:$F$6	Workbook	
TransportationList	{...}	=OFFSET('Exact Values...	Workbook	
TransportationSect...	{"Transportation","CO2...	='Exact Values'!$F:$J	Workbook	
WasteList	{...}	= OFFSET('Exact Value...	Workbook	
WasteSection	{"Waste","CO2e","Unit"...	='Exact Values'!$K:$O	Workbook	
WaterList	{...}	=OFFSET('Exact Values...	Workbook	
WaterSection	{"Water","CO2e","Unit",...	='Exact Values'!$P:$T	Workbook	

Main User Interface

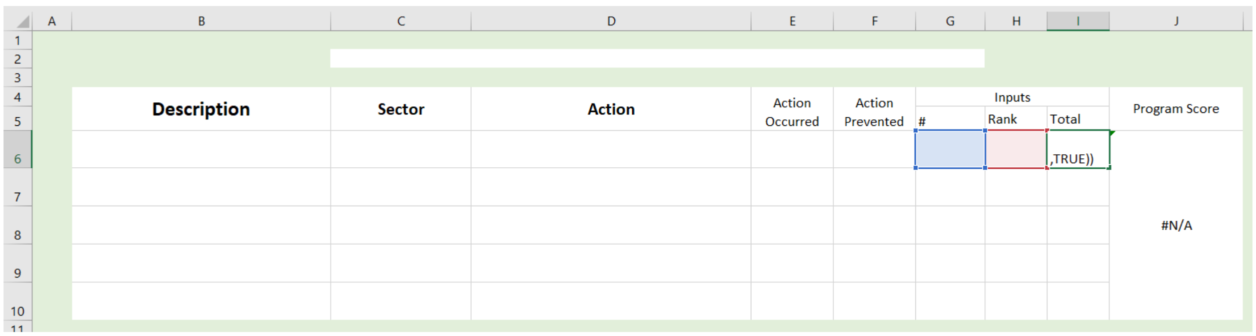
Rank Calculation

=IF($C6="Energy",VLOOKUP(D6,EnergySection,5,FALSE),IF($C6="Transportation",VLOOKUP(D6,TransportationSection,5,FALSE),IF($C6="Waste",VLOOKUP(D6,WasteSection,5,FALSE),IF($C6="Water",VLOOKUP(D6,WaterSection,5,FALSE),IF($C6="Carbon Capture",VLOOKUP(D6,CarbonSection,5,FALSE),"")))))



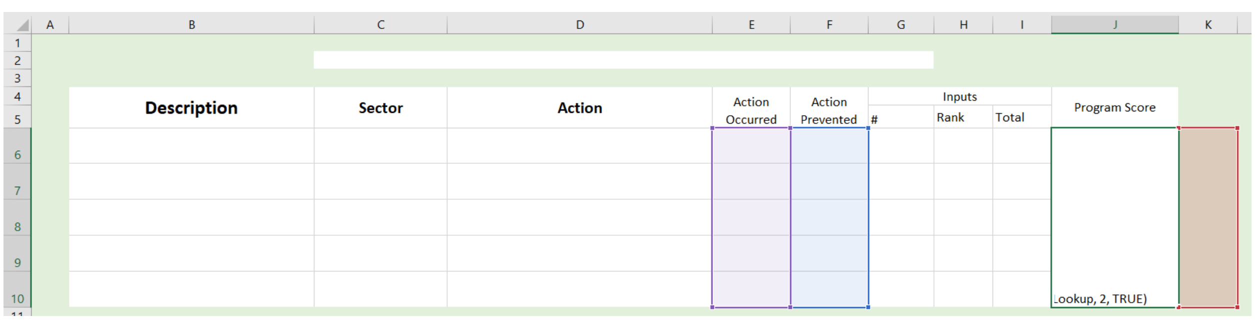
Total Calculation

=IF(ISBLANK($G6),"",VLOOKUP((VLOOKUP(H6,ActionLetterLookup,2,FALSE)*G6),ActionNumbLookup,2,TRUE))



