L'opacità dell'industria green non è solamente un problema strategico

Enrico Mariutti

Come si calcolano le emissioni delle tecnologie verdi?

$$\frac{\text{Tutte le emissioni correlate alla costruzione dell'impianto}}{\text{Tutta l'energia che l'impianto produrrà nel suo ciclo vita}} = \textbf{gCO2/kWh}$$

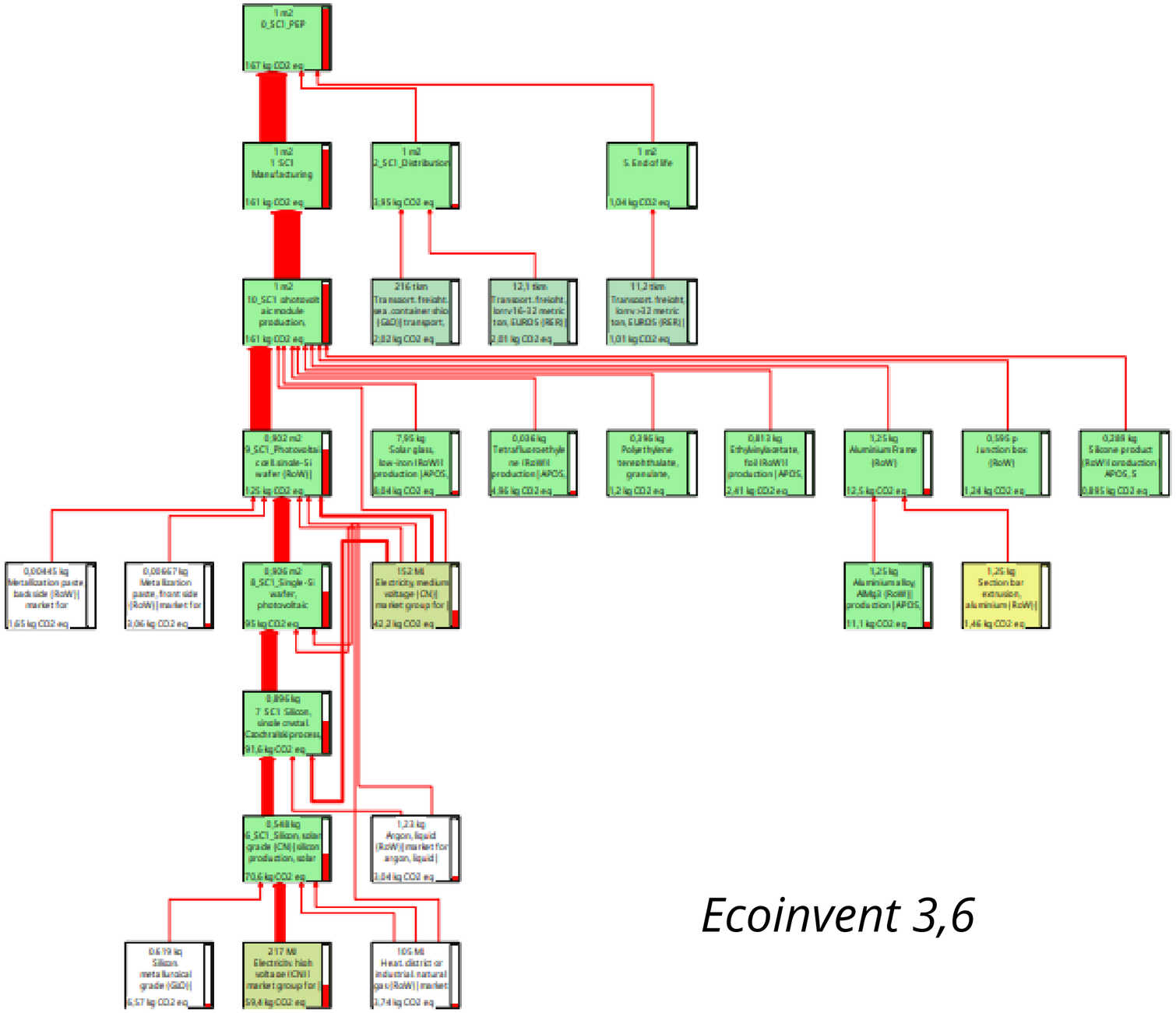
Come si calcolano le emissioni correlate alla costruzione di un impianto rinnovabile?

