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Programme Area: Light Duty Vehicles

Project: Electricity Distribution and Intelligent Infrastructure

Title: Costs and Supply Chain Analysis Report

Abstract:

This project was undertaken and delivered prior to 2012, the results of this project were correct at the time of publication and may contain, or be based on, information or assumptions which have subsequently changed. This report provides cost projections to 2050 for different types of plug-in vehicle recharging point. It is based on the technologies and options presented in the Charging Network Requirements Report, and should be read in conjunction with that report. The cost projections are summarized in the Executive Summary on pages 1 and 2. Cost projections are given for: (a) wall box (e.g. for domestic or workplace locations); (b) public charge post (e.g. for use on street); (c) DC charger (for very high power transfer); and (d) inductive charger (to avoid physical connections).

Context:

This project looked at the potential impact of electric vehicles on the UK electricity distribution grid.

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SP2/E.ON/05: Costs & Supply Chain Analysis Report

Plug-In Electric Vehicles Charging Infrastructure

Delta Final Report

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1 Executive Summary

Charging infrastructure prices are expected to fall rapidly for all technologies out to 2020 (Table 1), with a further (but much less significant) decline to 2030. After this, prices level off going out to 2050.

TABLE 1: CURRENT AND FUTURE PRICES FOR CHARGIGN INFRASTRCUTRE SOLUTIONS

Charging infrastructure prices are very high today, with significant cost reductions expected by 2050.

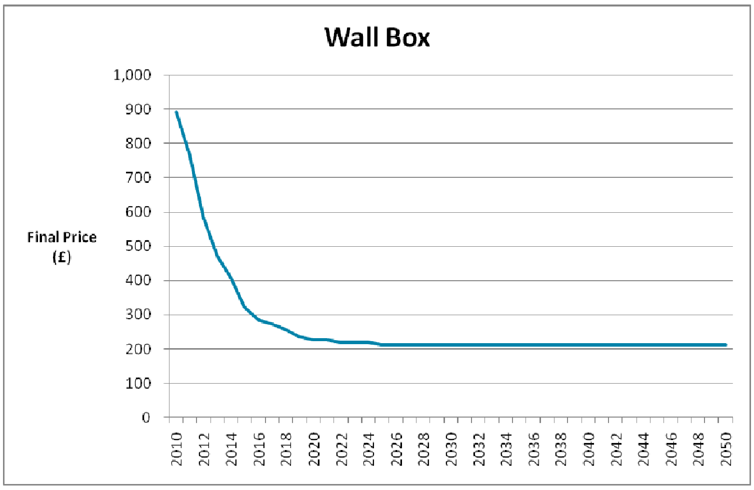
Solution	Current price (£)	2020 price (£)	2050 price (£)
Wall Box	891	221	190
Public Post	2,827	1,265	1,074
DC Charger	29,401	16,520	13,286
Inductive Charger	3,375	2,813	2,250

Delta Energy & Environment, 2010

The price reduction path for each technology varies (illustrated in Figures 1 – 4 below). The variation in paths will be influenced by a number of factors including:

- Increasing competition amongst manufacturers
- Scale up of manufacturing
- The cost trajectories of key components
- Demand for each solution

FIGURE 1: FINAL PRICE DEVELOPMENT OF WALL BOX



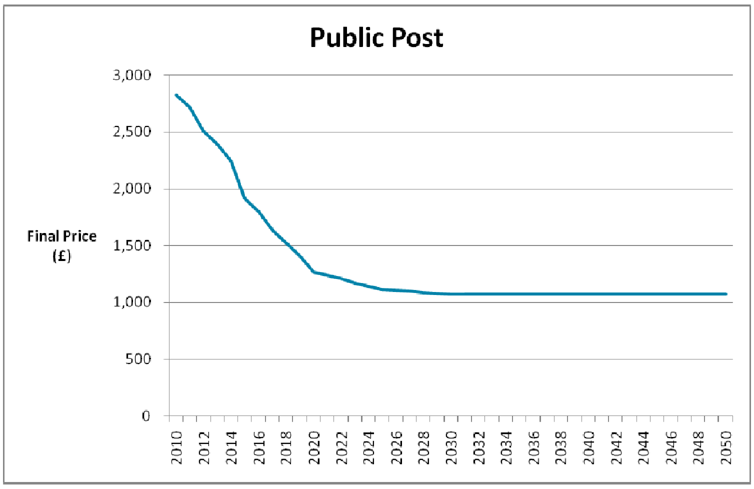
In 2010 to 2015 there is a rapid decline in the cost of Control Pilot (CP) box and socket. Manufacturing scale reduces enclosure cost and margins are squeezed as competition increases.

In 2015 to 2020 there is a step-change to scale manufacturing which reduces overheads.

Beyond 2020 there is a small reduction in overall cost to 2025 as margins are squeezed further, levelling out to 2050 as the price hits mass market floor.

