UNIVERSIDADE FEDERAL DE SANTA CATARINA

JOINVILLE - SANTA CATARINA - BRAZIL

CIRCULAR ECONOMY OFF-TRACK AWARD

Team EFICEM – Eletric and Combustion

By essence, EFICEM is an energy efficiency team that has the vision to contribute to the technological development of the automotive, mechatronics and composites industries, through sustainable and innovative solutions, in the management, conception and development of prototypes of energy efficiency. As well as values based on commitment to sustainability, people and processes, systemic vision, results orientation, innovation and teamwork. Therefore, we view sustainability and energy efficiency as pre-requisites for our projects. Encompassing the concept of circular economy, we can mention the following measures taken by the team to make projects increasingly sustainable, reusing materials, in addition to adopting materials less aggressive to the environment.

- Replacement of composites by discarded materials:

During the evolution of team projects, many kinds of materials have been tested in the construction of prototypes: steel, aluminum, PVC, composites (glass fiber, carbon fiber, natural fibers, etc). The most efficient configuration was the carbon fiber structural composites, which guarantee the lowest weight vs. structural capacity ratio, accordingly, we adapted our production methods to the carbon fiber. This fact was materialized in the project built for the Shell Eco Marathon Americas 2017 competition in Detroit, where the electric prototype Setta stood out as the lightest vehicle in the competition with its 21kg weight. Combining this advantage with other factors, we won third place in the category, broke the South American energy efficiency record in the electric category with 362km/kWh and months later, first place in Shell Eco Marathon Brazil 2017. Thus, the team incorporated carbon composite in all its projects.

Image 1: Old prototype made of Alluminium and glass fiber

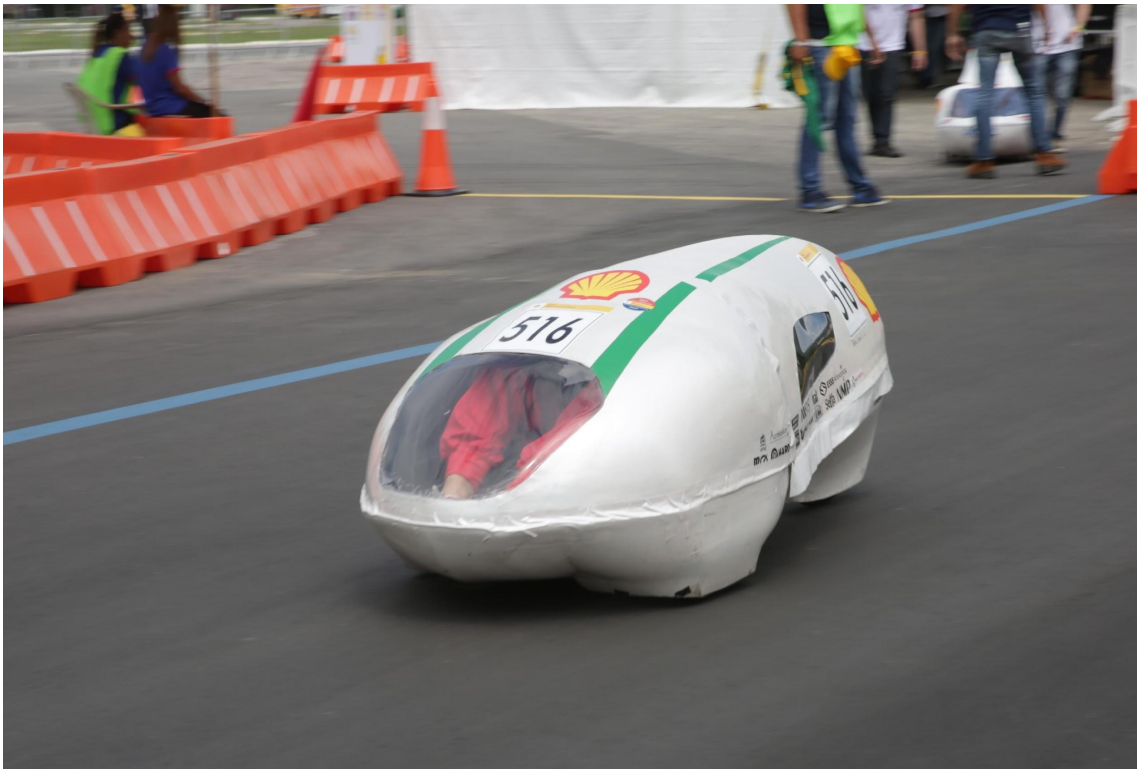

Image 2: Prototype Setta

Knowing the difficulty of recycling this type of material, the team began to take measures to mitigate its impact and try to minimize its consumption to the maximum. One of the first measures taken was the used parts of old cars in new projects, so pieces in carbon fiber that would be rejected began to be incorporated into new

