Hydrothermal Liquefaction

Green waste = Green Energy

Presenter: Joelis Velez Diaz
Advisors: Heather LeClerc, Michael Timko, Alex Maag
Chemical Engineering, Worcester Polytechnic Institute

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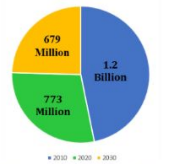
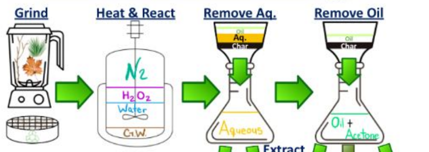
Social Impact

- SDG #7: **"Ensure access to affordable, reliable, sustainable and modern energy for all".**
- The project will also shape high schoolers in chemistry as the lab experience was transformed into a **lesson plan for interactive learning**.



Yard trimmings 2018: 35,400,000 tons

Transformation of Energy



Analysis After Extraction:

- Total Organic Carbon (TOC)
- Gas Chromatography-Mass Spectrometry (GC/MS)
- Characterization of Char & Oil

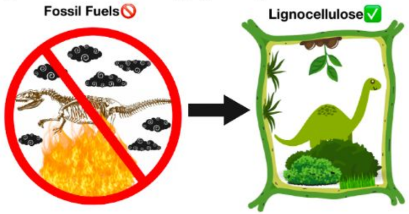
Discussion

Reactions	20min	60min
275°C	35.9wt%	29.8wt%
300°C	33.1wt%	25.9wt%
325°C	24.5wt%	21.5wt%
350°C	26.5wt%	N/A

The results demonstrate that the **procedure can be carried out at a lower temperature**, it will be more **energy efficient, economic, and less time-consuming**.

Green Waste and HTL

The Hydrothermal Liquefaction (HTL) process that was used is **sustainable, economically viable, and non-polluting**, thus allowing to **produce bio-oil** (clean energy) from energy-dense green waste feeds (yard clippings and agricultural waste).

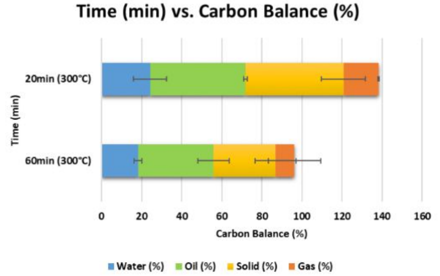


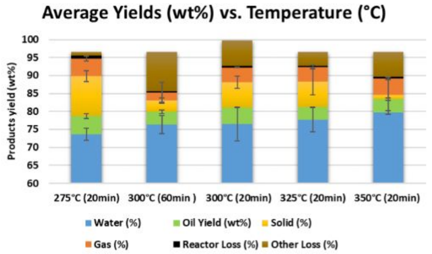
The HTL phases were characterized to determine the best conditions to **maximize oil production and quality**. Various reaction times and temperatures were also evaluated, to **achieve an optimal system**.

In the reaction Hydrogen Peroxide (the catalyst) acts as an **oxidant** to reduce the amount of char and produce more oil! More H_2O_2 results in gasification to CO_2

$$H_2O_2 \rightarrow H_2O + O^{2-}$$

Increasing Oil Yield and Quality





Future Work

Continuous research to achieve the most efficient system:

References

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3. *Lignocellulose.* Lignocellulose - an overview | ScienceDirect Topics. (n.d.).From https://www.sciencedirect.com/topics/engineering/lignocellulose#:~:text=Lignocellulose%20energy%20is%20a%20carbon%20resource%20that%20is,the%20dependence%20on%20fossil%20resources.%20%284%29%20Cleaning%20performance.
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Acknowledgements