Delta Energy & Environment, 2010

FIGURE 2: FINAL PRICE DEVELOPMENT OF PUBLIC RECHARGE POST



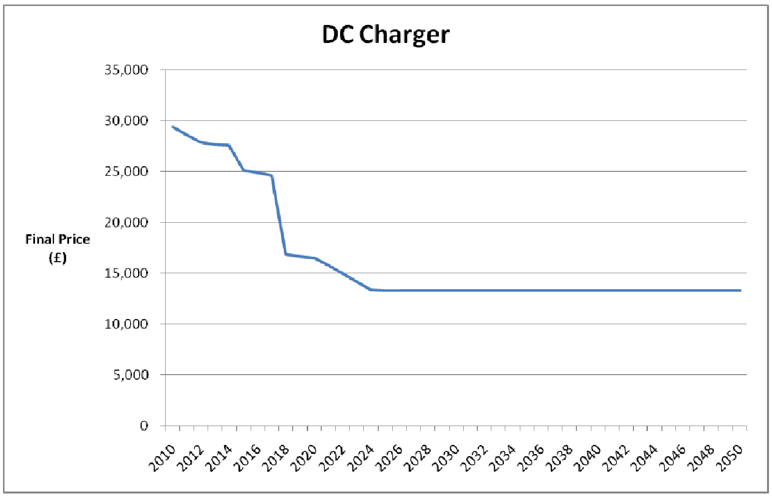
Delta Energy & Environment, 2010

In 2010 to 2015 there is a rapid decline in the cost of CP box and socket. Some margin reduction.

In 2015 to 2020 there is a step-change to scale manufacturing which reduces unit costs significantly. Printed Circuit Board (PCB) price falls by more than 70%. Further margin reduction as market competition intensifies.

Beyond 2020, PCB cost falls by another 50% and margins continue to decline, levelling out from 2025 to 2050 as price hits mass market floor.

FIGURE 3: FINAL PRICE DEVELOPMENT OF DC CHARGER



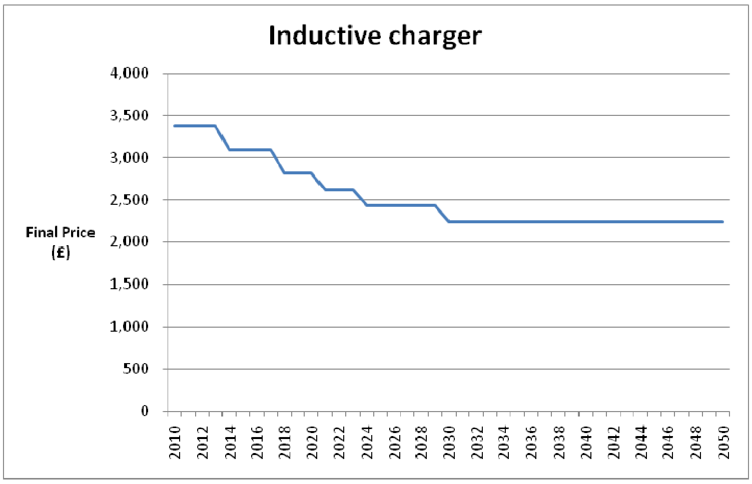
Delta Energy & Environment, 2010

In 2010 to 2015 there is little change in price as the AC/DC converter remains at current cost, sourced from Asia. The cost of the post falls, but has little impact on total price.

In 2015 to 2020 there is a major impact from a cost reduction of the AC/DC converter. There are also unit cost reductions from scale manufacturing.

In 2020 to 2025 there are some further efficiency improvements in manufacturing and margins are squeezed competition intensifies.

FIGURE 4: FINAL PRICE DEVELOPMENT OF INDUCTIVE CHARGER



Delta Energy & Environment, 2010

In 2010 to 2015 there is only a small decrease in price in inductive chargers as the market demands only low volumes.

After 2015, when demand and manufacturing capacity grows, prices will fall quickly. The industry consensus is that the current final price of just over £3,000 for a 3 kW unit will come down by approximately one third to £2,250 by 2030.

Beyond 2030, costs and margins are low, and the final system price remains constant.

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2 Acknowledgements

The data and figures used throughout this report have been gathered from interviews with a range of industry players. This information was given to Delta on an anonymous basis, unless otherwise stated.

Companies that have provided information are:

1. Infrastructure manufacturers:
    a. Aerovironment
    b. AkerWade
    c. Better Place
    d. Charge Master
    e. Charge Point
    f. Conductix Wamplifer
    g. Elektromotive
    h. Epyon
    i. Halo IPT
    j. Mennekes (also connector, plug and socket manufacturer)
    k. Park and Power
    l. Pod Point
    m. ROLEC
    n. Siemens (also component manufacturer)
    o. Takaoka
    p. TEPCO
2. Components manufacturer
    a. Cooper Industries
    b. Eaton
    c. Edmundson Electrical
    d. Elster Metering
    e. Honeywell
    f. Le Grand
    g. MK Electric
3. Standards bodies:
    a. Cenelec
    b. IEC
4. Trade associations
    a. BEAMA
5. Utilities
    a. EDF (France)
    b. E.ON UK

c. RWE (Germany)
d. Scottish Power

3 Introduction

The aim of this report is to provide an analysis of the capacity of the supply chain for the deployment of re-charging infrastructure in the UK, focusing on key component costs (excluding installation) today and out to 2050, taking into account the key drivers that will impact the future cost evolution of charging infrastructure. This is achieved by:

- Understanding the components required in each of the charging solutions today, and future solutions – looking out to 2050
- Market research and stakeholder/industry consultation to understand the current supply chain and costs of these components, and how these will evolve as the EV market takes off
- Analysing the global supply chain for key charging infrastructure components to identify potential bottlenecks, taking into account future key developments such as standardisations

The research undertaken for this project consisted of approximately 25 analyst-days of in-depth interviews, primary research and analysis. Interviews were conducted with the following industry stakeholder segments:

- EV infrastructure charging manufacturers from around the globe
- Component Manufacturers
- Utilities
- Trade associations

This report provides costs for each of the key components, and infrastructure solutions out to 2050.

