INITIATIVE FOR RENEWABLE ENERGY AND THE ENVIRONMENT

Richard “Dick” Hemmingsen, Director

June 2, 2010

INSTITUTE ON THE ENVIRONMENT
UNIVERSITY OF MINNESOTA
Driven to Discover℠

IREE Mission (est. 2003)

To promote statewide economic development, sustainable, healthy, and diverse ecosystems, and national energy security through development of bio-based and other renewable resources and processes.

Legislative Support

2003 Special Session, H.F. 9

$10 Mil. from Xcel Renewable Development Fund

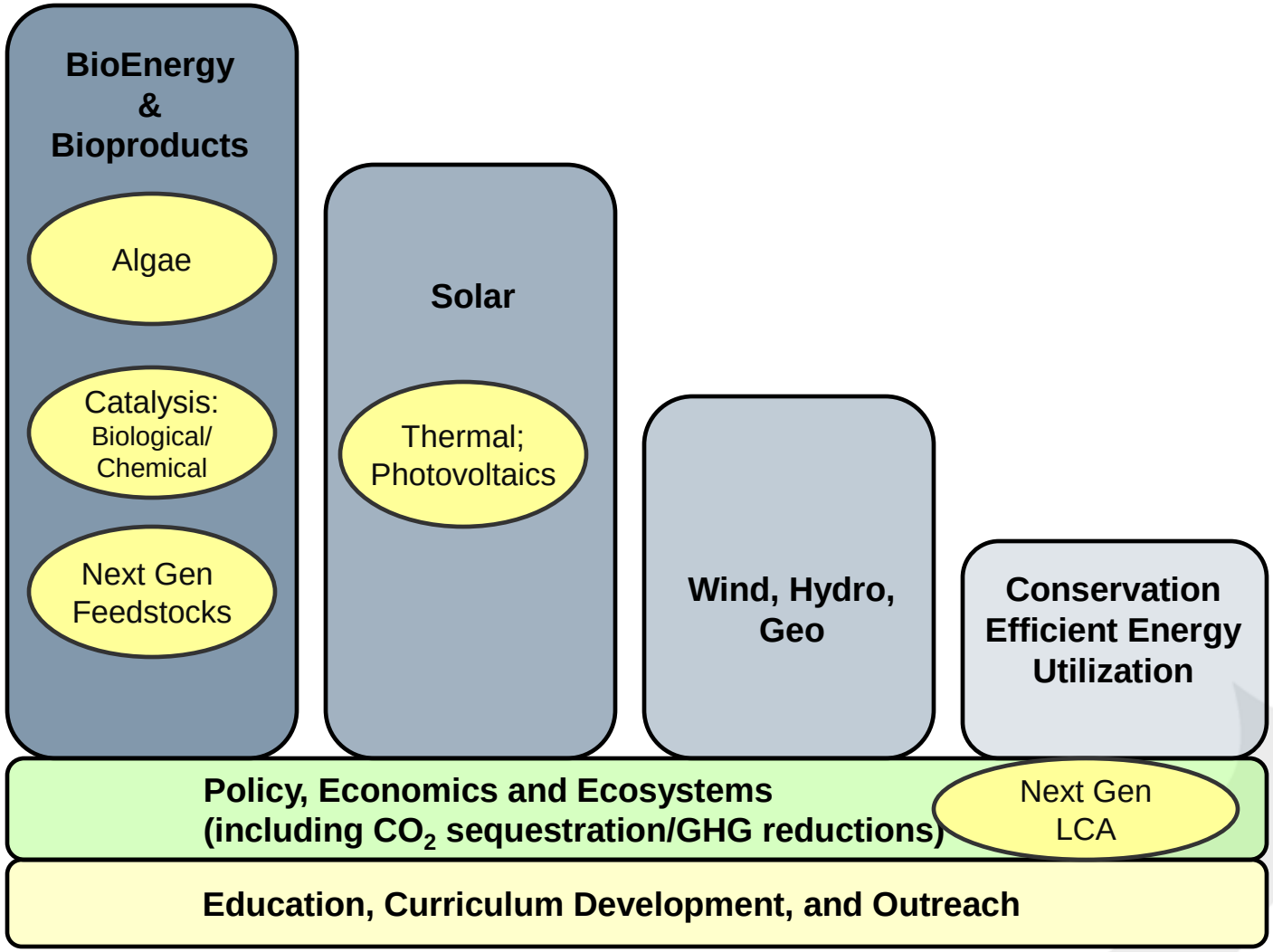
~$2Mil./yr for five years from Xcel CIP obligation

2007 Session

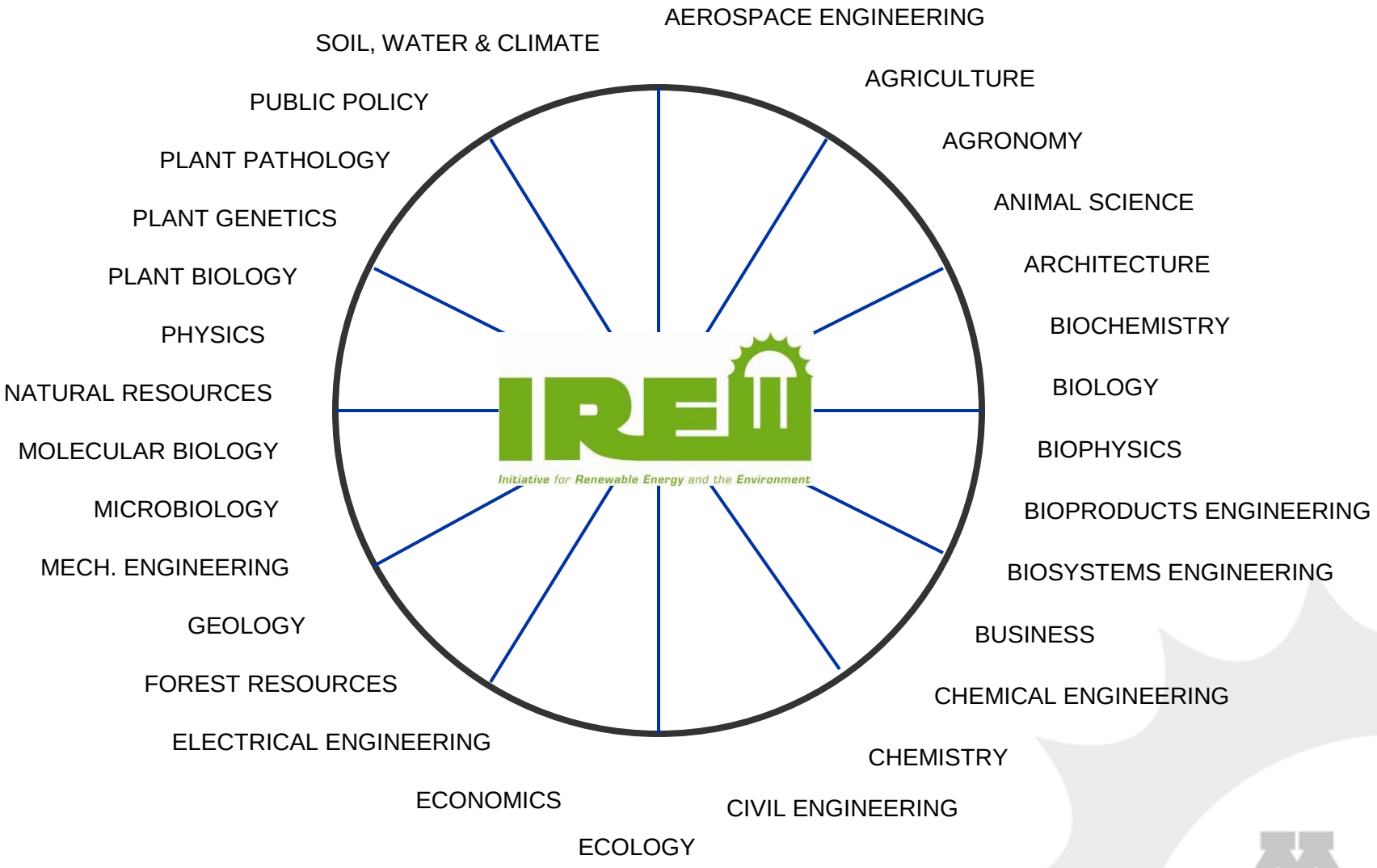
Re-authorized and transitioned to current level of $5 mil/year from Xcel Renewable Development Fund

