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**List of QESST Projects**

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| **Faculty** | **Affiliationnn** | **Sponsor** | **Name of Project** | **Thrust/Area** | |
| **Thrust 1: Terawatt Scale Silicon Photovoltaics** | | | | | |
| **Direct support** | | | | | |
| **Mariana Bertoni**  Zachary Holman | ASU  ASU | NSF | High-mobility, In-free Transparent Conductors for Solar Cells | Thrust 1 | |
| **Stuart Bowden**  Christiana Honsberg  Robert Opila  Harry Atwater  William Dauksher | ASU  ASU  UDel  Caltech  ASU | NSF | High Efficiency Silicon Devices Beyond the Classic Materials Limitations | Thrust 1 | |
| **Tonio Buonassisi**  Zachary Holman  Robert Opila  Mariana Bertoni | MIT  ASU  UDel  ASU | NSF | Defect Assessment and Modeling in High-Quality c-Si | Thrust 1 | |
| **Govindasamy Tamizhmani**  Stuart Bowden | ASU  ASU | NSF | Characterization and Reliability in Cell Manufacturing | Thrust 1 | |
| **Thrust 1: Terawatt Scale Silicon Photovoltaics** | | | | | |
| **Indirect support** | | | | | |
| **Zachary Holman** | ASU | NREL | Overcoming Bottlenecks to Lower Cost, Higher Efficiency Si PV & Industrially Relevant, Ion Implanted Interdigitated Back Passivated Contact Cell Development | Thrust 1 | |
| **Stuart Bowden** | ASU |  | Solar Power Lab and NNCI: The Nanotechnology Collaborative Infrastructure Southwest | Thrust 1 | |
| **Tonio Buonassisi** | MIT | Eni Spa | ENI-MITEI 2013 Framework-Polymer/Silicon 2.2.C | Thrust 1 | |
| **Stuart Bowden** | ASU | Power Film | Advanced 100 W Solar Blanket | | Thrust 1 |
| **Sayfe Kiaei** | ASU |  | I/UCRC: Phases III Communication Circuits and Systems Research Center | | Thrust 1 |
| **Stuart Bowden**  Harry Atwater | ASU  CalTech | DOE | Lateral Transport at Silicon Heterojunction Interfaces | | Thrust 1 |
| **Mariana Bertoni** | ASU | SolarWorld  DOE | NeoGrowth Silicon: US Manufacturing of Solar Wafers | | Thrust 1 |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Faculty** | **Affiliation** | **Sponsor** | **Name of Project** | **Thrust/Area** | | | | | | |
| **Thrust 1: Terawatt Scale Silicon Photovoltaics (Cont’d)** | | | | | |
| **Indirect support (Cont’d)** | | | | | |
| **Zachary Holman**  Mariana Bertoni | ASU  ASU | ARPA-e | PVMirror: A Solar Concentrator Mirror Incorporating PV Cells | | Thrust 1 |
| **Stuart Bowden** | ASU | Technic  DOE | Silver-Free Metallization Technology for Producing High Efficiency, Industrial Silicon Solar Cells | | Thrust 1 |
| **Tonio Buonassisi** | MIT | Masdar Institute of Science & Technology | Thin Cost-Effective Silicon Wafers for Heterojunction Based Photovoltaic Devices | | Thrust 1 |
| **Mariana Bertoni** | ASU |  | Origin of Interface Defect Levels for High Efficiency Solar Cells | | Thrust 1 |
| **Mariana Bertoni** | ASU | Owen Hildreth | PFI: AIR TT Low Temperature High Performance Metallization Using Reactive Ink Chemistries | | Thrust 1 |
| **Mariana Bertoni** | ASU |  | Sound Assisted Low Temperature Spalling for Low Cost Silicon Modules | | Thrust 1 |
| **Tonio Buonassisi** | MIT |  | CAREER: Toward Robust, Scalable, and Non-Intermittent Solar Power: Silicon-Based Multijunction Devices with Integrated Photocatalysis | | Thrust 1 |
| **Zachary Holman**  Mariana Bertoni  Govindasamy Tamizhmani | ASU  ASU  ASU | Natcore,  NREL | Monolithic Silicon Module Manufacturing at < 0.40 $/W | | Thrust 1 |
