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E-Mobility Solutions

Bus Rapid Transit

Wuppertal Institut

UN-HABITAT FOR A BETTER URBAN FUTURE

CAiF

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Future Radar project

UEMI SOLUTIONS

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UEMI

Urban Electric Mobility Initiative (UEMI) was initiated by UN-Habitat and the SOLUTIONS project and launched at the UN Climate Summit in September 2014 in New York.
UEMI aims to help phasing out conventionally fueled vehicles and increase the share of electric vehicles (2-,3- and 4-wheelers) in the total volume of individual motorized transport in cities to at least 30% by 2030. The UEMI is an active partnership that aims to track international action in the area of electric mobility and initiates local actions. The UEMI delivers tools and guidelines, generates synergies between e-mobility programmes and supports local implementation actions in Africa, Asia, Europe and Latin America.

Future Radar

Future Research, Advanced Development and Implementation Activities for Road Transport (FUTURE-RADAR) project will support the European Technology Platform ERTRAC (the European Road Transport Research Advisory Council) and the European Green Vehicle Initiative PPP to create and implement the needed research and innovation strategies for a sustainable and competitive European road transport system. Linking all relevant stakeholders FUTURE-RADAR will provide the consensus-based plans and roadmaps addressing the key societal, environmental, economic and technological challenges in areas such as road transport safety, urban mobility, long distance freight transport, automated road transport, global competitiveness and all issues related to energy and environment.

FUTURE-RADAR will also facilitate exchange between cities in Europa, Asia and Latin America on urban electric mobility solutions. The FUTURE-RADAR activities include project monitoring, strategic research agendas, international assessments and recommendations for innovation deployment as well as twinning of international projects and comprehensive dissemination and awareness activities. Overall it can be stated that FUTURE-RADAR provides the best opportunity to maintain, strengthen and widen the activities to further develop the multi-stakeholder road transport research area, for the high-quality research of societal and industrial relevance in Europe.

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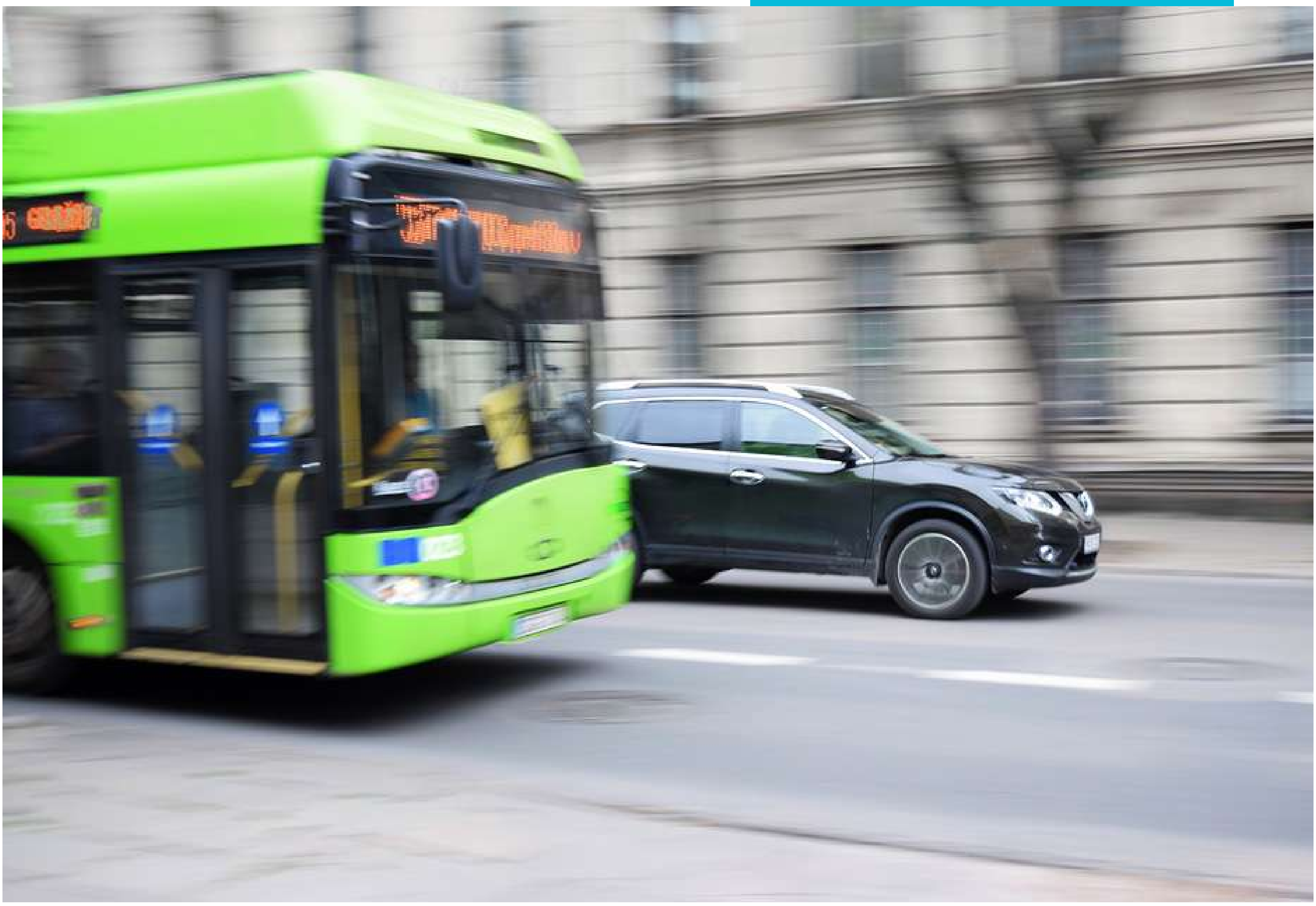
In brief

