

Not merely public transport but green too

From Footprint to Toeprint

Sweden, with 90% of the vehicle kilometres traversed by the buses in its public transportation system being powered by renewable fuel – biodiesel, biogas, bioethanol and electricity – is a model to emulate. What it has achieved may seem utopian for a large democracy like India, but yet, as they say, if one aims for the Moon and misses, one at least lands among the stars.

G. Venkatesh



I have never owned or driven a car, despite having had the means always to have done so. Affinity to public transport has endured for long, be that to BEST and trains in Mumbai, or to service providers abroad. Yes, this has included three-wheelers and cabs too, and not just buses and trains, while walking has been the preferred option whenever time and weather have permitted.

However, while the economic and psychological benefits associated with not owning a car may not be very clear at the outset, one may derive satisfaction from using the bus and train and partaking – a very small share – of the responsibility

(accountability) for the carbon dioxide emissions resulting from across the life-cycle of the bus. Now if this bus stops using fossil-diesel altogether, then this footprint (or 'toe-print', in comparison to what one leaves when one owns and drives a car regularly), shrinks to almost nothing.

The transport sector is indeed a significant contributor to climate change and can play its role in meeting the Sustainable Development Goals set by the United Nations, and more so contribute to circularity by collaborating with other sectors in the economy by being the 'sink' for the energy content of reusable/recyclable streams emanating therefrom. Sweden

stands out as a model to emulate when it comes to greening the public bus transport system on a nationwide scale. This article is inspired by a PhD thesis written and submitted by Malin Aldenius recently at the University of Lund, in southern Sweden.

Good, but can always be better

On date, nearly 90% of all vehicle kilometres traversed by buses in Sweden is powered by renewable fuels. When we use the term ‘renewable’, a whole range of alternatives exists – biodiesel (rapeseed methyl ester, fatty acid methyl ester and hydrogenated vegetable oil), biogas (liquid or gaseous, and derived from a plethora of waste streams, digested separately or co-digested), bioethanol and electricity.

Now, each of these in predefined contexts – economic, socio-cultural, geographical and political – fares differently from economic and environmental standpoints. What is just good for one part of Sweden may be the best for another, and may just not be favourable at all for a third. By the same token, what is good in Sweden may not work at all in India for instance. Setting up a reliable and well-oiled (metaphorically as well as literally) public transport system – guided by affordability, accessibility and availability as the three main criteria – must be the goal of every local government (this may be the municipality or the state or national government, depending on how power and responsibilities are entrusted and flow). While this is desirable from a social perspective, greening the system must perforce follow, slowly but steadily and surely.

Sweden, for one, is motivated by EU regulations and also by its own national targets (which oftentimes is more challenging than the former). Political will meets public support, acceptance and awareness half-way and ensures that policies are implemented and taste success. Public-private partnerships based on what are perceived as common problems, often do very well. There is a strong awareness of social and environmental issues associated with the upstream of some of the biodiesel which is used in the buses. Thereby, local solutions have struck root and blossomed, thanks to biorefineries which process organic waste streams (from across several industrial value chains). These will eventually gain a foothold in the future, and emerge as well-established suppliers of fuels like biogas and biodiesel, produced from locally-sourced organic waste streams.

Hydrogenated vegetable oil which made a foray in 2014 has already become popular enough to dominate the bus transport fuel mixes in several regions. This is a sustainable and durable valorisation approach adopted for vegetable oil waste streams from homes, restaurants and hotels. While biodiesel is the cheapest and most tried-trusted-tested option which service providers resort to, when no specific fuel-use requirements are laid out by the procuring bodies, biogas has established itself as the fuel of choice, in southern parts of Sweden. This, evidently, is due to the higher density of population and thereby the greater availability of organic digestible waste streams for the production of biogas, which is compounded by the fact that the southern region of Sweden experiences higher average temperatures which favour anaerobic digestion.

The next leap would be towards buses powered by electricity (which are in vogue in China now more than anywhere else in the world) – those with no emissions on the road, when battery powered, as well as those with emissions of just water vapour when powered by in-situ hydrogen fuel cells. However, where the electricity to charge the batteries comes from, the required charging frequency and the availability of charging stations (top-up or depot) will be decisive factors in the introduction of and the possible subsequent proliferation of electricity-powered buses.

In Sweden, the cap on hydropower has been reached, and for environmental reasons, there will not be any installations of new hydropower plants in the future. Nuclear energy will also be phased out gradually. The question then is where will the additional power for battery-buses come from? Imported hydropower from Norway on the Nordic grid, wind or solar energy added on within Sweden, combined heat and power plants powered by wastes, or newly-installed gas-fired power plants?

First things first

In India, if all the sewage is collected and treated, and the sludge is digested to generate biogas, one could think of biogas-powered buses, at least in many big cities, one after the other. This would be a big leap over the compressed-natural-gas-powered vehicles, which do have a carbon footprint, albeit smaller than the ones running on fossil-diesel or fossil-gasoline.

First things first then, in India. How about biorefineries (refer to an article by this author published in *Science Reporter* earlier, focusing on circular bio-economy in India) utilising the humungous volumes of organic wastes from fields, farms, forests and the food chain, to produce biogas among other useful products. Food waste that cannot be consumed otherwise as donated food, or ‘direct feed for animals’, can be valorised in such biorefineries. Hydrogenated vegetable oil can very well be looked upon as evidently, vegetable oil waste streams abound in India.

There is a lot to learn from the way organisations in countries like Sweden function, by defining common problems and working together on mutually-agreed-upon solutions. The way things have to work in any well-functioning democracy. The belief that things may be good but can always be better needs to be ingrained in the hearts and minds of administrators, entrepreneurs, researchers and the general public.

To begin with, try weakening the control your car has over you. Motivate and inspire other car-owners around you to do likewise. That may be the match which may start the ‘forest fire of change’. In other words, as Mahatma Gandhi said, try being the change you wish to see around you.

Acknowledgements: Malin Aldenius, for her PhD thesis – Steering Green Buses, submitted at the University of Lund, in Sweden.

Dr G. Venkatesh is Associate Professor, Department of Engineering and Chemical Sciences, Karlstad University, Universitetsgatan 2, Karlstad, Sweden – 65188.
E-mail: Venkatesh.govindarajan.se