

Appalachian Energy Center Appalachian State University

Work Plan

July 1, 2015 – June 30, 2017

The Appalachian Energy Center (AEC) at Appalachian State University conducts energy research and applied program activities in the areas of energy efficiency, renewable energy technologies, forecasting and modeling, economic development, and policy analysis in a multi-disciplinary environment that leverages the expertise of faculty, staff, and students from across the University as a resource for private industry, local, state and federal governments, and non-profits. Through its outreach programs and research, the Appalachian Energy Center provides benefits to communities and citizens across the state, including the creation of new jobs and businesses, and increased investment and income. The overarching goal of the AEC activities described here is to foster and facilitate interdisciplinary research, education and outreach to positively impact important energy decisions.

A. Clean Energy Conversion and Supply

This work seeks to support design, manufacturing, and implementation of renewable energy systems in North Carolina. Specific areas of work by Appalachian Energy Center staff and Appalachian faculty members include:

- Education, outreach, and research activities that lead to an increase in the number and scale of renewable energy systems installed in North Carolina. These systems include wind, solar, and hydro technologies. This work includes the acquisition and analysis of topographic, weather, hydrological, and land parcel data with geographic information systems (GIS) to assess and map areas with high renewable energy production potential.
- Continued support of the Appalachian Solar Energy Research and Demonstration Laboratory. The solar lab actively supports outreach, education, and applied research projects. Applied research projects aim to identify and characterize solar technologies that perform well in North Carolina climates. Verification and dissemination of solar system performance will allow North Carolina citizens to choose the solar technologies that offer the best return on investment. The lab hosts numerous public and special event tours, as well as hands-on solar workshops for the public. The facility allows potential solar adopters the chance to see first-hand installed modern solar technologies. The solar lab also offers Appalachian students valuable hands-on experience with a range of solar technologies. These students will likely join the North Carolina workforce and contribute to the growing renewable energy sector in the State. Partnerships with solar equipment manufacturers will also be pursued.
- Continued support of the Appalachian Small Wind Research and Demonstration Facility on Beech Mountain. This facility provides valuable information about wind turbine performance and durability to small wind manufacturers and utilities, while providing

students and the community with hands-on experience with small wind technology. Appalachian faculty and students are actively engaged in education, outreach, and research projects that utilize the facility. These projects benefit businesses and citizens of North Carolina interested in design, manufacturing, and implementation of wind energy systems. Research activities may include topics such as blade design, noise levels, impact on local bird populations, relationship of wind turbine performance to utility loads, storage technologies, etc. This work will also continue to include the monitoring and reporting of estimated output of wind energy facilities in North Carolina as installations expand in number and size.

- Support ongoing efforts to increase agricultural production of biodiesel crops, improve biodiesel production processes, and test emissions of vehicles utilizing biodiesel manufactured from various feed-stocks grown in North Carolina. This work includes education, outreach, and research activities that lead to an increase in the production and use of biodiesel fuel in North Carolina. Workshops and other technical assistance will be provided to support market development through growers of oil seed crops, as well as to biofuels manufacturing companies. This work will utilize the Biodiesel Research, Development, and Production Facility at the Catawba County EcoComplex in collaboration with Blue Ridge Biofuels, a private company that produces fuel at the facility.
- Support continued landfill gas (LFG) to energy project work in North Carolina, as well as the development of other anaerobic digestion biogas facilities. This work will include continued support of the counties with which the Center has previously worked, as well as support to additional local governments seeking to initiate a LFG or other biogas project. Appalachian Energy Center staff will provide technical analysis and input, as well as economic and financial analysis assistance for these projects. This analysis will include consideration for the sale of carbon credits and renewable energy certificates (RECs). Appalachian Energy Staff will also seek to work with private industry to create public-private partnerships for the development of landfill gas and biogas utilization projects in NC.
- Applied research activities that will directly support the activities above as well as other activities in the state may include:
 - Renewable energy system and product testing to analyze performance, reliability, and value.
 - Testing of state-of-the-art, cost effective systems for the utilization and treatment of landfill gas on small to medium-sized landfills in North Carolina. This work would include testing of gas separation technologies that would allow for higher quality methane fuel and clean carbon dioxide.
 - On-going work with counties and other landfill owners to develop a system of remote monitoring to reduce operation and maintenance costs of landfill gas systems and to create maximum return from sale of environmental attributes such as carbon credits and RECs.

