AAKRUTI Global 2024

Shaping Imagination

Theme: Green Energy generation,transmission and storage

Team: Delta
Team ID: AG24-1400610
College: IIT INDORE

Product: HexaEnergy Tyre

3DEXPERIENCE® Edu

SOLIDWORKS

Team Delta

Name : Sumit Sarkar
Mail Id:me230003075@iiti.ac.in

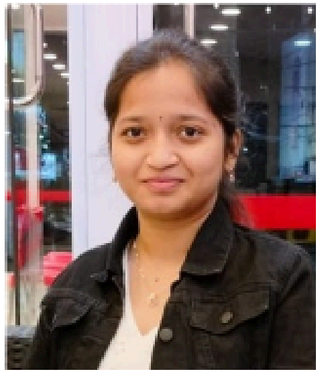
Designation: Team Leader

Name :Davinderpal Singh
Mail Id:me230003020@iiti.ac.in

Designation: Member

Name :Nambiar Anand S
Mail Id:me230003046@iiti.ac.in

Designation: Member

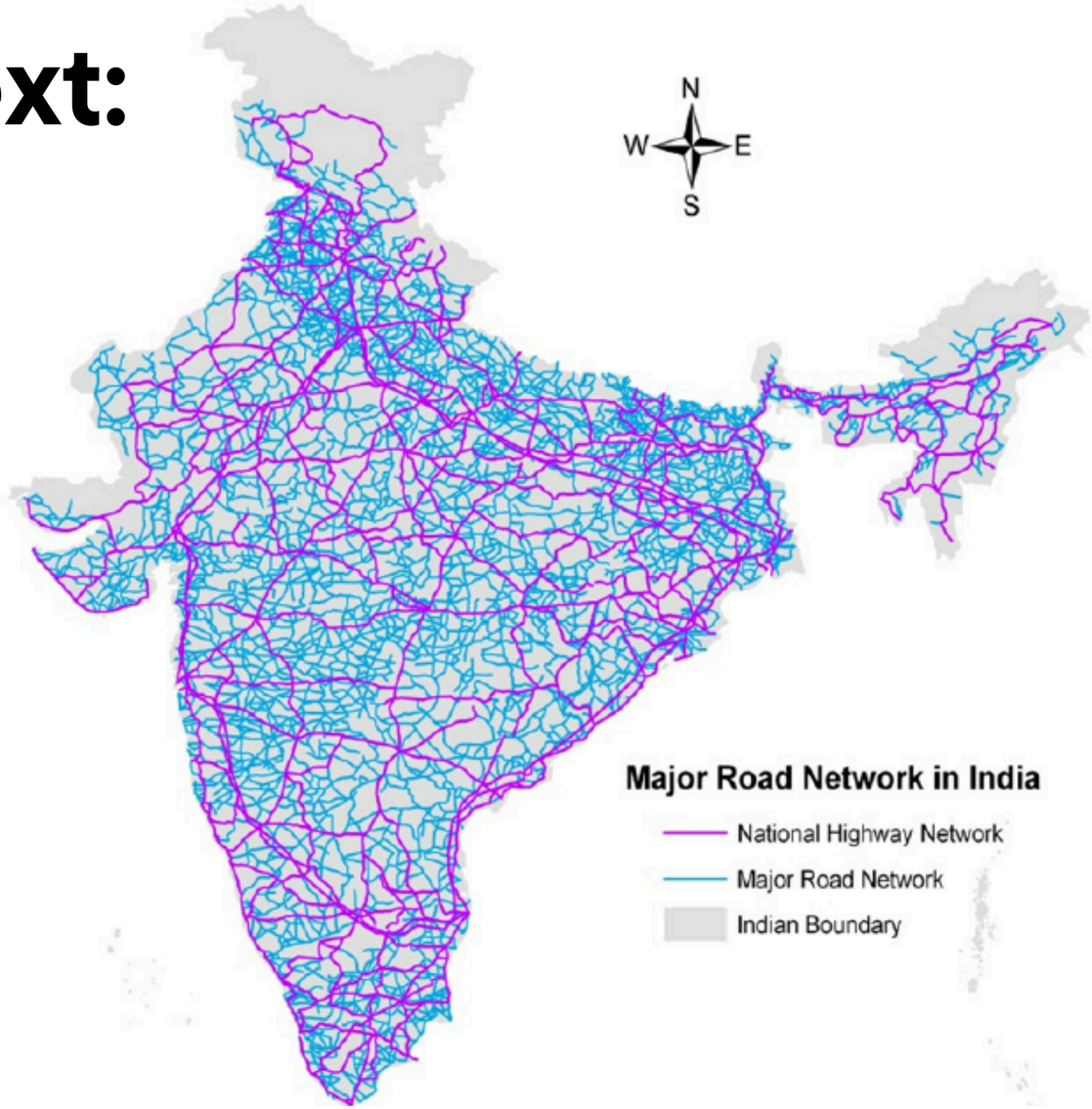


Name : Sri Varsha Dodda
Mail Id:me230003074@iiti.ac.in

Designation: Member

Within in the Indian Context:

