

Innovating for Clean Air Impact report



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Cities across the world are facing huge environmental challenges related to climate change.



The report was funded by UKRI

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Executive summary

Cities across the world are facing huge environmental challenges related to climate change. These can range from air quality issues to the need to support the electric vehicle transition and support the uptake of clean energy generation. Cities need and want to act – but often lack resources to tackle these challenges in a holistic manner, incorporate innovative solutions and untangle the complex knot of issues they face.

The Innovating for Clean Air (IfCA) project showed an innovative approach to addressing these issues. Led by the Energy Systems Catapult (ESC), the project was delivered between 2018 and 2021, included collaboration with a number of UK and Indian partners and supported the development of an innovative business ecosystem to develop and showcase solutions, raised citizen awareness and helped share valuable knowledge and best practice between the UK and India. The project achieved considerable impact and was recognised in both the UK and India.

In Q3 of 2021, UKRI allocated funding to a portfolio of three follow-on projects to expand and build on the impacts of IfCA. These included:

Extension of IfCA in Bengaluru/Karnataka to expand on the phase 1 project to expand and allow further deployment of innovative solutions currently being deployed in Bengaluru/Karnataka

Collaboration with Clean Energy International Incubation Centre to support the development of a clean energy platform resource to link innovations internationally and to show the value of bilateral collaboration by supporting a cohort of UK firms to explore the Indian market

Development of a model for EV charge point location optimisation, to support planners and policymakers in making evidence-based decisions on the siting of charge point infrastructure

The project achieved considerable impact and was recognised in both the UK and India.

These projects were delivered remotely, and to tight timescales, but successfully delivered considerable impact.

Impacts include:

4 pilot projects were enabled in Bengaluru



exploring solutions to challenges such as logistics decarbonisation, dynamic pricing and energy infrastructure planning.

The projects involved innovators from both the UK and India and are actively helping to move industry driven solutions for the Net Zero transition.

Research outputs supporting potential development of an online platform, linked to Mission Innovation, that can provide valuable visibility of challenges, support networks, proven solutions and funding opportunities.

7 UK Small and Medium Enterprises (SMEs) received hands-on support to prepare them for the Indian market



to develop their pitches and offerings accordingly and to connect with Indian organisations. This has created commercial opportunities for UK SMEs and also chances to provide their carbon reducing initiatives into the Indian economy.

A prototype charge point modelling tool

has been developed that has helped to develop new capabilities at IISc and can support Bengaluru's electricity utility, BESCOM, to make informed decisions about the location of charge point installations.

The deep engagement carried out through the projects has also created lasting partnerships between Indian and UK organisations, which can be the springboard for further collaboration. Furthermore, the projects have provided further evidence of the efficacy of the IfCA approach and informed the development of the IfCA: Innovating for X model which allows learnings and approaches from IfCA to be applied to different city challenges.

Key delivery partners

Extension of IfCA in Bengaluru/Karnataka

Swiggy Electrified Delivery Pilot Project



Energy Modelling Hackathon Pilot Project



Net Zero Charge Point IISc Pilot Project



EV Dashboard Pilot Project



Research partners



Collaboration with Clean Energy International Incubation Centre (CEIC)

