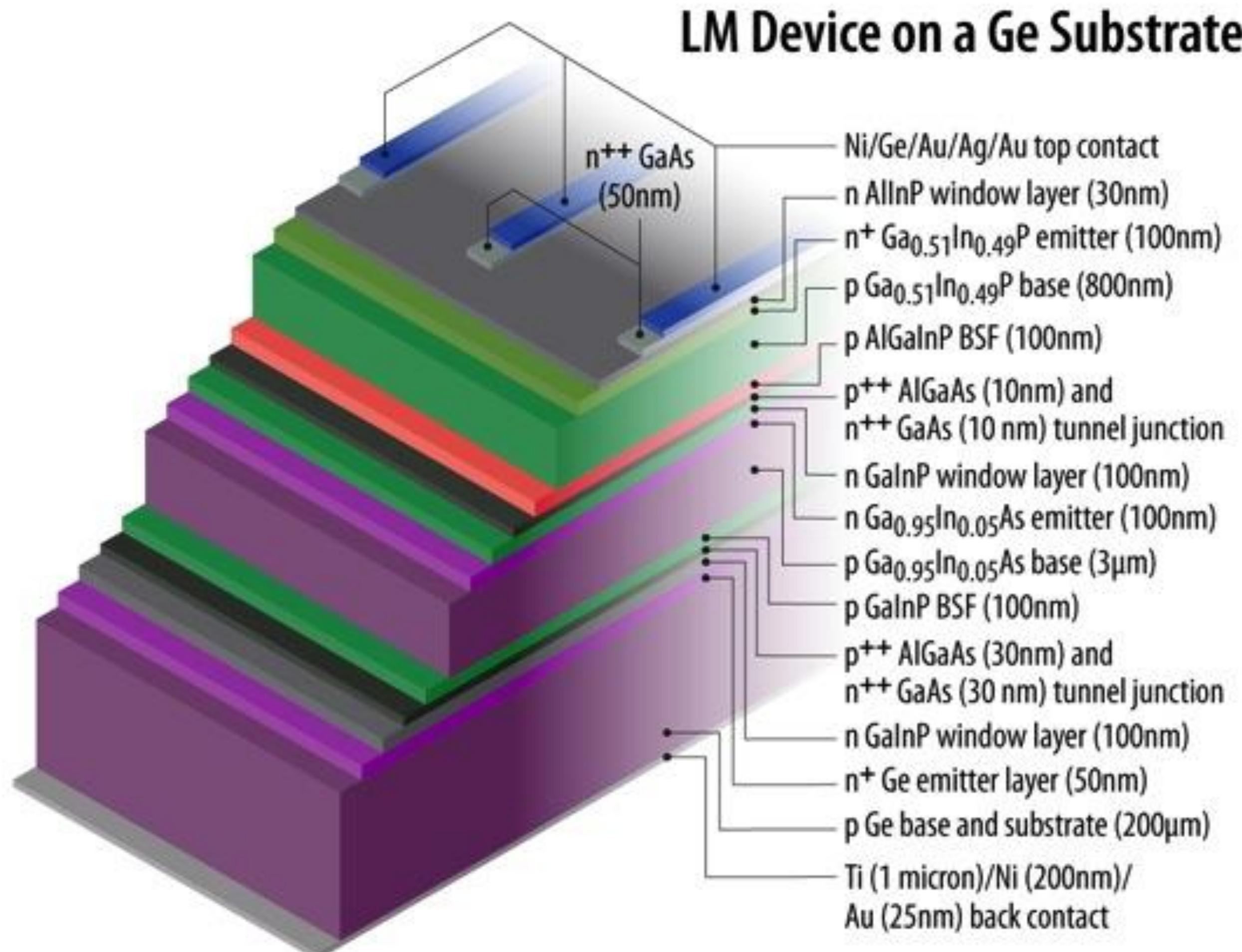


# Technoeconomic analysis and cost-reduction strategies for space-grade solar cells

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## Device