सत्यमेव जयते

SCIENCE & TECHNOLOGY CLUSTER

Flagship programme of the Office of the Principal Scientific Adviser to the Government of India

Whitepaper on the roundtable discussions on

"The role of science and technology in creating a sustainable future"

Held on 9th December at Le Meridien, New Delhi as part of

RESOLVE 2.0

Second edition of DRIIV's annual flagship conference

Contents

1. Context

'RESOLVE 2.0', the second edition of DRIIV's annual flagship event that brings key stakeholders from the industry, academia and government bodies together to deliberate on imperative environmental and societal issues that can be addressed with the use of science and technology, was held on 9th December at Le Meridien, New Delhi, in a roundtable format. There were three sessions covering – a) Sustainable mobility, b) Air pollution mitigation and c) Solid waste management and water security.

This paper summarises the discussions of the roundtable with a view to solve some of the pressing problems identified by the stakeholders by forming task forces comprising of relevant stakeholders and initiating pilot projects. Policy recommendations are also being made as required, for further action.

The list of participants is included in the appendix.

2. Session 1 – Sustainable mobility

2.1. Summary of discussions

Dr. Arun Bhardwaj, Scientist G, Office of the Principal Scientific Adviser (PSA) to the Government of India (GoI), chaired the roundtable. He introduced DRIIV as the Delhi science and technology cluster, a flagship initiative of the Office of the PSA to GoI. He presented the thematic areas of DRIIV and complimented the rapid strides that DRIIV has made in building the innovation ecosystem. He also mentioned that any success story coming out of DRIIV will have the highest visibility, it being the National Capital Region. Furthermore, scale can be achieved via deploying the successful solutions via the other S&T clusters nationwide.

2.1.1. Charging management system including charging space management

Ms. Shipra, CEO DRIIV, opened the session with the first problem statement as received from Delhi Transport during a recent discussion. Two related points were laid out for deliberation – a) need for a common platform to enable discovery of EV charging stations or end users, and b) utilisation of public and semi-public spaces for creating a robust EV charging infrastructure in Delhi.

Ms. Roli Agrawal, Strategic Partnerships Leader, Google India, offered that Google maps could show locations of EV chargers. However, the foundational data does not exist yet and

there is a need to create an aggregated data pool. It is for the group to deliberate on what is needed to build that pool of data.

Prof. Panigrahi, head CART IIT D, added that there is no common platform for different charging or swapping points. Such a platform, when developed, should have intelligence about the traffic intensity and power utility network in the vicinity. He also noted that currently, depot charging mostly happens at night. Smart charging management is needed.

Mr. Ramkrishna Singh, Head of Business Operations (EVs) TATA Power, mentioned that new housing societies are mandated to have some dedicated EV charging facility. He added that TATA Power has already installed 70K home chargers, 5K+ public chargers and 600+ ultra-fast bus chargers. Delhi NCR is 3rd in EV penetration and developing a robust charging infrastructure is a priority. Tata Power is managing the EV data in a very intelligent manner with the help of Artificial Intelligence and machine learning for predicting charging demand, optimizing resource allocation, and identifying maintenance needs for efficient system operation. Moreover, we are tailoring charging experiences based on individual user preferences and vehicle types.

Interoperability and standardization are also needed for ensuring seamless charging experience across different networks and charging providers.

Mr. Arun Kapur, CEO JBM Group, stated that there are charging stations set up by the government, for which a plethora of information is available and then there are those set up by the private sector. He floated the idea of creating an 'EV Grid' featuring all the chargers, emphasising the need for standardisation. Such an 'EV Grid' should talk to vehicles for the range of charge, based on the distance to be travelled. He also raised the issue of the power grid being impacted due to overloading. He suggested that one possible way to create efficiency in charging management is to create an appropriate infrastructure. He explained that in AC distribution, energy losses are higher as compared to DC distribution, adding that JBM is working on a Central plaza system with DTC where 2-5% efficiency is expected at MW level per depot, simply by switching to DC distribution.

Mr. Singh clarified that 'EV Yatra' under Bureau of Energy Efficiency is collating the information of all the Charge Point Operators. We could use this information to make it more efficient and create the platform that was discussed earlier.

Ms. Neha Jain, Head EV and Innovation Ecosystem, MG Motors, spoke about 'discovery anxiety' which an aggregated platform should be able to solve. She also highlighted 'reliability anxiety', alluding to the problem of non-functional charging points even if they are discoverable. Ms. Jain underscored the need of the users for safe, comfortable, public places, where they can spend a few hours, till their vehicles are being charged. She shared that MG Motors is working on community charging, in liaison with real estate partners. Furthermore,

1000 chargers are being installed in public locations and RWAs are nominating their societies for setting up the charging infrastructure. **Prof. Panigrahi** discussed another anxiety that users suffer from, which is the lack of a skilled workforce to service an EV in case of a breakdown. He emphasised the need for reskilling the existing manpower to service electric vehicles.

Mr. Singh clarified that as per usage data, 93% of EV consumers currently use home charging, with only 7% using public charging. TATA Power's app allows the facility to schedule and pre-book charging. CPOs have taken care of the range anxiety and TATA Power is taking the lead on it. Dynamic pricing is a good initiative to be taken for enhancement of charger utilization and cost effective charging facility to consumers who does not have charging facility at home due to vehicle parking etc. Dynamic pricing is basically adjusting of charging fees based on demand, time of day, and energy source to incentivize efficient use of resources.

Ms. Roli observed that whilst there were several problems to tackle in this domain, we should identify areas of easy wins and see how this ecosystem can come together at NCR level to make a difference.

Mr. Rajan Varshney, Dy. GM NTPC, emphasised the need for reworking the charging schedule in depots. He also mentioned that supercapacitors are available elsewhere for fast charging and should also be brought to Delhi.

