

Energy Initiatives at Virginia Tech – A Snapshot

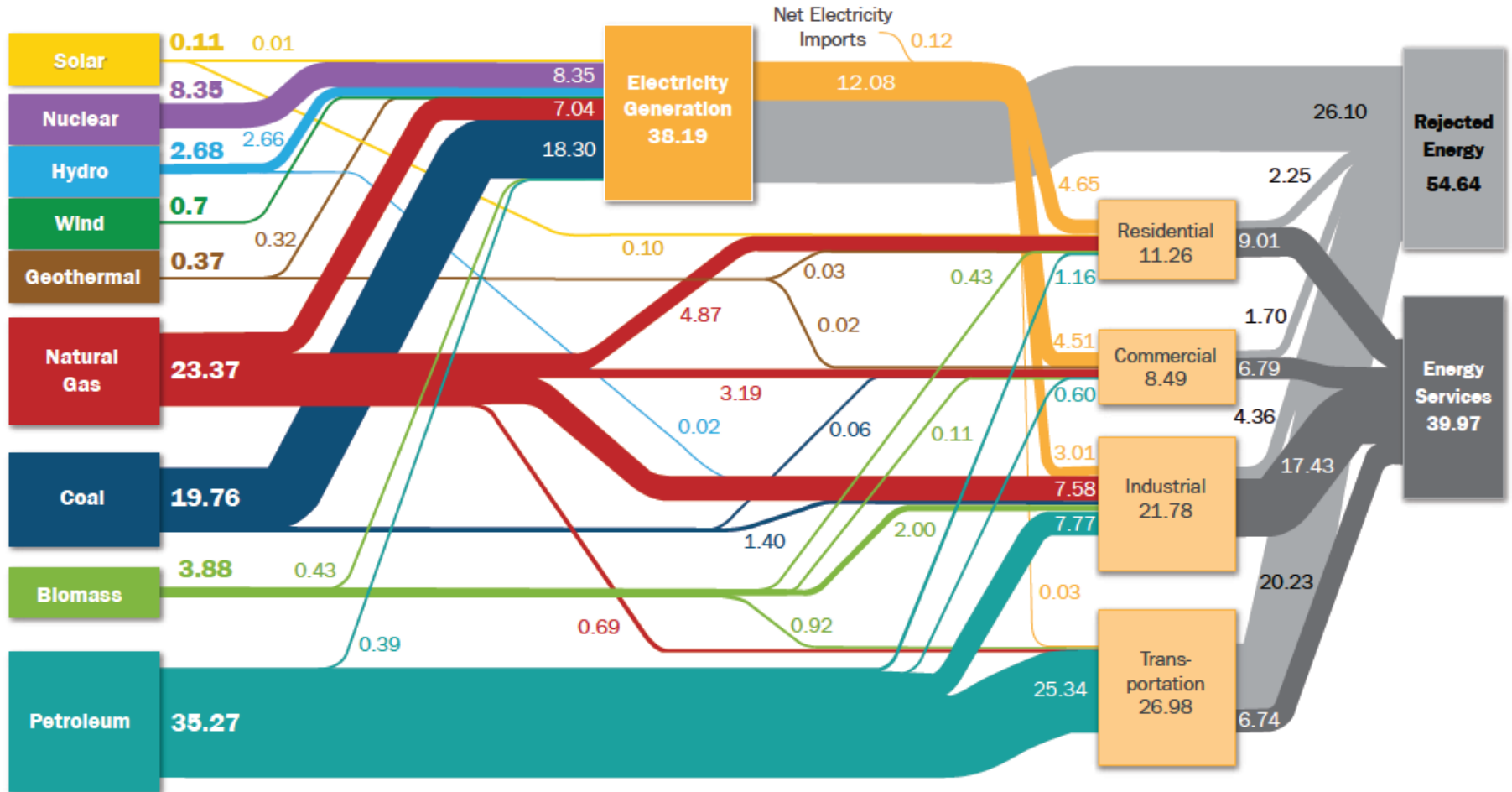
presented to
COE Administrative Committee