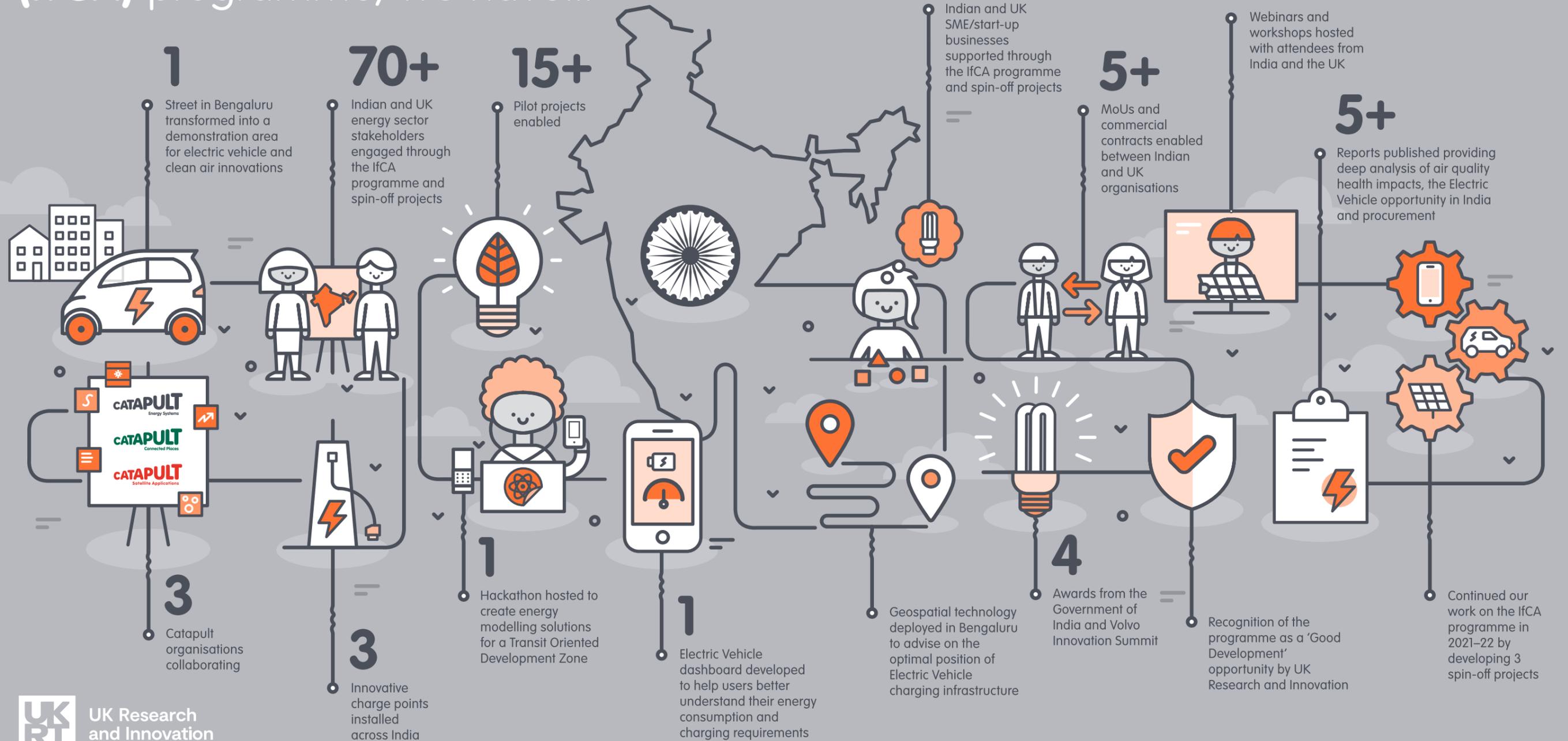


EV chargepoint



Figure 1: Original IfCA project objective

Through the 'Innovating for Clean Air' (IfCA) programme, we have...



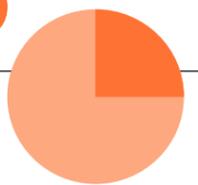
Needs and challenges in cities

In recent decades, cities in many parts of the world have grown at an incredible rate – and this trend looks set to continue.

Estimated changes in India in the next 30 years

25%

Increase in population



75%

of housing required has not been built



325 million people

Equivalent population of the USA will move into cities



300%

Increase in energy demand per capita



450 million

Increase of vehicles



This urbanisation, and the increasing infrastructure demands that come with it, will create huge problems for cities which at the same time need to address environmental challenges and those associated with climate change. It is already estimated that cities are responsible for 75% of global CO2 emissions. Cities worldwide need and want to act, but often lack resources to tackle the challenges they are facing. Innovative solutions and a systemic approach are needed to untangle the complex knot of issues they face.

Challenges to procuring innovative solutions



Lack of resources and numerous competing demands



Climate crisis and pressing local environmental issues



A series of complex interconnected challenges



Increasing public demand for action



For example, cities the world over are trying to address the interrelated challenges of reducing air pollution and increasing uptake of electric vehicles. Globally, transport is thought to account for 23% of energy-related greenhouse gas (GHG) emissions, and a study in New Delhi found that the transport sector accounted for 19% of PM10, 39% of PM2.52 and 81% of NOx3 emissions in the city. The effects that air pollution has, particularly on marginalised groups, women, children and the poorest part of society, is well-documented. Increased adoption of electric vehicles can be part of the solution, but innovation in the EV sector is crucial to achieving this uptake, with the development of new products, services and business models that make sense for and attract customers and can be managed given existing infrastructure. Increased innovation in the sector, and visibility of it, would also allow the flow of more investment into new and innovative solutions, in turn allowing faster scale up.

¹ <https://www.unep.org/explore-topics/resource-efficiency/what-we-do/cities/cities-and-climate-change>

Figure 2: The IfCA model

Innovating for Clean Air (IfCA) — the model



The Innovating for Clean Air model promotes best practice innovation and technology exchange, stimulating the local business ecosystem, creating a sustainable platform for ongoing bi-lateral collaboration.



The IfCA story so far

Phase 1

14 of the top 20 most polluted cities in the world are in India². This is estimated to cause considerable health and economic costs. At the same time, India has ambitious goals for the uptake of electric vehicles (EVs), for example through its Faster Adoption and Manufacturing of Electric vehicles (FAME) programmes³. Reducing Internal Combustion Engine (ICE) vehicle usage could have a hugely positive impact of air quality in India, and across the world.

Against this context, the Innovating for Clean Air (IfCA) project was delivered by a consortium led by Energy Systems Catapult (ESC), with Connected Places Catapult (CPC) and Satellite Applications Catapult (SAC) in partnership with several organisations in India. The project focused on building partnerships and addressing air quality and associated challenges in the city of Bengaluru, Karnataka. The project ran from December 2018 to March 2021 and had the goals of: (i) supporting the EV transition and encouraging electric vehicle adoption by sharing knowledge, building capacity and demonstrating relevant technologies; and (ii) raising awareness around air quality (AQ) challenges and enabling and demonstrating impactful AQ interventions, as seen in Figure 1.

Reducing Internal Combustion Engine (ICE) vehicle usage could have a hugely positive impact of air quality in India.

² <https://www.iqair.com/world-most-polluted-cities>

³ <https://pmmodyojana.in/fame-india-scheme>

Figure 3: Original IfCA project objective



The programme aimed to identify innovations that have the potential to improve air quality, and to provide an environment to test and refine ideas. In parallel, the programme attempted to contribute to a more detailed localised map of the air quality of Bengaluru through the unique combination of satellite and sensor data, including both on-the-ground and mobile data. Finally, the programme aimed to identify relevant challenges around EV charging infrastructure, grid management and integrating renewable energy to ensure a sufficient, reliable and clean source power and facilitate opportunities for Indian and UK innovators to collaborate in developing long-lasting relationships to address these challenges.

The original project achieved significant impacts and received considerable recognition. Table 1 highlights some of the awards/recognition the project received.

Volvo Indian Innovation Summit, 2021

Special recognition for the Church Street initiative.

'Good Development' project

Selected by UKRI as a project of international research and innovation.