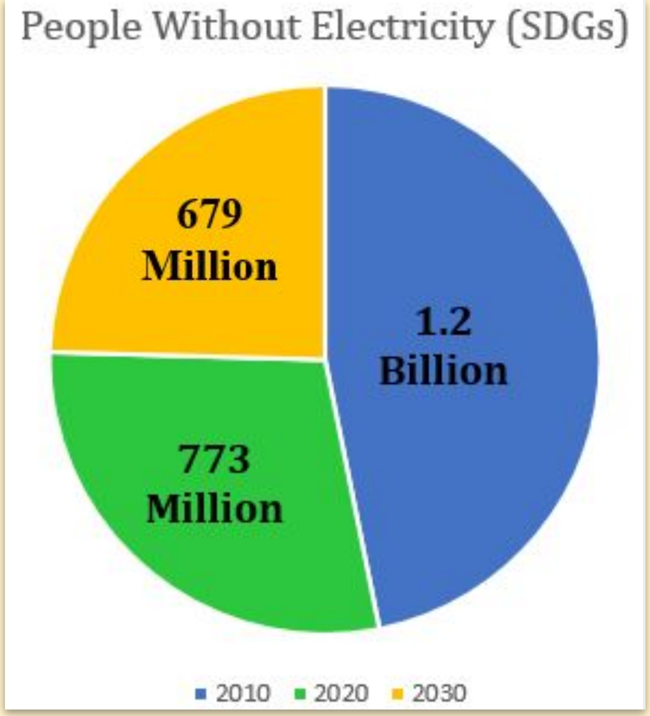
- Thank you: Advisors, CHE partners, RET fellow teachers and staff, for all the help and guidance.
- This material is based upon work supported by the National Science Foundation under Grant No. EEC-2055507.

Social Impact

SUSTAINABLE DEVELOPMENT GOALS

7 AFFORDABLE AND CLEAN ENERGY

Ensure access to affordable, reliable, sustainable and modern energy for all



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WPI Teacher Preparation Program

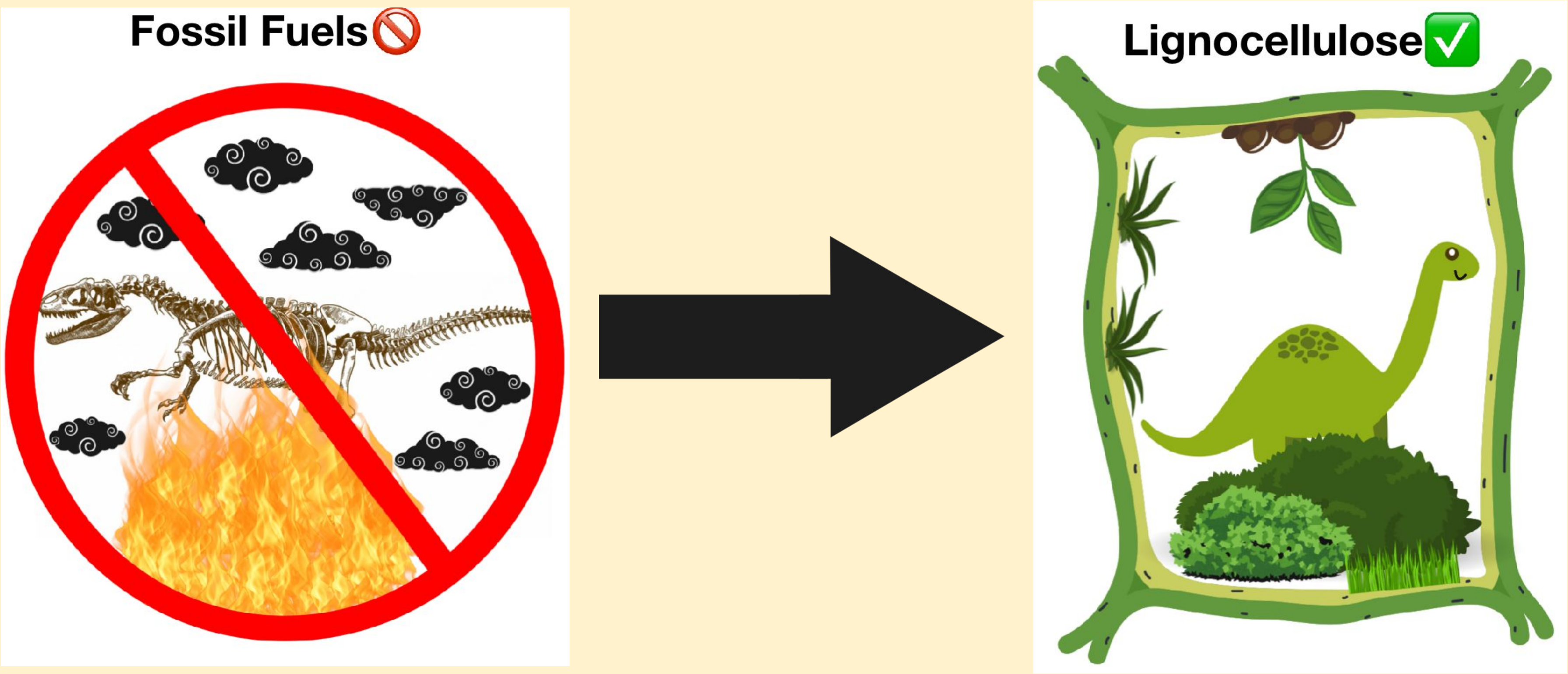
- The project will shape high schoolers in chemistry.
- The lab experience was converted into a **lesson plan for interactive learning**.