Satish V. Kulkarni
October 6, 2011

What I plan to discuss today

- National and local scene
- Virginia tech's strengths
 - Some areas are well organized, some rather diffused
 - **The Whole is Greater than the Sum of its Parts**
- Partnerships with DOE national labs (NETL/UEP), universities, industry
- Recent activities and new initiatives
- What are the missing pieces?
- Benchmarking

US energy flow in 2009



Values are in quadrillion british thermal units. Total energy input is approximately 95 Quads. EIA data as portrayed by Lawrence Livermore National Laboratory.¹⁷

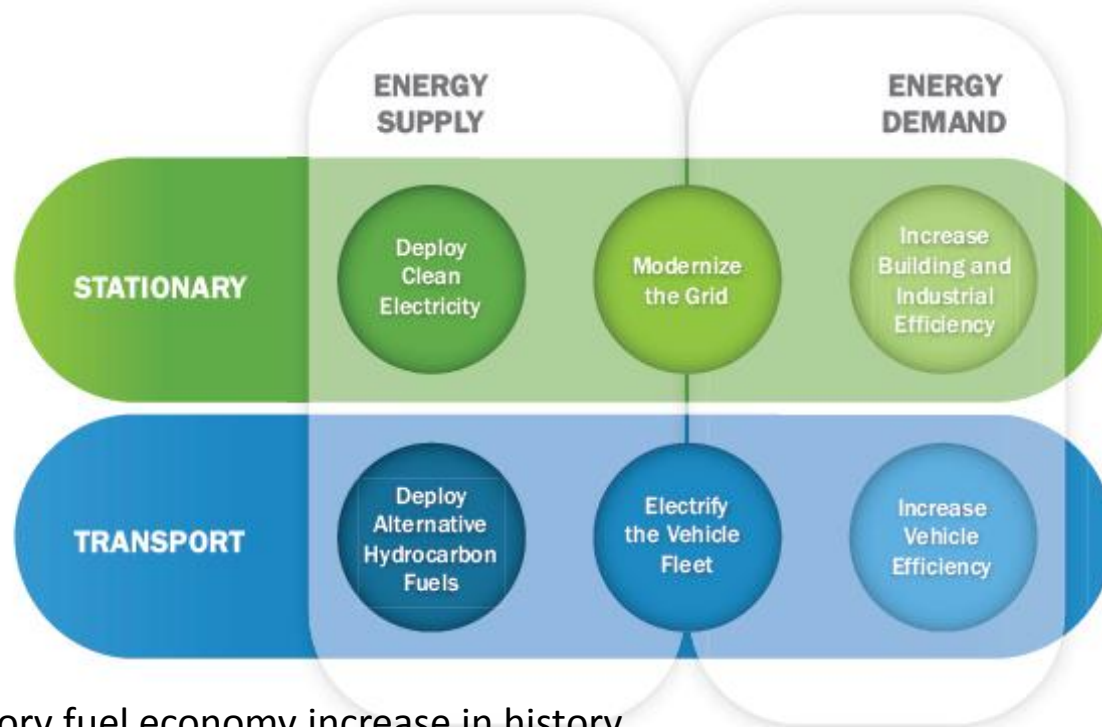
Important findings of the DOE Quadrennial Technology Review (QTR)

- DOE should give greater emphasis to the transport sector relative to the stationary sector.
- Among the transport strategies, DOE will devote its greatest effort to electrification of the light-duty fleet.
- Within the stationary heat and power sector, DOE should increase emphasis on efficiency and understanding the grid.
- Too much effort is devoted to research on technologies that are multiple generations away from practical use at the expense of analyses, modeling and simulation, or fundamental engineering research activities that could influence the private sector in the nearer term.
- In balancing timescales, the majority of DOE effort should be for mid-term impact (i.e., with consequential impact in 5-15 years).
- Public outreach identified DOE's roles as a source of information and as a convener as unique and highly valued.

The 3Ms of energy technologies

Maturity	Technologies that have significant technical headroom, yet could be demonstrated at commercial scale within a decade.
Materiality	Technologies that could have a consequential impact on meeting national energy goals in two decades. We define “consequential” as roughly 1% per year of primary energy.
Market Potential	Technologies that could be expected to be adopted by the relevant markets, understanding that these markets are driven by economics but shaped by public policy.

