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# High-Efficiency Silicon Solar Cells

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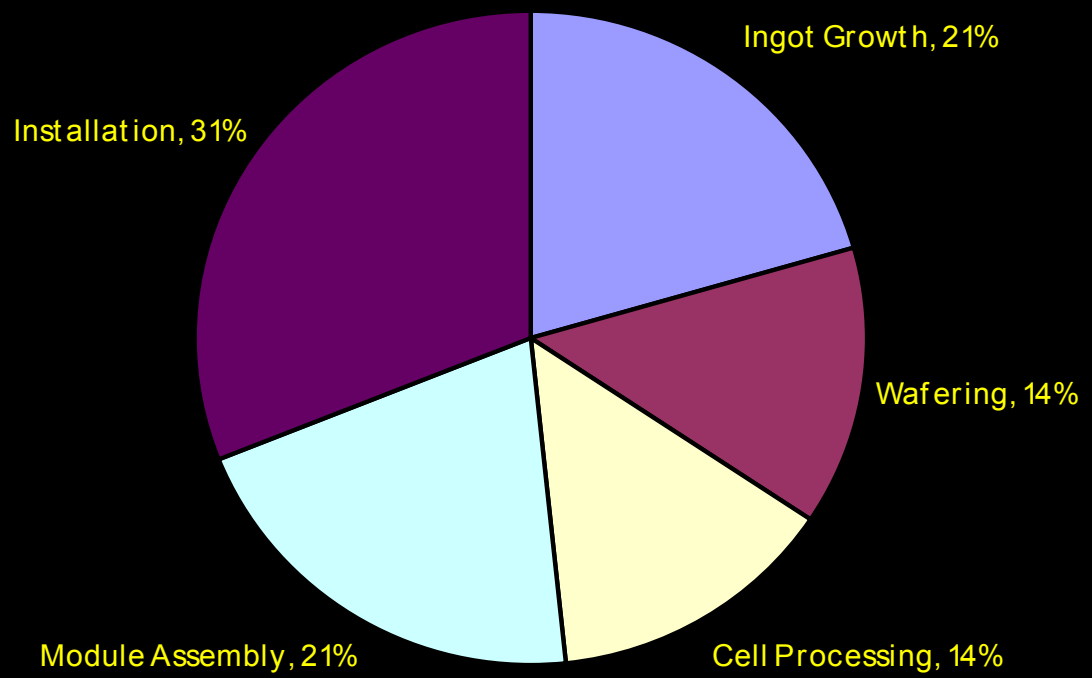
# PV System Cost Components