Ministry of Housing and Urban Affairs (MoHUA)

'Award in Urban Transport' and 'Best Research Paper Award' (1st Prize)

Table 1: Recognition of original IfCA project

Award / publication	Detail
Clean Air Street (recordings)	<p>Below are links to recordings posted online (YouTube) to showcase the Clean Air Street project.</p> <p>Church Street First Webinar - Part 1 - Introduction by Prof. Ashish Verma, IISc Bangalore, India</p> <p>Church Street First Webinar - Part 2 - Assessing Air Quality and Air Quality Index</p> <p>Church Street First - Webinar - Part 3 - PLOS and Boarding and Alighting at public transit stations</p> <p>Church Street First Webinar - Part 4 - Sentiment Analysis and Visitor's Opinion on Quality of Life</p> <p>Church Street First Webinar - Part 5 -Measuring Motivation, Shop Owner's Opinion and Quality of Life</p>
Volvo Innovation Summit (Award)	<p>Department of Urban Land Transport [DULT], Government of Karnataka, was honoured with a special recognition for their initiative in turning Church Street in Bengaluru into a test bed for future solutions in pedestrianization, clean air and electric micro-mobility.</p>
Ministry of Housing and Urban Affairs (Award)	<p>Award in Urban Transport under the category 'Running trophy for the state/UT, which has Implemented Best Urban Transport Projects' and 'Best Research Paper Award (1st Prize)'</p>
Innovate UK, Good Development Project (Recognition)	<p>UK Research and Innovation identified IfCA as a 'Good Development' project. To mark this, Ms. V. Manjula (Directorate of Urban Land Transport), Mr. Andrew Stokes (Energy Systems Catapult) and Professor Ashish Verma (Indian Institute of Science) joined BEIS Chief Scientific Advisor, Professor Paul Monks to discuss the innovative project that explores air quality, pedestrianisation of streets and the electric vehicle transition.</p>

Phase 2

Following the completion of IfCA, UKRI awarded ESC funding to continue their engagement and develop new projects with partner organisations. The overarching aim of these projects was to build relationships and partnerships with the Government of India or important Indian organisations; and deliver and/or explore new relationships and/or new ideas for future partnership.

ESC was awarded funding for three separate projects, all of which align to a number of aspects of the UK Innovation Strategy and the India-UK 2030 Roadmap, for example by facilitating the involvement of business in smart and sustainable urbanisation (Article 11), building India/UK partnerships and supporting bilateral collaboration on climate and clean energy and transport (Articles 21 and 22).

The overarching aim of these projects was to build relationships and partnerships with the Government of India.

Extension of IfCA in Bengaluru/Karnataka

This project was an extension of the IfCA phase 1 project to expand and allow further deployment of innovative solutions currently being deployed in Bengaluru/Karnataka.

Anticipated outcomes were:

Enhanced relationships between the UK and Indian businesses, research and public sector organisations.

Stimulated business ecosystem in Bengaluru with firms identified with relevant solutions for energy and air quality problems.

Pipeline of demonstration projects that can be rolled out to showcase the role of innovation, UK and Indian technologies, and raise public awareness.

Raised capacity amongst local stakeholders around challenges and approaches to them.

Framework to support the replication of IfCA in other cities globally.

This project continued to build on the partnerships and relationships formed in the original IfCA programme, to develop new testing and demonstration opportunities for innovators.

Activities were undertaken in three main workstreams and included:

- Engaging with stakeholders from across public, private and third sector organisations to understand needs and innovation opportunities. This learning was captured and documented in an 'EV integration – challenges and opportunities' report.
- Identification of new and existing innovations (from the UK and India) with relevance to the needs and opportunities identified. The project engaged with approximately 15 innovators from the two countries.
- Development of new pilot projects for innovators to deploy in Bengaluru and Karnataka (both UK and Indian), to allow additional collection of data; learning/ insights for policy makers; showcasing of technologies and involvement with citizens to build knowledge around the project themes. This included considerable support to innovators and pilot project 'hosts' to enable the pilots and maximise their chance of success. In total four new pilot projects were created.
- Research/knowledge sharing about the problems of air quality and possible monitoring methods, with a report to summarise the findings and a workshop to disseminate them.
- Research about approaches to the procurement of innovation in India and best practice from elsewhere, with a report to summarise the findings and a workshop to disseminate them.
- Evaluation and support to firms for next steps and capacity building with local stakeholders, including workshops with DULT and CII .
- Alignment of the IfCA project with other ongoing programmes in India and development of plans for further roll out.

Below are the details of the different pilot/ demonstration projects and activities.



Swiggy Electrified Delivery Pilot Project

The growth of e-commerce in India has been accelerated considerably by the pandemic, creating hundreds of thousands of jobs in the gig economy, largely in the last mile delivery sector. Food delivery companies such as Swiggy, Zomato; marketplaces such as Amazon, Flipkart, Grocers such as BigBasket and fashion retailers such as Ajio, Myntra, etc., are all contributing to this growth. The most common mode of transportation for deliveries are fossil fuel based two and three wheelers. There is an opportunity for makers of electric two/three wheelers and ancillary service providers to provide these services and accelerate EV adoption in the last mile delivery segment. However, higher capital costs (largely due to battery cost), concerns around the service ecosystem, and uncertainty around charge point availability are some of the deterrents/challenges that are slowing down the transition, and there is very limited information on how the whole ecosystem works when together.



EDrives eBike in Bengaluru

Swiggy, an online food ordering and delivery platform, has ambitions to decarbonise delivery services. ESC and its local partner Urban Morph worked with Swiggy to plan a test bed to trial new approaches, engage e-commerce companies and gig economy workers to try and buy, learn about gaps that exist in the market and produce a detailed analysis report that would be useful to further accelerate EV adoption. The Directorate of Urban Land Transport, Government of Karnataka, were affiliated with the project to oversee the efforts made and offer support should the trial require it.

