**Appalachian Energy Center**

**Appalachian State University**

**Annual Report, 2009 & 2010**

December 2010

**Appalachian Energy Center**

**MISSION**

**Appalachian Energy Center (AEC)** is committed to research, development, policy analysis, and demonstrations in all areas of energy, with a stated mission to facilitate the work of faculty and students engaged in teaching, research and outreach activities associated with energy technologies, conservation, and policy.

**History**

**Appalachian Energy Center** at Appalachian State University was established in 2001 to conduct energy research and applied program activities in a multi-disciplinary environment. It focuses on energy efficiency, renewables, policy analysis, forecasting, and economic development. The Center ties together faculty and staff from many different programs, departments, and colleges of the University including: Building Science, Appropriate Technology, Geography and Planning, Economics, Biology, Chemistry, Physics, and Political Science. The AEC also facilitates partnerships with the private sector as well as local, state, regional and federal governments.

AEC operates under the umbrella of Appalachian’s Research Institute for Environment, Energy, and Economics (RIEEE) which was established in November 2008 to enhance research opportunities for faculty and students whose interests are associated with environmental science, renewable energy and economics.

Appalachian State University has long been a home for renewable energy, sustainable development and an environmentally aware campus community. Appalachian State is home to one of the nation's first degree programs in renewable energy technology, and remains one of a handful of schools in the world that offers a Masters-level degree in renewable energy technology.

Because of its expertise and setting, Appalachian has drawn faculty and students who have a strong commitment and interest in environmental issues as expressed in many forms from energy conservation and innovative technologies to environmental economic policies. The University has built a reputation from its strong academic programs, community outreach and interdisciplinary research initiatives. Today, many faculty members across colleges and multiple disciplines focus on research at the intersection of energy, the environment and economic policy.

**PROGRAMS**

Appalachian Energy Center represented by a broad range of staff, ASU faculty, graduate students, and partners has pursued a diverse mix of over 30 activities during the July 2009 through December 2010 period. As a Center within the Research Institute for Environment, Energy, and Economics, AEC will continue to involve more disciplines and interested parties as we pursue our interdisciplinary outreach and research efforts. Our current work is collected within four general categories which are Building Energy Efficiency, Renewable Energy, Alternative Fuels, and Policy, Markets, and Economic Analysis. Core funding is provided by an Appropriation from the North Carolina Legislature with a large amount of additional funding provided by Federal, State, and private sources.

**Building Energy Efficiency**

Focus topics within this section include Low Income Housing, High Performance Residences, High Efficiency Existing Homes, Commercial Buildings, and Policy Analysis.

The Energy Center working through retail outlets participated in encouraging 20 families to step beyond the purchase of a standard manufactured home by providing Upgrade and Save ENERGY STAR Rebates. This NC industry has experienced a substantial drop in units sold over the last 10 years. In 2000 there were 27,000 NC units sold but that dropped to only 3000 units by 2009.

On a bolder note was the very successful combined NC ENERGY STAR and RESNET national conference in which there were over 950 attendees. North Carolina benefited from hosting the national 2010 RESNET Building Performance Conference within the statewide NC ENERGY STAR Conference. Participating NC businesses had the opportunity to present their information or show their products to a national audience and also were able to attend sessions lead by national trainers or see products from national businesses. The conference was a showcase for the NC building energy efficiency network of businesses and the NC State Energy Office.

Stakeholders in the shelter industry and consumers alike continue to benefit from the provision of workshops, direct consulting, and from both the publication and presentation of the results from applied research. One such publication and presentation was the Revised Duct Design presentation and power point within the RESNET national conference in Raleigh earlier this year. It is always an uphill struggle to have building trade members adapt new construction procedures as well as gain consumer acceptance. However this revised duct design has in its initial explorations demonstrated that comfort can be retained while reducing installation costs and saving space. The major potential benefit for two story homes with open stairwells would be the option to move the air handler from the attic into the space that currently is used to provide a chase for a return duct from the attic down to the first floor. Removing the air handler from the hostile environment of the attic would provide a noticeable energy efficiency gain.

A previously completed Radiant Barrier case study continues to be of interest, including at the national level as requests for electronic copies of the study have occasionally been received with the latest being in July 2010 which is a year and a half following it completion and publication.

Several Energy Center activities blend well into the growing national interest to establish a robust national energy efficiency effort for existing buildings. One item is the preliminary exploration into a Micro Injection Technique that would air seal the top of stud cavities from inside the home with limited cosmetic impact. With regard to practical air sealing techniques to improve a home’s energy efficiency, air sealing the ceiling plane is of primary importance [second only behind duct system air sealing]. A central element in this air sealing is to seal from the attic side both edges and all penetrations in stud wall cavity top plates. For existing homes this can be a challenge [floored attics, storage of goods, low attics, lots of ducts and equipment, existing ceiling insulation, and it is very hot during the summer]. This challenge is both costly to address and access for application is often limited. Air sealing at the ceiling plane has been measured and often equals 25% of the original building air leakage. Additionally, the physics of hot air rising out of the building is interrupted adding to this technique’s impact on building energy efficiency.

A second related activity is the development of Quality Indoor Environment Protocols for assessing the impacts of energy efficiency measures. We are interested in exploring the impacts on Quality Indoor Environments when buildings have energy efficiency measures applied to them. We are curious about positive, negative, and neutral impacts. We want to create and apply solutions to negative outcomes and learn to understand positive outcomes. A supplemental finding based on one medium sized case study was that 25% to 30% of existing heat pumps are operating with substantial inefficiency. Consumers were substantially unaware of this dismal performance and the wasted energy.

A third related activity is beginning the process of becoming knowledgeable about Behavior Facilitated Efficiency. When we understand the barriers to and encouragements for individual property owners to actually participate in purchasing efficiency upgrades we have “buyers.” With buyers we can begin to significantly reduce the numbers of existing energy inefficient properties. This can reduce the overall growth in demand for energy and also reduce the size of the demand at peak. It would slow the growth in the amount of funds paid to out of state energy resources. For some properties it would make the purchase of 100% sustainable energy a practical financial option. Substantial economic development and jobs creation would grow out of the business development necessary to provide a significant number of properties with efficiency upgrades.