Higher efficiency leverages cost savings throughout the value chain

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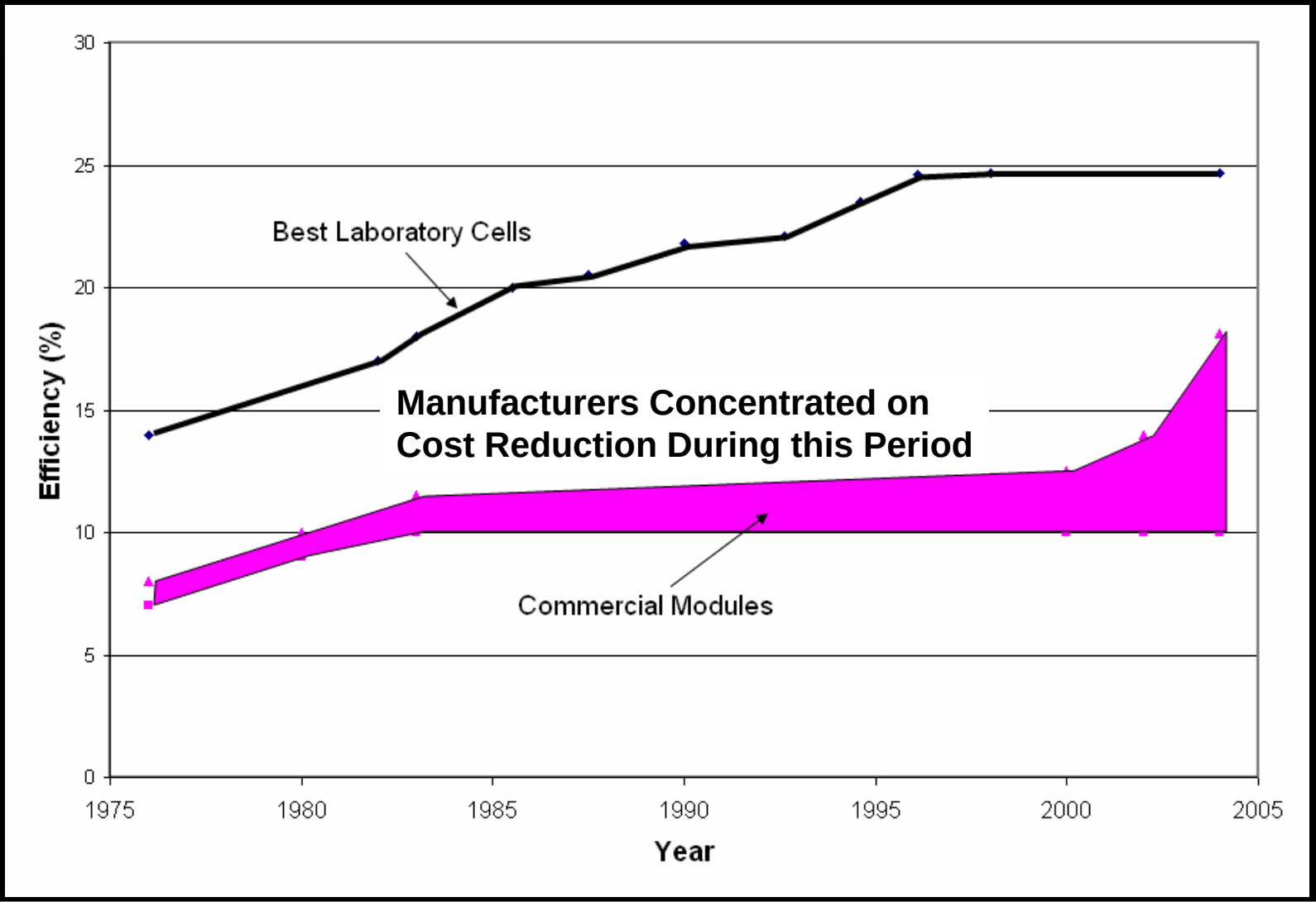
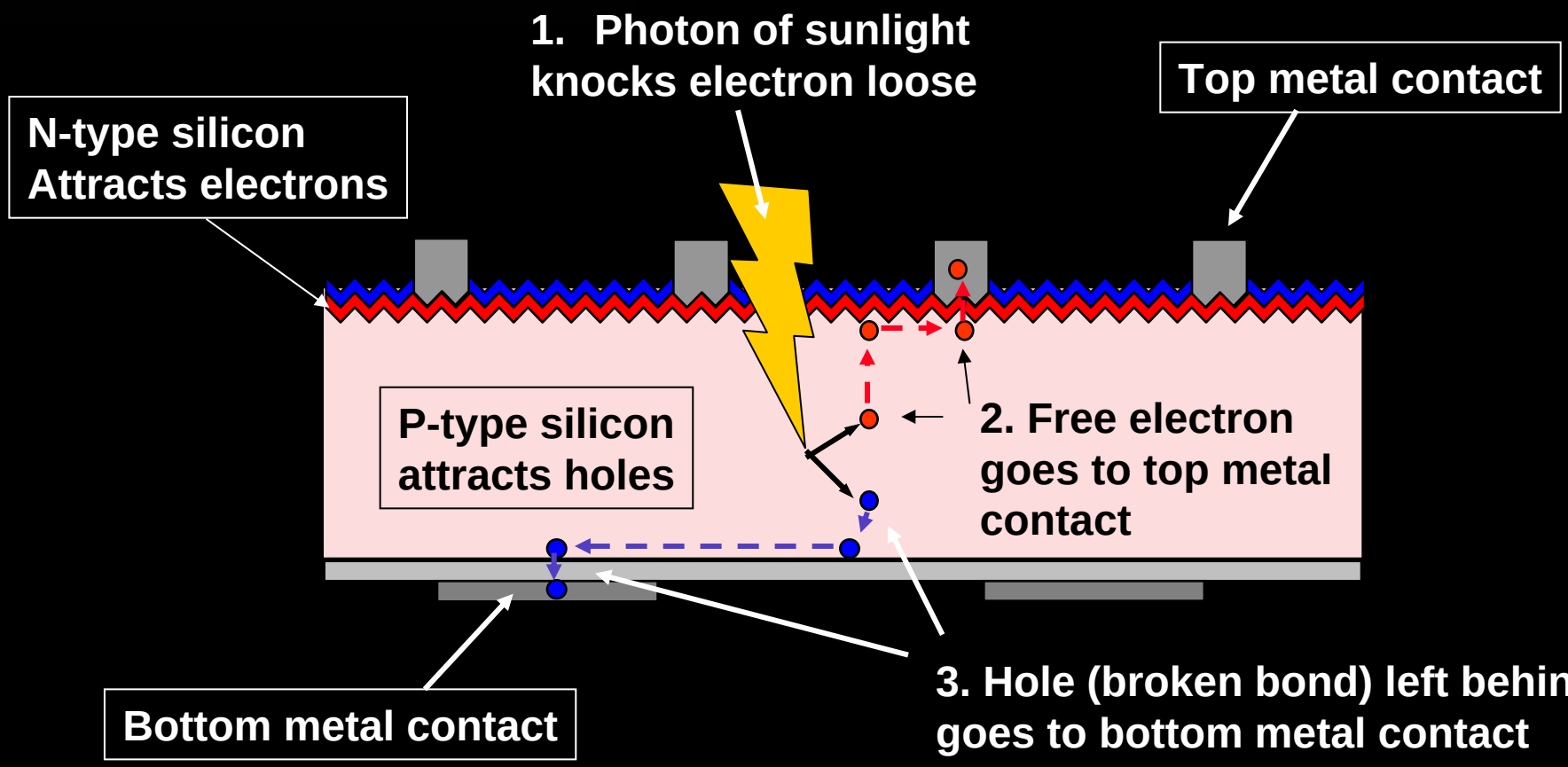
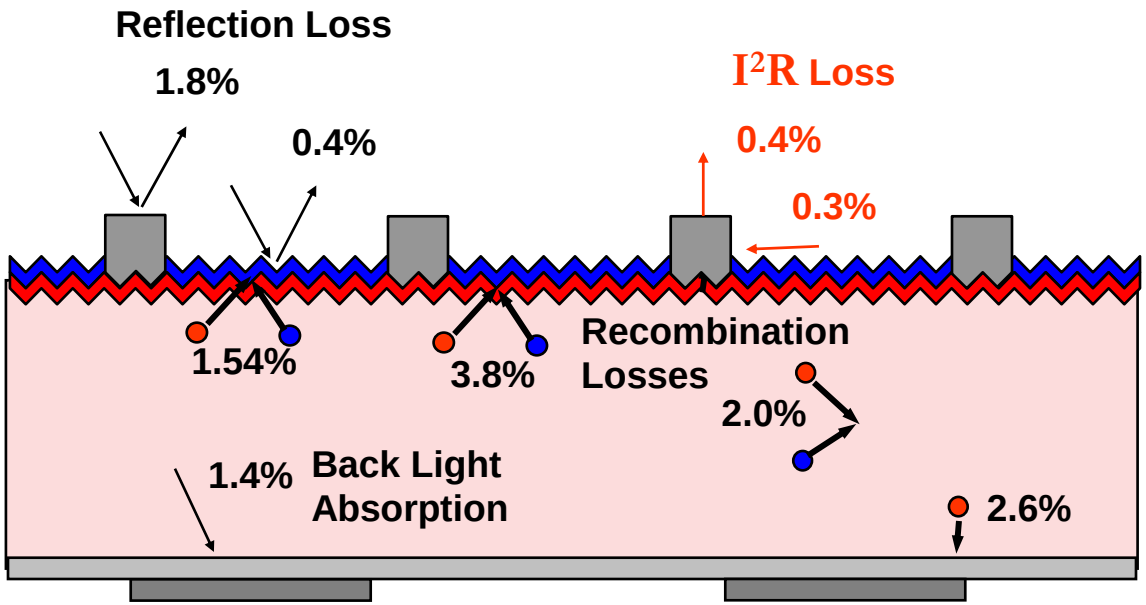
# Historical Silicon PV Efficiency



