

A.1 Embodied Energy Coefficients - Alphabetical.

MATERIAL	MJ/kg	MJ/m3	MJ/m2
Aggregate, general	0.10	150	
virgin rock	0.04	63	
river	0.02	36	
Aluminium, virgin	191	515 700	
extruded	201	542 700	
extruded, anodised	227	612 900	
extruded, factory painted	218	588 600	
foil	204	550 800	
sheet	199	537 300	
Aluminium, recycled	8.1	21 870	
extruded	17.3	46 710	
extruded, anodised	42.9	115 830	
extruded, factory painted	34.3	92 610	
foil	20.1	54 270	
sheet	14.8	39 960	
asphalt (paving)	3.4	7 140	
bitumen	44.1	45 420	
brass	62.0	519 560	
Carpet	72.4		
felt underlay	18.6		
nylon	148		
polyester	53.7		
polyethylterephthalate (PET)	107		
polypropylene	95.4		
wool	106		
Cement	7.8	15 210	
cement mortar	2.0	3 200	
fibre cement board	9.5	13 550	102/7.5mm
soil-cement	0.42	819	
Ceramic			
brick	2.5	5 170	
brick, glazed	7.2	14 760	
pipe	6.3		
tile	2.5	5 250	
Concrete			
block	0.94		
brick	0.97		
GRC	7.6	14 820	
paver	1.2		
pre-cast	2.0		
ready mix, 17.5 MPa	1.0	2 350	
30 MPa	1.3	3 180	
40 MPa	1.6	3 890	

MATERIAL	MJ/kg	MJ/m3	MJ/m2
roofing tile	0.81		
copper	70.6	631 160	
Earth, raw			
adobe block, straw stabilised	0.47	750	
adobe, bitumen stabilised	0.29		
adobe, cement stabilised	0.42		
rammed soil cement	0.80		
pressed block	0.42		
Fabric			
cotton	143		
polyester	53.7		
Glass			
float	15.9	40 060	240/6mm
toughened	26.2	66 020	396/6mm
laminated	16.3	41 080	246/6mm
tinted	14.9	375 450	
Insulation			
cellulose	3.3	112	
fibreglass	30.3	970	
polyester	53.7	430	
polystyrene	117	2 340	
wool (recycled)	14.6	139	
lead	35.1	398 030	
linoleum	116	150 930	337
Paint	90.4	118/l	6.5
solvent based	98.1	128/l	6.1
water based	88.5	115/l	7.4
Paper	36.4	33 670	
building	25.5		4.97
kraft	12.6		
recycled	23.4		
wall	36.4		
plaster, gypsum	4.5	6 460	
plaster board	6.1	5 890	33/9.5mm
Plastics			
ABS	111		
high density polyethelene (HDPE)	103	97 340	
low density polyethelene (LDPE)	103	91 800	
polyester	53.7	7 710	
polypropylene	64.0	57 600	
polystyrene, expanded	117	2 340	
polyurethane	74.0	44 400	
PVC	70.0	93 620	
Rubber			

MATERIAL	MJ/kg	MJ/m3	MJ/m2
natural latex	67.5	62 100	
synthetic	110		
sand	0.10	232	
Sealants and adhesives			
phenol formaldehyde	87.0		
urea formaldehyde	78.2		
Steel, recycled	10.1	37 210	
reinforcing, sections	8.9		
wire rod	12.5		
Steel, virgin, general	32.0	251 200	
galvanised	34.8	273 180	
imported, structural	35.0	274 570	
Stone, dimension			
local	0.79	1 890	
imported	6.8	1 890	
straw, baled	0.24	30.5	15.2
Timber, softwood			
air dried, roughsawn	0.3	165	
kiln dried, roughsawn	1.6	880	
air dried, dressed	1.16	638	
kiln dried, dressed	2.5	1 380	
mouldings, etc	3.1	1 710	
hardboard	24.2	13 310	
MDF	11.9	8 330	
glulam	4.6	2 530	
particle bd	8.0		
plywood	10.4		
shingles	9.0		
Timber, hardwood			
air dried, roughsawn	0.50	388	
kiln dried, roughsawn	2.0	1 550	
vinyl flooring	79.1	105 990	
Zinc	51.0	364 140	
galvanising, per kg steel	2.8		

A.2 Embodied Energy Coefficients - Ranked by Mass - MJ/kg.

