Grand Challenge Proposal

Submitted by
Colorado State University

Colorado State University has developed an integrated and interdisciplinary approach to addressing our nation's energy future. CSU has developed a Clean Energy Supercluster (CES) which combines campus-wide strengths in teaching, research, and outreach with enhanced efforts to transform program results into commercially viable products. The CES mission is:

> *The mission of the CSU Clean Energy Supercluster is to promote an institution-wide effort to develop and disseminate market-driven clean energy solutions – on a sufficient scale to significantly reduce the accumulation of greenhouse gases that are forcing global climate change.*

Colorado State University Approach

Creation of Superclusters: A Supercluster is a multidisciplinary alliance that integrates experts from many fields with the goal of improving quality of life - by taking research innovations to the global marketplace more efficiently and at an accelerated pace. Superclusters focus on overlap areas between Colorado State University's internationally competitive research and the great global challenges, such as infectious disease, cancer, agriculture, energy and the environment.

Superclusters vs. traditional tech transfer: Universities traditionally patent discoveries and seek companies willing to license such early stage innovations. Universities have pushed to bring these innovations to industry for consideration. The old model relied on scientists to gauge the marketability of research – a step that often occurred at the end of the discovery process. Conversely, the Superclusters allow business experts to gauge marketability, and create a pathway for the full life cycle of new products and services for the marketplace – from the research stage to use in society.

Structure of the Superclusters: Emulating solid business practices, each Supercluster, organized to address a specific global need, will appoint a chief scientific officer who oversees University research and academic activities for that area. Together the chief scientific officer and a chief operating officer will jointly focus on forging business alliances and developing new applications and opportunities for the results of that research via the non-for-profit vehicle called CSU Ventures. A technology transfer specialist working for a division of CSU Ventures seeks opportunities for patents, licenses and startups, as well as equity investors. Two additional support staff will facilitate and encourage increased funding respectively from foundations and the federal government.

Governance of the Superclusters: The Supercluster enterprises are divisions of a new not-for-profit entity called Colorado State University Ventures. CSU Ventures is governed by its own board with a CEO whose responsibility is to facilitate the component Supercluster enterprises. The entity is a subsidiary corporation of the existing Colorado State University Research Foundation (CSURF), a private, non-profit foundation that helps fund University research and education efforts.

What Colorado State University's Superclusters model means

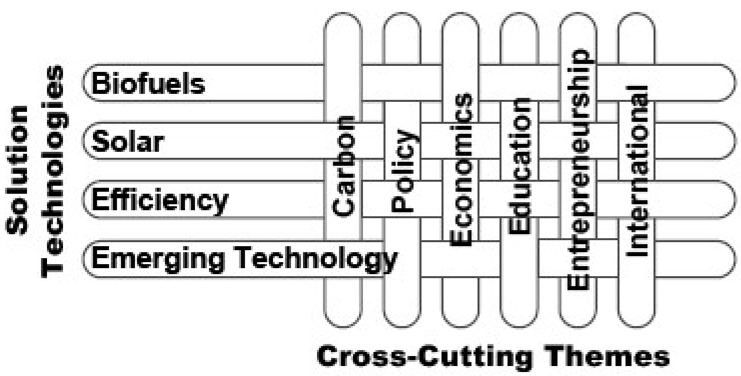
- **For academic research**: Researchers can focus on their area of expertise, while leaving the issues of transfer, patenting and licensing to experts with a specific focus on their research area. The academic structure of the Supercluster will encourage researchers to collaborate to address the broad challenges of a research problem and increase the likelihood of external funding for the research. In addition, researchers eager to have information in the global marketplace can see the technology adopted more quickly to better solve global problems.

- **For business development**: Businesses that thrive on commercializing cutting-edge technology can more easily work with Colorado State University through its ally – CSU Ventures - for licensing, collaborative research and partnership opportunities. The not-for-profit structure at the edge of the University will facilitate and encourage the involvement of industry expertise and the design will ease the challenges traditionally experienced when moving research from academia into the marketplace.
- **For global solutions**: The CES will be organized around areas where the University has preeminent expertise and where a "great global challenge" exists. The University's goal is to use its growing international connections to link strategically its Supercluster expertise to similarly interested governmental, academic, research, and corporate partners outside the United States - to play the central role in creating solutions to global health, environment and energy solutions.