Xcel Energy®

IREE's Portfolio – Moving Forward

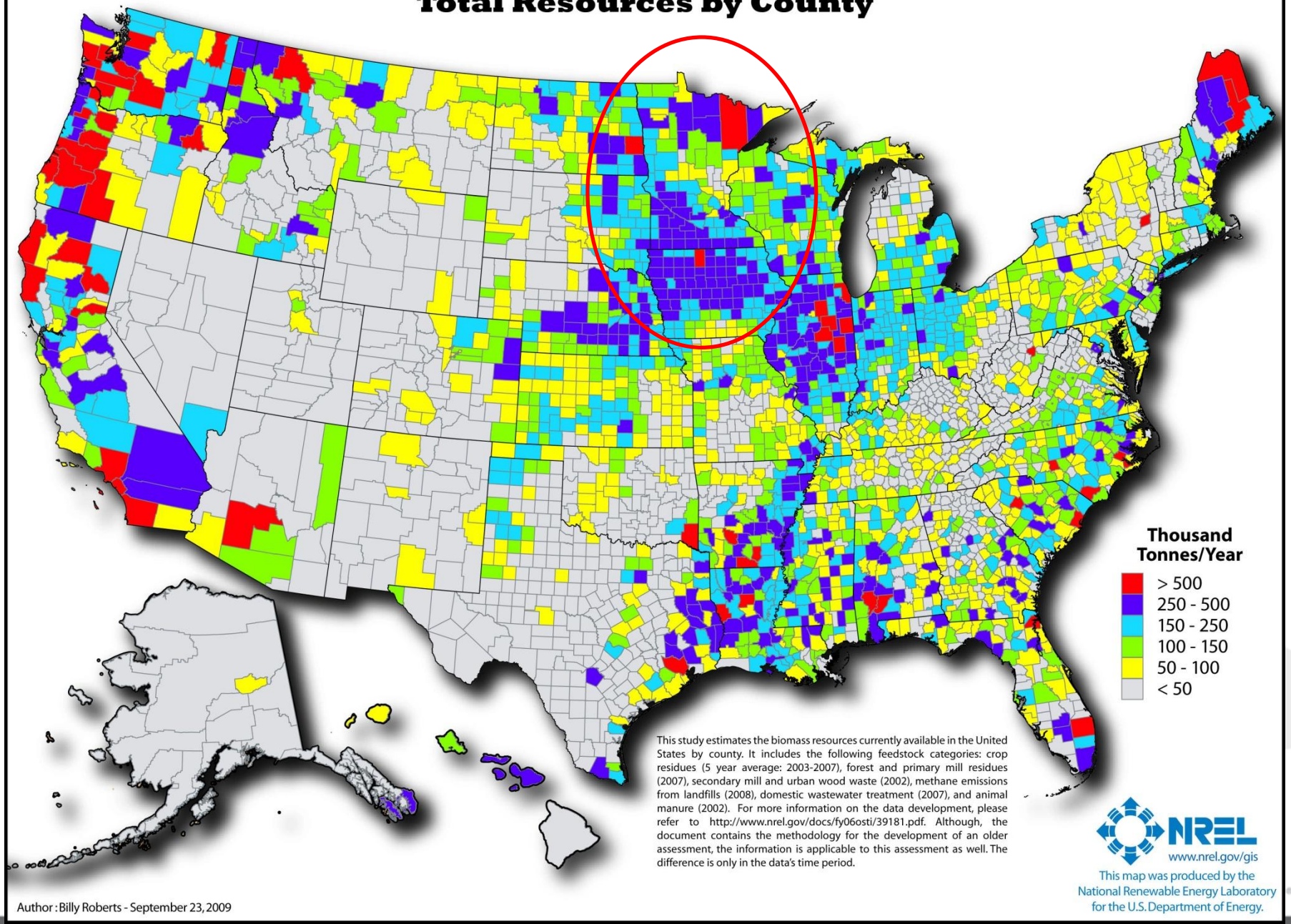


Facts and Figures – Disciplines



Biomass Resources of the United States

Total Resources by County



This study estimates the biomass resources currently available in the United States by county. It includes the following feedstock categories: crop residues (5 year average: 2003-2007), forest and primary mill residues (2007), secondary mill and urban wood waste (2002), methane emissions from landfills (2008), domestic wastewater treatment (2007), and animal manure (2002). For more information on the data development, please refer to http://www.nrel.gov/docs/fy06osti/39181.pdf. Although, the document contains the methodology for the development of an older assessment, the information is applicable to this assessment as well. The difference is only in the data's time period.

Author : Billy Roberts - September 23, 2009

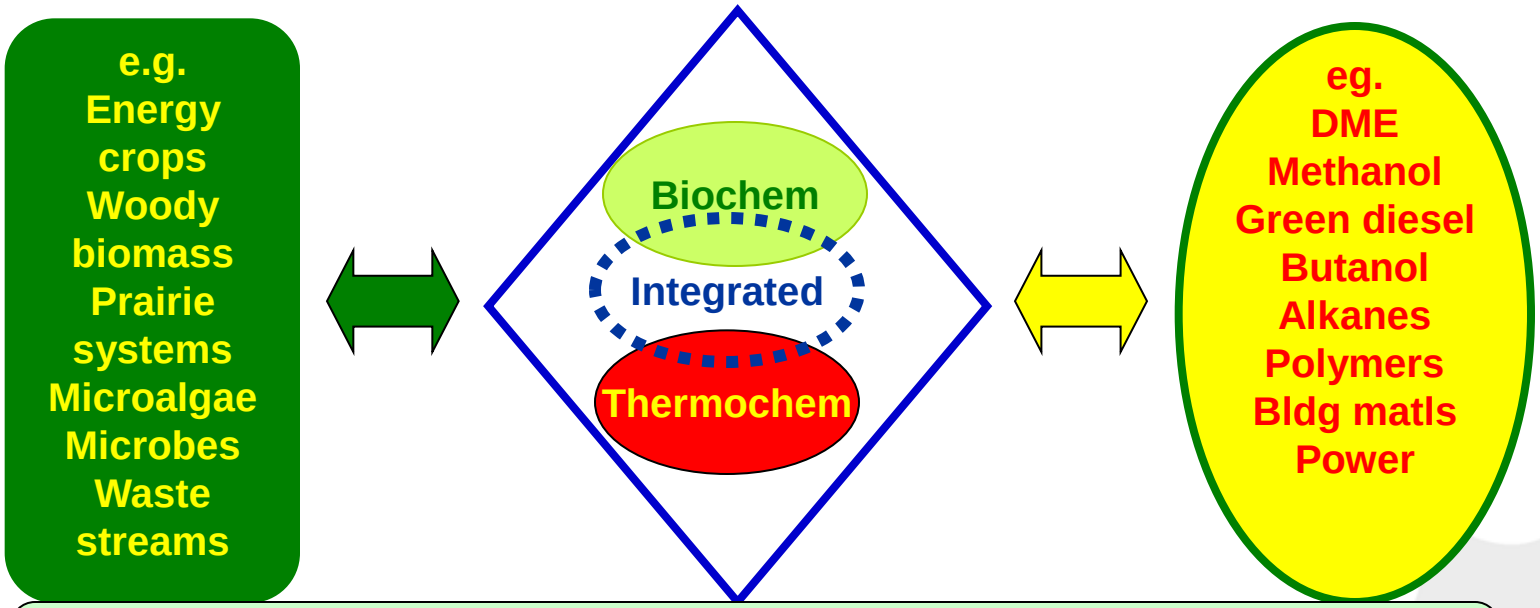
NREL
www.nrel.gov/gis
This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy.

Next Generation Bioenergy/Bioproducts Systems

Next-generation feedstocks

Next-generation conversion systems

Next-generation Fuels/products



Policy, Economics and Ecosystems
(including CO_2 sequestration/GHG reductions)

Carbon Negative Biofuels from Prairie Grasses

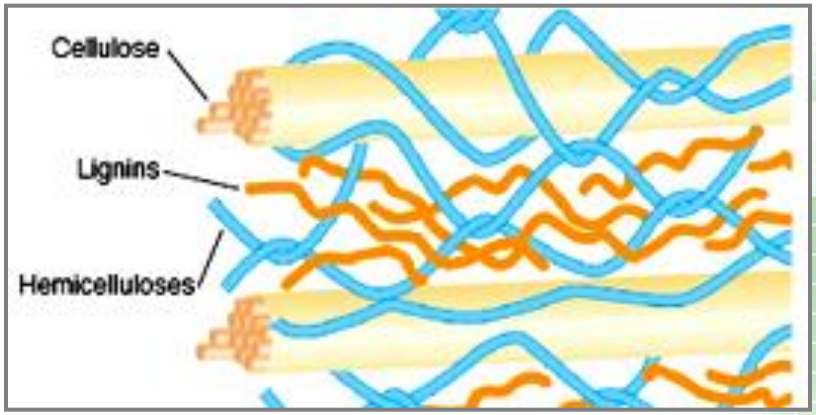
Impacts:

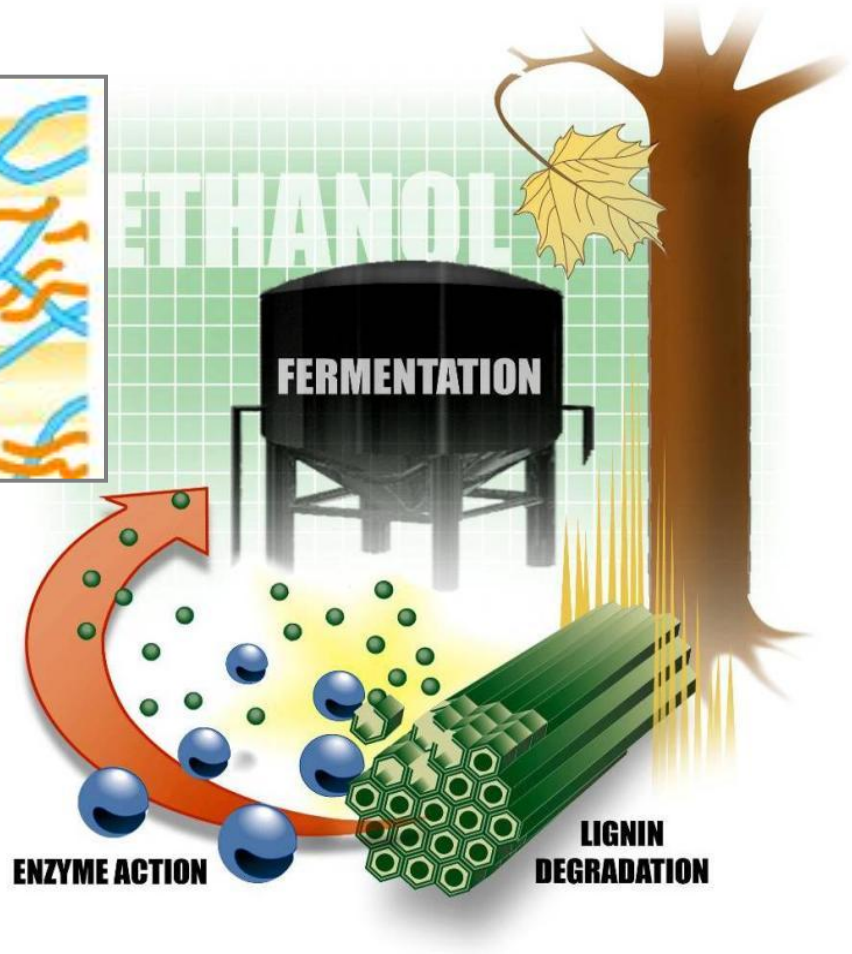
- 2x the biomass compared to monoculture
- Significantly reduced greenhouse gas emissions - Carbon Negative!
- Adapted to marginal soils
- Require fewer inputs to grow and cultivate
- More resilient to drought, disease, and pests
- Applicable to fuels and power

Thermochemical Approaches to Conversion of Biomass in Small-Scale, Distributed Systems

Project leads: Michael Tsapatsis, ChemE; Roger Ruan, BBE

BREAKING DOWN LIGNIN

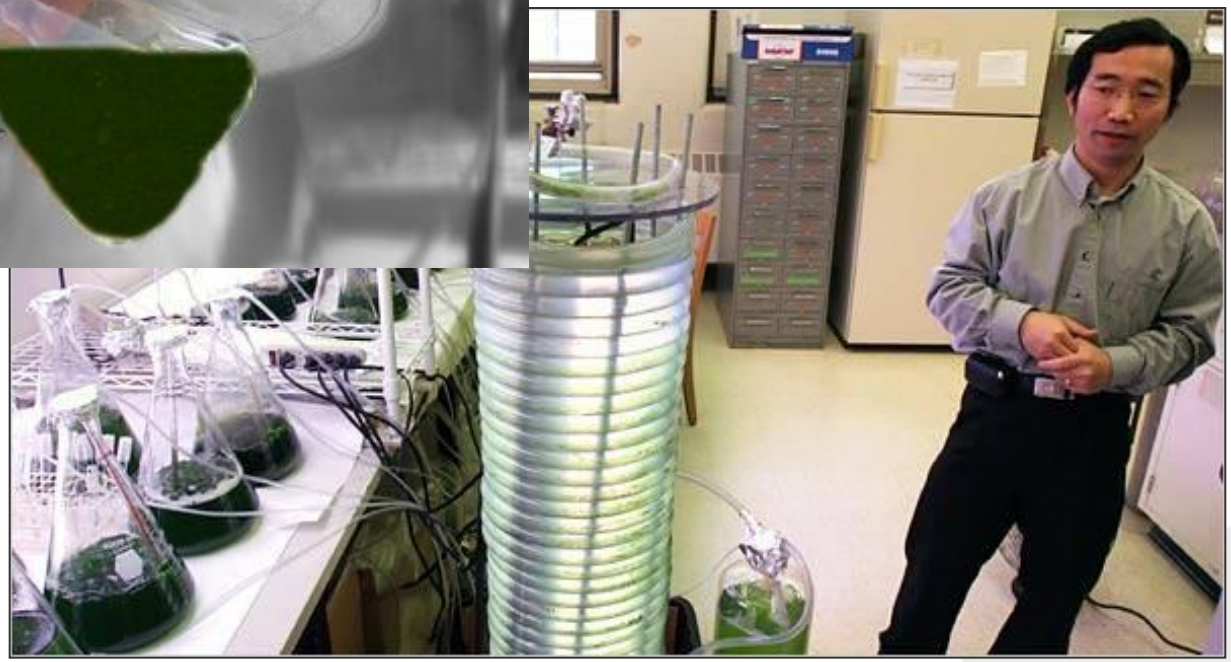




Related Sarkanen work included in BioEnergy Science Center led by the DOE's Oak Ridge National Laboratory in Oak Ridge

Related Schilling work selected as DOE Early Career award

Algae/waste water-to-biofuels/co-products research

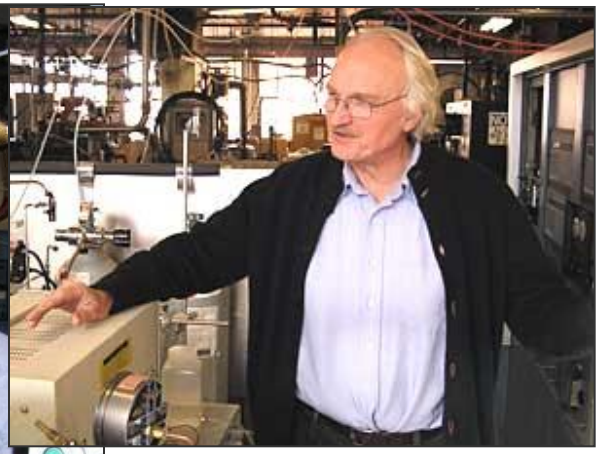


In Partnership with:

Metropolitan Council

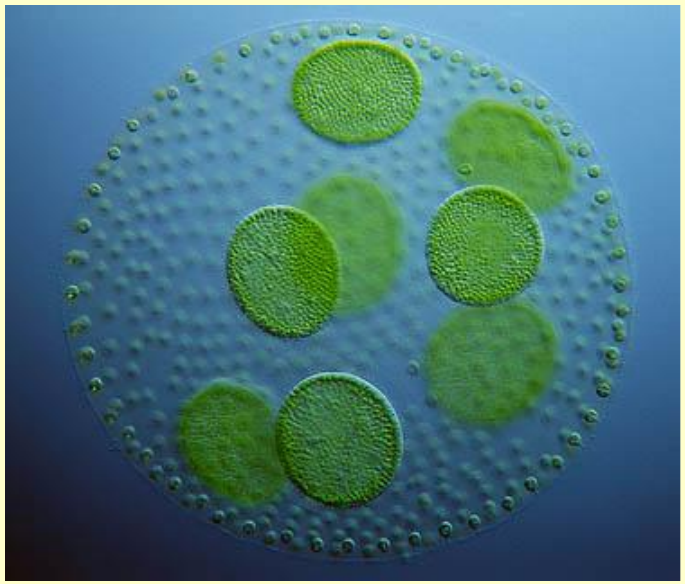
Xcel Energy®

NEXT GENERATION ENGINES AND EFFICIENT UTILIZATION OF BIOFUELS

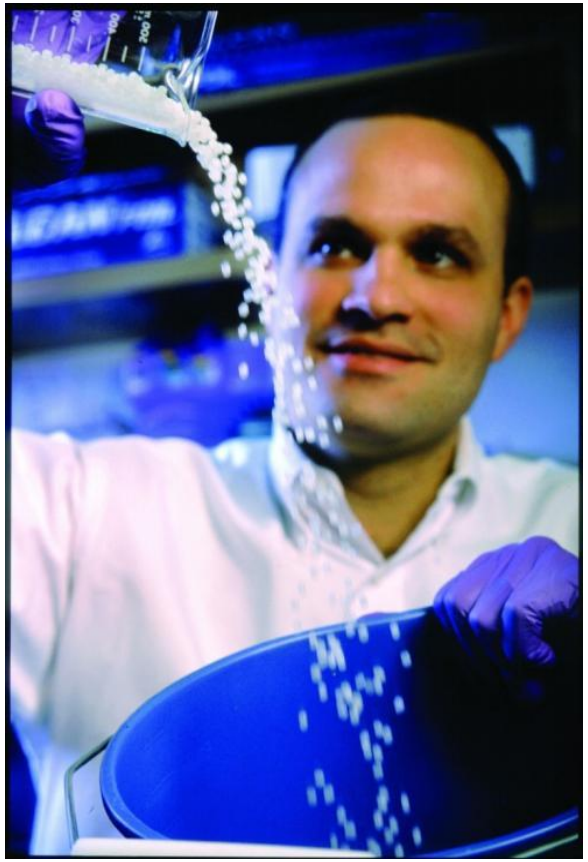


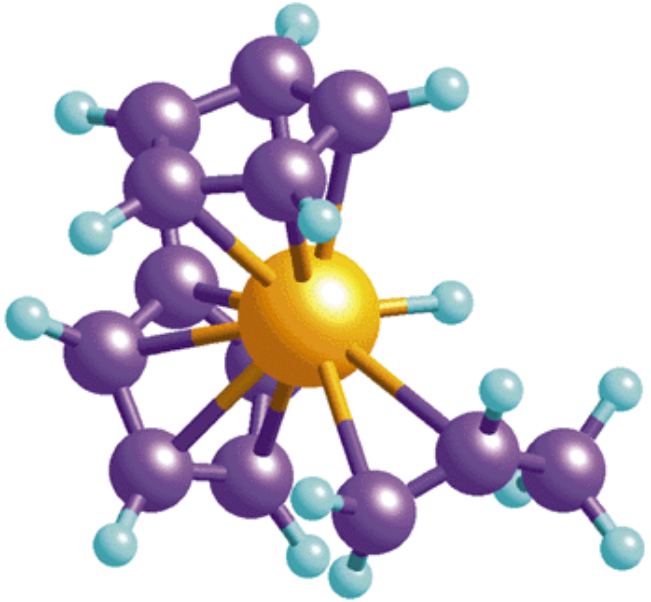
OPTIMIZING MICROBIAL FUEL CELLS

ENHANCING THE PRODUCTION OF HYDROGEN BY GENETIC ENGINEERING OF THE ALGA *Chlamydomonas Reinhardtii*



