Projects, Objectives, and Research Efforts
Electrochemical Conversion

Projects	Objectives	Research Efforts	Researchers
1. Solid oxide cells for power and fuel production	• Oxide-ionic and protonic solid oxide cells operating at reduced temperature with high rate, efficiency and robustness • Hydrogen-fueled SOFC with high efficiency and fuel utilization • Thermoneutral and endothermic operation of steam electrolysis • Fundamental understanding and design of electrode and electrolyte materials and interfaces	• Development of new protonic air/steam electrode materials and structures for minimized electronic leakage and high efficiency • Develop computational models for identifying protonic/oxide-ionic electrode and electrolyte materials • Development of highly efficient oxide-ion-conductor-based SOFC and SOEC • Assessment of electrodes, electrolytes and interfaces for fast ionic/electronic kinetics by advanced analysis techniques	Matsumoto, Ishihara, Tuller, Kilner, Staykov, Perry, Leonard,, Veeramani
2. Low temperature energy conversion	Fabrication and characterization of advanced fuel cells and electrolyzers with: • High durability, high efficiency • Wide temperature range operation • Low/no precious metal loading	• Polymer-coated carbon electrocatalyst for increasing durability and efficiency of PEFCs and PEECs • Operation of Pt-based / Pt-free HT-PEFCs • Advanced in-situ characterization of Pt-based and Pt-free electrocatalysts • Development of highly conductive electrolytes for high-temperature PEFC and PEEC • Structural optimization of porous transport layer for PEEC	Fujigaya, Gewirth, Yang, Sasaki, Ito, Kilner, Matsumoto, Staykov, Nishihara
3. Energy storage	• High capacity new concept batteries • Reversible fuel cell and electrolysis operation at high/low temperatures	• Development of dual carbon battery • Inorganic biocatalyst for storage of solar energy • SOFC/SOEC reversible systems • Development of new cell architectures for water electrolysis and fuel cells	Ishihara, Kilner, Matsumoto, Gewirth, Fujigaya, Ito, Leonard, Veeramani

Projects, Objectives, and Research Efforts
Photoelectrochemical Conversion

Projects	Objectives	Research Efforts	Researchers
4. Catalyst design for photochemical water splitting	• Water splitting with organic, enzyme and inorganic composites • Application of high-pressure torsion (HPT) for enhancing photocatalysis	• Optimization of photocatalyst-biocatalyst system for effective charge separation • Application of novel organic-inorganic interfaces for enhancing photocatalytic water-splitting activity • Improvement of photocatalytic activity using high-pressure torsion and high entropy phases	Ishihara, Staykov. Ertekin, Watanabe, Lippert, Takagaki, Son, Kosem, Song, Edalati, Wang, Arita
5. Solar energy harvesting for eco-friendly power generation	• High efficiency and operational stability from hybrid perovskite-based solar cells	• Optimization of film fabrication conditions, materials, and cell architectures • Realization of p-n junction and tandem solar cells • Development of large-area fabrication and encapsulation technology • Fabrication of lead-free perovskites • Understanding of efficiency loss and degradation mechanisms	Adachi, Rockett, Matsushima
6. Light-emitting system for low power consumption	• Efficient and stable organic and perovskite light-emitting diodes and laser diodes	• Optimization of optical resonator architectures and light outcoupling • Interface engineering and defect management • Development of novel emitting and carrier-transporting materials • Introduction of triplet scavenging and recycling methods • Understanding of efficiency loss and degradation mechanisms	Adachi, Matsushima, Nakanotani, Goushi