# Solar Cell Operation (cont.)



# Conventional Solar Cell Loss Mechanisms




| | |
|---|---|
| **Limit Cell Efficiency** | **29.0%** |
| **Total Losses** | **-14.3%** |
| **Generic Cell Efficiency** | **14.7%** |

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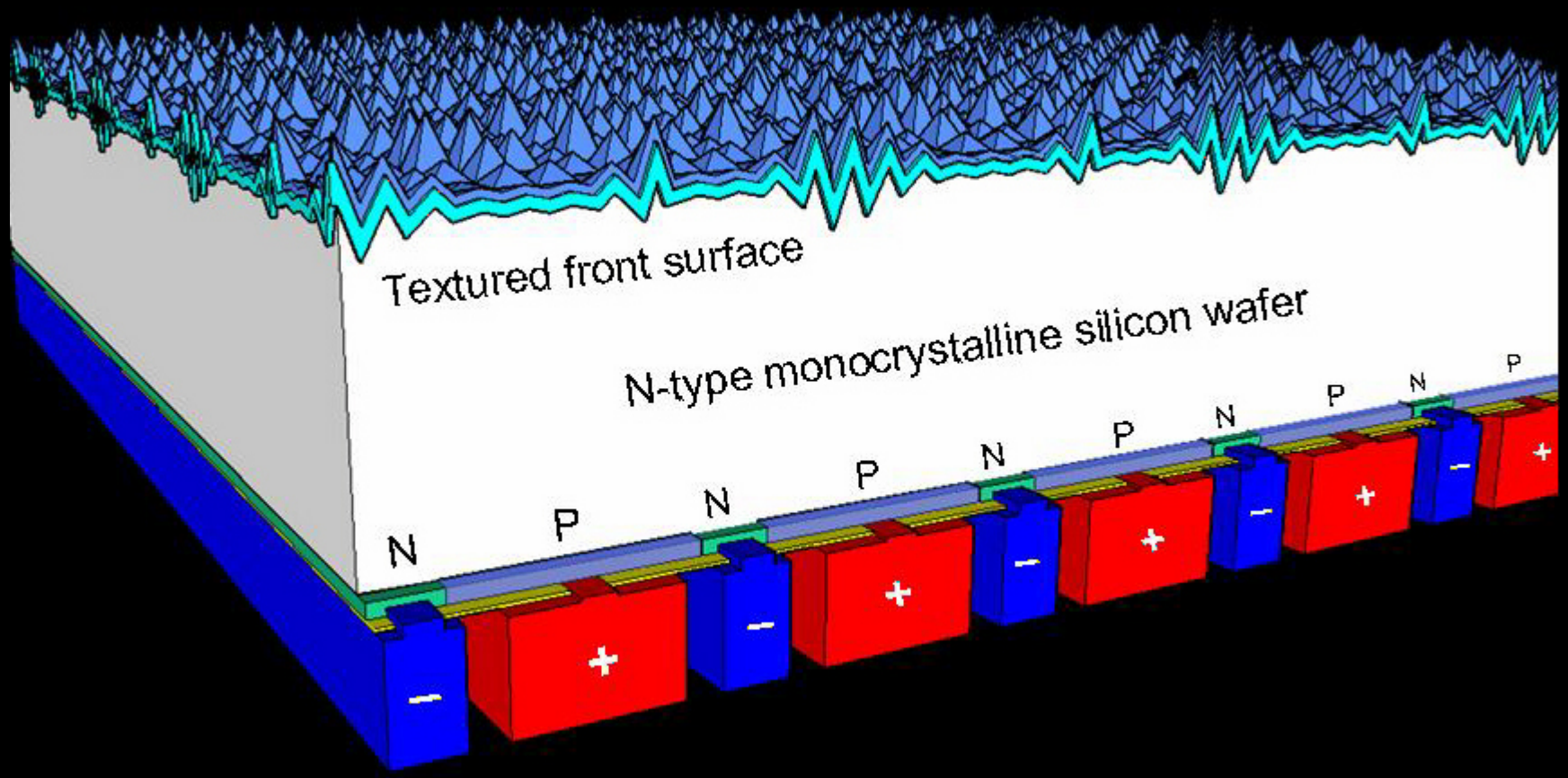
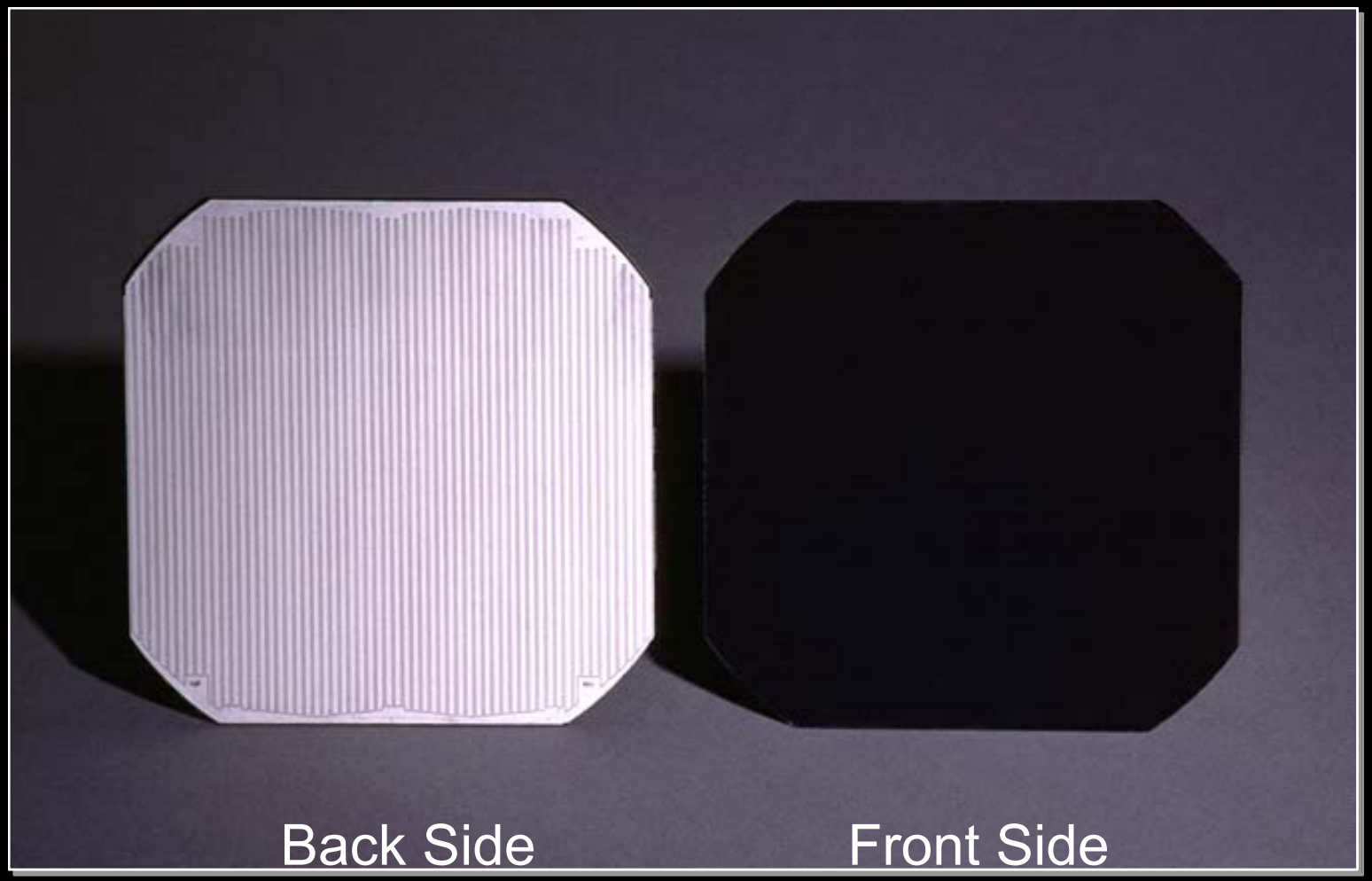
# The All-Back-Contact Solar Cell

