Eco-Spark Tile

Team Name: Green Squad

Problem Statement:

The urgent need for sustainable energy integration within high-traffic public spaces, such as airports and transit hubs, needs innovative solutions aligned with Sustainable Development Goal 7. This goal strives for affordable, dependable, and sustainable energy access for all. Conventional energy sources pose environmental challenges, driving the quest for cost-effective, eco-friendly energy alternatives to power public infrastructure sustainably.

What are Eco-Spark Tiles?

Eco-Spark tiles are specialized flooring components crafted from materials like crystals or ceramics. These tiles have the unique ability to generate electrical charge when subjected to mechanical stress or pressure, such as when someone walks or applies force on them. This distinctive property arises from the material's ability to convert mechanical energy into electrical energy.

When pressure is applied to these tiles, it causes a displacement of positive and negative charge centres within the material. This displacement results in the generation of an external electric field, leading to the production of electricity. In essence, Eco-Spark tiles capture the kinetic energy from footsteps or pressure and transform it into usable electrical power, making them valuable for harvesting energy from human movement in various public spaces.

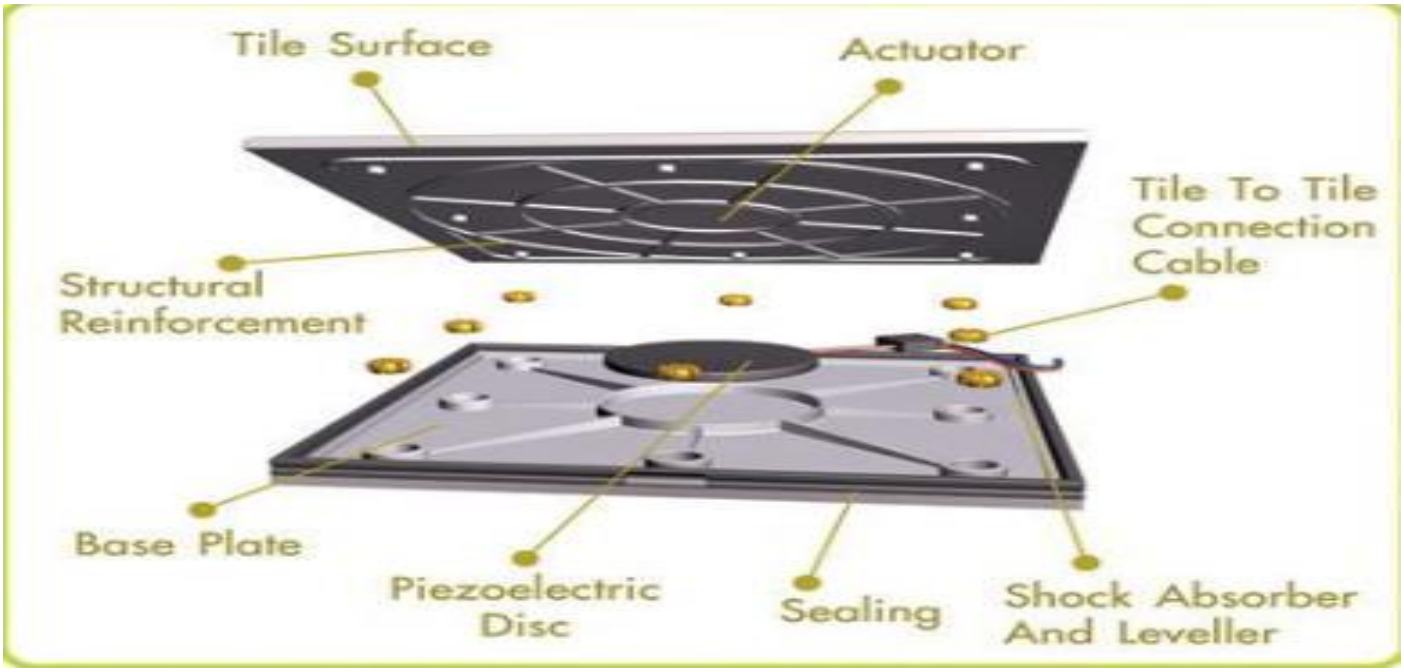
Supporting Schemes and Policies:

1) **Make In India:** Championing local materials and technology, the project embodies the ethos of indigenous manufacturing, supporting innovation within the country.
2) **Atmanirbhar Bharat:** Embracing indigenous materials, piezoelectric tiles mirror the self-reliance vision, highlighting innovation and self-sufficiency in technology.
3) **National Electric Mobility Mission Plan 2020:** Offering potential renewable energy sources for electric mobility, these tiles complement the mission's drive towards eco-friendly transportation.
4) **Swachh Bharat Abhiyan:** The use of recycled plastic aligns with the mission's goal of environmental cleanliness and sustainable waste management.
5) **National Action Plan on Climate Change:** Mitigating greenhouse gas emissions, these tiles play a pivotal role in India's efforts towards low-carbon development.

Beyond national policies, Eco-Spark tiles align with **Mission Innovation, Clean Energy Ministerial, Green Climate Fund, the Paris Agreement, and the Technology Mechanism**. Their presence aligns with the **Clean Energy Minitrial**’s focus on promoting clean energy deployment globally and echoes the aims of **Mission Innovation**, aimed at fostering transformative energy technologies worldwide.

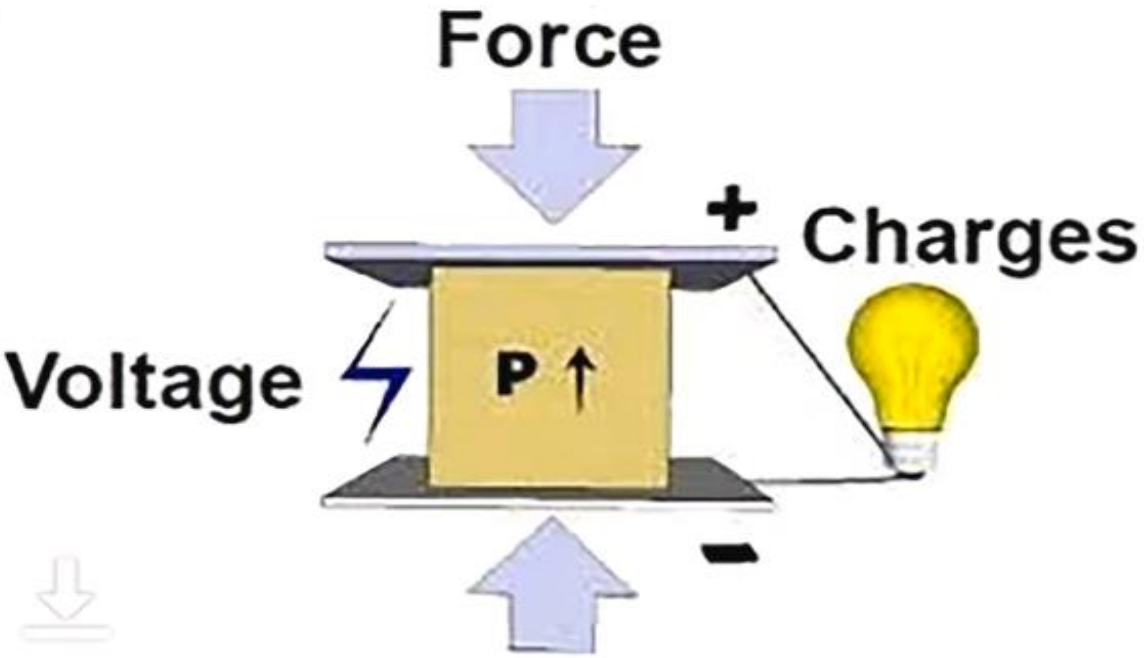
Furthermore, Eco-Spark tiles support the **Green Climate Fund**'s goals by presenting a practical means of generating renewable energy, contributing to mitigating greenhouse gas emissions. Their role in promoting clean and renewable energy sources harmonizes with the **Paris Agreement**'s aspirations of limiting global warming and combating climate change. As part of the **Technology Mechanism**, these tiles are an innovative technology-driven solution for sustainable energy generation, aligning with efforts to ease technology development and transfer for climate change mitigation and adaptation on a global scale.

