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# Mobile phone infrastructure development: Lessons for the development of a hydrogen infrastructure

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## ABSTRACT

The development of new infrastructure is often a consideration in the introduction of new innovations. Currently there is some confusion around how to develop a hydrogen infrastructure to support the introduction of FCVs. Lessons can be learned from similar technology introduction in the past and therefore this paper investigates how mobile phone infrastructure was developed allowing the mass-market penetration of mobile phones. Based on this successful infrastructural development suggestions can be made on the development of a hydrogen infrastructure. It is suggested that a hydrogen infrastructure needs to be pre-developed 3–5 years before the market introduction of FCVs can successfully occur. A lack of infrastructural pre-development will cause to the market introduction of FCVs to fail.

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## Introduction

The development of infrastructure to support new technologies and products is an integral aspect in the introduction of innovations. Many innovations would be useless without their associated infrastructure. A clear example of this is Fuel Cell Vehicles (FCVs). There is great interest in the development of hydrogen infrastructure to support FCV market entry [1–4]. Many case studies aim at solving some of the current issues of infrastructural development by investigating historical cases. Previous studies use the example of how internal combustion engine (ICE) vehicle infrastructure was developed in the late 1800s and early 1900s [5,6]. However, these examples are less helpful to the current situation. One reason for the success of the ICE was due to there being an existing petroleum supply network. This network supplied petroleum for lighting and for

stationary petrol generators, as well as the farming industry [5]. This meant that ICE outcompeted BEVs and steam engine vehicles precisely because infrastructure was already present. The availability of infrastructure was a compelling reason to purchase an ICE vehicle over competitive vehicles. This example can be useful to some new automotive technologies; for example, BEVs can make use of existing domestic electricity supplies, albeit with lower charge rates. FCVs require a totally new refuelling infrastructure. Furthermore, hydrogen is a commodity that is not supplied by the current transport fuel industry but by specialised companies. These might see new business opportunities and become new players within the automotive fuel industry. This means that the example of the development of petroleum supply networks is less helpful. What is needed is an example of a new infrastructure being developed to support an innovation that had no prior infrastructure available. Fortunately, a very instructive example

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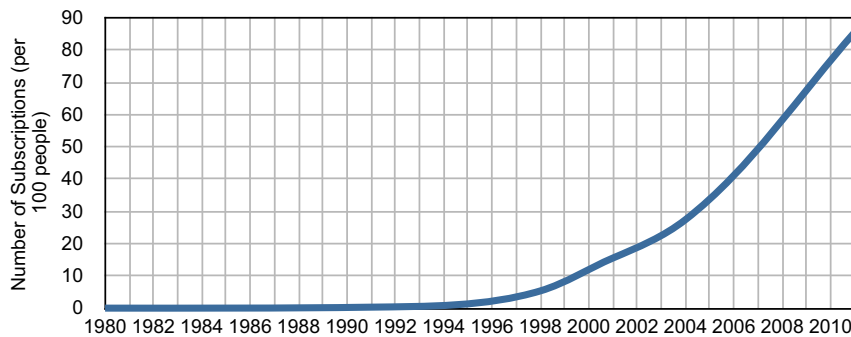


Fig. 1 – Global Mobile Phone Subscriptions per 100 people [13].

exists, this being the mobile phone and its network infrastructure. The mobile phone was a disruptive innovation heavily reliant upon infrastructure for it to gain success. FCVs share this characteristic as they are a potentially disruptive innovation [7] and are heavily reliant upon infrastructure.

Understanding how mobile communication networks were developed will allow us to learn exactly how new infrastructure is implemented and how the decision to heavily invest can be made; the hope is that these lessons can be applied to any disruptive or innovative infrastructure. The results here can be used to convince stakeholders to invest in hydrogen infrastructure. This paper will show that pre-development of infrastructure is vital to the successful introduction of any innovations requiring totally new infrastructure. This is highlighted by the fact that network development began 5 years before the first mobile phone was sold to the public.

### Disruptive innovation

The mobile phone was a disruptive innovation; this can be confirmed using the 3-point disruptive technology criteria. The criteria states that innovations are disruptive innovations if they require new infrastructure, are produced by new market entrants and not incumbents, and provide a greater level of service to the end users [7]. The mobile phone is aligned well to the three criteria. Clayton Christensen, the founder of disruptive innovation theory, also states that mobile phones are a disruptive innovation to land line telephones [8]. Mobile phones had clear added functionality over

landline phones; this functionality did however come at a high price. But with economies of scale and technological improvements handset unit costs were continually reduced and in around 30 years the mobile phone went from high cost low volume series in niche markets to occupying the whole landscape and achieving an enormous mass-market share (see section 1.2).

When the team at Motorola headed by Martin Cooper invented the mobile phone [9], it created a new market sector. The mobile phone had clear added value. The mobile phone met an existing need: it became possible to instantly communicate regardless of location, and be able to contact people in the event of an emergency situation. The mobile phone provided convenience greater than any other communication technology did before. Land lines, phone booths and pagers could not meet these needs. The cost of using a mobile phone far exceeded the costs of communication via landline, but people were willing to pay due to the added convenience. One further reason the mobile developed added value was thanks to it becoming a status symbol [10].

Mobile phones generate revenue at the point of sale, and provide continuous revenue in the form of service charges throughout their use. By 2015 the global mobile phone handset market is expected to reach \$340 billion [11]. The extent of market penetration of mobile phones is vast. Globally there are 85 phone subscriptions per 100 people. In developed countries like the UK 39% of people own a smart phone and there are more phone subscriptions than inhabitants. 52% of voice communications are now made via a mobile phone [12]. Figs. 1 and 2 show the global and UK increases in phone

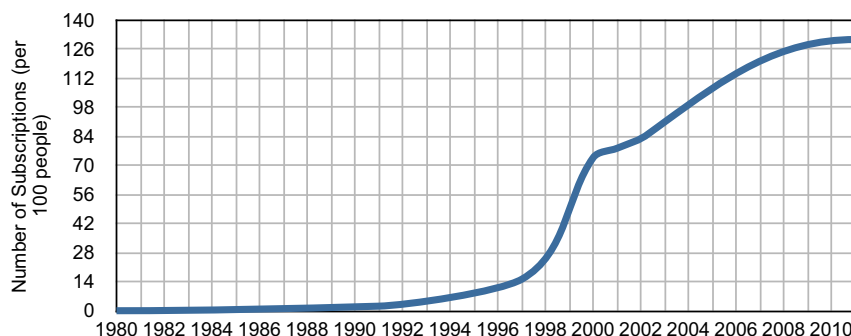


Fig. 2 – UK Mobile Phone Subscriptions per 100 people; note that there are more subscriptions than inhabitants in the UK. This is because many people have more than one phone, or SIM card [13].

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