Through the project, ESC has helped Swiggy to build a better picture of the state of the electrified two-wheel market in India and introduced them to a wide range of Innovators in the space. The real-world trial allowed a Swiggy Delivery Executive to gain experience of how an eBike could work for their use case. It also highlighted the challenges around data collection in some vehicles which Innovators are working to improve. The project has brought together some suggestions for future work that Swiggy could seek to carry to accelerate EV adoption among their fleet.

Pilot Project: Energy modelling hackathon

Transit Oriented Development (TOD) is an urban planning tool that offers cities the ability to manage development around transit nodes to maximise efficiencies in mobility due to density. However, the density will impose a cost on support services, energy being one of them. With an explosive increase in electric vehicles and upward building meaning a higher floor space index (FSI), energy modelling offers a view into the current demand and planning for higher demand in a higher FSI scenario. This local energy modelling project supported the development and show the utility of models to calculate current demand in a TOD zone and predict future energy consumption based on parameters and scenarios.

ESC, Urban Morph, and the Directorate of Urban Land Transport (DULT) decided to use a 'hackathon' approach. The purpose of the hackathon was to identify ideas and a solution for modelling the energy around metro station transit points to help improve energy efficiencies and advise future development from a net zero point of view.

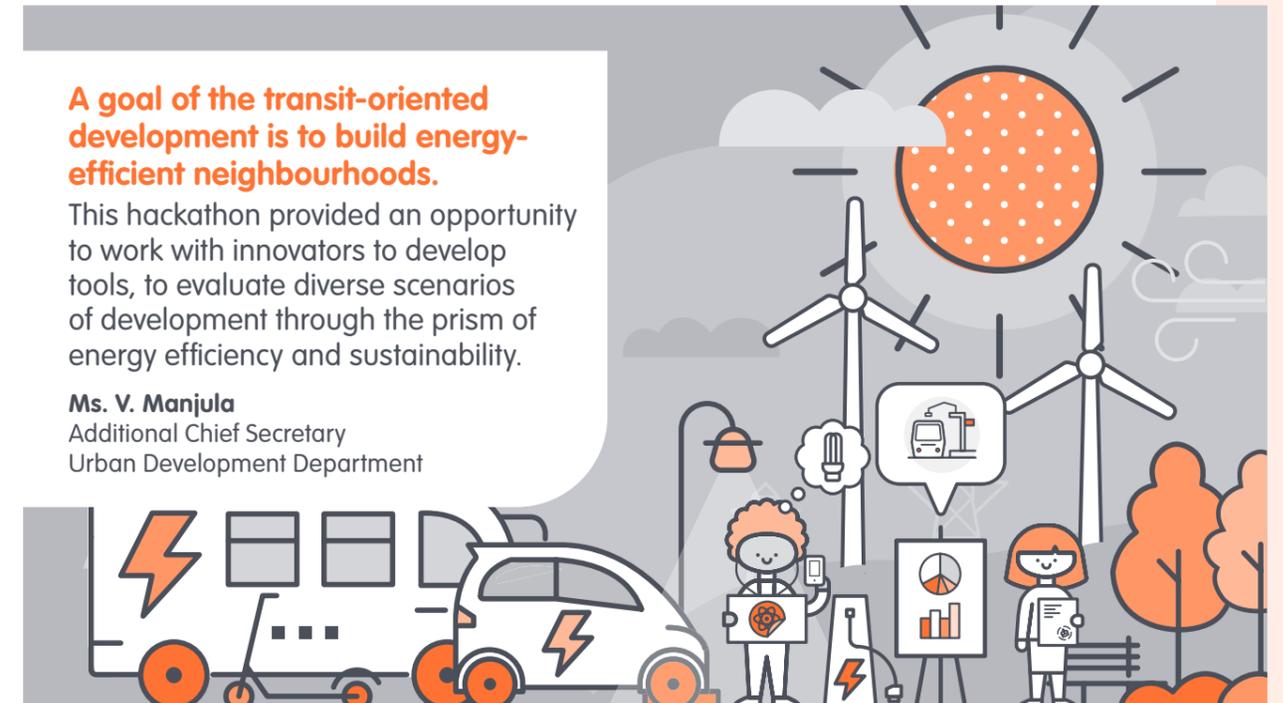


Energy modelling offers a view into the current demand and planning for higher demand.

A goal of the transit-oriented development is to build energy-efficient neighbourhoods.

This hackathon provided an opportunity to work with innovators to develop tools, to evaluate diverse scenarios of development through the prism of energy efficiency and sustainability.

Ms. V. Manjula
Additional Chief Secretary
Urban Development Department



Impacts of the hackathon include:

- Development of a useful outline framework for modelling energy efficiency.
- Future collaboration opportunities for participants taking part in the hackathon.
- Hackathon participant innovators and DULT staff have increased their capacity and understanding of solutions in this space.
- Insights into novel ways of using currently available datasets.

The hackathon winner was a joint private sector/academic collaboration by COLeaD + CEPT. The solution offered a logical methodology, showed initiative and provided a clear interface for users. The solution has real potential to be developed further into a really useful model for energy system modelling.

“A BIG Thank you for providing this opportunity to participate in the Energy Modelling Hackathon Challenge, it’s great to be associated with it. Secondly, it paved the way for exploring new skills and tools.”

GreenEnco

Maximising Asset Values

Net Zero Charge Point IISc Pilot Project

In the original IfCA programme (Phase 1), GreenEnco designed, developed and installed an EV charging station integrated with solar power generation and battery storage at the Indian Institute of Science (IISc.) campus. The next step for the project was to explore the payment and pricing mechanism for the solar powered EV charging station and collect user feedback. The pilot included the development of a mobile phone application for booking and payment and the development of a dynamic pricing mechanism. Following the development of the app and establishing the pricing approach, a trial was set up with EV users.