Mr. Anupam Saronwala, angel investor, highlighted the need for a framework at the State level, which would give some confidence to startups and their investors. **Mr. Subhash Goyal**, Chairman ICC, queried if existing petrol pumps can be mandated to install EV chargers. It was clarified that such a mandate already exists but space is the biggest constraint. Whilst an ICE vehicle takes, say, only five minutes to refuel, an EV takes a few hours. This implies that very few EVs can be charged during the course of the day in petrol stations within cities, where space is limited. Nonetheless, petrol pumps are installing EV chargers or swapping stations.

Mr. Pradeep Aggarwal, from BSES Rajdhani, made reference to Time-of-day tariff. Additionally, he mentioned that land available with schools and universities can be considered for public charging. Furthermore, route optimisation is also required to manage peak charging time. The charging management system should also be able to prioritise buses that are in greater need of charging.

Further, as per MoP Guidelines dated January 14, 2022 provides for EV charging stations tariff to not exceed "Average Cost of Supply" till March 31, 2025. Further, the revised Tariff Policy, 2016 provides that the appropriate commission would notify a roadmap such that tariffs are brought within ±20% of the Average cost of Supply. This would help in reducing burden on other categories of consumers.

Mr. Singh emphasised the need of a policy directive, where publicly available land with agencies such as the DDA, MCD, PWD, Discoms etc. should be used to develop public charging

infrastructure, with safe spaces where public can spend time while their vehicles are charging. These spare Govt. lands can be utilized for developing smart charging infrastructure along with the Shopping complex, Play zone, Food court and Offices etc.

Ms. Roli informed the audience about Google's Environment Insight Explorer, which can help identify ideal locations to install chargers.

2.1.2. Energy transition to solar, second life of batteries and battery recycling

Mr. Ramkrishna Singh, stated that for achieving Net Zero via EVs, transitioning the primary source of energy to renewable is key. As of date, TATA Power is already reducing 600T of CO2 emissions on a daily basis. The Delhi transport department has large land banks, where rooftop solar can be installed. Currently, ten depot charging facilities are being run by TATA Power. Each bus has 300-360 KW of storage capacity. For a 100 bus depot, 36MW of storage capacity would become available with renewable integration. This is also a great opportunity for Discoms. Moreover, Old battery packs of buses can be utilized for power storage in bus depots for charging in Non-peak hours and pushing the power in peak hours for cutting down the Grid peak demand.

PPP model can be developed for developing and maintaining the smart E-Bus charging infrastructure in Bus depot nationwide. Public-private partnerships (PPPs) can offer a promising approach to financing, developing, and operating bus charging infrastructure.

Prof. Panigrahi apprised that he is setting up a solar integrated charging point at IIT Delhi, where spent batteries from MG Motors and TATA Motors are being utilised for static storage, based on their remaining capacity. The idea is to also extend the usage of spent batteries for static storage in telecom towers that currently use diesel generators. Furthermore, damaged batteries can be recycled to extract precious materials. **Mr. Ramkrishna Singh** added that Vehicle-to-Grid is also a good alternative to which **Prof Panigrahi** agreed and said that he is coming out with another whitepaper on V2G.

Prof. Panigrahi shared that the CART lab is developing 5KV battery packs with a startup. These packs will be utilised for energy storage in conjunction with solar integrated charging points. These will also be used to replace diesel generators that have been used as power backups in public events and are now banned. A 100 KW battery truck has already been developed with these battery packs.

Mr. Singh remarked that the manufacturers should be responsible for recycling the batteries and provide public information on the same. He reiterated that rooftop solar combined with energy storage in recycled batteries is the solution for energy transition in EV space. 30 KW battery packs can be utilised in the absence of power supply.

Mr. Arun Kapur explained that regardless of the battery chemistry (NMC, LFP, LTO etc.) Li will stay for some time. At 80% State of Health (SOH), we need to start looking for repurposing of the batteries. JBM is working on creating a repurpose battery stack. These will be modular in nature. JBM requested that a quick project be set up with CART lab to develop these. The challenge is that BMS programming needs to be customised. It requires protocols which are not software agnostic. There is no common software for battery banks. Each manufacturer has their own protocol. JBM alone has 24 different algorithms as of date. A solution for standardisation needs to be developed. **Dr. Saurabh** from CART lab assured that he is working on developing technology standards for battery packs and will be happy to assist JBM on this project with DRIIV.

Mr. B.V. Babu, Head of waste management, CPCB emphasised that a strong focus be maintained on recycling of batteries. He explained that whilst fourteen recycling facilities are in pipeline, the recycling ecosystem is intrinsically linked to the procurement of spent batteries. Indigenous manufacturing in India is still at a very small scale, implying that manufacturers cannot be assigned the responsibility of developing the supply chain for collection and recycling. He further elaborated that that there are two key challenges in the recycling process currently being followed:

(i) Recovery of molecules – Co salt is the only valuable component. Li salt is of no use.

(ii) Black mass – separation of cathode material is a challenge.

Hence, extracted volumes are low, in the absence of efficient indigenous technologies at scale. Consequently, bulk of the batteries are being exported for recycling.

2.1.3. Next steps and way forward

I. Use of public and semi-public spaces for installing EV charging infrastructure

Semi-public and public spaces such as RWA, malls, highway corridors, under fly-overs etc. are promising locations to install EV charging and swapping stations. However, a) the process of assessing the best-fit locations, based on traffic, user convenience, usability etc. and b) an effective procedure for tendering that would encourage market forces to achieve the supply-demand equilibrium, within the norms of GFR, is unclear. Delhi Transport is looking at DRIIV's ecosystem to provide solutions for the same.

In a subsequent discussion with the Delhi Transport, two lines of action emerged, as noted below.

- Under the aegis of DRIIV, Ms. Roli to introduce Google's Environment Insights Explorer – a freely available data and insights tool that uses exclusive data sources and modeling

capabilities - to Delhi Transport. Whilst this tool is not available in India yet, it is being used in other countries by town planners to help cities and regions measure emissions sources, run analyses, and identify strategies to reduce emissions. With this tool, emissions from transport (among other sources) can be identified, helping the authorities assess traffic density and hence expected demand for EV charging/swapping facility. As this tool is not available in India yet, a pilot can be initiated collaboratively by Google, DRIIV and Delhi Transport in Delhi.

