ARPA-E PROJECT SELECTIONS –
FULL-SPECTRUM OPTIMIZED CONVERSION AND UTILIZATION OF SUNLIGHT (FOCUS)

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These projects have been selected for negotiation of awards; final award amounts may vary.

Lead Research Organization	Amount	Lead Organization Location (City, State)	Project Title Project Description
Arizona State University	$3,900,000	Tempe, AZ	**High-Temperature Topping Cells from LED Materials** Arizona State University will develop a solar cell that can operate efficiently at temperatures above 450°C, unlike today's solar cells, which lose efficiency rapidly above 100°C. The team will adapt semiconducting materials used in today's light-emitting diode (LED) industry to enable high-temperature operation. These solar cells will extract as much energy as possible from the highest-energy portion of the solar spectrum when used in the next generation of hybrid solar converters.
Arizona State University	$2,640,122	Tempe, AZ	**Solar-Concentrating Photovoltaic Mirrors** Arizona State University will develop a curved mirror made of solar cells to collect both direct and diffuse sunlight for conversion to electricity and heat. While today's concentrating solar systems cannot use diffuse sunlight that has been scattered by the atmosphere, this system will simultaneously convert diffuse sunlight and some direct sunlight into electricity in solar cells while reflecting the unused portion of the direct sunlight for conversion to heat. This design can provide a low-cost way to utilize the diffuse portion of the solar spectrum.
Cogenra Solar, Inc.	$1,996,127	Mountain View, CA	**Double-Focus Hybrid Solar Energy System with Full Spectrum Utilization** Cogenra Solar will develop a hybrid solar converter with a specialized light-filtering mirror that splits sunlight by wavelength, allowing a low-cost converter to integrate both efficient solar cells and a separate, high-temperature heat-storage component for on-demand conversion to electricity. The system would also capture waste heat from the solar cells, providing additional gains from the sun's energy. This hybrid converter could be used to provide inexpensive solar power from both centralized and distributed locations.

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Gas Technology Institute	$992,900	Des Plaines, IL	**Double-Reflector Hybrid Solar Energy System** Gas Technology Institute will develop a hybrid solar converter that bounces sunlight off a mirror into a solar cell that converts most visible wavelengths of light to electricity while reflecting other wavelengths to heat a stream of flowing particles. This double-mirror design is optimized to capture as much of the energy in sunlight as possible. The team's ultra-high-efficiency converter could be used to provide solar electricity and simultaneously collect solar heat near a centralized point of use, such as in industrial parks or shopping centers.
General Electric Global Research	$2,275,671	Niskayuna, NY	**Electrothermal Energy Storage with a Supercritical CO2 Cycle** GE will design and test components of a unique gas turbine that is driven by high-temperature, high-pressure carbon dioxide. The carbon dioxide expands to low pressure and extremely cold temperatures to generate electricity from stored electrical and heat energy. The dramatic change in temperature and pressure is necessitated by an innovative design that prevents thermal losses across the turbine. This grid-scale energy storage system could be coupled to a hybrid solar converter to deliver solar electricity on demand.
Massachusetts Institute of Technology	$3,420,000	Cambridge, MA	**Full-Spectrum Stacked Solar-Thermal and PV Receiver** The Massachusetts Institute of Technology will develop a hybrid solar converter that integrates a thermal absorber and a solar cell into a layered stack. The design allows focused sunlight to heat fluid piped through layers of optically transparent thermal insulation. The part of the spectrum most easily converted to electricity filters through to the solar cells. This unique stack design would enable low-cost solar energy conversion systems that can flexibly dispatch electricity when most needed.
Massachusetts Institute of Technology	$594,329	Cambridge, MA	**Low-Cost Hetero-Epitaxial Solar Cell for Hybrid Converter** The Massachusetts Institute of Technology will develop a high-efficiency solar cell grown on a low-cost silicon wafer incorporating a custom reflective filter. The color-selective filter is designed to split sunlight concentrated by a dish-shaped receiver into two components: one component is sent to the solar cells to be converted immediately into electricity and the other is sent to a thermal receiver to be stored as heat. The proposed system will enable more efficient use of solar energy to produce dispatchable renewable electricity on a utility scale.