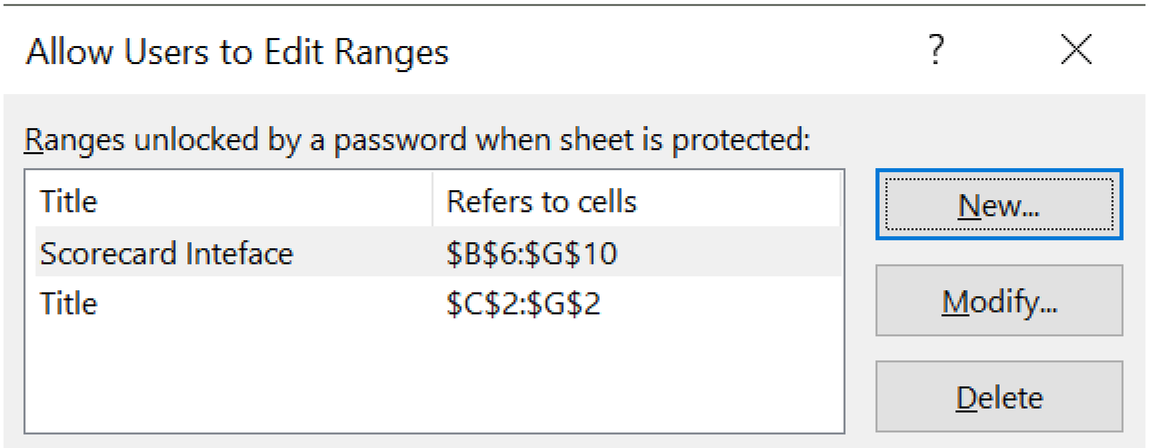
Program Score Calculation

=VLOOKUP((SUMIF(F6:F10,"x",K6:K10)*1)-(SUMIF(E6:E10,"x",K6:K10)*1),PetalLookup, 2, TRUE)



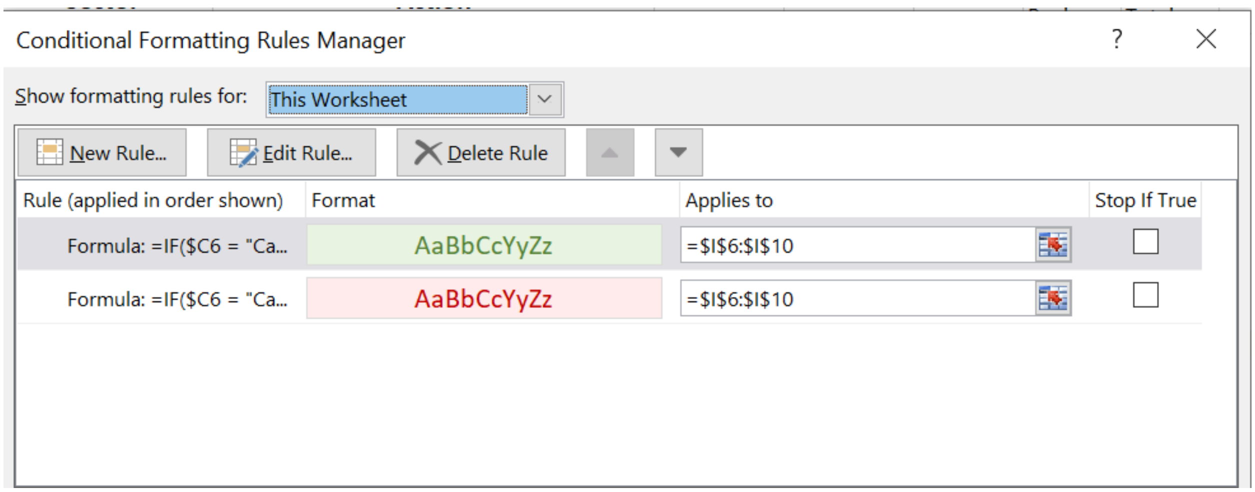
Unprotected Cells

These unprotected cells allow the scorecard to be used while the formulas are proceted from accidental tampering



Conditional Formatting

=IF($C6 = "Carbon Capture", IF($E6="x",TRUE, FALSE), IF($F6="x",TRUE, FALSE))
=IF($C6 = "Carbon Capture", IF($F6="x",TRUE, FALSE), IF($E6="x",TRUE, FALSE))



Dropdown Menus

The sector and action columns both use drop down menus to select inputs, these drop down menus are defined in the data validation function using the following formulas
Sector) Energy,Transportation,Waste,Water,Carbon Capture
Action) =IF($C6="Energy",EnergyList, IF($C6="Transportation",TransportationList, IF($C6="Waste", WasteList, IF($C6="Water", WaterList, IF($C6="Carbon Capture",CarbonList,"")))))

