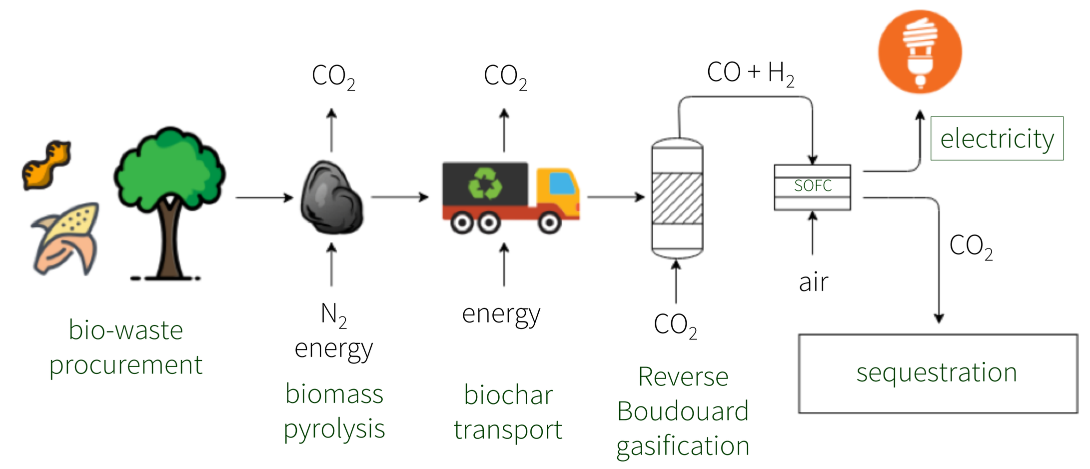
BACKGROUND

Nearly all techno-economic models that achieve the 2°C Paris climate goal require bio-energy with carbon capture and storage (BECCS), a negative emission technology that is neither well-developed nor widely deployed. The most common BECCS model is combustion of biomass in traditional power plants followed by separation and sequestration of the exhaust CO2. Our modified BECCS model is less carbon-intensive, coupling biomass waste pyrolysis with CO2 gasification (Reverse Boudouard) to generate synthesis gas for a solid oxide fuel cell (SOFC). The CO2 generated by the SOFC requires lower separation costs than traditional carbon capture and sequestration. The goal of this work is to investigate different waste biomass as feedstocks for this process.

ENVISION AN ALTERNATIVE BECCS



METHODS

Biochar was prepared by flash heating biomass under N_2 flow in a tube furnace. Tube furnace pyrolysis was mimicked in a thermogravimetric analyzer (TGA) to observe pyrolytic behavior of biomass via differential thermogravimetry (DTG). Reverse Boudouard gasification was analyzed via TGA.

PISTACHIO COCONUT WALNUT

RESULTANT BIOCHAR

CONCLUSIONS+ FUTURE WORK

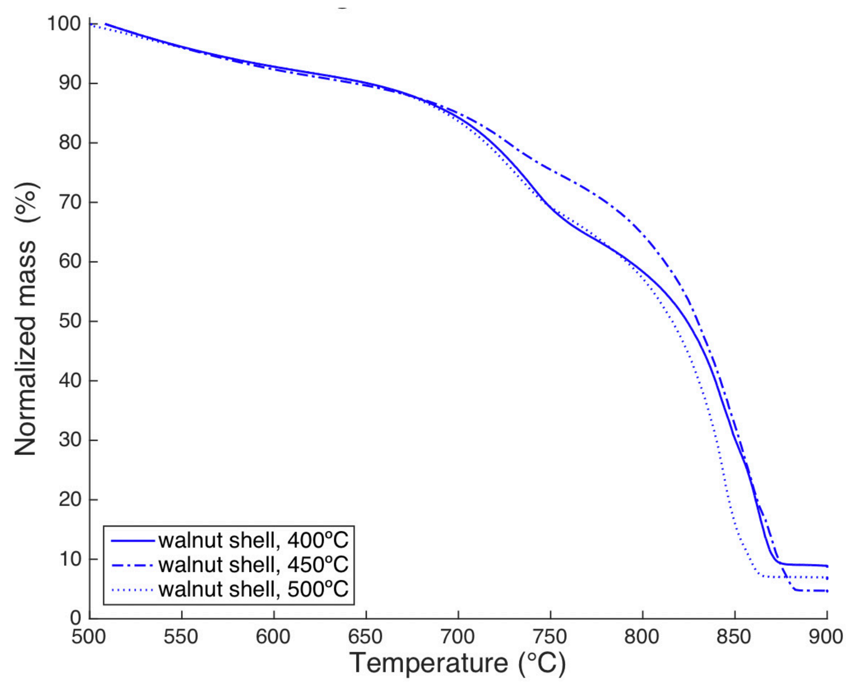
We can successfully generate biochar from common food waste and can successfully generate synthesis gas, a viable fuel for SOFC. The conditions favoring gasification lie within operating range of SOFC. The driving factors for biochar reactivity are biomass structure and, more importantly, inorganic content. Gasification is complicated and biomass structural composition is only a good indicator of reactivity when other factors are constant. Inorganics speed up gasification but will hinder the overall process.