- High Traffic Density
- Suboptimal Road Conditions
- Rapid Expansion of Roadways
- Eco-friendly focus



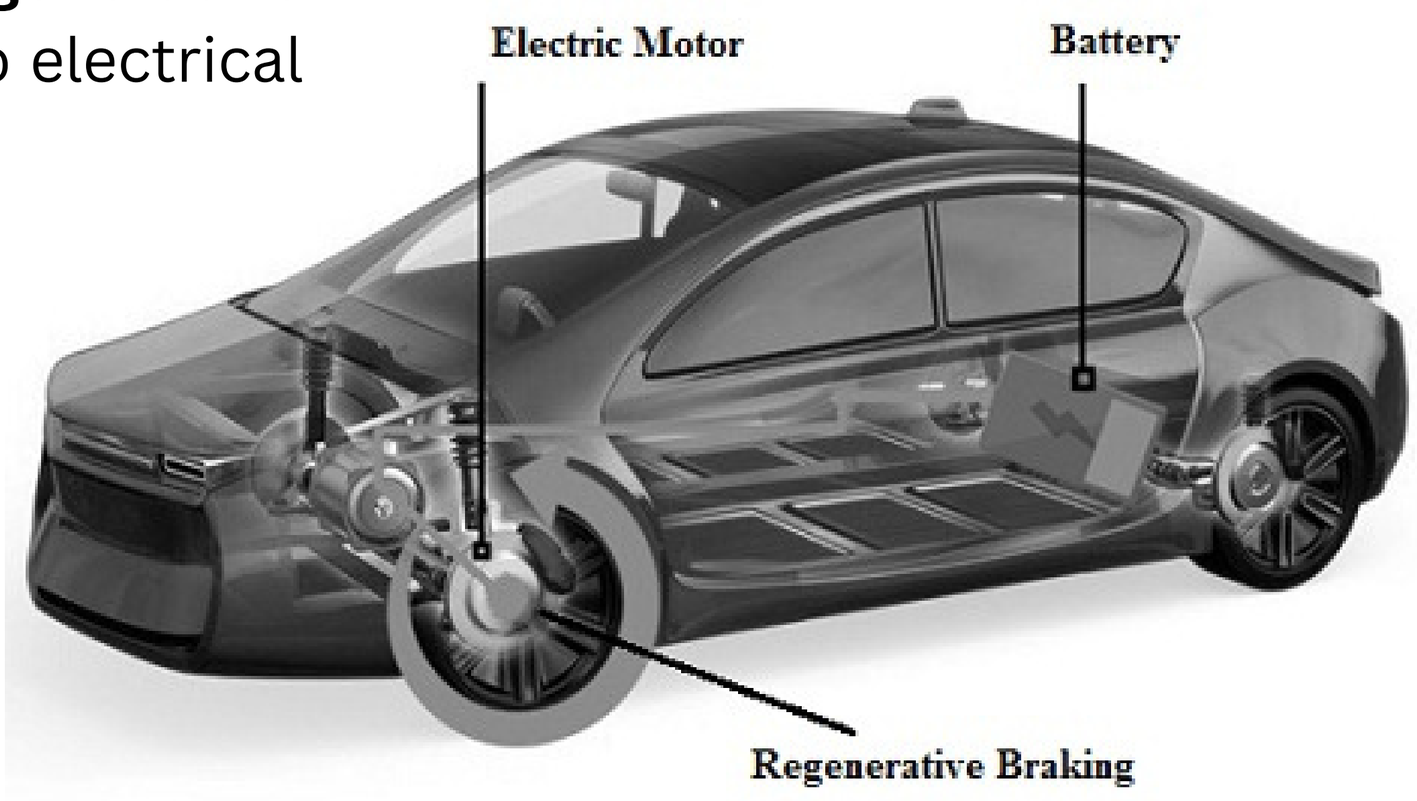
- Traditional tires mainly serve to give traction and movement
- There is a huge loss of energy in form of heat and friction
- Current challenge lies in harvesting a secondary source of energy from vehicle components in real time
- Tires being in constant motion, have huge potential for this

Market Research Findings

- Drivers and Automotive manufacturers are seeking for energy efficient, low maintenance and easy-to-integrate solution
- Comfort, Durability and Quiet operation
- Market survey highlights a gap for energy generating tires