- Continued research on Waste as a Resource to include MSW, food and agricultural waste.
- Continue research on the emissions from the combustion of biofuels manufactured from varying agricultural feedstocks.
- Expansion of LFG work to further research on community and farm based anaerobic digestion of organic wastes as a fuel source.
- Study of social, economic, and environmental impacts/benefits of renewable energy utilization in western NC.
- Support of local and regional Agro-energy projects, including bioenergy crop production, intercropping systems, and on-farm generation.

B. Efficient Distribution and Grid Integration

This work seeks to improve the efficiency of energy distribution across the State. Specific areas of work by Appalachian Energy Center staff and Appalachian faculty members include:

Distributed Generation & Emerging Power Systems

The Distributed Generation & Emerging Power Systems area covers activities that address renewable energy/distributed generation, smart grids, increased demand-side engagement, energy storage and related technologies. Specific focal points will include the policy, financial and economic aspects of rate structure design, net metering, avoided cost rates, integrated resource planning, third-party retail sales, government sales, novel mechanisms for financing and incentivizing, and similar issues.

Electric Utility Operations and Infrastructure Innovations

Through collaboration with New River Light and Power (NRLP), the Appalachian Energy Center is part of a team that is working to innovate the operation of the electric utility. The NRLP Living Laboratory will expand upon ongoing NRLP infrastructure upgrades to increase data collection and management capabilities four-fold and enable monitoring of not only customer usage but also discrete sections of the distribution grid up to the substation level. This project will develop the various policies, procedures, administrative, and management processes and mechanisms necessary to ensure the integrity of the laboratory's activities, adequate protection of NRLP's interests, and that all regulatory requirements are fulfilled. The knowledge gained from this project will be easily transferable to other small utilities across the State. Areas of research include integrating intermittent and distributed generation, peak contributions and coincidence for solar and wind, and load control.

C. Energy Consumption and Efficient Infrastructure

This work seeks to improve the energy efficiency of both new and existing buildings as well as some transportation systems in North Carolina. Specific areas of work by Appalachian Energy Center staff and Appalachian faculty members include:

- Education, outreach, and research activities that lead to an increase in the number of high performance buildings constructed in North Carolina. This work includes some continued support of and participation in the activities of the North Carolina Energy Efficiency Alliance (NCEEA), such as promoting high efficiency program standards and conducting building science training for appraisers, realtors, and building professionals.
- Support of affordable housing efforts, such as those of Habitat for Humanity and regional housing authorities, to increase the energy efficiency of affordable houses being constructed in North Carolina. This work includes homeowner education related to system operation and occupancy behavior; and assistance to these organizations in the design, material selection, and construction of their houses.
- Assist the NC Department of Environment Quality with education, outreach and research activities that lead to improved energy performance of commercial buildings in the State. This work includes contributions to the Appalachian Energy Summit and associated events and projects.
- Support of improved North Carolina building codes and their implementation through education, outreach, and research. This work includes building performance analyses that support decisions regarding inclusion of particular energy related items in the code, as well as outreach to and education of North Carolina building professionals related to the building science of the code requirements.
- Support the development, commercialization, and deployment of emerging transportation technologies through analysis of the state's competitive position and potential to benefit from both supply and demand side approaches, and through participation in education and outreach activities related to these technologies. These technologies include hydrogen based rail systems (Hydrail) and electric vehicles.
- Applied research activities that will directly support the activities above as well as other activities in the state may include:
 - Remote monitoring of building energy use and indoor environmental quality (IEQ) and their relationship to system operation and occupancy behavior.
 - Thermal characterization of building materials and systems that can lead to improved wall and roof system designs. This work could lead directly to reduced installation costs and improved resistance to heat transfer for buildings in North Carolina and beyond.