The QTR has framed six strategies to address national energy challenges; Obama announces 54.5 mpg CAFE Standard by 2025



- Largest mandatory fuel economy increase in history
- Will drastically reduce America's fuel consumption and carbon footprint and change the way cars are made.
- Present a major challenge to automakers, who must determine what technologies or combination of technologies will allow average fleet fuel economy to climb so high. They've got a lot of work to do.
- **And we should be working with them**

Governor McDonnell Announces Energy Month in Virginia *Will Host Three National Energy Events in the Commonwealth in October*

- Speaking about these events, Governor McDonnell commented, "One of the hottest and most important topics being discussed today is our nation's energy future. I have long argued that we must take an all of the above approach, utilizing traditional energy sources such as coal and natural gas, while also leveraging new sources such as wind, solar and biomass. The three events being hosted in Virginia in October will bring together top state officials and national energy leaders from across the country to **discuss and present ideas on important issues ranging from offshore oil exploration, to energy efficiency, to where coal and natural gas fit into our energy future. These are important issues. We must build consensus around an energy policy that will support economic development and job creation. We are working diligently here in Virginia to make the Commonwealth the "Energy Capital of the East Coast."** Part of that is hosting leaders from many states around the country to discuss what it will take to secure our energy future and ensure adequate supplies of affordable, reliable energy in the decades ahead."
- Governor McDonnell will kick-off with the SSEB (Southern States Energy Board) Governor's Energy Summit on Oct. 4 in Alexandria. Leading the discussion will be governors from member states, including governors Robert Bentley (AL) and Haley Barbour (MS). U.S. senators Lindsay Graham (SC), Joe Manchin (WV) and Mark Warner (VA), and CEOs of major energy companies will offer presentations to the governors on three key areas: **oil and gas development, nuclear energy, and EPA regulations.**

NETL-UEP Strategic Growth Area (SGA) Workshop: Summary

- SGA workshops successful in continuing to foster collaborative research environment
 - UEP and NETL-RUA maturing; demonstrated team commitment
- Executive Committee decides on 2-pronged approach for growth
 1. Continue to “fight” for FE R&D; FE is NETL-RUA primary mission
 - FE/ORD will continue to provide “anchor” to support the NETL-RUA
 - FE/ORD will contribute to SGA initiatives which build core mission R&D
 - Universities to develop and push a technical and political “Grand Strategy” for FE’s future (basis: **sustainable carbon management**)
 2. Diversify by leveraging NETL-RUA FE capabilities to create natural adjacent markets
 - Limited investment funds requires us to be focused and selective in areas with high potential for benefit across the Alliance
 - Continual investment: Teams encouraged to work together to mature strategies and offer new strategic growth areas

Grid Technology



Recommendation: Support Grid Technology

- Very well positioned in market, with focus on power electronics.
- Demonstrates the values of the NETL-RUA.
 - Broad participation from all members
- Not “hub dependent” for growth; sustainable market demand.
- Initial investments made with returns; a base to build upon and a proven growth model that “with help” can accelerate growth.
- Strong strategy articulated with regional support, students and alignment of interests and abilities.

Actions:

- Endorse team to pursue this opportunity.
- Provide seed funding for business plan development (model to use for other SGAs) with deliverables and go/no-go points clearly specified and to host strategic workshop
 - Investigate tying strategy to PSU GPIC and explore addition of elements of Energy Storage Strategic Growth Initiatives white paper.

Rare Earths

Recommendation: Support Rare Earths

- Rare Earths capabilities across NETL-RUA look strong.
- Strong Hub potential and state of industry supports investment.
- An enhanced understanding of the competitive landscape can help shape strategy implementation with small initial investment.

Actions:

- Endorse team to develop plan for seed funding
- Refine Strategy
 - Partnering
 - Should we lead a Hub proposal?
 - Do we partner and with whom (other labs, universities)?
 - Other refinements to consider
 - Addition of platinum group metals (with support from advanced materials & engineering group).
 - Potential to strengthen area further by including other capabilities we currently possess, can acquire, or team with, to win.

