

Land and Water Energy Nexus: the critical resource constraint

Generating all types of electric power requires land and freshwater resources. The land requirement starts from the mining of the Bill-of-Materials (BOM) for the electric power system, often a dominating factor in the use of land for the entire supply-chain (as it is for coal power). Freshwater withdrawal is critical for electricity generation by thermal power plants – a steam turbine cannot operate without this resource. Other urgent human needs compete for land and water, in particular agriculture for food production.

	Hydrometallurgical leaching of Uranium	Water fill of hydropower dam reservoirs
Mining footprint	Coal washing	Evaporation loss
Power plant deployment space	Fracking of Natural Gas	River diversion
Human and plant life safety buffer area	LAND WATER	Steam for Turbine
Roads	Hydrometallurgical leaching of Quartz	Cooling Requirement of thermal power plants
Transmission lines		Polysilicon processing
Waste disposal		Wafer cutting, cleaning
		Solar array cleaning

While the field data for land and water use is not available in as much precise detail as for industry manufacturing or laboratory processes, there is sufficient information for conclusive comparative analysis.

Land and freshwater resources are unevenly distributed, across national boundaries carved by historical happenstance, for human habitat. There are over 1,300 people per km² in Bangladesh vs 3 per km² in Australia. Egypt has only 600m³ per person per year of renewable freshwater resources, compared to 16,000m³ per person per year for the Congo. In our guide, “Managing Solar Energy”, we analyse the critical resource constraints of land and water for various electricity generation options, including solar photovoltaic (PV) power.

What resource limits sustainable regional and global electrification: is it the availability of unused land or renewable freshwater?

Which power plants can be deployed on different types of land?

What kind of electric power systems are suitable for dual-use of land, e.g. sharing land for agriculture?

How can an electricity generation portfolio result in a compounded crisis of acute electricity and water shortages?

Floating solar PV systems can save land and water. Land constraints for smaller countries are eased, and less freshwater held in reservoirs is lost to evaporation.