4TH MARCH :WORLD ENGINEERING DAY FOR SUSTAINABLE DEVELOPMENT 2024

THEME: *ENGINEERING SOLUTIONS FOR A SUSTAINABLE WORLD*

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at

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Harcourt Butler Technical University, Kanpur

OVERVIEW OF THE PRESENTATION

- INTRODUCTION TO WORLD ENGINEERS DAY
- UN SUSTAINABLE DEVELOPMENT GOALS
- KEY AREAS WHERE ENGINEERING CAN CONTRIBUTE TO SUSTAINABILITY:

1. RENEWABLE ENRGY
2. ENERGY EFFICIENCY
3. WATER MANAGEMENT
4. WASTE MANAGEMENT
5. TRANSPORTATION
6. INFRASTRUCTURE RESILIENCE
7. GREEN CHEMISTRY
8. PRECISION AGRICULTURE
9. BIOTECHNOLOGY FOR SUSTAINABILITY
10. REMOTE SENSING AND MONITORING
11. COMMUNITY ENGAGEMENT AND SOCIAL INNOVATION
12. EDUCATION AND AWARENESS

- CONCLUSIONS

The 4th of March is the founding day of the World Federation of Engineering Organizations (WFEO), a Federation consisting of hundred national members and international members, representing the engineering society of the world.

In 2020, this global celebration was renamed World Engineering Day as a joint venture with UNESCO and WFEO to highlight engineers' achievements around the world and improve the public understanding of the importance of engineering and technology.

The day also offers an opportunity to highlight engineers and engineering's achievements in our modern world and improve public understanding of how engineering and technology are central to modern life and for sustainable development.

There is a great deal to be done specially to achieve the UN Sustainable Development Goals in developing countries to ensure that everyone has access to clean water, sanitation, reliable energy, and other basic human needs. In all countries, there is also a great deal to be done – to deal with the impacts of climate change, environmental issues, our growing cities and the challenges of emerging technologies including artificial intelligence.

There are many opportunities and the Day can be used to engage with young people and say "If you want to change the world for the better, become an engineer".

UN Sustainable Development Goals

Sustainability in Engineering

In engineering, there is the opportunity to set a precedent and back it up. Engineers' decisions about the design and implementation of new projects can have a lasting effect. For example, choosing sustainable materials and manufacturing techniques can impact the amount of carbon, waste, and energy produced in the life cycle of a product.

Here are some key areas where engineering can contribute to sustainability:

1. Renewable Energy:

- Develop and improve renewable energy sources such as solar, wind, hydro, and geothermal power.

Human activity is overloading our atmosphere with carbon dioxide and other global warming emissions. These gases act like a blanket, trapping heat. The result is a web of significant and harmful impacts, from stronger, more frequent storms, to drought, sea level rise, and extinction.

What Is Renewable Energy?

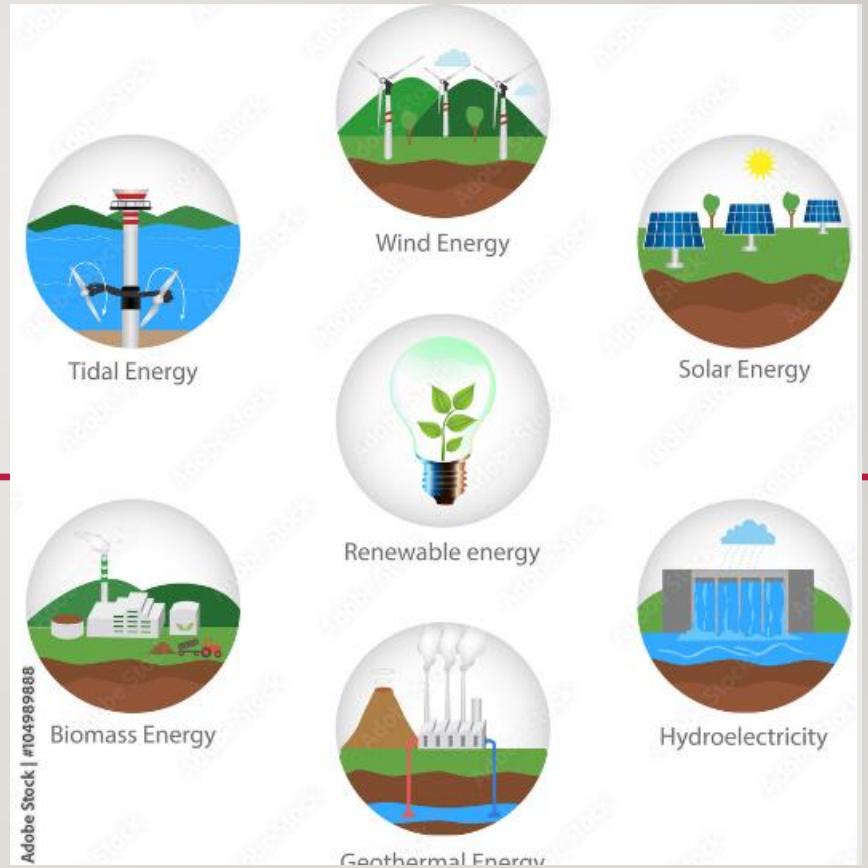
Renewable energy comes from unlimited, naturally replenished resources, such as the sun, tides, and wind. Renewable energy can be used for electricity generation, space and water heating and cooling, and transportation.

Non-renewable energy, in contrast, comes from finite sources, such as coal, natural gas, and oil.

https://www.un.org/en/climatechange/what-is-renewable-energy#:~:text=Renewable%20energy%20is%20energy%20derived,plentiful%20and%20all%20around%20us.

Here are some key areas where engineering can contribute to sustainability:

ADVANTAGES	DISADVANTAGES
Renewable energy won't run out.	Renewable energy has high upfront costs.
Renewable energy has lower maintenance requirements.	Renewable energy is intermittent.
Renewables save money.	Renewables have limited storage capabilities.
Renewable energy has numerous environmental benefits.	Renewable energy sources have geographic limitations.
Renewables lower reliance on foreign energy sources.	Renewables aren't always 100% carbon-free.
Renewable energy leads to cleaner water and air.	
Renewable energy creates jobs.	
Renewable energy can cut down on waste.	