SCOPE 1	Le emissioni dirette
SCOPE 2	L’energia
SCOPE 3	La supply chain

Un esempio reale: LONGI (2020)

SCOPE 1	93.000 tCO2
SCOPE 2	2.500.000 tCO2
SCOPE 3	21.000.000 tCO2

I Database

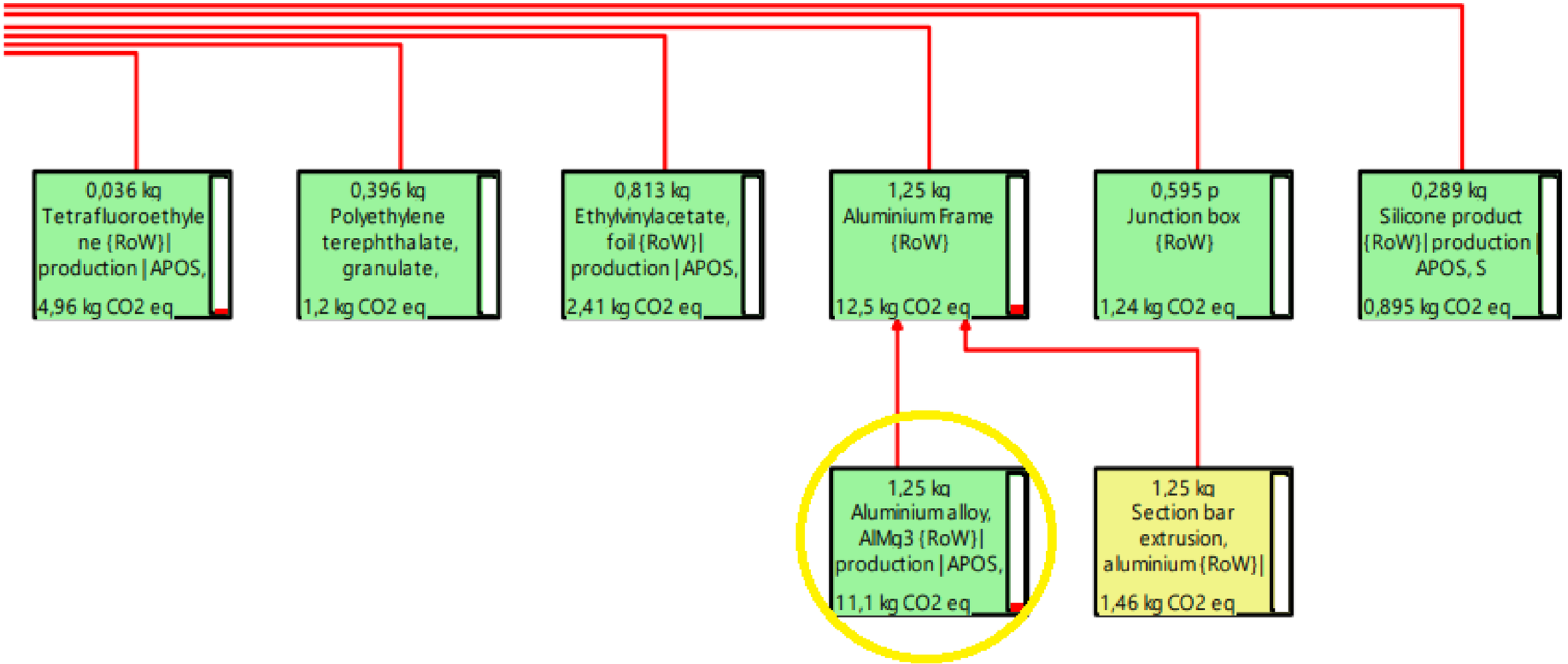


Ecoinvent 3,6

Trina Solar, 2023

Item	Data	Notes	Item	Data	Notes	Item	Data
Material consumptions:			Energy consumptions:			Waste emissions:	
Polycrystalline silicon slice	914.4 tons	3.66W / wafer Size: 8 inches	Electricity	50 million Kw		Cell workshop fluorinated wastewater	395,430 m^3
49% hydrofluoric acid	322.71 tons		Water	322.71 tons	1t water requires 7530 kJ 1 kWh energy equals 3600 kJ	General wastewater from component workshops	2120 m^3
66% nitric acid	428.65 tons					Domestic sewage	61,600 m^3
37% hydrochloric acid	537.72 tons					Clear water	153,448.7 m^3
98% sulfuric acid	33.38 tons					COD removal	0 tons
48% potassium hydroxide	191.15 tons		Combined energy consumption	50.83 million kwh		Fluoride	0.75 tons
POCl3	42.91 tons		Plant area	12,679 m^2		Silane	0.05 tons
Aluminum silver paste	12.96 tons					NOX	9.81 tons
Silver pulp	1415 tons		Equipment:			HCl	0.94 tons
Aluminum paste	12.49 tons		Diffusion furnace	8 set	6 million CNY/set	Cl2	5.96 tons
Glass	16,325.6 tons		Cleaning machine	4 set	0.6 million CNY/set	Silane	0.38 tons
PV Ribbon	210.3 tons		PEVCD	5 set	5 million CNY/set	Ammonia	1.68 tons
Nitrogen	2016.8 tons		Screen printing machine	9 set	1.2 million CNY/set	Terpineol	2.69 tos
Silane	4.32 tons		Sintering furnace	8 set	2 million CNY/set	Ethanol	2.05 tons
Ammonia	9.75 tons		Laminating equipment	15 set	130,000 CNY/set	General solid waste	579.82 tons
Oxygen	13.33 tons		Testing equipment	5 set	110,000 CNY/set	Hazardous solid waste	81.42 tons
EVA	1282.4 tons		Baling press	4 set	10,000 CNY/set	Garbage	283 tons
TPT	492.1 tons						
Aluminum frame	4953.9 tons		Employees: 1559				