At the beginning of this section we mentioned the Upgrade and Save program. Additional work in the manufactured home field includes a Review of Market Opportunities for High Efficiency Manufactured Homes. As mentioned, the manufactured home industry has been in steep decline over the last decade. If the new more energy efficient models can improve on the perception of these homes, they could help spur the industry and economic growth in the state, while also providing home buyers in North Carolina both an affordable home and an energy efficient home. In support of developing real world field performance data, preparations are underway for a combined energy study and indoor conditions case study comparing the performances of an ENERGY STAR manufactured home versus a standard manufactured home. Included in this effort will be the enhancement of our ability to remotely monitor and down load our logged data from homes through the internet.

Structural Energy Panels is a new effort. The primary objective of this project is to carry out exploratory experimental work that could allow solar energy technologies to be integrated with structural insulating panels. These panels will be referred to as structural energy panels or SEPs. The aesthetic integration of renewable energy technologies into new and existing building “skins” is an attractive option from the standpoint of energy independence, carbon foot-print reduction, and the development and/or enhancement of renewable energy manufacturing in the State. Any technologically successful and economically viable results of this work can be used to improve current renewable energy product development and develop new products.

With regard to commercial buildings we continue our effort to revise SB 668 presentations and provide related training. The General Assembly of North Carolina implemented Senate Bill 668 and other legislation, which became State Law in 2007. The legislation requires that new state buildings improve efficiency by at least 30% above the ASHRAE 90.1-2004 requirements. The PowerPoint presentations show designers and building owners and operators how to comply with the state requirements. They also provide recommendations for achieving increased efficiency. The benefits will be to improve compliance with the state law and improved efficiency of our state’s buildings.

Finally in our energy efficiency activities section is our work in Policy Analysis to look at the Impacts of High Performance Buildings. The ACEEE report submitted to the Energy Policy Council includes results of analysis prepared by Appalachian State over the past several years, with updated information from this year’s efforts. The ACEEE report also includes up-to-date information on energy code development in the state. The report will serve as the basis for policy recommendations by the Energy Policy Council, which will establish a portion of the agenda for future energy policy in the state. The energy code policy analysis has resulted in successful integration of recommendations into the energy code, which was approved by the state’s Building Codes Council at its December 2010 meeting.

**Renewable Energy**

Focus topics within this section include Solar Thermal and Photovoltaics, Wind Energy, and Renewable Energy Resources.

We continue to collaborate with the Department of Physics and Astronomy in their development of an extensive photovoltaic materials and device characterization facility which will provide the tools and training for ASU students and faculty to develop, fabricate and characterize PV devices. These facilities will serve as a user facility where PV researchers, fabricators, and users can have their PV materials and devices fabricated and tested. It is hoped and expected that the results of this work will serve as a resource for others who will need to use the tools we are developing to aid in their pursuit of fabrication and/or characterization of PV materials and devices. Appalachian can provide critical PV device measurements and characterizations at little or no cost to NC based companies and researchers.

Construction of our Solar Training and Research Facility on the Appalachian campus is near complete, greatly enhancing our solar research program. Testing and reporting on performance of available solar equipment will allow homeowners and businesses to adopt these technologies with confidence and make the best decisions about what technology to adopt. In addition, when complete, the facility will provide educational opportunities for future employees of the regional Green Economy.

Our activities in Wind Energy fall into four major work areas:

1. Manage the Small Wind Testing & Demonstration Facility on Beech Mountain and further develop our small wind turbine testing program
2. Continue Research on Key Wind Issues in Western NC
3. Technical Assistance & Website
4. Track wind energy and document wind energy facilities in North Carolina

Most of the wind turbines being installed in western NC and throughout the state have come about after significant consultation with Appalachian State’s Wind Application Center. We routinely provide wind maps and wind measurement equipment and analysis to individuals who subsequently install wind turbines. We also assist in connecting those interested in installing a wind turbine with companies who can install a turbine. We are also working with counties and state officials to assist them in developing ordinances which would provide for orderly and appropriate wind energy development. Substantial economic development and jobs creation would grow out of the business development necessary to construct wind turbines in the state.

Microhydro Analysis for Residential Energy takes a look at another NC energy resource. Microhydro is of great interest to the state’s renewable energy community as it is listed as a viable renewable energy resource eligible for renewable energy financial incentives. However, there is limited research on microhydro resources at the national and state level. The only prior research on microhydro resources in western North Carolina was done in 1983 with collaborators from Appalachian State. Our current project will update this study by using higher quality data and more advanced GIS methods to provide information on microhydro as a viable renewable energy source. This project will also provide information on microhydro resources that can be directly mailed to residents of North Carolina. This project will therefore help to better inform North Carolina residents on microhydro resources as well as potentially increase the number of residents using it as a renewable energy source. In addition, the technical report will be one of the very few research reports available nationally and the first on small scale systems at a state level. This makes this report a valuable contribution to citizens, energy policy researchers, and policy makers in North Carolina as well as other states.

**Alternative Fuels**

Focus topics within this section include Cell-Free Ethanol Production & NIR Monitoring of Biodiesel, Appalachian Biofuels and Biomass Initiative, Emissions Analysis for Different Biodiesel Feedstocks, Algae Oil Production, Harvest, & Extraction, Microwave-Assisted Synthesis of Biodiesel & Materials for Making Solar Cells, and Landfill Gas Research and Development.