This report feeds into SP2/E.ON/04 Charging Network Requirements Report, and also the Economics and Carbon Benefits Project (SP3).

4 Component Overview

The components that make up any EV charging solution can be categorised as:

1. “Off the shelf” electrical components. These are already manufactured in their millions, and serve the global electrical and power industries. Based upon our research, we believe that the EV market is not expected to be a primary driver of these component costs and there is no significant opportunity for these components to be purchased at lower cost, as will be explained in **Section 5.2.1**.
2. Key components. These are more specialist components that are either bespoke for the EV charging industry, or are manufactured and sold in much smaller quantities than the “off the shelf components”. We anticipate that there is significant potential for these components to be manufactured and sourced at lower costs than they are being bought for today.

4.1 Off the shelf components

Tables 2 and 3 give details and current costs of the off the shelf components. These are distributor prices, and therefore have no room to come down with bulk purchase.

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TABLE 2: CABLE OPTIONS (415KV-3PHASE, 240V-1PHASE)

This table refers to Appendix A-1 of SP2/E.ON/04

Component	Options	Standard	Current price (£)
External Cable	SWA (Steel Wire Armoured) XLPE Insulated	BS 5467 BS 6724	
	Single Phase 2-core twin and earth cable Cable sizes/ratings (Insulated wall installation): 1.5 mm^2, 14.0 A, 3.3 kW		**£0.64 / m**
	2.5 mm^2, 18.5 A, 4.4 kW		**£0.81 / m**
	4.0 mm^2, 25.0 A, 6.0 kW		**£1.09 / m**
	6.0 mm^2, 32.0 A, 7.6 kW		**£1.42 / m**
	10.0 mm^2, 43.0 A, 10.3 kW		**£2.18 / m**
	Three Phase 3 or 4 Core depending on earthing arrangement (See BS7671) Cable sizes/ratings (Insulated wall installation): 1.5 mm^2, 14.0 A, 3.3 kW		**£0.80 / m**
	2.5 mm^2, 18.5 A, 4.4 kW		**£1.09 / m**
	4.0 mm^2, 25.0 A, 6.0 kW		**£1.52 / m**
	6.0 mm^2, 32.0 A, 7.6 kW		**£2.37 / m**
	10.0 mm^2, 43.0 A, 10.3 kW		**£3.47 / m**
Internal Cable	2-core twin and earth cable, Insulated and Sheathed Cable sizes/ratings (Insulated wall installation): 1.5 mm^2, 14.0 A, 3.3 kW	BS 6004 Follow BS7671 for the de-rating of cables according to installation.	**£0.64 / m**
	2.5 mm^2, 18.5 A, 4.4 kW		**£0.81 / m**

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	4.0 mm^2, 25.0 A, 6.0 kW		**£1.09 / m**
	6.0 mm^2, 32.0 A, 7.6 kW		**£1.42 / m**
	10.0 mm^2, 43.0 A, 10.3 kW		**£2.18 / m**

E.ON UK, Delta Energy & Environment, 2010

TABLE 3: SUPPLY ENCLOSURE AND INTERNAL COMPONENTS

This table refers to Appendix A-2 of SP2/E.ON/04

Component	Options	Standard	Current price (€)
Feeder pillar (External)	4 to 24 Way 100A to 200A (DB) Max Incomer Rating Single or Three Phase DIN Rail Mounting Lockable door		**£310**
Consumer Unit (1 Phase)	4 to 8 Way 100A (CU) Max Incomer Rating Single Phase DIN Rail Mounting	BS EN 61439-3	**£17.75**
Distribution Board	4 to 24 Way 125 to 200A (DB) Max Incomer Rating Single phase DIN Rail Mounting Lockable door IP41 internal/ IP20 Open door Typical Dimensions: H:500mm to 1040mm, W:450mm, D:150mm	BS EN 61439-3	**£69.00**
	Three Phase		**£305.00**
MCCB Panel Board	400 to 800A Max Incomer Rating 6 to 12 Way	BS EN 60429-1	**£706.00**
Disconnector/ Isolator	100 to 200 A (DB) / 250 to 800 A (PB)	BS EN 60947	**£11.05**
RCD	High sensitivity (30mA), type A, group G Latching	IEC61008-1; IEC61009; IEC60364-4-41	**£68.00**

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	Single phase: 2 pole	IEC 60755	
	Three phase: 4 pole		**£72.00**
MCB	DIN rail mount, Single pole, Type B .	BS EN 608989 BS EN 60947	**Commercial grade Prices often heavily discounted for volume**
	Single phase, 16A		**£6.00**
	Single phase, 32A		**£6.00**
	Single phase, 63A		**£7.00**
	3- phase, 16A		**£50.00**
	3- phase, 32A		**£50.00**
	3- phase, 63A		**£53.00**
	3- phase, 100A		**£110.00**
MCCB	20A to 250A		**£90.00**