- Prof. Panigrahi, leading the sustainable mobility vertical of DRIIV, to engage with Charge Point Operators to assess market view on the matter. The market assessment would also take into account the existing electricity network.

DRIIV and Delhi Transport to arrive at a mutually agreeable course of action on the aforementioned points and sign an MoU on the same.

II. A common digital platform to enable the discovery of public charging infrastructure in Delhi

Improving the discoverability of the EV charging/swapping infrastructure for the end users is important in alleviating range anxiety and hence increasing EV adoption. Whilst individual operators currently have their own applications, such a fragmented approach is sub-optimal as it does not provide a comprehensive picture of the charging landscape to the users, particularly in a context where charging stations are far and few.

There need for a common digital platform therefore arises. However, the problem is not straightforward to solve as there is currently no policy in place that requires all operators to share the location of their charging stations, along with other relevant information, on a common platform.

To arrive at a common digital platform, there are many ways in which DRIIV can help Delhi Transport.

- Delhi Transport to consider making is mandatory for charge point operators to share relevant data on a common platform.
- Prof. Panigrahi to assist Delhi Transport in bringing on board some key corporate partners such as utility companies (eg. TATA Power, BESES Rajdhani etc.), charging/swapping operators (eg. Sun Mobility, MG Motors etc.) and any other existing sources of data that can be utilized for developing the common digital platform.
- Prof. Biyani to assist Delhi Transport in utilizing the existing feature in Chartr app that aids discovery of the charging/swapping stations.
- Ms. Roli to provide support from Google in developing the system and adopting it on the Google maps platform thereafter.

III. Charging management system

In order to bring in more efficiency to the charging process in depots, particularly as Delhi Transport scales up its fleet of electric buses, a smart charging management system is required that would prioritise the charging of the vehicles based on remaining charge, route plan, run schedule etc.

- Prof. Panigrahi to build such a software and pilot in one or two depots in Delhi.

IV. Integration of EV charging infrastructure with rooftop solar and repurposed battery stack, along with deployment of swapping stations

As EV adoption increases, the load on power grid also increases. The power companies are exploring renewable energy options to sustain the growing demand.

- DRIIV to create a pilot for Delhi Transport, along with TATA Power, BSES Rajdhani, Sun Mobility and JBM to utilize rooftop solar for power generation and repurposed battery stack for energy storage, for the purpose of charging electric buses. Alongside, swapping stations to be installed.

- Outline of the pilot to be shared with SMART City Faridabad, for consideration in their DPR.

IV. Developing standardised protocol for repurposed battery pack

- JBM to undertake a project with DRIIV where CART will develop standardised protocol for repurposed battery packs.

- Use cases for these battery packs will also be explored (in addition to EV charging) in areas such as alternative to diesel generators

V. Recycling of batteries

- DRIIV to liaise with DPCC for deploying indigenously developed advanced and efficient battery recycling technologies in the upcoming E-waste Eco park in Delhi.

Navigating the way forward requires a collaborative effort from stakeholders like charging infrastructure providers, energy companies, policymakers, automotive manufacturers, and research institutions. Focusing on technological advancements, data-driven optimization,

user-centric experiences, and supportive regulations will pave the path for a sustainable and efficient charging management system that enables rapid and seamless EV adoption.

VI. Dynamic pricing and time of day tariff

Flexible pricing of electricity to bring about a better balance of supply and demand for EV charging is required. DRIIV to explore 'Time of day' tariff to along with the power companies, Delhi Transport and the Ministry of Power.

3. Session 2 – Air pollution mitigation

3.1. Summary of discussions

Mr. B. V. Babu and **Mr. Pankaj Agarwal** opened the discussion, contextualising the problem of air pollution in Delhi with CPCB data. The National Clean Air Programme (NCAP) was launched in 2019, and 131 non-attainment cities were identified. Performance based grants (C. 20K Cr.) were allocated to these cities but till date, the utilisation of those funds (only c. 9K Cr.) has been low. In other words, the actions that would result in the utilisation are not being taken adequately. Long and tedious tendering process is part of the reason behind low utilisation of these funds. Additionally, the Urban Local Bodies have other sources of funding. Furthermore, there are implementation delays. The NCAP fund is a supplemental performance based grant. For greater synergy and effectiveness, there needs to be a convergence with other grants eg. SBM (1.5L Cr.), FAME, Smart Cities etc. On a positive note, 88 out of 131 non-attainment cities are on track. Upto 40% of the target reduction in PM levels has been achieved in 54 cities. The PRANA portal of CPCB provides a single point access to progress being made on NCAP, across all the seven thematic areas. They also informed that the City Action Committee, comprising of members from environment, transport, urban affairs, agriculture etc. prepares an annual action plan for mitigating air pollution.

3.1.1. Predictive analysis approach, policy action and indicators

Prof. Sagnik Dey, Centre of Atmospheric Sciences, IIT Delhi, mentioned that there is some progress in mitigating air pollution, although slow. Amongst all the sources of pollution such as vehicular emission, road dust, burning of fossil fuel and stubble etc., the ULBs can only address road dust and MSW burning on their own. For everything else, a collaborative effort is required from multiple stakeholders. Furthermore, all actions are currently being taken only within the boundaries of Delhi. Whereas, a local air shed approach needs to be adopted and

satellite cities need to be brought under the purview of these actions. He also mentioned that a comprehensive report on source apportionment and recommended actions has been submitted by NEERI to CPCB. He further suggested that we need to set some interim indicators to assess the effectiveness of the interventions.

Mr. Siddharth Sinha, Geo and climate policy lead, Google, re-emphasised that air pollution is an airshed issue. We also need to take a lifecycle approach while considering mitigants. Regarding adaptation, early warning would be helpful. He referenced the Environment Insights Explorer, which provides information about buildings, emissions etc. and can help authorities to plan the location of tree canopies as carbon sinks. He talked about Breezometer, which shows pollution hotspots and also gives an indication of how pollution is likely to vary and therefore corrective action can be taken. The app takes input data from CPCB. He added that transport emission contributes 14% to PM levels, of which 90% comes from road transport. He appraised that Google is taking steps to bridge the air quality data gap for cities through its Project Air View. They adopt a unique approach to establish hyperlocal AQ sensor networks for cities with sensors installed on the static locations and moving public service vehicles. In partnership with the local sustainability startups, municipal corporations and corporate houses they are on a track to deploy AQ sensor networks in 100+ cities.