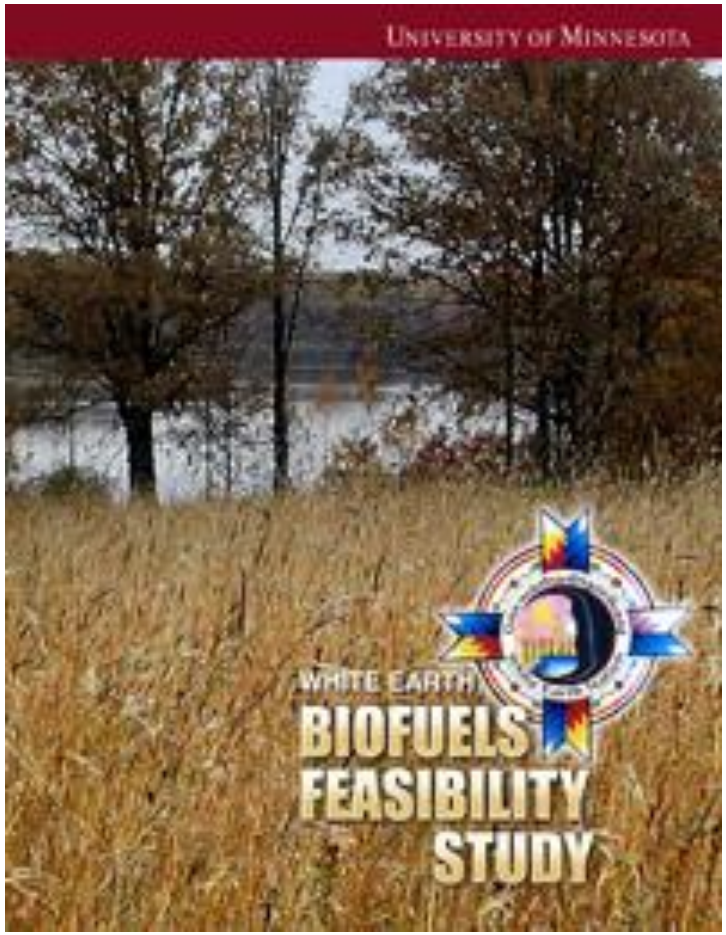
Sustainable Polymers: Tomorrow's Advanced Materials *Project lead:* Marc Hillmyer, Chemistry