Dr. Eric Allain’s lab in the Department of Chemistry has been focusing efforts on two main research areas: cell-free ethanol production and NIR monitoring of biodiesel production.  We are also collaborating with Dr. Nicole Bennett’s lab on a project studying the potential for microwave enhancement of enzymatic biodiesel production. Perhaps the biggest potential impact of this work in North Carolina will come from economic improvements in the fuel alcohol production process.  Currently, most of the US ethanol production is carried out in the Midwest and is based on corn as a feedstock.  Other regions of the country that are less ideal for corn growth are forced to consider alternative feedstocks for local ethanol production.  The problem with this is that processing of other feedstocks is often more expensive.  If a cell-free process for ethanol production is developed, economic efficiency gains through production rate increases could offset the added feedstock processing cost thus allowing states like North Carolina to grow non-corn energy crops for fuel ethanol production.

Appalachian Biofuels and Biomass Initiative is an effort to encourage and support economic expansion of biofuels and biomass sectors in North Carolina through outreach activities and dissemination of applied and fundamental research. Our current efforts include expanding the planting area and familiarity of alternative oilseed crops agronomics in Catawba Valley. Additionally, we are developing a system for B20 usage in off-road equipment at Blackburn Landfill in Catawba County. Emissions work that is being pursued will benefit the state by improving the understanding of combustion properties and life cycle analysis from alternative feedstocks grown and processed in NC. This work will become increasingly important with the trend towards quantifying carbon intensity of fuels. The Biofuels Center of North Carolina’s *Strategic Plan for Biofuels Leadership* states that *by 2017, 10% of liquid fuels sold in North Carolina will come from biofuels locally grown and produced.* The Biofuels Center also states that currently 5.6 billion gallons of fuel are consumed annually by the state. Not accounting for growth, by 2017 it will be expected that North Carolina will produce and consume approximately 560 million gallons of biofuel. Our current combustion emissions analysis research will allow a better understanding of the potential climate and health impacts of biofuels manufactured from different alternative feedstocks. With the amount of biofuels already consumed in the state as well as the estimated future consumption, it is important that we make informed decisions regarding not only which biofuels are most efficient economically and energetically, but also those with the least environmental and health impacts.

There is widespread interest in growing algae for Algae Oil Production, Harvest, and Extraction and ultimately biofuel production. This has not yet become an industrial reality because of inefficiencies in the process. First, algae do not reliably make large amounts of oil. By understanding the process better we hope to be able to better control their metabolism and increase yield. Second, algae are a microscopic crop grown in water. Harvesting methods are both expensive and energy intensive. Through work by Dr. Mark Venable’s laboratory (Biology) we hope that by growing algae on a solid substrate that we can efficiently harvest them at low cost. Third, oil extraction is somewhat inefficient. Dr. Venable’s lab has designed an extraction process that we feel will increase yield by 10-20%. With these improvements we hope to discover a system that will make the overall process both productive and efficient. This may lay the groundwork for a new component of biofuel industry for the state.

Another Appalachian State initiative in the Biofuels arena is Microwave-Assisted Synthesis of Biodiesel & Materials for Making Solar Cells. Once completed, the biodiesel research could be expanded into a collaborative effort with state wide biodiesel production facilities. The catalysts developed could be used with both industrial scale microwave reactors and standard industrial-scale batch reactors that use conventional heating. The prophyrin work is basic research that will be used by scientist in the field of photoconductivity to develop more robust solar cells.

Our final area of activity in the alternative fuels section is Landfill Gas Research and Development. This activity is to assist counties, especially rural economically challenged communities with smaller landfills, to develop landfill gas projects for community-based development, renewable energy implementation, and reduction of greenhouse gas emissions. Some of the benefits derived from our work include the following items.

* Local government educated on the value of landfill gas for fuel and carbon credits at 34 landfills in North Carolina.
* Local governments linked with resources for landfill gas development, project financing, incentives, and providers of landfill gas equipment, supplies and services.
* At least 15 projects in planning and development stages.
* Potentially several hundred thousand tons per year of CO2 equivalent emissions reduced.

**Policy, Markets, and Economic Development**

Focus topics within this section include Assess Carbon Market Opportunities in North Carolina, New Policy Developments and Analysis, State Energy Plan, Economic Development Analysis and Outreach – Parts A & B, Hydrogen & Fuel Cell Industry Development & Commercialization, and Student Energy Research Development.

Our first activity was to Assess Carbon Market Opportunities in North Carolina. Activities under this Task include monitoring developments in national carbon-emissions policies and market development for potential impacts on North Carolina’s economy, development of carbon offset supply from North Carolina, and examining characteristics of the current market for voluntary carbon offsets.

North Carolina will benefit from these activities by:

* Farmers, landowners, and local governments receiving income from GHG reductions prior to incurring costs associated with a federally imposed cap on GHG emissions;
* Leveraging the value of voluntary pre-regulated carbon emission reductions into investment, economic development and green energy project development;
* Developing strategies to manage the changing competitive economic environment in a post-carbon-regulation timeframe, i.e. stakeholders within the state will know of and be prepared for both opportunities and threats that future carbon constraints will present.

New Policy Developments and Analysis has provided several outputs. We have completed a working paper and two policy briefs related to ‘cash for clunkers’ research. We completed a working paper on Delaware’s Sustainable Energy Utility. And, we completed an article in the Economic Developer’s guide discussing swine and poultry set aside and feed-in tariff policy issues. Working papers will be submitted to academic journals. Additionally, Dr. Jason Shogren gave a lecture to the University community on Climate Policy. This research is contributing to current policy debates and preparing good resources to be cited in attempts by policy makers to improve policy outcomes in the state. It is also further educating student and university populations at Appalachian State University.

Revisions to the State Energy Plan have been completed. This work, caught in the transitions from the previous Governor’s administration to our current Governor’s administration, has been renamed the State Energy Report and submitted to the State Energy Office. There were extensive revisions involved in this effort. The total length of the report was reduced by about 60%, and the recommendations from a lengthy series of meetings with three Task Forces and the Energy Policy Council were removed. The State Energy Report shows the current energy situation in North Carolina regarding energy supplies and energy demand from the residential, commercial, industrial, transportation, and electrical generation sectors. The plan will serve to inform policy makers and others about the state’s energy situation. It includes analysis of the potential contribution of energy efficiency and renewable energy in reducing the state’s need for fossil fuel and nuclear resources.

