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TITLE: PREPARING NEW MEXICOS WORKFORCE FOR THE RENEWABLE ENERGY ECONOMY THROUGH PROFESSIONAL DEVELOPMENT FOR NM K-8 EDUCATORS

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Preparing New Mexico's workforce for the renewable energy economy through professional development for NM K-8 educators

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New Mexico's political and economic history has long been centered on the exploitation of natural resources. From precious metal mining to natural gas and petroleum extraction, New Mexico has traditionally been a provider of raw energy commodities to the United States. While fossil fuel extraction is still a primary component of New Mexico's economy, a worldwide change in energy production is underway as the world considers the environmental and political costs of fossil fuels. The move to 'renewable energy' (primarily solar and wind) is perceived by some as a threat to New Mexico's fossil fuel-based economy. However, New Mexico is uniquely suited to take advantage of alternative energy if it chooses to do so, as the potential for solar, wind, and geothermal energy generation is significant. For example, a map of potential solar energy (Appendix - Figure 1) shows New Mexico at the center of the nation's most productive solar zone while a wind speed map (Appendix - Figure 2) shows that eastern New Mexico has great potential for harnessing wind energy. In addition to potential solar and wind energy, active tectonism across much of New Mexico has resulted in a high geothermal gradient that gives New Mexico modest to high geothermal potential (NMEM, 2006) as illustrated in Figure 3 (Appendix).

The future of New Mexico's energy industry depends on many economic and political factors, but regardless of the exact scenario that plays out in the next few decades it is inevitable that our finite supply of fossil fuels will eventually yield to alternative energies. Renewable energy installations of all types (solar, wind, geothermal, and biofuels) do currently exist in NM, but in extremely small proportions compared to traditional fossil fuels (energyatlas.org). This transition may occur gradually, with a incremental ramping up of solar and wind farms over the next few decades, or may be drastically increased in a nationwide attempt to rapidly convert to alternative energy (Zweibel et al., 2008). The transition to solar is already occurring at a rate much faster than previously anticipated as the price of solar panels has decreased threefold in the past few years from China's investment into solar panel production (e.g., Bradsher, 2011; Mufson, 2011). Where solar has long been viewed as a fringe technology that could not

compete with the low cost of fossil fuels, the solar industry is now on the verge of profitability, even without current government subsidies. As of January 2012, there are 102 solar farms in operation in NM with 22 currently under construction and 398 in the development process (www.seia.org).

New Mexico will require a workforce capable of designing, implementing, and installing solar, wind, and geothermal energy facilities. This creates an opportunity to improve the workforce infrastruction in New Mexico to meet this challenge within our own population. We feel that interest and competency in skills related to the energy industry must be initiated early in a student's experience to foster a sustainable workforce for the long term. There are many skill sets that will be necessary across different careers in the alternative energy industry, but central to all of these careers is a solid understanding of how electricity is generated, distributed, stored, converted and used. According to the New Mexico Science Standards (2003), many topics related to energy already appear in K-8 grades; for example, as early as 4th grade students are expected to be familiar with simple series circuits and electricity. However, in most cases these topics are simply not being taught in NM schools. Part of this reason is due to the current standardized testing environment, which emphasizes reading and math skills over any other curricula. But another portion of the problem is that most primary teachers simply aren't comfortable with teaching topics in electricity, circuits, and energy. In addition, most schools do not have the necessary materials to let students do hands-on experiments with electricity.

We propose to offer professional development classes for K-5 teachers that emphasize alternative energy. These classes would be offered through three consecutive summers and would break down roughly as follows:

- **Basics of Electricity and Magnetism** (series and parallel circuits; ohm's law; watt's law; circuit building and troubleshooting; magnetism; electromagnets)

- **Basics of Renewable energy** (how to build simple circuits with solar cells and panels; how to build a solar farm [scale model but operational]; how to build a wind farm [scale model but operational]; how to build an electrolysis plant [for generating hydrogen])

- **Sun, Wind, and Tectonics**: Environmental factors that contribute to renewable energy (weather, wind, solar radiation, and a high geothermal gradient)

The goals of these classes would be to (a) demystify electricity and allow the teachers to be comfortable teaching circuits and magnetism in the classroom, (b) provide hands-on activities with renewable energy that would be reproducible in the classroom, and (c) explain the environmental factors that contribute to New Mexico's potential in renewable energy. Included with the *electricity and magnetism* and *renewable energy* classes would be circuit kits

that the teachers would be able to keep and take back to their schools for hands-on activities with their students. The *electricity and magnetism* kits would include such things as jumper wires, light bulbs, LEDs, battery holders, switches, motors, magnet wire, etc. The *renewable energy* kits would include solar panels, miniature windmills, and carbon rods for electrolysis.