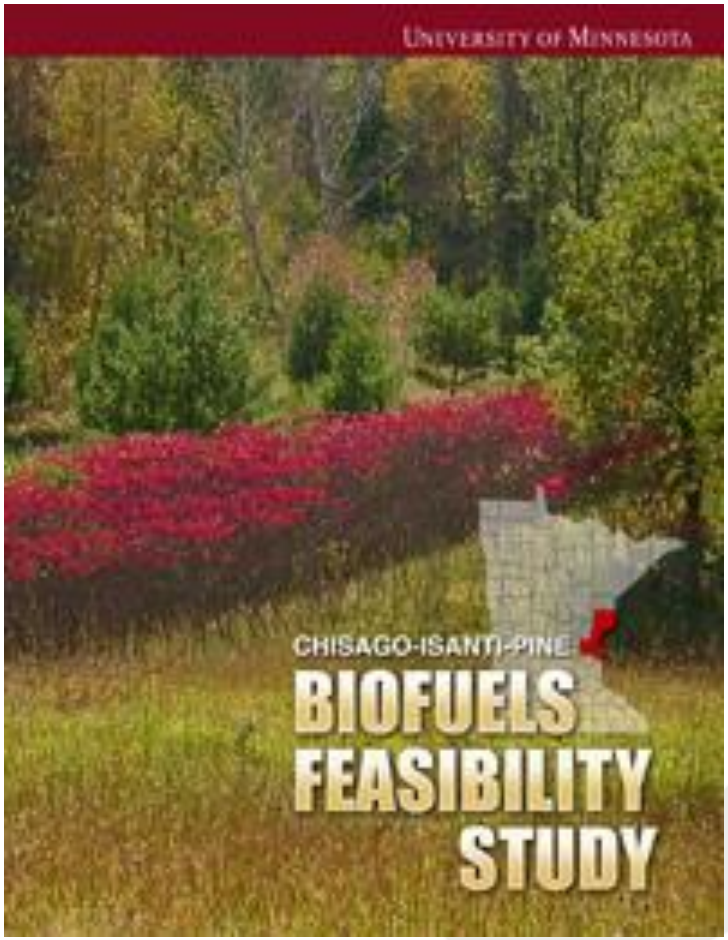




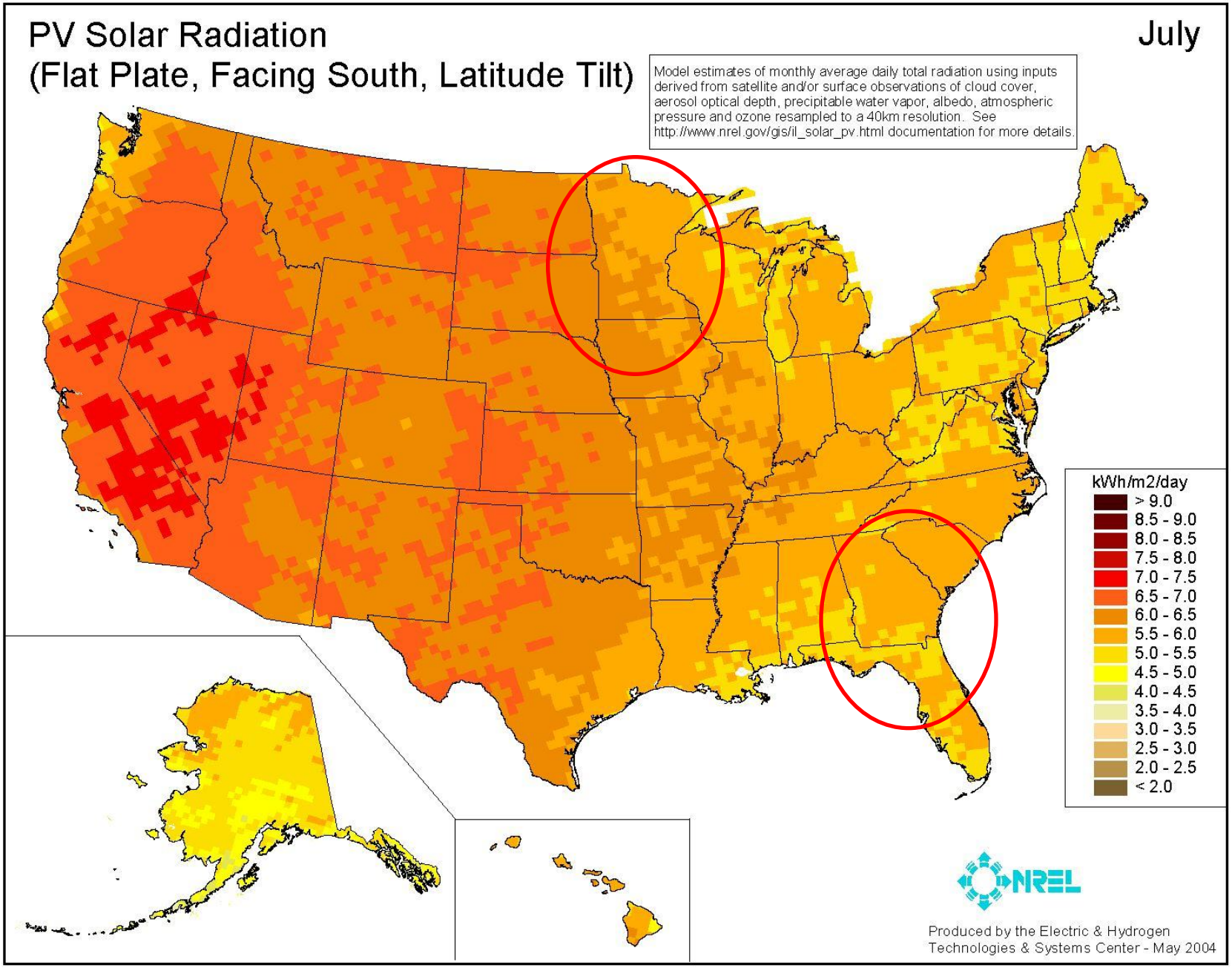
http://www.chem.umn.edu/csp/

IREE completes 2 comprehensive biofuels feasibility studies

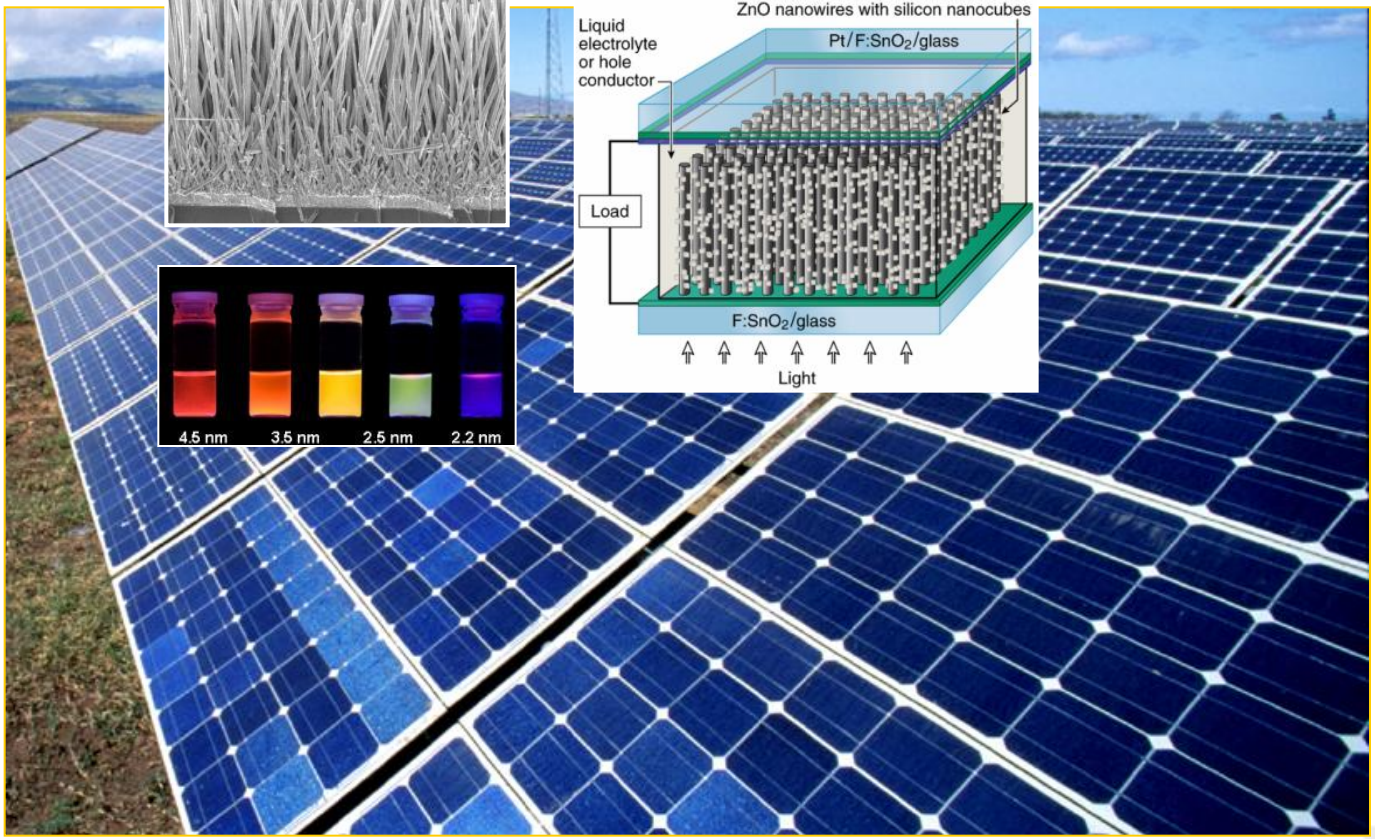




http://www.bti.umn.edu/WE_CIP/index.html

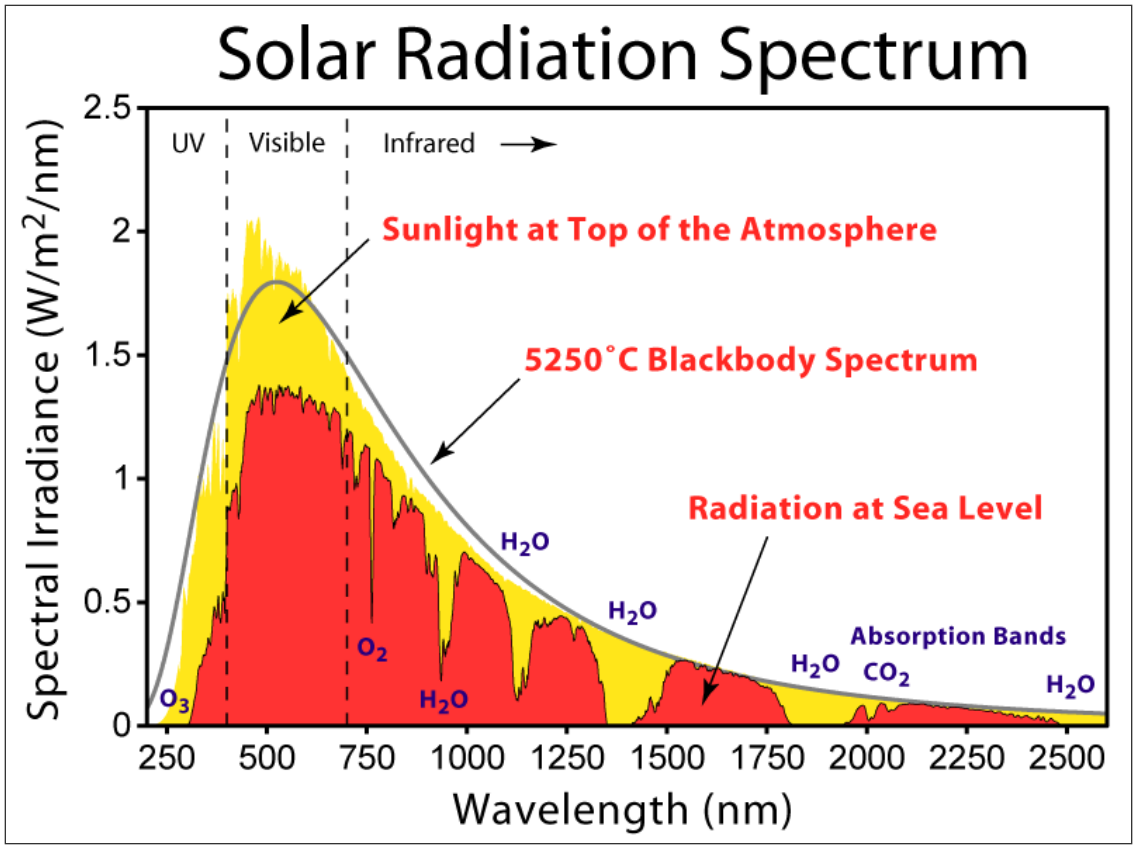

PV Solar Radiation
(Flat Plate, Facing South, Latitude Tilt)
July
Model estimates of monthly average daily total radiation using inputs derived from satellite and/or surface observations of cloud cover, aerosol optical depth, precipitable water vapor, albedo, atmospheric pressure and ozone resampled to a 40km resolution. See http://www.nrel.gov/gis/il_solar_pv.html documentation for more details.
kWh/m2/day
> 9.0
8.5 - 9.0
8.0 - 8.5
7.5 - 8.0
7.0 - 7.5
6.5 - 7.0
6.0 - 6.5
5.5 - 6.0
5.0 - 5.5
4.5 - 5.0
4.0 - 4.5
3.5 - 4.0
3.0 - 3.5
2.5 - 3.0
2.0 - 2.5
< 2.0
NREL
Produced by the Electric & Hydrogen Technologies & Systems Center - May 2004

USING NANOTECHNOLOGY TO CREATE HIGH-EFFICIENCY, LOW-COST SOLAR CELLS



Laterally Integrated Photovoltaic Systems

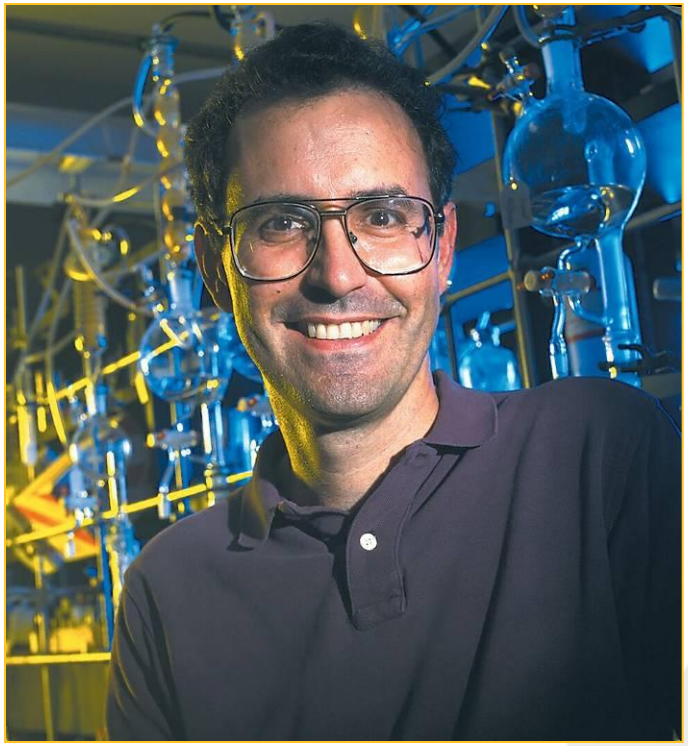
Project lead: Philip Cohen, Electrical and Computer Engineering