Economic Development Analysis and Outreach has involved multiple efforts, including the production of the Economic Developer’s Guide to the Renewable Energy Industries, Volume 4, Spring 2010. Additional benefits to the state from our focused expertise include: increased awareness and understanding of opportunities and strategies for capitalizing on the economic growth potential in the green economy; access to analysis and unbiased third-party financial reviews for local governments seeking to tap into the value of new markets for renewable energy and carbon offsets; and through stakeholder interactions the state benefits from increased economic activity, more productive economic development investments, and lower transaction costs resulting from stakeholder progress along the experience curve.

Our work in this type of analysis includes several other outcomes. We have produced a report on the technical and economic potential for wind development in North Carolina. Produced a paper that details how costs and benefits of wind development can be modeled and predicted to help determine site and turbine selection. Produced a policy brief and paper that details the hurricane threat to offshore wind development for North Carolina. And produced a report on supply chain problems associated with green buildings and communities. As a result of our analyses, developers and policymakers should be able to better assess the potential for economic development related to wind development and green building and community development in the state.

Our work on Hydrogen & Fuel Cell Industry Development & Commercialization reaches beyond the state and national arenas and onto the international stage. The Sixth International Hydrail Conference was held in Istanbul, Turkey on 1-2 July 2010. The conference is funded by the United Nations, through Istanbul-based International Centre for Hydrogen Energy Technologies (UNIDO-ICHET). Representatives from over a dozen countries were in attendance and a special information session for the Director of the Turkish State Railways was included. Of specific interest within North Carolina is that Charlotte has incorporated hydrogen-fueled mass transit technologies into their infrastructure planning and cost-benefit analyses. A manufacturer of hydrogen vehicles, Proterra LLC, engaged the state in an attempt to locate 1,000+ jobs in the Charlotte area (though eventually decided on the Greenville, SC area). North Carolina benefits from these activities through increased international recognition as a globally engaged state and source of high-technology innovation. These activities have brought new green transportation technology OEM’s to the doorstep, and will likely result in growth in supplier industry jobs in batteries, textiles, plastics, and reinforced composite materials production. Furthermore, these activities bring attention to a resource that will be vital to future energy systems, hydrogen.

The final initiative in our review is the Student Energy Research Development. In it we assist students at Appalachian State University to complete energy related research by providing seed funds to be used to carry out research activities mentored by an advisor. The program will help significant and important research to be completed within the state and provide students within the state an opportunity to significantly improve their research skills that they will carry with them into the workplace.

**FACILITIES**

**Solar Training and Research Facility** is in development at the University’s State Farm Road location, with construction nearing completion. This facility provides a site for testing and research on performance of available solar equipment. This work will allow homeowners and businesses to adopt these technologies with confidence and make the best decisions about what technology to adopt. The facility provides educational opportunities for future employees of the regional Green Economy.

**Small Wind Testing & Demonstration Facility** on Beech Mt provides a site for the testing small wind turbines. Most of the wind turbines being installed in western NC and throughout the state have come about after significant consultation with Appalachian State’s Wind Application Center. We routinely provide wind maps and wind measurement equipment and analysis to individuals who subsequently install wind turbines.

**Appalachian Biodiesel Research and Testing Facility** at the Catawba County EcoComplex provides valuable feedstock, fuel quality, and emissions data to the biodiesel industry in the State of North Carolina. The modular nature of our facility allows substitution of specific equipment in the production line to determine optimal engineering design for conversion of different feedstocks to biofuels while maximizing positive fuel properties and minimizing impact on air and water quality. The facility also allows experimentation with different processing elements to determine which components work together to provide the best overall production performance, fuel quality, and combustion emissions. Fuel quality and combustion emissions are analyzed well beyond ASTM and EPA standards, using advanced chemical analysis techniques.

**Alternative Fuels Research Labs** on campus include Biodiesel Education and Research Laboratory (BEReL), Cell-Free Ethanol Production & NIR Monitoring of Biodiesel Lab (Chemistry), Algae Oil Production, Harvest, & Extraction Laboratory (Biology), Microwave-Assisted Synthesis of Biodiesel (Chemistry), and Landfill Gas Research and Development Labs.

**Photovoltaic Materials and Device Characterization Facility** in the Department of Physics and Astronomy is under development. This site will provide the tools and training for ASU students and faculty to develop, fabricate and characterize PV devices. This facility serves as a user facility where PV researchers, fabricators, and users can have their PV materials and devices fabricated and tested. It is hoped and expected that the results of this work will serve as a resource for others who will need to use the tools we are developing to aid in their pursuit of fabrication and/or characterization of PV materials and devices. We can provide critical PV device measurements and characterizations at little or no cost to NC based companies and researchers.

**Landfill Gas Research and Development Labs** (Hickory, Boone, and local sites throughout North Carolina). This initiative develops landfill gas projects for community development, renewable energy implementation, and reduction of greenhouse gas emissions.

**PEOPLE**

**Director**

Dr. Jeff Ramsdell

**Staff**

Amanda Perry Brian Witmer

Bruce Davis Jason Hoyle

Jeremy Ferrell John Lehman

Kellie Stokes Joey Mosteller

Stan Steury Laurel Elam

Quint David

**MAJOR ACCOMPLISHMENTS**

**EXTERNAL FUNDING ACTIVITY**

**SUMMARY**

Appalachian Energy Center receives core funding through an Appropriation from the North Carolina Legislature. In addition, AEC supported 16 proposals that have remained active over the past year. One submitted proposal is currently under review and six additional were rejected. Of the 18 active funded projects, at least 14 provide indirect funds to the university. The total funds secured exceed $6,250,000. AEC staff have worked with 9 county governments to develop Landfill Gas proposals and thus far 7 have been funded with total funds secured equaling $6,367,280.

|  |  |  |  |
| --- | --- | --- | --- |
| AEC Proposals | Total Number | Number w/ Indirect | Total $ |
| Appropriation  Total Submitted | 1  24 | 1  14 of 18 active | $1,125,090  **$10,336,780** |
| Awarded | 16 | 12 | $5,125,348 |
| Under Review | 1 | 1 | $999,881 |
| Rejected | 6 | n/a | $3,086,461 |

Proposals With Counties

County Landfill Gas Proposals 9 n/a $7,067,282

Awarded 7 n/a $3,492,435

Additional leveraged funds from other sources n/a $2,874,845

**Total Funded $6,367,280**

Under Review 2 n/a $700,000

**PROPOSALS AWARDED**

**1. Green Economic Asset Mapping**

Researchers: Jason Hoyle

Funding Agency: Z. Smith Reynolds Foundation, Inc.