| **Thrust 2: Tandem Integration with Silicon Technologies** | | | | | |
| **Direct support** | | | | | |
| **Harry Atwater**  Stuart Bowden  Tonio Buonassisi | Caltech  ASU  MIT | NSF | Tandem III-V/Si Integration | | Thrust 2 |
| **Ganesh Balakrishnan**  Nikolai Faleev  Christiana Honsberg  Zachary Holman  Francesca Cavallo  Tonio Buonassisi | UNM  ASU  ASU  ASU  UNM  MIT | NSF | Epitaxial Strategies for the Demonstration of Dual Junction Si/III-Sb Solar Cells | | Thrust 2 |
| **Alan Doolittle**  Christiana Honsberg  Fernando Ponce  Stuart Bowden  Stephen Goodnick | GaTech  ASU  ASU  ASU  ASU | NSF | Terawatt Scale III-Nitride on Si In-situ | | Thrust 2 |
| **Faculty** | **Affiliation** | **Sponsor** | **Name of Project** | | **Thrust/Area** |
| **Thrust 2: Tandem Integration with Silicon Technologies (Cont’d)** | | | | | |
| **Zachary Holman**  Yong-Hang Zhang | ASU  ASU | NSF | Flat-Plate Tandem PV: A Marriage of Silicon and II/VI | | Thrust 2 |
| **Alex Freundlich**  Nikolai Faleev  Stephen Goodnick  Christiana Honsberg  Richard King  David Smith | UH  ASU  ASU  ASU  ASU  ASU | NSF | Dilute Nitride Materials and Devices | | Thrust 2 |
| **Thrust 2: Tandem Integration with Silicon Technologies** | | | | | |
| **Indirect support** | | | | | |
| **Zachary Holman** | ASU |  | Collaborative Research: 30%-Efficient III-V/Silicon Tandem Solar Cells | | Thrust 2 |
| **Zachary Holman** | ASU | RCSA | Scalable Tandem Architecture for Solar Water Splitting | | Thrust 2 |
| **Harry Atwater** | CalTech | DOE (Bay Area Photovoltaics Consortium) | Economic Silicon Heterojunction Solar Cells with Optimized Photon Management | | Thrust 2 |
| **Zachary Holman**  Yong-Hang Zhang | ASU  ASU |  | 15%-Efficiency (Mg,Zn)CdTe Solar Cells with 1.7 eV Bandgap for Tandem Applications | | Thrust 2 |
| **Harry Atwater** | CalTech | DOE | Joint Center for Artificial Photosynthesis | | Thrust 2 |
| **Stuart Bowden**  Harry Atwater  Mariana Bertoni  Tonio Buonassisi  Stephen Goodnick  Zachary Holman  Christiana Honsberg | ASU  Caltech  ASU  MIT  ASU  ASU  ASU | DOE | Thin Silicon Solar Cells: A Path to 35% Shockley-Queisser Limits (FPACEII) | | Thrust 2 |
| **Robert Opila** | UD |  | A Critical Analysis on the Thin Crystalline Silicon PV Module of the Lightweight PV System | | Thrust 2 |
| **Harry Atwater** | CalTech | DOE (EFRC) | Light Material Interactions in Solar Energy Conversion | | Thrust 2 |
| **Harry Atwater** | CalTech | Global Climate and Energy Project | Light Trapping in Thin Silicon Solar Cells Using Densely Spaced Effectively Transparent Contacts | | Thrust 2 |
| **Harry Atwater** | CalTech | Northrop Grumman | Space Solar Power Initiative | | Thrust 2 |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Faculty** | **Affiliation** | **Sponsor** | **Name of Project** | **Thrust/Area** | | | | | | |
| **Thrust 2: Tandem Integration with Silicon Technologies** | | | | | |
| **Indirect support (Cont’d)** | | | | | |
| **Zachary Holman** | ASU |  | A New Class of Tandems: Optically Coupled III-V/Silicon Module with Outdoor Efficiency Exceeding 30% | | Thrust 2 |
| **Harry Atwater** | CalTech | DOE (ARPA-E) | Tandem Micro-Optical Luminescent Solar Concentrator | | Thrust 2 |