prototypes. As an example, was the rear of the old combustion vehicle that was used as wheel protection for the new electric car.

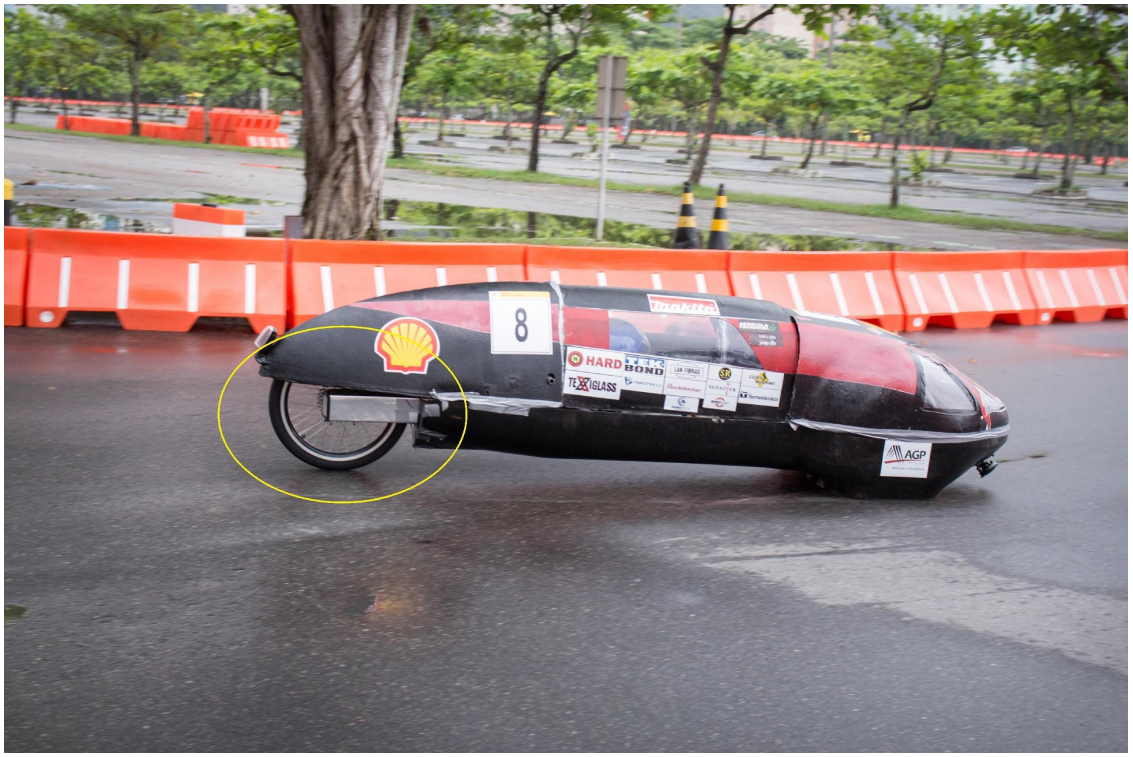

Image 3: The circled space in yellow shows the part of the car that was removed to be used as wheel guard on the other vehicle

Image 4: The yellow arrows indicate the wheel protection, made from the rear of the old car in image 3.

Another point was the replacement of lamination materials by similar materials:

- Inertial core

The inertial core is the material that goes between the carbon fiber layers to ensure structural stiffness of the part, by increasing the moment of inertia in the cross section of the object. We conventionally use divinycell sheets. As an alternative for this material, we started using EPS packaging and recycled food packaging material, which can be found in markets. The material has the same behavior predicted for divinycell. Previously it could not be used because it reacts with polyester resins, but since the team uses epoxy resins for carbon, the material no longer reacts and can be used in non-structural parts.