Amount: $34,602

Dates: 7/1/2010 – 6/30/2011 Indirect: NO

**2. Student Energy Internship and Fellowship Program**

Researchers: Marie Hoepfl, Jeff Ramsdell, Jeff Tiller, Dennis Scanlin

Funding Agency: ARRA – US DOE thru NC State Energy Office

Amount: $485,857

Dates: 4/30/2010 – 6/30/2012 Indirect: Yes

**3. NC Home Energy Efficiency Marketing Development and Implementation Program**

Researchers: Jeff Tiller, Jamie Russell, Lee Ball, and Bruce Davis

Funding Agency: ARRA – US DOE thru NC State Energy Office

Amount: $2,550,000

Dates: 5/1/2010 – 4/20/2012 Indirect: Yes

**4. 2011 Solar Decathlon \***

Researchers: Jamie Russell and Chad Everhart

Primary Funding Agency: National Renewable Energy Laboratory

Amount: $100,000

Secondary Funding Agency: Lowes

Amount: $350,000 (Cash and Equipment and Materials)

Dates: 5/1/2010 – 12/31/2011

\*(the Energy Center is providing financial management support for funds provided for this project by Lowes)

**5. Appalachian State University Wind Application Center – APPWAC**

Researcher: Dennis Scanlin

Funding Agency: National Renewable Energy Laboratory

Amount: $59,951

Dates: 9/1/2010 – 8/31/2011 Indirect: Yes

**6. Watauga County Energy Analysis Project**

Researcher: Jason Hoyle

Funding Agency: Watauga County

Amount: $1,975

Dates: 9/1/2010 – 10/31/2010 Indirect: No

**7. Community-based Landfill Gas Utilization In Brazil - Phase I**

Researcher: Jeff Ramsdell and Stan Steury

Funding Agency: U.S. Environmental Protection Agency

Amount: $120,000

Dates: 9/1/2009 – 3/31/2011 Indirect: Yes

**8. Community-based Landfill Gas Utilization in Brazil - Phase II and Extension**

Researchers: Stan Steury, Jeff Ramsdell, Jeremy Ferrell, Patricia Cornette

Funding Agency: U.S. Environmental Protection Agency

Amount: $120,000

Dates: TBD Indirect: Yes

**9. ASU Western North Carolina Wind Energy Initiative, NC Solar Center**

Researcher: Dennis Scanlin

Funding Agency: US Dept of Energy

Amount: $25,870

Dates: 7/1/2009 – 6/30/2011 Indirect: Yes

**10. NSF Planning Grant: Sustainable Integrated Buildings and Sites (SIBS)**

Researcher: Jeff Ramsdell

Funding Agency: NSF- Industry/University Collaborative Research Centers

Amount: $10,000

Dates: 2/1/2010 – 1/31/2011 Indirect: Yes

**11. Wind Powering America – NC Mountain Outreach**

Researcher: Dennis Scanlin

Funding Agency: US DOE Wind Powering America – National Renewable Energy Lab

Amount: $75,321

Dates: 3/19/2008 – 11/30/2010 Indirect: Yes

**12. Improved Energy Code for NC**

Researcher: Jeff Tiller

Funding Agency: US Dept of Energy thru NC State Energy Office

Amount: $254,546

Dates: 4/22/2009 – 12/31/2011 Indirect: Yes

**13. Extraction & Refinement of Oils from Biodiesel Feedstocks**

Researcher: Nicole Bennett

Funding Agency: Biofuels Center of NC

Amount: $129,133

Dates: 7/1/2009 – 11/30/2010 Indirect: Yes

**14. Technical Assistance – City and County Energy Efficiency**

Researcher: Jamie Russell

Funding Agency: ARRA – US DOE thru NC State Energy Office

Amount: $Reimbursement for expenses

Dates: 9/24/2009 – 5/31/2010 Indirect: Yes

**15. Watauga County Green Business Certification Program**

Researcher: Laurel Elam

Funding Agency: Watauga County Economic Development Commission

Amount: $58,093

Dates: 8/1/2007 – 6/30/2011

**16. Optimization of North Carolina Biodiesel Production through Data Regulated Processing of Variable Alternative Feedstocks – Biodiesel Car and Analysis Equipment**

*[Not included in summary statements and counts – included for historical reference]*

Researcher: Jeff Ramsdell, Nicole Bennett, Eric Allain

Funding Agency: The University of North Carolina Research Competitiveness Fund

Amount: $275,000

Dates: 3/1/2008 – 8/30/2008 \_\_\_\_\_\_ \_\_\_\_\_\_ Indirect: No

**17. Modular Biodiesel Testing Facility – Combustion Analysis – Dynamometer at Test Facility**

*[Not included in summary statements and counts – included for historical reference]*