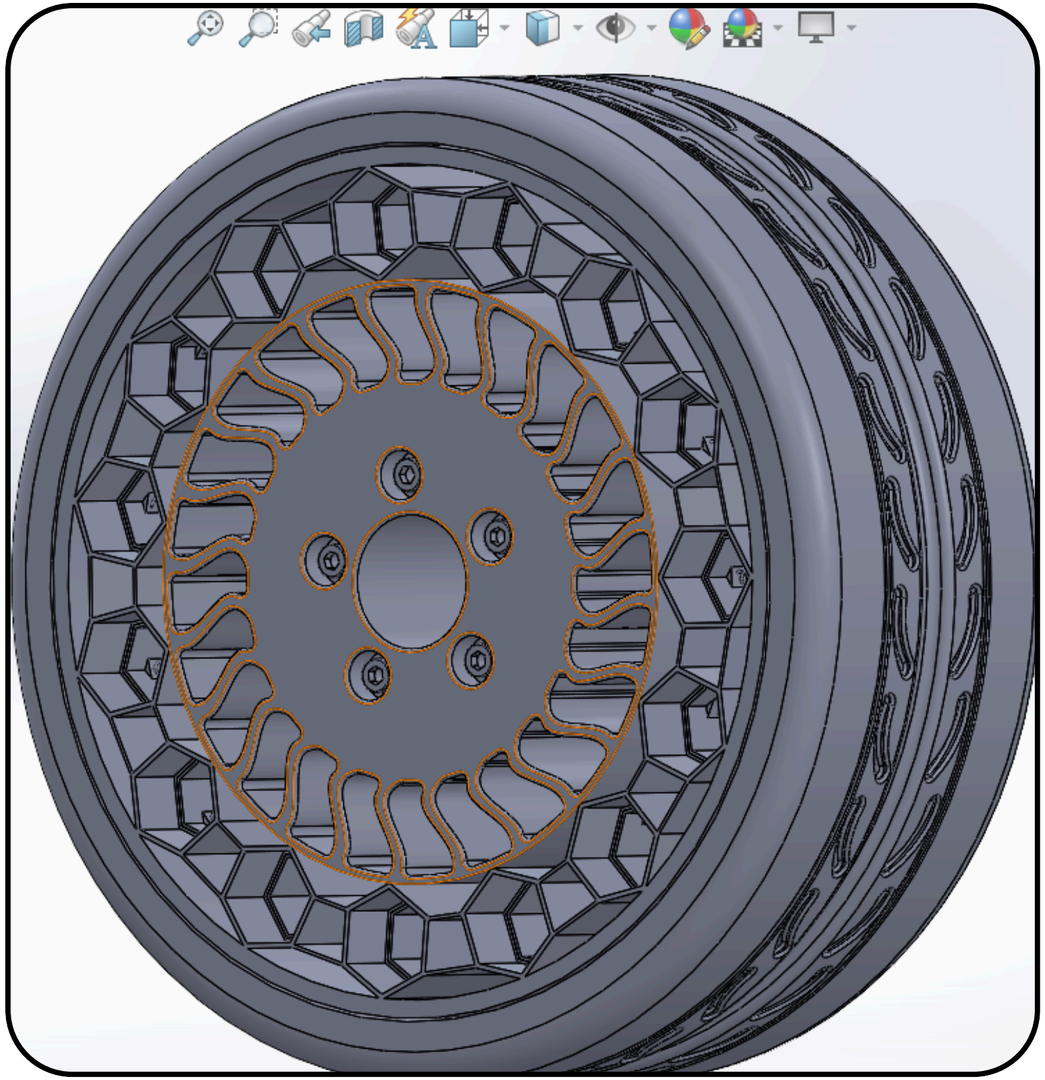
One of the current solution which focus on sustainable energy production is **Regenerative Braking System** which converts KE to electrical energy

- Highly dependent on Driving Conditions
- Limited Energy Generation
- High maintenance
- No continuous Generation



HexaEnergy Tires

- Hexagonal internal structure enhances both mechanical stability and energy conservation
- Effective Load distribution and Efficient usage of material
- Non pneumatic tires and mechanical efficiency guarantees lower maintenance, longer life span
- Larger surface area for better energy capture



HexaEnergy Tires

- TENG integrated tire addresses the need for continuous energy generation
- High power density from small displacement
- Light-weight and flexible integration to the hexagonal structure within tires
- Capable to power auxiliary electronic systems, sensors and HVAC system

Product Design Specifications

Components Required

- Slip Ring
- TENG
- HoneyComb Frame (TPE)
- Central Frame

Technical Requirement

HexaEnergy Tyre utilizes the principle of **Triboelectric Nanogenerators** to convert mechanical energy into electrical energy.