Architecture



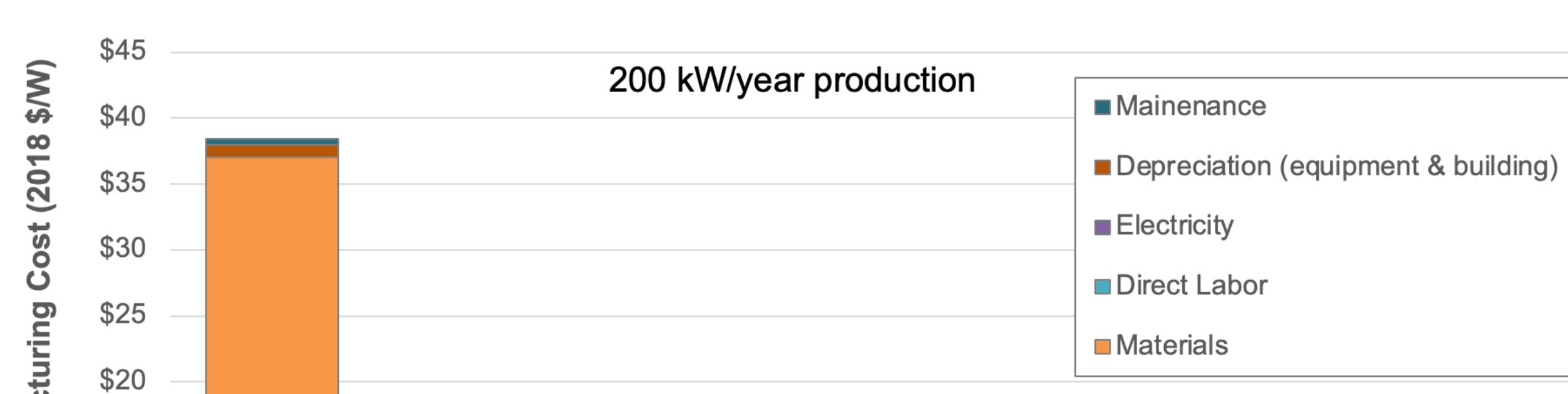
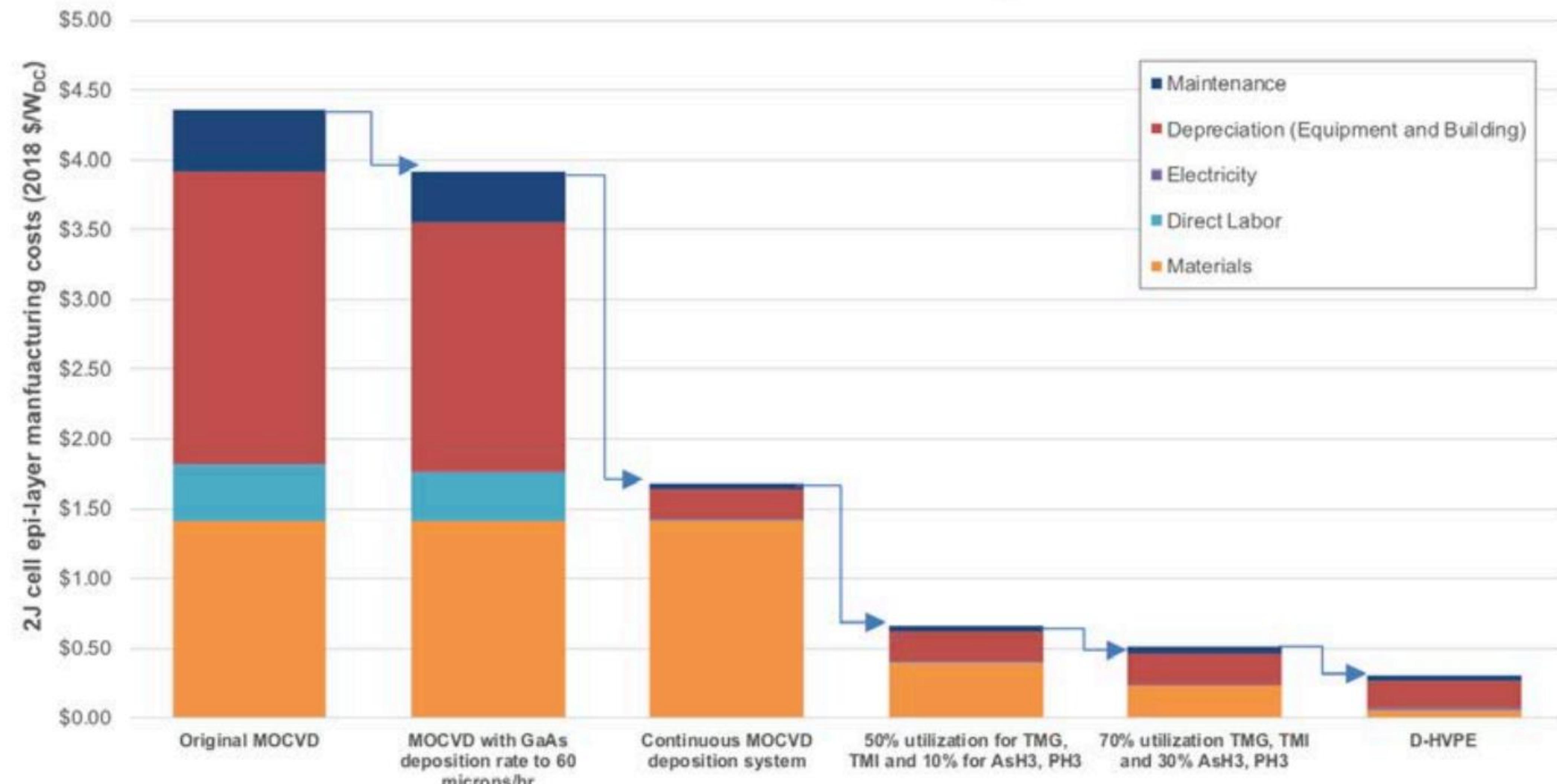
Schematic of generic 3J III-V cell device stack