Overview of the Clean Energy Supercluster

Colorado State University has a history of developing and implementing clean energy solutions and is well positioned to assume a global leadership role in the development of clean energy for the 21st century. Our faculty has the deep technical capability, the broad systems-level expertise, and the entrepreneurial spirit that will be required. Further, we have a long tradition of working side-by-side with students, many of whom will soon become leaders in the rapidly expanding clean energy industry. We have in place a clean energy leadership team with the ability and commitment to initiate the cluster and provide the guidance for its growth. The formation of the CSU Clean Energy Supercluster (CES) positions the University to effectively and creatively address the need for new, sustainable energy sources that minimize greenhouse gas emissions. Carbon dioxide from fossil fuel-based energy production is now widely recognized as the largest driver of global climate change. Addressing this challenge requires interdisciplinary teams comprised of researchers in fields as diverse as agriculture, natural science, engineering, economics, and business. Within CSU, we have an infrastructure in place to respond quickly and aggressively to large initiatives that cross disciplinary lines through the establishment of the Clean Energy Supercluster.

The Clean Energy Supercluster is structured into four different technical thrust areas, interwoven with six crosscutting themes, as shown in the graphic below.



Indications of Academic Excellence - The CES team has the breadth, depth, and entrepreneurial drive to be successful as a Supercluster. The breadth of the CES is seen in the 90+ self-selected faculty from all eight colleges at CSU. This faculty represents fields as diverse as the physical sciences, engineering, humanities, applied human sciences, and business.

Commitment to Widespread Dissemination of Solutions - The CES has a strong focus on developing low-carbon, clean energy solutions and getting them into production. This involves working closely with commercial partners when they are well-poised to disseminate CES solutions. There is a strong history of successful commercial interactions with energy companies in engineering and natural sciences. Commercial partners include traditional energy companies (BP, Shell, Conoco-Phillips, ExxonMobil, El Paso, Williams, Duke Energy, Xcel), new renewable energy companies (Spirae, Vestas), and equipment suppliers (Caterpillar, Cummins, Woodward Governor, John Deere). For some solutions, however, established companies may not provide the most effective path to dissemination. In these cases, the CES has shown its commitment to working in an entrepreneurial mode, helping to launch new companies so that CES solutions will go into production. Key examples of entrepreneurial efforts by CES faculty include Envirofit International (clean vehicle retrofit technology in Asia), AVA (low-cost solar PV systems), and Solix Biofuels (biofuels from algae).

Opportunities from the CES Structure - The CES structure provides a focal point for Clean Energy activities at CSU, facilitates the "branding" of the University as a global leader in clean energy, enables the recruitment of top quality students and faculty in the area, facilities fundraising from donors for Clean Energy activities, and maximizes CSU's competitiveness in interdisciplinary, team-centric proposals.

Solution Technologies

The CES will initially focus on developing solutions in three specific categories: (1) Biofuels and Biomass Energy, (2) Solar Energy (thermal and electrical), and (3) Energy Efficiency. The CES has explicitly established a fourth category, Emerging Technologies, to accommodate new initiatives in areas such as wind, nuclear, and hydroelectric energy. The following sections describe the CES approach to developing solutions in these four Solution Technology thrust areas.

Solutions Technology Area 1: Biofuels Derived from Agriculture

Overview – Biofuels have been proposed as a particularly attractive option to address the projected shortfalls in the demand for liquid fuels. Although US starch-based ethanol production recently surpassed 4 billion gallons/yr, this technology has significant limitations in terms of water consumption, land use, and energy conversion. As the US moves toward using renewable sources to replace a greater fraction of the 14 million barrels/day (215 *trillion* gallons/yr) of crude oil used for transportation, it is clear that major changes and innovations are required for all aspects of biofuels production.