Design Process

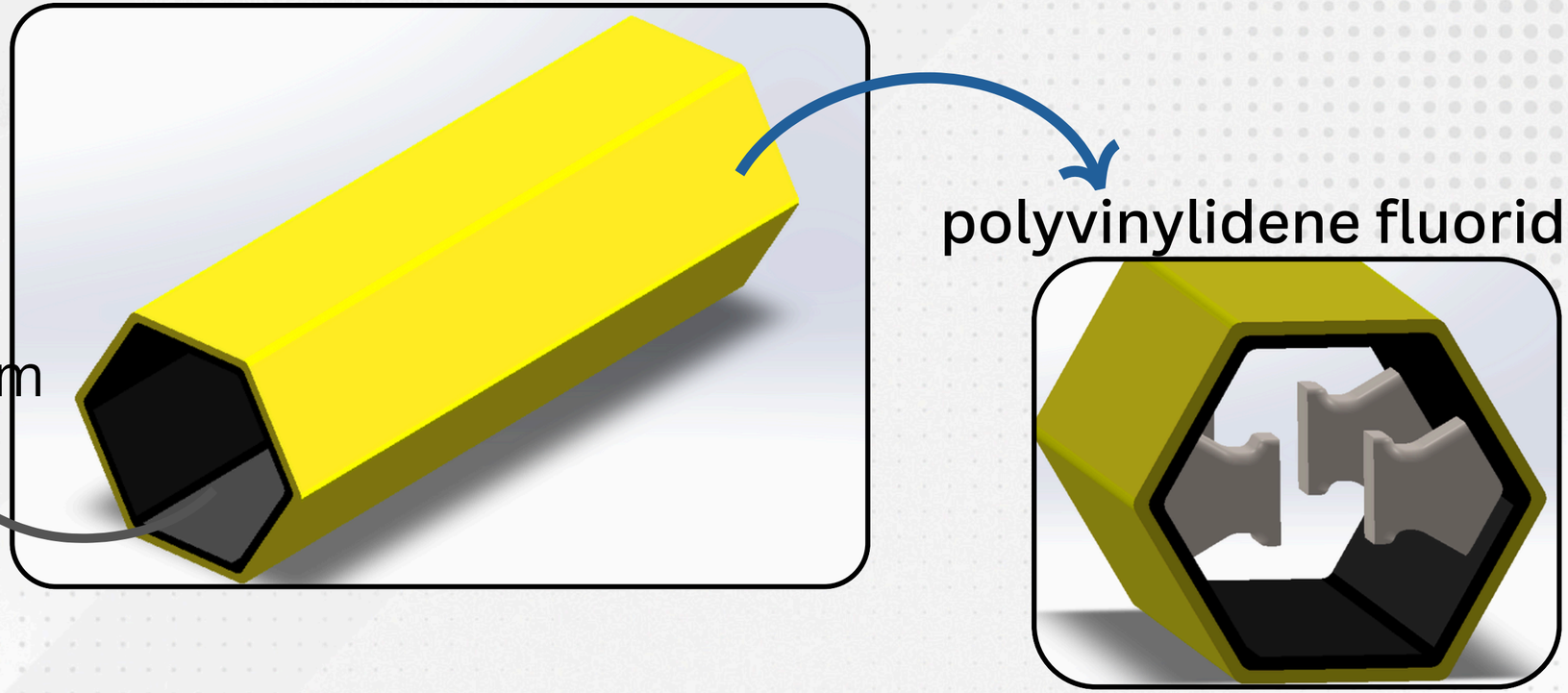
Why HoneyComb structure?

- Efficiently use the space
- Higher fatigue resistance
- Aesthetics

Why S-Shaped section?

This provides the Structural compliance to the tyre as the stiffenss is increased by the TENG

TENG:



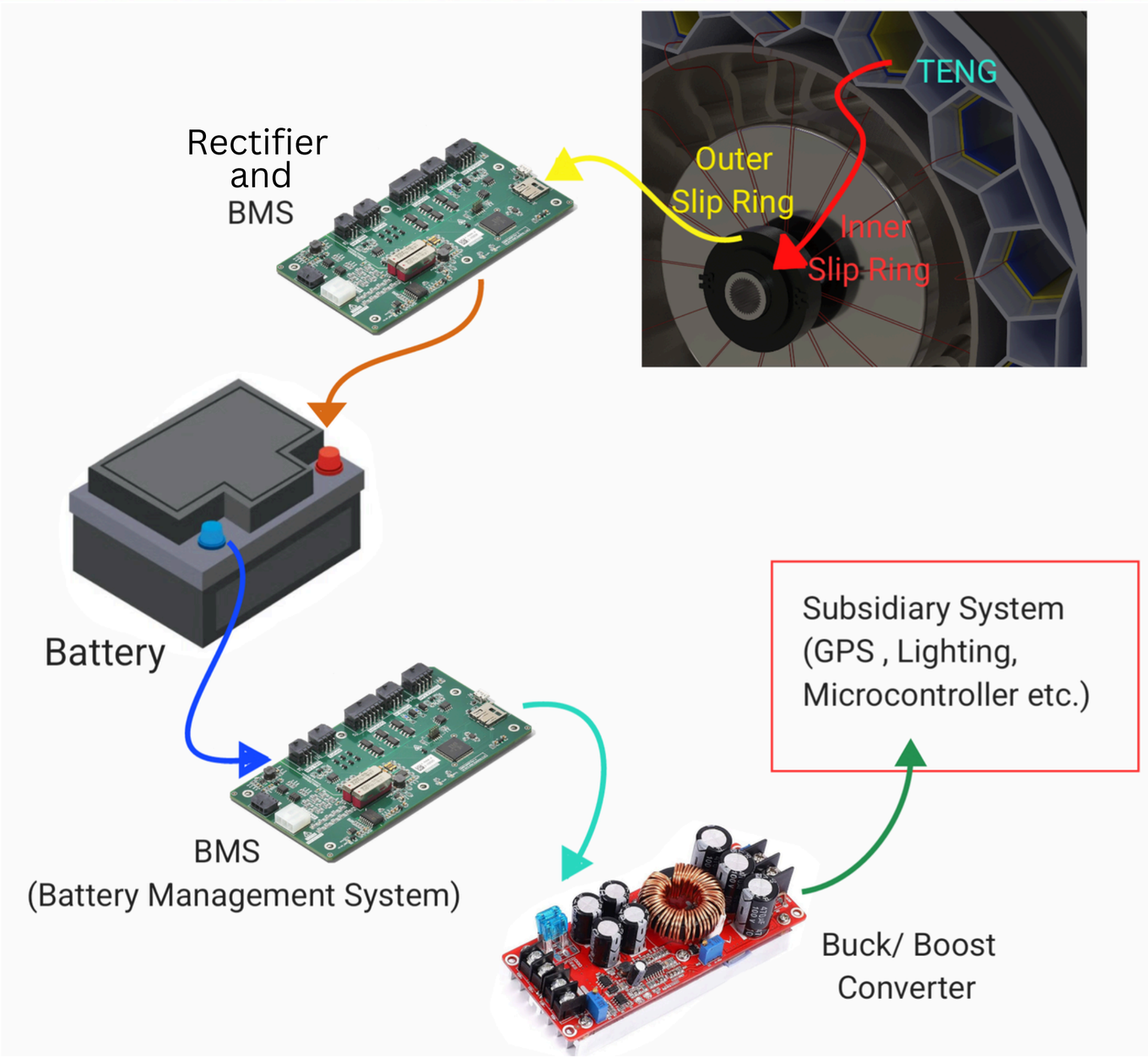
- Compression of the TENG occurs due to the impulses and self weight.
- Both the layers comes in contact and again separates.
- It Induces electricity due to electron transfer between the layers of triboelectrically positive(Aluminium) and triboelectrically negative surface(PVDF).
- Stopper mechanism for reduction of fatigue.

Energy Transmission:

Power is transmitted through a slip ring mechanism to avoid tangling of wires.
Slip Ring consists of 2 rings:

- **Inner Ring:**
  - Rotating Contact
  - Attatched to TENG components embedded within tire
  - Generated power transferred from TENG to slip ring system
- **Outer Ring:**
  - Stationary Contact
  - Attatched to Knuckle
  - Transfers Generated power to Storage Battery

Transmission from TENG to Subsidiary System

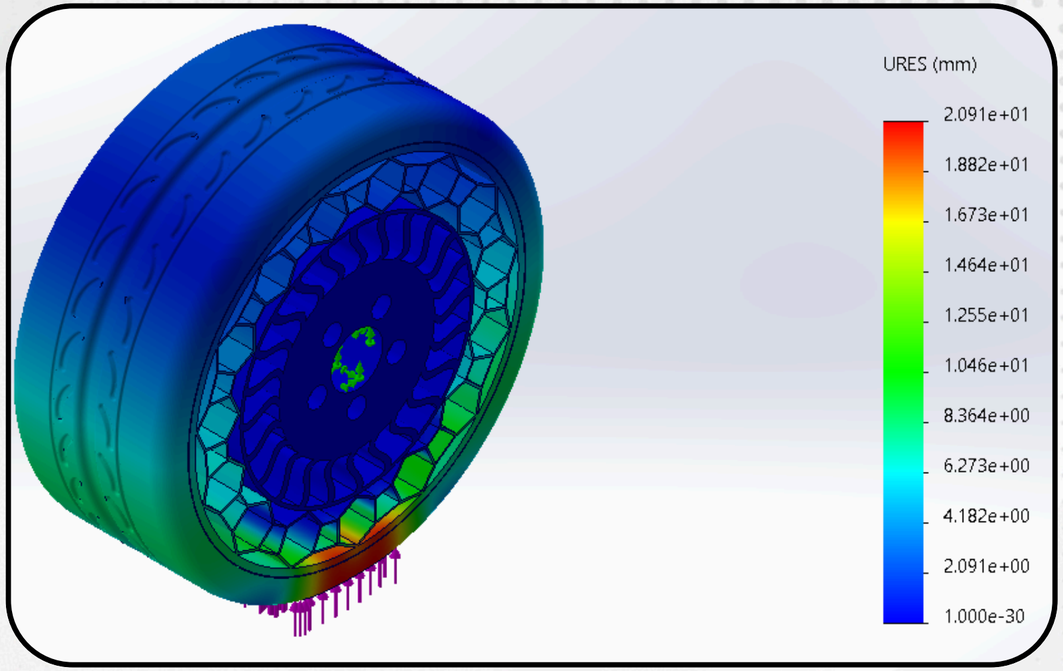


Product Simulation

FORCE APPLIED: 17000N
FIXED AT THE CENTER

MATERIALS USED:

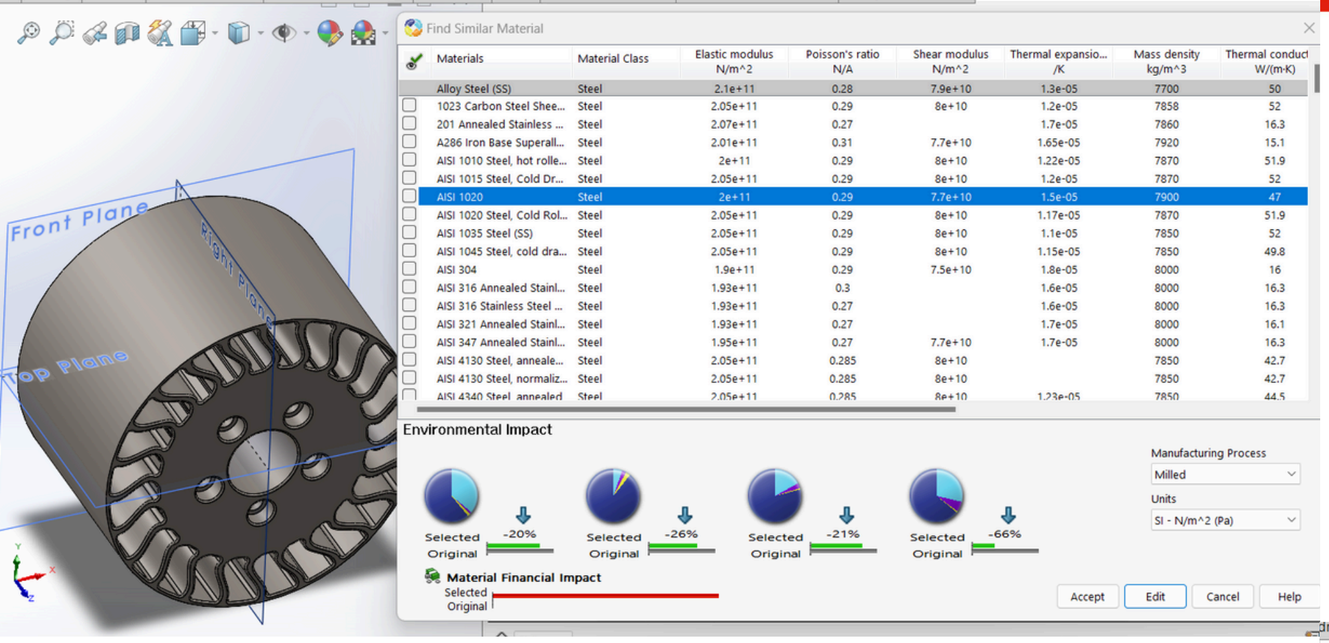
1. TPE FOR THE HONEYCOMB STRUCTRE
2. STAINLESS STEEL FOR THE CENTRAL FRAME
3. VULCANISED RUBBER FOR OUTER SURFACE

