Transport Policy 47 (2016) 178–188

Contents lists available at ScienceDirect

Transport Policy

journal homepage: www.elsevier.com/locate/tranpol

Operational and financial performance of Delhi's natural gas-fueled public bus transit fleet: A critical evaluation

Christian Krelling [a], Madhav G. Badami [b,*]

[a] School of Urban Planning, McGill University, Macdonald-Harrington Building, 815 Sherbrooke Street West, Montreal, QC, Canada H3A 0C2
[b] School of Urban Planning and McGill School of Environment, McGill University, Macdonald-Harrington Building, 815 Sherbrooke Street West, Montreal, QC, Canada H3A 0C2

ARTICLE INFO

Article history:
Received 23 June 2015
Received in revised form
5 February 2016
Accepted 5 February 2016
Available online 23 February 2016

Keywords:
Public transit
Bus transit
Delhi
Natural gas
Transit performance
Policy analysis

ABSTRACT

Following a Supreme Court of India directive, the bus fleet of the Delhi Transport Corporation (DTC) was converted to run on compressed natural gas (CNG) from around 1999 to 2000, to address the city's air pollution. We critically evaluate the operational and financial performance of DTC's bus fleet from 1989–90 to 2010–11 – that is, from ten years prior to CNG implementation until 10 years after – to assess how this performance was affected by the fuel switch, as well as the introduction of low-floor CNG buses.

CNG implementation caused a significant reduction in the capacity to deliver transit service at DTC in the initial stages of the fuel transition. Also, it necessitated investments in buses at a considerable cost premium relative to their diesel counterparts. Operating costs per kilometre grew, due to increased fuel expenditures per kilometre, because of the lower fuel economy, and increased maintenance costs and breakdowns per kilometre, on the CNG buses. These costs were further exacerbated by the introduction of the low-floor CNG buses. Despite increased capacity due to the investments in the CNG buses, passenger-kilometres generally declined over our analysis period. As a result, operating costs per passenger-kilometre, and the ratio of operating costs to traffic revenues, have progressively worsened.

We conclude that the financial situation resulting from these effects due to CNG implementation may have detracted from the ability to enhance transit capacity and provide transit service overall. Our study also demonstrates the need to analyze policies such as CNG implementation broadly, in terms of conflicts and trade-offs between environmental, and other (transit operation, socio-economic and equity) objectives, rather than narrowly in terms of only environmental outcomes.

© 2016 Elsevier Ltd. All rights reserved.

1. Introduction

Indian cities have been characterized by poor air quality since the 1990s. In Delhi, for example, suspended particulate matter levels have exceeded World Health Organization (WHO) guideline limits almost daily since the 1990s. Levels of PM_{10} (particulates below 10 μm diameter), which are strongly linked with respiratory and cardio-vascular illnesses and deaths, also exceed the WHO limits (CPCB, 2015). A global survey of urban air pollution (WHO, 2014) showed that Delhi had the highest annual average levels of fine particulates (PM2.5), which pose the most serious health risk. In response to this problem, a wide range of policies has been implemented since the early 1990s to address air emissions from urban transport. Delhi being the national capital, and given its serious air quality problems, many of these policies were first implemented there and in the other major metropolitan centres, and then in the rest of the country in a phased manner. These policies have included increasingly stringent vehicle emission and fuel quality standards, vehicle inspection and maintenance (I&M) to control in-use emissions, and the phasing out of old commercial vehicles (CSE, 2002; BIS, 2002; TERI – Tata Energy Research Institute, 2002; Kojima, Brandon and Shah, 2000). A Supreme Court of India ruling in 1998 mandated that all public and for-hire motor vehicles (buses, taxis and auto rickshaws) in Delhi be powered by compressed natural gas (CNG) (Supreme Court of India, 1998).

As a consequence of this ruling[1], all of the city's buses, including those that were publicly owned and operated by the Delhi Transport Corporation (DTC), had to be converted to run on CNG over a highly compressed time frame, by March 31, 2001. Due to resource, logistical, and institutional challenges, discussed later,

* Corresponding author.
E-mail address: madhav.badami@mcgill.ca (M.G. Badami).

[1] According to the ruling (Supreme Court of India, 1998), no 8-year old buses could ply in Delhi except on CNG (or "other clean fuels") beyond April 1, 2000, and further, the entire bus fleet in Delhi was required to be "steadily converted" to run on CNG by March 31, 2001.

http://dx.doi.org/10.1016/j.tranpol.2016.02.001
0967-070X/© 2016 Elsevier Ltd. All rights reserved.

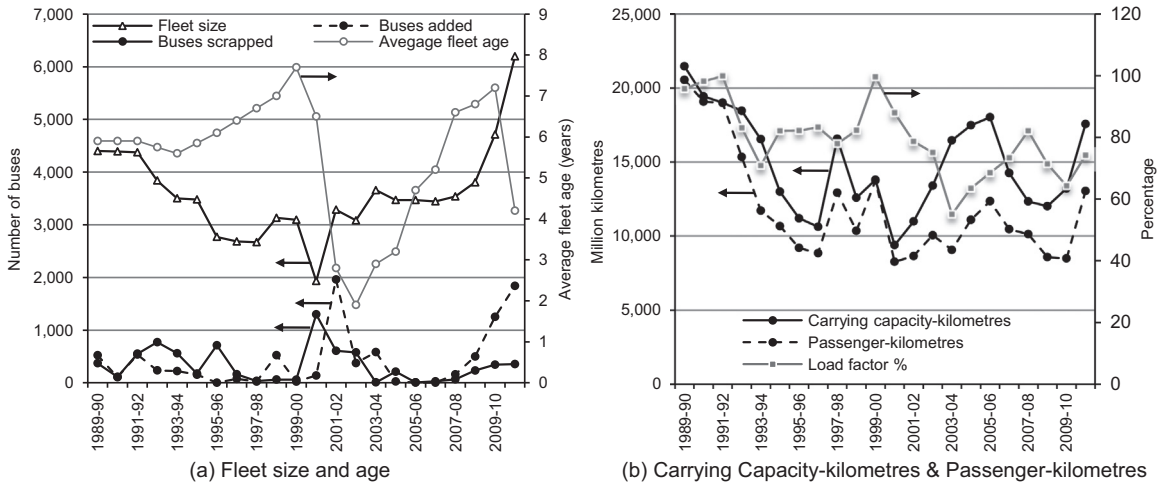

Fig. 1. Service provision and utilization.

