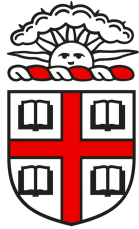


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Making Net Zero Emissions an Attainable Goal

Introducing graphene-enhanced
technologies to the regulated market to
mitigate carbon emissions

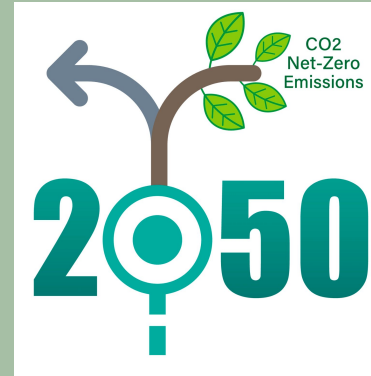
The Net Zero Emissions Goal

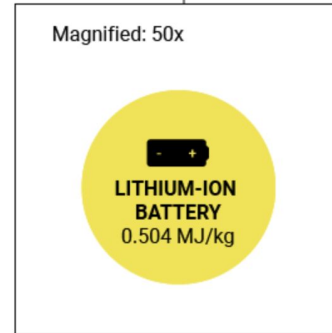
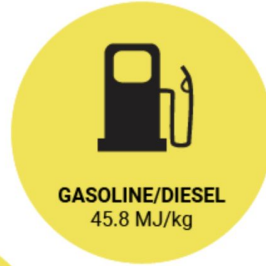
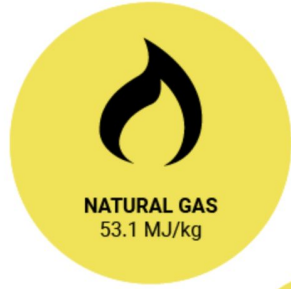
- To prevent the Earth's temperature from increasing by more than 1.5°C {above pre-industrial levels), several countries have agreed to work towards reaching net zero emissions by 2050
 - Net zero emissions involves cutting greenhouse gas emissions down to virtually 0, with remaining emissions being reabsorbed by forests and oceans
 - The worst impacts of climate change could be exacerbated (intense weather events, extinction of species) if global temperature increases by more than 1.5°C

Energy sector plays a large role in carbon emissions, with the U.S. emitting 4,964 million metric tons (MMmt) of carbon dioxide (CO₂) last year (13.8% of total global emissions).

Of this, 1,476 MMmt was produced from gasoline combustion.

By developing clean energy alternatives, we can get on track to achieving net zero emissions.





The Wonder Material of the 21st Century

- Graphite is a 3D allotrope of carbon that was discovered in the 1700s
 - Makes up the anode in lithium-ion batteries
 - Has a crystalline structure, making it brittle
 - Covalent bonds
- Graphene is a 2D layer of graphite that was discovered in 2004
 - Sigma and pi bonds (sp^2 hybridization)
 - Double the electrical conductivity of graphite

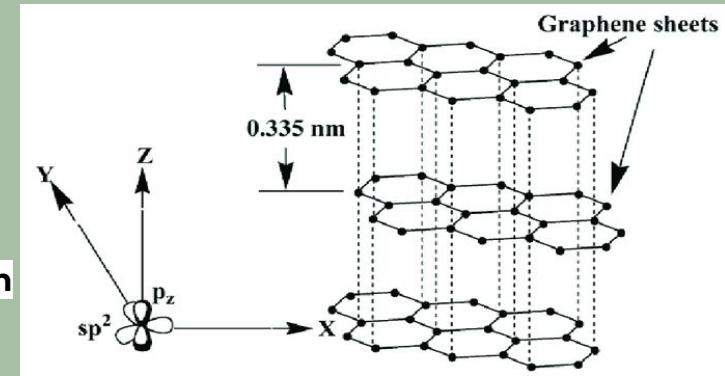
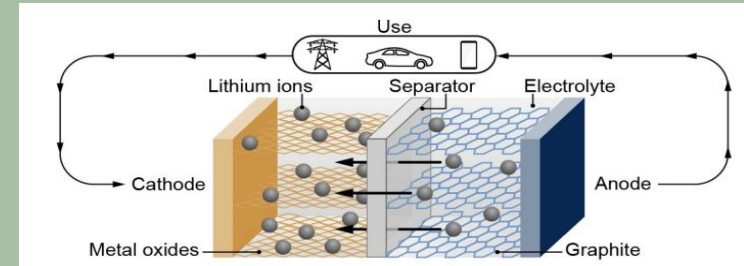
Strong. Flexible. Thin.

- 200 times stronger than steel
- One million times thinner than a single human hair

Graphene can be added/embedded into lithium-ion batteries to dramatically improve their performance!

