As we transition to renewable energy and electric vehicles, one challenge remains at the forefront: how to store and release electrical energy more efficiently. While today's batteries can store large amounts of energy, they take a long time to charge. On the other hand, capacitors can charge very quickly but store limited energy. Imagine if we could combine the best of both worlds – this is where our research comes in.

Our international research team is developing a revolutionary new material that combines two forms of carbon: diamond and graphite. This hybrid material, called diaphite, has unique properties that make it particularly promising for energy storage. Think of it as creating a perfect marriage between diamond's extraordinary strength and graphite's excellent electrical conductivity. By carefully engineering this material at the nanoscale – working with structures thousands of times smaller than a human hair – we aim to create energy storage devices that can both charge quickly and store large amounts of energy.

This project brings together experts from GdańskTech (Poland), Hasselt University (Belgium), and the California Institute of Technology (USA), combining cutting-edge computer simulations with advanced laboratory techniques. We use powerful computers to predict how different combinations of materials will behave, then test these predictions in the laboratory using specialized plasma technology – similar to what you might see in a neon sign, but much more sophisticated.

What makes our approach unique is the use of advanced manufacturing techniques, including high-power microwave plasma and laser patterning, to create precisely controlled structures. We're also exploring how adding small amounts of other elements, like boron and nitrogen, can enhance the material's performance. Think of it as creating a custom-designed recipe at the atomic level, where every ingredient serves a specific purpose.

The potential impact of this research extends far beyond the laboratory. Successful development of these materials could lead to:

- Electric vehicles that charge as quickly as filling up with gas

- More efficient storage of renewable energy from solar and wind power

- Smaller, more powerful electronic devices with longer battery life

- Reduced greenhouse gas emissions by enabling better energy storage solutions

Our project directly addresses one of the most pressing challenges in the fight against climate change. Transportation currently accounts for 29% of greenhouse gas emissions in both the United States and European Union. By developing better energy storage solutions, we can accelerate the transition to electric vehicles and renewable energy sources.

Looking ahead, we expect our research to provide fundamental breakthroughs in understanding how these hybrid materials work and how to manufacture them efficiently. This knowledge will be crucial for developing the next generation of energy storage devices that could transform how we use and store energy in our daily lives. Through this work, we're not just conducting scientific research – we're helping to build a more sustainable future.

The project provides excellent opportunities for training young scientists and engineers, ensuring that the next generation of researchers will be well-equipped to tackle energy challenges. By combining expertise from three renowned institutions across two continents, we're creating an international network of excellence in advanced materials research and energy storage technology.

As we progress, we'll be sharing our findings with both the scientific community and the public, contributing to the global effort to create more sustainable energy solutions. Our work represents a crucial step toward a future where clean energy is not just environmentally friendly, but also practical and efficient for everyday use.