E.ON UK, Delta Energy & Environment, 2010

4.2 Key components

Before detailing the list of key components, it is worth noting the 4 categories of charging solution that this report is analysing:

1. **External socket**. This is as simple as charging gets, at Mode 1, with no intelligence or communications. This can be either a strengthened 3-pin domestic socket, or an industrial socket. This solution is wholly made up of off the shelf components.
2. **Wall box**. This is a step up in sophistication from the external socket, and can be used in domestic and commercial applications. It enables Mode 3 charging, through a control pilot (CP) box and a Type 2 socket to accommodate a Type 2 connector.
3. **Public recharge post.** This system must also enable Mode 3 charging. As it is public, it must have added billing, data storage and communication, and access functionality. (In this report two types of public post are referred to: standard (3kW) and rapid (7kW)).
4. **DC charger.** This enables DC charging. Essentially, it is a public recharge post, with an added AC/DC converter. It also has a fixed DC connector
5. **Inductive charger.** Still in the R&D phase, this method of charging involves no physical connection between the charger and the vehicle. The system is comprised of a power supply, and an inductive charging transmitter pad. This charging also requires a corresponding receiver pad on the vehicle, but this component is outside the scope of this study.

Table 4 introduces these 4 charging solutions, and defines their current sale price. This price has been arrived at from Delta's analysis in **Section 5**, and will be discussed in detail there.

TABLE 4: RECHARGE POINT / OFF-BOARD CHARGERS

Component	Options	Standard	Current price (£)
External Socket	UK 3 pin switchable socket with integrated RCD	BS1363	**£33.90**
	Industrial socket single phase. IP rating according to installation, Blue, 240V, 16A or 32A rating.	IEC60309	**£3.75**
	Industrial socket three phase. IP rating according to installation, Red, 415V, 16A/phase rating.	IEC60309	**£5.40**
Wall box (Future development)	Future developments for PIEV specific connectors. Integrated RCD / Timer control PWM/ Control pilot test circuit Continuous earth test circuit Communication channels IP rated for external installation		**£891**
Public recharge post	- UK 3 pin socket with integrated RCD, or Type 2 / 3 socket to enable Mode 3 charging. - Public kerb side/ bay wall mount recharging post, integrated payment and locking mechanism.	BS1363	**£2,827**
DC charger (50 kW)	AC to DC Rectifier (Future- Inverter capability) Three phase connection 50kW unit Up to 250kW units available Dedicated fixed PiEV cable/ connector		**£29,401**
Inductive charger	- Power supply (typically 3 kW) - Transmitter pad (transformer).		**£3,375**

E.ON UK, Delta Energy & Environment, 2010

To step up in sophistication from an external socket to a wall box, public recharge post, DC charger or inductive charger requires additional key components. **Table 5** describes the ‘key components’ considered in this report and that are required in one or more of the recharging solutions. These are components which are not ‘off the shelf’, represent a significant share of the final charger cost, or that are necessary additions for particular system designs.

TABLE 5: KEY COMPONENT OVERVIEW

Component	Description	2010 price (£)
AC/DC converter (50 kW)	This device is contained inside the off-board charger, required for DC charging. It converts AC current from a 3 phase supply, to DC current.	£13,140
Residual Current Device (RCD) - Type B	An RCD is an electrical device that disconnects a circuit from the supply when it detects an imbalance in the current between the live and neutral conductors. It is not designed to protect against current overload or short-circuits.	£70
Smart meter	Located within public posts, measures the amount of energy consumed per consumer charge. This is necessary for accurately billing consumers using public charging systems.	£53
Printed Circuit Board (PCB)	This circuit board contains all the electrical components to provide data storage and communication, billing and access (RFID).	£400
Modem	A modem encodes and transmits digital information (by modulating a carrier signal). It also receives and decodes digital information. It enables digital data to be transmitted securely. This allows data collected in the chargers to be transmitted to the appropriate administrator.	Contained on PCB
Flash drive / Memory banks	This is a data storage device – storing data such as time of charge, duration of charge, energy consumed etc, until this information is transmitted to the administrator	Contained on PCB
Billing system	A software system enabling a charger to bill any customer supplied by any utility	Contained on PCB
Access device / RFID reader	This device provides secure access to the charger only to those who are eligible to charge. This requires recognition technology such as an RFID reader.	Contained on PCB
Screen	Simply a display which communicates basic information / instructions to the vehicle driver.	£20
Connector	This connects the electric vehicle to the charging infrastructure. Depending on the Case (discussed above) it comprises a plug, a cable (typically 4m) and a vehicle connector.	
	Type 2 4m cable, plug and vehicle connector at ends Manufactured by Mennekes and FCT Group	£315

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	DC charge connector Manufactured by Yazaki	£1,313
Type 2 Socket	Type 2 Manufactured by Mennekes and FCT Group	£96
Control pilot box	A CP box ensures vehicles are charged safely by enabling communication between the vehicle and charger.	£280
Enclosure (wall box)	Plastic enclosure, injection moulded	£50
Enclosure (public post)	Metal alloy (steel / aluminium)	£250
Power supply (inductive charging)	240 V AC, single phase	~ £1,200
Inductive transmitter pad	With magnetic sensor to identify presence of vehicle	~ £600

Delta Energy & Environment, 2010

It should be noted that not all of the components in **Table 5** are required in each of the solutions discussed above. Which components are needed in each system design is illustrated in **Table 6**, below.