Green Waste and HTL

GO GREEN

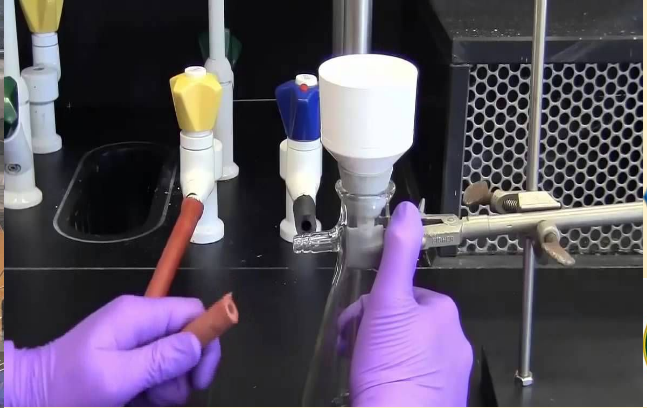
Sustainable Process



Reaction:

$$H_2O_2 \rightarrow H_2O + O^{2-}$$

Phases HTL Produces:

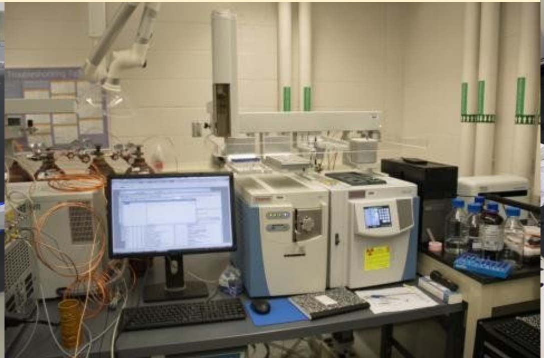


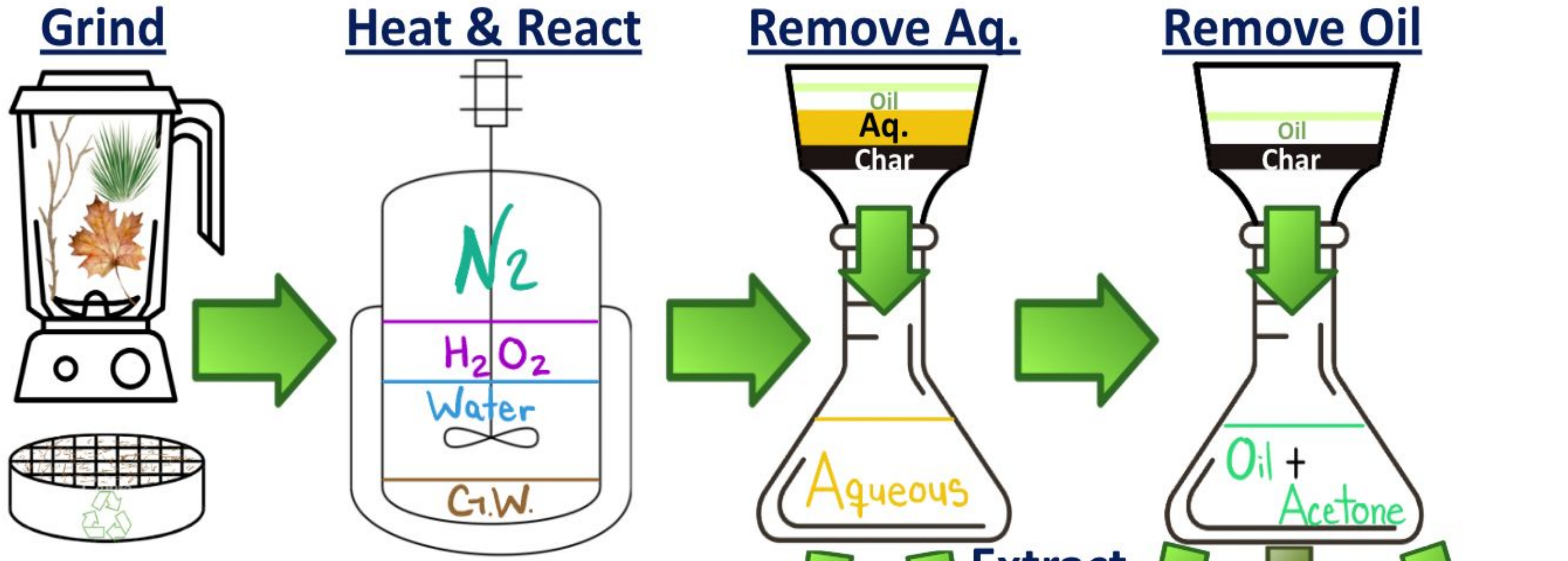
Timko Lab

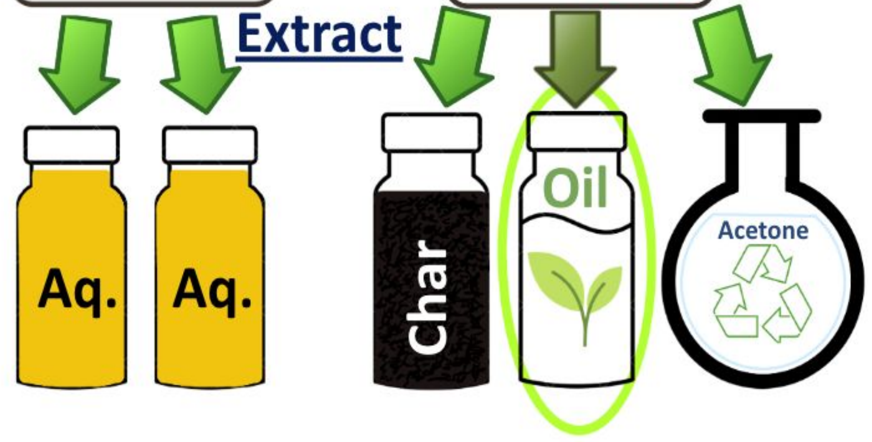
