THE BIG APPLE

to

THE GREEN APPLE

Converting a Metropolitan area to an Eco-Friendly Sustainable City

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Key Questions

- What is an Eco-Friendly Sustainable City?
- How are they helping in reducing the GHG (Green House Gases) and developing sustainable future?
- Technologies to help reduce the Carbon footprint
Eco-Friendly City

- Eco-Friendly **sustainable** urban neighborhoods that prioritize **energy efficiency**, **use of renewable resources**, and **green spaces** to reduce its ecological footprint.

- They aim to create a harmonious balance between human habitation and the natural environment, promoting a **high quality of life while minimizing ecological impact.**
Carbon Footprint

- A carbon footprint is the **total amount of greenhouse gases** (including carbon dioxide and methane) that are generated by our actions.
- **Eco-Friendly** areas offer numerous **benefits** such as reduced carbon footprint, improved air and water quality, enhanced community resilience, and economic opportunities.
- The **average carbon footprint for a person in the United States** is **4 time higher** than global average.
Green House Gasses & Carbon Dioxide

Overview of Greenhouse Gas Emissions

- 79.4% CO₂
- 11.5% CH₄
- 6.2% N₂O
- 3.0% HFCs, PFCs, SF₆, and NF₃

U.S. Carbon Dioxide Emissions, by Economic Sector

- Transportation 35%
- Electricity 31%
- Industry 15%
- Residential & Commercial 11%
- Other (Non-Fossil Fuel Combustion) 8%
Manhattan - NY
Solar Resource Map – Manhattan NY
Wind Resource Map – Manhattan NY & Boston
New York City – Manhattan
Wind Turbines – Roof Top & Street Lights
Resource Assessment - Tools

LiDAR
Light Detection and Ranging

Metmast

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Hydrogen Fuel Cell

- Hydrogen fuel cells offer a sustainable and efficient solution for building energy needs.
- Hydrogen fuel cells can be integrated into building energy systems for **power generation**, **heating**, and **cooling**.
Hydrogen Fuel Cells – Reference Information (DOE)

### Comparison of Fuel Cell Technologies

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| Polymer Electrolyte Membrane (PEM) | Perfluoro sulfonic acid | <120°C | <1 kWh - 100 kW | 60% direct H₂, 40% reformed fuel | • Backup power  
• Portable power  
• Distributed generation  
• Transportation  
• Specialty vehicles | • Solid electrolyte reduces corrosion  
& electrolyte management problems  
• Low temperature  
• Quick start-up and load following | • Expensive catalysts  
• Sensitive to fuel impurities |
| Alkaline (AF)           | Aqueous potassium hydroxide soaked in a porous matrix, or alkaline polymer membrane | <100°C | 1 - 100 kW | 60% | • Military  
• Space  
• Backup power  
• Transportation | • Wider range of stable materials allows lower cost components  
• Low temperature  
• Quick start-up | • Sensitive to CO₂ in fuel and air  
• Electrolyte management (aqueous)  
• Electrolyte conductivity (polymer) |
| Phosphoric Acid (PAFC)  | Phosphoric acid soaked in a porous matrix or mixed in a polymer membrane | 150 - 200°C | 5 - 400 kW, 100 kW module (liquid PAFC); <10 kW (polymer membrane) | 40% | • Distributed generation | • Suitable for CHP  
• Increased tolerance to fuel impurities | • Expensive catalysts  
• Long start-up times  
• Sulfur sensitivity |
| Molten Carbonate (MC/EC) | Molten lithium, sodium, and/or potassium carbonates, soaked in a porous matrix | 600 - 700°C | 300 kW - 3 MW, 300 kW module | 50% | • Electric utility  
• Distributed generation | • High efficiency  
• Fuel flexibility  
• Suitable for CHP  
• Hybrid/gas turbine cycle | • High temperature corrosion and breakdown of cell components  
• Long start-up time  
• Low power density |
| Solid Oxide (SOFC)      | Yttria stabilized zirconia | 500 - 1000°C | 1 kW - 2 MW | 60% | • Auxiliary power  
• Electric utility  
• Distributed generation | • High efficiency  
• Fuel flexibility  
• Solid electrolyte  
• Suitable for CHP  
• Hybrid/gas turbine cycle | • High temperature corrosion and breakdown of cell components  
• Long start-up time  
• Limited number of shutdowns |
Brooklyn Microgrid Project

- The Brooklyn Microgrid (BMG) project is aimed at creating a localized energy network within the Brooklyn borough of New York City.
- BMG project is a significant step towards reimagining how energy can be produced, distributed, and consumed at the community level.
- Utilizing blockchain technology for energy transactions, BMG seeks to empower residents and businesses to generate, store, and trade renewable energy directly with one another, thereby enhancing sustainability, resilience, and community engagement in energy decisions.
Converting City into an Eco-City - Typical Steps

1. **Assessment**: Evaluate current environmental impact, energy usage, and waste management.
2. **Stakeholder Engagement**: Involve communities, businesses, and local authorities to gain support.
3. **Urban Planning**: Implement sustainable urban planning strategies including increase greenery.
4. **Energy Efficiency**: Upgrade buildings for energy efficiency, utilize renewable energy generation sources and energy storage, and energy management systems.
5. **Waste Management**: Implement recycling programs, reduce waste generation, and explore innovative waste-to-energy solutions.
6. **Water Conservation**: Implement water conservation practices, and invest in sustainable water management.
7. **Transportation**: Encourage eco-friendly transportation options like cycling, walking, EV and public transit.
8. **Smart Technologies**: Incorporate smart technologies for efficient resource management, including smart grids and IoT solutions.
Potential Technologies - Transform a City to Eco-City

- Solar - Roof Top & Glass / Walls
- Wind - Street Lights, Building Roof Tops
- LED Lighting
- Energy Efficiency
- Efficient Appliances
- Hydrogen Fuel Cells (Electricity and Heating)
- Efficient District Heating (or reusing the heat)
Conclusion

- Building environmentally friendly cities requires a holistic approach that encompasses **urban planning**, **renewable energy** generation & **storage**, **efficiency** improvements, **waste management**, water **conservation**, **community engagement**, and **policy frameworks**.
- **Hydrogen fuel cells** have the potential to revolutionize sustainable building energy solutions, offering **clean**, **efficient**, and **economically viable** alternatives.
- By embracing innovation and collaboration, Eco-Cities pave the way for a more resilient, harmonious and sustainable future.
Thank You

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