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EVALUATION OF ADVANCED R&D TOPICS IN PHOTOVOLTAICS

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Objective

- DEVELOP PRIORITIZED LIST OF ADVANCED R&D AREAS IN PHOTOVOLTAICS TO ASSURE OPTIMAL USE OF LIMITED FUNDS.

Approach

- IDENTIFY AR&D AREAS (SERI/JPL/SANDIA PV PROGRAM MANAGERS/RESEARCHERS, OMB GUIDELINES, SPEAC AND ERAB REPORTS)
- DEVELOP EVALUATION CRITERIA
- SOLICIT EVALUATIONS FROM PV EXPERTS IN INDUSTRY, UNIVERSITIES AND GOVERNMENT
- EVALUATE RESPONSES; IDENTIFY RELATIVE IMPORTANCE OF AR&D AREAS; ALLOCATE FUNDING

AR&D Areas

- 35 AR&D ACTIVITIES WERE IDENTIFIED IN 10 MAJOR AREAS:
  - AMORPHOUS SILICON
  - CONCENTRATOR CELLS
  - CRYSTALLINE SILICON
  - HIGH EFFICIENCY: III-V AND RELATED AREAS
  - INNOVATIVE CONCEPTS
  - LUMINESCENT CONCENTRATORS
  - PHOTOELECTROCHEMICAL AREAS
  - SUPPORT RESEARCH
  - SYSTEMS AND MODULES
  - II-VI AND RELATED AREAS

Evaluation Criteria

- CONTRIBUTION TO BASIC SCIENTIFIC UNDERSTANDING:

VERY LIKELY	TO PRODUCE SIGNIFICANT ADVANCES, DISCOVERIES,...
LIKELY	TO ADD FUNDAMENTAL KNOWLEDGE
NOT LIKELY	TO ADD NEW KNOWLEDGE

- POTENTIAL IMPACT (IN 5 YEARS OR MORE) ON FURTHER TECHNOLOGY DEVELOPMENT BY PRIVATE INDUSTRY:

EXCELLENT	PROBABILITY OF SIGNIFICANT IMPACT
PROBABLE	THAT POSITIVE OR INDIRECT IMPACT WILL RESULT
UNLIKELY	TO HAVE ANY IMPACT

- PRIORITIES FOR FEDERAL AR&D FUNDING:

VERY HIGH PRIORITY	MUST BE FUNDED, REGARDLESS OF TOTAL BUDGET AVAILABLE
HIGH PRIORITY	SHOULD BE FUNDED IF POSSIBLE
MEDIUM PRIORITY	FUND IF ADEQUATE FUNDS EXIST
LOW PRIORITY	FUND ONLY UNDER HIGHEST BUDGET
VERY LOW PRIORITY	SHOULD NOT BE FUNDED

Example

III-V COMPOUND SEMICONDUCTOR MATERIALS FOR HIGH EFFICIENCY PHOTOVOLTAIC CELLS

THIS INCLUDES STUDIES OF NUCLEATION AND GROWTH, DOPANT INCORPORATION, DEFECT DENSITY REDUCTION, LATTICE MISMATCHED GROWTHS, STRESSED LAYERS AND SUBSTRATE DEVELOPMENT. MATERIALS SHOULD INCLUDE BINARY, TERNARY, AND QUATERNARY III-V COMPOUNDS, THIN POLYCRYSTALLINE FILMS AND THIN FILMS ON REUSABLE OR SACRIFICIAL SUBSTRATES.

CONTRIBUTION TO BASIC SCIENTIFIC UNDERSTANDING	VERY LIKELY		LIKELY		NOT LIKELY
POTENTIAL IMPACT ON FURTHER TECHNOLOGY DEVELOPMENT BY PRIVATE INDUSTRY	EXCELLENT		PROBABLE		UNLIKELY
PRIORITY FOR FEDERAL AR&D	ERY HIGH	HIGH	MEDIUM	LOW	LOWEST

COMMENTS:

Evaluation Summary

- 62 RESPONSES WERE RECEIVED FROM PV EXPERTS IN INDUSTRY, UNIVERSITIES AND GOVERNMENT:
  - 29 INDUSTRY
  - 9 UNIVERSITY
  - 24 GOVERNMENT
- NORMALIZED SCORES WERE CALCULATED BY ASSIGNING VALUES TO QUALITATIVE RATINGS; AREAS WERE RANK-ORDERED FOR EACH EVALUATION CRITERION
- FOLLOWING CHARTS SHOW RANKINGS (1^{ST} THROUGH 35^{TH}) OF AR&D AREAS FOR THE THREE EVALUATION CRITERIA

Amorphous Silicon

	SCIENTIFIC VALUE	TECHNOLOGY IMPACT	FUNDING PRIORITY
LIGHT INDUCED CHANGES IN AMORPHOUS SILICON AND EFFECTS ON SOLAR CELL STABILITY	1	2-3	1
INTERFACE PROBLEMS ASSOCIATED WITH AMORPHOUS SILICON PHOTOVOLTAIC DEVICES	11-12	2-3	4
DEPOSITION METHODS FOR AMORPHOUS FILMS	11-12	1	2
MATERIAL CHARACTERIZATION AND THEORETICAL UNDERSTANDING OF THIN FILM AMORPHOUS MATERIALS	2	7	3
NEW AMORPHOUS MATERIALS	8-9	9-10	15