Mr. Babu mentioned that the existing traffic data can be linked to these apps, to get sound predictive analysis.

3.1.2. Increasing ridership of public transport

Mr. Sinha continued that making transport more predictable for users will help encourage the use of public transport. Real time arrival information of public transport will encourage its wider use.

Ms. Roli shared that fitting buses with GPS tracker will help create the necessary infrastructure to source such real time information. She mentioned that such tracking has already been enabled in DIMTS buses but there have been data quality, stability and formatting challenges related to DTC buses which need to be resolved. Google is working with Prof Pravesh Biyani from IIIT Delhi and DTC to find resolution and hoping to be able to launch DTC real time bus transit information on Google Maps in 2024 itself. She also informed about the ‘Traffic Lights’ pilot being conducted in three cities. Greenlight project as it's called uses AI and Google Maps driving trends to model traffic patterns and make recommendations for optimizing the existing traffic light plans. City engineers can implement these in as little as five minutes, using existing infrastructure. By optimizing not just one intersection, but coordinating across several adjacent intersections to create waves of green lights, cities can improve traffic flow and further reduce stop-and-go emissions.

3.1.3. Retrofitment of diesel vehicles

Mr. Rakesh Vaid, Delhi Transport, explained the issues associated with controlling emissions from heavy commercial vehicles. He shared that under GRAP, when diesel vehicles are banned, there is a public outcry. He also highlighted the practical problems associated with disallowing non-destined or overloaded commercial vehicles passing through the city, pointing out the challenges in installing motion bridges, which only add to the queuing (and increase idling time) of polluting vehicles, defeating the purpose of controlling emissions. Furthermore, lack of a differential toll between highways passing through cities vs. peripheral by-passes, disincentivizes the vehicles to use the longer by-passes. He emphasized that such restrictions should be at NCR level and not just Delhi and should apply throughout the year and not just in the winter months. He also opined that diesel and petrol vehicles need some retrofitting solutions. Existing retro fitment of EV batteries is expensive, at around R. 90K.

The possibility of retro fitment of diesel vehicles was explored by the group. It emerged that whilst retrofitting four wheelers is possible, it is not an economically viable option for mass market cars. For two wheelers and autos that require smaller battery packs, it is already being done. **Prof Panigrahi**, head CART IIT D, informed that a few startups have retrofitted army gypsies. The Delhi government has allowed retrofitment and subsidies for the same are also being considered. Replacing the engine with motor and controller is not an issue. The biggest challenge is in deciding where to install the battery in the vehicle without upsetting its centre of gravity. This requires intensive modelling to ensure balance. Cost is the most important factor. Some retro fitment technologies are awaiting approval with ICAT. Diesel buses can be retrofitted.

Regarding buses and trucks, **Mr. Rakesh Vaid** explained that HCNG option was tried by Delhi Transport earlier but the cost was prohibitive due to high energy consumption.

Mr. Rajan Varshney differed saying that CNG buses can be easily run on HCNG and do not require additional expenses except minor tuning of the vehicle. He spoke about auto-catalytic reformer installed in the CNG tank for dispensing HCNG at DTC Rajghat Bus Depot in a pilot project. 50 DTC buses of Ashok Leyland make were run for six months from October 2020 and the emissions were found to have been reduced drastically by upto 70%.

He further mentioned that switching to EVs does not solve the lifecycle problem as 90% of the electricity is still produced using coal. Furthermore, Li and Cd used in batteries and the rare earths used cause environmental pollution due to processes and interventions such as excavation, deforestation, refining and transportation. These are also expensive and have geo-political dependencies. Instead, solar EVs should be considered. Companies such as Lightyear, Sion, Squid are producing them with good efficiency.

Furthermore, hydrogen based vehicles should be considered and FAME-II incentives can also be provided to FCEVs. Hydrogen can be produced from municipal waste, solving two problems at once.

Prof. Dey, spoke about vehicle mounted filters that can be installed on top of the buses to capture particulate matter as they move. These filters have been tested, among the suite of technologies piloted with DPCC under project SAMEER, and they have shown to capture more carbon than is emitted by the vehicle, for all fuel types. Perhaps Delhi transport can consider installing these filters on its buses.

3.1.4. Controlling methane emission from MSW

Mr. Rajan Varshney, Dy. GM NTPC, mentioned that methane from landfills is a major pollutant. He shared that there are several decentralised waste management solutions that can harness such gases and utilise them as fuel. He emphasised the need to handhold startups/MSME that are working on such waste to energy solutions and facilitate access to funds for them.

3.1.5. Creating natural carbon sinks

Mr. Singh mentioned that natural interventions such as increasing green cover, reviving water bodies, and using algae for carbon capture should also be considered. Pollutant contributors (road dust, C&D activities etc.) should be assigned limits and there should be regular monitoring.

Mr. Agarwal added that some low emission zones can be created in cities. He mentioned that a similar pilot is currently being conducted in Bhubaneshwar and the same can be implemented around tourist spots in Delhi. He informed about the 'Nagar Van Yojna' scheme of MoEFCC for urban forestation and talked about the rapid greening of spaces using the popular Miyawaki plantation model.

3.1.6. Public awareness campaigns

All delegates concurred that changing public mind-set is key to bringing about meaningful impact. **Mr. Singh** mentioned that TATA Power runs several community engagement campaigns (eg. URJA), and they could look at engaging with drivers and influencing their behaviour. **Mr. Agarwal**, informed about the SAMEER app of CPCB and referred to Mission LiFe where sustainable lifestyle practices should be encouraged. **Prof. Dey** spoke about ITC's work with the farmers in Kapurthala district and, consequently, how that region has almost zero incidents of stubble burning. Prof Panigrahi informed the audience about DRIIV's

Effective Education vertical and how it engages with schools and colleges to conduct workshops on sustainability/public health topics.