Planned Activities – Activities within the biofuels and biorefining thrust will be focused in four key areas: bioenergy crop sciences, biomass conversion and processing, biofuels utilization, and biorefining. The bioenergy crop sciences area encompasses research on directed breeding and genetic engineering of plants to have physical and chemical characteristics more favorable to biofuels production. These modifications may include the production of more starch and cellulose and less hemicellulose and lignin, higher oil content, and growth on marginal and arid lands. Crop management issues ranging from water use to mineral nutrition are also vital since these affect photosynthesis and energy conversion. Research in the area of biomass conversion and processing will span all biological, chemical, and physical processes used for conversion of biomass to biofuels, including protein engineering to obtain more active cellulases, metabolic engineering and other approaches to increase solvent tolerance of strains that ferment sugars, reactor designs for high solids processing, novel fermentation strategies to increase productivity, downstream processing to yield high purity biofuels, development of bioreactors for growth of algae with high lipid content, and metabolic engineering and process development for photosynthetic hydrogen production using algae and cyanobacteria. Work in the biofuels utilization area will address the problems that arise because biofuels have different properties from conventional fuels, with the goal of ensuring clean and efficient utilization of these fuels through concurrent engineering of both the fuel properties (combustion properties, energy density, storage properties) and the end-use device (i.e. engine, turbine, fuel cell, etc.). Finally, research on biorefining will focus on the identification and production of phytochemicals that can add value to the overall biofuel production process.

CSU Strengths – Within the biofuels areas identified above, Colorado State has significant strengths in terms of both internationally recognized expertise and long-term research and development activity. These include:

Agricultural research: Researchers in the College of Agricultural Sciences have international reputations in traditional crop breeding, crop and land management, pest management, water resource issues, and agricultural production under dryland and irrigated semi-arid conditions.
Plant biotechnology: Groups in several academic units have expertise in plant molecular biology and are leaders in new fields such as synthetic biology applications to plants.
Biomass characterization and pretreatment: Since the mid-70s, researchers in Chemical Engineering and Microbiology have studied enzymatic hydrolysis of cellulosic materials as well as thermal and chemical pretreatment technologies. CSU also leads in approaches for biomass characterization, including NMR and computer simulation of plant cell wall structures.
Bioprocessing: The Chemical and Biological Engineering program has been involved in bioprocessing, including value-added bioprocessing of agricultural materials, since its inception. The Colorado Bioprocessing Center, affiliated with CSU for many years, also supported the development of expertise at the University.
Engine technology: The Engines and Energy Conversion Laboratory is known internationally for research on many aspects of engine design, including engine modification for alternative fuels.

Solutions Technology Area 2: Solar Energy

Overview – The photovoltaic (PV) conversion of sunlight into electricity is the most direct and efficient way to utilize the sun's energy for electrical generation. The PV commercial sector has increased production at a 35% annual rate over the past 20 years, and last year it delivered approximately 2.3 GW of new PV products worldwide. At the same time there is an increasing maturity in solar-thermal applications and progress toward efficient decomposition of water to produce hydrogen and toward other strategies for solar-generated energy storage. Colorado State University has a diverse mix of basic and applied PV research with strong ties to industrial activities, it has a long-term tradition in the solar-thermal area, and it is developing a presence in hydrogen generation and energy storage.

CSU Strengths – Colorado State's College of Engineering has long had a nationally recognized program in solar-thermal research. Many of the solar heating, domestic hot water and cooling system designs being sold today were first experimentally evaluated at CSU, and pioneering studies on the viability of solar thermal electric power generation were conducted here. Solar-cell or PV research at CSU began with a joint physics/electrical engineering program in 1974. This work has received increasing international recognition over the intervening years, especially in the area of thin-film, or second-generation PV conversion, which is well suited for cost-effective large-scale electrical production. During the last decade, the thin-film PV manufacturing program in Mechanical Engineering has achieved a high level of success in both manufacturing feasibility and in the quality of thin-film CdTe solar cells. In a similar time frame, chemistry research on solar energy has expanded in several areas of PV electrical generation, formulation of fuels such as hydrogen, and the storage of solar-generated energy.

Solutions Technology Area 3: Energy Efficiency

Overview –The technology exists to repeat that doubling in efficiency again, resulting in a tremendous global impact; it is estimated that nearly 60% of carbon emission reductions achievable between now and 2030 will accrue from efficiency efforts. Two areas where CES research may have a large impact are on the generation of electricity and the development of high-efficiency vehicle technology. Over 44% of the energy we consume is the in the form of electricity. However, the nationwide efficiency of production, transmission and distribution of electricity is only 32%, which means that for every unit of energy we use as electricity; two additional units are wasted as unusable low-grade heat. CES researchers are working to reduce these losses by increasing the efficiency of electricity generation and transmission. Automobiles produce 20% of US CO_2 emissions. Increasing the Corporate Average Fuel Economy (CAFE) standard from the 27.5 mpg (the current target) to 33 mpg would reduce US CO_2 emissions by 4%. CES research on batteries for hybrid electric vehicles and hydrogen storage techniques can help achieve these goals. One-third of CO_2 production in the US is for industrial processes. CES research in Chemistry and Engineering can help to reduce these CO_2 emissions.