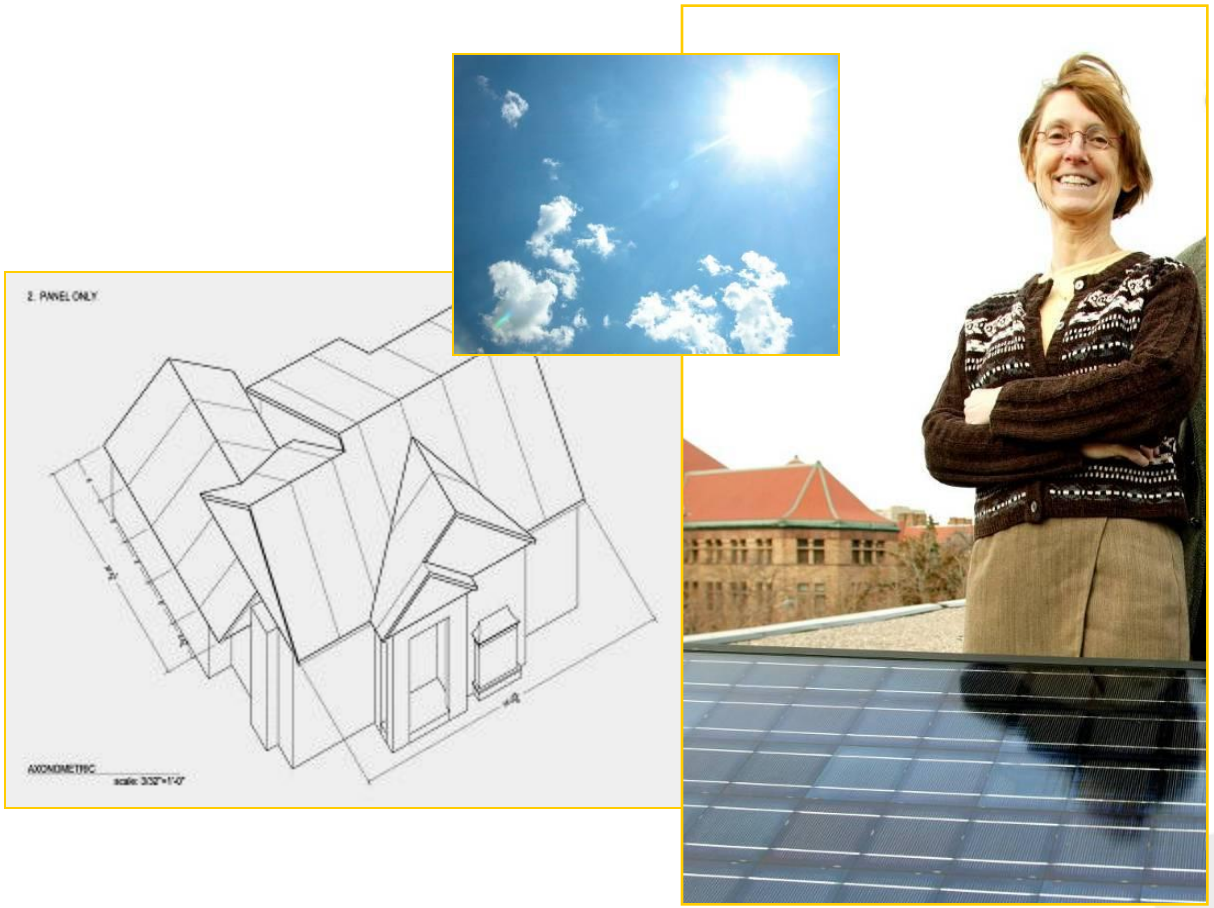
Ink Jet Direct Write Solar Cells

Research to develop lower-cost solar cells using ink jet technology.

Impact: Will Enable solar technology to be cost competitive with other current energy generation sources, thereby providing a strong driving force for it to be incorporated into a diversified power generation portfolio.

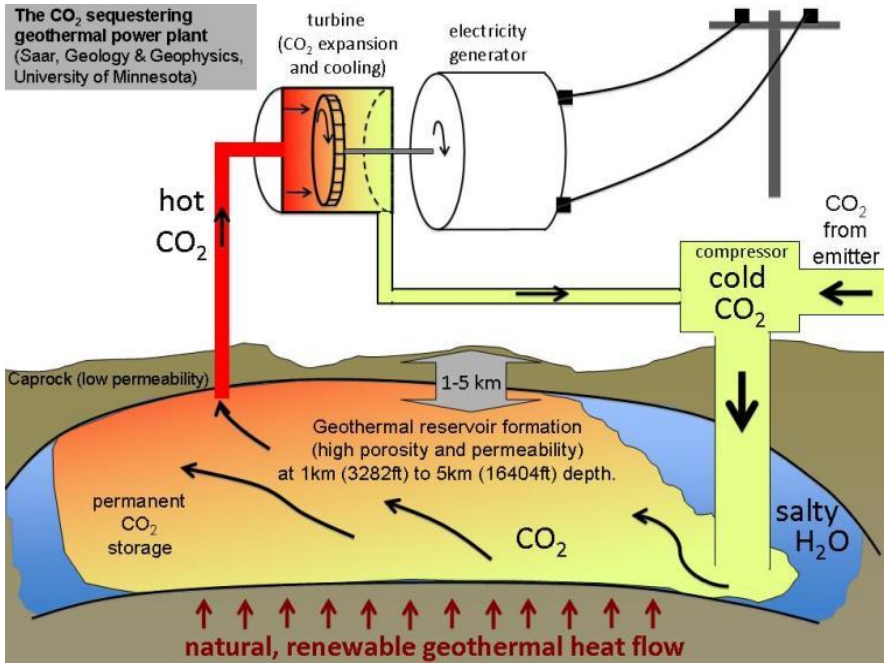


SOLAR-THERMAL RESEARCH



Combining Geothermal Energy Extraction and CO2 Sequestration to Produce Clean, Renewable, Carbon Negative Electricity

Project lead: Martin Saar, Geology and Geophysics



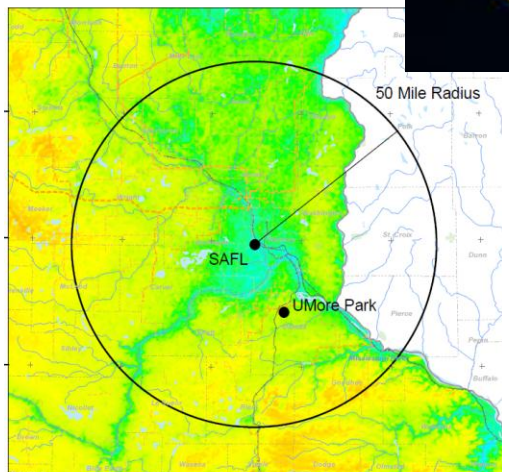
Low-temperature Geothermal – Minnesota

High-temperature Geothermal – Iceland

U.S. DEPARTMENT OF ENERGY

$1.5 mil award (11/09)

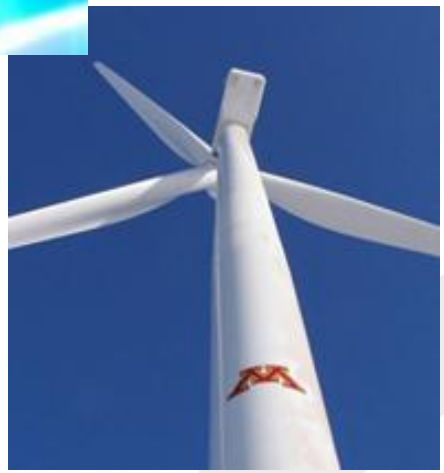
Industry/Academe Consortium for Achieving 20% wind by 2030 through Research & Workforce Training



U.S. DEPARTMENT OF ENERGY

IREE
A SIGNATURE PROGRAM OF THE INSTITUTE ON THE ENVIRONMENT

Xcel Energy™



Consortium Participants

Institutions of Higher Learning

- University of Minnesota, Twin Cities (UM)
- Syracuse University (SU)

Technical College

Dakota County Technical College (DCTC)

Industrial Partners

Funding

$8M (DOE) + $3.5M(cost-share)