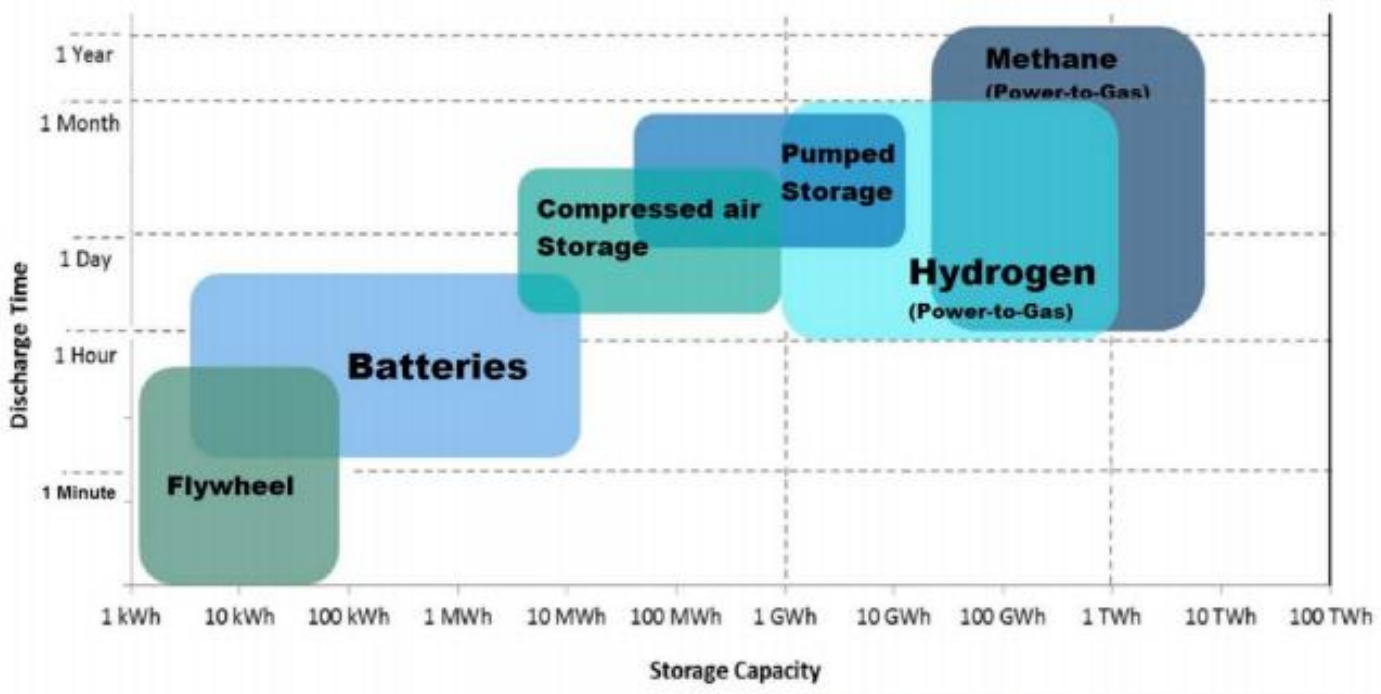


https://www.energy.gov/eere/renewable-energy

Here are some key areas where engineering can contribute to sustainability:

1. Renewable Energy:

- Enhance energy storage technologies to ensure a reliable and continuous power supply.



Source: School of Engineering, RMIT University (2015)

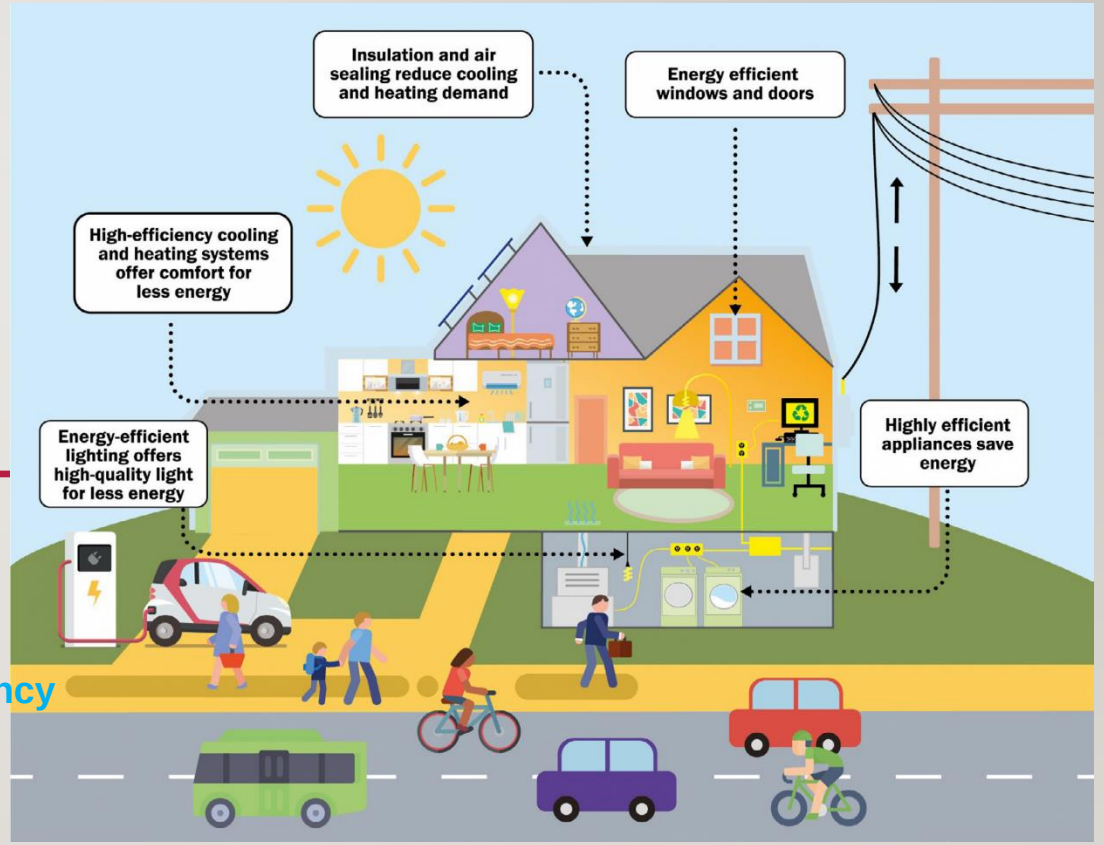
Figure 3. Available storage technologies, their capacity and discharge time.

https://en.wikipedia.org/wiki/Energy_storage

Here are some key areas where engineering can contribute to sustainability:

2. Energy Efficiency:

- Design energy-efficient buildings, appliances, and industrial processes.



https://www.energy.gov/eere/energy-efficiency-buildings-and-industry

Energy Efficiency Benefits and Modes

COST SAVINGS
COMMUNITY BENEFITS
ENVIRONMENTAL BENEFITS
RESILIENCE AND RELIABILITY
HEALTH BENEFITS

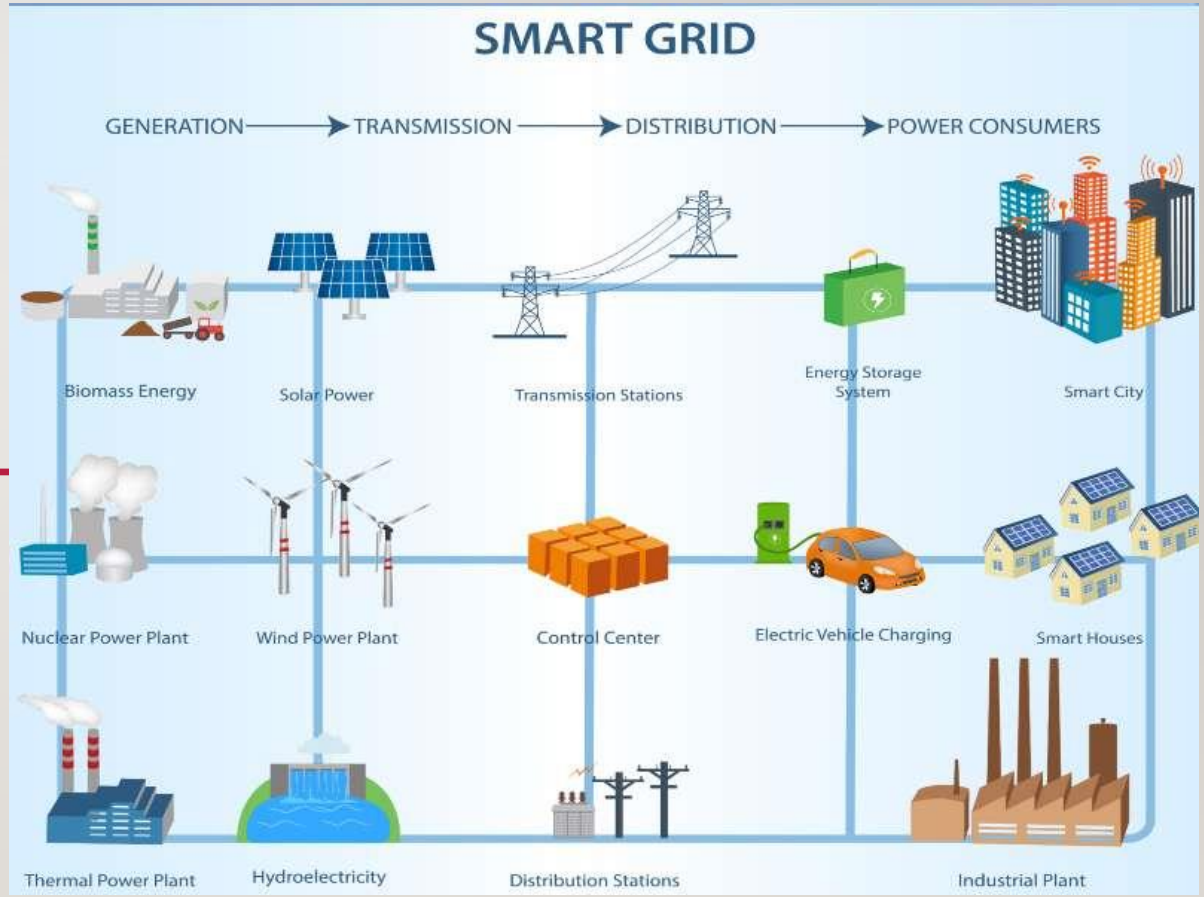
Industrial Decarbonization and Energy Efficiency
Energy-Efficient Driving and Vehicles
Energy-Efficient Products

Here are some key areas where engineering can contribute to sustainability:

2. Energy Efficiency:

- Implement smart grid technologies to optimize energy distribution and consumption.