CSU Strengths – Efficiency research at CSU spans the entire spectrum from fundamental science to commercialization and collaboration with energy sector partners. Efficiency research at CSU also encompasses the energy lifecycle from production, through transmission and storage, to end use.
Production: CES researchers have contributed to the characterization and analysis of the solid acid catalysts used in the catalytic cracking and refining of crude petroleum feedstocks.
Transmission/storage: CES researchers are working to improve energy efficiency by improving the efficiency of electricity production and transmission through the development of distributed power generation and intelligent electric grids.
Engines Laboratory: CSU's Engines and Energy Conversion Laboratory has developed fuel injection technology for pipeline engines that is responsible for preventing 100 million pounds of pollution (NO & NO_2) and has saved over 2.5 billion cubic feet of natural gas.

Solutions Technology Area 4: Emerging Technologies

Overview – In addition to the three technology solution areas previously discussed, the CES anticipates the emergence of other energy technologies that are not currently the focus of concerted efforts at CSU. In the near term, wind energy appears to offer significant opportunity, while "next generation" nuclear energy may be an example of a technology that becomes a focus in the longer term. Finally, CSU has a history of involvement with large hydroelectric power generation projects; this is not an "emerging area", but an area of historical strength.
Wind energy holds significant near-term opportunity for the CES and is one of the most cost effective renewable energy options. Colorado has the opportunity to increase its role as both an implementer of wind energy and a developer of wind energy technology. Colorado has 291 MW of wind power installed, with an additional 320+ MW of wind power in the planning stages. Statewide, Colorado's potential wind power is almost 55,000 MW. On the research side, the National Renewable Energy Laboratory hosts the National Wind Technology Center.

CSU Strengths – Although CSU does not have a dedicated wind energy program, there are faculty who work in closely related areas such as wind engineering (dealing with wind interactions on buildings), robust intelligent control, and composite materials. The Grid Simulation Laboratory was recently commissioned at the Engines & Energy Conversion Laboratory. This facility, funded by the Danish national utility company, was established to develop solutions for instabilities in the electric grid which arise from the transient nature of wind energy.

Crosscutting Themes

Crosscutting Theme 1: Carbon Metrics

The primary goal in developing renewable energy fuels is to mitigate the buildup of CO_2 and other greenhouse gases. Hence, accurate and comprehensive measures of the greenhouse gas (GHG) reductions that result from the development and deployment of the renewable energy technologies are needed. Carbon dioxide emissions are involved in all facets of energy systems, from production, processing, distribution and end use, and thus methods are needed that integrate over the entire system. Likewise other greenhouse gases (e.g. N_2O, CH_4, CFCs) can be produced as a byproduct of industrial processes and, in particular, as a result of biofuel production. To understand the true impacts of renewable energy alternatives, full carbon and greenhouse gas accounting approaches over the full 'life cycle' of energy systems are needed. This information feeds into other crosscutting themes, including the economic assessment of alternative energy solutions and policy analysis of government programs to promote alternative energy. In addition to greenhouse gas assessment technologies, an even wider view of the 'sustainability' of biofuel production systems is needed to ensure that biofuel resources are developed in an environmentally responsible way. The agronomics of biomass production systems involve a complex set of trade-offs, not only with respect to greenhouse gases, but also for soil, water and air quality (as well as economic impacts of food/fiber vs. energy production). Farmers and other land managers are key players at the base of biomass energy production systems and they need information and decision support tools to make well-informed choices for their situation. Likewise, government regulatory bodies are in need of similar capabilities, but that integrate over larger (e.g. county, state, federal) areas.