Concentrator Cells

	SCIENTIFIC VALUE	TECHNOLOGY IMPACT	FUNDING PRIORITY
CONCENTRATOR CELL OPTIMIZATION	28	21	20

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Crystalline Silicon

	SCIENTIFIC VALUE	TECHNOLOGY IMPACT	FUNDING PRIORITY
DEFECT PASSIVATION AND MATERIALS MODIFICATION FOR POLYCRYSTALLINE SILICON	10	8	12
BASIC MECHANISMS IN POLYCRYSTALLINE SILICON	6	15-16	10-11
CELL PHYSICS IN CRYSTALLINE SILICON	15-17	15-16	14
SILICON SOURCE MATERIAL RESEARCH	29	17-18	22
SILICON MATERIAL GROWTH	21	4	18-19

High Efficiency: III-V and Related Areas

	SCIENTIFIC VALUE	TECHNOLOGY IMPACT	FUNDING PRIORITY
III-V COMPOUND SEMICONDUCTOR MATERIALS FOR HIGH EFFICIENCY PHOTOVOLTAIC CELLS	4	12	6-7
FUNDAMENTAL STUDIES IN III-V COMPOUND SEMICONDUCTOR MATERIALS AND SOLAR CELLS	3	19	10-11
STRUCTURAL ELEMENTS OF HIGH EFFICIENCY PHOTOVOLTAIC CELLS	15-17	6	5

Innovative Concepts

	SCIENTIFIC VALUE	TECHNOLOGY IMPACT	FUNDING PRIORITY
NEW CONCEPTS	14	13-14	8
ORGANIC MATERIALS AND DEVICES	13	29	30

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Luminescent Concentrators

	SCIENTIFIC VALUE	TECHNOLOGY IMPACT	FUNDING PRIORITY
PHOTOCHEMICAL RESEARCH ON LUMINESCENCE IN SOLIDS	19	33-34	31-32
LUMINESCENT CONCENTRATORS	27	33-34	31-32

Photoelectrochemical Areas

	SCIENTIFIC VALUE	TECHNOLOGY IMPACT	FUNDING PRIORITY
FUNDAMENTAL PHOTOELECTROCHEMICAL PROCESSES	8-9	30-31	26-27
POLYCRYSTALLINE THIN FILMS FOR PHOTOELECTRO-CHEMICAL SOLAR CELLS	22-23	28	28
PHOTOELECTROCHEMICAL CELL STABILITY	20	30-31	26-27
OTHER RESEARCH IN PHOTOELECTROCHEMICAL CELLS	26	32	34
PHOTOELECTROCHEMICAL STORAGE	18	24-25	21

Support Research

	SCIENTIFIC VALUE	TECHNOLOGY IMPACT	FUNDING PRIORITY
ENCAPSULANT RESEARCH	24	9 10	16-17
INSOLATION RESOURCE ASSESSMENT	30	24-25	24
MEASUREMENTS AND CHARACTERIZATION	25	5	6-7
METALLIZATION RESEARCH	22-23	17-18	16-17

Systems and Modules

	SCIENTIFIC VALUE	TECHNOLOGY IMPACT	FUNDING PRIORITY
FLAT PLATE MODULE RESEARCH	34	13-14	23
CONCENTRATOR MODULE RESEARCH	33	23	25
ADVANCED PHOTOVOLTAIC SYSTEMS RESEARCH	32	22	29
FRESNEL LENS RESEARCH	35	27	33

II - VI and Related Areas

	SCIENTIFIC VALUE	TECHNOLOGY IMPACT	FUNDING PRIORITY
RESEARCH ON COPPER INDIUM DISELENIDE ($CuInSe_2$) CELL STRUCTURES AND FABRICATION	15-17	11	9
BASIC STUDIES IN COPPER INDIUM DISELENIDE ($CuInSe_2$)	5	20	13
CONTINUED RESEARCH ON CdS/Cu_2S	31	35	35
ALTERNATE POLYCRYSTALLINE THIN FILM PHOTOVOLTAIC MATERIALS	7	26	18-19

Conclusions

- RANKINGS WERE GENERALLY CONSISTENT AMONG THE THREE GROUPS OF RESPONDEES
- "CONTRIBUTION TO BASIC SCIENTIFIC UNDERSTANDING" WAS RATED HIGHEST IN HIGH-RISK AREAS
- "POTENTIAL IMPACT ON FURTHER TECHNOLOGY DEVELOPMENT BY PRIVATE INDUSTRY" WAS ASSOCIATED WITH NEAR-TERM TECHNOLOGIES
- "PRIORITIES FOR FEDERAL AR&D FUNDING" WERE HIGHEST IN AREAS NOT WIDELY ADDRESSED BY INDUSTRY
- COPIES OF EVALUATION RESULTS ARE AVAILABLE ON REQUEST