

PROCESS DEVELOPMENT

N86-29387
LIFE-CYCLE COSTS OF HIGH-PERFORMANCE CELLS

JET PROPULSION LABORATORY

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Introduction

- **Value of PV system must include all costs and revenues associated with the system over its lifetime**
- **Methodology used in this study determines:**
 - (1) **The value of improvements to the lifetime power output of a PV system**
 - (2) **How much additional expense could be added during cell and module fabrication to achieve that added performance**
- **How does the initial cost relate to the final value?**

Study Activities

- **To compare the NPV of the life-cycle cost of four PV module production technologies**
 - (1) **1985 MY SOA Cz at 5 MW annual prod.**
 - (2) **1992 MY SOA Cz at 25 MW annual prod.**
 - (3) **1992 MY high-eff. Cz at 25 MW annual prod.**
 - (4) **1992 MY high-eff. web at 25 MW annual prod.**
- **Look at various module and system configurations:**
 - **Large and standard module size**
 - **Series — parallel circuitry**
 - **Cross strapping**
 - **Bypass diodes around each cell**
 - **Series — parallel modules**
 - **Bypass diodes around each series block, module and parallel module group**
- **Module replacement**
 - **Cell failure (opens only; 1 per 10,000 per year), causing module back bias of 0.5 volt**

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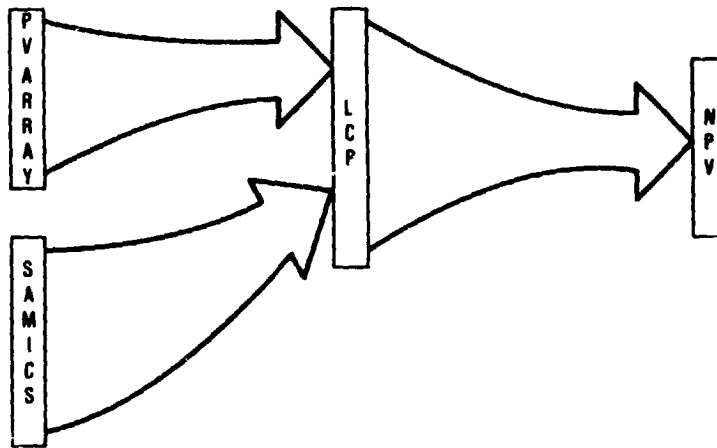


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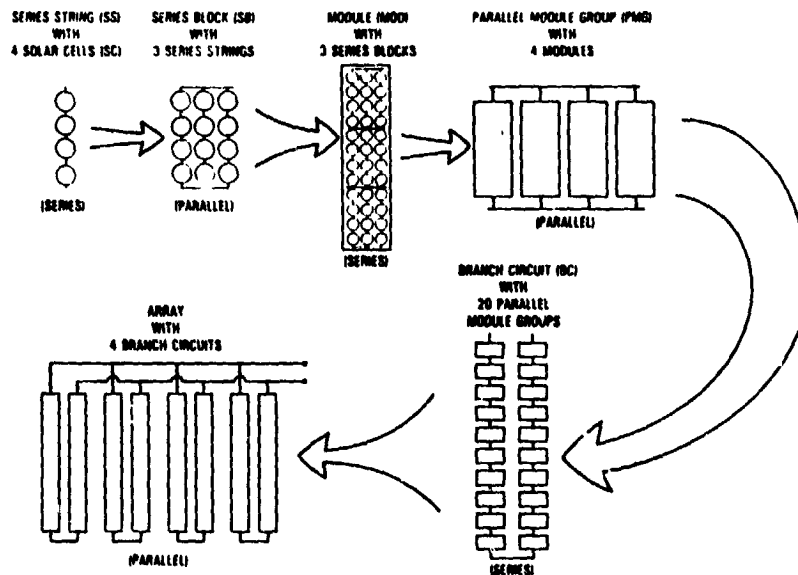
Methodology

- Use three PA&I-developed simulation models
 - PVARRAY – system array performance
 - SAMICS – simulated module manufacturing industry
 - LCP – simulates the energy output, cost and value of a PV power plant over its useful lifetime