The smart grid technology is an intelligent and interconnected electrical system that enables efficient management of electricity generation, distribution, and consumption. It incorporates various digital communication and automation tools to optimize energy utilization and minimize wastage.



https://www.iea.org/energy-system/electricity/smart-grids

Here are some key areas where engineering can contribute to sustainability:

Key Features and Advantages of Smart Grid Technology

Energy efficiency: Real-time monitoring and smart metering enable buildings to identify and eliminate energy wastage, leading to reduced carbon emissions.

Demand response programs: Participating in demand response programs helps balance electricity supply and demand, avoiding unnecessary fossil fuel power generation and decreasing carbon emissions.

Renewable energy integration: Integrating renewable energy sources into the smart grid reduces reliance on fossil fuels, leading to a greener and more sustainable energy mix for buildings.

Storage solutions: Efficient energy storage using smart grid technology promotes the optimal utilization of renewable energy, minimizing carbon emissions and ensuring uninterrupted power supply.

https://utilitiesone.com/the-role-of-smart-grid-technology-in-optimizing-building-energy-and-water-use

Here are some key areas where engineering can contribute to sustainability:

3. Water Management:

- Create efficient and sustainable water treatment and desalination technologies.

The number of people experiencing water shortages to be at 60 percent by 2025. With 97 percent of the world's water in oceans, seawater desalination represents a major opportunity for alleviating water stress across the globe.

At most plants, electrical energy accounts for about 35 to 40 percent of total operating costs, energy-efficient desalination is at the forefront of research into developing clean water technologies.

https://www.waterworld.com/drinking-water/treatment/article/14177014/sustainability-in-desalination

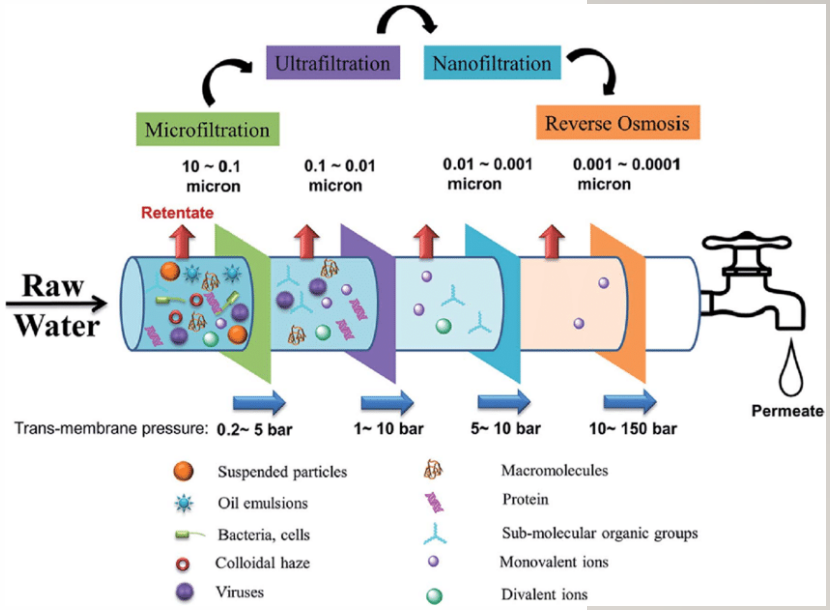
Here are some key areas where engineering can contribute to sustainability:

3. Water Management:

- Create efficient and sustainable water treatment and desalination technologies.

Top 10 Advanced Water Treatment Technologies (2024)

1. Water Quality Monitoring
2. Membrane Technology
3. Carbon-based Purification
4. Water Disinfection Solutions
5. Desalination
6. Modular Water Treatment Systems
7. Bio-based Water Remediation
8. Nanofiltration
9. Industrial Internet of Things
10. Energy-Efficient Integrations



https://www.researchgate.net/figure/Pressure-driven-membrane-processes-for-water-treatment-technologies-showing-the_fig2_328882399

Here are some key areas where engineering can contribute to sustainability:

3. Water Management:

- Develop smart irrigation systems

Smart irrigation systems leverage technology and data to optimize landscape water use. These systems are equipped with weather sensors and moisture detectors, allowing them to adjust irrigation schedules based on real-time weather conditions and soil moisture levels.

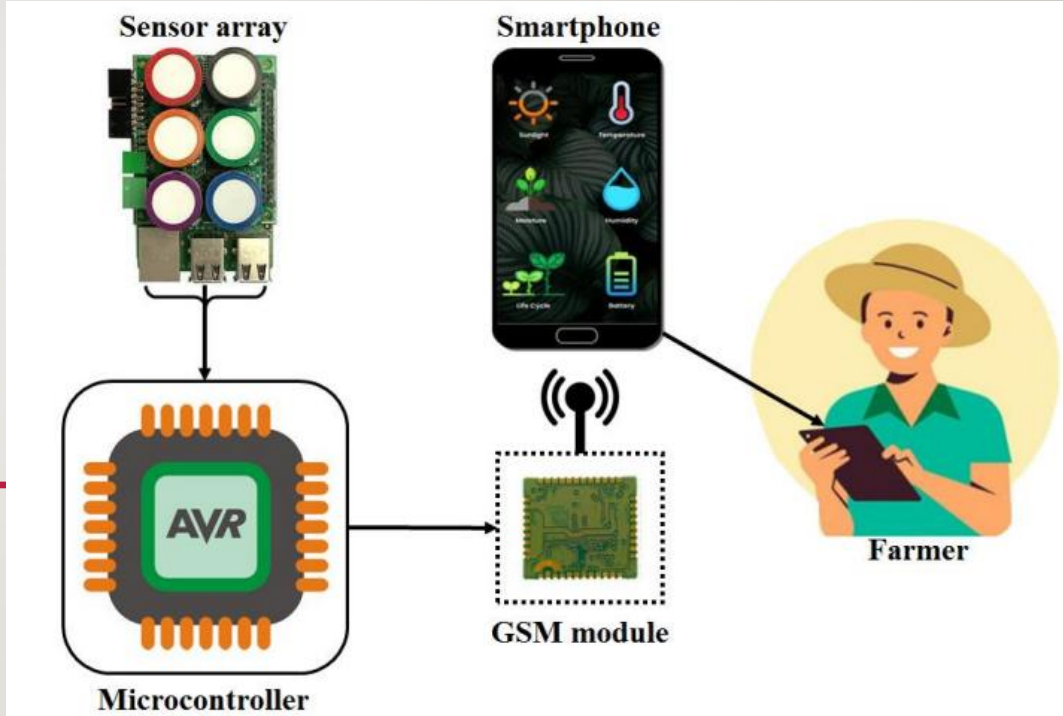


Figure 1. Overview of irrigation systems based on smart sensors.

https://www.mdpi.com/journal/water/special_issues/smart_irrigation

Here are some key areas where engineering can contribute to sustainability:

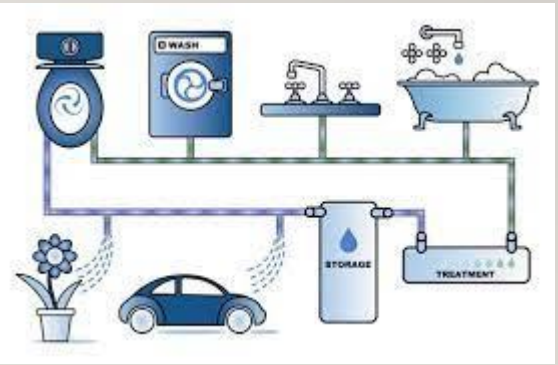
3. Water Management:

- Develop water recycling techniques to conserve water resources.