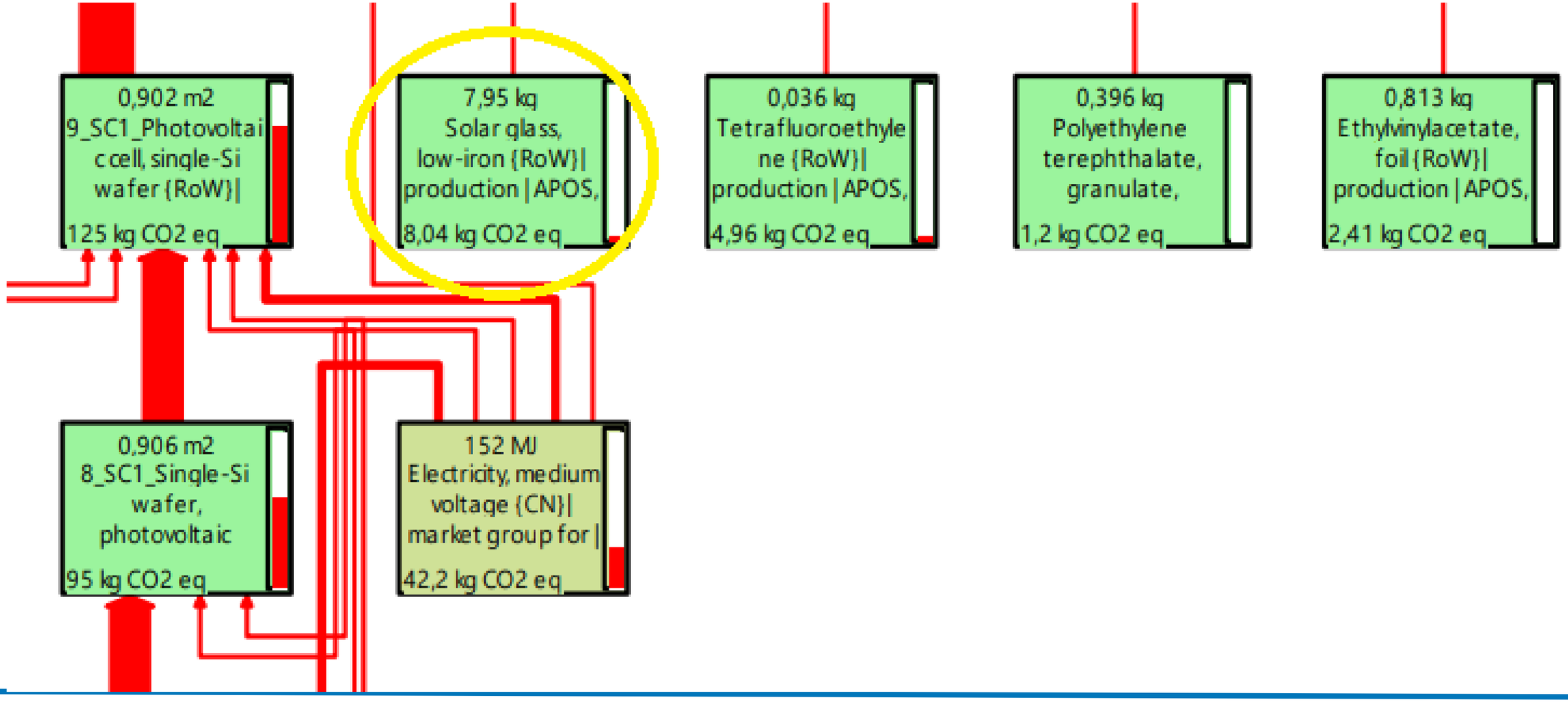
L’alluminio


0,036 kg
Tetrafluoroethylene {RoW}| production | APOS,
4,96 kg CO2 eq
0,396 kg
Polyethylene terephthalate, granulate,
1,2 kg CO2 eq
0,813 kg
Ethylvinylacetate, foil {RoW}| production | APOS,
2,41 kg CO2 eq
1,25 kg
Aluminium Frame {RoW}
12,5 kg CO2 eq
0,595 p
Junction box {RoW}
1,24 kg CO2 eq
0,289 kg
Silicone product {RoW}| production | APOS, S
0,895 kg CO2 eq
1,25 kg
Aluminium alloy, AlMg3 {RoW}| production | APOS,
11,1 kg CO2 eq
1,25 kg
Section bar extrusion, aluminium {RoW}|
1,46 kg CO2 eq

Period		Electricity-Indirect	Perfluorocarbon (PFC) – Direct	Process (CO_2)-Direct	Ancillary Materials-Indirect	Thermal Energy-Direct/Indirect	Transport-Indirect	Total-Cradle to Gate
2021	tonnes of CO_2e per tonne of primary aluminium							