We are facing a real shortage of rare earth elements

- **Rare earth elements**

- [Neodymium](#), [Lanthanum](#), [Europium](#), [Cerium](#), [Erbium](#)
- [Samarium](#), [Terbium](#), [Praseodymium](#), [Dysprosium](#)

- Rare earths are essential to a host of green machines, including hybrid cars and wind turbines
 - The battery in a single Toyota Prius contains more than 20 pounds of the rare earth element lanthanum; the magnet in a large wind turbine may contain 500 pounds or more of neodymium

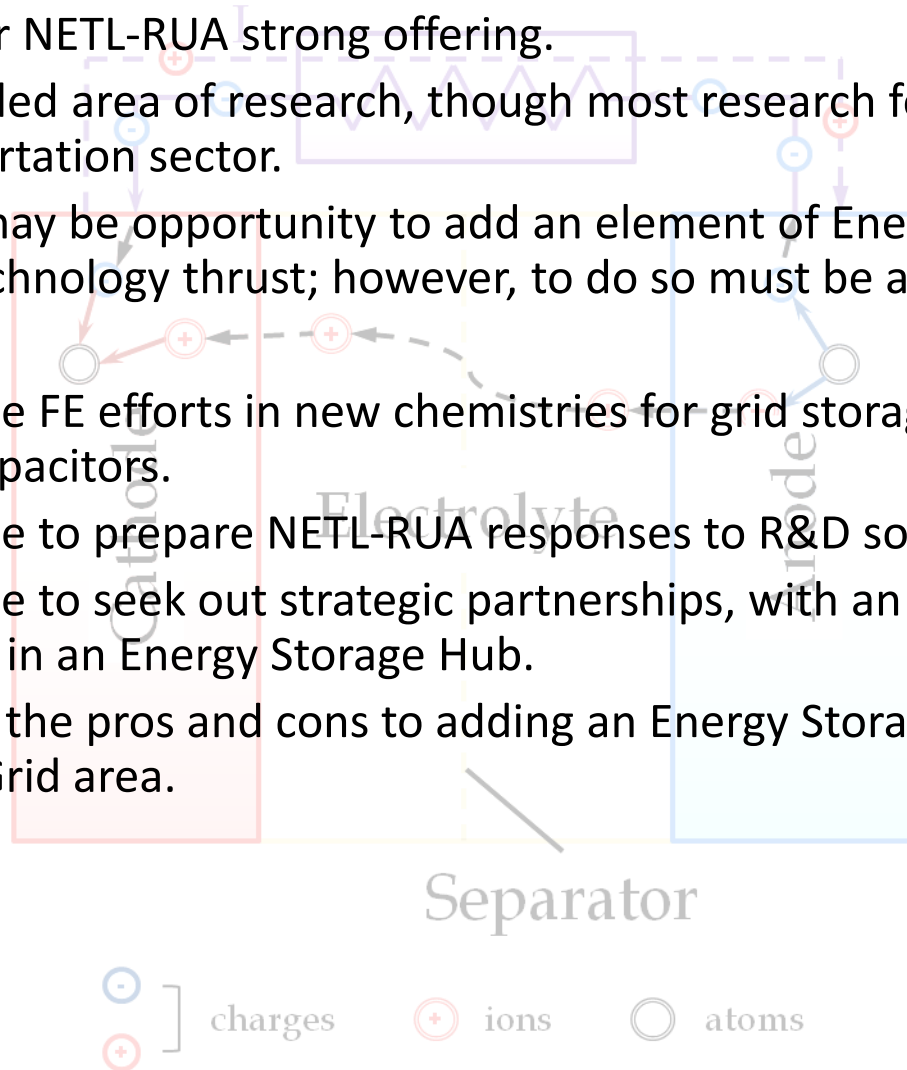
Energy Storage

Recommendation: Wait and watch

- No clear NETL-RUA strong offering.
- A crowded area of research, though most research focus is on the transportation sector.
- There may be opportunity to add an element of Energy Storage to the Grid Technology thrust; however, to do so must be a value add.

Actions:

- Continue FE efforts in new chemistries for grid storage, flow batteries, and ultra-capacitors.
- Continue to prepare NETL-RUA responses to R&D solicitations in this area.
- Continue to seek out strategic partnerships, with an eye toward being a partner in an Energy Storage Hub.
- Explore the pros and cons to adding an Energy Storage element to the Smart Grid area.



Energy/Water

Recommendation: Refocus effort

- Topic appears ripe for NETL-RUA, but availability of near-term funding for energy/water is a major question.
- Topic important over long run and compelling case for government role makes the NETL-RUA position stronger.

