Powerful Conversion

OSU research plays pivotal role in biomass-based fuels

In Oklahoma and other parts of the Midwest, gasoline prices have been skyrocketing this year. And as gas prices go, so go the prices for just about everything else, boosting the general cost of living.

So to start at the beginning of the cycle: How do we lower or at least stabilize the cost of that fuel? Research at Oklahoma State University's Biobased Products and Energy Center suggests that biomass-based fuels could be the answer.

"In 2009, the U.S. Environmental Protection Agency predicted that 85 percent of the production of dedicated energy crops such as switchgrass and forage sorghum in the U.S. would occur in Oklahoma by 2022," says HASAN ATIYEH, assistant professor of bioprocessing and renewable energy in OSU's Department of Biosystems and Agricultural Engineering. "The use of Oklahoma's biomass for biofuels can improve profitability for farmers, enhance local economies, attract capital ventures and improve energy security of the U.S."

This leading-edge research is gaining national attention as Atiyeh and his colleagues at OSU and the University of Oklahoma have discovered new microorganisms for the production of drop-in biofuels including propanol, butanol and hexanol. These higher alcohols can be converted with chemical catalysts to produce renewable gasoline, diesel and jet fuels.

"We are advancing the hybrid gasification-syngas fermentation conversion technology," says Atiyeh. "My group and collaborators from OU have discovered microorganisms that can convert synthesis gas (also called syngas) to butanol, a C4 alcohol, and hexanol, a C6 alcohol, that are considered as drop-in fuels to replace exiting petroleum-based fuels."

LEADING THE FIELD

These findings, along with the development of methods that significantly sustain culture activity, gas uptake and improve selectivity for alcohol production during syngas fermentation, have placed Atiyeh and his team at the top of this field.

"Syngas contains mainly carbon monoxide, hydrogen and carbon dioxide that can be converted using microbial catalysts in our novel process to alcohols, organic acids and other chemicals," says Atiyeh. "The new method resulted in the production of 26 times the ethanol concentration compared to the conventional method."

This could have a significant impact on U.S. energy production, but many challenges still exist.

High capital costs and technological obstacles are hindering the development of a viable biorefinery industry.

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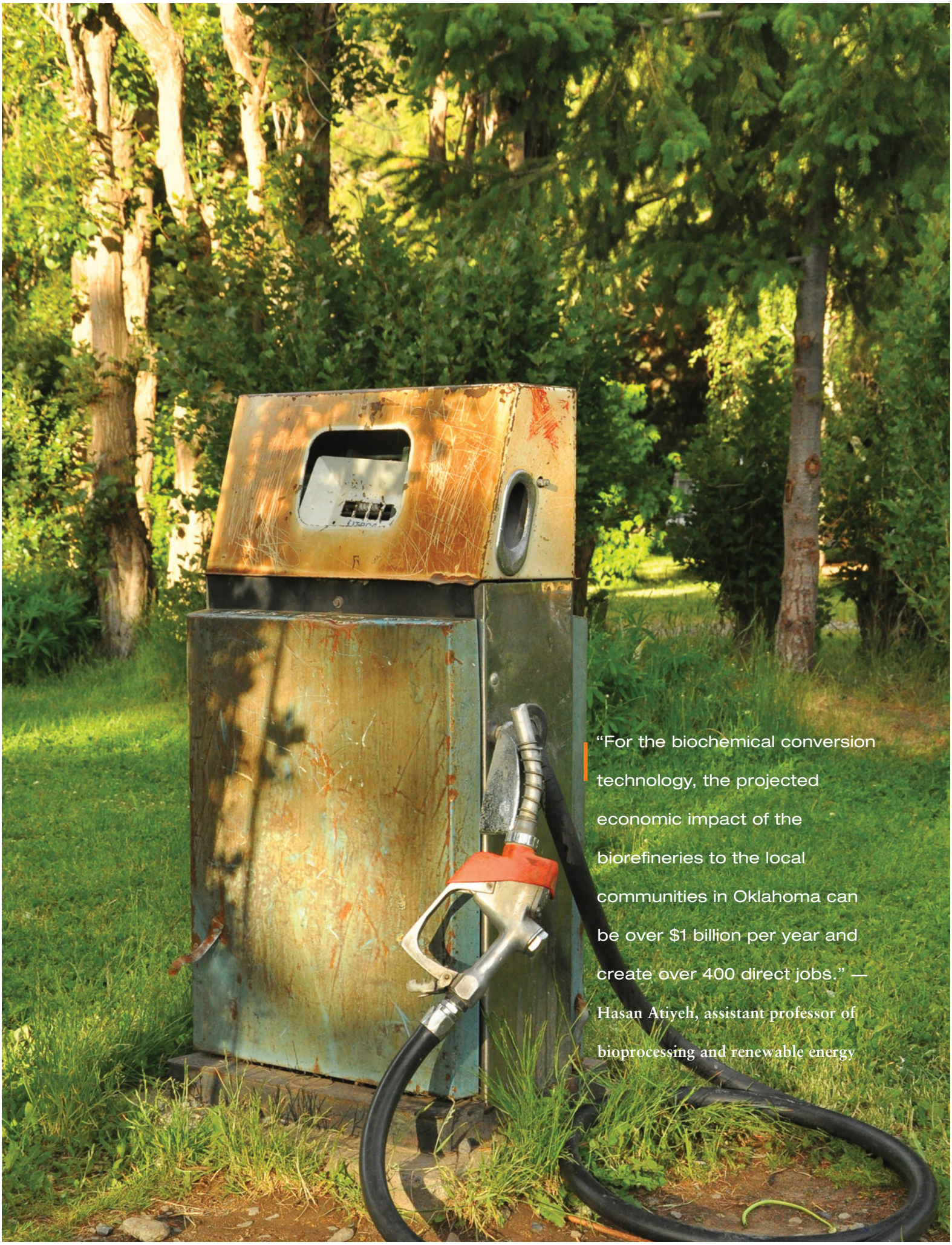


"For the biochemical conversion technology, the projected economic impact of the biorefineries to the local communities in Oklahoma can be over $1 billion per year and create over 400 direct jobs." — Hasan Atiyeh, assistant professor of bioprocessing and renewable energy

"Challenges in biochemical conversion include the high cost of pretreatment and enzymes and the lack of microorganisms that can efficiently co-ferment C5 and C6 sugars," says Atiyeh. "In comparison, the major challenges for the hybrid conversion technology are mass transfer limitations due to low gas solubility in the medium, low cell productivity, enzyme inhibition and the high cost of fermentation media."