Mr. Sinha suggested that it would be a good idea to consolidate several ongoing public awareness campaigns under the banner of DRIIV for greater impact. The link between congestion and emission should be brought into general awareness. Public should also be engaged in offering solutions.

3.1.7. Preventing stubble burning

The issue of stubble burning was discussed and **Mr. B. V. Babu** and **Mr. Pankaj Agarwal** shared CPCB insights on the matter. They stated that stubble contributes up to 15% of Delhi's air pollution. C. 22 million tons of stubble is generated in Punjab and 1.7 million tons is generated in Haryana. Stubble management is almost 100% in Haryana, resulting in almost no burning. However, in Punjab whilst 83% is being actively managed (11.5 million ton in situ bio decomposer, 3.52 million ton biofuel, 1.3 million ton as fodder), remaining 17% is currently being burnt. The sheer volume of stubble in Punjab creates the problem of having to manage it in a short window of time. Additionally, Haryana government has also rolled out certain financial incentives for alternative uses of stubble such as pelletisation and bricketing, crop diversification, direct seeding of rice vs. conventional transplantation, subsidies for transporting bales, free distribution of bio decomposer etc., categorising panchayats into red, yellow and green zones based on the severity of stubble burning for suitable interventions. Some of these measures can also be adopted by the Punjab government. PUSA has also developed a faster maturing variety of rice, which could be encouraged to allow for greater time gap between crops. CAQM has also mandated co-firing of bio-pellets in coal based plants.

Prof. Dey added that ITC's programme in Kapurthala on sustainable farming practices can be scaled up with other industry partners.

Dr. Govil shared that the existing solutions for alternative uses of stubble are not very effective because of the high cost and limited window of time. Further, compost selling is a problem. He spoke about a decentralised dry digester technology that he is working on to convert paddy straw to biogas in two weeks. The biogas/CNG thus produced can be locally consumed as clean fuel. Local youth can also be gainfully employed in this circular economy.

3.2. Next steps and way forward

I. Setting interim indicators for predictive analysis and policy measures

- Under the aegis of DRIIV, Ms. Shipra and Mr. Sinha to form a working group, drawing upon relevant experts from the industry/academia/public bodies (Google India, IIT Delhi, CPCB etc.) to draft an outline of the project.

- DRIIV to engage with the City Action Committee for Delhi on this.

- Commission and publish scientific research studies targeting Delhi's unique air quality challenge and propose solution and implementation plan in partnership with the academia and industry experts.

- Augment the existing reference grade AQ sensors with hyperlocal AQ sensor network to enable targeted policy intervention and validating the effectiveness of the policy measures.

- Formalize the country level air quality governance ecosystem by identifying and defining the roles of each of the constituent members.

- Enable the citizen partnership in improving AQ in the city through awareness and engagement.

II. Increasing the ridership of public transport

Delhi Transport would like to explore solutions for increasing the ridership of buses. A study was previously done by TRIPP, IIT D, where the performance of various bus routes was assessed. It was asserted in the report submitted by TRIPP that greater predictability of arrival information of buses would increase uses. Furthermore, an increase in ridership has been observed with digitization of DMITS buses via One Delhi app.

In a subsequent discussion with the Delhi Transport, it was agreed that a two pronged approach would help increase ridership.

- Google maps to show live tracking of DTC buses also, along the lines of DMITS. The challenges related to data quality for the DTC buses to be identified and addressed collectively by Ms. Roli, Prof. Biyani and Mr. Shehzad.

- TRIPP, IIT D, under the aegis of DRIIV to undertake a study for exploring other ways of increasing ridership, eg. making bus stops safer, esp. for womenfolk, ensuring road safety around the alighting points, adequate lighting in the vicinity, etc. Mr. Shehzad to advise on the scope of the study and suggest the appropriate time to submit the proposal.

III. Retrofitting diesel vehicles

- Prof. Panigrahi, along with CART startups, and Mr. Varshney to explore retrofitting buses/autos/diesel vehicles with batteries/HCNG

- DRIIV to engage with Delhi Transport on this.

IV. Decentralised waste management – landfills and stubble

- DRIIV to work with MCG on decentralised MSW waste management solutions. Also covered in the next section.
- DRIIV to work with the industry on commercialising decentralized dry digester solution for stubble.

V. Urban forestry

- DRIIV to work with DPCC and approach MoEFCC with a proposal on 'Nagar Van Yojna'

VI. Public awareness campaigns

- Mr. Singh, Mr. Sinha, Prof. Dey, Prof. Panigrahi and Ms. Shipra to brainstorm on consolidating various community engagement programmes under one umbrella.

4. Session 3 – Solid waste management and Water security

4.1. Summary of discussions

4.1.1. Treatment of legacy waste and disposal of inert fractions

Mr. Raghavendra Rao, Chairman HSPCB, opened the session, outlining the problems in managing legacy waste. Citing the example of the Bandhwari landfill, he mentioned that the site carries c. 60 lakh tons of legacy waste, half of which is below ground level. Even if it is segregated, there are no takers for the resulting inert fractions, leading to the problem of their disposal. Given the presence of a biodiversity park and the Aravalli forests nearby, there is no available land to treat the legacy waste or set up a waste to energy plant.

Additionally, more than 2000 tons of fresh waste is generated every day. The municipal authorities tried setting up decentralised treatment plants for fresh waste but failed due to strong public resistance. So fresh waste keeps getting dumped at the site. Furthermore, the waste arriving at the dumpsite has no economic value (stones, metal pieces, C&D waste etc.) as all the waste that can potentially be processed for a circular economy, is already extracted and removed in the value chain. He added that there should be a policy directive on the disposal of inert fractions.

He continued that JBM has an 8 MW WTE plant in Sonepat. The challenge is that the waste coming to this plant is unsegregated (mix of wet and dry waste), thus resulting in the loss of calorific value. Even if segregation is done at source, different types of waste get mixed during transportation.