MIDWESTMICRO lab

U.S. DEPARTMENT OF ENERGY

Transformation of Energy







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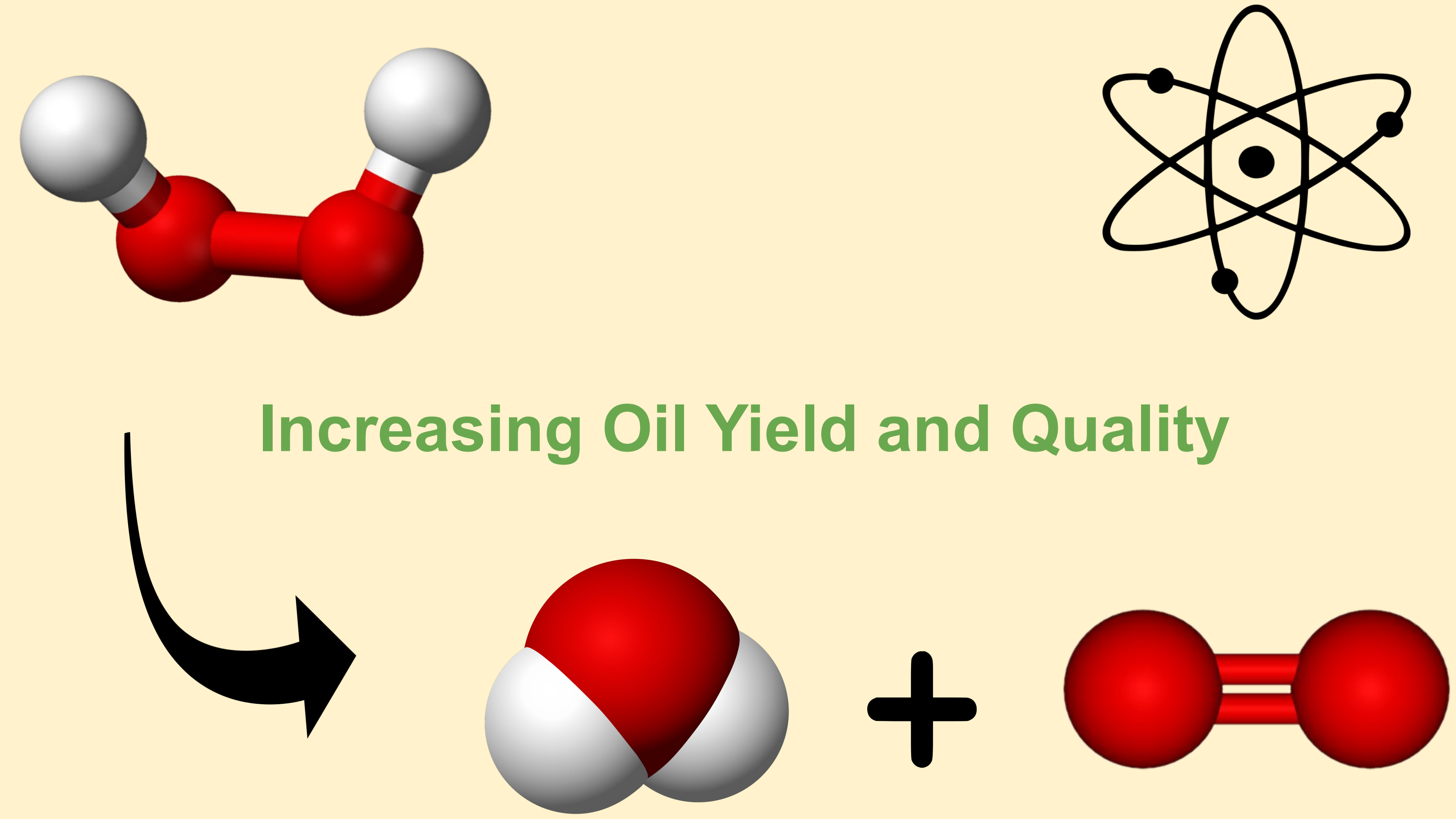
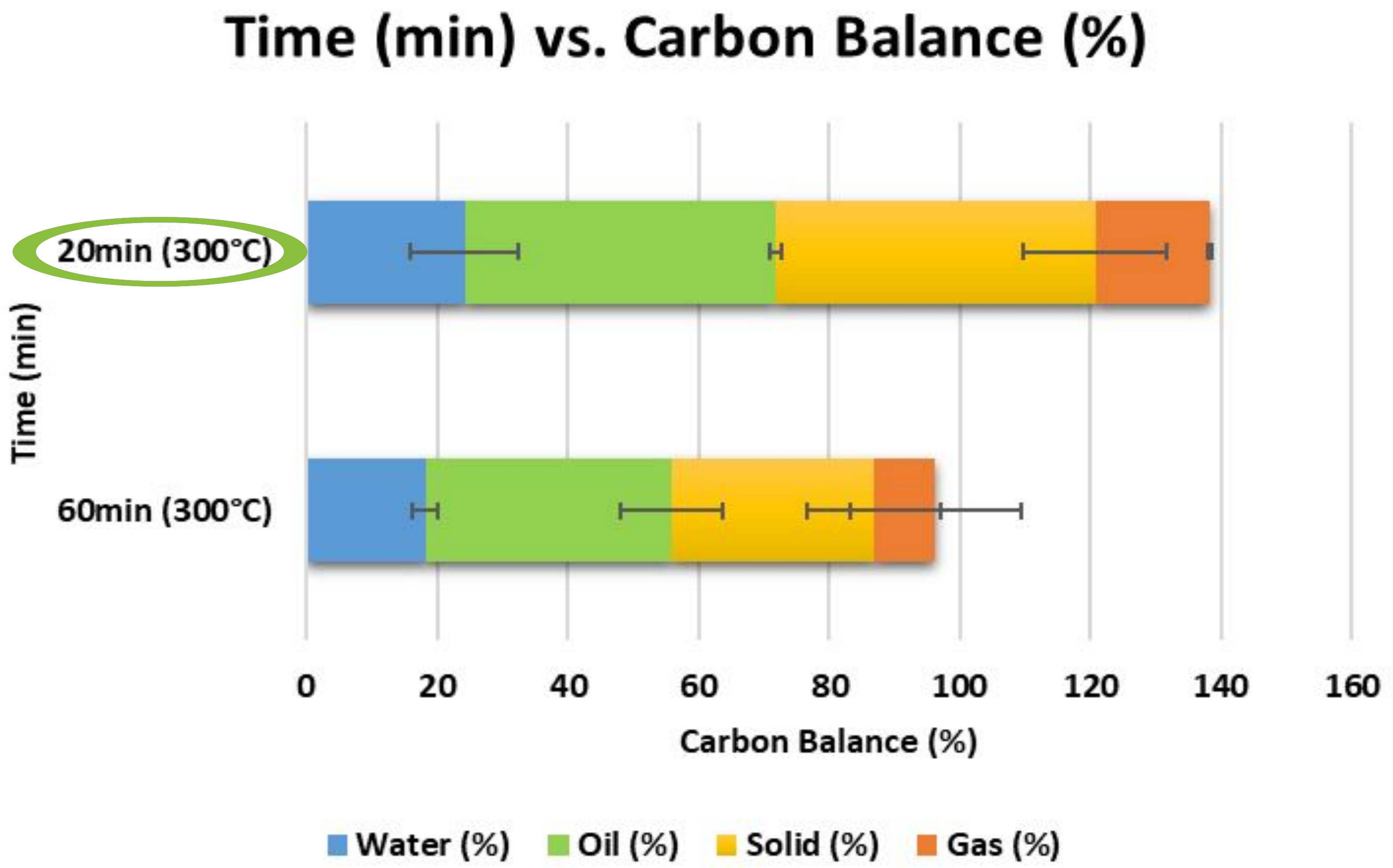
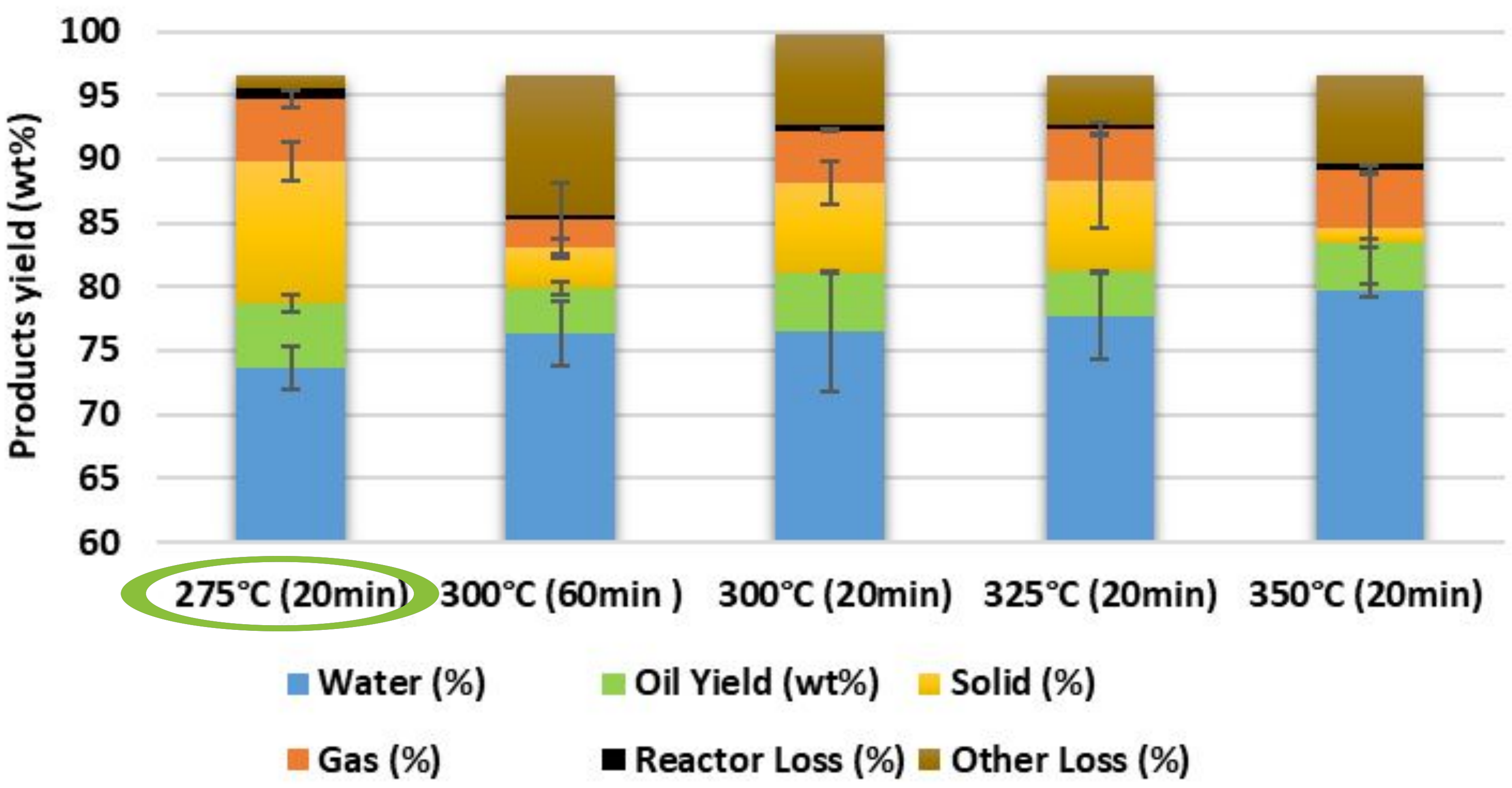
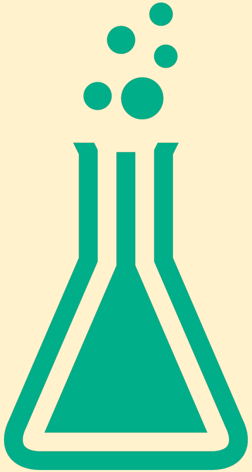