MATERIAL	MJ/kg
aggregate, river	0.02
virgin rock	0.04
sand	0.10
aggregate, general	0.10
straw, baled	0.24
adobe, bitumen stabilised	0.29
softwood timber, air dried, roughsawn	0.30
pressed earth block	0.42
soil-cement	0.42
adobe, cement stabilised	0.42
adobe block, straw stabilised	0.47
hardwood timber, air dried, roughsawn	0.50
dimension stone, local	0.79
rammed soil cement	0.80
concrete roofing tile	0.81
concrete block	0.94
concrete brick	0.97
concrete, 17.5 MPa	1.0
concrete paver	1.2
softwood timber, air dried, dressed	1.2
concrete, 30 MPa	1.3
softwood timber, kiln dried, roughsawn	1.6
concrete, 40 MPa	1.6
concrete, pre-cast	2.0
hardwood timber, kiln dried, roughsawn	2.0
cement mortar	2.0
softwood timber, kiln dried, dressed	2.5
ceramic brick	2.5
ceramic tile	2.5
galvanising, per kg steel	2.8
softwood timber mouldings, etc	3.1
cellulose insulation	3.3
asphalt (paving)	3.4
plaster, gypsum	4.4
glulam	4.6
plaster board	6.1
ceramic pipe	6.3
dimension stone, imported	6.8
brick, glazed	7.2
GRC	7.6
cement	7.8
particle board	8.0
aluminium, recycled, general	8.1
steel, recycled, reinforcing, sections	8.9
shingles	9.0

MATERIAL	MJ/kg
fibre cement board	9.5
steel, recycled, general	10.1
plywood	10.4
MDF	11.9
steel, recycled, wire rod	12.5
kraft paper	12.6
wool insulation (recycled)	14.6
aluminium, recycled, sheet	14.8
glass, general	15.9
float	15.9
tinted	15.9
glass, laminated	16.3
aluminium, recycled, extruded	17.3
carpet, felt underlay	18.6
aluminium foil, recycled	20.1
paper, recycled	23.4
hardboard	24.2
building paper	25.5
glass, toughened	26.2
fibreglass insulation	30.3
steel, virgin, general	32.0
aluminium, recycled, extruded, factory painted	34.3
steel, virgin, galvanised	34.8
steel, imported, structural	35.0
lead	35.1
paper, general	36.4
wall paper	36.4
aluminium, recycled, extruded, anodised	42.9
bitumen	44.1
galvanising, per kg zinc	61.0
zinc	51.0
polyester	53.7
brass	62.0
polypropylene	64.0
rubber, natural latex	67.5
PVC	70.0
copper	70.6
carpet, general	72.4
polyurethane, general	74.0
adhesive, urea formaldehyde	78.2
vinyl flooring	79.1
adhesive, phenol formaldehyde	87.0
paint, water based	88.5
paint, general	90.4
polypropylene	95.4
paint, solvent based	98.1
low density polyethelene (LDPE)	103
high density polyethelene (HDPE)	103

MATERIAL	MJ/kg
carpet, wool	106
polyethylterephthalate (PET)	106
rubber, synthetic	110
ABS	111
linoleum	116
polystyrene	117
cotton fabric	143
carpet, nylon	148
aluminium, virgin, general	191
sheet	199
extruded	201
foil	204
extruded, factory painted	218
aluminium, virgin, extruded, anodised	227