Exact Values

Ranking Actions

=IF(B2<10, "F", VLOOKUP((B2/1000),ActionNumbLookup,2,TRUE))

	A	B	C	D	E
1	**Energy**	CO2e	Unit	Source	Ranking
2	Standard Grid Electricity Use (1 kWh)	733	g CO2 / kWh	https://clim	›,2,TRUE))
3	Powershop Energy Use (1 kWh)	0	g CO2 / kWh	https://www	F
4	Brown-coal Electricity (1 kWh)	1404	g CO2/ kWh	https://www	D+
5	Natural gas (1 kWh)	0.004	g CO2/ kWh	https://www	F

Binnig

While there are no formulas of this sheet, these ranges, ActionLetterLookup, ActionNumberLookup, and PetalLookup form the foundation of many of the formulas and so if these ranges are deleted or values are deleted, the entire scorecard will break.

	A	B	C	D	E	F
1	General Catergory (kg)				Petal Categories	
2	0.0001	F	0.0001		1	1 Petal
3	0.001	D-	0.001		50	2 Petals
4	0.1	D	0.1		200	3 Petals
5	1	D+	1		800	4 Petals
6	5	C-	5		1000	5 Petals
7	25	C	25			
8	50	C+	50			
9	100	B-	100			
10	150	B	150			
11	200	B+	200			
12	400	A-	400			
13	600	A	600			
14	800	A+	800			
15	1000	A++	1000			

“Exact Value” CO_2e Calculations

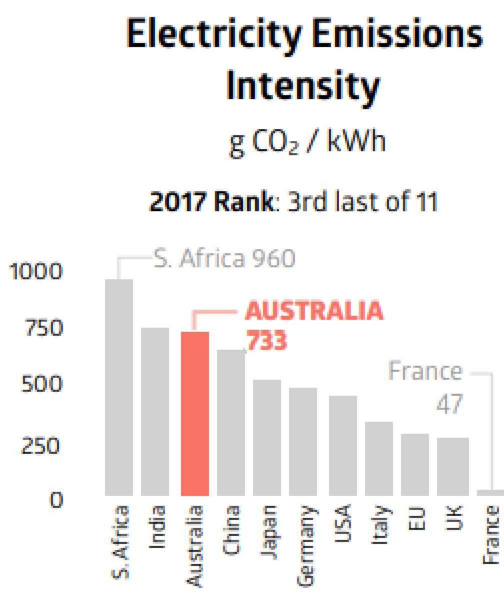
Energy

Standard Grid Electricity Use (1 kWh)

Source:
https://climateanalytics.org/media/australiaclimatefactsheets2018-electricitysector-climateanalytics.pdf
Year: 2018
Region of Study: Australia

Calculations:

Carbon Emission for electricity use (pg 1)



733 g CO2 per kWh

Powershop Electricity Use (1 kWh)

Source: [Carbon Neutral Certification - Powershop]()
Year: 2021
Region of Study: Australia

Calculations:

Carbon offsets through Carbon Certificates

Meridian Energy Australia, Powershop (us), and all our operations are certified carbon neutral under the Climate Active Carbon Neutral Standard. But importantly for our customers, the carbon neutral certification applies to our product as well. So if you're a Powershop customer all your energy usage is certified carbon neutral.

0 g CO_2 per kWh

Brown-coal Electricity Use (1 kWh)

Source:
https://www.portphillip.vic.gov.au/media/c12b5uyh/copp-report-smallest-file-size_pages.pdf
Year: 2005
Region of Study: Port Phillip (Yallourn power station)

Calculations:

Brown Coal electricity CO2e creation (pg 33)

indeed in the world[59]. The carbon intensity of Yallourn power station, for example, is 1.404 tonnes of carbon dioxide per megawatt-hour of energy produced[60]. This is significantly more than other forms of power

1.404 tonnes CO_2e per MWh x 1000000 g per metric ton = 1404000 g per MWh
1404000 g per MWh / 1000 kWh per MWh = 1404 g CO_2e per kWh

Transportation

Petrol (1 L)

Source: Ecoscore
Year: 2021
Region of Study: European Union

Calculations:

Petrol CO2

Petrol:

1 liter of petrol weighs 750 grammes. Petrol consists for 87% of carbon, or 652 grammes of carbon per liter of petrol. In order to combust this carbon to CO_2, 1740 grammes of oxygen is needed. The sum is then 652 + 1740 = 2392 grammes of CO_2/liter of petrol.

