The purpose of this proposal is to seek approval to conduct a feasibility report regarding the remodeling for improved energy efficiency of old, single-family houses in the State College rental market. As the energy standards for new house construction have been increasing over decades, houses built in the past are now comparatively energy inefficient. This proposal will further describe this problem, explain plans to conduct the relevant research, and provide a schedule to complete the proposed report.

Problem Statement

It appears that many houses in State College were built before the 1980s, some perhaps well before then. Since these have been built, new materials and construction techniques have been developed, many of which have been incorporated into the standards for new house construction over the years. These have included, but not been limited to improvements in: insulation for exterior walls and attics, windows, and heating ventilation and air conditioning (HVAC) systems. Unless older houses, which had lower standards during construction, are renovated with newer technologies, they will continue to become marginally more expensive to live in compared to new houses. In addition, the systems themselves in a house are likely to become less efficient with age.

Many houses in downtown State College are on the rental market. In most cases, the tenants are responsible for the energy bills (e.g. electric, heating, and cooling) of the property. The tenants themselves do not have the economic incentive, or perhaps even the permission or ability, to make major renovations on the rental property to decrease their energy bills; this responsibility rests solely on the property owner.

Large energy bills will exist for a house that is older and energy inefficient. We assume that renters will be concerned with the total price (rent and utility bills), so for a house with high energy bills the rental rate will be depressed so that a market-competitive total price results. If a property owner makes renovations on a property that increases its energy efficiency and lowers the renters’ energy bills, the rental rate can be raised and a market-competitive total price will be maintained.

There are no feasible alternatives to renovation for lowering the renters’ energy bills. It is the freewill of the renters as to what conveniences and degree of climate control they wish to have in the house. The unit cost of electricity, heating oil, etc. is set by the utility.

We propose to write a feasibility report for the renovation of old, energy-inefficient single-family houses in the State College rental market for greater energy efficiency. The audience of the report will be owners of properties for which the aforementioned problem is relevant.
Research Plan

The first step in the research will be to learn more about the old houses in State College. It is important for our analysis to know how they were constructed and what systems currently exist in them. We may find, for example, that the walls or attics cannot accept some forms of insulation. We also need to estimate what future energy bills will be, either through estimation based on the characteristics of the houses, or from extrapolating real bills on record. If we find a great deal of information for one or more specific houses, and we determine this information is reasonably representative of those houses in our audience, we may decide to solely use such information for our analysis. Regardless, this will require conducting a survey of house exteriors, and interviews of house owners or of other people who know about the houses. Finally, we must also investigate if there are any local ordinances or permits relating to house renovations, and the availability and price of the various forms of energy in State College.

We will then conduct a thorough literature review on materials and systems that are available for our single-family houses and relevant to energy efficiency. This assessment will be focused on costs, impacts on energy efficiency, and the details of installation. It will be narrowed in scope by any requirements discovered in researching the houses in question.

With the available options for renovations known, we will conduct a feasibility analysis of each of the individual improvements, and several complete renovation projects that we will propose. Our criteria for our feasibility analysis are as follows:

- Is the expected payback period (from increased rental revenue) short enough? Included in costs are any lost rental revenue during renovation, and financing costs.
- Is the risk on total operations with this investment sufficiently small? (Are the capital requirements not prohibitive?)
- If tenants are living in house during renovation, will they be sufficiently satisfied with the living conditions?

We may have to make assumptions and approximations on the combined effect of multiple systems, but we will research for established methodologies.

Our report can be distributed to owners of rental houses on an individual basis. These property owners can be identified through public record. Though our report uses rental income and the duration of rental periods as the basis for analysis, the recommendations would likely be in some way relevant and transferrable to owners of permanent residence houses. Therefore, a more open and public distribution of this report may be justified, especially if it is effective in our target audience.

Schedule

**February 20-27:** Research buildings in State College/Meet with realtor
**February 27-March 2:** Await acceptance of proposal
**March 5-9:** Spring break
**March 12-16:** Do literature review on materials and technologies
**March 19-30:** Perform cost analysis
**April 2-6:** Construct progress report
April 9-20: Compile research into formal report on feasibility of implementing plan
April 23-27: Revise formal report

Qualification

Dr. **** *** *** holds B.S. and M.S. degrees in Materials Engineering from Sungkyunkwan University, Seoul, Korea, and a Ph.D. in Engineering Science from the Pennsylvania State University. Dr. *** is a Research Associate in the Center for Nanotechnology Education and Utilization (CNEU) at the Pennsylvania State University. Before joining CNEU, Dr. *** worked as a Research Director in Solarity LLC, and led a research team in developing solar cells using nanotechnology. Dr. *** has extensive knowledge and experience in the research area of renewable energies. He holds several patents and is author of a number of research articles in the field of solar cell technology.

Mike **** is pursuing a B.S. in Materials Science and Engineering at the Pennsylvania State University studying polymers, an important material used in insulation. Recent projects Mike has worked on were related to energy efficient remodeling and this project will extend the study to the State College area.

Scott **** is in the Schreyer Honors College and an Integrated Undergraduate/Graduate student in Meteorology at the Pennsylvania State University. Scott is currently working in two research projects relating to numerical weather prediction and climate modeling respectively. Largely separate from his major-related work, Scott has a strong interest and working knowledge in energy and finance.

Conclusions

Success in the renovation of old houses will make them more competitive in rental market since it will not only reduce the utility bills but also offer more comfortable living environment. Our report based on the proposed feasibility studies will give more detailed ideas about the renovation to owners of properties, and help them to make their decision on whether or not to do the proposed renovation.