In brief

E-BRT is a variation of a bus rapid transit systems that utilizes electric buses as the primary vehicles, and combines such into conventional BRT system features. BRT systems are deemed to contribute towards reducing overall congestion in highly dense urban areas by providing high-capacity bus services with dedicated right-of-way and supporting infrastructure and measures that aim to facilitate high volume passenger flows.



Examples

E-BRT takes-off from conventional BRT system characteristics such as dedicated bus lanes, barrier-free entry, pre-ticketing systems, prioritisation on roads, high capacity vehicles, close proximity stations, controlled ingress and egress of passengers, at grade entry, centralized control systems, and user-information systems.

E-BRT systems may potential utilize pure electric buses or hybrid electric ones which combine conventional internal combustion engines with an electric propulsion system. Hybrids are also classified into conventional, or plug-in, with the latter enabling charging through an external power source.[1]

1 Grutter, 2017.

Examples Measures

Results

Passengers would save time while externalities are lessened. By converting the BRT buses into electric ones, the system is deemed to contribute further to cleaner air, less transport noise, as well as operations savings due to the absence of the traditional engine and transmission systems of conventional buses. BRT systems are also relatively faster to implement than rail-based systems and are competitive in terms of passenger capacities, costs, and have less life-cycle impacts (as compared to impact-heavy infrastructure for rail-based systems).

Results

Technical & Financial Considerations

Electric buses are significantly more expensive than conventional diesel buses. The San Joaquin buses for example, are priced at 850,000 USD (average mark-ups vary by region, but range between 85% to 400%). Hybrid buses are relatively more cost competitive, with cost increments ranging from 45% to 130%.[1]

As with other options that rely on grid electricity for propulsion, consideration needs to be given to the energy system providing the electricity. Real-time monitoring of energy performance, and battery status is needed.

Once adopted on a massive scale, e-BRT systems utilizing pure electric buses may potentially impact peak hour electricity demands, and considerations for off-peak charging need to be considered seriously if the system will run on grid electricity. While on-route charging technologies are already existing, these would require significant capital investments, sever the flexibility in terms of routes, and the buses would have lower distance ranges (40-60 km vs 120-150 km for off-route charged buses).[2] However, such on-route charging technologies would yield benefits associated

Technical & Financial Considerations

2 http://www.repic.ch/files/7114/4126/7442/Grutter_FinalReport_e_web.pdf

3 https://bctransit.com/servlet/documents/1403648390140

with smaller battery capacity requirements.[3] Off-route charging models require less complex charging infrastructure and fleet deployment, and enable off-peak charging, but requires upgraded garage terminals.

Other considerations include transit facility, and city infrastructure upgrades, and battery replacement modalities. It must also be noted that the battery performance is impacted by a variety of factors including topography, climate and temperature, weight of the bus, energy capacity of the batteries. The electric bus fleets that have operated in the recent years had larger fleets to allow for downtimes for recharging (non-provision of fast charging).[4]

4 In Geneva, Switzerland, an ultra-rapid charging system is being tested (flash charging) (Grutter, 2017).

5 http://oro.open.ac.uk/41076/1/Miles%20and%20Potter_(revised).pdf

Policy/legislation

Ideally, a city should also have a Sustainable Urban Mobility Plan (SUMP) which is based on clear targets (short, medium, and long term) that would encourage systematic changes towards more sustainable urban transportation. In addition to the SUMP, complementary plans, regulations, and instruments related to BRT operations are needed (kindly see the BRT factsheet here).

Policies, and economic instruments that would encourage the electrification of BRT (and even conventional bus systems) should ideally be placed (e.g. preferential tax measures and incentives, or emissions-based fees).

The operational aspects of the system is inter-linked with the technical specifications of the system as well. The battery packs, for example, determines the operating ranges, as well as the kind of infrastructure needed for the system. They may also impact passenger capacity, based on their size.

Adjustments, and training (in case of existing BRT system upgrades) must be implemented in terms of route structure, facility designs, bus operations, among other day-to-day aspects.