4.1.2. Decentralised waste management

Mr. Varshney shared that NTPC and the municipalities are collaborating to establish decentralised waste to energy plants. There are several solution providers, backed by willing investors, who are looking to set up WTE plants that leave zero residue. Unsegregated waste can be converted into biomethanol and other fuel via gasification or pyrolysis. He added that the constraint is that the municipal corporations are not willing to provide 25 year contracts, which will provide confidence of guaranteed returns to the investor.

Mr. Rao explained that because of inherent agency problems – such as the issue in Gurugram where a foreign company was granted a long term contract but did not deliver - municipal corporations are wary of long lock-in periods.

Dr. Rajiv Singh, CSIR-NPL, added that indigenous technologies exist with CSIR labs and other research institutes that can treat all kinds of waste – legacy, plastic, electronic – effectively. He mentioned that he had had several discussions in the past with the MCD. However, the problem is that imported solutions are being preferred over indigenous ones. He added that high arsenic content in water is a big problem in the Indo-Gangetic plain, particularly in West Bengal. Indigenous solutions exist where local soil is used to create filters that can remove arsenic. However, such solutions are not being adopted. As another example, Vedanta partnered with CSIR labs to explore alternative uses of red mud as it was making the soil alkaline. Whilst CSIR came up with suitable technologies, no investor is willing to adopt it. Whilst 'Make in India' is gaining momentum in certain sectors with high revenue potential (e.g. drones), low margin but environmentally crucial sectors are being ignored.

Dr. Pawan Labhasetwar, CSIR-NEERI, elaborated that often, solution providers make claims that are a stretch, putting their credibility to question. He suggested that DRIIV can play a catalytic role in bringing together relevant stakeholders, establishing a panel of experts and setting up a process for validating these technologies.

Mr. Satish Parasher, MCG, spoke about the need for a granular analysis of waste coming from various sources. He stated that household waste would have a different composition from that of say bulk generators. A granular study, inventorising waste from these sources, will inspire better informed policy actions so that the quantum of waste going to landfills can be reduced.

4.1.3. Capacity building and community engagement for waste management

Mr. Subhash Goyal, ICC, shared how circular waste management practices have been introduced into the hospitality and travel industry. He stressed upon the need for a policy directive on practices such as waste management, water harvesting, integration of solar energy etc. in all government buildings and new housing projects, just as they have been introduced in the hospitality industry.

Mr. Parasher, continued that it is important to raise awareness about waste management and engage various communities for capacity building.

4.1.4. Cost effective solutions for leachate treatment

Dr. Babu Ram, Technical expert, HSPCB, explained that presence of heavy metals in the leachate from landfills, makes it carcinogenic. The problem is aggravated in the rainy season, when the leachate finds its way into the water bodies and soil, making them biocidal.

He added that the existing technologies for leachate treatment are prohibitive and therefore not usable. We need cost effective solutions for leachate treatment.

4.1.5. Plastic waste and multi layered plastic

Dr. Babu Ram, highlighted the problem of plastic waste, particularly in unsegregated and legacy waste. He shared that plastic waste in an unsegregated mix, particularly in landfills, is very dirty and requires treatment before it can be recycled, adding to the cost of recycling.

Dr. Rajiv added that multi layered plastic (MLP) is a bigger menace. The aluminium coating in MLPs and microplastic enter the water cycle and soil, increasing their toxicity. There should be a policy directive for the packaging industry for collecting and recycling MLPs.

4.1.6. Problem statements from DJB

Shri. Anbarasu, CEO DJB, opened the session stating that DJB is the largest water utility in South Asia but unfortunately, its practices are not adequate. He mentioned that DJB is responsible for water supply and wastewater (sewage) treatment and management. Regarding the water supply, DJB is in the process of signing an MOU with the Government of Odisha as they are converting water supply to “drink from tap” and making water available continuously (24x7). However, DRIIV can help with the drainage part. Some of the issues are being discussed below.

4.1.6.1. No account of borewells

There is currently no database for borewells. It is estimated that 80% of the borewell water is used for domestic purposes and the remaining 20% for commercial use. DJB needs help in preparing this database.

4.1.6.2. Converting secondary treated water to tertiary

Out of the 1000 mgd water being used, there is currently 632 MGD installed capacity for treating wastewater. There are plans to increase the installed capacity. However, only 90 MGD of this treated water is being put to structured reuse after treatment. Rest is being released in Yamuna. DJB would like to explore cost effective technologies for tertiary treatment of this secondary treated water and reuse it for non-potable purposes.

4.1.6.3. Improving energy efficiency of treatment processes

It is imperative that the STPs run in an energy efficient manner. Hence, an energy audit and technologies enhancing energy efficiency are required. Another area to explore is generating energy from wastewater.

4.1.6.4. Water contamination

Although booster pumps are banned in Delhi, they are still widely used. Reverse pressure and cracks in pipelines aggravate the problem of water contamination. Solutions from preventing such contamination are required.

4.1.6.5. Network survey

Health of infrastructure, particularly below ground, needs to be surveyed. There are a number of startups working in this domain, which can help with proactive maintenance, as opposed to the current practice of reactive maintenance.

4.1.6.6. Small surveillance/service vehicles

Small sized vehicles, with smart technology, that can move through the narrow lanes of Delhi and carry pipes and equipment are needed. The existing vehicles get stuck in narrow lanes and manpower is needed to re-mobilise them or carry the equipment manually.

4.1.6.7. Decentralised wastewater management

There are 3000+ parks being maintained by the municipal corporation, some of which run into acres. A decentralised solution for treating and reusing the waste water for irrigating these parks.

4.1.6.8. Yamuna flood plain management

Flood plain is shrinking in Delhi. Yamuna becomes very narrow in the stretch between Wazirabad and ITO. There are some success stories that DDA has implemented. A more rigorous approach is required to prevent floods.

4.1.6.9. Nature based technologies for drains

There are some large drains in Delhi. Wastewater treatment systems, that are based on natural solutions and are cost effective, are required. Such systems can be installed along the length of the drains, say at intervals of 100-150 m.