2392 g CO2/L

Diesel (1 L)

Source: Ecoscore
Year: 2021
Region of Study: European Union

Calculations:

Diesel CO2

Diesel:

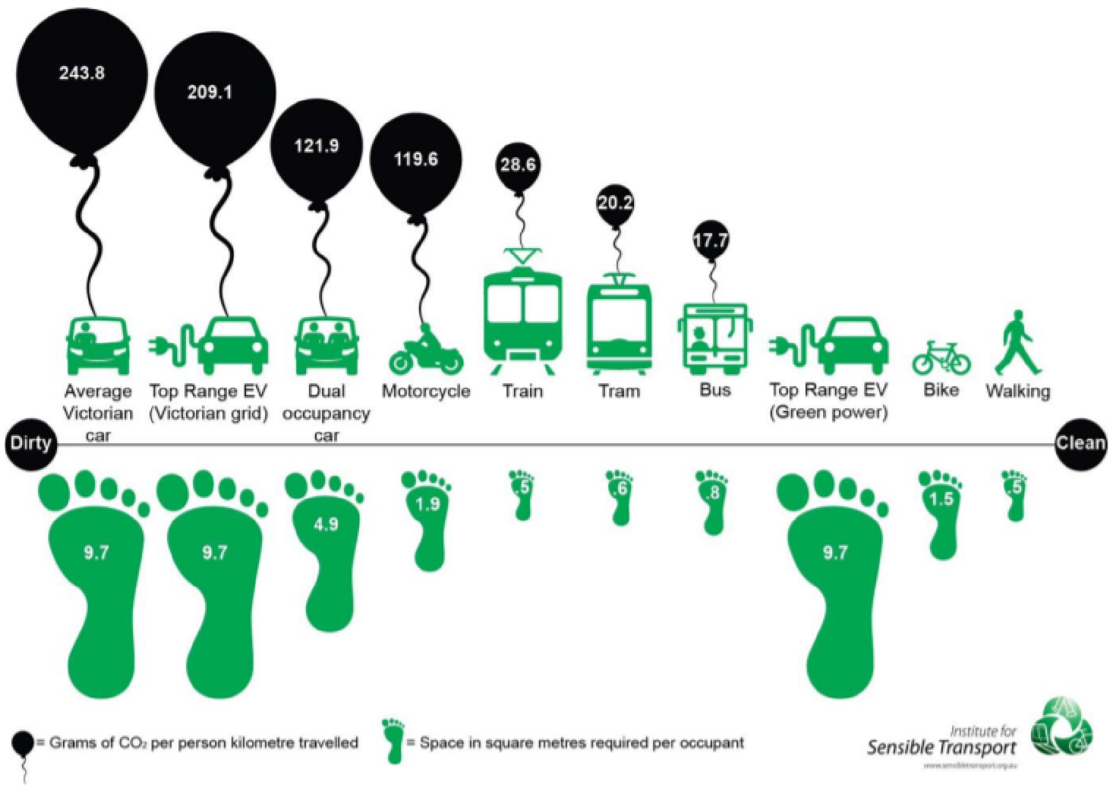
1 liter of diesel weighs 835 grammes. Diesel consist for 86,2% of carbon, or 720 grammes of carbon per liter diesel. In order to combust this carbon to CO_2, 1920 grammes of oxygen is needed. The sum is then 720 + 1920 = 2640 grammes of CO_2/liter diesel.

2640 g CO2/L

CO2 emissions of different vehicles in Melbourne

Source: [Transport Strategy Refresh]
Year: 2018
Region of Study: Melbourne

Vehicle CO2e emissions (pg 4)



CO2 emissions of cars in Australia

Source: https://apo.org.au/sites/default/files/resource-files/2020-06/apo-nid306386.pdf
Year: 2020
Region of Study: Australia

Vehicle CO2e emissions (pg 30)

