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FACT SHEET

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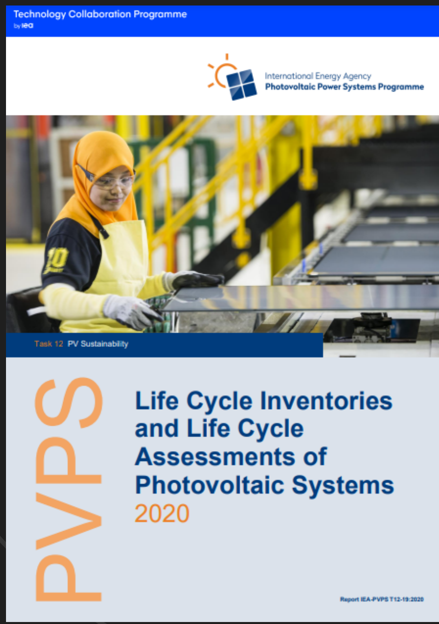


Environmental life cycle assessment of electricity from PV systems

PV POWER SYSTEMS TASK 12

R. Frischknecht, L. Krebs (Ed.)

Task 12 Operating Agents:
Jose Bilbao, UNSW, Australia
Garvin Heath, NREL, USA

IEA PVPS

Life Cycle Assessment

PV Life Cycle Assessment (LCA) is a structured, comprehensive method of quantifying and assessing material and energy flows and their associated emissions from:

01 **Manufacturing** - resource extraction, raw material production, wafer, cell and panel production

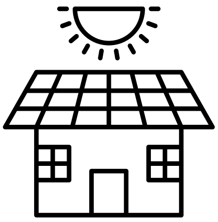
02 **Transport** - distribution and storage

03 **Installation** - roof mounting and cabling

04 **Use** - over 30 years and maintenance (with water)

05 **End of Life** - dismantling, recycling, waste management

PV scope



The scope of this study represents an average residential PV system:

- 1 kWh AC energy, produced with a 3 kWp roof-mounted PV system in Europe
- Scope includes PV panel, cabling, mounting structure, inverter and system installation
- 975 kWh/kWp annual production
- Linear degradation 0.7%pa
- Service life: Panel 30 yrs, Inverter 15 yrs

This study includes four PV module technologies with the following efficiencies:

1. Cadmium-Telluride (CdTe) 18%
2. Copper-Indium-Gallium-Selenide (CIS/CIGS) 16%
3. Multi crystalline Silicon (multi-Si, BSF) 18%
4. Mono crystalline Silicon (mono-Si, BSF) 19.5%

Resources

Report: Life Cycle Inventories and Life Cycle Assessments of Photovoltaic Systems 2020

Publications: IEA PVPS Task 12

Environmental Impacts

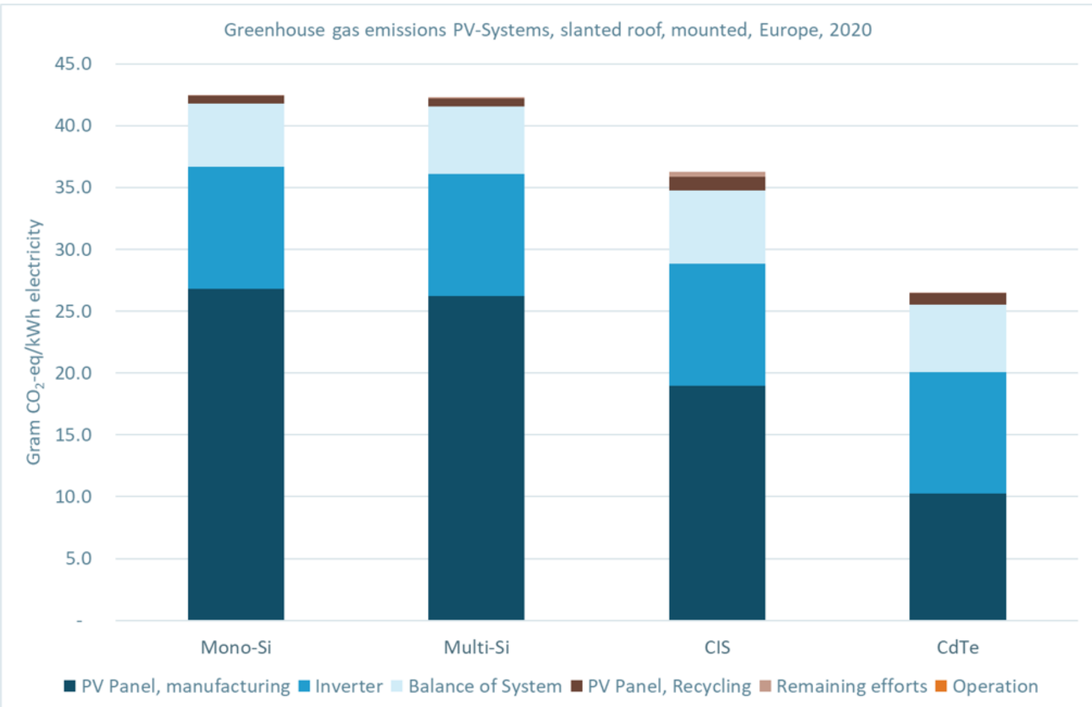
The carbon emissions associated with the generation of 1 kWh of solar electricity from PV systems are far lower than emissions from fossil fuel generators, which can emit up to 1 kg of CO_2 per kWh.

	Unit	Mono-Si	Multi-Si	CIS	CdTe
Greenhouse gas emissions	g CO_2 eq	42.5	42.3	36.3	26.5
Resource use, fossil fuels	MJ	0.54	0.54	0.54	0.38
resource use, minerals and metals	mg Sb eq	5.28	5.35	4.65	5.26
particulate matter	10^{-9} disease incidences	3.63	3.51	1.38	1.08
acidification	mmol H+ eq	0.36	0.36	0.23	0.19
water scarcity	l water eq	7.49	6.71	4.88	3.08
module efficiency	%	19.5	18.0	16.0	18.0

Emissions Contribution

Almost all emissions from the PV life cycle are through the **manufacture** of the system. There is little impact from end-of-life activities and almost no impact at all from their operation.

This is in direct contrast to fossil and nuclear power plants which release the majority of emissions through their ongoing **operation and fuel supply**.

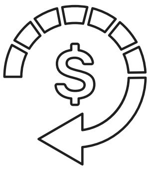


Environmental Impact Improvements

The environmental impact of PV systems has markedly reduced in values (expressed relative to 2011 values which equal 100%):

	Mono-Si	Multi-Si	CIS	CdTe
Greenhouse gas emissions	40.2%	63.7%	79.0%	94.8%
Resource use, fossil fuels	44.6%	66.1%	79.6%	95.9%

Payback time



Non renewable energy payback time is defined as the period required for a renewable energy system to generate the same amount of energy (in terms of non renewable primary energy equivalent) that was used to produce the system itself:

	unit	Mono-Si	Multi-Si	CIS	CdTe
NREPBT	year	1.2	1.2	1.3	0.9

Task 12 objectives

- Quantify the environmental profile of PV in comparison to other energy technologies;
- Define and address environmental health & safety and sustainability issues that are important for market growth.

Sub tasks:

1. End of Life of PV Systems
2. Environmental Life Cycle Assessment (LCA)
3. Other PV sustainability topics

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