Actions:

- FE will continue to fund research and build NETL-RUA capabilities to position for the future.
- Efforts across the Alliance will be focused to further refine and/or define NETL-RUA “niche.”
- Bring in and/or identify an “expert lead” to own and daily drive program creation in this area
- Universities to push for a call to develop a water-energy strategic plan/roadmap with NETL as author
 - Position NETL to “house” an energy and water program

Shale Gas

Recommendation: Proceed with caution

- Concern over “honest broker” role
 - May be a demand for information, but consequence of results may drive desire to withhold information or biased reporting.
- Concern whether industry-focused target market will provide funding
- Marcellus Shale a complex landscape to navigate:
 - Reputation Risks – already reportedly two missteps in information with negative consequence to institutions, people and publicity
 - Financial Risks – financial damages from NETL-RUA work which inhibits industry evolution

Actions:

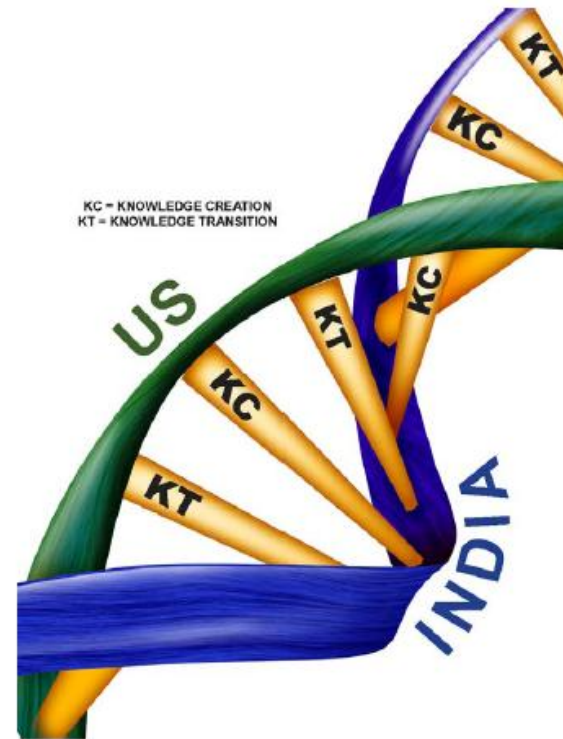
- Continue with FE core research to strongly position us for future.
- Clarify market evolution forecasts – define what we think will happen and when, and what our role will be and will not be.
- Support a “leader” to further develop strategy and build relationships toward commercial or government funding of an initiative that leverages FE work.

JICEEB

Joint Innovation Center for Energy Efficient Buildings

Project Narrative

- The US team includes: the National Energy Technology Laboratory, National Institute of Building Science, Local Energy Alliance Program and Comfort Systems US
- The Indian team consists of: IIT Roorkee, Central Building Research Institute, Paharpur Business Center, Edifice, ACRI Software and Eletrohms
- An important feature of this partnership is the possible tie-up of JICEEB with Virginia Tech's Innovation Center for Energy at the upcoming VT-India campus near Chennai



The US-India JICEEB bridges the two research strands in our countries with the base pairs of Knowledge Creation and Knowledge Transition (KC+KT)

A Joint US-India Partnership Proposal
Submitted by Team Virginia Tech – IIT-Kanpur
In response to: DE-FOA-0000506
August 16, 2011

Nuclear Science and Engineering Lab (NSEL) at VTRC



Vision - Enable Virginia Tech Nuclear Engineering Program, Mechanical Engineering Department, to take a leading role in nuclear education and research at the National Capital Region (NCR)



Activities

- Identified key **faculty members** from VT and beyond
- Establishing a **regional triangle** (VT-NCR, VT- Blacksburg & CAER-Lynchburg) for research (resources, collaboration with industry and government) and teaching (broadcast courses)
- **Visits** to and from: AREVA, B&W, CAER, Mitsubishi Nuclear Energy System, Newport News Shipping, Northrop Grumman, Mitsubishi Nuclear Energy System
- **Outreach to India (Sept 29 – Oct 1)**: Invited to ANS Summit on nuclear energy safety in Mumbai
- **Vic Reis** (Adviser to DOE Office of Science and Nuclear Energy) at VTRC on Oct 14
- Organizing a **visit with the DOE NE** leadership
- Organizing visit for Assistant Secretary of Nuclear Energy, **Dr Peter Lyons, to VT**
- Leading **SUNRISE initiative** for establishing a nuclear facility
- Establishing a **simulation and visualization** laboratory for nuclear safety, security, and medicine (CASL-like initiative; seeking industry involvement and support)
- Nov 7-11, VT³G offering a **one-week workshop** on particle transport methodologies