The faculty has expertise in greenhouse gas inventory methods and life cycle and integrated assessment approaches to analyze the impacts and efficacy of renewable energy applications. We have national and international leadership in the development and implementation of greenhouse gas inventory methods and excellence in ecosystem and integrated assessment modeling to combine environmental, economic and policy components. Specific examples include:

- Serving as Coordinating Lead Authors and Lead Authors on IPCC (Intergovernmental Panel on Climate Change) national inventory methods
- Providing annual greenhouse gas estimates from agriculture for US reporting to the UN Framework Convention of Climate Change (UNFCCC)
- Development of a web-based accounting system for farm-level GHG accounting, being implemented as part of the US Voluntary GHG reporting system (1605B Program)
- Development of advanced methods for national inventory reporting in 11 developing countries
- Development of guidelines for biomass projects in developing countries under the Clean Development Mechanism (CDM) for the UNFCC
- Integrated assessments of biofuel production from agricultural crop residues

Crosscutting Theme 2: Economic Analysis

While the invention and development of new clean energy technologies is a necessary step toward reducing global environmental damage and satisfying domestic and international energy demands, the economic viability and impacts of these new technologies must be considered to develop appropriate policy responses that increase net social welfare. As these new technologies are essentially substitutes for those that currently exist, their introduction could potentially trigger large changes in institutional structures, incentives for crop production and community development, land use, regional and macro- level economic indicators, infrastructure development, and environmental damage. These complicated responses occur at a variety of scales, both spatial and temporal, and on both the supply and demand sides of the market. In addition to these predictive considerations, society must determine what paths are relevant and desirable, and the policy instruments that are needed to bring about the preferred path(s), including any potential environmental effects. In many cases, introducing new technologies and establishing associated market infrastructure would require various incentive structures (such as subsidies and tax-breaks) to ensure market success. In a similar vein, commercialization of new technologies requires an understanding of player incentives and cost/benefit tradeoffs to ensure optimal returns to research investments.

The Departments of Economics and Agricultural and Resource Economics are uniquely positioned to perform these types of analyses. Macro-level studies of regional development and national impacts are in the domain of the former, while micro-level environmental and natural resource economic considerations are the specialty of the latter. Economics provides a large toolbox that can be utilized to conduct analyses, such as private and social benefit-cost analyses, that can determine whether particular clean energy technology is worthwhile both from the point of view of private investors as well as society, while also incorporating any potential environmental effects. Researchers at CSU have developed and implemented a number of models to help quantify these impacts, and these in turn can be used to predict and inform about the consequences of alternative policy and technological development regimes.

Crosscutting Theme 3: Policy Analysis

The widespread adoption of clean energy technologies will require a thorough understanding of the political context in which technology innovation takes place. Political scientists at Colorado State University conduct research and provide insight on the decision-making processes involved in energy and climate change policy. Political science research can illuminate the ways that these elements of the political context shape the development of policies, which in turn influence clean energy innovation by creating opportunities and obstacles for investment in R&D and the operation of markets. Political policy must support Colorado and Northern Colorado in particular, to become leaders in the alternative energy sector.

Members of the Political Science Department are nationally and internationally recognized for their work on energy and climate change politics and policy making. Members also have experience conducting research using a range of social science methods and possess an extensive set of research and methodological tools. In addition, the Department's doctoral program focuses on environmental politics and policy, providing research resources.

Crosscutting Theme 4: Education

The educational components of Clean Energy Supercluster will consist of graduate research, formal credit course offerings, and non-credit activities offered through outreach programs. We see the educational component of the CES evolving over time to meet the needs of both on-campus students and off-campus stakeholders and clientele.

Graduate Education – Each of the Colleges represented in the CES emphasizes graduate research programs leading to thesis degrees focused on clean energy. Training a new generation of scientists, engineers, and policy makers with a deep understanding of clean-energy technologies is the greatest single contribution we can make to long-term clean-energy solutions. Although the individual research projects span many programs and departments, the CES will facilitate cross-fertilization of research developments across campus through its annual symposia and its sponsorship of distinguished speakers. The grants program included in the Supercluster will also provide support for research by undergraduate students.