The pilot project has:

- Enabled GreenEnco to develop a mobile application for the charging station bringing their solution closer to commercialisation.
- Collected data on how EV drivers perceive the concept of using solar generated electricity to power their vehicles. The outputs reinforce the argument that drivers place high importance on the source of the electricity they use.
- Allowed IISc and GreenEnco to showcase the EV charging station concept to a range of stakeholders and disseminate the value of green generated electricity for EV charging.
- Allowed EV drivers at the IISc. campus to use solar generated electricity to power their vehicles and further reduce the carbon intensity of their travelling.

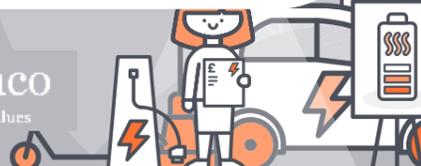


Is the power green to your EV?

To demonstrate net zero transportation, GreenEnco designed and executed a solar powered EV charging infrastructure with battery storage as an option. GreenEnco has been making an environmental impact and developing a sustainable socio-economical ecosystem in the local market by creating local partnerships.

Dr Jyoti Roy
 Founder & CEO, GreenEnco Ltd.

GreenEnco
 Maximising Asset Values



eFleet Analytics



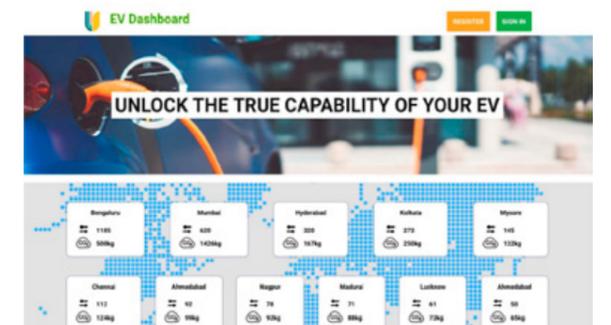
EV Dashboard Pilot Project

In this pilot, the UK company eFleet Analytics and the Indian electric taxi firm eee-Taxi worked together to automate the collection of performance data from vehicles. This data is valuable for fleet operators and drivers, as insights collected from the data can improve charging patterns and optimise daily operations. Furthermore, the fleet operator can understand how to improve the fleet's performance and energy consumption.

The pilot project tested SIM card-based devices for the data collection directly from vehicles and providing data and analytics to the fleet operator via an EV Dashboard developed by Urban Morph. The EV dashboard constitutes a light and easily interactable tool for users to learn about EVs and EV infrastructure. The dashboard can be continuously used for every new trip with an advanced trip and battery-related statistics being generated each time, for the benefit of fleet operators, other industry, policy makers and citizens.

Impacts from the pilot include:

- eFleet Analytics can trial their SIM-based devices with vehicles produced for the India market and explore what analytics are used by fleet operators in India.
- eee-Taxi will gain insights on how their vehicles are driven and how they can improve performance.
- The EV Dashboard is developed further into a tool that could be used on a wider scale.
- Urban Morph will trial the integration of data and additional analytics to their platform.



The fleet operator can understand how to improve the fleet's performance and energy consumption.



The importance of monitoring for mitigating and managing exposure to poor air quality

In this workstream, Satellite Applications Catapult (SAC) worked with the City of Bengaluru and relevant stakeholders to highlight the importance of a systemic approach to air quality looking at monitoring sources of pollution, public health impacts and opportunities to change and sustain behaviours. The activity provided the latest examples and recommendations on how to monitor and personally or collectively mitigate exposure to poor air quality while leveraging UK experience.

The workstream focused on engaging with stakeholders to identify and categorise key issues and research areas, collecting data through desk research and interviews and providing assessment and insight of the results. The resulting report identifies the latest opportunities and recommendations to leverage UK expertise, combining research and interview insights. The project also delivered a workshop with the City of Bengaluru and relevant stakeholders to showcase the process undertaken, analysis of results gathered, insights and next steps.



Source: Mckinsey & Company, Inc, "Environment and Energy Sustainability an Approach for India," Mckinsey, 2009.

The main themes identified in this project were:

- The importance of having a systemic understanding of air pollution in terms of source, dispersal, temporal coverage and effects, to inform policy making and take evidenced based action. In order to achieve this with ground-based monitors, a dense network would be required at great cost. But technological advancements in satellite enabled technologies and low-cost sensors mean that a hybrid monitoring network can deliver similar benefits at significantly lower cost. An example of this is the detection of brick kilns. The Indian brick kiln industry is the second largest brick producer in the world, comprising more than 100,000 operating units and producing about 250 billion bricks annually. Satellite image analysis offers a promising solution for periodically mapping and monitoring brick kiln operations across large areas as opposed to time and resource consuming ground-based surveys.
- The importance of public engagement. Air pollution affects everyone, although there are inequalities in exposure and impact, and yet the general public are also significant contributors to air pollution. Informing and engaging residents on the issue of air pollution builds support for policies to tackle the problem, promotes healthy behaviours and facilitates mitigation of personal exposure.