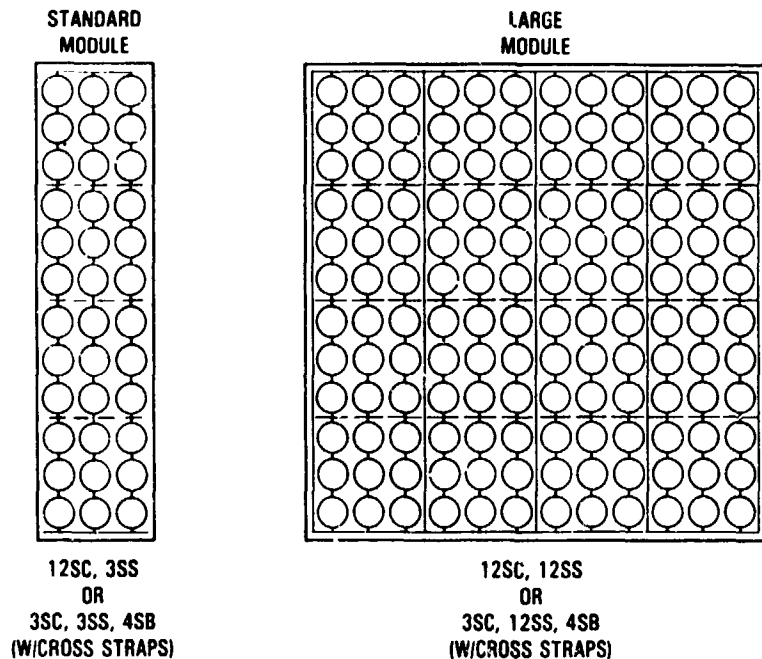
PV Array Design Economic Evaluation Methodology



PVARRAY Terminology



PVARRAY Module Configurations



Input Parameters

LCP

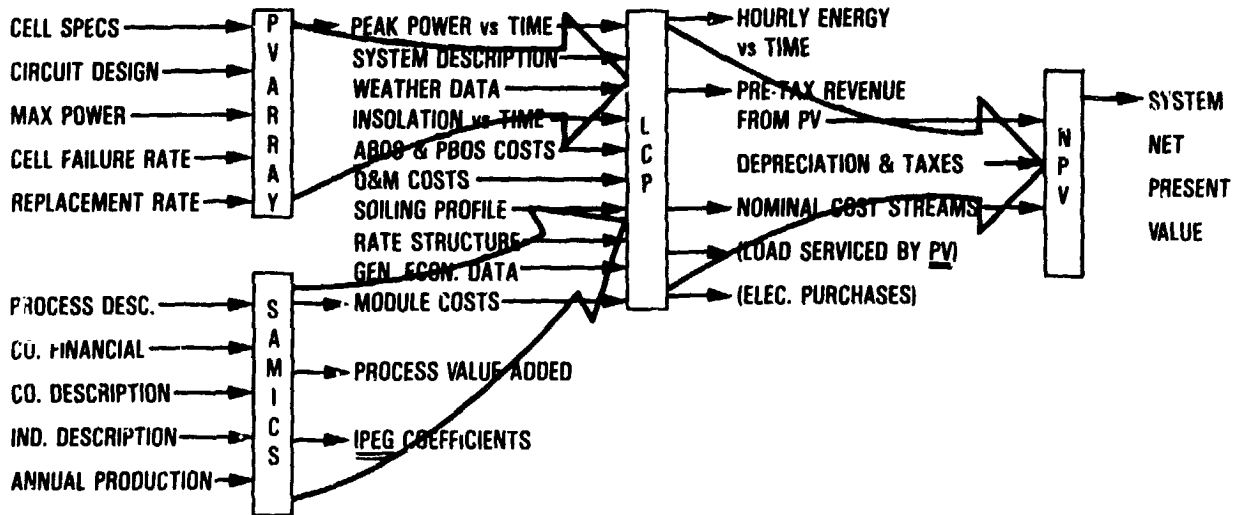
Mfg. yr	1985	1992
ABOS (\$/m ²)	115	60
PBOS (\$/kW)	600	150
O&M (\$/m ² /yr)	1.30	1.30

Rate Structure (¢/kWh) – 8.5 peak, 7.1 mid-peak, 6.0 off-peak
 Insulation – 2300 kWh/yr