A.3 Embodied Energy Coefficients - Ranked by Volume - MJ/m³

MATERIAL	MJ/m ³
straw, baled	30.5
aggregate, river	36.0
aggregate, virgin rock	63.0
cellulose insulation	112
wool insulation (recycled)	139
aggregate, general	150
softwood timber, air dried, roughsawn	165
sand	232
hardwood timber, air dried, roughsawn	388
polyester insulation	430
adobe, bitumen stabilised	490
softwood timber, air dried, dressed	638
adobe, cement stabilised	710
adobe block, straw stabilised	750
earth, pressed block	810
soil-cement	819
softwood timber, kiln dried, roughsawn	880
fibreglass insulation	970
softwood timber, kiln dried, dressed	1 380
hardwood timber, kiln dried, roughsawn	1 550
earth, rammed soil cement	1 580
softwood timber, mouldings, etc	1 710
stone, dimension, local	2 030
polystyrene, expanded	2 340
concrete, 17.5 MPa	2 350
glulam	2 530
concrete, pre-cast	2 780
concrete, 30 MPa	3 180
cement mortar	3 200
polystyrene, high density	3 770
concrete, 40 MPa	3 890
particle board	4 400
shingles	4 930
ceramic brick	5 170
ceramic tile	5 250
plywood	5 720
plaster board	5 890
plaster, gypsum	6 460
asphalt (paving)	7 140
polyester	7 710
MDF	8 330
fibre cement board	13 550
ceramic brick, glazed	14 760
GRC	14 820

cement	15 210
MATERIAL	MJ/m³
stone, dimension, imported	17 610
hardboard	21 300
aluminium, recycled	21 870
paper	33 670
steel, recycled	37 210
glass	37 550
float	37 550
aluminium, recycled, sheet	39 960
glass, laminated	41 080
polyurethane	44 400
bitumen	45 420
aluminium, recycled, extruded	46 710
aluminium, recycled, foil	54 270
polypropylene	57 600
rubber, natural latex	62 100
glass, toughened	66 020
steel, recycled, reinforcing, sections	69 790
low density polyethylene (LDPE)	91 800
aluminium, recycled, extruded, factory painted	92 610
PVC	93 620
high density polyethylene (HDPE)	97 340
steel, recycled, wire rod	97 890
vinyl flooring	105 990
paint, water based	115 000
aluminium, recycled, extruded, anodised	115 830
paint, general	117 500
rubber, synthetic	118 800
ABS	125 430
paint, solvent based	127 500
linoleum	150 930
steel, virgin, general	251 200
steel, galvanised	273 180
steel, imported, structural	274 570
zinc	371 280
lead	398 034
aluminium, virgin, general	515 700
brass	519 560
aluminium, virgin, sheet	537 300
aluminium, virgin, extruded	542 700
aluminium, virgin, foil	550 800
aluminium, virgin, extruded, factory painted	588 600
aluminium, virgin, extruded, anodised	612 900
copper	631 164

A.4 Embodied Energy Coefficients - Comparison with Other Data

Local data shows best estimate and high and low ranges. Overseas data shows high and low published data.

MATERIAL	MJ/kg				
	LOCAL DATA			OVERSEAS DATA	
	BEST	HIGH	LOW	HIGH	LOW
Aggregate, general	0.10				
virgin rock	0.04	0.05			
river	0.02				
Aluminium, virgin	191	292	123	241E	170L
extruded	201				
extruded, anodised	227				
extruded, factory painted	218				
foil	204				
sheet	199				
Aluminium, recycled	8.1				
extruded	17.3				
extruded, anodised	42.9				
extruded, factory painted	34.3				
foil	20.1				
sheet	14.8				
asphalt (paving)	3.4		3.1		
bitumen	44.1				
brass	62.0				
Carpet	72.4			72.4S	
felt underlay	18.6			18.6E	
nylon	148			148E	
polyester	54.0			54.0E	
polyethylterephthalate (PET)	107			107E	
polypropylene	95.4			95.4E	
wool	106	108	76.0		
Cement	6.9	8.2	5.6	9.4E	7.0L
cement mortar	2.0			2.0L	
fibre cement board	9.5				
soil-cement	0.42	1.2	0.15	0.70L	
Ceramic, brick	2.5			9.3E	1.7L
pipe	6.3			6.3F	
tile	2.5			19.5E	2.1S
Concrete				24E	
block	0.94			2.2E	0.81S
brick	0.97				
GRC	7.6				
ready mix 17.5 MPa	1.0	1.9		2.3L	0.54S
30 Mpa	1.3				
ready mix 40 MPa	1.6				