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MicroLink Devices	$3,600,000	Niles, IL	**Epitaxial Lift-Off III-V Solar Cell for High Temperature Operation** MicroLink Devices will develop a high-efficiency solar cell that can operate at temperatures above 400°C, unlike today's solar cells which lose efficiency rapidly above 100°C. The team will customize the materials as well as the design of today's low-temperature concentrator solar cells to provide reliability over the 25-year lifetime needed in the field. In addition, MicroLink will use manufacturing techniques that allow for the reuse of expensive solar cell manufacturing templates to minimize costs. The high-temperature solar cells will be optimized to extract the most energy possible from sunlight when integrated with hybrid solar converters.
Northrop Grumman Aerospace Systems	$2,362,197	Redondo Beach, CA	**Thermo-Acoustic PV Hybrid Solar Energy System** Northrop Grumman Aerospace Systems will develop a dish-shaped hybrid solar converter that combines a high-efficiency solar cell with a thermo-acoustic engine that converts heat into electricity. The thermo-acoustic unit, which was originally designed for space missions, converts waste heat from the solar cell into sound waves that generate electricity using few moving parts. The engine and solar cell are surrounded by salts that store heat as needed by melting when the sun shines and releases the heat to make electricity by solidifying when the sun is not shinning. This combination could lead to inexpensive, on-demand electricity from solar energy.
Otherlab	$3,000,000	San Francisco, CA	**Hybrid Solar Converter with Solar Pond Receiver** Otherlab will develop an integrated system that splits the solar spectrum, converting the most suitable wavelengths of sunlight into electricity via high-efficiency solar cells and using the rest of the spectrum to directly heat a pool of molten salt. The system will collect sunlight using an array of small, pneumatically driven mirrors that track the sun's movement, allowing the molten salt pool to cost-effectively store solar heat for generation of dispatchable electricity. This technology could enable a low-cost solar system that would fit easily inside a football field, in contrast to today's solar fields that can cover several square miles.
Sharp Labs of America	$4,182,929	Camas, WA	**High-Concentration Full-Spectrum Solar Energy System** Sharp Labs of America will develop a hybrid solar converter that incorporates a partially transmitting mirror to reflect visible wavelengths of light to extremely high-efficiency solar cells while passing ultraviolet and most infrared light to heat a thermal fluid. The extremely high concentration of visible wavelengths of light would allow expensive solar cells to be

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			used in an inexpensive converter. The converter could enable utilities to provide dispatchable, on-demand, solar electricity at low cost.
The University of Tulsa	$1,758,951	Tulsa, OK	**Liquid Filter with Plasmonic Nanoparticles** The University of Tulsa will develop a hybrid solar converter that captures non-visible wavelengths of light to heat a fluid containing light-absorbing nanoparticles that are far too small to be seen with the naked eye. The fluid would also transmit the part of the spectrum most easily converted to electricity to a solar cell and passes waste heat back to the fluid. This heat in the fluid can be stored to provide low-cost solar energy beyond the time when the sun is shining.
Yale University	$2,530,000	New Haven, CT	**High-Temperature Dual-Junction Topping Cells** Yale University will develop a dual-junction solar cell that can operate efficiently at temperatures above 400 °C, unlike today's solar cells which lose efficiency rapidly above 100°C. The team's efficient dual-junction design, which allows the cell to collect a wider range of the light spectrum, could provide reliability over the 25-year lifetime needed in the field. Yale's high-temperature solar cells will fully utilize the solar spectrum to convert some wavelengths of light into electricity while using the remainder to provide dispatchable heat when the sun is not shining.