Graphene powder can be turned into a slurry to be painted onto the current collector

Graphene can also be used as an additive agent in electrode materials



The Issue

- Graphene-enhanced lithium-ion batteries (est. 2016) have:
 - More stable electrodes than traditional lithium-ion batteries
 - Reduced internal resistance
 - 5 times the energy density (energy/mass) of lithium-ion batteries
 - Greater heat dissipation



Complicating Factors

Graphene is very difficult to produce on a large scale → few macro-level production methods exist as of now

There is a lack of trust within the graphene supply chain since the “graphene” on the market varies drastically

How can we accelerate the creation of nanomaterial standards?

How can we foster competition and transparency in the nanomaterial industry?

How do we get major industries to use the most effective technology available?

However, the technology has **NOT** been implemented in American EVs or energy grids

- Based on Executive Order 13859, titled “Maintaining American Leadership in Artificial Intelligence”
 - Vague outline of federal strategies that can be used to position the United States as a global leader in the AI industry
- Has focus on outcompeting China
- Mandates that federal agencies allocate some of their budget to AI research and development
- Promotes fellowships and education grants for academic work in AI security



Recommendation 1

**Mandate EPA
adherence to
deadlines for the
creation of regulations
through an Executive
Order**

EO XXXXX: Promoting
American Innovation in
the Graphene Industry

- Graphene product labels should include
 - Carbon content
 - Method of graphene production utilized
 - Optimal application of the graphene product based on the form the material is in
- Mimic Federal Trade Commission's (FTC) 2018 policy on recycled oil
 - Features definitions that clarify the difference between various forms of oil (new, processed, used, refined)
 - Administer penalties when companies do not adhere to labeling standards
- Create NIST program dedicated to researching and developing graphene standards
 - Building code projects

Recommendation 2

Adopt a standardized, nuanced graphene identification system.

Test Procedures and
Labeling Standards for
Graphene Products

NIST



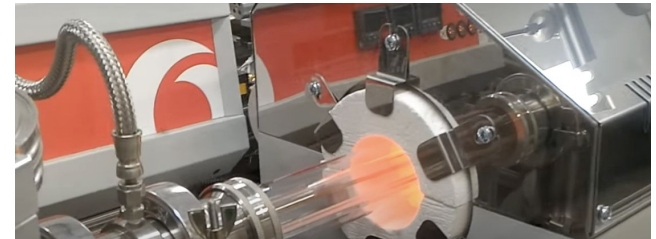
- Engineers at MIT have created a scalable method for graphene production
 - Continuous “aluminum foil” strip of graphene
 - 5 cm of graphene/min
- Collaboration between DoD, EPA, ERDC, and research institutions can increase national focus on clean energy sector
- Current government-funded research is limited, with a few partially funded projects available with very large organizations like the NSF
- Require that some funds from the annual budget of EPA, DOE etc. are allocated towards collaborative research with universities
 - Gradually increase budget to reward researchers



Recommendation 3

Incentivize collaborative research on large-scale graphene production methods

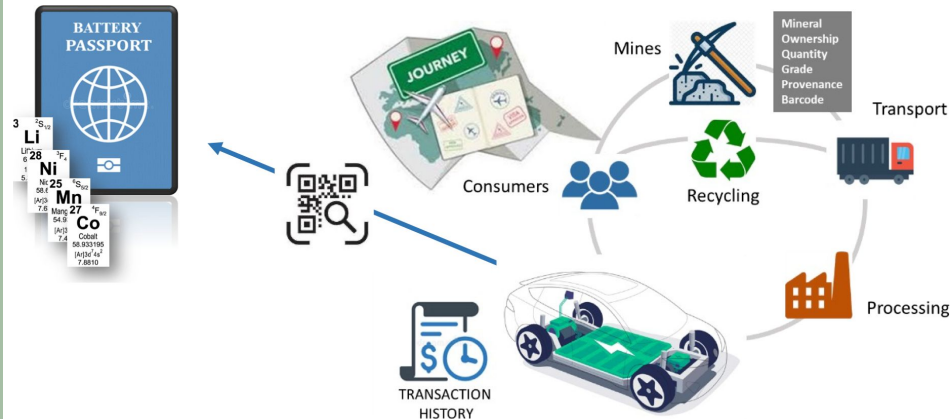
“The Federal Research Agency”



- “Battery Passport” is pilot program introduced by the Global Battery Alliance
 - Requires a digital “passport” (a QR code imprinted on each battery) containing the following information:
 - percentage of recycled components that the battery contains
 - origin of the materials used
 - estimated amount of carbon emissions from the production of the battery
 - details on manufacturing history
- Creates framework for the evaluation of batteries
- Facilitates supply chain transparency in global battery industry

Recommendation 4

Implement a national “Battery Passport” program to increase transparency and competitiveness in battery and graphene industries



Transparency. Reliability. Efficiency.

By targeting:

- **Research** on methods of creating graphene
- **Regulations** based on the health and safety information of various quantities of graphene
- **Standards** to monitor the quality of graphene produced

We can work towards implementing more effective graphene-enhanced technology in the clean energy sector.

Questions?

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Thank you!