Water recycling, also known as water reuse or water reclamation, is the process of reclaiming water from various sources and treating it for reuse. The treated wastewater can be used for many purposes, including:

- Agriculture and irrigation
- Potable water supplies
- Groundwater replenishment
- Industrial processes
- Environmental restoration
- Flushing in toilets

Water recycling uses a combination of membrane filtration and biological treatment to remove solids and organic matter. Modern water recycling units use a single system called a Membrane Bioreactor (MBR).



https://extension.okstate.edu/fact-sheets/smart-irrigation-technology-controllers-and-sensors.html

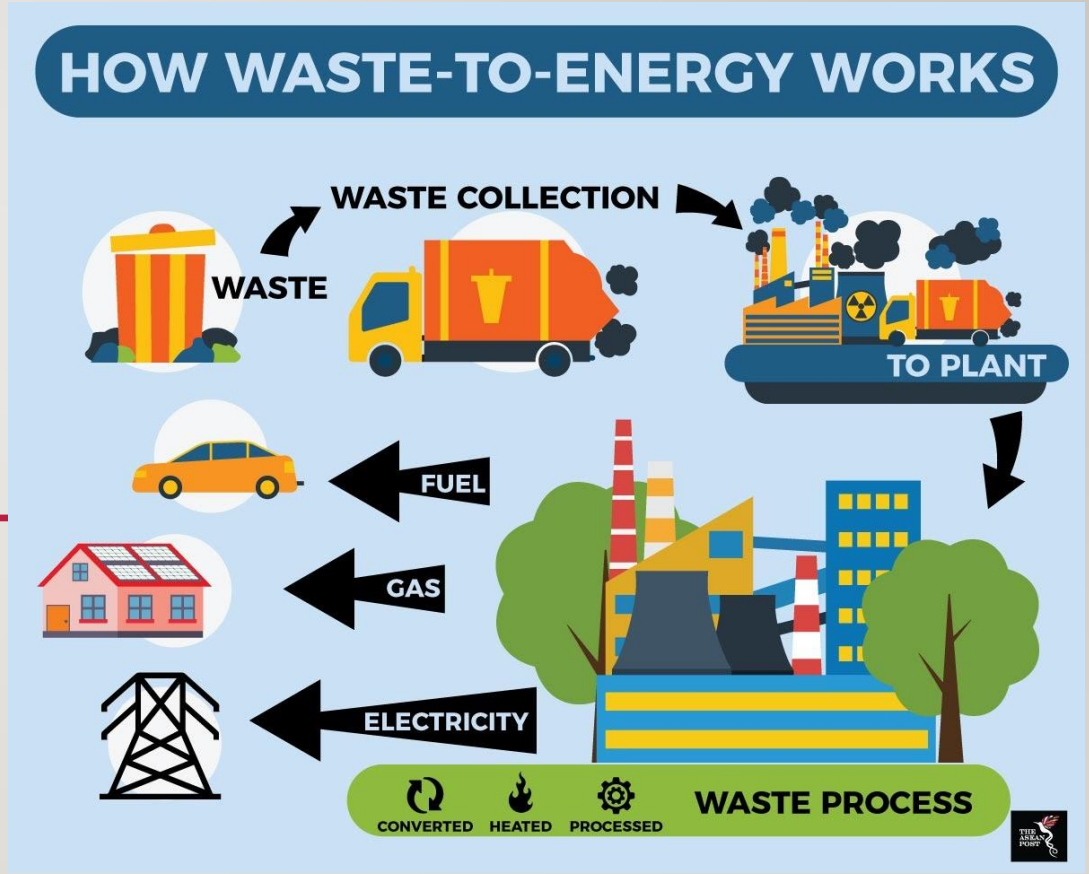
Here are some key areas where engineering can contribute to sustainability:

4. Waste Management:

- Engineer innovative waste-to-energy technologies and recycling processes.

Waste-to-energy technology includes fermentation, which can take biomass and create ethanol, using waste cellulosic or organic material.

It is predicted that the worldwide energy potential of waste ranges from 8 to 18 EJ/year in 2010 and 13 to 30 EJ/year in 2025



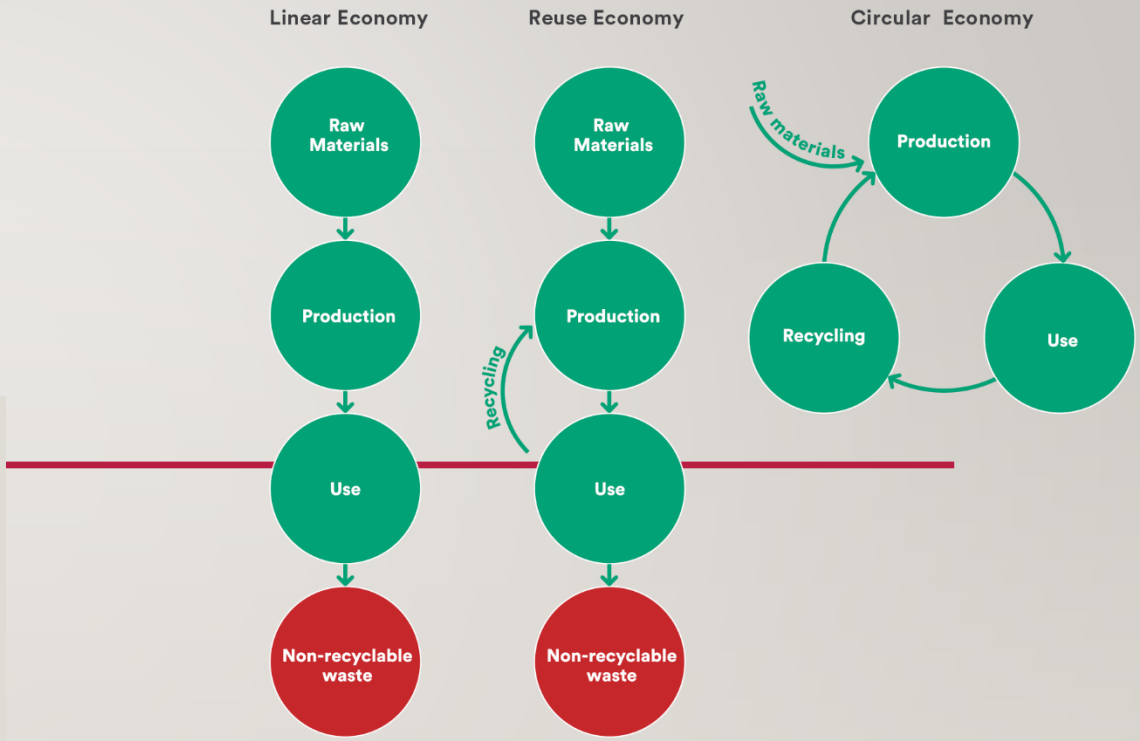
https://www.worldenergy.org/assets/images/imported/2013/10/WER_2013_7b_Waste_to_Energy.pdf

Here are some key areas where engineering can contribute to sustainability:

4. Waste Management:

- Design products for easy disassembly and recycling, promoting a circular economy.