Researcher: Jeff Ramsdell

Funding Agency: U.S. Department of Energy

Amount: $295,200

Dates: 5/1/2008 – 9/30/2010 Indirect: Yes

**18. Biodiesel Testing Facility**

Researcher: Jeff Ramsdell

Funding Agency: Golden Leaf Foundation

Amount: $750,000

Dates: 7/1/2007 – 12/31/2010 Indirect: Yes

**19. AEC Core Funding – NC Legislature Appropriation**

Researchers: Jeff Ramsdell + all associated faculty and staff

Funding Agency: MOA NC Dept of Commerce and ASU

Amount: $1,125,090

Dates: 7/1/2009 – 6/30/2011 Indirect: Yes

**PROPOSALS AWARDED – to Counties With AEC Assistance**

**1.Landfill Gas Proposals for Counties Supported by AEC**

Researcher: Stan Steury, Jason Hoyle, Joey Mosteller

Funding Agency: ARRA – thru NC State Energy Office

The following grants were recently approved for our cooperating counties in response to proposals we helped develop.   
• Columbus County -- $544,500 to install landfill gas generators to produce electricity and to develop on-site greenhouses to use waste heat from the generators - Total cost of the project is $951,500  
• Edgecombe County -- $325,000 to install generators to produce electricity and develop uses for the waste heat from the generators - Total cost of the project is $825,000  
• Robeson County -- $1 million to capture, condition, and compress methane gas and use it to produce thermal energy for adjacent business use - Total cost of the project is$1,549,900  
• Rockingham County -- $814,300 to install and operate a methane collection system carbon credit verification equipment and electricity generators and electricity interconnect upgrades -Total cost of the project is $1.9 million  
• Scotland County -- $250,000 to build a gas collection system and use the methane to run an engine/generator for electricity generation - Total cost of the project is $336,045   
• Wilkes County -- $358,635 to complete a gas collection system and use the gas for electricity generation and thermal heat for a greenhouse project   
 Gaston County -- $200,000 to install landfill gas generators – Total project cost is $446,200

**PROPOSALS UNDER REVIEW**

**1. What Are People Breathing? Establishing Baselines Before and After Home Weatherization Measures**

Researchers: Susan Doll and Bruce Davis

Funding Agency: US HUD – Healthy Homes Technical Studies

Amount: $999,881

Date: 11/8/2010

Indirect: Yes

**2. Landfill Gas Proposals for Counties Supported by AEC**

Researcher: Stan Steury, Jason Hoyle, Joey Mosteller

Funding Agency: ARRA – thru NC State Energy Office

Caldwell County -- $300,000 to install landfill gas generators to produce electricity

Rutherford County -- $400,000 to install landfill gas collection system and generators and greenhouses heated with waste heat from the generators

**PROPOSALS REJECTED**

**1. Energy Code Training**

Researcher: Jeff Tiller

Funding Agency: ARRA – US DOE thru NC State Energy Office

Amount: $998,236

Date: 8/2/2010 Indirect: Yes

**2. Passive Energy & Building Systems: Finance, Design, Engineering, Construction, and Operations**

Researcher: Jeff Ramsdell – ASU and Volker H. Hartkopf – CMU

Funding Agency: NSF – EFRI SEED Grant

Amount: $606,390

Date: 4/6/2010 Indirect: Yes

**3. Closed Loop Biodiesel Technology Transfer; from Appalachia to the Nordeste Phase I**

Researcher: Jeremy Ferrell, Martin Mezner, & Jeff Ramsdell

Funding Agency: USDA (International Science and Education Grants)

Amount: $60,743 Not Funded

**4. Appalachian State University - Testing of Small Wind Turbines at Regional Test Center - Small** **Wind Test Center**

Researcher: Dennis Scanlin

Funding Agency: National Renewable Energy Laboratory

Amount: $636,458 Not Funded

**5. Bio-char Cost-Benefit Analysis**

Researcher: Jason Hoyle

Funding Agency: NC Farm Center for Innovation and Sustainability

Amount: $34,717 Not Funded

**6. STEMulating Appalachia**

Researchers: Brian Raichle, Jerianne Taylor, Laura England, & Carla Ramsdell

Funding Agency: Golden LEAF Foundation, Inc.

Amount: $749,917 Not Funded

**FACULTY PARTICIPATION**

AEC staff and associated faculty developed a multiple discipline initiative plan through which to apply funding from the North Carolina Legislature Energy Centers Appropriation and received a MOU to proceed from the NC Energy Office. Work has been being pursued by 11 Center staff, more than 34 project staff, and 24 faculty.

AEC competed for additional externally funded projects which involved 6 additional faculty.

|  |  |
| --- | --- |
| Campus Researchers | Total Number |
| Total | 24 |
| Department/College |  |
| Technology/FAA | 11 |
| Chemistry/CAS  Physics/CAS | 4  3 |
| Geography & Planning/CAS | 2 |
| Biology/CAS | 1 |
| Economics/COB  ORSP/Grad School | 1  1 |
| Sustainable Development/UC | 1 |
|  |  |

AEC’s efforts entailed collaborations with many other research institutions (e.g., subcontracts, co-PIs, etc.)

|  |
| --- |
| Off-Campus Collaborations |
| University of North Carolina Charlotte |
| Carnegie Mellon University |
| North Carolina Solar Center at NCSU  Catawba County EcoComplex |
| Southern Energy Management |
| Center for Energy Research & Technology at NC A&T |
| City College of New York |
| NC Fuel Cell Alliance |
| Advanced Energy Corporation  County Governments – Multiple for Landfill Gas Initiatives |

**RESEARCH REPORTS**

Taylor, Marcus, 2010, Public Opinion of Wind Turbines in Watauga County, North Carolina (report in progress)

Scanlin, Taylor & Kersey, 2010, Public Opinion of Wind Development in Western North Carolina (report in progress)

Scanlin, Taylor & Flynt, 2010, Wind Resources of Western North Carolina (report in progress)

Scanlin, Taylor & Flynt, 2010, Potential Economic Impacts of wind energy development in Western North Carolina (report in progress)

Tiller, Jeff. 2010. “Impact and Projected Costs of the Proposed North Carolina Energy Code.” A Report for the North Carolina Building Code Council.

Tiller, Jeff. 2010. “Development and Implementation of an Improved Residential Energy Code for North Carolina.” A Report for the North Carolina Building Code Council.

Tiller, Jeff. 2010. “Development and Implementation of an Improved Commercial Energy Code for North Carolina.” A Report for the North Carolina Building Code Council.

