SCHOOL of SUSTAINABILITY
ARIZONA STATE UNIVERSITY

In Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

Pei Zhai

Will defend her dissertation

Environmental, Policy and Social Analysis of Photovoltaic Technologies

Abstract

Many expect renewable energy technologies to play a leading role in a sustainable energy supply system and to aid the shift away from an over-reliance on traditional hydrocarbon resources in the next few decades. This dissertation develops environmental, policy and social models to help understand various aspects of photovoltaic (PV) technologies.

The first part of this dissertation advances the life cycle assessment (LCA) of PV systems by expanding the boundary of included processes using hybrid LCA and accounting for the technology-driven dynamics of environmental impacts. Hybrid LCA extends the traditional method combining bottom-up process-sum and top-down economic input-output (EIO) approaches. The embodied energy and carbon of multi-crystalline silicon photovoltaic systems are assessed using hybrid LCA. From 2001 to 2010, the embodied energy and carbon fell substantially, indicating that technological progress is realizing reductions in environmental impacts in addition to lower module price.

A variety of policies support renewable energy adoption, and it is critical to make them function cooperatively. To reveal the interrelationships among these policies, the second part of this dissertation proposes three tiers of policy architecture. This study develops a model to determine the specific subsidies required to support a Renewable Portfolio Standard (RPS) goal. The model is based on two forecasting assumptions: future renewable energy installation which realizes the RPS goal and experience curve-based cost reductions. The model is applied to the case study of solar energy adoption in the state of Arizona. The financial requirements are calculated (in two scenarios) and compared with predictable funds from public sources. A main result is that the expected investments to achieve the RPS goal far exceed the economic allocation for subsidy of distributed PV.

Social acceptance plays a role in the adoption of residential photovoltaic and other renewable energy technologies. Even with subsidies there are often challenges with social acceptance. The third part of this dissertation originally develops a fuzzy logic inference model to relate consumers' attitudes about the technology such as perceived cost, maintenance, and environmental concern to their adoption intention. Fuzzy logic inference model is a type of soft computing models. It has the advantage of dealing with imprecise and insufficient information and mimicking reasoning processes of human brains. This model is implemented in a case study of residential PV adoption using data through a survey of homeowners in Arizona. The output of this model is the purchasing probability of PV. It also quantifies the sensitivity of purchasing probability to the perception variables.

November 22, 2010
2:00 – 4:00 PM
ED 236
21 E. Sixth Street, Tempe, AZ 85287

Faculty, students, and the general public are invited.

Supervisory Committee:
Dr. Eric Williams (Chair)
Dr. Patrick Phelan (Member)
Dr. Braden Allenby (Member)