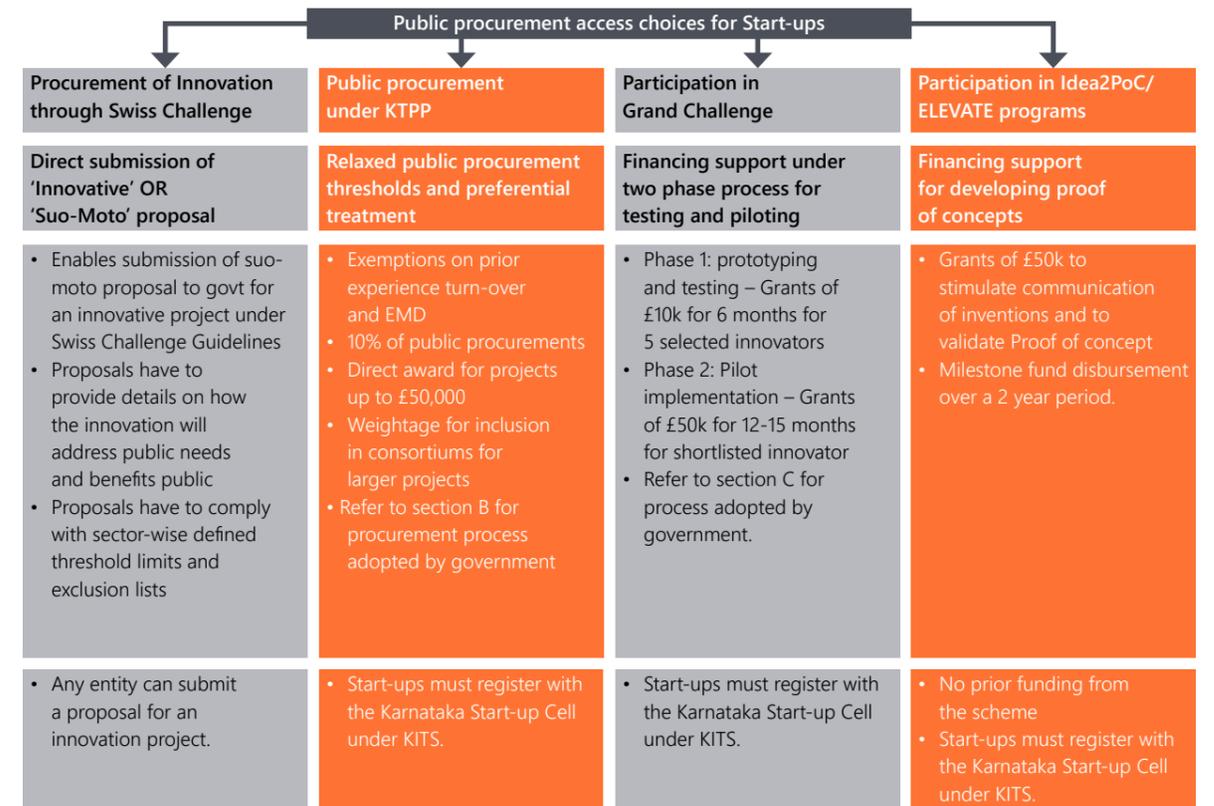
Enabling the sustainability of UK-India city demonstrators (A Guide to Public Procurement of Innovation in Karnataka, India)

£380 billion is annually spent on public sector procurement in India, which represents 22% of the country's GDP. Major reforms in recent years to public procurement are designed to increase efficiency and transparency with the establishment of electronic procurement. Mainstreaming public procurement for domestic and foreign innovators is a chance to enhance efficiency and sustainability of urban infrastructure and service delivery with national and international innovators.

This workstream, based on consultations with relevant stakeholders in the City of Bengaluru and State of Karnataka and led by CPC, focused on collecting and analysing data to identify the key barriers for the procurement of innovative solutions.

The report summarises the history of policy regulations and main challenges and gaps of innovations being brought to market, with a focus on procurement mechanisms and approaches. It also provides best practices and recommendations on how to optimise engagement and procurement mechanisms leveraging UK experience in India.

Access choices for Start-ups in Karnataka's public procurement landscape



Enabling the sustainability of UK-India city demonstrators (A Guide to Public Procurement of Innovation in Karnataka, India) – Continued

The main findings identified were:

- To promote innovations in public procurement, Karnataka has taken multiple commendable initiatives that both position it as a global innovation and start-up hub through its multi-sectoral start-up policy whilst also enhancing the public procurement of such innovations in the State.
- Karnataka has been ranked as one of the best performers in the innovation and start-ups landscape: in the top three amongst major states in Department for Promotion of Industry and Internal Trade State Start-up Ranking 2019 and highest ranked in the India Innovation Index 2020.
- There is still scope for improvement to leverage the dividends of such innovative policies leading to actual implementation.
- UK and foreign businesses can only benefit from the impressive progress in public procurement innovative processes in India and Karnataka in particular.
- In addition to a more conducive regulatory environment, the enhanced public spending on procurement combined make India, Karnataka and local Indian authorities much more attractive and successful places to do business.
- Next steps are mainstreaming public procurement innovation to reap greater benefits from increased start-up and SME engagement with the public sector services and delivery.

The report and associated workshop and engagements will have helped share knowledge about challenges and best practice in public procurement of innovation. This knowledge and increased understanding will help both Indian innovators and those from other countries, such as the UK.

£380 billion is annually spent on public sector procurement in India, which represents 22% of the country's GDP.



Collaboration with Clean Energy International Incubation Centre (CEIIC)

ESC engaged with CEIIC during the original IfCA project. CEIIC showed considerable interest in collaboration and approached the ESC to support their idea of developing a Mission Innovation Climate Action Exchange (MI-ClimEx) Platform. This platform would create a network of validated and tested clean energy innovation solutions, incubators and investors to encourage international collaboration. Other countries are also being asked to join.

This project aimed to work with CEIIC in Delhi to support their work on creating a MI-ClimEx Platform and to demonstrate the value of bilateral incubator collaboration by supporting a cohort of UK clean energy SMEs interested in the Indian market.

A network of validated and tested clean energy innovation solutions, incubators and investors to encourage international collaboration.

The anticipated outcomes of the project were:

Increased mutual visibility of UK and expertise and innovations, and direct linkages between UK innovators and relevant Indian organisations.

An understanding of how UK organisations could get involved in the potential MI-ClimEx platform.

Research outputs that show clean energy challenges, potential support networks and UK firms with innovative solutions.