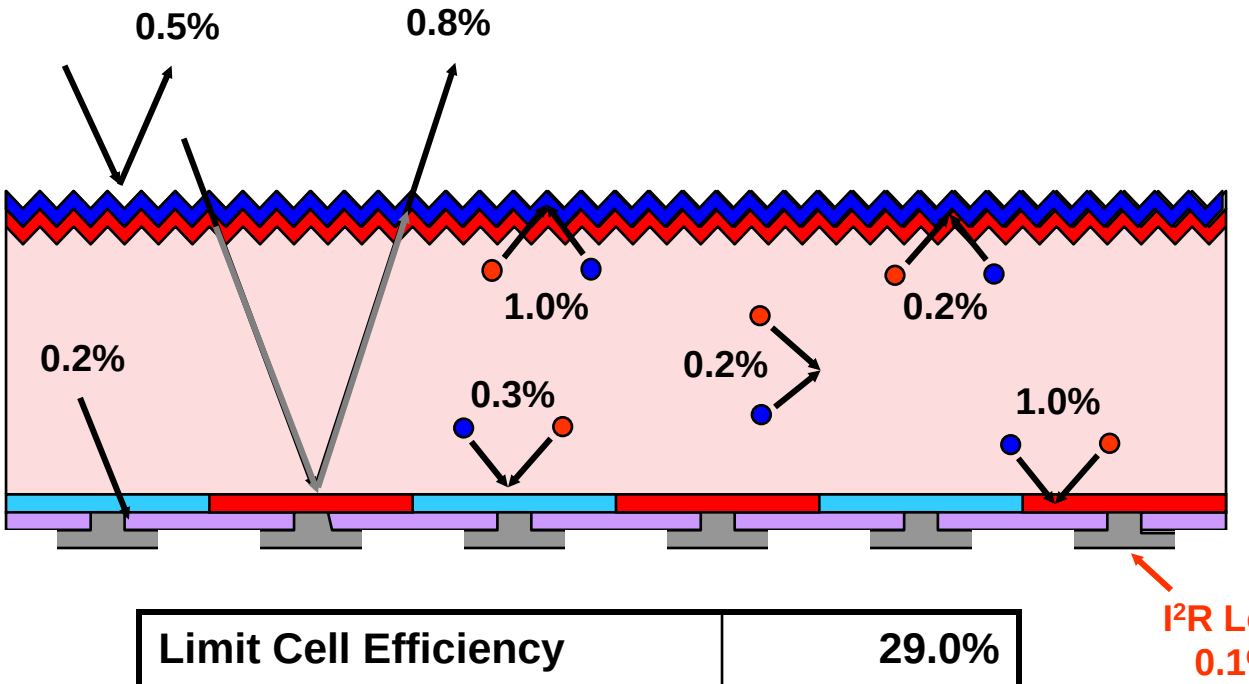



By locating all of the electrical contacts on the back surface, SunPower is able to achieve conversion efficiencies up to 50% higher than conventional solar cells.