NSEL Leadership: Profs. Haghghat (Director), Kulkarni and Farkas;

NSEL Organization: NSEL operates under **auspices of ICTAS**

Nuclear Engineering @ VT, VTRC and CAER*



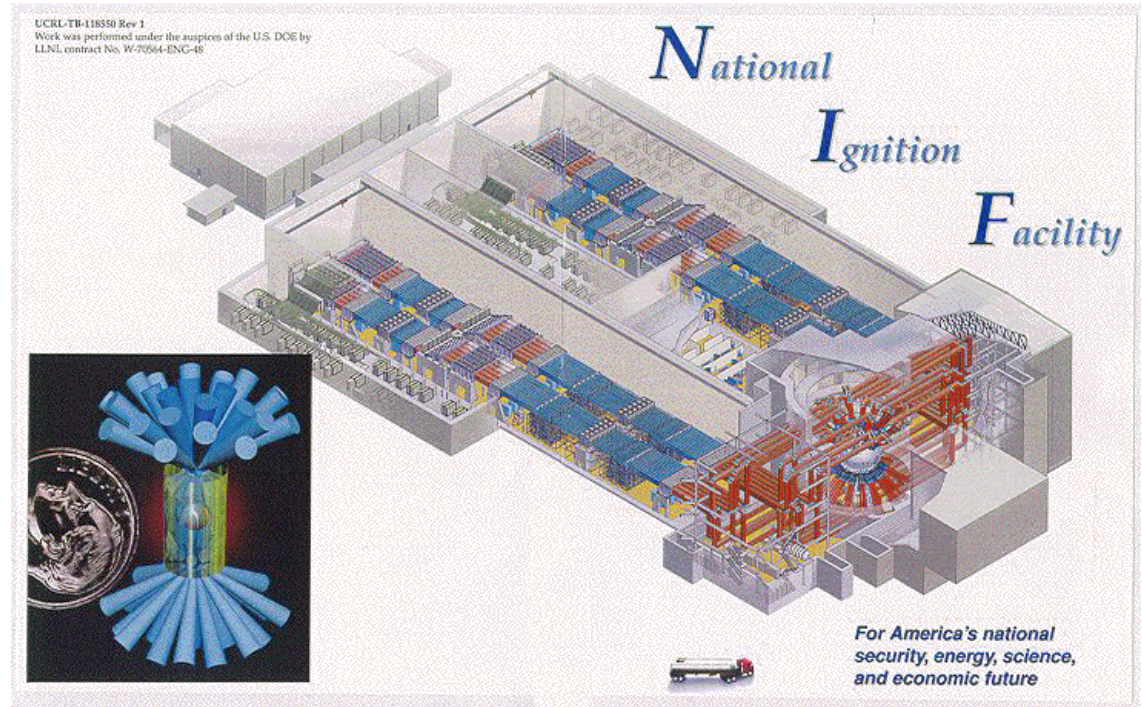
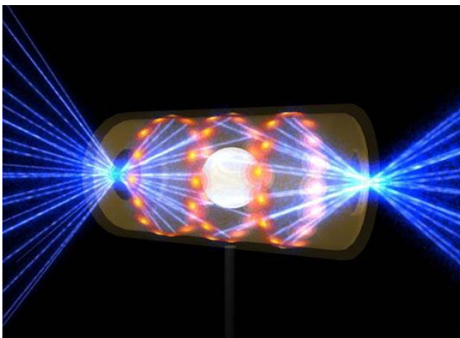
*We are also looking into establishing two thrust areas:
Emergency Response to Nuclear Accidents and
System Modeling, Simulation and Visualization

