National Renewable Energy Lab

Dr. Martin Keller, Lab Director

BERAC Meeting

March 23, 2016

Laboratory mission and overview

	Analysis & System Integration	Innovation & Application	Foundational Knowledge
Core Capabilities			
Market-Relevant Solutions	Systems Engineering & Integration Decision Science & Analysis	Chemical Engineering Mechanical Design & Engineering Power Systems & Electrical Engineering	Chemical and Molecular Science Biological/Bio-process Science & Engineering Materials Science & Engineering
Impact	Provide market insight and inform landscape	Respond to market challenges with solutions and identify knowledge gaps	Scientific discovery that fills gaps and disrupts current technology

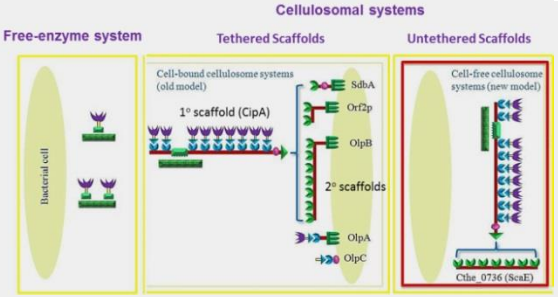
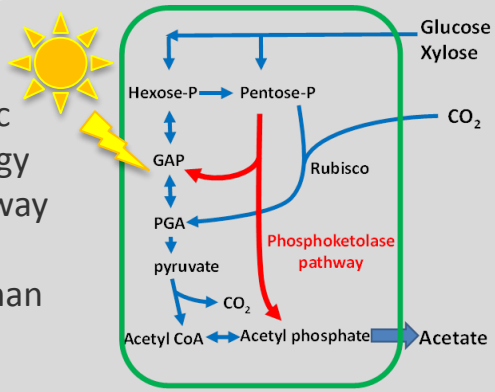
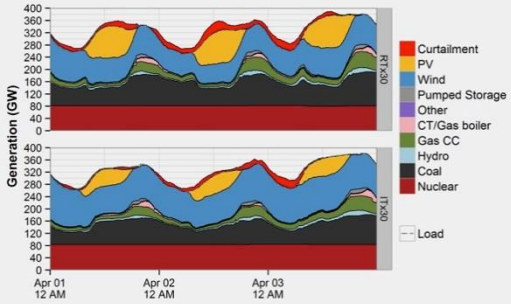
Emerging and Enabling Capabilities:

Advanced Computer Science, Visualization & Data

Biological Systems Science

Large-Scale User Facilities

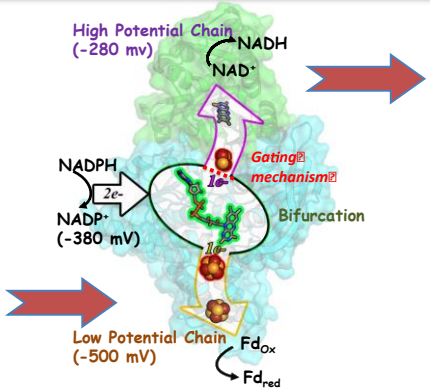
BER related core capabilities: research & facilities

Capabilities	Accomplishments	Impact	Facilities
Advanced imaging and computational modeling	Discovered that *C. thermocellum* can deploy all known cellulase paradigms: free enzymes, tethered and untethered scaffolds. (***Science Adv. 2016***) 	Opens the door for a variety of enzyme design strategies to improve upon the most effective lignocellulosic degrading microbe known today.	Integrated Biomass Refinery Facility
Anaerobic Microbiology	Determined role of cyanobacteria metabolic pathway critical to energy conversion; major pathway for CO_2 utilization and more carbon efficient than traditional pathways. (***Nature Plants 2015***) 	Shines new light on carbon utilization and energy management within cyanobacteria and allows for more carbon efficient biofuels production strategies.	Biomass Surface Characterization Lab
Protein Engineering			Ultrafast Spectroscopy
Redox Biochemistry			Nuclear Magnetic Resonance
Energy Transduction			
High Throughput Biomass Screening			Spin Resonance Facility
Energy Systems Modeling	Used high performance computing to model the operations of the Eastern U.S. power grid at 5-minute resolution with >300 GW wind and solar (***in press, 2016***) 	Provides new insight into how best to integrate emerging clean energy technologies with existing energy infrastructure	High Performance Computing
Hardware-in-the-loop Simulation			

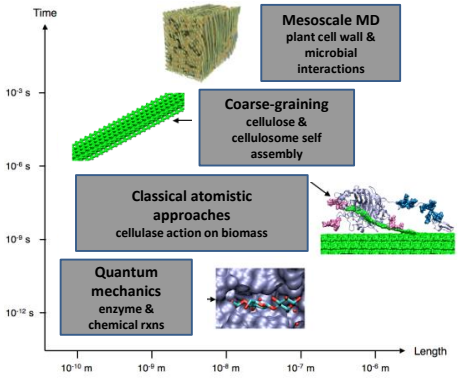
Future BER related strategic science priorities

New Scientific Findings

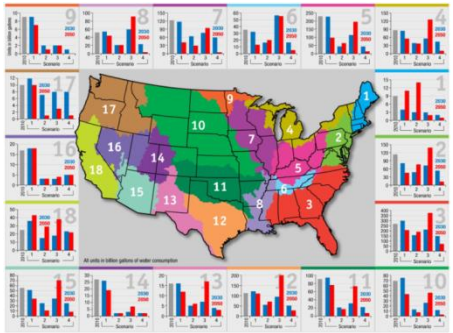
New fundamental understandings of electron transfer over multi-length timescales for challenging catalytic transformations and energy conserving reactions (***Science 2016***)



New fundamental understanding of the critical multi-length scale interactions between catalysts and plants that govern biomass recalcitrance (***Science 2013; Chem. Sci. 2016***)



New fundamental understanding of the interplay between future electricity system evolution and water demands by the power sector (***Env. Research Letters 2012***)



Future Scientific Strategic Direction

Bioenergetics: Further understanding of redox biochemistry and carbon metabolism to control flux through metabolic pathways; Gain advanced understanding to refine energetic principles for rational microbial redesign

Science at Multi-scales and Complexity: Understanding the multi-length scale science of biomass recalcitrance will require further development and application of computational, advanced imaging, and systems biology tools

Coupled Energy-Climate System Modeling: Understanding the coupled interactions between climate change, energy demand, energy supply, food production, and water resources using advanced multi-scale and flexible modeling platforms

Future BER related strategic partnerships

BER Facilities/Labs	BER/BES Centers	Gov't Agencies	Commercial Partners
EMSL	BESC BioEnergy Science Center	U.S. DEPARTMENT OF ENERGY | Office of Science	ceres
JGI Joint Genome Institute Department of Energy	Great Lakes Bioenergy Research Center	U.S. Department of Energy Energy Efficiency & Renewable Energy	novozymes
Berkeley Lab	SNS Spallation Neutron Source		POET
Oak Ridge National Laboratory	jbei Joint BioEnergy Institute	arpa·e Changing What's Possible	ArborGen
Pacific Northwest National Laboratory	C3Bio	USDA	DuPont
Sandia National Laboratories	ATP e⁻ ΔG BETCy	NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce	opxbio good chemistry.
		NCAR National Center for Atmospheric Research	ADM
			Cargill
			LYGOS
			AMYRIS Biotechnologies
			VIRENT

NREL
National Renewable Energy Laboratory