We plan to offer these classes with the existing network of Bernalillo Public School (BPS) district teachers in our *Pathways to Inquiry* program, which has been in progress since 2007, and is a collaboration between the BPS, the Science Education Institute of the Southwest (SEIS) and the University of New Mexico. The primary goal of the *Pathways to Inquiry* program is to provide content-rich science learning experiences for K-5 teachers that includes explicit attention to classroom applications. The general format of the *Pathways to Inquiry* program includes up to 5 days of full-day classes during the summer with up to 4 days of follow-up during the school year. This schedule is significantly better than "one-shot" professional development that has not been shown to improve either teacher knowledge or classroom practice (Birman et al., 2000). The format also provides an opportunity for in-depth content coverage, implementation of activities into classrooms and follow-up to investigate (and improve) both the delivery of professional development and trouble-shoot classroom implementation. *Pathways to Inquiry* has also been successful at building an informal science professional learning community for BPS teachers and engaged the community through family science nights that were organized in 2007 and 2008 as part of the professional development program.

As part of EPSCoR's Energy-Environment-Water nexus project we would propose to organize an additional three years of the *Pathways to Inquiry* professional development with a focus on BPS teachers, but open to up to 10 teachers from outside of the BPS district. We would develop an evaluation protocol that would look at gains in teachers' science and pedagogical content knowledge and potentially investigate changes in student knowledge (given enough funding and approval from teachers and school districts). A longer term and potentially interesting question would also be the impact of the professional development on student career choices and workforce trajectories. In the minimum, both the professional development framework for *Pathways to Inquiry* and the evaluation protocol and data may be appropriate for publication in science education journals. We also believe that the *Pathways to Inquiry* program built around the energy-environment-water nexus could be transferable to other EPSCoR institutions, particularly in New Mexico and within the Tri-State partnerships.

BUDGET

We have operated past Pathways for Inquiry project on a range of budgets primarily dependent on the number of days. Expenses include teacher stipends, supplies for teacher participants, evaluator fees, and salaries for instructors and facilitators. A preliminary estimate would be

$100K for a 9 day institute, which includes the cost of evaluation. If EPSCoR provided evaluation services the total would be closer to $80K.