Image 5: Divinycell sheets

Image 6: EPS packaging

- Glass micro sphere

The glass microsphere is a very fine powder used in composite materials to fill cavities between the inertial core.

Image 7: Glass micro sphere

In order to avoid having to acquire this raw material, the team began to produce its own micro sphere. Thus, we produce the microsphere from parts of the old cars,

grinding, shredding these parts and transforming them into dust. This material has the properties of carbon fiber and inertial core, when mixed with resin again constitutes a lighter and more resistant composite, when compared to the glass microsphere.

Image 8

Image 9

Image 10

Image 11

Image 12: Images 8-12 represent the process to obtain glass micro sphere

- Model for mold manufacturing

The first models were made of processed wood, which requires not only a lot of wood, but also a lot of machining time. Together with one of our sponsors (Termotechnics, http://www.termotecnica.ind.br/sustentabilidade-reciclagem-de-eps/), who have practice in recycling processes of EPS and PET bottles, in a project of circular economy in force, we began to use recycled EPS blocks for machining the molds. This was one of the main advances in the production of the prototypes, allowing the team to produce a car in 3 weeks, by saving many hours of machining (energy), in addition to replacing the raw wood for recycled material.

Image 13: Old manufacturing method using wood

Image 14: New maufacturing method using EPS

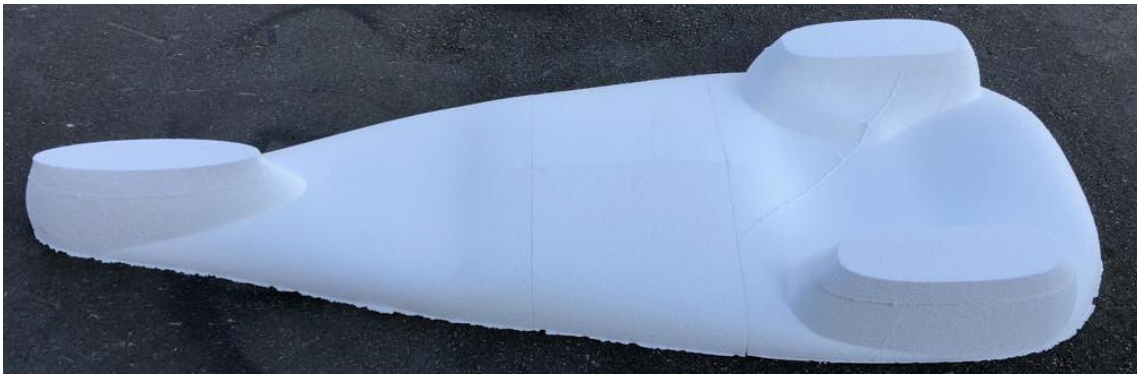

Image 15: Lower part of the car in EPS

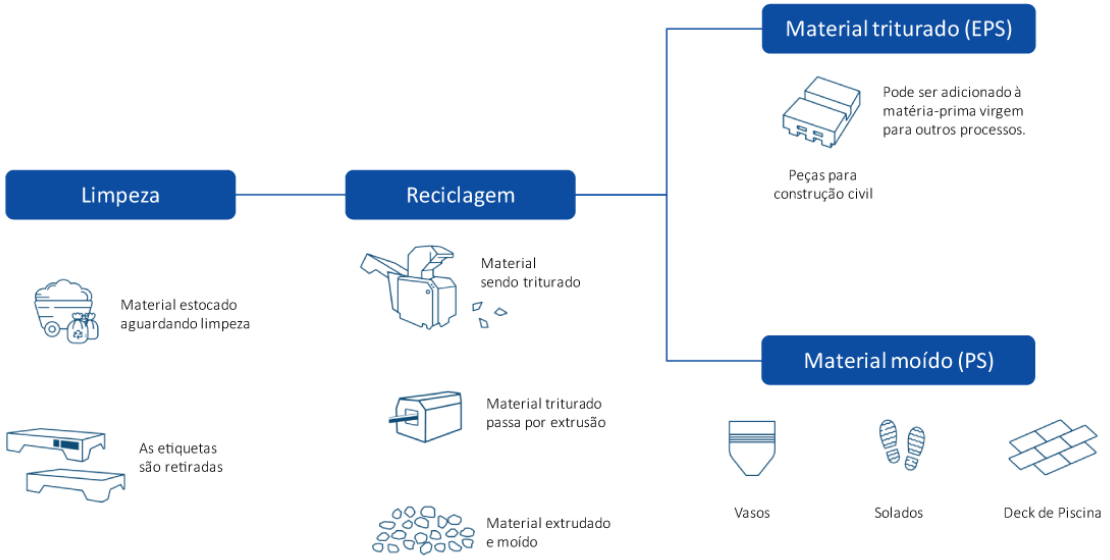

Image 16: Recycling scheme of the EPS

Termotécnica

- Natural Fibers

Among composites, natural fibers are the most sustainable materials. That's why the team started to adopt this type of material in non-structural parts of vehicles. More specifically, bamboo fibers.