Future plans include answering the following questions: What will our gasification reactor look like?
Which inorganics are most active?
What other feedstocks can we test?
How will they change at scale?
Can this proposed alternative stand up to traditional BECCS?

PYROLYSIS + CO2 GASIFICATION OF BIO-WASTE AS A PATHWAY TO CARBON NEGATIVE ELECTRICITY

RESULTS

REVERSE BOUDOUARD GASIFICATION OF WALNUT SHELL BIOCHARS



HOW DOES PYROLYSIS TEMPERATURE AFFECT BIOMASS YIELD?

Results indicate that yield increases with decreasing pyrolysis temperature.

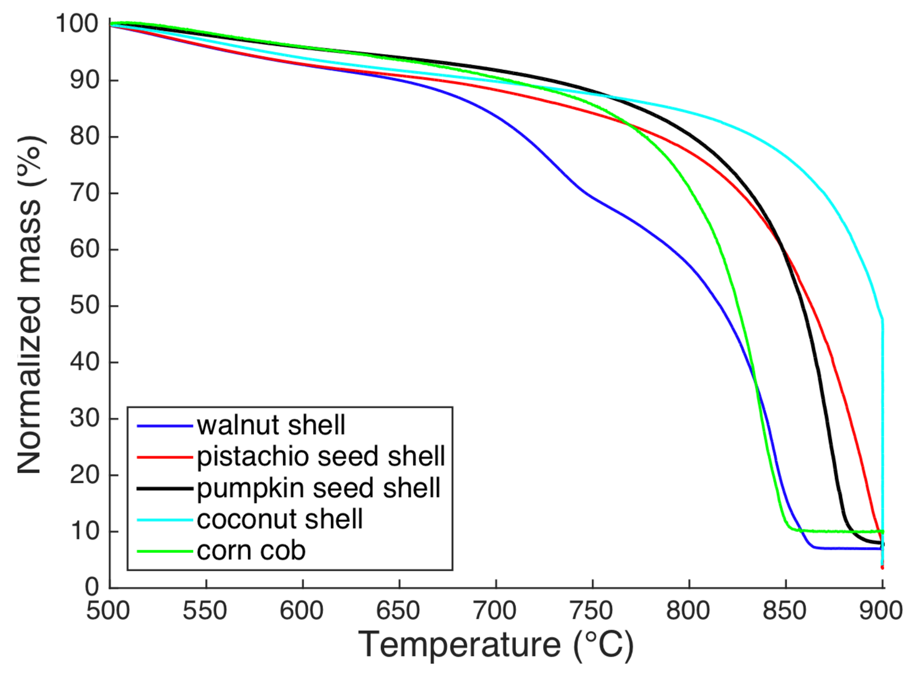
DOES PYROLYSIS TEMPERATURE AFFECT GASIFICATION REACTIVITY?

Thermogravimetric analysis of biochar during RB gasification shows that reactivity is not affected by pyrolysis temperature.

	Mass Yield		
Sample	**400°C**	**450°C**	**500°C**
Walnut	31.6%	32.5%	23.5%
Pistachio	28.9%	23.0%	21.7%
Coconut	33.1%	31.6%	28.2%
Pumpkin	34.3%	32.6%	28.7%
Corn cob			25.2%

FEEDSTOCK VARIABILITY

COMPARING REVERSE BOUDOUARD GASIFICATION OF DIFFERENT BIOCHARS



ASH CONTENT

WHAT DIFFERS BETWEEN THESE FEEDSTOCKS: ASH CONTENT

Ash remaining after gasification (unreacted material) is a good indicator of inorganic content of biochar.

Inorganics (alkali and alkaline earth metals—Ca, Na, K) have been shown to catalyze the Reverse Boudouard reaction.

Measured ash content as percentage of biochar sample remaining after gasification.

Biomass	Calculated ash content (%)
Corn Cob	8.7
Pumpkin Seed Shell	7.0
Walnut Shell	6.2
Coconut Shell	3.9
Pistachio Shell	3.3

MAXIMUM CONVERSION RATE V. ASH CONTENT