For specific data please refer to the QR code

Energy Generation Calculations

To calculate the potential energy generation from each technology, we will use the provided data and standard efficiency values.

Piezoelectric Sensors

- **Efficiency**: Assume 15% efficiency as a standard value.
- **Energy per Vehicle**: Assume 0.05 kWh per vehicle (as a rough estimate).
- **Daily Traffic**: 500 vehicles per day.
- **Annual Energy Generation**:

$$\text{Piezoelectric Energy per Day} = 500 \times 0.05 = 25\,\text{kWh/day}$$
$$\text{Piezoelectric Energy per Year} = 25 \times 365 \times 0.15 = 1368.75\,\text{kWh/year}$$

  However, a study suggests that a 1 km stretch of piezoelectric road can generate about 44,000 kWh per year. For a 6 km stretch:

$$\text{Piezoelectric Energy per Year} = 44,000 \times 6 = 264,000\,\text{kWh/year}$$

Solar Panels

- **Efficiency**: Assume 18% efficiency.
- **Solar Irradiance**: Assume 1 kW/m².
- **Available Area**: 5000 m².
- **Sunlight Hours**: 5.5 hours per day.
- **Annual Energy Generation**:

$$\text{Solar Energy per Day} = 5000 \times 5.5 \times 0.18 = 4950\,\text{kWh/day}$$
$$\text{Solar Energy per Year} = 4950 \times 365 = 1,806,750\,\text{kWh/year}$$

  Alternatively, using the average solar panel output:

  - Each solar panel produces about 2 kWh per day. For 5000 m², assuming a typical panel size of about 1.6 m², you can fit approximately 3125 panels (5000 m² / 1.6 m² per panel).

$$\text{Solar Energy per Day} = 3125 \times 2 = 6250\,\text{kWh/day}$$
$$\text{Solar Energy per Year} = 6250 \times 365 = 2,281,250\,\text{kWh/year}$$

Kinetic Speed Breakers

- **Efficiency**: Assume 20% efficiency.
- **Energy per Vehicle**: Assume 0.1 kWh per vehicle.
- **Vehicles per Day**: 225 vehicles.
- **Annual Energy Generation**:
$$\text{Kinetic Energy per Day} = 225 \times 0.1 = 22.5\,\text{kWh/day}$$
$$\text{Kinetic Energy per Year} = 22.5 \times 365 \times 0.20 = 1642.5\,\text{kWh/year}$$

Cost-Benefit Analysis

Installation Costs

- **Piezoelectric Sensors**: Approximately ₹3.5 crores per km for installation. For 6 km, the cost is about ₹21 crores.
- **Solar Panels**: The cost can vary, but a typical range is ₹50 to ₹75 per watt. For a system capable of covering 5000 m², assuming an average efficiency and panel size, the cost could be substantial, potentially exceeding ₹10 crores.
- **Kinetic Speed Breakers**: The cost is not well-documented, but assuming a similar scale to piezoelectric systems, it could be high.

Annual Energy Savings

- **Cost per kWh**: ₹6.
- **Piezoelectric Annual Savings (using 264,000 kWh/year)**:
$$264,000 \times 6 = ₹\ 15,84,000$$
.
- **Solar Annual Savings (using 1,806,750 kWh/year)**:
$$1,806,750 \times 6 = ₹\ 10,80,45,000$$
.
- **Kinetic Annual Savings**:
$$1,642.5 \times 6 = ₹\ 9,855$$
.

Payback Period

- **Piezoelectric Payback Period**:
$$21,00,00,000 / 15,84,000 \approx 13.25$$
years.
- **Solar Payback Period**:
$$10,00,00,000 / 10,80,45,000 \approx 0.93$$

years.
- **Kinetic Payback Period**: This calculation is not feasible due to the high cost and low energy output.

Environmental Impact

Carbon Emission Reduction

- **Carbon Emission per kWh**: Assume 0.0007 metric tons of CO_2 per kWh.
- **Piezoelectric Carbon Reduction**:
$$264,000 \times 0.0007 = 184.8$$
metric tons per year.
- **Solar Carbon Reduction**:
$$1,806,750 \times 0.0007 = 1264.725$$
metric tons per year.
- **Kinetic Carbon Reduction**:
$$1,642.5 \times 0.0007 = 1.14975$$
metric tons per year.

Feasibility Recommendations

Most Feasible Technology

Based on the payback period and environmental impact, **solar panels** are the most feasible technology for your college. They offer a quick payback period and significant carbon emission reduction.

Implementation Plan

1. **Assessment and Planning**:
    - Conduct a detailed assessment of the solar potential and available space.
    - Plan the layout and installation of solar panels.
2. **Funding**:
    - Apply for government grants from the Education or Power ministries.
    - Explore private partnerships or CSR initiatives.
    - Consider crowdfunding or international research grants.
3. **Installation**:
    - Hire a professional solar panel installation company.
    - Ensure all safety and quality standards are met.
4. **Maintenance and Monitoring**:
    - Regularly inspect and maintain the solar panels.
    - Monitor energy generation and savings.

5. **Expansion**:
    - Consider integrating piezoelectric sensors or kinetic speed breakers in high-traffic areas for additional energy generation.

Timelines

- **Assessment and Planning**: 2 months.
- **Funding**: 3-6 months.
- **Installation**: 3 months.
- **Maintenance and Monitoring**: Ongoing.

Funding Options

- **Government Grants**: Apply through official channels.
- **Private Partnerships**: Negotiate with companies interested in CSR initiatives.
- **Crowdfunding**: Use platforms like Kickstarter or GoFundMe.

Visual Representation

Energy Generation and Costs Table

Technology	Annual Energy Generation (kWh)	Installation Cost (₹)	Annual Savings (₹)	Payback Period (Years)
Piezoelectric	264,000	21,00,00,000	15,84,000	13.25
Solar	1,806,750	10,00,00,000	10,80,45,000	0.93
Kinetic	1642.5	Not Feasible	9,855	Not Feasible

References

- Piezoelectric Sensors for Road Energy Generation
- Solar Panel Energy Production
- Kinetic Energy from Speed Breakers
- Piezoelectric Roadway Costs
- Solar Panel Costs