NPV

Inflation rate – 5%
 Discount rate – 9%
 Depreciation – 15-yr life

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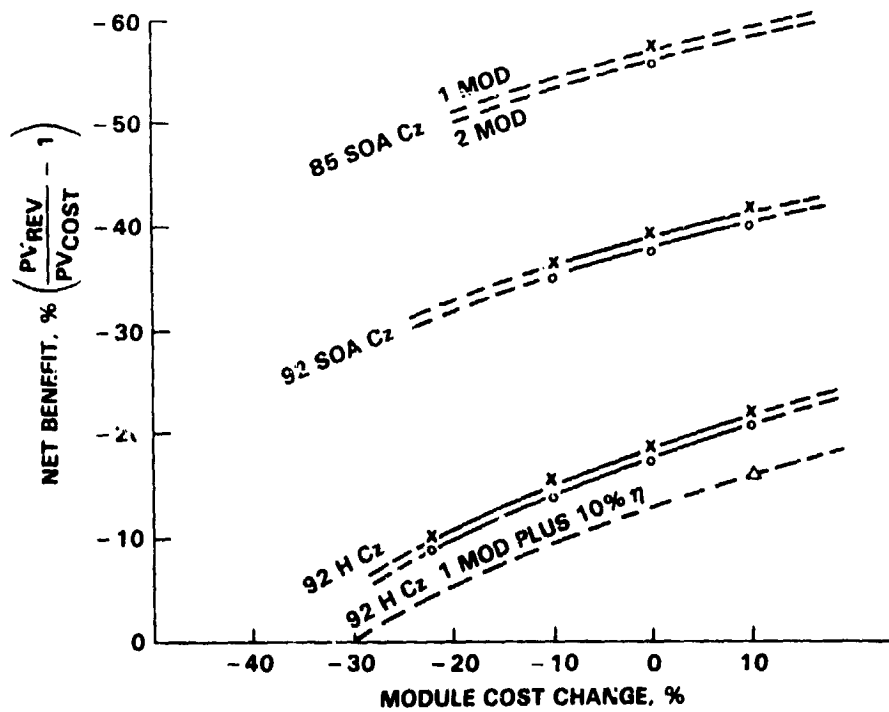
SAMICS: SOLAR ARRAY MANUFACTURING INDUSTRY COSTING STANDARDS

LCP: LIFETIME COST AND PERFORMANCE MODEL

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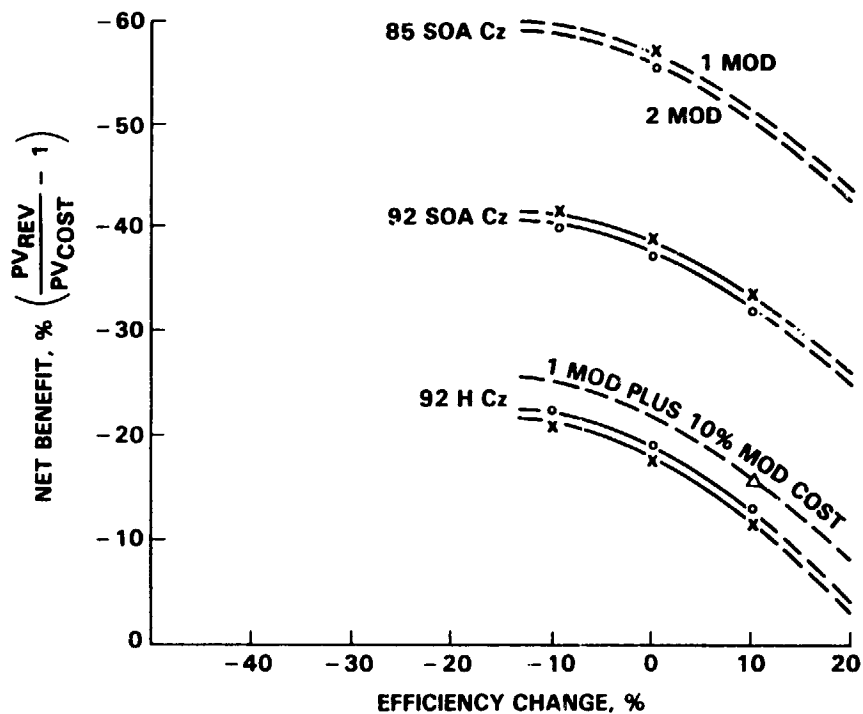
Mfg. yr	SOA Cz		High-Efficiency Cz
	1985	1992	1992
Mod. Size	1.2 x 1.2 m	1.2 x 1.2 m	1.2 x 1.2 m
Cell Eff.	11.9%	11.9%	18.7%
Mod Eff.	9.5%	9.5%	16.2%
W _p /Mod.	147	147	233
Annual Prod.	5 MW	25 MW	25 MW
Si Cost, 82\$	\$34 /kg	\$18/kg	\$18/kg
Value Added			
\$/W _p	3.52	2.40	1.65
\$/m ²	359	245	27

Sensitivity of Net Benefit to Module Cost Change



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Sensitivity of Net Benefit to Efficiency Change



Summary

- Models PVARRAY, SAMIS and LCP provide a tool for evaluating PV technologies and PV systems
- Two evaluation rankings possible, system performance and NPV
- Can identify system and performance tradeoffs

Preliminary Conclusions

- Parallel redundancy recommended
- For large modules, value of bypass diodes is marginal
- High efficiency and lower module cost are needed for PV to be economically attractive

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Future Work

- **High-efficiency web**
- **Standard-size modules (0.30 × 1.2 m)**
- **Cross strapping**
- **Diodes around series blocks and individual cells**
- **A look at several specific processes and their effects on module cost and efficiency**