Formal Courses **–** In addition to graduate research programs, the faculty affiliated with the CES has initiated steps to enhance the course offerings to our students. The courses developed will target undergraduate upper-classmen as well as graduate students. The following sequence of two courses is being developed: a) Biofuels and Biomass Energy taught by an interdisciplinary team of faculty from the Colleges of Agricultural Sciences, Engineering, Natural Sciences, Liberal Arts, and Business and b) Clean Energy Seminar

Informal Educational and Outreach Programs **–** The CES contains faculty who have formal Cooperative Extension appointments as well as others who have an interest in developing educational programs or materials for delivery through the Division of Continuing Education. The Vice Provost for Outreach and Strategic Programs will be engaged to insure that outreach opportunities are coordinated between CES and Cooperative Extension, Colorado Water Resources Research Institute, and the Division of Continuing Education. Other outreach efforts will include programs targeted to P-16 students. Collaborative programs with local entities such as the Northern Colorado Clean Energy Cluster will also be pursued. A primary focus of the CES educational activities will be to develop tomorrow's energy leaders. These leaders will need both strong grounding in scientific fundamentals and true interdisciplinary breadth in clean energy applications. Students will gain depth in the field through their home department, but there will be a formal program of cross-disciplinary integration. The interdisciplinary objective will be accomplished through jointly-taught classes, cross-disciplinary seminars, an inter-university "exchange program" between students in various research laboratories, domestic and international service-learning projects, and a Clean Energy certificate program.

Crosscutting Theme 5: Entrepreneurship

A key focus of the CES is on disseminating clean energy solutions. In many cases, that means partnering with existing business to get solutions into production. But in other cases, it may be necessary to launch new businesses. In these cases, the Entrepreneurship Center (E-Center) in the College of Business (CoB) is expected to play a key role. This is consistent with the mission of the E-Center; the strategic plan for the Entrepreneurship Center in the College of Business states, "We believe that by providing would-be entrepreneurs with a world-class education they will have a positive impact on the community of Fort Collins, the state of Colorado, the United States, and the world." The E-Center is already active in this helping to launch clean energy startups; Envirofit International was launched in 2003 to disseminate clean energy technology (2-stroke retrofit kits) in Asia.

Currently, E-Center students are working to launch other business through the Global Innovation Center—an Engineering/E-Center initiative to jointly develop new technologies and new business models to address needs at the "Bottom of the Pyramid"—the poorest segments of society.

The College of Business (CoB) currently offers a Social and Sustainable Entrepreneurship course. This course supports the CES and is open to all CSU students. A CoB faculty member who has played an active role in clean-energy dissemination and commercialization currently teaches this class. In the future, with more faculty resources, the CoB and E-Center plan to develop a Clean Energy Entrepreneurship course that is team-taught by Entrepreneurship Faculty from the CoB, together with Energy faculty from Economics, Engineering, and/or Science. The CoB will also provide student project support and teach entrepreneurship classes to support the CES and implement a required internship class for students to work on entrepreneurial projects, such as the CES.

The CoB Global Social Sustainable Enterprises Program is accepting its first class for the fall of 2007. This program requires a summer project of each student. This could include such projects as helping commercialize clean energy technologies, and researching feasibility of such technologies in the developing world, based on student's interest.

The E-Center is also in the first year of working with CSU Outreach in implementing an internship program whereby students work with communities around Colorado to help the communities identify business development opportunities to spur economic growth. Technology concepts developed from the CES could form the basis of some of these internships, with student teams working to analyze feasibility for developing and commercializing these businesses within Colorado.

Crosscutting Theme 6: International Partnerships & Outreach

Energy utilization, environmental degradation, and climate change are global issues. Conversely, they provide a global market for solutions, and offer the opportunity for CSU-developed Solution Technologies to achieve worldwide impact. All of the UN Millennium Development goals—ranging from poverty reduction to better education to improved health—require access to electricity. Currently, over 2.1 billion people do not have access to electricity. To facilitate development and improve health, these underserved populations must gain access to electricity. This could increase CO2 emissions unless it is accomplished with efficient technology, and/or accompanied by commensurate reductions in CO2 production elsewhere. In addition, over 2.8 billion people—almost half of the world's population—cook on solid fuels such as wood, dung, or coal. The poor efficiency and high pollution from household energy systems (i.e., cookstoves) contributes to deforestation, greenhouse gas emissions, and has a devastating health impact. The smoke from cookstoves is the highest cause of death in children (under age 5) and the third leading cause of death among women.

