

Thesis Project Portfolio

Assessing the Potential for Renewable Energy Development in Appalachia
(Technical Report)

Analyzing the Influence of Societal Standards on Renewable Energy Projects in Appalachia
(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia | Charlottesville, VA

In Fulfillment of the Requirements of the Degree
Bachelor of Science, School of Engineering

Conor Murphy

Spring, 2024

Department of Systems and Information Engineering

Table of Contents

Sociotechnical Synthesis

Assessing the Potential for Renewable Energy Development in Appalachia

Analyzing the Influence of Societal Standards on Renewable Energy Projects in Appalachia

Prospectus

Sociotechnical Synthesis

The area of study of this portfolio focuses on renewable energy technologies and their application in the socio-economic region of Appalachia. In the technical portion, a feasibility assessment of renewable energy development in Appalachia was conducted to determine the most viable regions for various renewable technologies. An analysis of the socio-technical aspects of the region of Appalachia was conducted to determine the most influential factors in the approval and successful implementation of a proposed renewable development.

The economy of Appalachian Virginia has historically relied on the coal industry, whose productivity is declining due to concerns around climate change. The technical paper explores the potential for renewable energy development to revitalize the region's economy, while also reducing greenhouse gas emissions contributing to global climate change. To explore this question, our team first quantified the potential production of solar, wind and hydroelectric energy in the region, taking advantage of the reclamation of mined lands. When assessing the potential for these energy sources, the group used a weighting scheme to identify counties that best balanced conflicting stakeholder objectives, with different sets of weights representing different sets of stakeholders. Metrics contributing to a counties' score included their solar energy, wind energy, and hydroelectric energy resources, the potential for renewable energy development to improve their struggling economy, and the extent to which local policy encourages the development of renewable energy sources. The team used ArcGIS Pro to compute these metrics over land that is available for development. Our findings uncovered that Carroll, Floyd, Henry and Montgomery counties were the strongest candidates. After narrowing our scope down to these four counties, we found specific sites that were favorable for renewable energy development and laid the groundwork for utility scale energy production in these areas. The ultimate goal of this analysis is to help the population of these counties develop renewable

energy resources that will stimulate the surrounding economy and address environmental concerns. The team landed on two regions in Floyd and Carroll counties, spanning roughly 15,000 acres, that best meet the criteria identified above.

In the STS paper, social factors influencing renewable energy developments were researched to determine how to best implement a renewable energy development. The importance and urgency of the situation will be illustrated, and different cases examined to gain a better understanding of what factors lead to the abandonment of a project. Land use and the allocation of land as a resource is something that constantly affects development projects, beyond just renewable energy projects. Cases reveal that land acquisition is one of a few bottlenecks for renewable developments- land has historical ties and uses and the land necessary for a utility scale project is very hard to come by. Another bottleneck identified is public policy towards renewables. Ordinances on energy limit the amount of land that can be used for utility scale projects in some Appalachian counties. Additionally, public attitudes towards renewables in Appalachia- an area historically heavily reliant on the coal industry- is skeptical at best.

The technical paper considers quantifiable metrics, such as transmission density and potential energy production; however, the models created in this portion of the project do not include qualitative social factors that may influence the regions selected as “most viable” to develop. In an effort to gain a holistic understanding of what it takes to install a utility scale renewable development, the social determinants were studied in the STS paper. Using the work completed in this research project, one could identify a location for renewable development that is both technically and socially feasible. For our nation to meet the goals set forth by the UN and the Biden administration, it is key that utility scale renewable energy plants are efficient, optimized, and can be built in the first place.