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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 | ASUASU | NSF | High-mobility, In-free Transparent Conductors for Solar Cells | Thrust 1 |
| **Stuart Bowden**Christiana HonsbergRobert OpilaHarry AtwaterWilliam Dauksher | ASUASUUDelCaltechASU | NSF | High Efficiency Silicon Devices Beyond the Classic Materials Limitations |  Thrust 1 |
| **Tonio Buonassisi**Zachary HolmanRobert OpilaMariana Bertoni | MITASUUDelASU | NSF | Defect Assessment and Modeling in High-Quality c-Si | Thrust 1 |
| **Govindasamy Tamizhmani**Stuart Bowden | ASUASU | 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 | ASUCalTech | DOE | Lateral Transport at Silicon Heterojunction Interfaces | Thrust 1 |
| **Mariana Bertoni** | ASU | SolarWorldDOE | NeoGrowth Silicon: US Manufacturing of Solar Wafers | Thrust 1 |
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| **Faculty** | **Affiliation** | **Sponsor** | **Name of Project** | **Thrust/Area** |

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| **Thrust 1: Terawatt Scale Silicon Photovoltaics (Cont’d)** |
| **Indirect support (Cont’d)** |
| **Zachary Holman**Mariana Bertoni | ASUASU | ARPA-e | PVMirror: A Solar Concentrator Mirror Incorporating PV Cells | Thrust 1 |
| **Stuart Bowden** | ASU | TechnicDOE | 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 BertoniGovindasamy Tamizhmani | ASUASUASU | Natcore, NREL | Monolithic Silicon Module Manufacturing at < 0.40 $/W | Thrust 1 |
| **Thrust 2: Tandem Integration with Silicon Technologies** |
| **Direct support** |
| **Harry Atwater**Stuart BowdenTonio Buonassisi | CaltechASUMIT | NSF | Tandem III-V/Si Integration | Thrust 2 |
| **Ganesh Balakrishnan**Nikolai FaleevChristiana HonsbergZachary HolmanFrancesca CavalloTonio Buonassisi | UNMASUASUASUUNMMIT | NSF | Epitaxial Strategies for the Demonstration of Dual Junction Si/III-Sb Solar Cells | Thrust 2 |
| **Alan Doolittle**Christiana HonsbergFernando PonceStuart BowdenStephen Goodnick | GaTechASUASUASUASU | 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 | ASUASU | NSF | Flat-Plate Tandem PV: A Marriage of Silicon and II/VI | Thrust 2 |
| **Alex Freundlich**Nikolai FaleevStephen GoodnickChristiana HonsbergRichard KingDavid Smith | UHASUASUASUASUASU | 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 | ASUASU |  | 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 AtwaterMariana BertoniTonio BuonassisiStephen GoodnickZachary HolmanChristiana Honsberg | ASUCaltechASUMITASUASUASU | 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 |
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| **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 HonsbergMariana BertoniGunny BalakrishnanRichard R. KingDavid Smith | ASUASUASUUHASUASU | NSF | Defects in Semiconductor Compounds (DISC) | Thrust 3 |
| **Zachary Holman**Stephen GoodnickChristiana HonsbergDavid Smith | ASUASUASUASU | NSF | Light Management in Thin Silicon Cells using Nanomaterials and Nanostructures  | Thrust 3 |
| **Stephen Goodnick**Dragica VasileskaAlexandre FreundlichChristiana Honsberg | ASUASUUHASU | NSF | Multiscale Modeling of Dilute Nitride Materials and Silicon Heterojunctions | Thrust 3 |
| **Raymond Kostuk**Harry AtwaterZachary Holman | UACaltechASU | NSF | Spectral/Spatial Light Management Optics for Tandem and Separated Multiple Bandgap Cell PV Systems  | Thrust 3 |
| **William Shafarman** Mariana BertoniUjjwal DasRichard R. KingBabatunde OgunnaikeRobert Opila  | UDASUUDASUUDUD | 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 | ASUASU | 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 SolarSan Jose State University | Solution for Predictive Physical Modeling in CdTe and Other Thin-Film PV Technologies | Thrust 3 |
| **Dragica Vasileska** | ASU | First SolarNRELCSU | 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 BuonassisiJeffrey CotterZachary HolmanChristiana HonsbergMichelle JordanMariana BertoniRobert Opila | ASUMITASUASUASUASUASUUD | NSF | Student-Led Pilot Line | Testbed 1 |
| **Mariana Bertoni**Bertan BakkalogluSayfe KiaeiStuart Bowden | ASUASUASUASU | NSF | Advanced Modules and Integration | Testbed 2 |
| **Christiana Honsberg**Stuart BowdenTonio BuonassisiClark MillerMatthew Fraser | ASUASUMITASUASU | 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 KurdgelashviliClark MillerMatthew Fraser | ASUUDASUASU | NSF | Systems Dynamics of PV Sustainability at the Terawatt Scale | Sustainability |
| **Cross-Cutting Research: Sustainability** |
| **Indirect support** |
| **Sayfe Kiaei**Clark MillerZachary Holman | ASUASUASU | USAID | US Pakistan Centers for Advanced Study in Energy | Sustainability |
| **Thomas Seager** Clark Miller | ASUASU | 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 | ASUASU |  | 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 | ASUASU | 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 HusmanDuane Shell,  | ASUUNeb | NSF | Examining Emotions and Stress Responses in Engineering Education | Education Research |
| **Cross-Cutting Research: Education Research** |
| **Indirect support** |
| **Jenefer Husman**Christiana HonsbergStephen Goodnick | ASUASUASU | NSF | IGERT: Solar Utilization Network | Education Research |
| **Zachary Holman**Mariana BertoniChristiana HonsbergRichard KingMichelle Jordan | ASUASUASUASUASU | 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 |