	Mining	0.01	0.00	0.00	0.00	0.04	0.00	0.04
	Refining	0.4	0.0	0.0	0.4	1.6	0.2	2.7
	Anode Production	0.0	0.0	0.1	0.7	0.1	0.0	0.9
	Electrolysis	10.3	0.8	1.5	0.1	0.0	0.2	12.9
	Casting	0.0	0.0	0.0	0.0	0.1	0.0	0.1
	Primary Aluminium	10.7	0.8	1.7	1.2	1.8	0.4	16.6

International Aluminium, 2021

Il vetro


0,902 m2
9_SC1_Photovoltaic cell, single-Si wafer {RoW}|
125 kg CO2 eq
7,95 kg
Solar glass, low-iron {RoW}| production | APOS,
8,04 kg CO2 eq
0,036 kg
Tetrafluoroethylene {RoW}| production | APOS,
4,96 kg CO2 eq
0,396 kg
Polyethylene terephthalate, granulate,
1,2 kg CO2 eq
0,813 kg
Ethylvinylacetate, foil {RoW}| production | APOS,
2,41 kg CO2 eq
0,906 m2
8_SC1_Single-Si wafer, photovoltaic
95 kg CO2 eq
152 MJ
Electricity, medium voltage {CN}| market group for |
42,2 kg CO2 eq