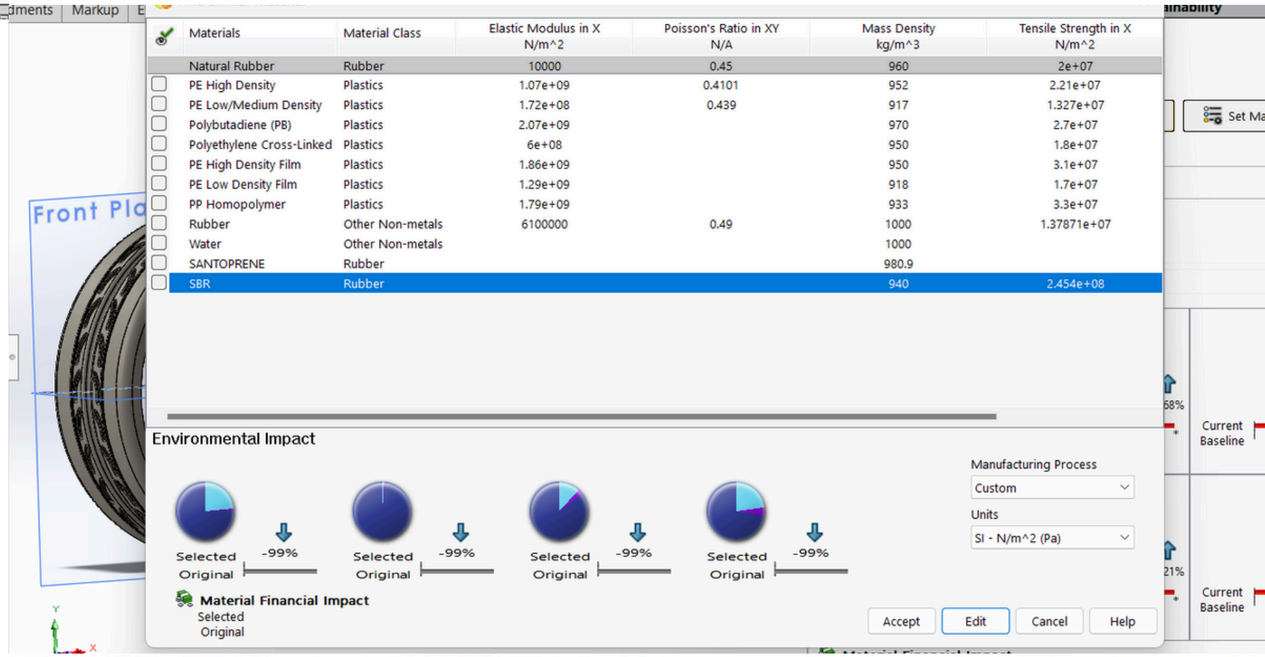


OUTPUT DISPLACEMENT: 21 mm

***TPE**: THERMOPLASTIC ELASTOMERS*

SUSTAINABILITY IMPACT TEST





Power Generation

Displacement (d): 21 mm (21×10^{-3} m)
Force (F): 17000 N
Frequency (f): 300 Hz (20× 15 Hz)
Permittivity of PVDF (ϵ): 2.1×10^{-11} F/m
Surface Charge Density (σ, Al-PVDF): 25 μC/m²
Contact Area (A): 9558 mm × 6 = 57348 mm² = 57.348×10^{-3} m²