## Manufacturing Costs and Sensitivity Analysis

Parameter	Value	Notes
MOCVD tool cost	\$2.8million/tool	Includes installation and auxiliary costs
MOCVD batch size	8	6-inch wafers
MOCVD tool uptime	85%	
Heat/cool + pump/vent time for MOCVD	30 min	
GaAs deposition rate	15 μm/hour	
InGaP deposition rate	4 μm/hour	
Trimethylgallium (TMG) price	\$1/g	Prices can vary widely depending on the production location and company's leverage and supply chain. Prices as low as \$0.45/g for Chinese manufacturing (of LEDs and other devices) have been reported.
Trimethylindium (TMI) price	\$12/g	Prices can vary widely depending on the production location and company's leverage and supply chain.
TMG, TMI material utilization rate	30%	Used to calculate AsH <sub>3</sub> and PH <sub>3</sub> usage
Average V/III ratio	22	
Arsine (AsH <sub>3</sub> ) price	\$0.44/g	
Phosphine (PH <sub>3</sub> ) price	\$0.35/g	
Gold (Au) price	\$43/g	Assume recycling of Au that is utilized
Silver (Ag) price	\$0.55/g	
Ge substrate price	\$130/6-inch substrate	Prices can vary depending on the production location and company's leverage and supply chain, with prices roughly between \$120/substrate and \$150/substrate
Cell area	133 cm <sup>2</sup>	Cropped 6-inch (150mm) wafer
Cumulative yield loss	20%	For the 3J cell on Ge only. Higher yield loss is assumed for later analysis on lift-off cells and is specified in Table 2.
Equipment depreciation	5-year straight-line	
Building depreciation	20-year straight-line	
Labor rates	\$14/hr for unskilled labor, \$25/hr for skilled labor	Will vary by location; these are meant to represent a mid-cost location in the United States.

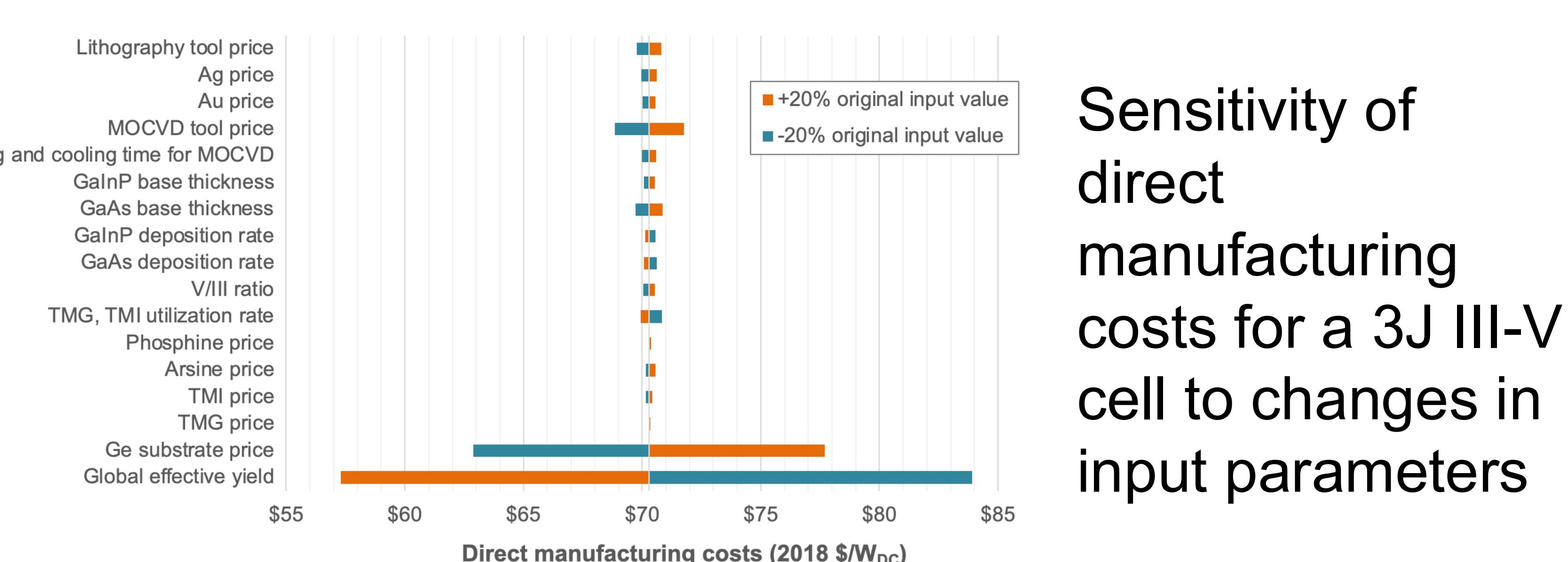
Example input parameters for 3J III-V device cost modeling

## Low Cost Pathways



Impact of throughput and utilization on 2J GaInP/GaAs epi-layer costs

Step-by-step manufacturing cost breakdown for the 3J LM III-V solar cell



Sensitivity of direct manufacturing costs for a 3J III-V cell to changes in input parameters

Ongoing work: Identifying solutions for scaling space solar cell manufacturing and bringing research innovation to commercialization

## References

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