Table 12: Average emissions intensity and annual sales by segment, 2018 and 2019

Segment	Average emissions intensity (g/km)		Change from 2018 to 2019 (%)*	Sales	
	2018	2019		2018	2019
SUV Medium	174	171	-2.1	206,450	201,371
Pick-up/Chassis 4×4	224	226	0.9	173,263	168,584
Small	151	148	-1.6	199,123	163,243
SUV Small	157	157	0.5	139,163	138,883
SUV Large	207	205	-1.1	132,662	122,681
Light	135	134	-0.2	76,664	63,050
Medium	153	150	-1.9	46,231	42,994
Pick-up/Chassis 4×2	219	221	0.6	37,668	32,783
Vans/Cab Chassis	205	204	-0.5	23,328	20,898
SUV Upper Large	259	257	-0.8	16,933	19,738
Sports	219	214	-2.0	18,571	14,344
People Movers	217	217	0.2	13,357	12,543
Large	202	189	-6.5	15,405	11,422
Micro	129	129	-0.2	7,819	6,505
Upper Large	206	219	6.1	1,109	943
Light Buses	258	258	0.0	2,642	857
Total	**181**	**181**	**-0.2**	**1,110,388**	**1,020,839**

* Due to rounding, average emissions intensity may appear the same for 2018 and 2019 in some rows of the table. However, the percentage change considers the unrounded figure.

Calculating an EcoCentre Average using the average of all small and medium values

(151 + 148 + 157 + 157 + 135 + 134 + 153 + 150 + 174 + 171) = 1530 g CO2e per km

1530 g CO2e per km / 10 = 153 g CO2e per km

Waste

The calculations for waste draw from several sources

[Various materials] Landfill (1 kg) and bought new (1 kg)

https://www.legislation.gov.au/Details/F2020C00600
Year: 2020
Region: Australia

- Operates by starting with a total volume of waste in a landfill and calculating percentage of waste types in the landfill. This makes it difficult to calculate values for small scales and for one type of waste. Could be adapted for scorecard but finding individual values is difficult and could cause uncertainties to be greater
- Has categories for the environment in the landfills and defines Victoria landfills as dry,temperate. This can be applied in the WARM database. (Chapter 5 Part 5.2 Division 5.2.2 Sec 5.14)

k values for Solid Waste at a Landfill

Item	Landfill classification	Waste mix type	k values
1	Temperate dry	Food	0.06
		Paper and cardboard	0.04
		Garden and Green	0.05
		Wood	0.02
		Textiles	0.04
		Sludge	0.06
		Nappies	0.04
		Rubber and Leather	0.04
		Alternative waste treatment residue	0.04

k values for Solid Waste at a Landfill

Item	State or Territory	Waste mix type	k values
1	NSW	Food	0.185
		Paper and cardboard	0.06
		Garden and Green	0.10
		Wood	0.03
		Textiles	0.06
		Sludge	0.185
		Nappies	0.06
		Rubber and Leather	0.06
		Alternative waste treatment residue	0.06
2	VIC, WA, SA, TAS, ACT	Food	0.06
		Paper and cardboard	0.04
		Garden and Green	0.05
		Wood	0.02
		Textiles	0.04
		Sludge	0.06
		Nappies	0.04
		Rubber and Leather	0.04
		Alternative waste treatment residue	0.04

https://www.epa.gov/sites/production/files/2020-12/documents/warm_management_practices_v15_10-29-2020.pdf
and
https://www.epa.gov/sites/production/files/2020-12/documents/warm_background_v15_10-29-2020.pdf
Year: 2020
Region: USA

- Points of interest are the Source reduction, landfilling, and compost data.
- Source Reduction: Isn't exact to Australian standards, but takes into account industrial manufacture practices averages so can apply to australia pretty closely. There also isn't much similar values in any Australian sources.
    - Source Reduction refers to the practice of reducing the use of a material by redesigning a product to use less material, extending its useful lifespan, reusing

    - materials before sending them to end of life processing, or preventing their use altogether. (Pg 1-1)
    - Mixed Recyclables, Organics, and MSW cannot be reduced because the category is too broad. Reducing specific recyclables, organic waste, and MSW must be modeled instead (Pg 1-4)
- Landfilling: Based of a laboratory study so the raw values are applicable to Australia
    - The values for landfilling emissions were taken from a simulated landfill test of many types of matter done at North Carolina State University by Barlaz etc al.(Pg 6-4)
- Compost: Looks at large scale mechanically turned compost so none of the data is relevant.