4.1.6.10. Restoring water bodies in Delhi

There are 1000+ water bodies in Delhi. Reviving these water bodies should be a priority.

4.1.6.11. Rainwater harvesting

Whilst rainwater harvesting has been made mandatory, there is no system for its maintenance or monitoring. Consequently, there is no information about whether the rainwater is being harvested effectively. Technology solutions that can monitor the effective utilisation and maintenance of these systems are required.

4.1.6.12. Efficient tap fixtures

Mr. Dalbir Singh, DJB, enquired whether there can be a rating system for tap fixtures so that the consumers can get efficient fixtures that do not leak, because a significant amount of water is currently being lost at the consumer end.

Dr. Pawan mentioned that the Bharat Tap rating and spoke about his association with the **Indian Plumbing Association**, who are looking at rating water efficient fixtures.

We need to make our treatment systems climate resilient. In February 2021, two of our water treatment plants had to be closed down because we got very high turbidity due to glacier retreat in Uttarakhand. Another problem is algal cyanobacteria. Plants can be retrofitted with ultrafiltration.

4.1.7. Upkeep of rural ponds

Mr. Prabhaker K. Verma, Executive Vice Chairman Haryana Pond Authority, mentioned that The Pond Authority has real time data of almost all 19649 ponds on revenue land, ranging from 0.5 to 50 hectares. As of date, c. 2000+ ponds have been restored. The authority is treating the grey water through natural technology before it enters the ponds. The treated water is being utilised for irrigation and pisciculture. Recharging groundwater and using micro-irrigation. Management of solid waste and cattle dung in rural areas that is polluting the water bodies is a concern. Encroachment is another issue – 40% - 60% of the pond area is getting encroached.

'Jan Bhagidaari' is another issue. There is a lack of awareness about pond restoration and the ownership of ponds is non-existent. The Authority is collaborating with NGOs and Universities that engage with villagers to spread awareness. In developing the ponds, the Authority is also encouraging the plantation of native fruit trees nearby to aid local biodiversity.

4.1.8. Creating water reservoirs

Mr. Tarun Agarwal, Haryana Irrigation Department, spoke about five major issues: a) household water security – tap water supply in every household (Jal Jeevan Mission addresses this, b) economic water security – availability of water for irrigation, c) urban water security – cities should have adequate supply, d) environmental water security – rivers should not be polluted, e) resilience of water bodies. He expressed concerns over floods and droughts occurring in the same year and expectation of more extreme events happening in the near future. He added that we should explore storing the flood waters and emphasised the need for creating more reservoirs. He observed that the Haryana Pond Authority is doing this very well. He suggested that water can be stored between the barrages of Okhla and Wazirabad in Delhi. Secondly, contamination of water bodies is a big issue. Untreated water/tertiary treated water is being released into the rivers. He also added that treated water should not go into rivers but should be reused locally.

4.1.9. Septic management

Dr. Pawan shared that Nagpur Municipal Corporation has created a 190 MLD STP. This tertiary treated water is supplied to two power plants, thereby reducing consumption of fresh water. This also incentivised the sound operation of the STP as the treated water is a revenue source (18Cr. annually to Nagpur Municipal Corporation).

He shared another example from Bangalore. The city has about 3000 decentralized sewage treatment plants. He added that STPs with more than 50,000 litre capacity can earn enough revenue to be self-sustainable. Lakes such as Nandihalli and other smaller water bodies are being filled up with treated sewage water. He emphasised that if the disposal-discharge narrative is changed to reuse, it is possible to make the treatment process effective and commercially viable.

Mr. Verma shared that the Haryana Pond Authority have treated an open drain in the village of Kasanda/Kasandi near Panipat, where industrial waste water from Panipat was being drained.

Mr. Varshney added that NTPC has installed a decentralised STP in their NOIDA office, which is running effectively and energy efficiently. Similarly another technology installed in Pune (SBT/SBRE) is also cost effective and efficient.

Mr. Gourish, Ion Exchange, talked about decentralized solutions to the water & wastewater treatment. In this regard, modular / containerised plants for treating waste water. There are technologies for removing toxic / undesirable metals (Fe, Mn, As, Nitrate,Uranium, Chromium, etc), organic matter etc. from water. The media can be used optimally; this can

be used in small applications (like attachments to taps) or can be used in large water treatment systems.

Dr. Babu Ram, raised concern that, currently, the septic systems are not meeting the regulatory parameters. **Dr. Pawan** shared an example of a process from Vishakhapatnam, that can be adopted for Faecal Sludge Treatment collected from the existing septic tanks for meeting the standards.

Mr. Goyal suggested that sharing best practices across regions would be helpful. He offered that ICC, through its members, will help channelize ESG and CSR spend into sustainability projects that address some of the problem statements that have been discussed during the course of the day.

4.2. Next steps and way forward

I. Policy on inert waste disposal

- Inert fractions resulting from processing of legacy waste in landfills have no economic value and hence no buyers. Consequently, they continue to occupy the landfills.

- DRIIV to seek guidance from the PSA Office regarding a policy framework on the disposal of inert fractions.

II. Expert Committee for validation of technologies

- Currently, there is no robust mechanism for public bodies to source reliable technologies for their problem statements. The tendering process has its own limitations. In order to ease the process of technology adoption by public bodies, there is a need to set up:

A. A committee of experts that would validate technology solutions

B. Processes for sourcing/curating technology solutions, validating them and their subsequent adoption

- DRIIV to set up aforementioned processes and expert committees.

III. Inventorisation of waste coming to MCG

- There is a need to inventorize fresh waste from various sources in Gurugram so that informed actions can be taken to minimise the quantum of waste going to landfills.

- Ms. Shipra to engage with Mr. Parashar regarding the waste inventorisation project that DRIIV can undertake with MCG.

IV. Leachate treatment

- The existing leachate treatment technologies are expensive and imported.
- Ms. Shipra to engage with Mr. Babu Rao on sourcing cost effective, indigenous solutions for leachate treatment.