How do Eco-Spark [Piezoelectric] Tiles produce electricity?



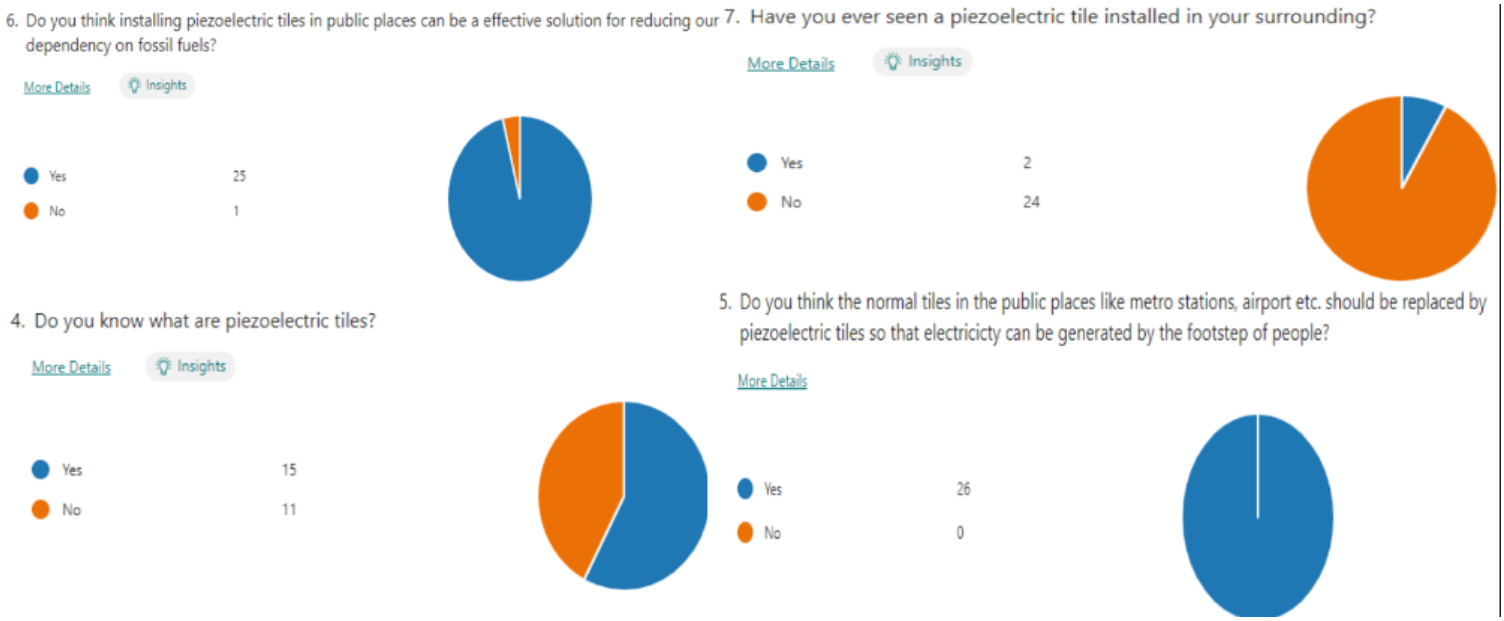
Piezoelectric tiles function through a phenomenon known as the piezoelectric effect. Crafted from materials like crystals or ceramics, these tiles have a unique ability to convert mechanical stress or pressure into electrical energy. When force is applied to these materials, it triggers a displacement of charge centres within their structure, generating an electric field across the material. This displacement leads to the separation of charges and the later production of electricity. Essentially, the tiles capture the kinetic energy from footsteps or pressure and transform it into usable electrical power. This innovative capability allows piezoelectric tiles to play a crucial role in harvesting energy from human movement in various public spaces, contributing to sustainable energy solutions.

We also plan to incorporate a coil with the composition 20% lead zirconate titanate and 80% stainless steel, aiming to harness typically wasted heat energy from conventional piezoelectric tiles. This innovative design looks to perfect energy use efficiently.