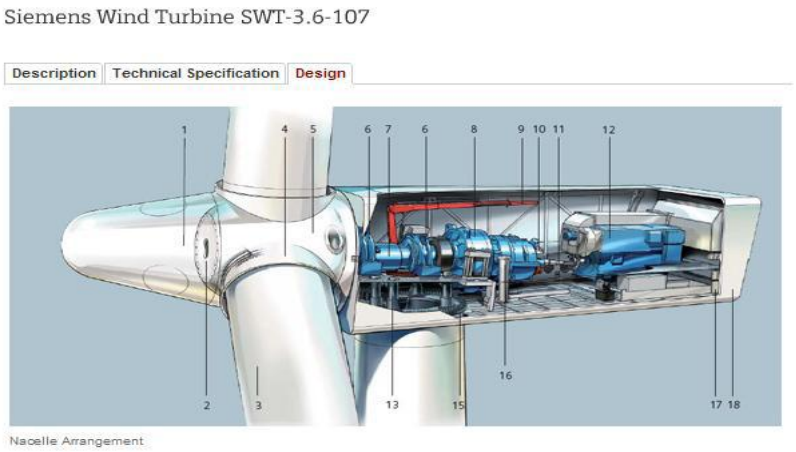
Project PI

Fotis Sotiropoulos – (CE) UM

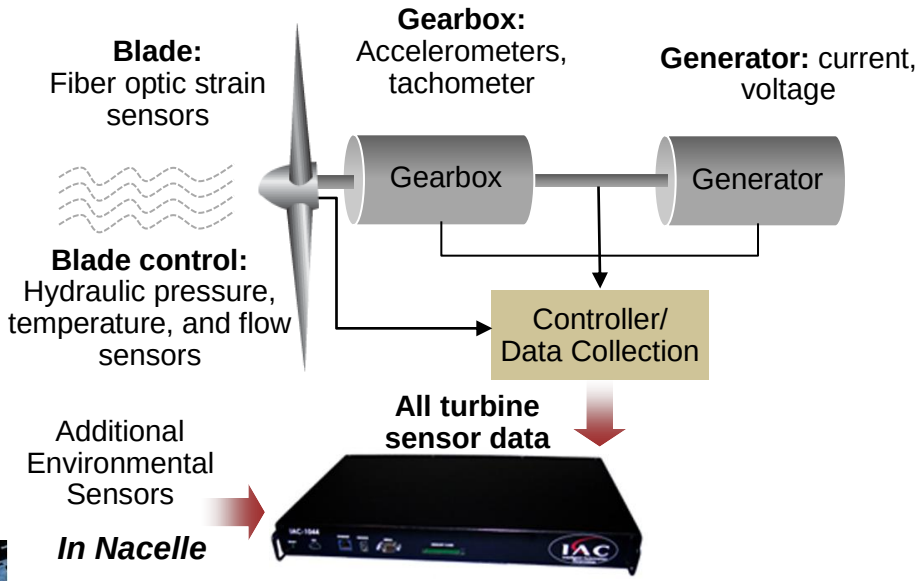
Project co-PIs

- R. E. Arndt – (CE) UM
- G. Balas – (AEM) UM
- M. Glauser – (MAE) SU
- M. Jovanovich – (ECE) UM
- M. Kaveh – (ECE) UM
- J. Labuz – (CE) UM
- S. Mantell – (ME) UM
- N. Mohan – (ECE) UM
- F. Porte-Angel (CE) UM
- K. Stelson – (ME) UM
- H. Stolarski – (CE) UM

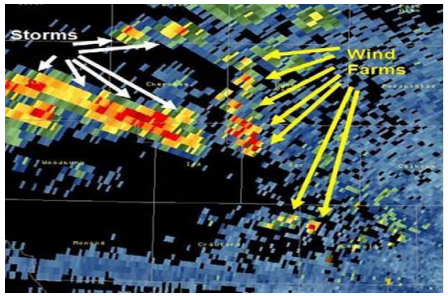
Research Challenges



Gear box and generator reliability & efficiency



Foundation design



Wind farms & weather radars

Health-based monitoring and preventive maintenance

Wind-to-Battery Storage

Wind-to-Hydrogen

U of M Morris / WCROC

Refrigerants

Anhydrous Ammonia

Anhydrous Storage

Reformer

H_2 + N

Hydrogen Storage

Hydrogen Fueling

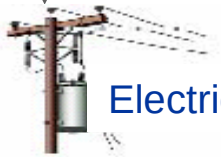
Hydrogen Vehicles

Electrolyzer

Short-term Storage

Fuel Cells and Engines

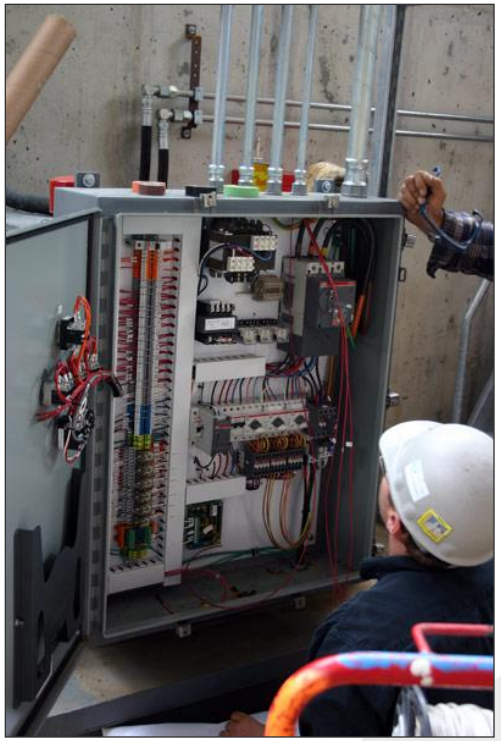
Fueling Station Electrolyzer



Electric Grid

Evaluation, Validation and Demonstration of Small-Scale Renewable Energy Systems for Homes and Businesses

Project lead: Michael Reese, Morris WCROC



Air Pollution Impacts of Conventional and Alternative Fuels: A Spatial and Temporal Life Cycle Analysis Decision Support Tool

(Advanced Life Cycle Analysis: tracking amount, location, and timing of GHG emissions

Project lead: Julian Marshall, Civil Engineering

FY 2010 Investment Strategy

Large Grants

25 pre-proposals (100 investigators - $15.6 mil)
19 invited full proposals (71 investigators - $10.8 mil)
9 proposals awarded (36 investigators - $4.85 mil)

*Early Career Grants ($750K)

16 pre-proposals (22 investigators - $2.3 mil)
10 invited full proposals (12 investigators - $1.5 mil)
6 proposals awarded (8 investigators,- $796,361)

Seed Grants ($750K)

27 proposals (51 investigators - $1.8 $ mil)
9 proposals awarded (23 investigators - $565,574)

Special Opportunity Program

Waste to energy?
Conservation/Energy Efficiency?
Leveraging significant (DOE) solicitations?

Matching Grant Program

Status May 27. 2010

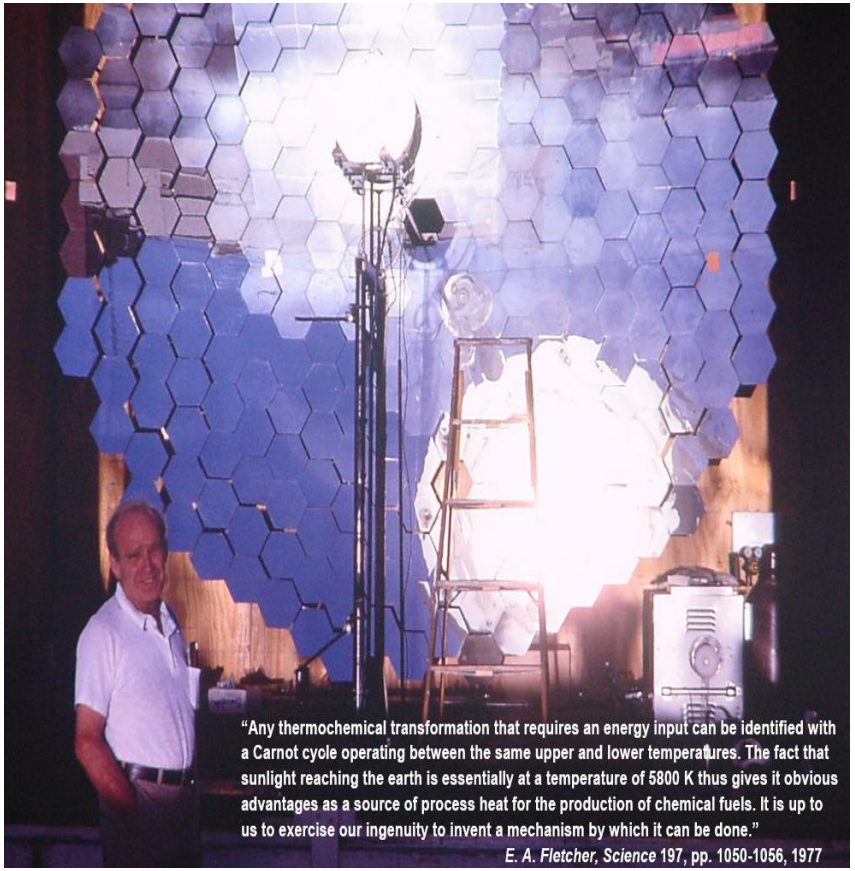
14 currently active Matching Grants

- $ 1,919,520 IREE investments
- $14,044,920 extramural funds leveraged

15 currently pending Matching Grants

- $ 1,55,129 IREE funds pledged
- $28,249,828extramural funds leveraged if all funded

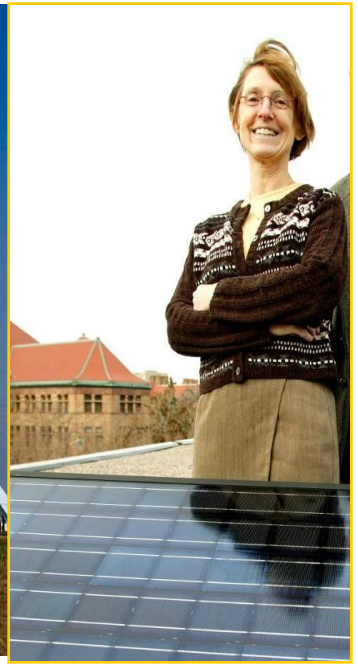
The critical need for substantial and sustained investment in public research