Policy/legislation

Institutions

Such systems would entail the support of institutions that are primarily involved in setting up traditional BRT systems. At the national level, such are primarily led by transportation ministries or departments, or by similar agencies operating at the state or local level. Close coordination with government agencies responsible for environment, energy, urban development, public works, urban space, social and economic development, and financing should also be ensured.
Coordination with power sector (generation and distribution) is highlighted in relation to E-BRT systems as to ensure that needed system upgrades are implemented (if needed), as well as with the municipal/local governments.

Institutions

Transferability

It is estimated that 168 cities globally have BRT systems with 4.9 thousand kilometres and 33.3 million passengers per day.[1] Cities have also increasingly been adopting incremental changes towards electrifying BRT buses (as well as conventional city buses). In China, for example, there have been continuing trend in terms of electric bus sales in the recent past as shown on the graph below:

Globally, it is estimated that more than 385 thousand electric buses are operating, with 99% of these in China.

Many cities are doing trials and demonstrations on electric buses (e.g. Canada – Vancouver Translink, Edmonton, Winnipeg Transit). The Foothills Transit trials, for example, concluded that the electric buses rated 7 out of 9 in terms of technical readiness criteria set out by the U.S. National Renewable Energy Laboratory.[2]

The transferability of such an electric-based BRT system is dependent on ensuring that proper incentives are provided to operators, and system owners to shift towards electric buses. Such is then dependent on the proper inclusion of aspects outside of the direct financial costs in the evaluation process. A study done by the Global Environment Facility and World Bank, for example, shows that the life cycle cost of e-buses in Shenzhen, China are comparable to diesel ones.[3] In many developing cities, a strong social marketing campaign that would disseminate information about the system should be put in place in order to maximize its usage potential, as well as alleviate relevant concerns (e.g. safety).
The existence of an entity that consolidates the views of public transport operators, and enables collaboration towards identification of locally-derived measures that can optimise the use of E-BRT would be beneficial, such as the Urban Transit Research and Innovation Consortium in Canada.[4]

Transferability

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6 https://brtdata.org/

7 https://bctransit.com/servlet/documents/1403648390140.

8 http://projects.worldbank.org/P127036/china-gef-large-city-congestion-carbon-reduction-project?lang=en

9 https://bctransit.com/servlet/documents/1403648390140.

Case Study: Shenzhen, China

Context

The City of Shenzhen, a major city in Guangdong Province, and located north of Hong Kong, is said to have more electric buses than all of the United States – more than 16 thousand electric buses. At the end of 2017, the City completed its move to have all of its bus fleets to be 100% electric. It also intends to replace all of the taxi fleets to electric by 2020.[5] The City used to be a small fishing village in the 1980s, but is now a metropolis home to more than 12 million residents, and has an urban density of 6,100 persons per square kilometre.

In action

In action

Shenzhen has incrementally added infrastructure to enable it to charge electric vehicles conventionally. It has built 300 bus chargers, as well as installed more than 8,000 streetlights that also function as charging stations for electric cars. The buses charge for an average of 2 hours. The City spent almost 500 million in 2017 alone to support the conversion initiative. The initiative has also been fully supported by the national government, which is said to have provided amounts that would have covered half of the purchase cost of the buses.[6]

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10 https://cleantechnica.com/2018/01/01/shenzhen-completes-switch-fully-electric-bus-fleet-electric-taxis-next/

11 WRI as quoted in https://www.citylab.com/transportation/2018/05/how-china-charged-into-the-electric-bus-revolution/559571/

Results

Based on the estimates, the electric buses are expected to reduce 345 thousand tons of diesel per year, and save up to 1.35 million tons of CO_2. Moreover, the shift towards electric buses would save fuel costs as comparable energy costs from electricity are a third of those from diesel.[7] Based on the analysis of Grutter (2017), the well-to-wheel CO_2 emissions of a 12 meter electric bus with air-conditioning (data based on 500 units operating in Shenzhen) which consumes 1.2 kWh/km is 40% lower than a comparable diesel unit.[8]
In Beijing, ten (10) new 18-meter pure electric buses were deployed in October 2017 in one of the busiest routes in Chang-an Avenue. The buses feature silver titanium-titanate batteries, with spacious interiors and can accommodate 160 to 200 passengers. It can rapidly be charged within 6 minutes, and can accommodate wider temperature resistance ranges (-50 C to 60 C), and has a 30-year life cycle.[9]

Hybrid electric buses utilized in BRT systems are currently more common (e.g. Sao Paulo, Rio de Janeiro, Santiago in Latin America, as well as cities in Germany, UK (London), and USA (New York). Fuel savings from these BRT systems utilizing hybrid buses have been estimated between 10% to 45%.

Results

12 https://cleantechnica.com/2018/01/01/shenzhen-completes-switch-fully-electric-bus-fleet-electric-taxis-next/

13 However, due to the lower posted carrying capacity of the sample electric buses as compared to diesel ones, the discrepancy in GHG emissions is lower in actuality.

14 http://www.evpartner.com/news/5/detail-31194.html

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More Information

Implementing Partners

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