As our world’s energy demands are rapidly increasing, sustainable energy sources are in high demand due to the indication of the adverse climate effects caused by the various byproducts of fossil-fuel combustion. These byproducts form hazardous compounds in Earth’s atmosphere that lead to the contamination of water, air, and soil; causing human-health hazards, destruction of forests and agriculture, and increased corrosion. For this reason, renewable energy sources, such as solar, tidal, and wind, are growing in interest due to their sustainable, emission-free nature; however, an efficient means to store this energy is necessary in order to fully utilize these transient energy sources. Electrical-energy storage devices such as batteries and capacitors are a common way to store the energy harvested by these renewable sources. These devices are then used to cleanly power consumer products such as electronics and electric automobiles. Capacitors currently exhibit lower energy storage capabilities than batteries, but deliver the energy faster with longer stability. I will be investigating the enhancement of energy storage for capacitor applications in order to quickly deliver high amounts of energy with long-term stability.

There has been a lot of research conducted on nanoscale Carbon for efficient electrical-energy storage materials, and this study plans to investigate how to maximize the energy and power of nanostructured Carbon materials. This will be achieved through using novel Earth-abundant metal complexes to act as molecular spacers for nanostructured Carbon. These novel complexes will effectively sandwich between individual Carbon nanoparticles by binding to the surfaces and will act as spacers by preventing complete aggregation. Aggregation is common for these Carbon materials, and preventing aggregation will increase porosity and surface area. This is important because the amount of energy that can be stored is directly proportional to the accessible surface area. Increased porosity will also allow faster ion-transport for the high-power applications desired in automobiles. The novel coordination complex of interest, $+2 \text{Zn}_2$ Hydrazone, during this study will be probed as a potential molecular spacer for various nanostructured Carbon materials that are commonly used in energy-storage applications. The
Hydrazone complex will be explored for its ability to bind to the surface of these materials including Carbon nanotubes (CNTs) and Graphene sheets. The strength of binding will be explored as well as how the complex affects the energy-storage properties of these materials. The materials’ energy storage will be tested and optimized by increasing the porosity and surface area through optimization of the percent loading of the Hydrazone complex.

This study aims to facilitate the integration of nanostructured Carbon materials into our society by enhancing their energy-storage and probing their ability to scale to industrialized applications. If this nation can successfully halt its uses of fossil-fuel combustion and integrate more sustainable ways to harvest and store the energy we consume, we can drastically decrease the amount of adverse climate effects, and maintain the beautiful landscape this nation is well-known for.