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| **Faculty** | **Affiliation** | | | **Sponsor** | | | **Name of Project** | **Thrust/Area** | |
| **Thrust 3: Fundamentals for High Efficiency Photovoltaics** | | | | | | | | | |
| **Direct support** | | | | | | | | | |
| **Nikolai Faleev**  Christiana Honsberg  Mariana Bertoni  Gunny Balakrishnan  Richard R. King  David Smith | | ASU  ASU  ASU  UH  ASU  ASU | NSF | | Defects in Semiconductor Compounds (DISC) | | | | Thrust 3 |
| **Zachary Holman**  Stephen Goodnick  Christiana Honsberg  David Smith | | ASU  ASU  ASU  ASU | NSF | | Light Management in Thin Silicon Cells using Nanomaterials and Nanostructures | | | | Thrust 3 |
| **Stephen Goodnick**  Dragica Vasileska  Alexandre Freundlich  Christiana Honsberg | | ASU  ASU  UH ASU | NSF | | Multiscale Modeling of Dilute Nitride Materials and Silicon Heterojunctions | | | | Thrust 3 |
| **Raymond Kostuk**  Harry Atwater  Zachary Holman | | UA  Caltech  ASU | NSF | | Spectral/Spatial Light Management Optics for Tandem and Separated Multiple Bandgap Cell PV Systems | | | | Thrust 3 |
| **William Shafarman**  Mariana Bertoni  Ujjwal Das  Richard R. King  Babatunde Ogunnaike  Robert Opila | | UD  ASU  UD  ASU  UD  UD | NSF | | Polycrystalline Thin Film and Perovskite Solar Cell Development | | | | Thrust 3 |
| **Thrust 3: Fundamentals for High Efficiency Photovoltaics** | | | | | | | | | |
| **Indirect support** | | | | | | | | | |
| **Harry Atwater** | | Caltech | DOE | | Full Spectrum Conversion Photovoltaics | | | | Thrust 3 |
| **William Shafarman** | | UD | NSF | | Collaborative Research: High Efficiency Tandem Perovskite-Copper Indium Selenide Solar Cell | | | | Thrust 3 |
| **Mariana Bertoni** | | ASU | Argil Inc | | Degradation Studies of Electrochromic Windows | | | | Thrust 3 |
| **Stephen Goodnick**  Christiana Honsberg | | ASU  ASU | DOE | | High Temperature InGaN Thermionic Topping Cells | | | | Thrust 3 |
| **William Shafarman** | | UD | Stion | | Improved Performance and Reliability of Cu(InGa)(SeS)2 PV Modules Using the Reaction of Metal Precursors | | | | Thrust 3 |
| **Faculty** | **Affiliation** | | | **Sponsor** | | | **Name of Project** | **Thrust/Area** | |
| **Thrust 3: Fundamentals for High Efficiency Photovoltaics** | | | | | | | | | |
| **Indirect support (Cont’d)** | | | | | | | | | |
| **Mariana Bertoni** | | ASU |  | | In-situ X-ray Nanocharacterization of Defect Kinetics in Chalcogenide Solar Cell Materials | | | | Thrust 3 |
| **Dragica Vasileska** | | ASU | First Solar  San Jose State University | | Solution for Predictive Physical Modeling in CdTe and Other Thin-Film PV Technologies | | | | Thrust 3 |
| **Dragica Vasileska** | | ASU | First Solar  NREL  CSU | | Unified Numerical Solver for Device Metastabilities in CdTe Thin-Film PV | | | | Thrust 3 |
| **Yong Hang Zhang** | | ASU |  | | CdTe Virtual Substrates Grown on Lattice Matched InSb Substrate | | | | Thrust 3 |
| **Raymond Kostuk** | | U of A | University of Colorado | | Holographic Spectrum Splitting for Multijunction Organic Photovoltaics | | | | Thrust 3 |
| **Testbeds** | | | | | | | | | |
| **Direct support** | | | | | | | | | |
| **Stuart Bowden**  Tonio Buonassisi  Jeffrey Cotter  Zachary Holman  Christiana Honsberg  Michelle Jordan  Mariana Bertoni  Robert Opila | | ASU  MIT  ASU  ASU  ASU  ASU  ASU  UD | NSF | | | Student-Led Pilot Line | | | Testbed 1 |