Formulae

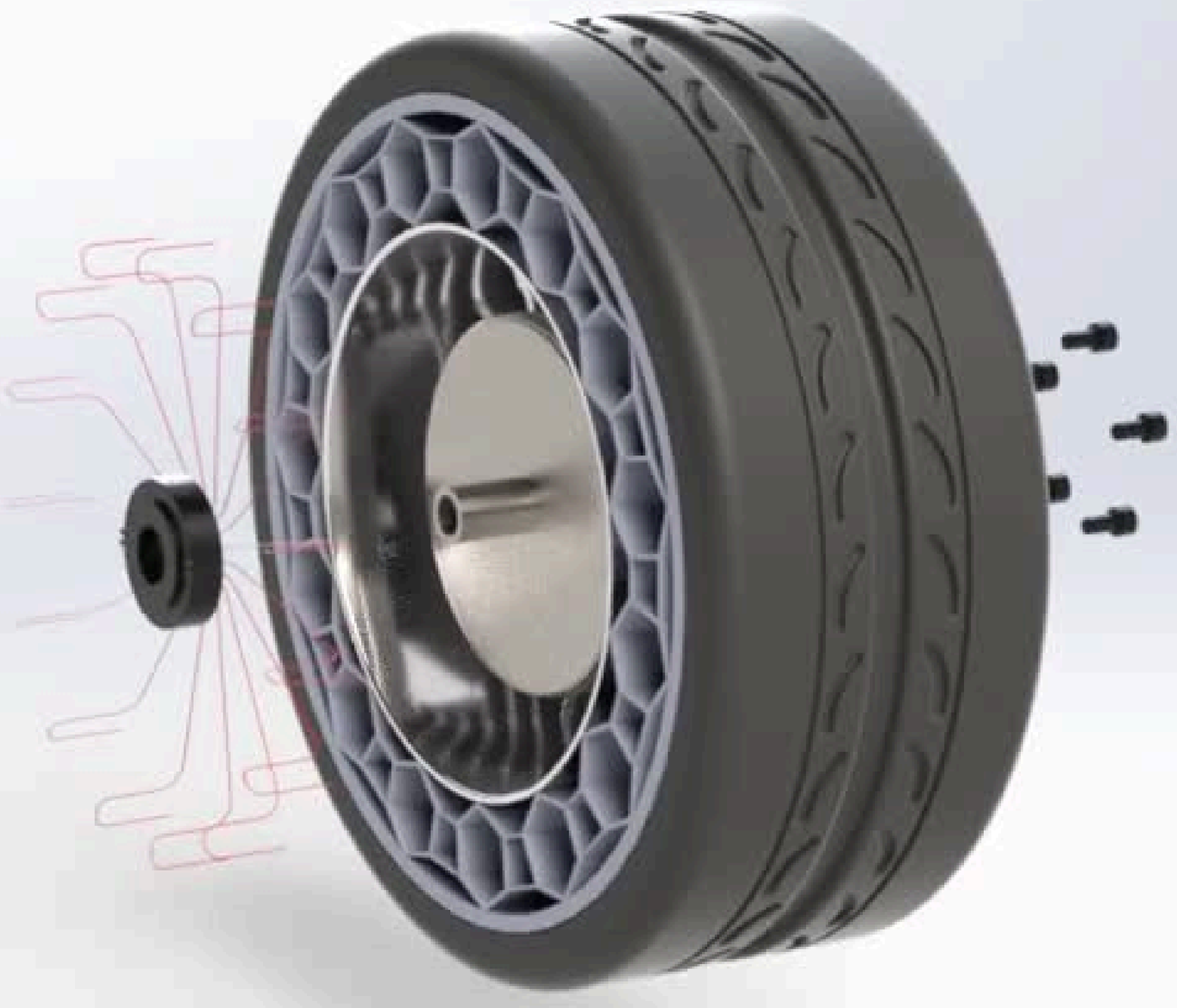
$C = \epsilon.A/d$

$Q = \sigma.A$

$V = Q/C$

$P = [(C.V^2)/2].f$

Final power generated : 5.4 W



Product Reflection

Benefits of the Product

- Harness vehicle's self-weight and road deformities to generate electricity.
- Electricity is used to run microcontrollers, lighting, and other subsidiary systems.
- Reduced reliance on external power sources.
- Airless tyres: Easy for Maintenance over traditional tyres.

Constraints:

- Wear and Tear of Tires
- Complexity in Manufacturing
- Energy Storage and Management
- Integration with Existing Systems

Impact of HexaEnergy Tyres

1. Optimized Energy Usage
   - Efficient power generation , minimal waste and energy loss
2. Reduced Environmental Impact
   - Eco-friendly materials and processes ; lower carbon footprint
3. Educational and Economic Opportunities
   - Skill development , innovation and job creation in emerging sectors
4. Encouragement of Technological Advancements
   - Drives innovation in energy harvesting and development of new technologies

Sustainability

- Fuel Consumption Reduction: TENG tires generate electricity from movement, reducing the need for engine power and saving fuel.
- Lower Carbon Emissions: By using less fuel, TENG tires help decrease greenhouse gas emissions, contributing to cleaner air.
- Energy demand reduced, lowering environmental impact.
- Stainless Steel (100% recyclable) and AISI 1020 steel are recyclable materials.
- Aluminum: reduction of 95% energy required to produce new aluminum.
- Polyvinylidene fluoride (PVDF) is easily recyclable without much loss of it mechanical properties.

Bill of Materials

Component	Price/unit (Rs.)	No. of Units	Total Price (Rs.)	Link
Tyre:				
Vulcanized rubber	100/kg	5.82 kg	582	https://www.indiamart.com/kgn-rubber-enterprises/rubber-seal.html?utm_source=Enqmai
TPE (Thermoplastic Elastomer)	150/kg	2.85 kg	427.5	https://www.indiamart.com/proddetail/thermoplastics-elastomer-tpe-9474966612.html
AISI 1020 Steel	54/kg	12.69 kg	685.26	https://www.indiamart.com/proddetail/sae-aisi-1020-steel-round-bar-7227991088.html
Slip Ring	4500/unit	1 unit	4500	https://www.indiamart.com/proddetail/wind-turbine-slip-ring-13865987212.html
M18 Nut-Bolts	17/unit	5 unit	85	https://www.indiamart.com/proddetail/18mm-ms-hex-nut-bolt-14090354591.html?srsltid=
TENG:				
Aluminum	270/kg	808.65 g	218.7	https://www.indiamart.com/proddetail/aluminum-marine-products-2850674554673.html
polyvinylidene fluoride(PVDF)	800/kg	424.8 g	339.84	https://www.indiamart.com/proddetail/ptfe-sheet-2854676884897.html
Stainless Steel (for Stopper)	210/kg	107.55 g	22.47	https://www.indiamart.com/proddetail/ss-304-wire-20171194955.html
Net Price			6860.77	

Business Plan

Senario	%Margin	Total Sales (in K)	Total Revenue (in L)	Total Cost (in L)	Profit (in L)
Partnership	0.15	39.1	5471.8104	4559.842	911.9684
Inflation	0.05	34	4996.0008	4163.334	832.6668
Marketing	0.1	37.4	5233.9056	4361.588	872.3176
Manufacturing efflciency	0.2	34	3806.4768	3172.064	634.4128

By 2028, Indian truck tire market may reach a demand of 34 million units.

Market Share (just entered) = 0.1%

Annual Sales = 0.34 lakh

Cost per unit(BOM, storage, transport etc) = **11662 INR**

Selling Price per unit (profit 20%) = **13995 INR**

Total Revenue = **47.5 Cr**

Total Cost =**39.6 Cr**

Profit = 7.9 Cr

Thank you!!