		FG (0% RC)	CG (0% RC)	GW (0% RC)	AGG (0% RC)
Embodied energy distribution between product stages	1: Raw material sourcing & transportation	24% (Guardian Europe 2012)	28% (Guardian Europe 2012)	16% (Guardian Europe 2012)	N/A
	2: Glass melting	61% (Schmitz et al. 2011)	57% (Schmitz et al. 2011)	39% (Schmitz et al. 2011)	N/A
	3: Molten glass to primary product	15% (Schmitz et al. 2011)	15% (Schmitz et al. 2011)	45% (Schmitz et al. 2011)	N/A
	4: Additional processing i.e. Primary product to secondary product	COA = + 10% (Guardian Europe 2021) LAM = + 49% (Guardian Europe 2021) TOU = + 49% (Guardian Europe 2012)	N/A	N/A	N/A
Total embodied energy: Stages 1–3 (MJ/kg_{output})		16.9	14.3	25.2	0.083 (Hammond and Jones 2011)
Total energy saving potential ($MJ/kg_{secondary\ app}$)		4.5	3.8	4.4	0.083
Total embodied carbon: Stages 1–3 (kg CO_2-eq/kg_{output})		1.29	1.13	1.69	0.0052 (Hammond and Jones 2011)

Guardian Europe, 2022

Solare: non è solo questione di pannelli

Table 4 components for solar plant installation (per 50MWcapacity)

Components		Unit	Value
Module required per series	JKMxxxM-72H-V	pcs	1.25E+05
	JKMxxxM-72H-TV	pcs	1.27E+05
	JKMxxxM-7RL3-V	pcs	1.05E+05
	JKMxxxM-7RL3-TV	pcs	1.06E+05
	JKMxxxM-78H-V	pcs	1.12E+05
Inverter, 50kw		pcs	997
Bracket		ton	2806.7974
Cable, 1kv		km	675
Cable, 35kv		km	12
Compact sub-station		kg	149000
Steel		t	654.7
Concrete		m^3	5565.15
Transformer		kg	66260

Note: As for weight of cable, the mass is calculated with density 70kg/km for 1 kV cable, and 2000kg/km for 35kV cable. For concrete, the density is 2360kg/m3.