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Appendix

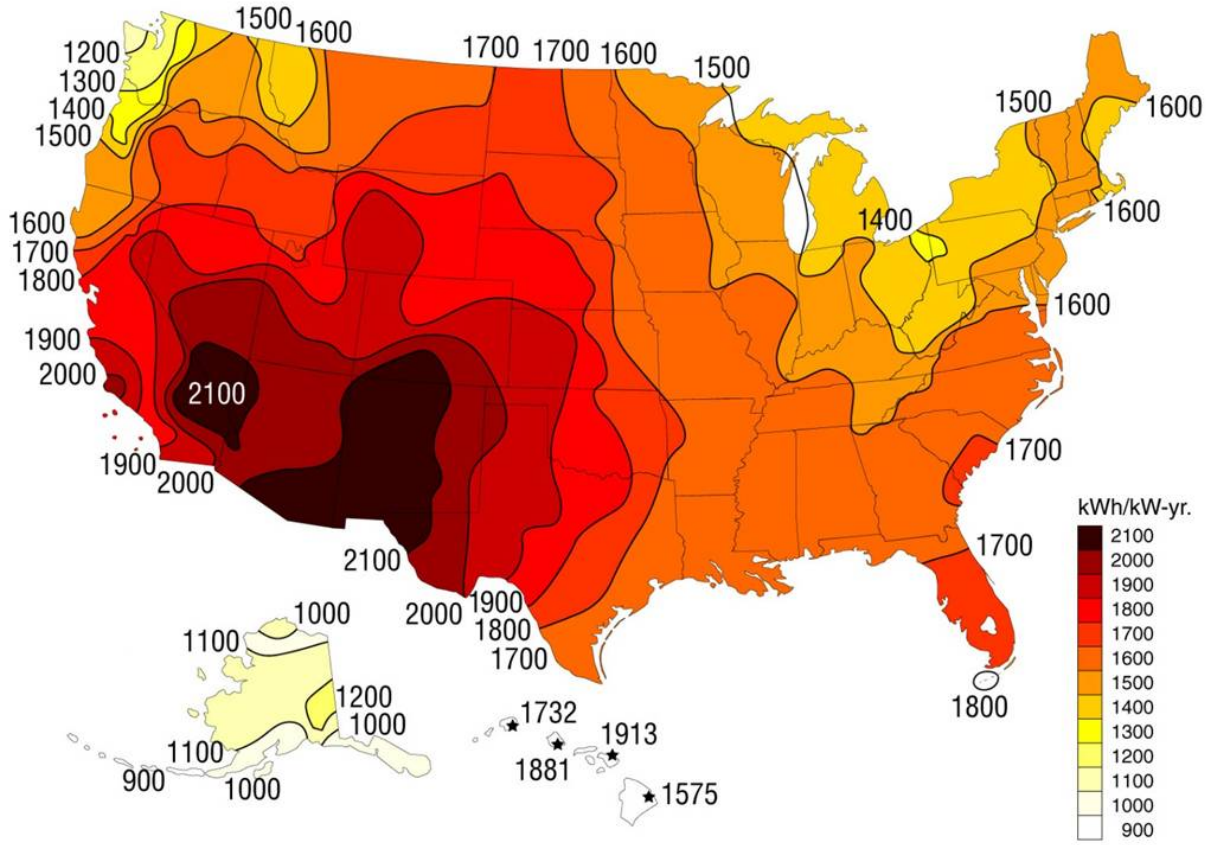

Figure 1

Map of potential solar energy in the United States. Units are in kwh/day per square meter. Compared to the rest of the country, New Mexico has the highest potential for solar energy. (from globalwarming.house.gov)

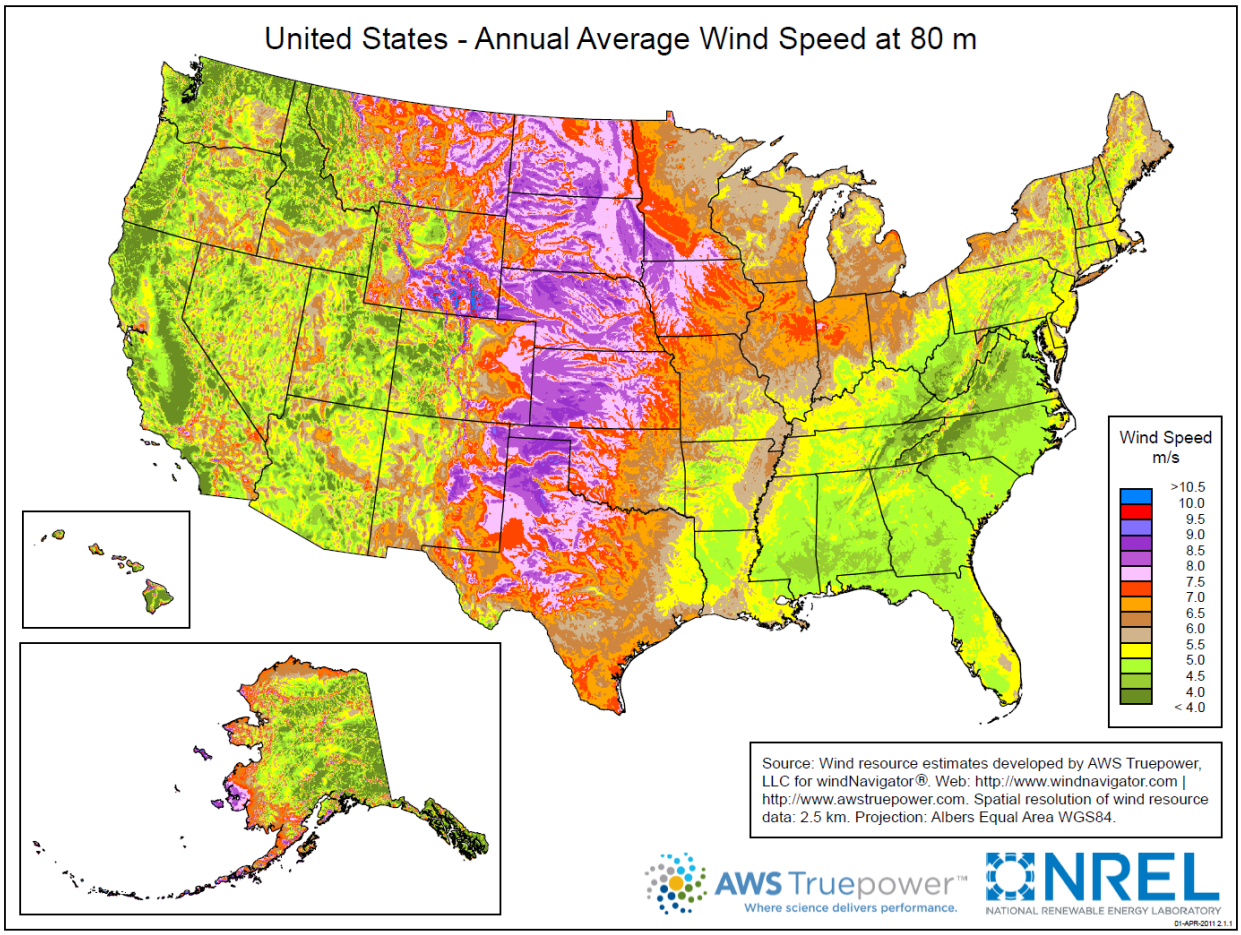

Figure 2

Map of potential wind energy in the United States. Regions within eastern New Mexico have good potential for wind energy development. (from windpoweringamerica.gov)