TABLE 6: CHARGING TECHNOLOGY CHECKLIST

	Type B RCD	AC/DC converter	Meter	PCB	Screen	Connector	Type 2 socket	CP box	Enclosure (wall box)	Enclosure (public post)	Power supply	Charging pad
External socket (Domestic / Commercial)	N	N	N	N	N	N	N	N	N	N	N	N
Wall box (Domestic / Commercial)	Y	N	N	N	N	N	Y	Y	Y	N	N	N
Public recharge post	Y	N	Y	Y	Y	N	Y	Y	N	Y	N	N
DC charger	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	N
Inductive charger	N	N	N	N	N	N	N	N	N	N	Y	Y

Delta Energy & Environment, 2010

What are the implications for this analysis?

The key components detailed in this section currently make up the lion's share of the final price of charging solutions and are the focus of our analysis. We forecast that these costs will fall, in some cases very rapidly, meaning significant cost reductions will be seen in the next 2 to 10 years. The evolution of these costs will be discussed in Section 0.

5 Current Market and Key Component Forecasts

5.1 Technology uptake rate

A key assumption underpinning this analysis is that of the growth of the EV market, and the breakdown of locational charging, i.e. how many domestic and commercial chargers, how many public recharge posts, and how many DC charging stations.

Delta has reached its conclusions based on an industry consensus, and also on maximum and minimum uptake figures provided by Arup. Our analysis assumes that uptake broadly sits at the midpoint of these two uptake rates.

Economic and Carbon Benefits Project's Maximum and Minimum Uptake Rates

The below text has been quoted directly from the Economics and Carbon Benefits Project

Max UK annual requirement

We suggest the following based on Ricardo's HIGH vehicle take up rate of 10.0m Urban EVs, 14.5m Suburban EVs, and 5.5m rural EVs by 2050.

For standard charge (3 kW), assume number of chargers required is 1 per 10 vehicles. Assuming 30 million EVs is achieved in 20 years, the number of chargers required is: 3 million chargers in 20 years = 150,000 per annum

For rapid charge (7 kW), assume each car uses this once per month, and that each charger charges 10 cars per day for 30 minutes each. So, the number of chargers required = 30 million / 30 / 10 =100,000 over 20 years = 5,000 per annum.

For DC fast charge, assume each car uses once per six months, and that each charger charges 20 cars per day for 10 minutes each. Number of chargers = 30 million / 180 / 20 = 8,000 over 20 years = 400 per annum.

Min UK annual requirement

Using Ricardo's LOW vehicle take up of 20,000 EVs on road in 2015.

For standard charge, assume 1 charger per 4 cars. I.e. 5,000 points in 5 years = 1,000 per annum

For rapid charge, we will only have a few hundred in the next 5 years. Assume 500 chargers = 100 per annum.

For DC fast charge, assume 50 by 20105 = 10 per annum.

The long term urban/suburban/rural vehicle split could be used to estimate where the charging points may be if needed for installation costs. Whether rapid points will appear in rural locations in the long term, we are not sure.

We have assumed that DC fast chargers would be at motorway service stations.

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Delta forecasts that the four charging solution categories will see different levels of growth.

5.1.1 Wall box (domestic and commercial) – steady growth proportional to the number of EVs sold

The mass market may take some years to really take off and begin steady growth, but the fact is that for many domestic EVs sold, there will need to be a home charger installed. The exception being for drivers living in city-centre apartments, where there is only on-street parking.

The market for commercial chargers will show the earliest signs of life, as it is expected that fleets and other commercial vehicles will be where the early EV market lies.

As there is little to no difference in the engineering and design of domestic and commercial chargers, they will both be considered together for this analysis.

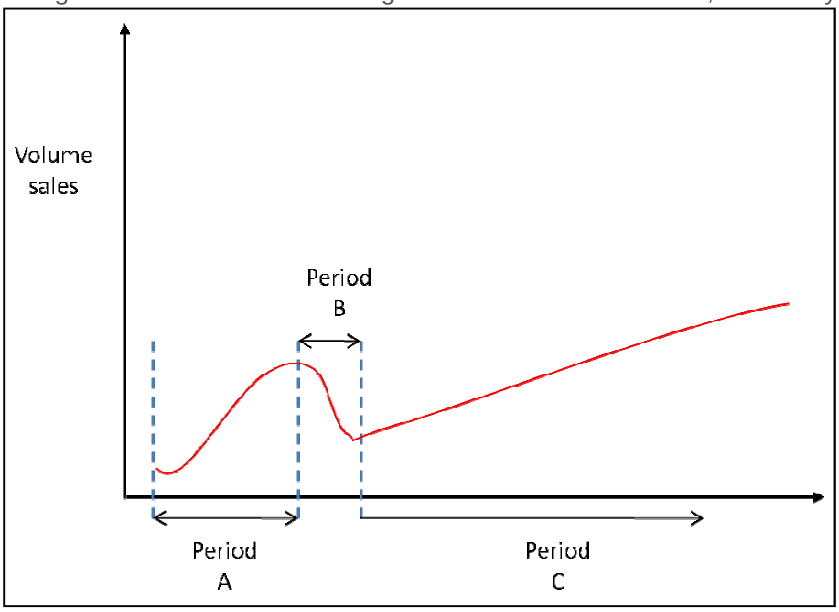
5.1.2 Public, on-street chargers – a more complicated growth rate

The development of the on-street public charging market is a lot less certain. **Figure 5** illustrates our assumption regarding future uptake, based upon our research.