- Research on high density, low cost thermal energy storage. This work provides the opportunity to improve the functionality and performance of both passive and active solar thermal collector systems in buildings for thermal comfort and domestic hot water. These systems can be manufactured by leveraging existing heat exchanger manufacturing technologies providing a new product line for existing industries in North Carolina.
- Continued examination of the impact of simplified duct design on comfort and performance. This work will continue to assist residential builders in North Carolina by reducing HVAC system costs and providing improved comfort for their clients.

D. Emerging Issues, Policy, Economics, and Societal Impacts

Activities under this area of work support the pursuit of economic prosperity, new jobs, technological development and deployment, and the growth of business and industry with a focus on more productive use of natural resources, more efficient and efficacious use of energy, and increased activity by businesses in energy or environment related markets with activity and opportunities for North Carolina. This work will be accomplished through applied research, analysis, program and project development, and education and outreach in topic areas that include the following:

Greenhouse Gases

The Greenhouse Gases topic is focused primarily on two distinct but related areas – implementation of the EPA regulations on GHG emissions within North Carolina and greenhouse gas accounting (e.g., carbon footprint calculations, carbon offset protocol design, jurisdictional-scale aggregate accounting). This topic, in particular, will require flexibility as these policies and their implementation are only now beginning to take shape at the state level, but this work is anticipated to concentrate on identifying and understanding tradeoffs, barriers, and opportunities for a variety of policy options.

Environmental Asset Markets

The Environmental Asset Markets topic area includes work related to the markets for renewable energy certificates (RECs), carbon offsets, renewable fuel credits, and other intangible forms of commoditizing and monetizing attributes related to energy. We intend specific work in this area to consist of market analysis (including policy options impacting these markets), examining opportunities for these markets to support increased economic activity or income, and education and outreach efforts to facilitate participation and understanding of these markets.

Development & Deployment

The Development & Deployment topic area covers a broad range of subjects, all of which are focused in some way on growth and improved economic outcomes for citizens and businesses. Some specific focal points include: expansion, refinement, and continued application of community-based economic development models (particularly those that leverage energy in some way); development, facilitation, and adaptation of project development structures for both energy- and environmental asset-related projects; and the many facets related to the development, deployment, integration, and adoption of new energy-related technologies such as smart grid/smart home and energy management systems, hydrogen fuel cells for transport (i.e. trains specifically) and stationary applications, energy storage, and other emerging technologies related to the energy field.

E. Extension, Education, and Outreach

This work seeks to disseminate knowledge related to energy efficiency and renewable energy through education, outreach, and extension programming. Specific areas of work by Appalachian Energy Center staff and Appalachian faculty members include:

Workforce Development and Continuing Education in Building Science and Renewable Energy Technologies

The annual Appalachian Energy Center Workshop Series offers continuing education and training opportunities for experienced professionals looking to stay competitive and those seeking to broaden their knowledge base or transition into the energy field. Our workshops are appropriate for those already working in directly related fields such as architects, engineers, contractors and code inspectors and those working in fields that impact energy decisions such as appraisers, realtors, lawyers, and accountants.

Outreach and Community Engagement

Through outreach and community engagement activities we serve as a resource for community members and educators to increase awareness and understanding of energy issues and support energy conservation and renewable energy adoption. This effort provides information via a quarterly newsletter and website and offers workshops and facility tours to community members, students and K-12 educators.

Extension Services and Development Assistance

The Appalachian Energy Center's energy extension and renewable energy development assistance programming will serve the public and private sectors in Western North Carolina and beyond. We engage Appalachian students in hands-on learning experiences by conducting low cost site assessments, economic feasibility studies and energy audits. We also conduct product performance evaluations for industry partners utilizing existing Appalachian facilities such as the Solar Energy and Small Wind Research and Demonstration sites.