Discovery with delivery in energy sciences and engineering

Advanced ground vehicle power; Batteries and advanced electrochemical systems; Biofuels; Coal; Efficient buildings; Hydrogen; Nuclear; Wind; Solar; Social, economic and policy aspects
Use-inspired discovery

- Hydrogen Fuel Cells
  - Use hydrothermolysis to generate $\text{H}_2$
  - Has applications to recharge batteries in portable electronic devices

Professor A.K. Varma and his research team
Low-Cost Solar Cells from Inorganic Inks

- CulnSe2 (CIS) and CulnGaSe2 (CIGS) nonocrystals are synthesized directly from solution-based-chemistry (“ink”)
- The ink can be easily applied to thin film solar cells using a spray coating or roll coating.
- This solar cell technology has a low cost of production.
Innovative sensing technology and data analytics

**Smart Wind Turbines & Farms**
that can sense, predict, and control their own performance & reliability

**Simulation Based Models**
that can help engineers and owners optimize wind turbine and wind farm designs

**MEMS bimorph temperature sensor**

**Durability**
**Repair**
**Reliability**
**Efficiency**
**Noise**
**Economics**
Center for direct catalytic conversion of biomass to biofuels (C3Bio)
Translation to market

Green Tech America
Develop genetically engineered yeast to ferment xylose to ethanol

Sorian Inc.
Improve reliability and maintenance of wind turbines

AlGalCo
Produce Hydrogen on demand from Al and Ga alloy

Swift Enterprise
Create synthetic hydrocarbons from biomass
Training the next generation of energy scientists and engineers in multidisciplinary research

**Education TODAY**

**Entering Students**

- Electrical Engineering
- Mechanical Engineering
- Agricultural Engineering
- Chemistry
- Agriculture
- Chemical Engineering
- Oil to Wheels
- Energy Economics & Policies

**Monodisciplinary Professionals**

- Sun to Electricity
- Sun to Heat
- Sun to Food
- Oil to Chemicals

**SECS-IGERT Education**

- **Economics & Policy (PU)**
  Tyner, Shivley, Raymond, Gramig
- **Chemical Engineering (PU)**
  Agrawal, Hillhouse, Harris, Pekny, Ribeiro
- **Leadership & Entrepreneurship (PU)**
  Duval-Couetil
- **Industrial Training**
  Ascent, Dow, ITN, SoloPower
- **National Laboratory Training**
  NREL, SNL, FISE, HZB
- **Education Research (PU)**
  Bodner, Capobianco
- **Mechanical Engineering (PU)**
  Garimella, Murthy
- **Earth & Atmospheric Science (PU, UTEP)**
  Diffenbaugh,
- **Materials, Science & Engineering (PU, UD, UTEP)**
  Stach, Birkmire, McClure
- **Electrical Engineering (PU, UTEP)**
  Schwartz, Gray, Zubia, Lush, Lundstrom
An electric vehicle Grand Prix to engage students of all ages

Indiana Advanced Electric Vehicle Training & Education Consortium

- Develop degree/certificate programs
- Produce web-enabled courses
- Establish SmartEnergyHub
- Develop active partnerships
- Develop educational modules for secondary schools
- Develop an Electric Vehicle Grand Prix
Energy supply and use in the United States
Science and technology shifts can reshape the future

From Horse Power to Horsepower

By Eric Morris

In 1890, delegates from across the globe gathered in New York City for the world’s first international urban planning conference. One topic dominated the discussion: the new housing, land use, economic development, or infrastructure. The delegates were driven to desperation by horse nuisance.

The horse was no newcomer on the urban scene. But by the late 1800s, the problem of horse pollution had reached unprecedented heights. The growth in the horse population was outpacing even the rapid rise in the number of human city dwellers. American cities were drowning in horse excrement as well as odor, and the predominant mode of transportation: urban, suburban, and traffic accidents. Widespread cruelty to horses was a form of environmental degradation as well.

The situation seemed dire. In 1894, the Times of London estimated that by 1900, every street in the city would be buried five feet deep in horse manure. One New York prognosticator of the 1890s concluded that by 1930, the horse droppings would rise to Manhattan’s third-century windows. A public health and sanitation crisis of almost unimaginable dimensions loomed.

And no possible solution could be devised. After all, the horse had been the dominant mode of transportation for thousands of years. Horses were absolutely essential for the functioning of the nineteenth-century city—her personal transportation, freight handling, and even mechanical power. Without horses, cities would quite literally starve.

All efforts to mitigate the problem were proving sadly inadequate. Stymied by the crisis, the urban planning conference declared its work fruitless and broke up in three days instead of the scheduled ten.