The **circular economy** is a system where materials never become waste and nature is regenerated. In a circular economy, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting. The circular economy tackles climate change and other global challenges, like biodiversity loss, waste, and pollution, by decoupling economic activity from the consumption of finite resources.



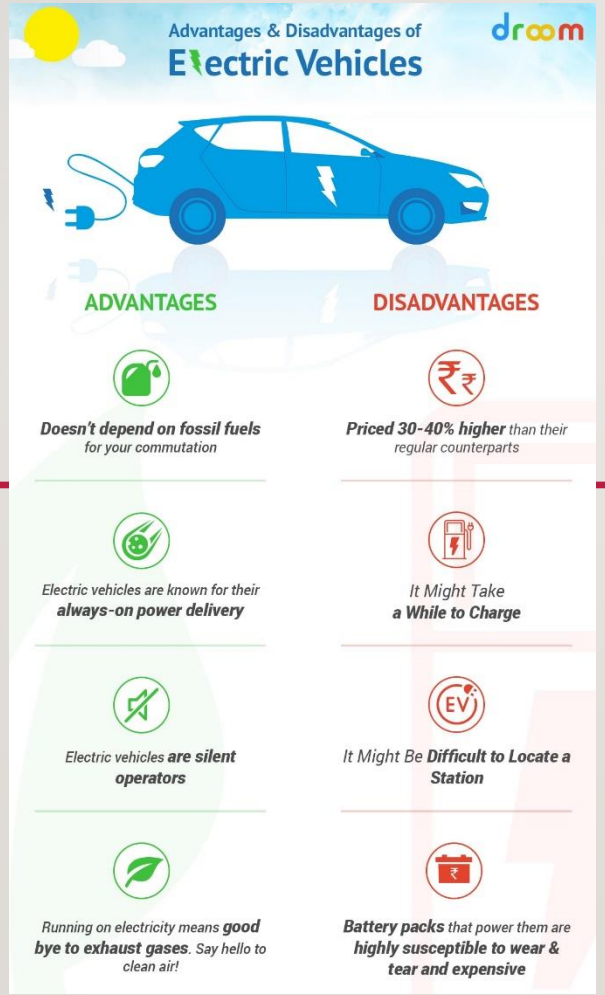
French chemist Antoine-Laurent de Lavoisier:
“Nothing is lost, everything is transformed.”

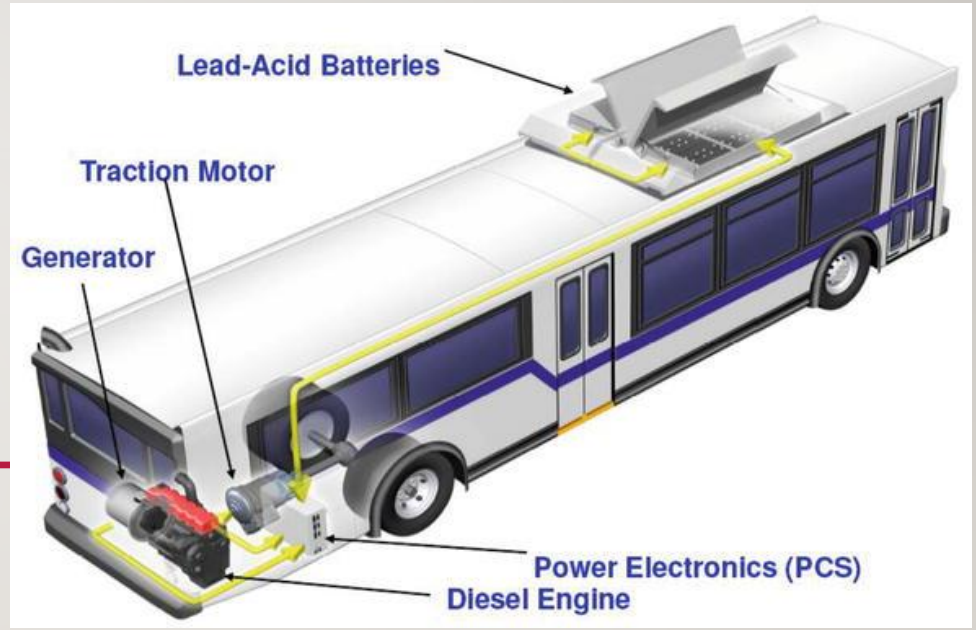
/https://www.rts.com/resources/guides/circular-economy

Here are some key areas where engineering can contribute to sustainability:

5. Transportation:

- Develop electric and hybrid vehicles.





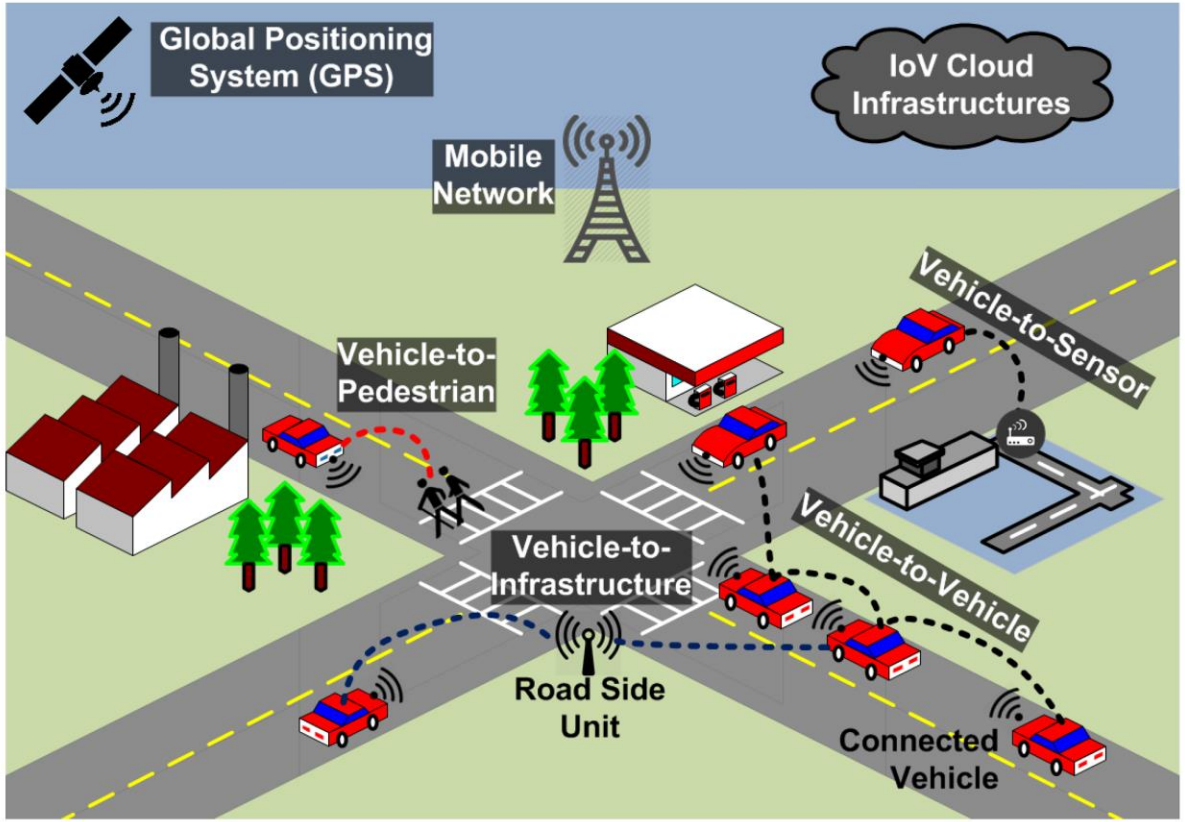
https://www.travelers.com/resources/auto/buying-selling/electric-cars-and-hybrid-cars-pros-and-cons

Here are some key areas where engineering can contribute to sustainability:

5. Transportation:

- Develop as well as efficient public transportation systems.