The Status of Fusion Research and Implications for Science and Fusion Energy

- Sustained nuclear fusion in the laboratory has been an intense science and engineering endeavor for over 50 years because of applications for central power plant energy and for nuclear weapon analysis
- Magnetic fusion employs magnetic fields to contain plasma of D-T ions and applies various methods to heat the plasma to near the desired temperature. Inertial fusion compresses a miniature spherical shell of D-T by high power lasers (most commonly), ion beams, or pulsed power machines with challenges dominated by the hydrodynamics of that extreme process. The scientific challenges are dominantly plasma instabilities for both approaches
- The International Thermonuclear Experimental Reactor (ITER, in France) for magnetic fusion and the National Ignition Facility (NIF, in California) for inertial fusion are currently the world's leading facilities. ITER will take some time to come into operations (after 2020) while the NIF is operating and nearing the attempt for fusion ignition now
- Some implications for related science and energy should be of interest to us

The National Ignition Facility (NIF)

Laser Fusion and
fundamental high
energy density
science at NIF



The long sought goal of achieving self sustained
nuclear fusion and energy is closer to realization

Bioenergy

- **This is a topic where conflicting interests of the biofuels and paper and pulp industry, cogeneration and electrical utilities, and conservation advocates intersect**
- **Is the correct approach to go from wood products to biofuels or directly to energy production? Pros and cons?**
- **What will be the impact on the paper and pulp industry?**
- **What about forest sustainability?**
- **Can industry have cogeneration without paying a penalty to the utilities?**
- **Role of PUCs and EPA?**
- **Met with MeadWestVaco, Organization of Industrial Energy Consumers of America and Pinchot Institute**
 - **They would like VT to host a forum of all the stakeholders and prepare a position paper**
 - **Dean Winistorfer is exploring this**
- **Prof Mary Leigh Wolfe is pulling together a VT-only symposium on bioenergy**
- **Visited IALR twice and met Ben Davenport**
 - **IALR would like help in defining its strategic vision**
- **Enhance our participation in the DOE Bioenergy Center at ORNL?**

Missing pieces in the energy picture

- Energy-Water Nexus
- Energy-Climate Change Research

Benchmarking

CENTER FOR ENERGY



Regional University Alliance

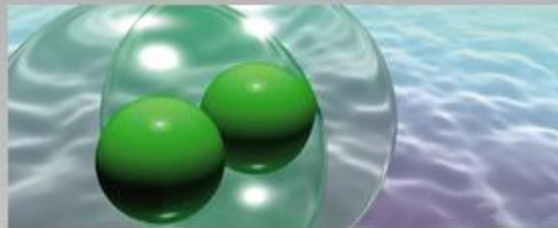
Rising to the energy challenge and positioning our region for the future.

HOME | REGIONAL DEVELOPMENT | RESEARCH | NEWS | VIDEOS | ABOUT US | SEARCH

THE UNIVERSITY OF PITTSBURGH: A LEADER IN ENERGY RESEARCH

The significant growth in worldwide demand for energy has led to:

- strong pressures to reduce consumption
- a call for more reliable, efficient, and environmentally friendly solutions
- a need for diversification of energy sources



VIDEOS



Gregory Reed, electrical engineering, talks about Pitt's research on smart grid technologies and our partnerships with ind...

University of Maryland Energy Research Center

>> Deploying energy efficient technologies and practices



UM Wins 2011 Solar Decathlon

Photo: Jim Tetro/U.S. DOE Solar Decathlon

Sustainable Energy is... Minimizes Environmental Impact

- HOME
ABOUT US
NEWS & EVENTS
ELECTROCHEMICAL ENERGY
ENERGY EFFICIENCY
SMART GRID
POWER ELECTRONICS
RENEWABLE ENERGY
NUCLEAR ENERGY
CHEMICAL ENERGY CONVERSION
CARBON CAPTURE & SEQUESTRATION
CLIMATE CHANGE & ENVIRONMENT
ENERGY POLICY
EDUCATION



The Need

>> NEWS & EVENTS

- Watch Grand Opening Webcast
Watch Dr. Majumdar's seminar

UMERC News

- University of Maryland Wins 2011 Solar Decathlon
UM Fourth in Solar Decathlon Engineering Competition
Whiting-Turner Lectures Kick Off October 6

Upcoming Events