Collaboration with Clean Energy International Incubation Centre (CEIC) – Continued

The activities undertaken and impacts achieved include:

- Extensive engagement with CEIC to understand their activities, needs and scope for collaboration. This has led to increased understanding of CEIC capabilities and the support structure they can provide for SMEs wishing to engage with Indian industry.
- Mapping of UK clean energy innovation challenges to help increase understanding.
- Mapping of UK clean energy funding and financing to help increase visibility for businesses.
- Identifying, and showcasing in an infographic, UK organisations active in the flexibility and energy storage subsectors.
- Identifying clean energy incubators/ accelerators across Mission Innovation countries and engaging with a subset of them.
- Identifying organisations that invest in clean energy innovation across Mission Innovation countries.
- Showcasing these outputs to the UK supply chain and Indian partners so that the wider energy supply chain can benefit.
- Working with Mission Innovation UK staff and CEIC to explore how the UK could potentially remain involved in the Mission Innovation Climate Action Exchange Platform.
- Identifying a group of UK clean energy SMEs in the EV and energy storage space with an interest in the Indian market and working with CEIC to provide support to them to help them understand and prepare for the opportunity.
- Business matching and network building activities between UK innovators and organisations identified in India to enable collaboration, principally delivered via two industry pitching events.
- Supporting linkages between the firms in the UK cohort – principally delivered via online sessions and a face-to-face networking event.



Development of model for EV charge point location optimisation

Transportation is one of the fastest growing sectors in India and is still mostly dependent on liquid fossil fuels. It is an important emitter of greenhouse gases in India, contributing to global climate change. Locally transport also contributes to noise, air and water pollution. The effects of local pollution disproportionately impact the health of the poor (e.g., roadside vendors) and marginalised/vulnerable groups such as women and children who walk or cycle along congested roads. To combat air pollution the Indian Government has begun implementing ambitious policy for the electrification of transport. State Governments are also competing in some instances to become an 'EV hub' and take the title of the most advanced state in terms of electrifying mobility.

However, the rollout is slow, with differences between states in their ability and enthusiasm to implement, a lack of supporting regulation (e.g., interoperability standards) and typical consumer worries such as range anxiety and waiting times for charging influencing low consumer uptake.

Working with Indian partners (principally the Indian Institute of Science (IISc)), this project aimed to develop a modelling tool to inform the optimal location, type and size of EV charge points in the city of Bengaluru for private vehicles.

The model created by the Sustainable Transport Lab (IST) team at IISc, with support from ESC, Connected Places Catapult (CPC) and Urban Morph, aims to benefit local stakeholders such as the local power distributor, BESCOM, to make low-regret choices on where to install EV charging infrastructure. The model outputs and the final user dashboard have been designed with BESCOM in mind.

The negative externalities of motorised transportation disproportionately

affect the health of the poor (e.g. roadside vendors) and marginalised groups including women and children, who, despite their small contribution to the problem, are more exposed to air pollution while walking or cycling along congested roads.

Prof. Ashish Verma
Professor
Indian Institute of Science





In parallel to model development, The Energy and Resources Institute (TERI) also produced a report, 'Readiness and Capacity Needs Assessment for Electric Vehicle Adoption in Indian Cities'. The reports analyse the profiles of four Indian cities with varied transportation landscapes, using a holistic approach that includes institutional, technological, economic, social, environmental and innovation criteria. It ranks the cities' readiness for an EV transition and identifies the capabilities that need to develop to achieve it.

The anticipated outcomes of the project were:

Workable tool for planners and policy makers in Bengaluru to understand the optimal positioning of EV charge points and thereby encourage the EV transition.

Increased knowledge and capabilities in stakeholders in both the UK and India for modelling and EV infrastructure related work.

Tool that could be replicated in other cities across India as an example of UK – India collaboration, with potential application in other countries.

Strong research collaboration linkage developed between UK Catapults and a leading Indian university, which could be leveraged for future collaboration.

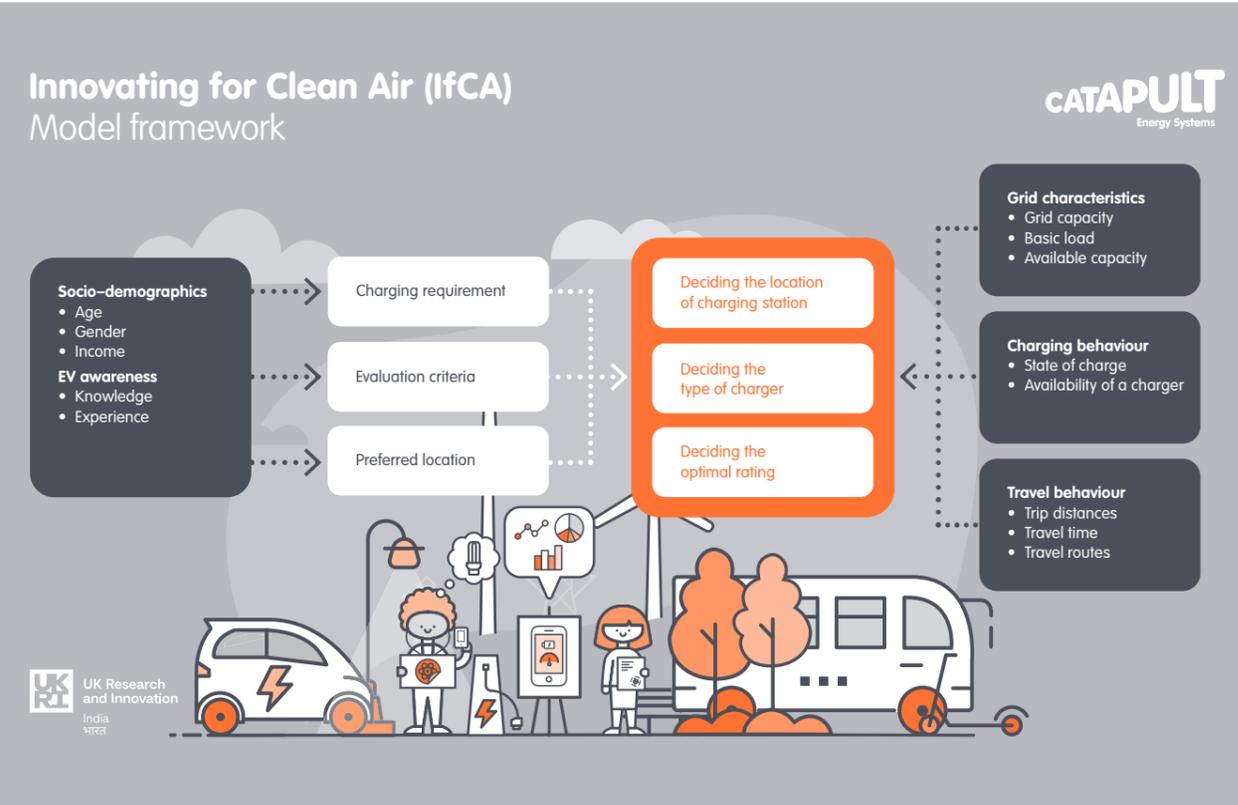
The activities undertaken included:

- Collecting primary data from consumers, including a travel diary survey and behaviour survey.
- Creating a model that took into account grid impact, traffic flow and behavioural preferences and fed those into an optimisation module, in order to help planners and policy makers in Bengaluru to understand the optimal positioning of EV charge points and thereby encourage the EV transition.
- Creating a prototype user dashboard (a 'GUI') to be used by BESCOM employees.
- TERI investigated the status of electric vehicle rollout in the four Indian cities of Bengaluru, Delhi, Panaji and Guwahati and produced a report to score these cities on the economic, governance/ policy, innovation, technological, environmental and social aspects of electrification of transport. This analysis builds understanding of how the EV charge point model might be used in other cities, who likely stakeholders are and what their obstacles might be to full EV rollout.

The model provides proof of concept to important local stakeholders such as the power distributor in Bengaluru, BESCOM, of the usefulness of modelling EV charge point locations and their impact on the electricity grid. Staff from BESCOM have their own access to the user dashboard and have provided guidance and feedback on it and have shown strong interest in the development of this tool.

The model is highly replicable in other cities which also have similar challenges with air pollution and underperformance of the power grid. Application of this approach elsewhere has the potential to support evidence-based and informed decision making and greatly increase efficiencies.

This collaboration has ensured bi-directional knowledge transfer between leading UK and Indian institutions. ESC expertise in power grid modelling complements IISc's expertise in traffic flow and consumer behaviour modelling. Both Catapults were able to provide guidance and support to the project, and by working closely with IISc university students, ESC team members were able to help them develop their coding skills and impart some best practice for working in a more commercial environment that will hopefully support them in their future careers. Indian partners have also provided vital local insights and made use of their networks and reputation to gather data and ensure important stakeholders were engaged.



Impact

The IfCA phase 2 projects created considerable impact, as highlighted in this section.

Extension of IfCA in Bengaluru/Karnataka

6 firms (2 from the UK and 2 from India) were able to develop and test solutions in a risk-free environment through engagement in the energy modelling hackathon and the EV dashboard. They also established close relations with international partners.

10+  UK SMEs were given masterclasses on understanding the Indian energy sector and on doing business in India.

- Working on IfCA with ESC helped progress DULT's plans in the space of innovation and testing environments, resulting in DULT establishing its own internal research and innovation team in November 2021. This is the first unit of its kind in Bengaluru, and focuses on collating challenges/problem statements from across stakeholders in Bengaluru and running 'test beds' and pilot projects to explore relevant solutions.
- Engagement in the hackathon increased DULT staff knowledge of hackathon approaches as well as data-driven solution.

10+ private sector organisations gained an understanding of Swiggy's needs and use cases, which positions them well for further collaboration. Swiggy has also gained visibility of the current state of the market and increased its understanding of insights data and vehicle trials can provide.

- GreenEnco was able to expand and test its offering and incorporate new functionality in a risk-free environment. Due to IfCA, GreenEnco has established connections to apply its technologies and solution elsewhere.

Sector knowledge sharing

The following were shared with public, private and third sector stakeholders in the UK and India, to help raise awareness/ knowledge:

- Report on Bangalore's "EV integration – challenges and opportunities"
- An event 'Procurement of Innovation in Bengaluru' was held to explain the challenges for innovators in public procurement and steps that can be taken to increase opportunities
- A report and event on the challenges of air pollution and how satellites and other monitoring approaches can help to understand and benchmark the problem.

Collaboration with CEIC on Mission Innovation Platform

7 UK SMEs supported and received bespoke support to develop their propositions, understand the Indian market and connect to potential Indian partners/ Clients. The SMEs rated the support very highly (>8.5/10) and indicated increased their knowledge of India and the market opportunity and that the introductions made were very valuable.

- Research outputs on the following were shared widely in the UK and also with CEIC to disseminate in this network, to increase understanding bilaterally and help businesses gain visibility:



- International investors into clean energy innovators
- UK funding for the clean energy innovation sector
- International incubators/accelerators active in clean energy
- UK innovators active in the energy storage and flexibility sectors

Development of model for EV charge point location optimisation

- The project provided BESCO, the electric utility in Bengaluru, with a tool to help them identify locations for EV charge points, which can greatly improve their future planning of EV infrastructure, aid evidence-based decision making, and increase BESCO staff knowledge.
- The project commissioned a report 'Readiness and Capacity Needs Assessment for Electric Vehicle Adoption in Indian Cities' (produced by TERI). The report gives a comprehensive overview of the typical barriers to implementing an EV rollout in four distinct cities.
- This collaboration has ensured bi-directional knowledge transfer between leading UK and Indian institutions. For example, ESC staff gained important local insights and IISc staff increased their knowledge of power grid issues and mode development.

For more information or to receive updates
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