Source Reduction and Landfilling Emissions in MT CO2e/Short Ton from WARM (Pg 1-4)

Material	Net Source Reduction Emissions for 100% Virgin Inputs	Net Landfilling Emissions
Mixed Paper	(7.61)	0.07
Mixed Plastics	(1.94)	0.02
Mixed Electronics*	(18.57)	0.02
Food Waste (Fruit and Veggies)	(0.44)	0.50
Glass	(0.60)	0.02

*Values were taken from the average of all electronics listed in the sheet
Parentheses indicate that emissions are saved, non-parentheses indicate emissions are released

1 MT = 1,000,000 g
1 Short Ton = 907.185 kg
1 MT/ 1 Short Ton = 1,000,000/907.185 = 1102.31 g CO2/kg <- Conversion Factor

Source Reduction and Landfilling Emissions in g CO2e/kg adapted from WARM (Pg 1-4)

Material	Net Source Reduction Emissions for 100% Virgin Inputs	Net Landfilling Emissions
Mixed Paper	(8386)	77
Mixed Plastics	(2138)	22
Mixed Electronics*	(20470)	22
Food Waste (Fruit	(485)	550

and Veggies)		
Glass	(661)	22

*Values were taken from the average of all electronics listed in the sheet
Parentheses indicate that emissions are saved, non-parentheses indicate emissions are released

Exhibit 1-1: Greenhouse Gas Emissions from Management Options Modeled in WARM ($MTCO_2E$/Short Ton of Material)

Material	Net Source Reduction Emissions for Current Mix of Inputs	Net Source Reduction Emissions for 100% Virgin Inputs	Net Recycling Emissions	Net Composting Emissions	Net Combustion Emissions	Net Landfilling Emissions	Net Wet Anaerobic Digestion with curing
Corrugated Containers	(5.58)	(8.09)	(3.14)	NA	(0.49)	0.18	NA
Magazines/Third-class Mail	(8.57)	(8.86)	(3.07)	NA	(0.35)	(0.43)	NA
Newspaper	(4.68)	(5.74)	(2.71)	NA	(0.56)	(0.85)	NA
Office Paper	(7.95)	(8.23)	(2.86)	NA	(0.47)	1.13	NA
Phonebooks	(6.17)	(6.17)	(2.62)	NA	(0.56)	(0.85)	NA
Textbooks	(9.02)	(9.32)	(3.10)	NA	(0.47)	1.13	NA
Mixed Paper (general)	(6.07)	(7.61)	(3.55)	NA	(0.49)	0.07	NA
Mixed Paper (primarily residential)	(6.00)	(7.64)	(3.55)	NA	(0.49)	0.02	NA
Mixed Paper (primarily from offices)	(7.37)	(7.93)	(3.58)	NA	(0.45)	0.11	NA
Food Waste	(3.66)	(3.66)	NA	(0.12)	(0.13)	0.50	(0.06)
Food Waste (non-meat)	(0.76)	(0.76)	NA	(0.12)	(0.13)	0.50	(0.06)
Food Waste (meat only)	(15.10)	(15.10)	NA	(0.12)	(0.13)	0.50	(0.06)
Beef	(30.09)	(30.09)	NA	(0.12)	(0.13)	0.50	(0.06)
Poultry	(2.45)	(2.45)	NA	(0.12)	(0.13)	0.50	(0.06)
Grains	(0.62)	(0.62)	NA	(0.12)	(0.13)	0.50	(0.06)
Bread	(0.66)	(0.66)	NA	(0.12)	(0.13)	0.50	(0.06)
Fruits and Vegetables	(0.44)	(0.44)	NA	(0.12)	(0.13)	0.50	(0.06)
Dairy Products	(1.75)	(1.75)	NA	(0.12)	(0.13)	0.50	(0.06)
Yard Trimmings	NA	NA	NA	(0.05)	(0.17)	(0.20)	NA
Grass	NA	NA	NA	(0.05)	(0.17)	0.12	NA
Leaves	NA	NA	NA	(0.05)	(0.17)	(0.53)	NA
Branches	NA	NA	NA	(0.05)	(0.17)	(0.54)	NA
HDPE	(1.42)	(1.52)	(0.76)	NA	1.29	0.02	NA
LDPE	(1.80)	(1.80)	NA	NA	1.29	0.02	NA
PET	(2.17)	(2.21)	(1.04)	NA	1.24	0.02	NA
LLDPE	(1.58)	(1.58)	NA	NA	1.29	0.02	NA
PP	(1.54)	(1.54)	(0.79)	NA	1.29	0.02	NA
PS	(2.50)	(2.50)	NA	NA	1.65	0.02	NA
PVC	(1.93)	(1.93)	NA	NA	0.66	0.02	NA
Mixed Plastics	(1.87)	(1.94)	(0.93)	NA	1.26	0.02	NA
PLA	(2.45)	(2.45)	NA	(0.09)	(0.63)	(1.64)	NA
Desktop CPUs	(20.86)	(20.86)	(1.49)	NA	(0.66)	0.02	NA
Portable Electronic Devices	(29.83)	(29.83)	(1.06)	NA	0.65	0.02	NA
Flat-Panel Displays	(24.19)	(24.19)	(0.99)	NA	0.03	0.02	NA
CRT Displays	NA	NA	(0.57)	NA	0.45	0.02	NA
Electronic Peripherals	(10.32)	(10.32)	(0.36)	NA	2.08	0.02	NA
Hard-Copy Devices	(7.65)	(7.65)	(0.56)	NA	1.20	0.02	NA
Mixed Electronics	NA	NA	(0.79)	NA	0.39	0.02	NA
Aluminum Cans	(4.80)	(10.99)	(9.13)	NA	0.03	0.02	NA
Aluminum Ingot	(7.48)	(7.48)	(7.20)	NA	0.03	0.02	NA
Steel Cans	(3.03)	(3.64)	(1.83)	NA	(1.59)	0.02	NA
Copper Wire	(6.72)	(6.78)	(4.49)	NA	0.03	0.02	NA
Mixed Metals	(3.65)	(6.22)	(4.39)	NA	(1.02)	0.02	NA
Glass	(0.53)	(0.60)	(0.28)	NA	0.03	0.02	NA
Asphalt Concrete	(0.11)	(0.11)	(0.08)	NA	NA	0.02	NA
Asphalt Shingles	(0.19)	(0.19)	(0.09)	NA	(0.35)	0.02	NA
Carpet	(3.68)	(3.68)	(2.38)	NA	1.10	0.02	NA
Clay Bricks	(0.27)	(0.27)	NA	NA	NA	0.02	NA
Concrete	NA	NA	(0.01)	NA	NA	0.02	NA
Dimensional Lumber	(2.13)	(2.13)	(2.66)[a]	NA	(0.58)	(0.92)	NA
Drywall	(0.22)	(0.22)	0.03	NA	NA	(0.06)	NA
Fiberglass Insulation	(0.38)	(0.48)	NA	NA	NA	0.02	NA
Fly Ash	NA	NA	(0.87)	NA	NA	0.02	NA
Medium-density Fiberboard	(2.41)	(2.41)	NA	NA	(0.58)	(0.85)	NA
Structural Steel	(1.67)	(3.42)	(1.93)	NA	NA	0.02	NA
Vinyl Flooring	(0.58)	(0.58)	NE	NA	(0.31)	0.02	NA
Wood Flooring	(4.03)	(4.03)	NE	NA	(0.74)	(0.86)	NA
Tires	(4.30)	(4.46)	(0.38)	NA	0.50	0.02	NA
Mixed Recyclables	NA	NA	(2.85)	NA	(0.42)	0.03	NA
Mixed Organics	NA	NA	NA	(0.09)	(0.15)	0.18	NA
Mixed MSW	NA	NA	NA	NA	0.01	0.31	NA