# A300

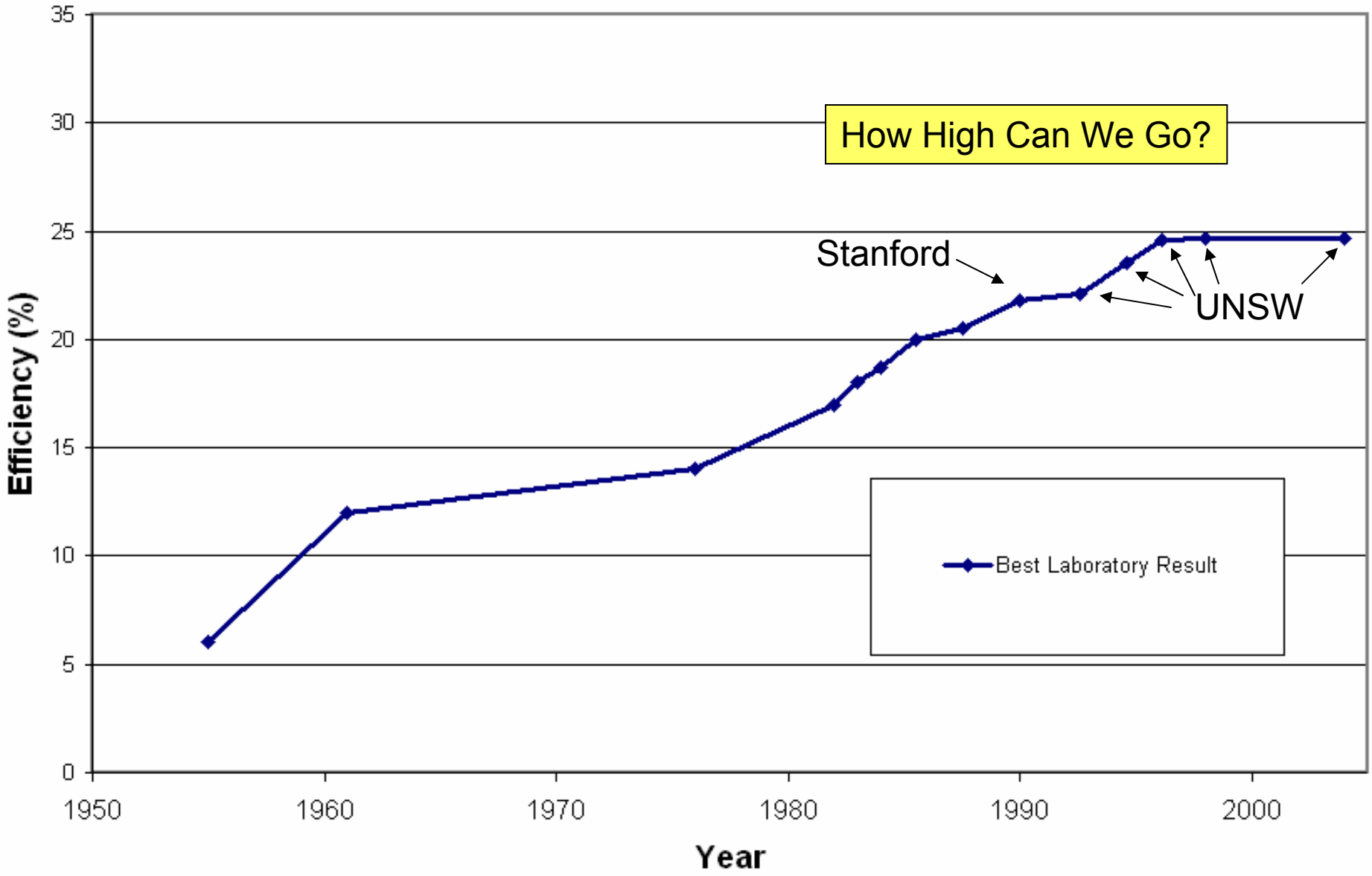


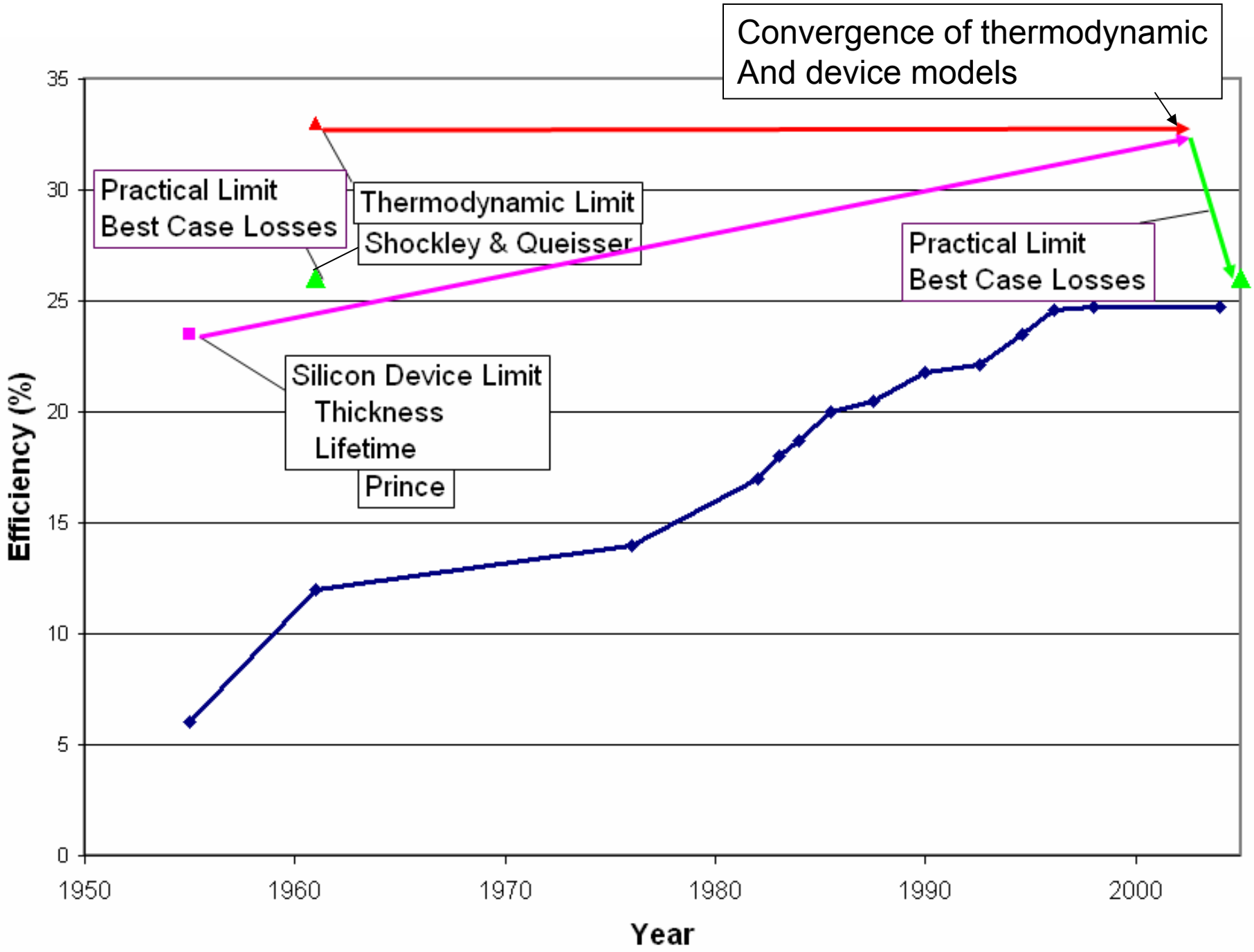
# High-Efficiency Back-Contact Loss Mechanisms