Survey:

Feedback from surveys conducted overwhelmingly supported the adoption of piezoelectric tiles in public spaces. Participants unanimously advocated for the replacement of conventional tiles with piezoelectric ones. While the majority showed a willingness to pay ₹10,000 for these tiles, the project's estimated cost is notably lower at ₹2,000. This substantial cost difference positions the project as an affordable and appealing solution for sustainable energy generation in high-traffic areas.



Cost Distribution of our Tiles:

Material Required	Cost
Waste Plastic	Re-Used [Minor Cost of Molding around ₹49]
Customised Sensor [Transducer]	99
Top Layer	199 - 699
Pressure Absorber	499
Caulk	99
Coil	99-499 [Size can be adjusted according to need]

The total cost of the project ranges from ₹1499 to ₹1999. By customizing the build, we have the flexibility to adjust according to our requirements, thereby reducing costs and enhancing energy production. This cost-efficient approach stands significantly lower compared to alternatives priced at minimum ₹10,000, making our solution a more affordable and effective choice for sustainable energy generation.

About our project:

Our project centres on developing and implementing piezoelectric tiles designed for sustainable energy generation in public spaces. Utilizing specialized materials and innovative construction methods, we aim to create cost-effective tiles capable of harnessing kinetic energy from foot traffic. These tiles, crafted from reused plastic as a base, incorporate piezoelectric sensors, pressure absorbers, and customized design elements to efficiently generate electricity. The electricity produced can either be stored in batteries or used directly, offering a green energy solution for high-traffic areas like airports and transit hubs.

Case Study:

Pragati Maidan, a renowned exhibition and convention center in India, witnesses a regular footfall averaging 1.5 lakh visitors during fairs. This high volume of traffic presented an opportunity to address energy demands sustainably. Conventional energy consumption at such a venue posed a challenge that called for innovative solutions to meet the power needs while promoting sustainability.

The introduction of piezoelectric tiles emerged as a solution to harness the kinetic energy from the constant movement of visitors. Specifically designed zones within Pragati Maidan were equipped with these tiles strategically placed in high-traffic areas like entryways, corridors, and main halls. The tiles, crafted for durability and aesthetic appeal, integrated reused plastic as the base material along with piezoelectric sensors, pressure absorbers, and innovative design elements. This integration seamlessly blended with the existing flooring infrastructure.

The installation of piezoelectric tiles not only served the immediate purpose of generating clean, renewable energy from foot traffic but also functioned as an educational showcase. It brought attention to sustainable energy solutions and highlighted the potential for implementing similar technology in other high-traffic venues. The project demonstrated the viability of harnessing kinetic energy and converting it into usable electrical power, thus contributing to the venue's green initiative.

Application at Various Locations:

Piezoelectric tiles offer an effective means of generating electricity in public spaces frequented by many individuals daily. These tiles strategically positioned in areas with substantial foot traffic present an opportunity to harness kinetic energy and convert it into usable electrical power, aligning with sustainable energy goals.

Airports, accommodating approximately 50,000 travellers daily, represent a prime location for implementing piezoelectric tiles. Installing these tiles strategically across terminals, security checkpoints, and check-in areas allows for the efficient capture of energy generated by passenger movement. This initiative not only generates significant electricity but also supports the airport's commitment to sustainable practices.

Beyond airports, piezoelectric tiles find applicability in various other bustling locations. Train stations, shopping malls, exhibition centres, and transit hubs serve as ideal settings for the installation of these energy-harvesting tiles. Placing them strategically in key areas like entrances, corridors, or waiting zones perfects the capture of kinetic energy from pedestrian movement, contributing substantially to electricity production while reducing environmental impact.

The strategic placement of piezoelectric tiles not only maximizes electricity generation but also eases significant cost savings. By effectively harnessing kinetic energy from foot traffic, these tiles diminish reliance on traditional energy sources, leading to long-term operational cost reductions.

Energy Produced (Calculated):

- Tile size: 15cm * 15cm = 225 square centimeters = 0.0225 square meters.

- Power generated per step on this tile: 1W.

- Approximate weight of each step: 1 kg only.

- Assuming the person consistently steps on each tile while walking 1 km.

To calculate the number of tiles needed to cover 1 km:

- 1 km is equal to 1000 meters.

- Assuming the person takes steps of approximately 50 centimeters (a common stride length), they would take around 2000 steps to cover 1 km (1000 meters / 0.50 meters per step ≈ 2000 steps).