CONCENTRATING) SOLAR RESEARCH -- circa 1970's

Thermochemical Fuels: Solar at Night

Project lead: Jane Davidson, Mechanical Engineering



H_2 production two step water splitting/Zn0 cycle

Concentrating solar for biomass gasification

Solar Recycling of $C0_2$ to fuels

** Sunlight to fuels – $C0_2$ to hydrocarbons - DOE Hub

The Larry Wackett Research Group

Shewanella as an Ideal Platform for Producing Hydrocarbon Biofuels

- Leverage DOE investment in *Shewanella* to develop novel hydrocarbon production strains utilizing renewable substrates

  - Wackett and Gralnick Labs, U. Minnesota

- Collaboration with Pacific Northwest National Laboratory to use *Shewanella* and phototroph co-cultures to make hydrocarbons

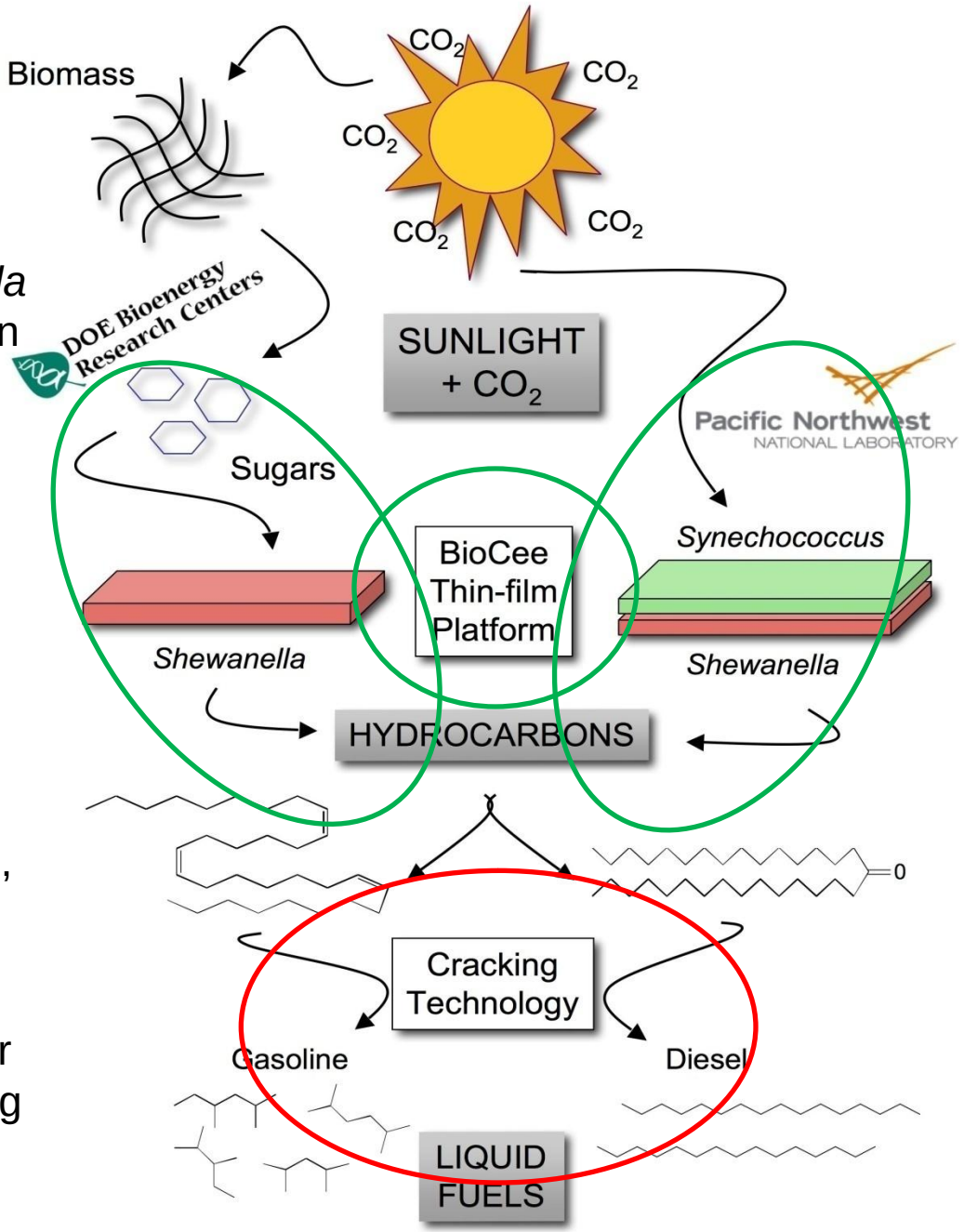
  - Fredrickson and Beliaev Labs, PNNL

- Thin-film biocatalysis using BioCee biocoating technology for cost reduction, stabilization and control

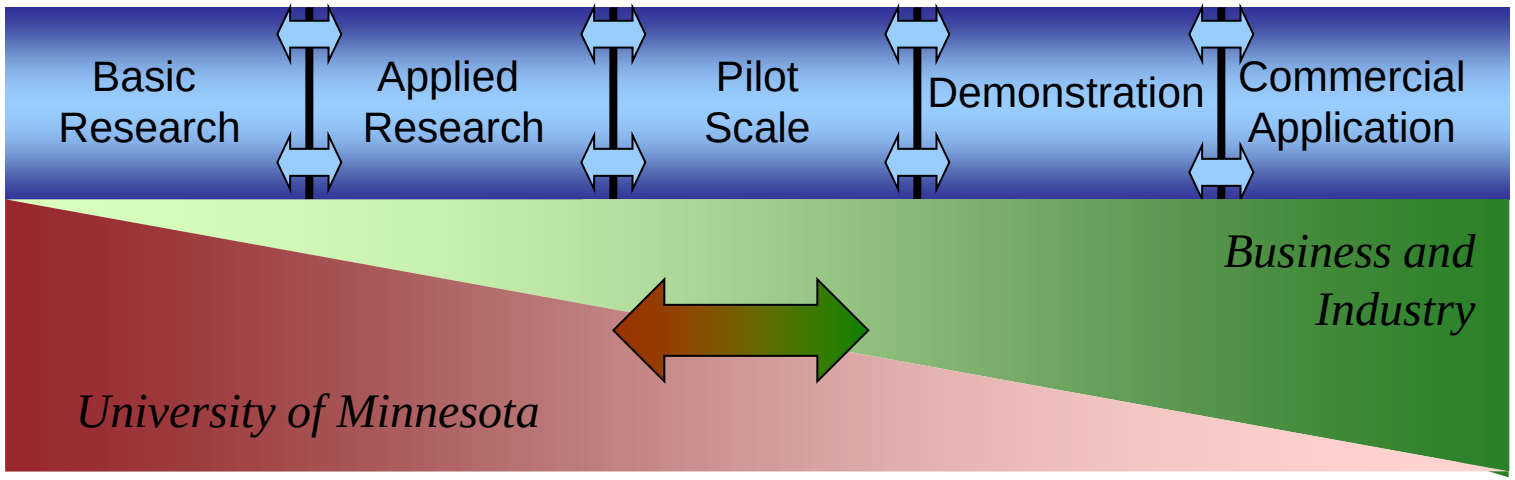
  - BioCee, Inc, Minneapolis, MN

- Novel single-pipe metal & zeolite reactor configuration for hydrocarbon processing

  - Schmidt and Bhan Labs, U. Minnesota



The Research-Development-Commercialization Continuum



Mark your calendar!

GLOBALSUSTAINABLEBIOENERGY

NORTH AMERICAN CONVENTION 2010

SEPTEMBER 14-16 AT MARQUETTE HOTEL, MINNEAPOLIS

environment.umn.edu/gsb

Mark your calendar!

The Midwest's Premier Energy, Economic and Environmental Conference

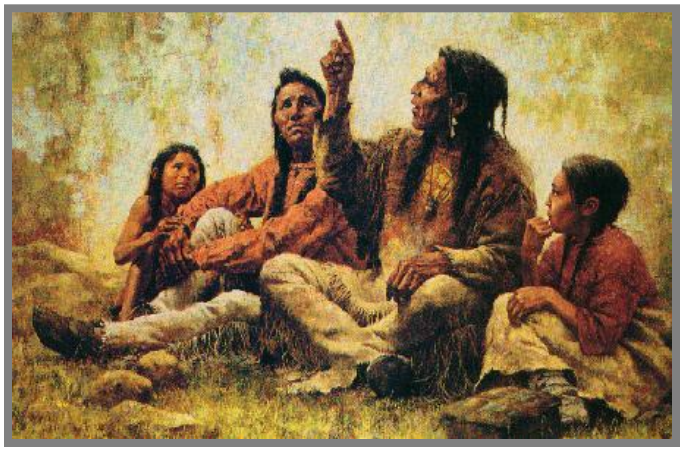
Nov. 30 and Dec. 1 at the Saint Paul RiverCentre

www.iree.umn.edu/e3

We need to develop *next-generation renewable energy systems* with multiple benefits…*systems approaches* for the best mix of desirable benefits:

- Economic benefits
- Energy security benefits
- Environmental benefits
  - water quality
  - air quality
  - soil quality
  - habitat

IN CLOSING…



"Treat the earth well: it was not given to you by your parents, it was loaned to you by your children. We do not inherit the Earth from our Ancestors, we borrow it from our Children."

- Ancient Indian Proverb


THANK YOU
MINNESOTA
Questions?