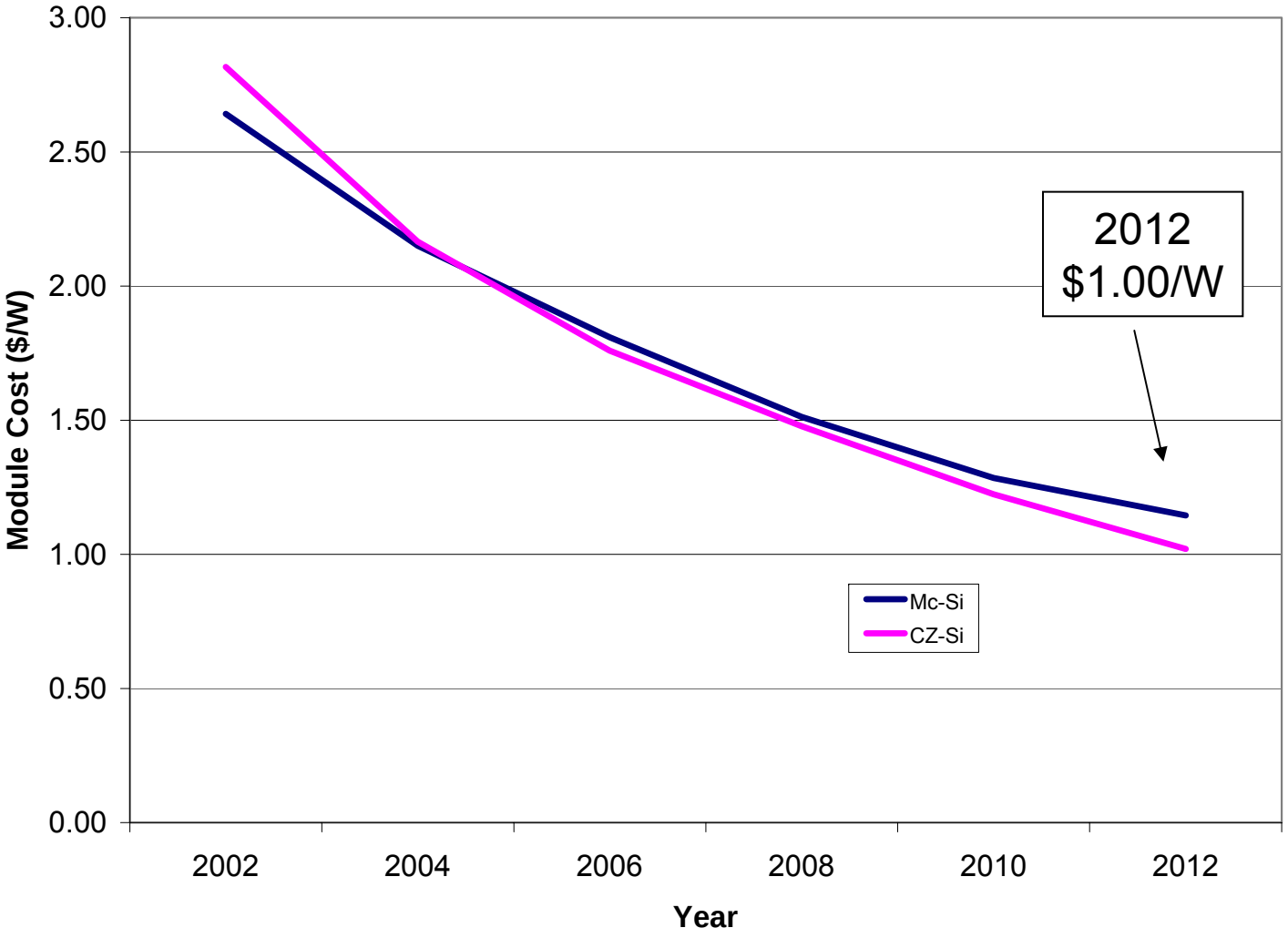

| | |
|---|---|
| **Limit Cell Efficiency** | **29.0%** |
| **Total Losses** | **-4.4%** |
| **Enabled Cell Efficiency** | **24.6%** |

# History of Best Laboratory Silicon Cells




Convergence of thermodynamic
And device models
Practical Limit
Best Case Losses
Thermodynamic Limit
Shockley & Queisser
Practical Limit
Best Case Losses
Silicon Device Limit
Thickness
Lifetime
Prince
Efficiency (%)
Year
0
5
10
15
20
25
30
35
1950
1960
1970
1980
1990
2000