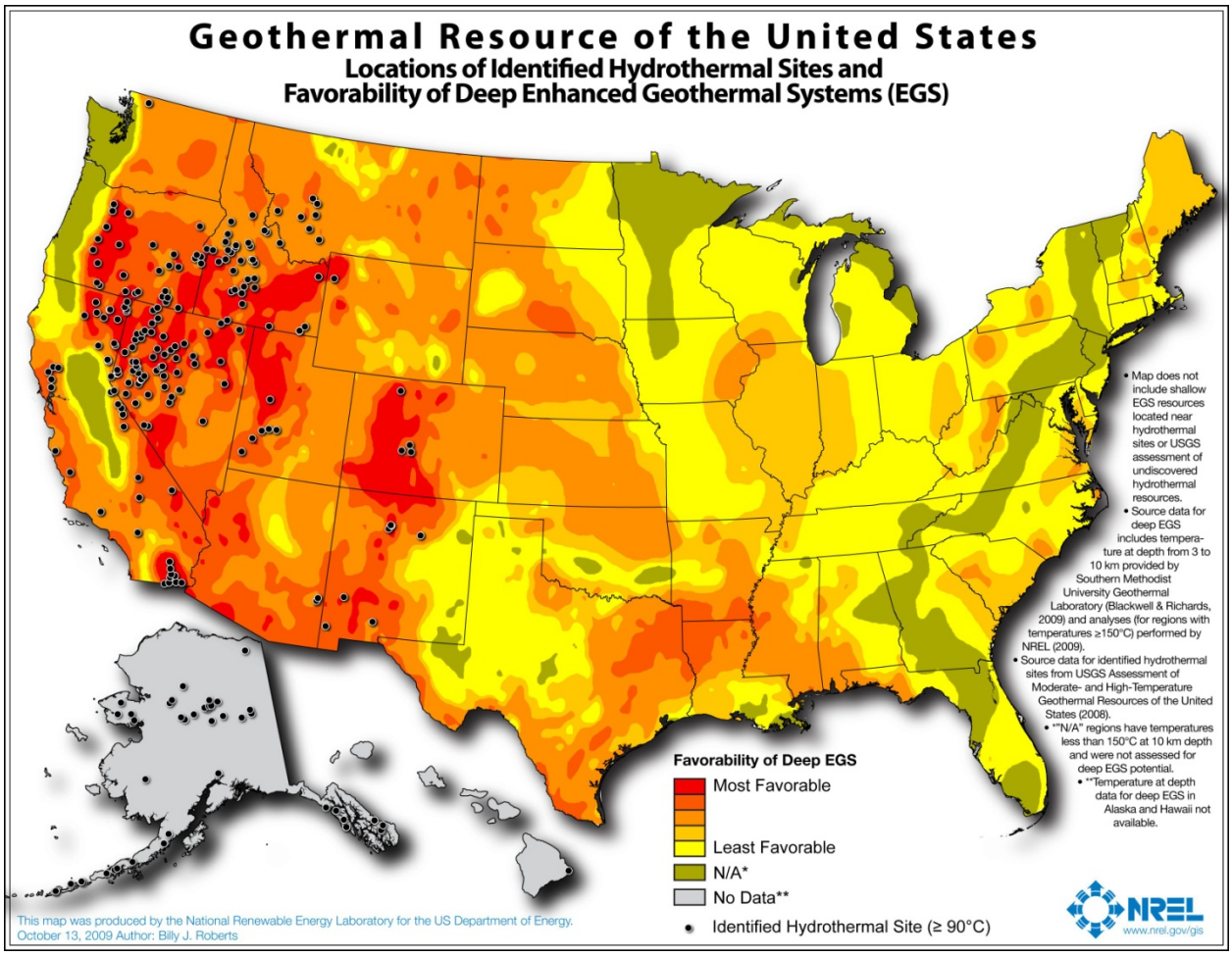

Figure 3

Map of potential geothermal energy. Central New Mexico contains regions considered "favorable" to geothermal energy production. (pennenergy.com)