V. Plastic waste from landfills/unsegregated waste and multi-layered plastics

- DRIIV to explore technology solutions for treating plastic waste from unsegregated mix in a cost efficient manner.
- DRIIV to liaise with the PSA Office for a policy directive to packaging industry on multi-layered plastics.

VI. Collaboration with DJB

- DJB shared several problem statements with DRIIV
- DRIIV to follow up with DJB regarding the problem statements and develop a joint programme to source and implement solutions, starting with a workshop.

VII. Waste management in rural ponds

- Haryana Pond Authority shared the problem of management of solid waste near ponds and also expressed interest in community engagement initiatives.
- DRIIV to engage with Haryana Pond Authority on both the aforementioned points.

VIII. Creating water reservoirs in Delhi

- It was raised that more reservoirs should be created to store flood water
- DRIIV to engage with DJB to explore the creation of water reservoirs

IX. Sourcing ESG and CSR funds

- DRIIV to engage with ICC to channelize CSR/ESG spend towards sustainability projects utilising S&T solutions.

X. Capacity building, community engagement and awareness programmes

- Ms. Shipra to engage with Mr. Parashar to understand the need and work with industry partners such as ICC to execute community engagement programmes on waste management.

- Ms. Shipra to engage with Mr. Verma on community engagement programmes for Haryana Pond Authority

5. Appendix A – Summary of policy actions

I. Policy recommendation for utilising publicly available land for developing EV charging infrastructure

In order to increase EV adoption, there is a need to expand the EV charging infrastructure. In addition to private spaces (such as residential societies and offices), public places – such as hospitals, colleges, parks etc. – can effectively be utilised for creating the charging infrastructure at scale. These spaces should be safe and can be developed in a manner such that people can spend time there comfortably while their vehicles are charging. Publicly available land with agencies such as the DDA, MCD, PWD, Discoms etc. can be used for this purpose.

The working group (comprising of Delhi Transport and industry partners), under the aegis of DRIIV, will present a concept note with policy recommendation on this matter, for further guidance on required actions.

II. 'Time of Day' tariff for EV charging

The guidelines from the Ministry of Power, dated January 14, 2022, provide for EV charging stations tariff to not exceed "Average Cost of Supply" till March 31, 2025. Further, the revised Tariff Policy, 2016 provides that the appropriate commission would notify a roadmap such that tariffs are brought within ±20% of the Average cost of Supply. This would help in reducing burden on other categories of consumers.

DRIIV to explore 'Time of day' tariff to along with the power companies, Delhi Transport and the Ministry of Power.

III. Policy on inert waste disposal

The inert fractions from landfills have no commercial value and hence have no buyers. Consequently, they continue to occupy the landfills.

DRIIV to seek guidance from the PSA Office regarding a policy framework on the disposal of inert fractions. Such fractions can be utilized for the purpose of road construction or brought to use for afforestation purposes.

IV. Plastic waste from landfills/unsegregated waste and multi-layered plastics

- DRIIV to explore technology solutions for treating plastic waste from unsegregated mix in a cost efficient manner.
- DRIIV to liaise with the PSA Office for a policy directive for packaging industry on recycling/reuse of multi-layered plastics.

6. Appendix B – List of roundtable participants

Name	Designation	Organisation
Dr. Arun Bharadwaj	Scientist G **(Chair)**	O/o PSA to GoI
Ms. Shipra Misra	CEO **(Organiser)**	DRIIV
Shri P. Raghavendra Rao	Chairman	HSPCB
Dr. Babu Ram	Technical Expert	HSPCB
Shri Sanjeev Budhiraja	Sr. Environment Engineer	HSPCB
Shri Bharat Kumar Sharma	Member Secretary	CPCB
Shri Pankaj Agarwal	Head of Air Quality	CPCB
Shri B.V. Babu	Head of Waste Management	CPCB
Dr. Sunil Kumar Ambast	Chairman	Central Ground Water Board
Shri Prabhaker K. Verma	Executive Vice Chairperson	Haryana Pond Authority
Mr. Rajan Varshney	Deputy General Manager	NTPC
Mr. Pradeep Aggarwal	General Manager	BSES Rajdhani Power Limited
Mr. Arun Kapur	CEO	JBM Group
Mr. Ramkrishna Singh	Head of Business Operations (EV)	TATA Power
Ms. Roli Agarwal	Head of Product Partnerships	Google India
Mr. Siddharth Sinha	India Policy Head	Google India
Mr. Subhash Goyal	Chairman (Aviation, Travel & Tourism Committee)	Indian Chamber of Commerce
Ms. Neha Jain	Head (EV & Innovation ecosystem)	MG Motors
Mr. Anupam Saronwala	Angel Investor	IAN
Dr. Sagnik Dey	Professor (CAS)	IIT Delhi
Dr. B.K. Panigrahi	Professor (EE)	IIT Delhi
Dr. G. P. Govil	Dean	Maharaja Agrasen University
Dr. Pawan Labhasetwar	Chief Scientist & Head	CSIR-NEERI
Mr. Gourish Chakravorty	CEO	Ion Exchange
Mr. Tarun Agarwal	Superintending Engineer	Haryana Irrigation Department
Dr. Rajiv K. Singh	Principal Scientist	CSIR-NPL
Mr. Rakesh Vaid	PLT Inspector	Delhi Transport
Mr. A. Anbarasu	CEO	Delhi Jal Board
Mr. Dalbir Singh	Additional Chief Engineer	Delhi Jal Board
Mr. A.M. Sharma		Delhi Jal Board
Mr. Satish Parasher	Chief Town Planner	Municipal corporation Gurgaon & Faridabad (MCG)
Dr. Naresh Kumar	Joint Secretary	MCG
Dr. R. K. Bagri	Chief Engineer- Infra	SMART City- Faridabad
Mr. Amitab Kumar	DGM IT	SMART City- Faridabad
Mr. Aman Pal		SMART City- Faridabad
Dr. Anil Kumar	Senior Manager	Mahindra & Mahindra Limited
Md. Zubair	Executive Engineer Mobility	FMDA