warming. In multiple labs at the department, researchers have been working for many years now on magnesium and titanium-based alloys as alternatives to aluminium. These alloys have great potential to make automobiles and aircraft fuel-efficient by making them lighter than they are now and reduce carbon emissions.

Satyam Suwas, Chair of the department, has been leading efforts to make magnesium-based alloys a reality. These alloys are known to be stronger and lighter than steel and aluminium. "Magnesium alloys are anisotropic – on deformation they expand differently in different directions. Our focus was to reduce this anisotropy, so that the components made using this alloy will be perfect and would serve their purpose," he says. Another drawback is that magnesium alloys are not ductile enough to be made into parts, and that's also a challenge that the researchers at IISc are currently working on.

Electric vehicles

Just like the aviation sector, the transportation sector is also a major contributor to carbon dioxide emissions – around 23% of the total emissions in 2010, for example, according to the IPCC. Governments of many countries have been pushing for the adoption of electrical vehicles (EVs) with the goal of adopting a 'cleaner' method of transportation, and reducing emissions. But as much as they are touted as being 'zero-emission sources', they aren't really so if the source of the electricity supplied to such vehicles is itself not green. A major fraction of electricity supplied to cities is still from either coal power plants or other carbon emitting sources. In India, as of January 2022, renewable energy stands only at 38.56% of the total capacity. Continuing to use electricity from standard power sockets to charge your EVs does not technically reduce carbon emissions to zero.

However, one way to really achieve zero emission transport is to power the charging stations using renewable sources such as solar panels. Researchers at IISc have been testing the viability of setting up such zero emission EV charging points. Ashish Verma, Professor at the Department of Civil Engineering, and his team have set up one such charging point on campus behind the JRD Tata Memorial Library. Over a year, they tracked how much power was being collected and stored by the charging point and how frequently it was being used. The study, which was launched as an Indo-UK joint initiative, reported some positive results, and moreover was very well received by the IISc and Bangalore community, Ashish says. Many IISc community members had even purchased EVs with the reassurance that they could charge their vehicles on campus. But once the study was completed, the charging point was discontinued. "Many members of the community wrote to me enquiring about the charging point, expressing their disappointment on finding out that it was closed," says Ashish. Given the overwhelming response, he is currently working with the Institute administration to scale up the charging points on campus.

Photos courtesy: Ashish Verma

The zero emission EV charging point set up on IISc campus

But just one such point isn't enough. Would people buying EVs be able to find enough charging points across the city and state, and be able to make long-distance rides without worrying about running out of power? This is one of the challenges that Ashish's lab is trying to address. They have developed computer simulations and methods to optimise the locations where EV charging points can be installed after taking into account various factors, including the load on the power grid, usage, and population. Ashish and his team have been working closely with BESCOM, the government agency in charge of electricity supply in Bangalore, to set up optimal charging points and grid modifications.

The road for EVs has not been smooth so far. In the past few months, there have been various reports of EVs catching fire. Ashish says that while adoption might be hampered temporarily due to such incidents, he expects that the technologies will "mature" over the next 10 years, by which time more people would be more willing to adopt them. He argues that now is the right time for all the stakeholders to come together and set down ground rules for these technologies – standards for battery shapes and sizes, battery swapping policies and other battery-related needs.

Organic solar cells

EVs are only recent entrants in the energy race, but solar power-based energy generation has been around for several decades. Even though solar energy is considered a purely 'green' source, manufacturing solar cells can be both resource and energy intensive. First and second generation solar cells that are currently available in the markets are silicon-based and India does not have large reserves of silicon, leading to large imports and reliance on other countries. In the year 2021, silicon imports cost our country about USD 3.5 billion, with nearly 90% of the material coming from China, according to Mercom India Research, a clean energy communication and consulting firm.

“To fully harness the potential of sunlight and reach the goals of sustainable energy for all, solar cells made with organic and perovskite materials are key players,” says Satish Patil, Professor at the Solid State and Structural Chemistry Unit at IISc. He, along with other researchers at IISc, is working on enhancing the efficiency of organic and perovskite-based solar cells. These solar cells, which mimic the green leaves of plants that carry out photosynthesis, use photosensitive organic chemicals and polymers for light absorption and charge transport in order to produce electricity. They offer the promise of being less expensive, more flexible, thinner and more amenable to a wide range of lighting conditions, all of which make them suitable for a host of applications beyond rooftop and solar-farm panels, Satish says.

Photo: Manasi Venkatramani

The facility used to fabricate organic solar cells in the Solid State and Structural Chemistry Unit, IISc

Currently, Satish’s team has been able to achieve 17% power conversion efficiency for these organic solar cells. A major challenge in developing organic solar cells is their lifetime and durability, which depend on the stability of the molecules used. His team is currently evaluating several candidate molecules for their stability and efficiency.

Another challenge is integrating solar panels with greenhouses. Organic solar cells are particularly attractive, because their light-absorbing capacity can be tuned, and they are inexpensive, thin and light-weight.

Unlike silicon-based solar cells, the main advantage of organic photovoltaics is that they can be made semi-transparent. These solar cells can be installed above existing agricultural lands and greenhouses. The organic molecule is chosen such that the panels allow light that the plants require to pass through and absorb light from other parts of the visible light spectrum. “Making dual use of the land has several benefits, both in the context of climate change and economical benefits for the farmers,” says Satish, whose team plans to develop such semi-transparent cells.

Miles to go, and time too short

The ultimate question, however, is whether such innovations that happen inside the labs of IISc are enough to combat climate change on a large scale. Srinivasan says that while various scientists are doing their part in developing new technologies and improving existing ones, many of these technologies take years to materialise in the markets. He also stresses the importance of collaborations with industries as a driving force for research. In fact, the early efforts to study and develop magnesium-based alloys by Satyam and his colleagues at IISc was first initiated and funded by General Motors, who wanted magnesium-based alloys to manufacture lightweight parts for their automobiles.

Srinivasan also believes the current academic system needs to be revamped so that it rewards researchers who work on socially-relevant issues such as sustainability.

Climate change is a “problem that transcends generations,” as scientist and educator Carl Sagan put it, requiring efforts that are both large-scale and long-term. And time is running out to initiate them. “We have been using fossil fuels for more than 100 years and now we need to reduce carbon emissions to zero within the next 30-40 years. Unfortunately, right now, in most countries, leaders cannot plan beyond 10 years,” says Srinivasan.

During World War II, the US civilian industry was completely overhauled to make vast quantities of military equipment in an exceedingly short time frame. But such organised efforts shouldn’t wait until 20 million people lose their lives in a heatwave.

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