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A solution to mitigate the ever-growing challenge of climate change is only about 149.6 million kilometers away - literally.

The energy from the fiery, radiant star at the center of our solar system - the sun - already supports almost all life on Earth, so why not harness that power and create renewable energy to help soften the blow of fossil-fuel emissions on the environment? Scientists at four local universities are doing just that.

A Solar Consortium comprising of a team of scientific experts from N.C. A&T State University, Wake Forest University, Winston-Salem State University and UNC Greensboro is working on a project to significantly reduce the cost of generating electricity from sunlight, while also conserving as much heat energy as possible in the process.

'It takes highly specialized experts and highly specialized equipment to solve some of these problems,' said Barry Burks, the vice chancellor for research and economic development at N.C. A&T. 'This project proposes to develop a system for collecting sunlight and converting that to power that is cheaper than the conventional solar farms you see installed currently.' Burks said the most expensive components of solar farms are the photovoltaic panels composed of solar cells that convert the energy of sunlight directly into electricity.

The team's specific goal is to develop a low-cost solar concentrator device that will be more economical and energy efficient, said Richard Williams, the Reynolds professor of physics at Wake Forest, who spearheaded the group's formation. The consortium is in its second year and Phase 2 of the project, which was one of three finalists for a $100,000 Triad Interuniversity Planning Project Grant. Each school provides $25,000 in financing for the project. The project received $100,000 during Phase 1 as well.

The team's first priority is to collect the sunlight in a more cost effective way, Burks said. The second priority is to capture the leftover waste heat and convert that into usable energy. To accomplish these goals, the scientists at each school are focusing on a specific component of the solar concentrator system, which will be ideally integrated into a final prototype next year by the end of Phase 2, Williams said.

'Lots of people are interested in doing something about the energy problem,' Williams said. 'We put this together as a way that people with certain expertise can come together under one roof and see if we can fit certain pieces of the puzzles together.'

Different components

The team at WSSU - Lei Zhang, associate chemistry professor, and Wyndham Wilkinson, plastics manufacturing consultant - is focusing on creating parabolic mirrors that would concentrate and focus the sunlight light onto high efficiency, double- or triple-junction, photovoltaic cells.

The researchers are also working on multiple ways of developing the concentrated mirrors, to make them more economic and efficient. They are working with two local companies - 3A Composites of Colfax and Slane Marine in High Point - to possibly use a fiberglass core composite, through a molding process, to create the mirrors. They are also working with 3M on a thin film solar reflector to apply to the mirror, Williams said.

At A&T, Shanthi Iyer, research professor in electrical and computer engineering and nanoengineering at the Joint School of Nanosciences and Nanoengineering, is researching high efficiency solar cells, including triple-junction cells. The cells sit in the middle of the dish, and the mirrors allow the sunlight to directly hit the cells.

'The idea of the concentrator is instead of a large area of cells, you concentrate the light onto small area,' Williams said. This saves money by using fewer cells, and saves energy by using more efficient photovoltaic cells.

Researchers at Wake Forest are Williams; David Carroll, director at Wake Forest's Center for Nanotechnology

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and Molecular Materials; Abdou Lachgar, chemistry professor; and Keerthi Senevirathne, a postdoctoral fellow at Wake Forest's Center for Energy, Environment and Sustainability.

Williams said these scientists are focusing on researching two different technologies: thermoelectric recovery and watersplitting for energy recovery and storage.

'This is a special project that is aiming at energy storage and dealing with nights and cloudy days,' Williams said. One problem with solar energy is that it is not readily available 24 hours a day and can be weather-dependent. Instead of a photovoltaic solar cell, a cell with watersplitting technology could be placed in the dish. The cell would use concentrated sunlight to split water molecules into hydrogen and oxygen to create electricity.

Researchers are working on methods of storing the electricity on site so that it can be used at night or on cloudy days, Williams said. In addition to either a photovoltaic or water cell in the dish, the group is also considering the use of fuel cells and splitting carbon dioxide molecules to possibly create fuel, Williams said.

Williams said Carroll is also doing a lot of solar cell work but focusing on methods of recovering the waste heat. Once the sunlight hits the cell in the concentrator dish, there is still heat energy leftover that often goes to waste. The team is trying to harness this waste heat as well through the use of a Stirling engine and possibly a thermoelectric box.

Stirling engines are not like a typical car engine. A fixed amount of a gas is sealed inside the engine and a series of events changes the pressure of the gas inside the cylinders, causing a piston to do work.

'It's an engine, but no material goes in and no material goes out. There is no fuel going in and no exhaust coming out; it's just heat,' Williams explained.

'They're quiet and they just run. It seems perfect for waste heat recovery; literally, it just runs on sunshine.' The engines are not readily available commercially and are expensive, Williams said. The researchers are in discussions to partner with Cool Energy Inc., a company in Boulder, Colo., that produces low-temperature Stirling engines.

The researchers at UNCG - Ray Purdom, director of the Lilly Conference on College and University Teaching in Greensboro, and Liam Duffy, assistant professor of chemistry and physics - are mainly researching the Stirling engine, as well, Williams said.

End Goals

The team hopes to determine the components they plan to use for the solar concentrator by the end of next year and to build a prototype, Williams said.

The team also has a goal of educating others about the technology, which they hope to accomplish by allowing the students at the universities to follow the development of the project. The next of step of the project will be to acquire more financing.

'Hopefully, this project will be successful to lead us to a bigger proposal,' Zhang said.

Burks said the team plans to submit a proposal to the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy for grant financing and will also seek out venture capitalists.

Burks said another goal is to create jobs and benefit the economy.

'If we're successful with this project, it also means that it would create jobs. We would hope to spin off companies or license technology to existing companies in the state. That would be creating jobs, but also creating energy at lower cost,' he said.

'One of the reasons that this project was chosen is that it does have the potential for high impact on the economy of our local community.'

Global Impact

Working in a consortium allows the scientists to share resources and combine ideas, Burks said.

'None of the four universities would have taken this on independently, and the collaboration has been critical to the success of the project,' he said. 'What you're trying to do is solve a multidisciplinary problem and come up with an integrated system, so you need to have collaboration.' Carroll agreed. 'This is a big problem. Creating the kind of power that you want is difficult to do, so having groups of people that constantly question each other, that's a good thing to do, it's the way that good science is done,' he said.

Williams said that all the scientists involved had an interest in renewable energy and developing technology to help combat climate change.

'All of us involved are energy conscious enthusiasts,' he said. 'Climate change is one thing, but carbon dioxide concentration is something that has been measured and is increasing. Even if you want to argue about other things responsible for the warming, the reason for carbon dioxide increase is pretty dead certain to us.' Burks said the project could help the country become more energy independent.

'Right now there's a tremendous dependence on imported oil, and any opportunity we have to reduce our dependence on external sources of oil is good thing for the security and economy of the country,' he said.

'Secondly whether you believe in what's happening to the climate and the impact that burning fossil fuels has on the ozone layer, whether you believe all that or not, it's inescapable that burning coal puts pollutants in air - and I'm a nuclear proponent but it has its drawbacks as well - so it's hard to come up with an energy source other than solar or wind that has as small of a carbon footprint.' Williams said he is hopeful the consortium can solve the major problems with solar energy.

'We're doing research at a time that with a little bit of tilting and realization we ought to be able to do something and have an impact in the energy area.'

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