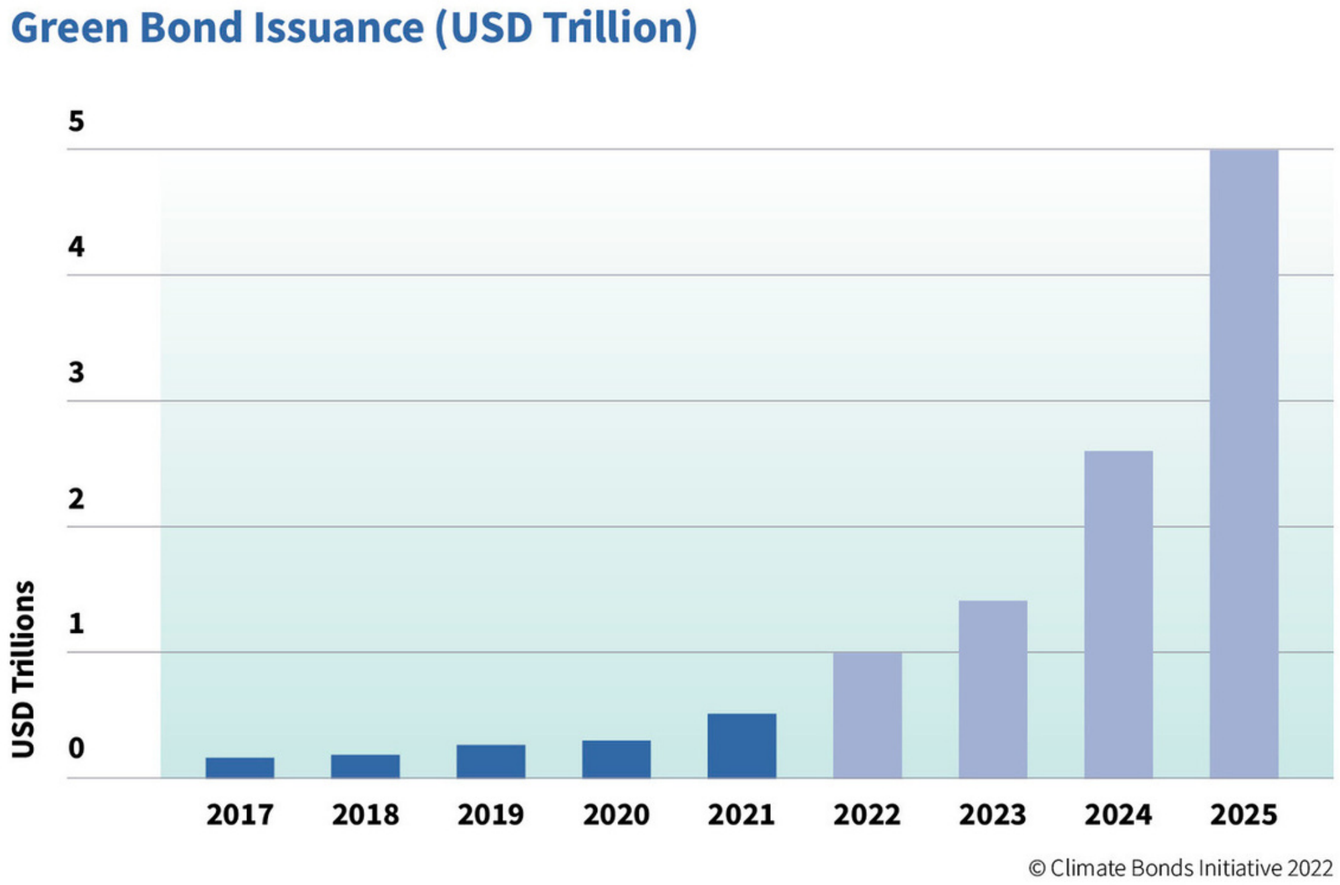
Jinko Solar 2021-2026 sulla base del LCI-database Ecoinvent 3.4

L’Unione Europea l’ha sempre saputo

Technical Expert Group on Sustainable Finance: Taxonomy feedback and workshop invitation

	The mitigation criteria outlined in this table considers only energy generation from PV, not taking into account emissions from PV manufacturing. Solar PV emissions can vary between 20g and 200g CO2-eq/kWh depending on the on the manufacturing processes implemented and on the materials used. Further consideration of how to capture emissions from manufacturing and materials will be addressed in the 2nd Round.

Il convitato di pietra



Ci sono delle alternative, usciamo dalla dimensione "decrescitista" e abbracciamo una prospettiva migliorativa.

CDR method	Status (TRL)	Cost[1] (USD tCO_2^{-1})	Mitigation potential[1] ($GtCO_2\ yr^{-1}$)	Risk and impacts
Afforestation/ reforestation	8–9	0–240	0.5–10	Reversal of carbon removal through wildfire, disease, pests may occur. Reduced catchment water yield and lower groundwater level if species and biome are inappropriate.
Soil carbon sequestration in croplands and grasslands	8–9	–45–100	0.6–9.3	Risk of increased nitrous oxide emissions due to higher levels of organic nitrogen in the soil; risk of reversal of carbon sequestration.
Peatland and coastal wetland restoration	8–9	Insufficient data	0.5–2.1	Reversal of carbon removal in drought or future disturbance. Risk of increased CH_4 emissions.
Agroforestry	8–9	Insufficient data	0.3–9.4	Risk that some land area lost from food production; requires very high skills.
Improved forest management	8–9	Insufficient data	0.1–2.1	If improved management is understood as merely intensification involving increased fertiliser use and introduced species, then it could reduce biodiversity and increase eutrophication.

AR6, Technical Reoport