Tiller, Jeff, Bruce Davis, Sean Gray, Erica Porras. 2009. “Preliminary Report: Revised Duct Design Performance.” Appalachian Energy Center Report.

Gray, Sean M., Susan C. Doll, Bruce E. Davis. 2010. “While Laurel HVAC Performance Study at Laurel Reach.” A Report Submitted to Northwestern Regional Housing Authority, May 25.

Lehman, John. 2010. Trends in the Manufactured Home Industry. Draft report for the Appalachian Energy Center.

Erwin, Anna. 2010. Implementing a PACE Program Using Community-Base Social Marketing. Draft report for Appalachian Energy Center.

Scanlin, Dennis. 2010. Development and completion of three surveys on attitudes toward wind energy in western NC (Watauga Co., 24 counties of WNC, and owners of windy land).

Badurek, C.A., et al., 2010. *NC-MARE: North Carolina Microhydro Assessment for Residential Energy. Technical Report for Energy Center, Appalachian State University.*

Badurek, C.A., 2010. Using GIS for Microhydro Assessment for Residential Energy in Ashe County, NC. *North Carolina Arc Users Group Conference, Carolina Beach, NC, Sept. 2010.*

Hyman, A., and Badurek, C.A., 2010. A GIS Approach to Estimating Microhydro Energy in Western North Carolina. *North Carolina Arc Users Group Conference, Carolina Beach, NC, Sept. 2010.*

Anthony, M., Saunders, B., and Badurek, C.A., 2010. Potential Residential Users of Microhydro Power in Western North Carolina. *North Carolina Arc Users Group Conference, Carolina Beach, NC, Sept. 2010.*

Hyman, A., Badurek, C.A., Anthony, M., and Saunders, B., 2010. GIS Methods for Estimating Potential Residential Users of Microhydro Energy in Western North Carolina. *Southeastern Division of the AAG Annual Conference, Birmingham, AL, Nov. 2010.*

Ferrell, J. (2009). Testing Modular Biodiesel Processing, Oilseed Feedstocks, and Combustion Emissions at the EcoComplex in Catawba County, North Carolina. Proceedings from 1st Biofuels Technology Shortcourse, Fulbright Commission-Brazil, Sao Paulo.

Sanderson, Matthew C., Mark E. Venable. A Novel Assay of Acyl-CoA: Diacylglycerol Acyltransferase Activity Utilizing Fluorescent Substrate. Under second review in the journal Lipids, Springer Life Sciences

Schwab, A. D. (Author Only), Kanupp, A. (Presenter & Author), Sears, T. (Author Only), Conway, M. (Author Only), Casey, B. (Author Only), Cauthen, L. (Author Only), Miller, J. (Author Only), Bennett, N. S. (Author Only), State of North Carolina Undergraduate Research Symposium, "Synthesis of tetra(4-sulfonatophenyl)chlorin from tetra(4-sulfonatophenyl)porphyrin," North Carolina, Wilmington, NC. (November 21, 2009).

Bennett, N. S. (Author Only), Lopez, M. (Presenter & Author), State of North Carolina Undergraduate Research Symposium, "USE OF MAGNETITE TO REMOVE FATTY ACIDS FROM WASTE OIL: APPLICATION TO BIODIESEL SYNTHESIS," Wilmington, NC. (November 21, 2009).

Steury, Stan – Edgecombe County Sweet Potato Processing Feasibility Final Report 7/8/2009

Steury, Stan – Wilkes County Germantown LFG Pump Test & Demo Final Rpt 9/2/2009

Steury, Stan – Watauga County LFG to Energy Analysis 9/8/2009

Steury, Stan – Electricity Generation at Small Landfills 9/15/2009

Steury, Stan – A Strategy for Landfill Gas Development At The East Carolina Regional Landfill 3/2/2010

Steury, Stan – Golden LEAF Community TIES Final Report 3/14/2009

Hoyle, Jason. *Carbon Credit Purchasing in the Local Decision Context*. Presentation to EPA LMOP Conference. Baltimore, MD. Jan. 12, 2010.

Hoyle, Jason; Little, Joseph; Cherry, Todd; et al. *Retail Carbon Offset Survey 2009*. May 2010. Available at <http://www.envcc.com/images/pdf/retailcarbonoffsetsurvey2009.pdf>

Lehman, John. 2009 Cash for Clunkers: The Good, the Bad and the Ugly. Working paper for Appalachian Energy Center and CERPA

Lehman, John. 2009 Cash for Clunkers: Should Ownership be required. Policy Brief for Appalachian Energy Center and CERPA

Lehman, John. 2009 North Carolina and U.S. Impacts from Cash for Clunkers. Policy Brief for Appalachian Energy Center and CERPA.

Lehman, John. 2010. Contracting Out the Energy Utility. Working paper for The Appalachian Energy Center and CERPA

Lehman, John. 2010. Policy Matters. Economic Developer’s Guide. The Appalachian Energy Center.

North Carolina State Energy Report. Tiller, Jeffrey S., Anna Erwin, and Laurel Elam. Appalachian State University Department of Technology and Energy Center. Published by the North Carolina State Energy Office. March, 2010.

Economic Developer’s Guide to the Renewable Energy Industries, Volume 4, Spring 2010

Lehman, John. 2010. North Carolina Western Wind Draft Report. Research Institute for Environment, Energy and Economics and Appalachian Energy Center.

Lehman, John and Joey Mosteller. 2010. The Hurricane Threat for North Carolina Offshore Wind Development. Policy Brief for Appalachian Energy Center and CERPA.

Lehman, John and Quint David. 2010. Choosing a Wind Site. Working paper for Appalachian Energy Center and CERPA.

Lehman, John. 2010. Supply chain problems in the delivery and sale of green buildings and communities. Draft report for Appalachian Energy Center.

**RESEARCH PRESENTATIONS**

Tiller, Jeff, Bruce Davis, Sean Gray, Erica Porras, Andrew Windham. 2010. “Performance of Revised Duct Design, Save Money and Cool Customers.” A power point and presentation delivered at the national RESNET conference, Raleigh, NC. February 24.