Increasing Oil Yield and Quality


Time (min) vs. Carbon Balance (%)
20min (300°C)
60min (300°C)
Time (min)
0
20
40
60
80
100
120
140
160
Carbon Balance (%)
Water (%)
Oil (%)
Solid (%)
Gas (%)

Average Yields (wt%) vs. Temperature (°C)





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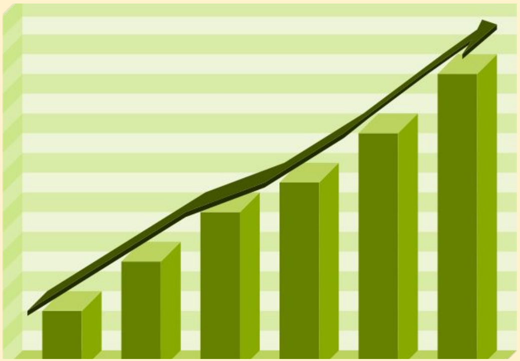
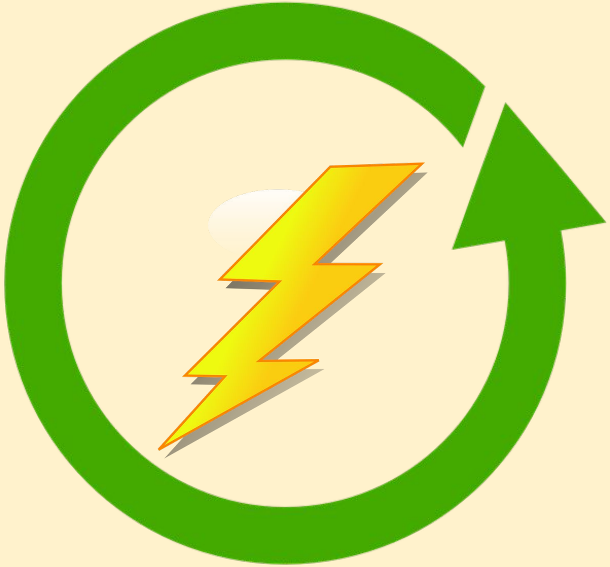
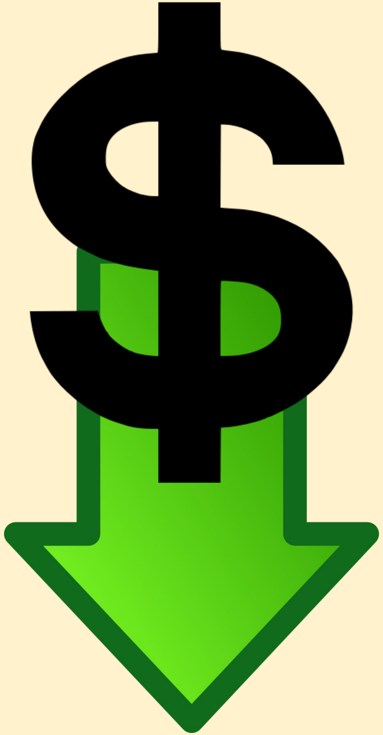
Future Work



Lower Temperatures



Lower cost



Shorter reaction time

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