CNG implementation on Delhi's buses began only in 1999–2000. In any event, Delhi today has the largest bus fleet in India, currently numbering, according to official statistics, around 60,000 buses (GNCTD – Govt. of NCT of Delhi, 2012) – and given that all of the city's buses run on CNG – one of the largest bus fleets running on this, or indeed any alternative fuel, globally. Further, DTC, the focus of our study, has the second largest publicly owned and operated urban bus fleet in India, with around 5800 CNG buses currently in operation (GNCTD – Govt. of NCT of Delhi, 2012). It serves the National Capital Territory of Delhi, as well as neighbouring cities in surrounding states, and carried 4.5 million passengers daily in 2010–11 (CIRT, 2012).

The literature on the implementation of CNG in Delhi's public vehicles has focused almost exclusively on its emissions outcomes (for example, Kathuria, 2005; Jalihal and Reddy 2006; Chelani and Devotta, 2007; Reynolds and Kandlikar, 2008; Reynolds et al., 2011; Narain and Krupnick, 2007; Kumar and Foster, 2009), with little if any attention devoted to its operational or financial aspects. Sen et al. (2007) discuss this gap in research, pointing to the lack of sufficient focus on the part of decision-makers on the creation of financially viable and self-supporting urban transport systems. Further, we argue, while the emissions outcomes of CNG implementation are important from a societal perspective, and are an important focus for policy evaluation, it is also important and useful to critically evaluate this, and indeed, any such policy from the perspective of vehicle users and operators, because it is the policy responses of these actors that crucially determine the extent to which implementation, and the associated emissions reductions, actually occur and are successful.

More particularly, analyzing the operational and financial performance of bus fleets on CNG or any other alternative fuel is important because it is this performance that critically determines the bus operator's policy responses. Such an analysis is also useful from a policy perspective, given the need to provide quality, convenient and affordable bus services within the constraints of limited budgets on which public transit operators typically rely, to prevent the migration of ridership to private motor vehicles, with all of their negative impacts. In this regard, note that, while buses and other public transit modes still account for a significant share of passenger trips (43% in Delhi), their mode share has been declining significantly, due to the growing role of personal motor vehicles (WSA – Wilbur Smith Associates, 2008).

In view of the foregoing, we critically evaluate the operational and financial performance of DTC's CNG-fueled bus fleet, in order to assess how the conversion from diesel to CNG has affected fleet operations and finances. We also critically discuss the implementation experience in terms of the associated infrastructure, logistical and institutional challenges. The 10-plus years of experience accumulated by DTC, a major public transit operator, of such a large-scale conversion of its bus fleet to CNG, provides a valuable opportunity for this retrospective analysis. Apart from addressing an important research need (such a post-implementation assessment has not been reported on so far), our analysis will hopefully be useful to decision makers and urban bus transit operators in contexts similar to India's, by drawing lessons for the long-term viability of large-scale conversions of bus fleets to CNG, for comparison with other CNG bus transit fleets, and for informing techno-economic and environmental analyses of CNG bus transit operations. In particular, our study, coupled with others that have focused on its emissions outcomes, should help assess the cost-effectiveness of Delhi's CNG policy.

1.1. CNG implementation on DTC's bus fleet

Despite the 1998 Supreme Court mandate to convert the entire bus fleet in Delhi to run on CNG by March 31, 2001, only around 150 CNG buses had been put into service at DTC by then. Implementation gained momentum only in 2001–02, and was completed only by 2003–04 (Fig. 1A). There were serious logistical and technological challenges related to the large-scale fuel-system conversion that DTC (and even more so, Delhi's private bus operators) faced, particularly with retrofitting diesel engines to run on CNG. Therefore, they mostly opted for factory-built CNG buses, which were supplied by two of the largest Indian bus manufacturers, Tata Motors and Ashok Leyland. More generally, there was a "sequencing problem", namely that of implementation depending on the availability of financial resources for conversion as well as reliable refueling infrastructure and vehicle technology (Bell et al., 2004). The bus manufacturers and infrastructure providers wanted assurances of demand for the technology, without which they were reluctant to invest in production. In order to break this supply-demand vicious-cycle, DTC, the bus manufacturers and Indraprastha Gas Limited (IGL), who provided the dedicated refueling infrastructure in DTC's depots, created a task force to coordinate their respective roles. Despite the challenges, CNG implementation was accomplished on Delhi's bus fleet over a short period, from 2001 to 2004 (Bell et al., 2004; Patankar and Patwardhan, 2006).

Table 1 highlights the key vehicle and engine attributes of the diesel and CNG bus technologies used at DTC during our analysis period. The first generation of CNG buses, which we refer to as the Standard CNG model, were introduced from 2000 to 2004, when they replaced a fleet of similar configuration diesel buses (Table 1), with most of these CNG buses being inducted in the 24-month

Download English Version:

https://daneshyari.com/en/article/1064761

Download Persian Version:

https://daneshyari.com/article/1064761

Daneshyari.com