paver	1.2				
pre-cast	2.0				
MATERIAL	MJ/kg				
	LOCAL DATA			OVERSEAS DATA	
	BEST	HIGH	LOW	HIGH	LOW
concrete roofing tile	0.81				9.0S
copper	70.6			100L	
Earth, raw					
adobe block, straw stabilised	0.47		0.03		
adobe, bitumen stabilised	0.29			4.4E	0.29E
adobe, cement stabilised	0.42				
rammed soil cement	0.80				
pressed block	0.42				
Fabric, cotton	143			143E	
polyester	53.7			53.7E	
Glass	15.9			15.0E	12.7
float	15.9				
toughened	26.2				
tinted	15.9				
laminated	16.3				
Insulation					
cellulose	3.3			4.3S	0.35E
fibreglass	30.3			30.3E	18.3S
polyester	53.7				
polystyrene	117			189S	111F
wool (recycled)	14.6				
lead	35.1			30.0L	11.0L
linoleum	116			116E	
Paint	90.4			76.8E	40.3S
solvent based	98.1			96.8E	
water based	88.5			53.0E	76.8E
Paper	36.4			36.4E	25.6E
building	25.5			12.0S	
kraft	12.6	33.0	3.0		
recycled	23.4			23.4E	
wall	36.4			36.4E	4.4S
plaster, gypsum	4.5				3.4L
plaster board	6.1			9.4E	4.4L
Plastics, ABS	111			111F	
HDPE	103			98.2F	
LDPE	103			90.0L	
polyester	53.7			53.7E	
polystyrene, expanded	117			117E	
polyurethane,	74.0			72.2E	
PVC	70.0	93.3	38.6	189S	63.3E
polypropylene	64.0				64.0E
Rubber, natural latex	67.5			67.5E	
synthetic	110				
Sealants and adhesives					

phenol formaldehyde	87.0				
urea formaldehyde	78.2				
MATERIAL	MJ/kg				
	LOCAL DATA			OVERSEAS DATA	
	BEST	HIGH	LOW	HIGH	LOW
Steel, recycled	10.1	12.5	8.9		9.0E
reinforcing, sections	8.9				
wire rod	12.5				
Steel, virgin, general	32.0			45.0E	10.4E
imported, structural	34.5				
galvanised	34.8				
Stone, dimension, local	0.79		0.25	5.9L	0.37S
imported	6.8	10.4	3.3	13.9L	1.3E
straw, baled	0.24			0.24	
Timber, softwood				7.4S	6.1E
air dried, roughsawn	0.30				
kiln dried, roughsawn	1.6	3.2	0.43	3.4L	
air dried, dressed	1.2				
kiln dried, dressed	2.5		3.0	6.1	4.0L
mouldings, etc	3.1				
hardboard	24.2				
MDF	11.9				
glulam	4.6			11.0L	
particle bd	8.0				
plywood	10.4				14.6S
shingles	9.0			9.0S	
Timber, hardwood					
air dried, roughsawn	0.50				
kiln dried, roughsawn	2.0				
vinyl flooring	79.1			79.1E	31.8S
Zinc	51.0			51.0L	

Suffix codes:

E - American Institute of Architects, Environmental Resource Guide.⁹

F - Franklin Associates Ltd.¹²

L - Lawson.¹³

S - Sheltair Scientific Ltd.¹⁴

A.5 IFIAS Level, Date and Source of Data.