An efficient public transport system offers travellers short waiting times between departures, quick travel times, punctuality and clear information

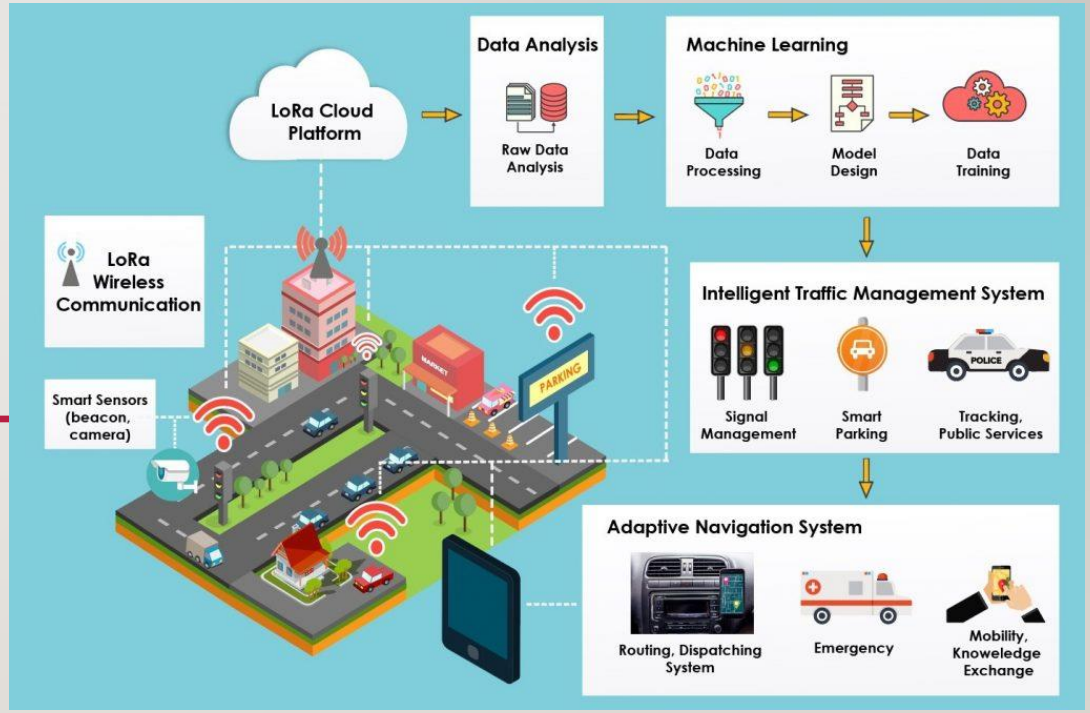


https://www.mckinsey.com/capabilities/operations/our-insights/building-a-transport-system-that-works-five-insights-from-our-25-city-report

Here are some key areas where engineering can contribute to sustainability:

5. Transportation:

- Implement intelligent traffic management systems to reduce congestion and emissions.



6 Features Global Cities Seek In Traffic Management Systems

1. Video traffic detection systems with edge processing capabilities
2. Advanced safety and pollution analytics
3. Predictive traffic planning
4. Smart junction management
5. Electronic road pricing and toll collection
6. Smart parking integration

https://intellias.com/intelligent-traffic-management/

Here are some key areas where engineering can contribute to sustainability:

6. Infrastructure Resilience:

- Design infrastructure with climate change resilience in mind, considering rising sea levels, extreme weather events, and other environmental factors.

Five ways to make buildings resilient to climate change

1. **Building resilience to heatwaves**
2. **Building resilience to drought**
3. **Building resilience to coastal flooding and sea-level rise**
4. **Building resilience to cyclones and strong winds**
5. **Building resilience to cold**

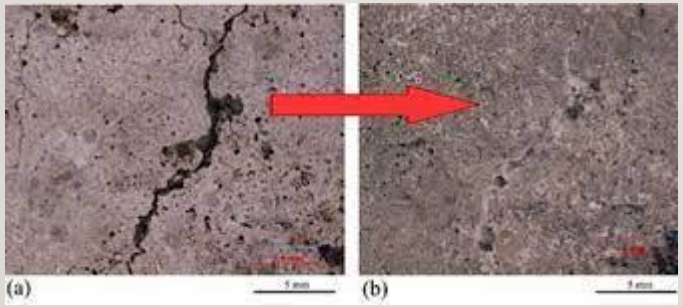
https://www.unep.org/news-and-stories/story/5-ways-make-buildings-climate-change-resilient

Here are some key areas where engineering can contribute to sustainability:

6. Infrastructure Resilience:

- Develop sustainable and durable construction materials.

According to Professor Charles J. Kibert, sustainable construction focuses on six principles: “conserve, reuse, recycle/renew, protect nature, create nontoxic and high quality.”



Innovative Materials for Resilient Infrastructure

1. Self-Healing Concrete: Utilizing bacteria
2. Advanced Composites and Alloys: Lightweight yet solid and advanced composites and alloys like carbon fiber and high-strength aluminum
3. Bendable Concrete
4. Mass Timber
5. Salvage Materials
6. Bamboo
7. Mycelium
8. Precast Concrete
9. 3D Printed Concrete

https://www.autodesk.com/blogs/construction/top-sustainable-construction-materials/, https://www.bigrentz.com/blog/sustainable-construction

Here are some key areas where engineering can contribute to sustainability:

7. Green Chemistry:

- Design environmentally friendly chemical processes and products.

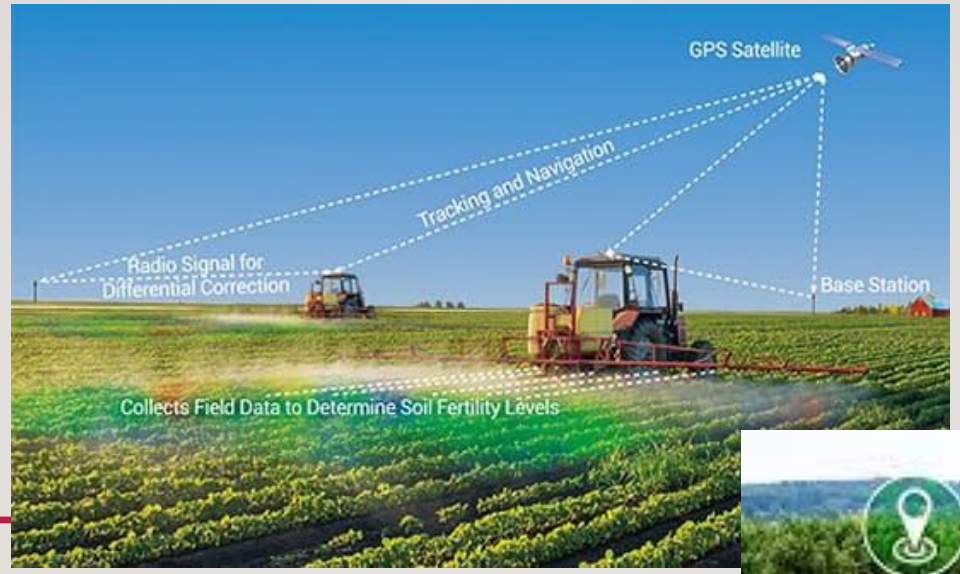
- Reduce the use of hazardous materials in manufacturing.

https://www.acs.org/greenchemistry/principles/12-principles-of-green-chemistry.html

Here are some key areas where engineering can contribute to sustainability:

8. Precision Agriculture:

- Implement technology-driven approaches for precision farming, optimizing resource use and minimizing environmental impact.



- Develop monitoring systems for soil health and crop conditions.

Precision agriculture (PA) is a farming management strategy based on observing, measuring and responding to temporal and spatial variability to improve agricultural production sustainability. It is used in both crop and livestock production.