CSU has a strong international heritage, particularly in the fields of water and agriculture. In recent years, however, CSU has established a strong international presence in the field of clean energy. Examples of this presence include:

- Philippines – Envirofit International (launched by the Colleges of Engineering and Business) is disseminating its clean 2-stroke engine technology in the Philippines, and expanding into India.
- India – Several projects, including cookstove dissemination with local partners, small-scale electric grids for village power, clean diesel retrofits, and clean 2-stroke retrofits.
- China – (1) Collaboration on cookstove manufacturing and commercialization; and (2) potential collaboration on algae-based biodiesel.
- Nepal – Working to commercialize the TEG cookstove.
- Israel – University and commercial collaboration on algae-based biofuels
- Nicaragua – Working to commercialize the TEG cookstove.
- Mozambique – Ford Foundation scholar working to improve the efficiency of the electric grid.
- Guatemala and Honduras – Collaboration on clean cookstoves.

- Chile- Potential university and commercial collaboration on algae-based biofuels.
- Denmark – Working to develop smart-grid technology to allow higher utilization of wind energy.
- Japan – CIS-21 Collaboration to achieve thin-film solar cell efficiencies above 20%.

Technology Transfer, Dissemination, & Commercialization

Technology Transfer and Economic Development – The PV manufacturing technology developed by in Mechanical Engineering has received $3.75M in private funding and is in the process of being commercialized by the AVA Technologies Company located in Fort Collins. At the same time, the AVA management has been discussing partnerships with a number of major industrial corporations. Other solar-energy faculty is also involved with industrial projects and in exploratory discussions that may lead to a commercialization path in the future.

Ongoing efforts in smart grid technology with Spirae, clean vehicle technology with Envirofit and tech transfer efforts include multiple patent filings and product development in partnership with DOE, Woodward Industrial Controls, and Caterpillar.

The CES is working to promote regional economic development by assisting with the recruitment of Vestas. In addition, significant regional benefit could accrue from development of a wind farm on university land. Finally, the Grid Simulation Laboratory is working with a local company, Spirae, to develop solutions to grid interconnection and anticipates expanding these activities.

Commercialization - A research accomplishment only has impact when it is implemented, that is, when a solution goes into production. Thus, a primary focus will be to get CES solutions into production on a wide scale. CES faculty has a strong history of successfully transferring CSU-developed technology into the marketplace, while maintaining a history of scholarly achievement. This has been achieved through conventional licensing arrangements, through development partnerships, and by establishing new startup companies. A sampling of these dissemination activities is listed below:

- “Low-Cost Photovoltaic Technology,” through AVA
- “Autobalancing Fuel Injection,” with Woodward Governor
- “High Pressure Fuel Injection for Pipeline Engines”, with Woodward Governor, Enginuity, Hoerbiger
- “Advanced Ignition Systems for Pipeline Engines,” with Altronic & Diesel Supply
- “Laser Ignition Systems for Natural Gas Engines,” with Woodward Governor
- “2-Stroke Direct Injection Retrofit Kits,” through Envirofit International
- “Grid Stabilization Technologies for Renewable Energy,” through Spirae
- “Biodiesel from Algae,” through Solix Biofuels
- “Efficiency Improvement,” with MIT, ExxonMobil, Waukesha
- “Cookstove Technology Dissemination”, through AHDESA, HELPs International, Aprovecho, others

Additional Information Available at Clean Energy Supercluster Website

Superclusters™
Clean Energy
A Sustainable Path for Energy Production and Use
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Mission

The mission of the CSU Clean Energy Supercluster is to promote an institution-wide effort to develop and disseminate market-driven clean energy solutions – on a sufficient scale to significantly reduce the accumulation of greenhouse gases that are forcing global climate change.

Background

The formation of the CSU Clean Energy Supercluster (CES) will position the University to effectively and creatively address the need for new, sustainable energy sources that minimize greenhouse gas emissions. Carbon dioxide from fossil fuel-based energy production is now widely recognized as the largest driver of global climate change. As a result, there are a number of large federal, state, and private initiatives underway on clean, “low-carbon” energy, and more will emerge. However, many of these initiatives require large inter- disciplinary teams comprised of researchers in fields as diverse as agriculture, natural science, engineering, economics, and business. Thus, it is critical that within our university, we have the infrastructure in place to respond quickly and aggressively to large initiatives that cross disciplinary lines.

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