The biochemical conversion technology that Atiyeh and his team are creating has the potential to produce butanol with yields 20 percent higher than traditional ABE technology.

"We are also leading the way towards the development of the gasification-syngas fermentation hybrid technology," says Atiyeh. "My research team at OSU is a nationally recognized leader in developing the hybrid conversion technology. We are also developing cutting edge technologies that will speed the deployment of viable integrated biorefineries internationally."

ENERGY CENTER'S IMPACT

This novel research is possible through the Biobased Products and Energy Center at OSU. With strong support from state and industry leaders, the generation of new technologies and products through this center can result in large economic returns to Oklahoma and the energy sector.

"For the biochemical conversion technology, the projected economic impact of the biorefineries to the local communities in Oklahoma can be over $1 billion per year and create over 400 direct jobs," says Atiyeh. "To realize this benefit, the novel biocatalytic conversion process for butanol production would need to be implemented widely."

The opportunities are immense in this area of research.

Atiyeh hopes to keep expanding his research with existing biomass conversion technologies to drop-in fuels and chemicals. One future goal is to focus on the production of renewable hydrocarbon fuels from biomass and waste materials, says Atiyeh.

"We are focusing on the production of bio-oil from biomass to hydrocarbon fuels," says Atiyeh. "Hydrocarbon biofuels are similar to gasoline, diesel and jet fuels that are compatible with the existing fuel infrastructure."

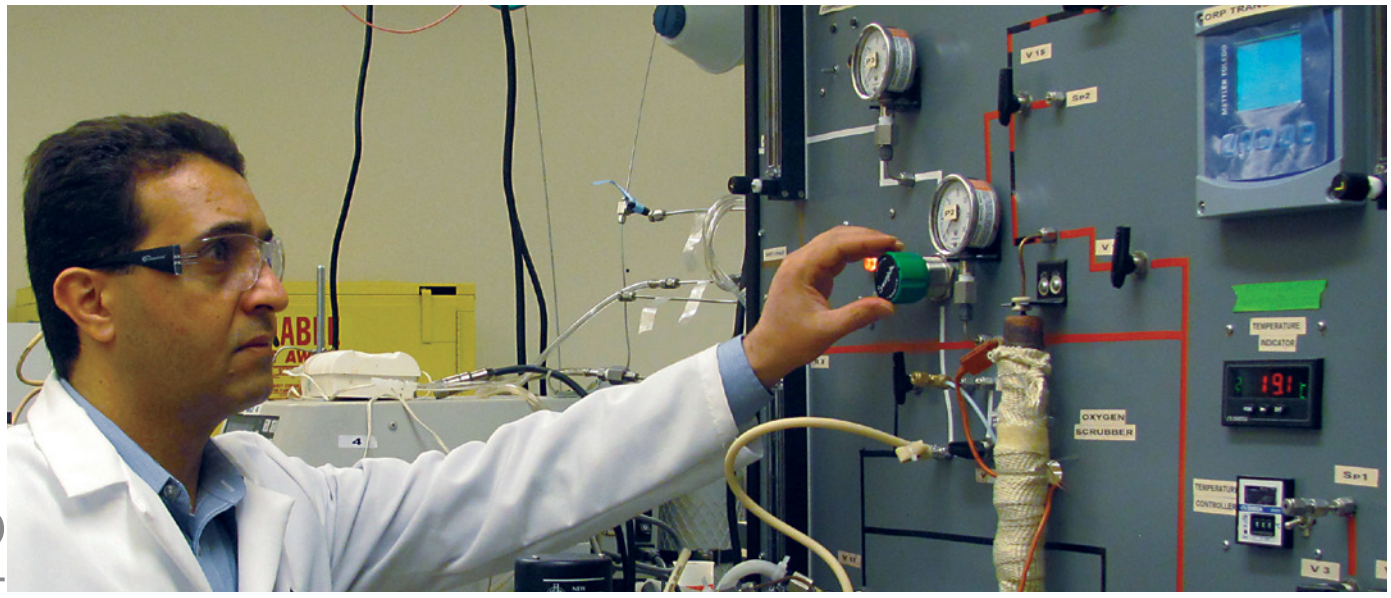
Once complete, this hybrid technology could provide 35 percent more ethanol from the same amount of biomass compared to the biochemical conversion technology.

"We are optimizing operation of various reactor designs to enhance mass transfer and alcohol productivity," says Atiyeh. "We are also developing tools to facilitate designing and control of large-scale bioreactors with increased alcohol productivity and gas utilization to make the hybrid conversion process more economically viable for the production of biofuels."

Atiyeh says using this hybrid technology to produce even 25 percent of the federally mandated 16 billion gallons per year of renewable transportation fuels such as ethanol could result in savings of more than $650 million per year.

WRAVENNA BLOOMBERG

Hasan Atiyeh's projects include evaluating bioreactors to enhance mass transfer and alcohol productivity.



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