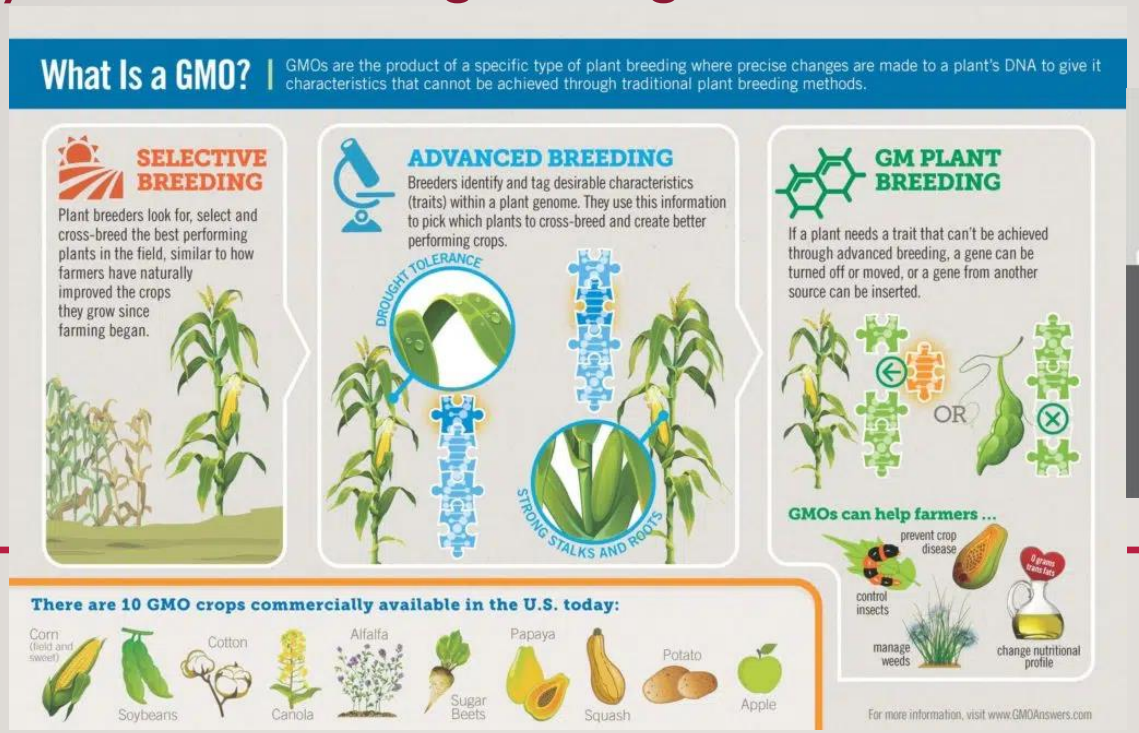
https://en.wikipedia.org/wiki/Precision_agriculture

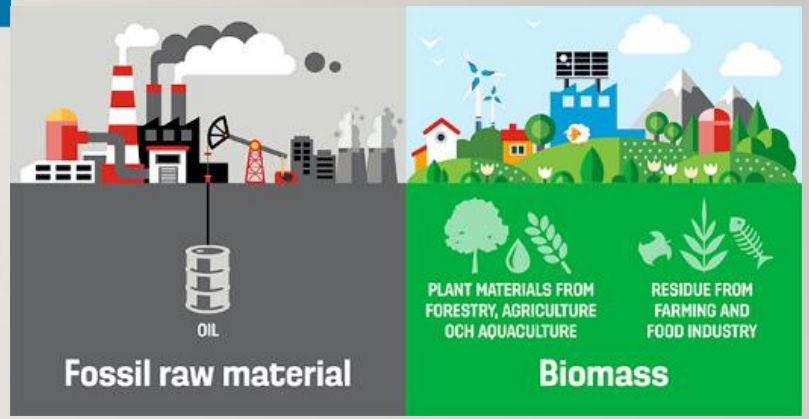
Here are some key areas where engineering can contribute to sustainability:

9. Biotechnology for Sustainability:

- Utilize biotechnology for sustainable food production, including genetically modified organisms for increased crop yields with reduced environmental impact.

- Explore bio-based materials and fuels as alternatives to traditional sources.





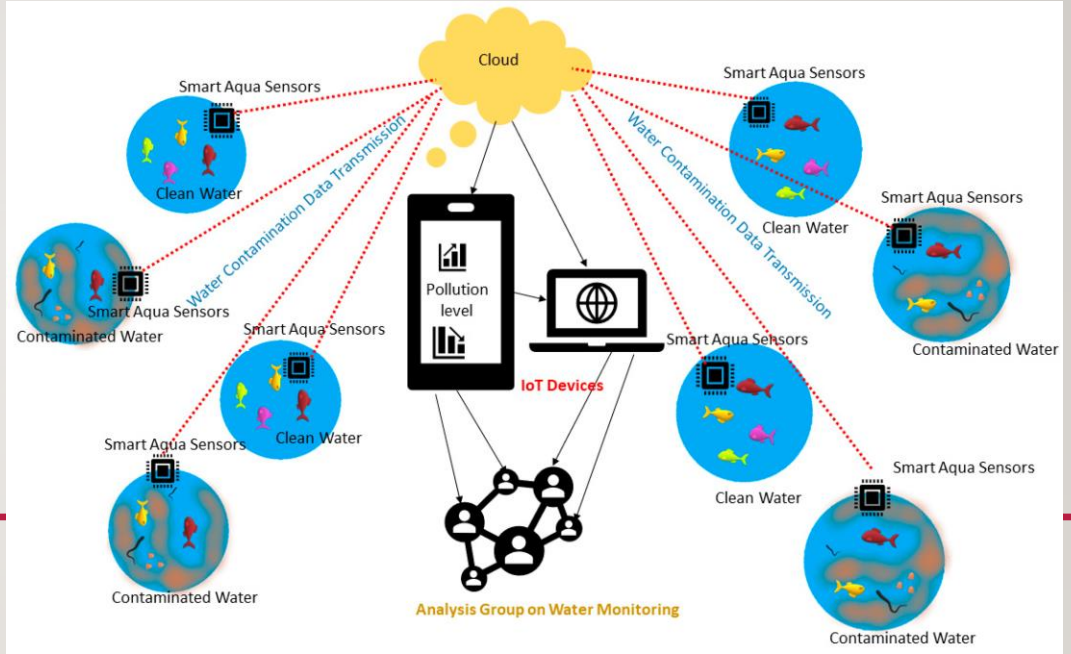
Genetically edited crops have the potential to lower both pesticide use and soil damage (cultivating disease-resistant, herbicide-resistant, and stress-tolerant plants and increasing the nutritional quality of plants) and reduce greenhouse gas (GHG) emissions.

Here are some key areas where engineering can contribute to sustainability:

10. Remote Sensing and Monitoring:

- Develop advanced remote sensing technologies for monitoring and managing natural resources.

- Implement real-time monitoring systems for pollution, deforestation, and other environmental indicators.



Geolocation technology is a powerful tool for monitoring environmental indicators such as air quality, water pollution, deforestation, and climate change. It provides real-time data, precision, and accuracy, efficient resource allocation, and enables comprehensive data integration for better decision-making.