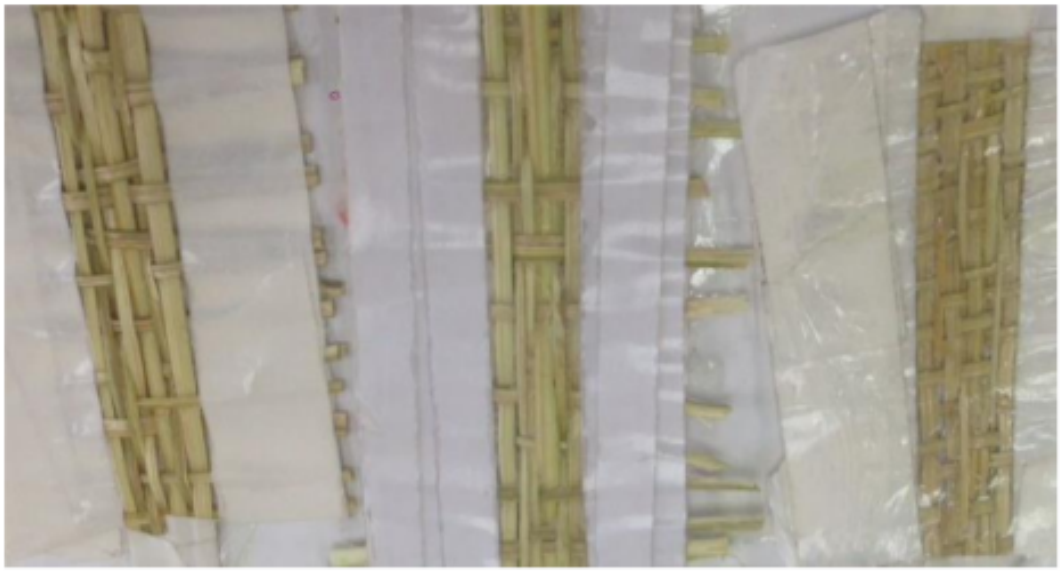

Image 17: Carnaúba fiber

● Eco-efficient inks

We use Thermo-off ink in our cars (https://www.thermooff.com.br/), which reduces the internal temperature of the cars, due to its differentiated technology. Avoiding the standard of automotive painting, the team found in this paint used in buildings, a sustainable option for the paintings, which currently have no ecological differential.

This specific paint has thermal properties that reduce the heat of the internal environment and has also won the ENEL ENERGY 2018 Sustainability Award, for having developed a technology capable of artificial photosynthesis. The ink, through photovoltaic reactions, reduces the temperature in the place and acts in the decontamination of air.

● Disposal wood:

The team uses waste wood obtained from the college itself, as well as from companies located nearby, for the construction of work furniture.

Image 18: Disposal wood used in the team’s work environment

Image 20: Disposal wood used in the team’s work environment

In addition to these achievements, the team has participated in the UN project of the 17 Sustainable Development Goals (SDGs), being present at events on the agenda and committed to the 17 goals in their daily lives.

Image 21: Event on the UN agenda of the 17 Sustainable Development Goals (SDGs)

● The team currently has a committed team to develop an Urban Concept. It is worth mentioning the following topics foreseen in the project for the year 2020:

● Use a bank of old notebook batteries as a power source for the electric powertrain.

● Install thermoelectric generators in disc brakes to convert the heat from braking to electrical energy.

● Install photovoltaic panels in the vehicle fairing.

● To use parts of the old cars in its construction.