- **Period A** – this represents the early years of the EV market. The Government is keen to roll out a network of on-street chargers that are clearly visible to the public. This will help to overcome range anxiety, and give them the reassurance needed to invest in an EV. This will drive a healthy demand for on-street chargers in this period.
- **Period B** – the actual sales of mass market EVs are unlikely to keep pace with the installation of on-street posts. It will become apparent that no more public chargers are required. Therefore, once a critical number of posts are installed, there will be a period of declining sales as the EV market catches up.
- **Period C** – Once the EV market does catch up, sales of posts will grow again, and the market will eventually develop into a replacement market

FIGURE 5: GROWTH OF THE ON-STREET CHARGER MARKET

The growth of the on-street charger market will not be linear, or directly proportional to the sale of EVs



Delta Energy & Environment, 2010

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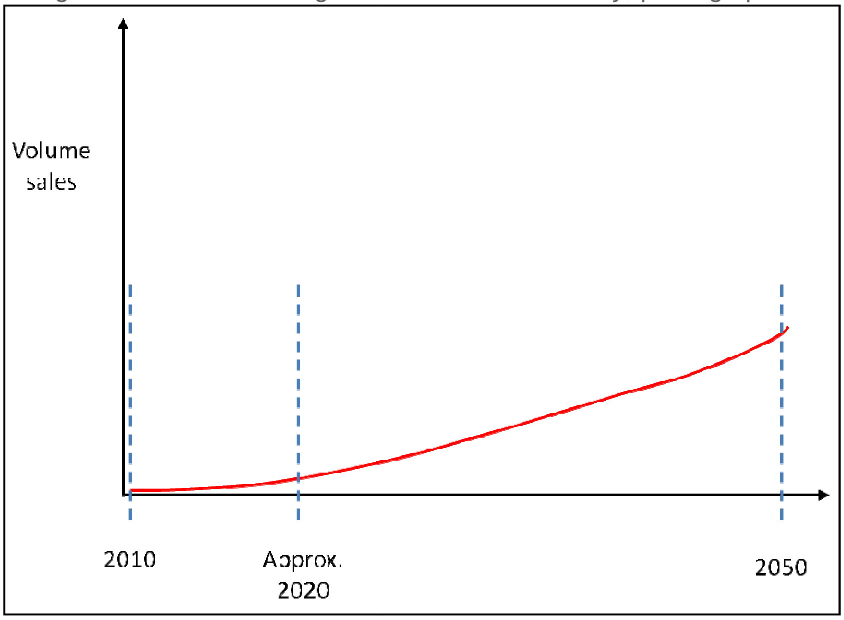
5.1.3 DC chargers – slow beginnings, but steady growth from

Demand for DC chargers will be slow, but steadily increasing as the market develops. The early years will see some demand, primarily from the commercial and industrial sector. Demand for public DC charge posts will pick up closer to 2020. **Figure 6** illustrates Delta's understanding of the growth of this market.

FIGURE 6: GROWTH OF THE DC CHARGER MARKET

The growth of the DC charger market will start slowly, picking up to steady growth around 2020



Delta Energy & Environment, 2010

5.1.4 Inductive chargers – slow beginnings, but steady growth from

Inductive charging technology for the mass market is still in the late stages of R&D, with solutions expected to become commercially available in the coming years. Delta understands that demand for this technology will depend on both cost and technical efficiency. Therefore we assume a similar rate of growth as for DC chargers. This conservative assumption takes the risk of the technology failing to break the market into consideration.

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5.2 Critical drivers of component costs and final price

This section will analyse the market forces that may have an impact on both the costs of the individual components and on the final price of the charging solution. The issues to be considered are summarised in **Table 7**.

TABLE 7: CRITICAL DRIVERS OF COMPONENT COSTS AND FINAL CHARGER PRICE

Cost Driver	Impact on Cost
Volume	Once volume production is reached, costs will be driven down through economies of scale: - Bulk purchasing of components - Manufacturing costs and overheads are spread widely across volume production - Once a critical volume is reached, one of the big industry players may invest in the R&D necessary to make a breakthrough in system design, reducing component and manufacturing costs
Supply chain of key components	Several of the key components currently only come from one or two suppliers, who are already struggling to keep up with demand. If this does not improve, it will be difficult to drive the costs of these components down. These components currently make up a significant proportion of the overall cost (e.g. around 60% of the total cost of a domestic Mode 3 Wall Box).
Ability of the industry to scale up, and become self sustaining	Unless sufficient financing is brought to the industry, it will find it difficult to scale up to the level required for mass market, and costs could actually pushed up as demand outweighs supply. The entry of the big industry players to the market is critical to the industry successfully scaling up. This is already being seen, indicating low barriers to entry.
Commodity prices	Currently, the raw materials of the individual components make up an insignificant proportion of the final charger price. In the very long term, rising commodity prices (copper & oil) seem likely, but our research has not identified that this will be a significant driver of component costs considered in this report.