Three presentations for Building Code Mechanical Inspectors on the NC Energy Code

One presentation for Council of Educational Facility Planners International conference on Building Envelope Failure Examples

Two, hands-on, In the Field Building Diagnostic and Performance Measurement Workshops Completed revisions of the following PowerPoints, with presenter notes for presentation:

1. Intro to SL 1946 and 668
2. Complying with SL 1946 and SB 668
3. Architectural-Engineering Design Strategies
4. Lighting, Controls, Daylighting
5. HVAC Systems and Controls
6. Commissioning and Measurement and Verification
7. Energy Modeling and Life Cycle Cost Analysis
8. Water Efficient Strategies
9. Operations for Energy Efficiency

Completed a day-long PowerPoint presentation on Energy Modeling for Architects

Conducted workshops on Energy Modeling for Architects for the North Carolina chapter of the

American Institute of Architects on March 17th in Charlotte and March 31st in Raleigh. 2010.

PowerPoint presentation “AIA Commercial Code Presentation 9\_30\_09” for the North Carolina

American Institute of Architects Annual Board Meeting, Greenville, SC, 9/2009.

Presented economic analysis of the proposed energy code to the NC Chapter of the American

Institute of Architects in Spartanburg, SC at their 2010 annual meeting.

**PUBLIC ENGAGEMENT**

**High Performance Buildings**

On February 21 – 24, 2010, over 950 building performance professionals gathered in Raleigh, North Carolina to participate in the combined NC Energy Star and 2010 RESNET Building Performance Conference. The conference provided a unique opportunity for participants to share the latest information on successful business models, program delivery, technical innovations and policy initiatives. Not only did this year's conference top all previous conference attendance records, it also offered the most break-out sessions, 70, plus 8 preconference sessions. There were also 62 vendors in the exhibit hall.

Conference keynote addresses were presented by:

Donna McIntire of the United Nations Environmental,

David Goldstein of the Natural Resources Defense Council, and

Philip Fairey of the Florida Solar Energy Center.

**Hydrail Conference**

The Sixth International Hydrail Conference was held in Istanbul, Turkey on 1-2 July 2010. The conference is funded by the United Nations, through Istanbul-based International Centre for Hydrogen Energy Technologies (UNIDO-ICHET). Representatives from over a dozen countries attended and a special information session by the Director of the Turkish State Railways was included in the schedule.

**Wind Initiatives**

Approximately 1000 people have attended our wind energy workshops over the last 7 years. Participants have come from more than 30 US states and 10 different countries. Many more have visited the small wind turbine site at Beech Mountain, which is open to the public.

**Biofuels**

We have had multiple successful workshops on oil extraction with press demonstrations.

The first workshop was part of the Western North Carolina Renewable Energy Series and demonstrated the technology to 14 participants including community members, and students. The second workshop was for the Unifour Cooperative Extension Advisory Council. This group consisted of 40 participants from Catawba, Alexander, Burke, and Caldwell Counties.

Public Policy Polling, 2010, Wind Energy Survey Results report, completed and placed on

wind.appstate.edu website

Produced a map of 174 schools in North Carolina with average annual wind speeds greater than

10 mph at 30 meters and a data base of contact information

1 small wind workshop developed, advertised and conducted

10 presentations given at conferences and meetings

Developed an updated factsheet on wind energy

Developed a new informational kiosk on Wind Energy for the Beech Mt test facility

**DEVELOPMENT**

Major development items for the Appalachian Energy Center for this period include facility enhancements and expansions, organizational structure improvements, and expansion of internal and external collaborations.

**1. FACILITY ENHANCEMENTS AND EXPANSIONS**

As discussed in more detail in the facilities section above, the Appalachian Energy Center has continues to expand and enhance our facilities both on campus and off. Major expansions and additions include: the Solar Training and Research Facility at the University’s State Farm Road site, the Appalachian Biodiesel Research and Testing Facility at the Catawba County EcoComplex, and Landfill Gas Research and Development Lab at the Watauga County Landfill. While these facilities are currently operating on a limited basis and offering some data, all three will be complete and fully operational by the end of 2011.

**2. ORGANIZATION STRUCTURE IMPROVEMENTS**

Ongoing improvements in the organizational structure of the Appalachian Energy Center include the formalization of our program areas, staff titles and reporting hierarchy, and development of titles and responsibilities of associated faculty. These efforts are being completed in collaboration with the other two centers of the Research Institute for Environment, Energy, and Economics (RIEEE).

**3. EXPANSION OF COLLABORATIONS**

Both internal and external collaborations have greatly expanded in the current reporting period. Significant additional collaborations include the development of an NSF I/UCRC with UNC Charlotte, Carnegie Mellon University, and City College of New York (part of the CUNY system), the development of renewable energy engineering programs with UDLAP in Puebla, Mexico and The University of the Free State in Bloemfontein, South Africa. Internal collaborations have expanded greatly as shown in the faculty participation section above.

**PROBLEMS/NEEDS**

Important needs include proper salaries for permanent staff, research space on campus, and an increase in the number of full-time technical staff.

**1. PROPER STAFF SALARIES**

Salaries of a few Appalachian Energy Center staff are currently well below market rate. Even with the current state budget crisis these salaries should be increased to market rate in order to retain these important employees and continue our current success. These employees have performed exceptionally well and are experts in their field.

**2. ON-CAMPUS RESEARCH SPACE**

The Appalachian Energy Center continues to operate with no real research space on campus other than that of a few collaborating faculty. This lack of space greatly reduces our ability to expand important research programs, especially in the area of high performance buildings. We are currently turning away external funding opportunities due to this lack of on-campus space.

**3. FULL-TIME TECHNICAL EMPLOYEES**

The Appalachian Energy Center is also in great need of further full-time technical researchers. This need is most apparent in the lack of any full-time staff dedicated to renewable energy technologies. This deficiency greatly reduces our ability to apply for large external grants.