| **Mariana Bertoni**  Bertan Bakkaloglu  Sayfe Kiaei  Stuart Bowden | | ASU  ASU  ASU  ASU | NSF | | | Advanced Modules and Integration | | | Testbed 2 |
| **Christiana Honsberg**  Stuart Bowden  Tonio Buonassisi  Clark Miller  Matthew Fraser | | ASU  ASU  MIT  ASU  ASU | NSF | | | Sustainability of Terawatt PV deployment | | | Testbed 3 |
| **Testbeds** | | | | | | | | | |
| **Indirect support** | | | | | | | | | |
| **Sayfe Kiaei** | | ASU | NSF | | | I/UCRC Phase III Communication Circuits and Systems Research Center | | | Testbed 2 |

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| **Faculty** | **Affiliation** | **Sponsor** | **Name of Project** | **Thrust/Area** |
| **Cross-Cutting Research: Sustainability** | | | | |
| **Direct support** | | | | |
| **Thomas Seager**  Lado Kurdgelashvili  Clark Miller  Matthew Fraser | ASU  UD  ASU  ASU | NSF | Systems Dynamics of PV Sustainability at the Terawatt Scale | Sustainability |
| **Cross-Cutting Research: Sustainability** | | | | |
| **Indirect support** | | | | |
| **Sayfe Kiaei**  Clark Miller  Zachary Holman | ASU  ASU  ASU | USAID | US Pakistan Centers for Advanced Study in Energy | Sustainability |
| **Thomas Seager**  Clark Miller | ASU  ASU | NSF | RCN-SEES: Sustainable Energy Systems | Sustainability |
| **Clark Miller** | ASU | DOE | Social Value of Energy | Sustainability |
| **Ganesh Balakrishnan** | UNM | NSF | Sustainable Energy Pathways Through Education and Technology | Sustainability |
| **Clark Miller** | ASU |  | Distributed Solutions to End Energy Poverty | Sustainability |
| **Raymond Kostuk** | U of A | NSF | Establishing Uniform Solar Energy Output During Periods of Cloud Obscuration Through Joint Design of Optical and Energy Converter Systems | Sustainability |
| **Clark Miller**  Jason O’Leary | ASU  ASU |  | Adoption and Distribution of Rooftop Solar PV in Arizona: A Complex Systems Approach | Sustainability |
| **Thomas Seager** | ASU | NSF | Life Cycle Assessment for Emerging PV Tech | Sustainability |
| **Clark Miller**  Jason O’Leary | ASU  ASU | NSF | Social Sustainability of Photovoltaic Systems | Sustainability |
| **Clark Miller** | ASU |  | Systems Dynamics of PV Growth and Differentiation | Sustainability |

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| **Faculty** | **Affiliation** | | | **Sponsor** | | **Name of Project** | **Thrust/Area** | |
| **Cross-Cutting Research: Education Research** | | | | | | | | |
| **Direct support** | | | | | | | | |
| Jenefer Husman  Duane Shell, | | ASU  UNeb | NSF | | Examining Emotions and Stress Responses in Engineering Education | | | Education Research |
| **Cross-Cutting Research: Education Research** | | | | | | | | |
| **Indirect support** | | | | | | | | |
| **Jenefer Husman**  Christiana Honsberg  Stephen Goodnick | | ASU  ASU  ASU | NSF | | IGERT: Solar Utilization Network | | | Education Research |
| **Zachary Holman**  Mariana Bertoni  Christiana Honsberg  Richard King  Michelle Jordan | | ASU  ASU  ASU  ASU  ASU | NSF | | REU Site: Solar Energy Research for the Terawatt Challenge | | | Education Research |
| **Michelle Jordan** | | ASU | Mary Lou Fulton Teachers College | | Implementing Collaborative Design Projects to Facilitate Teachers’ Design Thinking | | | Education Research |