Delta Energy & Environment, 2010

The following sections evaluate the above four drivers in detail, asking the following questions:

- Why is each driver important for this cost analysis?
- How will each driver evolve between now and 2050?
- What will be its impact on the costs of individual components, and on the final price of charging solutions?

The combination of all these drivers on component costs and final price will then be quantified and discussed in **Sections 5.3 and 5.4**.

5.2.1 Impact of volume

Why is this driver important for this cost analysis?

To date, the industry has been made up of small players, developing and manufacturing small volumes of chargers in workshops. This, as with all start-up industries, has resulted in high R&D and manufacturing unit costs, which are passed on to the customer through high final price tags.

However, the imminent launch of mass market electric vehicles, such as the Nissan Leaf, has already catalysed growing industry interest in the production of low-cost charging solutions in large volumes.. Volume production needs to be reached as soon as possible, to drive costs down.

Volume is the crucial driver for cutting costs:

- Increased volume has the potential to bring increased purchasing power, cutting the costs of individual components.
- Volume enables manufacturing to be scaled up, achieving economies of scale and reducing the final sales price
- When new technologies reach a critical volume, larger industry players can decide to invest heavily in R&D to reduce costs. In a technology such as an EV charger, this could likely involve combining the functionality of various individual components on a single motherboard component (as has been achieved in the mobile phone industry). This would result in a reduction in size and manufacturing and component costs.

  Other volumes impacts, such as cost reductions in new components that are bespoke to the EV charger market and which players compete in the industry, and discussed in detail in later sections.

How will this driver evolve between 2010 and 2050?

The evolution of the different locational charging solutions has been discussed in **Section 5.1**.

What will be the impact of volume on the costs of individual components, and on the final price of charging solutions?

Increased purchasing power
Buying components in bulk can be a common method of reducing individual component costs. However, the majority of the components in an EV charger are off the shelf and mass produced. The costs quoted for these components in **Tables 2 and 3** are distributor costs, and therefore have virtually no room to come down with volume purchase.

For the more bespoke, key components, there will be some room for cost reduction with increased volumes purchased.

What are the implications for this analysis?

The off the shelf components listed in **Tables 1 and 2** are already at their 'sharpest' level, quoted at distributor prices. Therefore it is assumed that **volume purchase will have no impact on off the shelf components**.

Key component costs will come down in cost as volumes increase. The rate of cost decrease will depend on the rate of volume increase, which will be greater for wall box components. These will also reach much higher overall volumes than public recharge posts and DC chargers.

Economies of scale in manufacturing, and other overheads

In the early years of the EV market, slow but steady growth in demand will bring the costs of manufacturing (and other overheads) per unit slowly down. Once a critical volume is reached, a step-change in manufacturing cost reduction can be achieved thorough full automation, or even moving manufacturing to a lower labour cost market such as the Far East.

Scaling up of manufacturing will be different across the different charging types, due to the different uptake rates discussed in **Section 5.1**. We will assume the same rate of change for domestic and commercial wall boxes, as indicated in **Section 5.1.1**.

What are the implications for this analysis?

Manufacturing and other overheads (per unit) will come down rapidly for wall boxes, but much less quickly for public recharge posts and DC chargers.

R&D Breakthrough

Once expectations are such that a critical volume will be reached, big industry players are likely to invest a substantial amount in R&D to combine the functionality of many key components on one 'motherboard', analogous to developments in the mobile phone industry. This will reduce component costs, manufacturing costs, and reduce the size of the charger.

What are the implications for this analysis?

We expect this R&D breakthrough to happen between 2020 and 2025, when volumes are significant enough to justify investment. In terms of our component cost forecasts, we have assumed this cost reduction will be spread evenly across this period.

5.2.2 Components with critical supply chains

Why is this driver important for this cost analysis?

By and large, the individual components that make up any EV charging solution are off the shelf, technologically mature and used widely in other industries. Sudden growth in the international EV industry will have little effect on supply of these particular components. There are, however, a small

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number of more bespoke components whose development, production and sale may depend strongly, if not wholly, on the EV market.

Those components are:

- Specialised plugs, connectors, and their respective sockets
- The CP box
- The Type B RCD, currently only manufactured by Siemens
- The AC/DC converters required for DC charging
- The PCB, enabling data storage and transfer, and billing capability
- The smart meter

These components make up a significant proportion of the overall cost of the infrastructure, so their supply chain is critical to this analysis.

How will this driver evolve between 2010 and 2050?

Plugs, connectors and sockets
As indicated in **Table 5**, the prices of these components are currently very high due to supply constraints. Not only that, the infrastructure manufacturers are experiencing significant delays, with waiting lists of several months for delivery of ordered connectors and sockets.

There is nothing inherently difficult in the engineering and manufacture of Type 1, 2 and 3 connectors, plugs and sockets. The reasons for these high costs are outlined below.