Now, calculating the energy produced:

- Each step generates 1W on a single tile.

- If the person steps on a tile every step of the way for 1 km (2000 steps), that will result in 2000 steps * 1W = 2000W or 2 kW for the entire 1 km walk.

It is essential to consider numerous factors influencing the actual energy produced, such as the efficiency of energy conversion, step frequency per hour, and the force applied in each step.

Enhancements in tile design, like customized transducers and pressure absorbers, aim to maximize energy output while maintaining cost-effectiveness. These improvements not only increase electricity generation but also position piezoelectric tiles as a promising technology for sustainable energy solutions in high-traffic areas.

What makes our Project stand out?

Feature	Our Piezoelectric Tile Models	Existing Piezoelectric Tiles
Flexibility	Flexible design using eco-friendly caulk	Rigid structure reduces durability
Heat Management	Integrated coil (80% PZT, 20% stainless steel) to prevent heat wastage	Normal tiles produce excess heat, leading to energy wastage
Cost Effectiveness	Affordable at ₹1999 with customization options	Expensive installation costs
Installation Environment	Easy installation in public places (e.g., airports) for increased electricity generation	Limited electricity generation due to positioning
Water Resistance	Water-resistant with Acrylic caulk	Non-water resistant

VARIETIES OF OUR TILES:

The Eco-Spark Tile project boasts a range of options, supplying piezoelectric tiles in assorted designs, shapes, sizes, and colours. These tiles are available in an assortment of visually appealing designs, catering to diverse preferences and aesthetic tastes. Whether it's ceramic finishes, marble textures, or vibrant patterns, the project ensures a wide selection to suit different architectural styles and environments.

Here are some sample designs:

CERAMICS:

MARBLE:

DESIGNS:

Important sensors and tools used in our model:

- **PIEZOELECTRIC SENSORS**- These sensors serve as the cornerstone of the tile's functionality, converting mechanical stress from footsteps into electrical energy. Custom-built piezoelectric sensors are strategically embedded within the tiles, capturing kinetic energy efficiently and converting it into usable electricity.
- **CAULK**- These sensors serve as the cornerstone of the tile's functionality, converting mechanical stress from footsteps into electrical energy. Custom-built piezoelectric sensors are strategically embedded within the tiles, capturing kinetic energy efficiently and converting it into usable electricity.
- **PIEZOCERAMIC MATERIAL**– The use of piezoceramic materials ensures the robustness of the piezoelectric sensors against elevated temperatures, specifically safeguarding them from damage caused by curie temperature. Additionally, these materials enhance the charge coefficient, perfecting the efficiency of electricity generation.
- **CUSTOMISED TRANSDUCER** – A key element, the customized transducer seamlessly integrates into the tile's design, enhancing overall efficiency in conjunction with the coil. This tailored design maximizes functionality and performance, ensuring best energy conversion from mechanical stress.
- **COIL-** The coil, forming 20% PZT (Lead Zirconate Titanate) and 80% stainless steel, serves to harness heat energy typically wasted in conventional piezoelectric tiles. This innovative design aims to perfect energy use effectively, further enhancing the tiles' efficiency.

FUTURE ASPECTS:

- Q = F * d * b/a [Where Q is produced charge; F is the forced applied; d is the piezoelectric coefficient of the substance used to make the transducer; b is the width; a is the thickness]

- Hence, to increase the charge produced:

1) We will customize the transducer by shape, size and material used to make it unlike in the prototype.
2) We will increase the width (surface area) and decrease the thickness of the transducer.
3) The dimensions of our tiles are 2 ft by 2 ft which we plan to increase to enhance efficiency and improve design.

- The project emphasizes the incorporation of specialized pressure absorbers and caulk between tiles. These components are added to manage force distribution more effectively across multiple piezoelectric sensors. By enhancing tile flexibility and waterproofing through the application of caulk, this innovation aims to safeguard the sensors and increase the overall durability of the tile infrastructure.

Links and Other Resources

Video:
https://youtu.be/MlrrisDAcx0?si=asulAOWSxdYGFfbv

Website:

https://green-squad.netlify.app/