MATERIAL	IFIAS No.	AGE OF DATA	SOURCE of BASIC DATA
Aggregate, general	4	1993	Industry data
virgin rock	3	1994	Manufacturer
river	3	1994	Manufacturer
Aluminium, virgin	3	1994	Companies in New Zealand and Australia. Published data for carbon anodes. Process analysis of Trans-Tasman shipping operation.
extruded	3	1995	
extruded, anodised	3	1995	
extruded, factory painted	3	1995	
foil	3	1995	
sheet	3	1995	
Aluminium, recycled	1	1995	Manufacturer
extruded	3	1995	
extruded, anodised	3	1995	
extruded, factory painted	3	1995	
foil	3	1995	
sheet	3	1995	
asphalt (paving)	4	1995	Manufacturer
bitumen	4	1995	Manufacturer
brass	4	1994	Manufacturer
Carpet			Sheltair Scientific Ltd. 1991
felt underlay	4	1992	AIA ERG
nylon	4	1992	
polyester	4	1992	
polyethylterephthalate (PET)	4	1992	
polypropylene	4	1992	
wool	4	1994	Industry data
Cement	4	1994	Industry data
cement mortar	2	1994	Lawson
fibre cement board	4	1994	Manufacturer
soil-cement	2	1995	Industry data
Ceramic			
brick	3	1994	Manufacturer
pipe	4	1991	Franklin Associates
tile	3	1994	Manufacturer
Concrete			
block	2	1994	Manufacturer
brick	2	1994	
GRC	3	1994	
ready mix 17.5 MPa	3	1994	Manufacturer
30 Mpa	3	1994	
40 Mpa	3	1994	
paver	3	1994	Manufacturer
pre-cast	2	1994	Lawson
concrete, roofing tile		1991	Sheltair Scientific Ltd. 1991
copper	3	1994	Manufacturer

MATERIAL	IFIAS No.	AGE OF DATA	SOURCE of BASIC DATA
Earth, raw			
adobe block, straw stabilised	4	1994	Manufacturer
adobe, bitumen stabilised		1991	AIA ERG
adobe, cement stabilised	2	1995	Industry data
rammed soil cement	2	1994	Lawson
pressed block	2	1995	Industry data
Fabric			
cotton	4	1991	AIA ERG
polyester	4	1991	
Glass	2	1994	Manufacturer, Lawson
float	2	1994	Manufacturer
laminated	2	1994	
tinted	2	1994	
toughened	2	1994	
Insulation			
cellulose	3	1995	Manufacturer
fibreglass	4	1991	AIA ERG
polyester	4	1991	
polystyrene		1991	Sheltair Scientific Ltd. 1991
wool (recycled)	3	1995	Manufacturer
lead	3	1995	Manufacturer
linoleum	4	1991	AIA ERG
Paint	4	1994	Manufacturer
solvent based	4	1994	
water based	4	1994	
Paper	4	1988	AIA ERG
building	2	1995	Manufacturer
kraft	2	1994	Industry data
recycled	4	1991	AIA ERG
wall	4	1988	
plaster, gypsum		1991	Sheltair Scientific Ltd. 1991
plaster board	3	1995	Manufacturer
Plastics	1	1994	Lawson
ABS		1991	Franklin Associates Ltd, 1991
HDPE		1994	Manufacturer
LDPE		1994	
polyester	4	1991	AIA ERG
polypropylene	4	1994	
polystyrene	2	1994	
polyurethane	2	1991	Manufacturer
PVC	2	1992	Manufacturer, industry data
Rubber			
natural latex	4	1991	AIA ERG
synthetic	2	1994	Lawson
sand	4	1993	Industry data
Sealants and adhesives			
phenol formaldehyde	2	1994	Lawson

MATERIAL	IFIAS No.	AGE OF DATA	SOURCE of BASIC DATA
urea formaldehyde	4	1990	AIA ERG
Steel, recycled	4	1995	Manufacturer
reinforcing, sections	4	1995	
wire rod	4	1995	
Steel, virgin, general	2	1994	Lawson
imported, structural	2	1994	Manufacturer
galvanised	2	1994	Lawson
Stone, dimension			
local	4	1993	Industry data
imported	1	1994	Importer
straw, baled	1	1978	Long, Taylor and Berry ¹⁵
Timber, softwood		1992	AIA ERG
air dried, roughsawn	1	1995	Industry data
kiln dried, roughsawn	1	1995	
air dried, dressed	1	1995	
kiln dried, dressed	1	1994	Lawson
mouldings, etc	1	1995	Industry data.
hardboard	1	1994	
MDF	4	1994	Manufacturer
glulam	1	1992	
particle board	1	1994	Lawson,
plywood	1	1994	
shingles	1	1991	Sheltair Scientific
Timber, hardwood			
air dried, roughsawn	1	1994	Lawson
kiln dried, roughsawn	1	1994	
vinyl flooring	2	1991	Sheltair Scientific
Zinc	2	1994	Lawson
galvanising	2	1994	manufacturer