

# Material Demand for 1MW rated capacity for Solar, Wind, Geothermal plants

- The quantities of materials needed to manufacture and install 1 megawatt (MW) of silicon-based solar PV, Onshore Wind, Offshore Wind and Geothermal plants vary vastly across projects and total amounts differ depending on the models and manufactures. There are averaged quantities of materials in the table below\*.
- Installation of Renewable systems will increase demand for metals significantly, which means more mining. Raw materials are becoming essential components of a future clean global energy system.
- According to the International Energy Agency (IEA), global demand for critical raw materials will quadruple by 2040.

Tonnes	1MW power plant				
	Solar	Onshore Wind	Offshore Wind	Geothermal (2 new wells)	Geothermal (2 repurposed wells)
Steel	56	117	550	400	0
Concrete	47	457	1	900	0
Aluminium	19	3	0	0	0
Copper	7	2	381	0	0
Lead	0	0	300	0	0
Glass	70	0	0	0	0

# The difference between rated and effective capacities

- Rated (or nominal) capacity is the maximum capacity for which a system is designed at specified conditions
- Effective (or actual) capacity is the maximum rate of the output which can be achieved under the operating constraints. Always lower than design capacity.
- Solar and Wind are intermittent, and even being designed to produce 1MW, such power plants work at rated capacity only 30-40% of the time.
- To supply 1MW for 24 hours, i.e. 24MWh/day, Solar and Wind plants need to be designed with more than 1MW rated capacity and with energy storage systems (batteries) to store surplus electricity for supply during night time and wind lulls.
- Geothermal 1MW plant provides persistent, stable, flat 24MWh/day, regardless of weather conditions and without energy storage systems.

# Material Demand for 1MWe (effective) Solar, Wind, Geothermal plants

- To supply 1MW for 24 hours, i.e. 24MWh/day, Solar plant should be sized about 6MW with ESS is about 20MWh\*.
- To supply 1MW for 24 hours, i.e. 24MWh/day, Wind plant should be sized about 4MW with ESS is about 12MWh\*.
- The averaged quantities of materials and associated carbon footprint to manufacture and install 1 MWe Solar PV, Onshore Wind, Offshore Wind and Geothermal plants are represented in the table below.
- No transportation emissions are estimated. Averaged emissions factors tCO2 per 1 tonne of material are used.

	6MW power plant	4MW power plant		1MW power plant	
Tonnes	Solar	Onshore Wind	Offshore Wind	Geothermal (2 new wells)	Geothermal (2 repurposed wells)
<b>Steel</b>	336	468	2200	410	10
<b>Concrete</b>	282	1828	4	900	0
<b>Aluminium</b>	114	12	0	0	0
<b>Copper</b>	42	8	1524	0	0
<b>Lead</b>	0	0	1200	0	0
<b>Glass</b>	420	0	0	0	0
<b>tCO2/1MWe</b>	<b>2751</b>	<b>2527</b>	<b>10733</b>	<b>1618</b>	<b>23</b>
<b>tCO2/batteries</b>	<b>1600</b>	<b>960</b>	<b>960</b>	<b>0</b>	<b>0</b>

# Carbon Footprint from 1MWe Solar, Wind and Geothermal plants

- Building Renewable power plants creates a carbon footprint, which varies between different renewable types with the lowest emissions from repurposed wells for Geothermal power plants.
- Among renewable sources, only Geothermal can provide persistent and dispatchable baseload.
- Solar and Wind are intermittent, and even being designed to produce 1MW, such power plants work at rated capacity only 30-40% of the time.
- The life-cycle emissions from Renewable power plants are much smaller than the remaining emissions from conventional fossil fuel power plants.