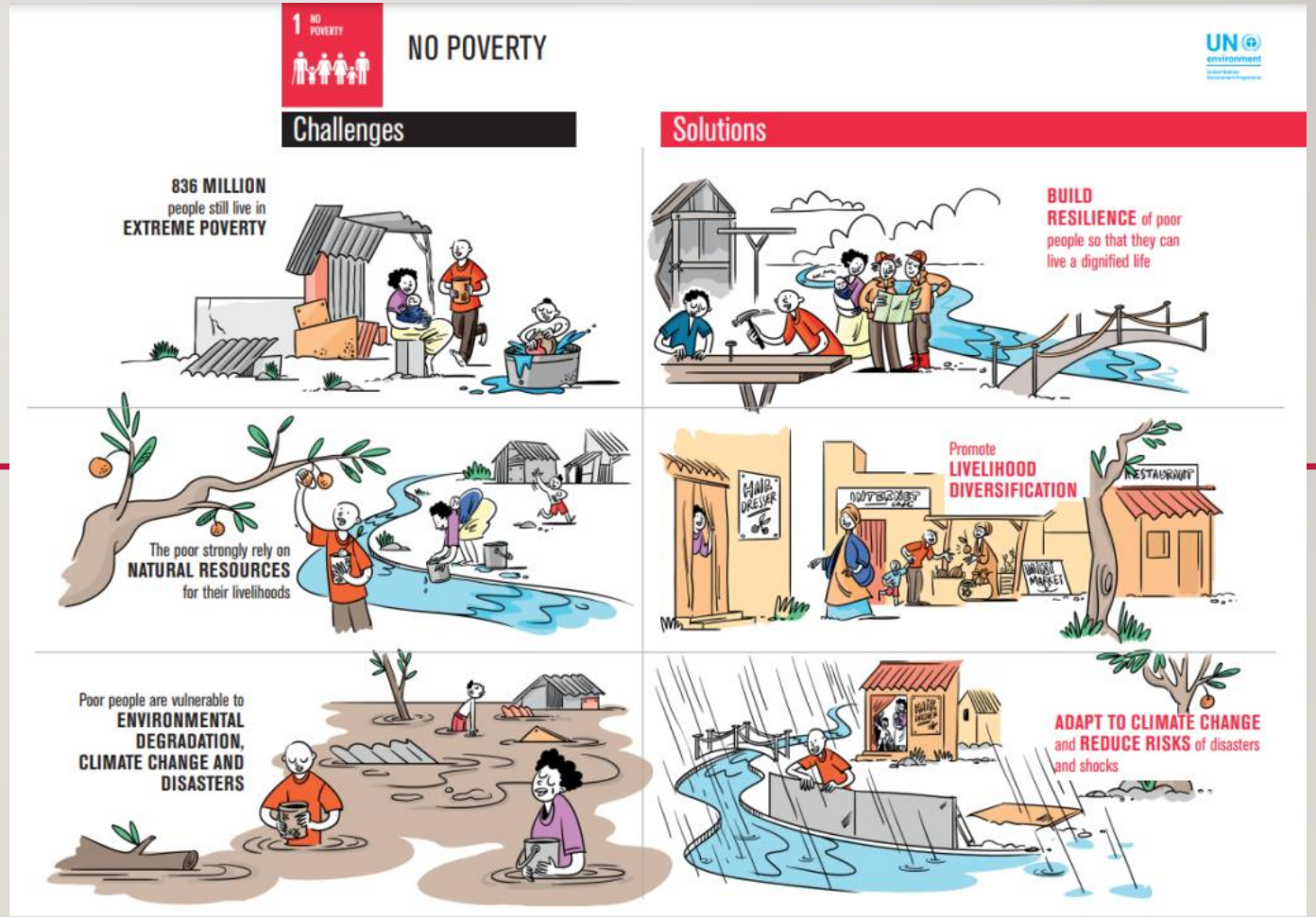
https://utilitiesone.com/mapping-and-monitoring-environmental-performance-indicators-using-geolocation

Here are some key areas where engineering can contribute to sustainability:

11. Community Engagement and Social Innovation:

- Involve local communities in the design and implementation of sustainable engineering projects.

- Foster social innovation to address local challenges and enhance community well-being.



https://ugreen.io/sustainability-engineering-addressing-environmental-social-and-economic-issues/#:~:text=Engage%20the%20community%3A%20sustainability%20engineering,is%20responsive%20to%20local%20concerns.

Here are some key areas where engineering can contribute to sustainability:

11. Community Engagement and Social Innovation:

The Importance of Empowering Local Communities:

1. Ownership and Relevance
2. Bottom-up Approach
3. Building Social Capital

Strategies for Empowering Local Communities:

1. Education and Awareness
2. Capacity Building
3. Collaboration and Partnerships
4. Access to Information and Technology

Examples of Empowered Community-driven Sustainable Development:

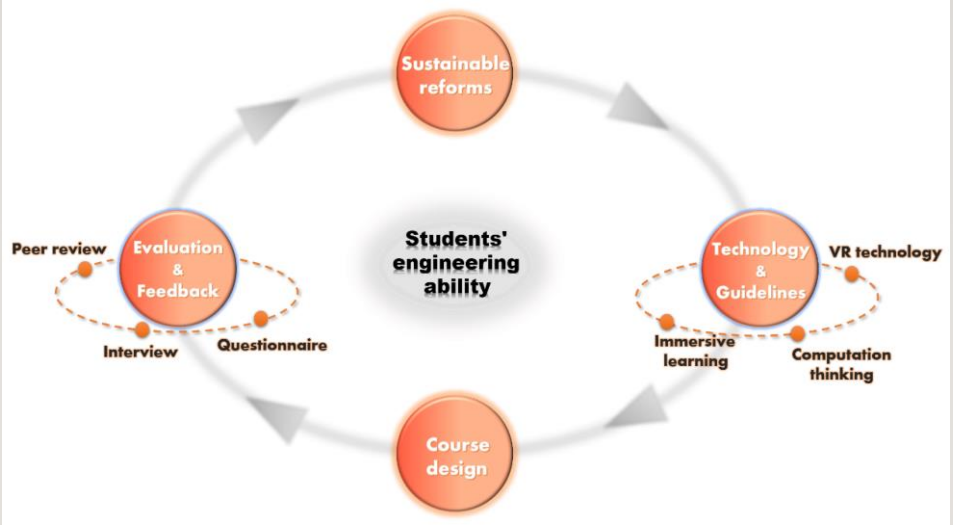
1. Community-Based Forest Management
2. Sustainable Agriculture Cooperatives
3. Community-led Renewable Energy Projects
4. Eco-tourism and Cultural Preservation

https://www.linkedin.com/pulse/empowering-local-communities-sustainable/

Here are some key areas where engineering can contribute to sustainability:

12. Education and Awareness:

- Promote sustainability education in engineering curricula.



- Raise awareness among engineers and the general public about the importance of sustainable practices.

Here are some key areas where engineering can contribute to sustainability:

Integrating Sustainability into Engineering Curricula

1. **Infusing sustainability into core courses**
2. **Offering specialized sustainability tracks**
3. **Incorporating practical projects**
4. **Collaborating with industry partners**

The Advantages of Sustainability Integration in Education

1. **Enhanced employability**
2. **Positive environmental impact**
3. **Long-term cost savings**
4. **Innovation and creativity**

https://utilitiesone.com/integrating-sustainability-concepts-into-engineering-curriculum-engineering-for-a-greener-future

CONCLUSIONS

Benefits of sustainability engineering

1. **Environmental benefits**
2. **Resource efficiency**
3. **Enhanced quality of life**
4. **Cost savings**
5. **Social and economic benefits**

Challenges of implementing sustainability engineering

1. **Cost**
2. **Limited resources**
3. **Complexity**
4. **Regulation**
5. **Public perception**

- Overall, there are many challenges to implement sustainability engineering. However, these challenges can be overcome by developing strategies to address them, such as finding ways to reduce costs, seeking funding and other resources, building partnerships and collaborations, and engaging with stakeholders and the public.

https://ugreen.io/sustainability-engineering-addressing-environmental-social-and-economic-issues/#:~:text=Engage%20the%20community%3A%20sustainability%20engineering,is%20responsive%20to%20local%20concerns.

At Last……

Collaboration among engineers, scientists, policymakers, and communities is essential to create holistic and effective solutions for a sustainable world.

The celebration of World Engineering Day is an opportunity to promote engineering as a career and highlighting how engineering can change the world for the better.

The Day is an opportunity to engage with government and industry to address the need for engineering capacity and the quality of engineers around the world and develop strategic frameworks and best practices for the implementation of engineering solutions for sustainable development.

The celebration of World Engineering Day is also about promoting engineering as a career and how it is an opportunity to change the world for better.