Compostables in composting bay (1 kg)

Source: https://journals.sagepub.com/doi/10.1177/0734242X07088432
Year: 2008
Region of Study: Austria and Germany

Table 1: Experimental data of backyard composting trials BYC-1 and BYC-2.

	BYC-1	BYC-2
Period of weekly biowaste input	3.9.1999–25.11.1999 (12 weeks)	20.4.2000–12.4.2001 (51 weeks)
Period of emission measurements	12.9.1999–23. 3. 2000 (30 weeks)	22.4.2000–1.7.2001 (64 weeks)
Total biowaste input	1775.3 kg	2930.8 kg
Biowaste input $week^{-1}$	161.4 (eight composters)	57.5 kg (two composters)
Biowaste input day^{-1}	21.1 kg	8.2 kg
Biowaste input $year^{-1}$	7714.1 kg	2996.4 kg
Biowaste input $week^{-1}$ & composter	min 3.1 kg–max. 46.8 kg	min. 5.7 kg–max. 52.7 kg
Inhabitants served depending on specific biowaste production		
260 kg Inh^{-1} *a	30 Inh	12 Inh
170 kg Inh^{-1} *a	45 Inh	18 Inh
100 kg Inh^{-1} *a	77 Inh	30 Inh
85 kg Inh^{-1}*a	91 Inh	35 Inh
Loss of fresh matter		
Phase 1 (first turning)		34%
Phase 2 (extraction)	30%	41%
Total (after maturation)	57% (m/m)	59%
Leachate water / composter	3.4 l	29–56 l
Leachate water / week & composter	0.3 l	1.5 – 2.1 l

Since input materials were taken every week from source separated organic household waste from a nearby settlement, the raw material was not analysed. Rather, it was important in this experiment to simulate a composting system that is very close to a full-scale typical composting system.

