

# Environmental Impact: Semiconductor Fabrication

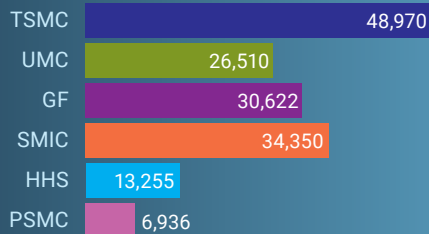
Fabricating semiconductor chips involves large quantities of raw materials and waste generation. In a 2022 study in *Science of the Total Environment*, Marcello Ruberti, an economist with the University of Salento, Italy, analyzed the impacts of a number of key chip producers. We highlight some of his findings below. (For a look at an effort to make microchip production more sustainable, see p. 18.)

## FABRICATION MARKET SHARE

Wafer fabrication firms with the largest market shares made up nearly one fifth of the total global semiconductor market revenue, which was more than US\$550 billion in 2021.

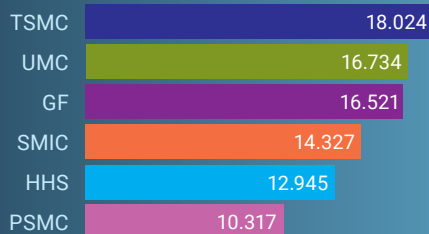
**53%** Taiwan Semiconductor Manufacturing Company (TSMC) | **18%** Samsung Semiconductor Global\* | **7%** United Microelectronics Corp. (UMC) | **6%** GlobalFoundries (GF) | **5%** Semiconductor Manufacturing International Corp. (SMIC) | **2%** Hua Hong Semiconductor Ltd. (HHS) | **2%** Powerchip Semiconductor Manufacturing Corp. (PSMC)

## REVENUE [USD/wafer-m<sup>2</sup>]



## ENERGY INTENSITY [MWh/wafer-m<sup>2</sup>]

Energy powers equipment and guarantees continuous high critical cleanroom standards.

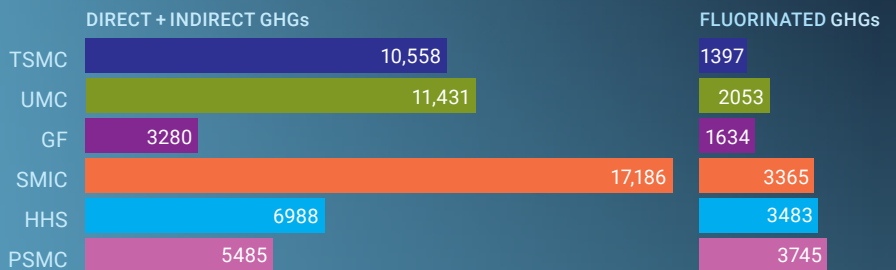


REPORT PARAMETERS: A single common manufacturing index was adopted to process company data, equivalent to the total area of the wafers annually produced [wafer-m<sup>2</sup>] by a specific foundry, taking into account the number of wafers manufactured and number of masking steps or layers required.

\*Samsung Group was excluded from the findings, as performance info about its Semiconductor Division alone was not available.

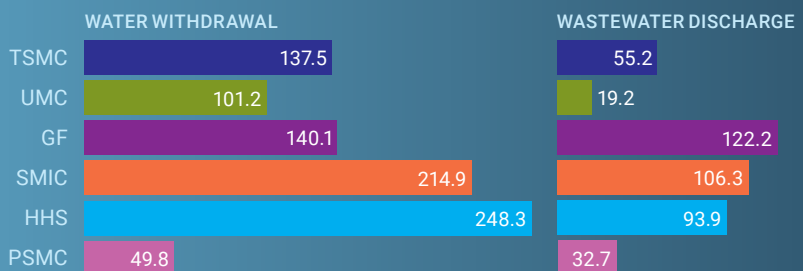
## GREENHOUSE GAS (GHG) EMISSIONS [kg CO<sub>2</sub>e/wafer-m<sup>2</sup>]

Semiconductor fabrication produces a considerable amount of GHG emissions, and huge amounts of fluorinated compounds (CH<sub>3</sub>F, CHF<sub>3</sub>, CH<sub>2</sub>F<sub>2</sub>, CF<sub>4</sub>, C<sub>2</sub>F<sub>6</sub>, C<sub>3</sub>F<sub>8</sub>, NF<sub>3</sub>, SF<sub>6</sub>) with high global-warming potential are used during the process.



## WATER USAGE [tons/wafer-m<sup>2</sup>]

Enormous volumes of ultrapure water, which must be completely free of dissolved particles, ions and gases, are required for the production of a single square meter of wafer.



## WASTE GENERATED [kg/wafer-m<sup>2</sup>]

Many different wastes are produced during chip fabrication, both general (e.g., sludge from water treatment and domestic waste) and hazardous (e.g., waste acids and solvents).