# Module Manuf. Cost Roadmap



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# Factors Driving Future Cost Reduction

- Increasing efficiency: 16% →25%
- Reduced thickness: 220 µm → 120 µm
- Increased cell size: 125 mm → 200 mm
- Improvements in crystal growth technology
- Improvements in slicing technology
- Increased manufacturing scale:
  200 MW → 500 MW
- More automation

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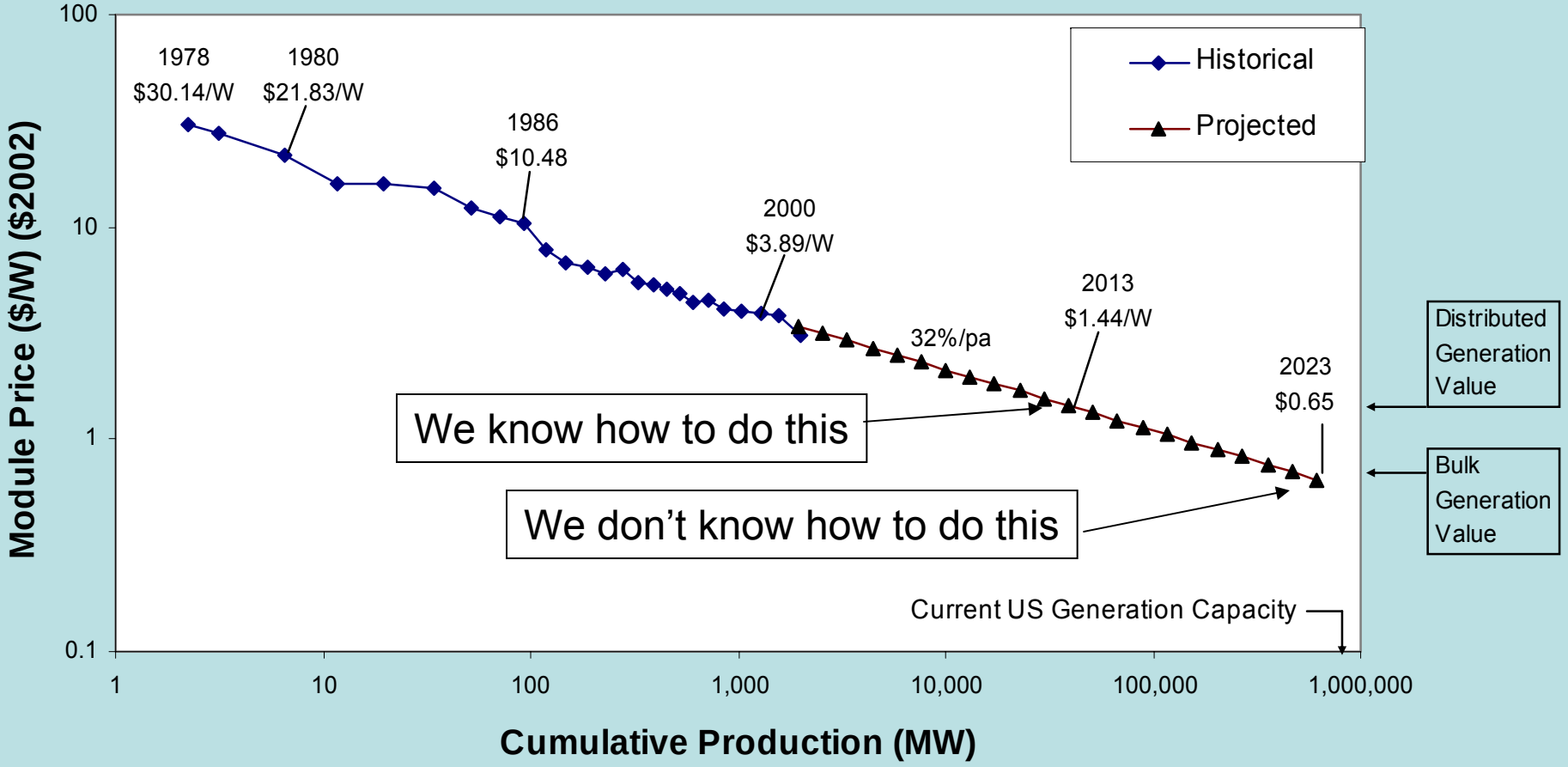
# Extending Projection to 2023 Predicts Cost-effective Bulk Power



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# Bottom Line
# The Future of Solar Cells

| Year | PV Market | System Cost | Energy Status | Dominant Technology |
|---|---|---|---|---|
| 2005 | 1 GW | $6.00/W | Negligible Contribution | Wafered Silicon |
| 2010 to 2015 | 10 GW | $3.00/W<br>Building Integrated Incentive Investments End | "The Tipping Point"<br>Cost Effective Building Integrated Applications | Wafered Silicon |
| 2020 to 2025 | 100 GW | $1.50/W | Emergence of Large Distributed Plants. PV Becomes a Major Source of Energy. | • Wafered Silicon?<br>• Thin Films?<br>• Concentrators?<br>• NANO? |