Our own measurements showed that the highest emission rates (76 kg CO_2-equ Mg^{-1}) tended to be from home composting of treated kitchen and garden waste that was mechanically turned every 12 weeks (BYC-2). We consider the results from this experiment to be highly representative, since they represent a full year of regular measurements that covered typical continental seasonal variations. On the other

76 kg CO2e / Mg (1g / 1000 kg) (1000Mg / 1kg) = 76g / kg of compostables

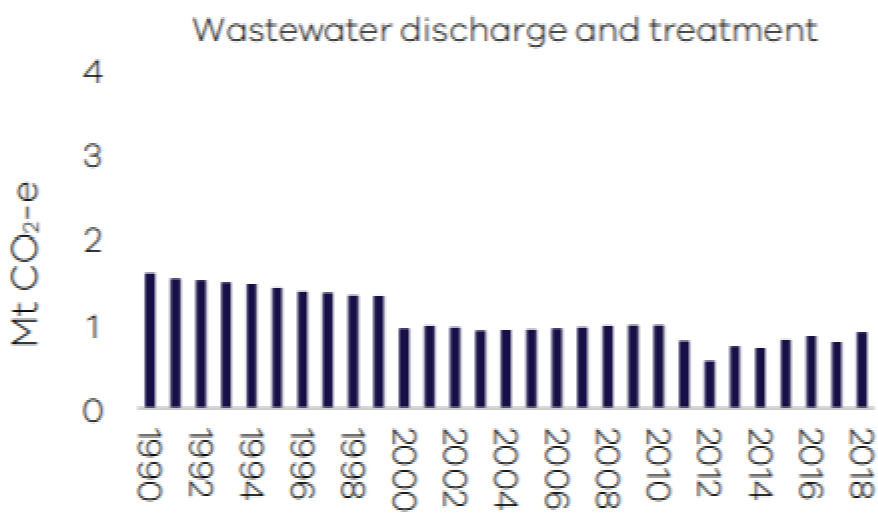
Water

Potable Water (1 L)

Source:
https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0026/504188/Victorian-Greenhouse-Gas-Emissions-Report-2018a1.pdf
Year: 2018
Region of Study: Victoria
And
Source:https://www.water.vic.gov.au/media-releases/2020/victorian-water-accounts-201819-now-available
Year: 2020
Region of Study: Victoria

Calculations:

CO2e emission from wastewater treatment (pg 36)



(2018 value equals 0.9 MT CO2e)

GL of water used in 2018-2019 year

These accounts show the total volume of surface water, groundwater and recycled water available in 2018–19 was 12,073 GL, compared to 15,375 GL in the previous year. Of the water available, 3,976 GL was taken for consumptive purposes, compared to 4,087 GL taken in 2017–18.

0.9 MT CO2e (1000000 g / 1 MT) = 900000 g CO2e
4,087 GL water (1,000,000,000 L/ 1 GL) = 4,087,000,000,000 L water
900,000 g CO2e / 4,087,000,000,000 L water = 0.0000002 g CO2e / L water

Carbon Capture

Saltmarsh, Mangroves, and Seagrass (1 m^2)

Source:http://www.ppwcma.vic.gov.au/Resources/PublicationDocuments/117/PPW%20Blue%20Carbon%20Report%20March%202014.pdf
Year: 2015
Region of Study: Port Phillip (While the values are not from Port Phillip, it was seen fit to apply them to Port Phillip in this report)

Estimates from some parts of the world indicate that carbon is sequestered at a rate of up to 151.0 g C m^{-2} yr^{-1} in saltmarsh, 139.0 g C m^{-2} yr^{-1} in mangroves, and 83.0 g C m^{-2} yr^{-1} in seagrass (Smith 1981; Duarte *et al.* 2005; McLeod *et al.* 2011). The relatively anaerobic soils