Currently little competition in supply

Taking the Type 2 connector as an example (as it is likely to be the standard adopted in Northern Europe), the only supplier to date has been the German company Mennekes. Very recently, FCT Group has entered the market, bringing competition and (slightly) undercutting Mennekes prices. However, the lack of competition in supply keeps a strong upward pressure on price. More companies will certainly enter the market soon (as indicated in **Table 8**), however careful consideration is being given to the standardisation process as will be discussed next.

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TABLE 8: CURRENT AND IMMINENT SUPPLIERS OF CONNECTORS, PLUGS AND SOCKETS
Competition is already entering into this market, which will drive costs down.

Supplier Name	Connector Types / Standards	Comments
Yazaki	SAE J1772	Components currently available.
Delphi	SAE J1772	Components due to go into production before the end of 2010.
FCI	SAE J1772 IEC 62196-2 Type 1	Components due to go into production before the end of 2010.
Mennekes	IEC 62196-2 Type 2	Components currently available.
Bals Elektrotechnik	IEC 62196-2 Type 2	Components currently available.
FCT Group	IEC 62196-2 Type 2	Components currently available
SCAME	IEC 62196-2 Type 3	Components due to go into production before the end of 2010.

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Standards have yet to be set in stone

Despite the likes of Mennekes setting out its stall, and betting that its particular technology will be adopted, the uncertainty around which standard will actually be adopted is stalling cost reductions in two ways:

- New entrants are not willing to gamble and begin the expensive tooling process to begin mass production, therefore competition remains low
- Mennekes itself is holding back on scaling up and automating manufacturing, still building to order.

Manufacturing and R&D (unit) costs remain high

Mennekes' own manufacturing unit costs remain high at small volumes. Moreover, it has invested substantially in R&D during the development process, and is trying to recoup some of these costs through initially high prices.

The critical issue to be resolved is standardisation. Once a standard is set, more companies will enter the market quickly, and at scale. This will drive costs rapidly downward.

Communications box
This is necessary for Mode 3 charging. There are no supply issues regarding the components that make up the communications box, nor is IP a significant barrier to developing them. The issue is with their availability today.

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Almost no competition today – significant potential for cost reduction

As it stands, Mennekes is the sole manufacturer of these products, and therefore they carry a very high price tag, with limited availability. Siemens will enter this market later in 2010, with a similar product, but at a fraction of the price.

Being a component required in all charging solutions in the future, we anticipate more big players entering the space. This will resolve the availability issue seen today, and push the cost of this component down further.

Siemens RCD

This Type B RCD is currently only being manufactured by Siemens, and is under patent. As yet, there are no supply issues with this component, but a sudden spike in demand could trigger a short-term bottleneck, and prevent any future cost reductions

However, Siemens does not foresee any supply issues, and is capable of ramping up production quickly to meet any increase in demand.

AC/DC converter

AC/DC converters are very expensive pieces of kit due to the small volumes being manufactured today – 10s of units per year. This is largely due to a lack of demand. The result is that there is only a handful of AC/DC converter manufacturers active.

However, these manufacturers are keen to ramp up manufacturing, and have the capability to scale up production to varying degrees, if demand rises.

We expect DC charging to account for a relatively small proportion of the future charging network. Therefore these manufacturers, plus others that move into the space will satisfy demand.

Smart meter

Although the global smart meter rollout has yet to reach full swing, this technology is already considered to be fully developed, and there are dozens of manufacturers already manufacturing at reasonable scale. This meter will only be required in public charging stations, which will not be made in sufficient volumes to create supply constraints. Therefore, there will be no critical supply chain issues for this component.

Printed Circuit Board (PCB)

These components are again already mass market, and manufactured at scale for many different electronics industries. As with the smart meter, this component is only required for public posts, so the growth of the EV market will have little to no impact on supply. No constraints are predicted for this component.

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What will be the impact of supply chain on the costs of individual components, and on the final price of charging solutions?

What are the implications for this analysis?

- The cost of plugs, sockets and connectors will fall rapidly, beginning in 2012 when standards are set. By 2020, these components will be well and truly mass market and the costs will reflect this.
- The CP box price will fall rapidly initially as competition enters the market, then more steadily to 2015 as R&D costs are recouped, and more slowly to 2020 as it reaches its floor price
- Though Siemens is the only company producing the Type B RCD, it has no issue scaling up to meet demand so price will not be pushed upward.
- AC/DC chargers, though only manufactured in the handful at the moment, will not see a serious supply chain issue. Asian suppliers are already cropping up to supply demand, and at cheaper prices.
- The smart meter and PCB supply chains are determined by other industries, and we foresee no issues with them meeting the demand of the EV charging industry.

5.2.3 Ability of industry to scale up and become self-sustaining

Why is this driver important for this cost analysis?

EV charging has long been a cottage industry, made of start-ups and small specialised companies. To meet a mass market demand for chargers, this industry needs to scale up significantly, with heavy financing required to be behind it. The worry is that the current providers would remain small and underfinanced, and struggle to cope with meeting the growing demand. This would put significant upward pressure on final charger prices, with demand far outweighing supply.

How will this driver evolve between 2010 and 2050?

It is almost certain that this will not be the case. The reason for this is the sudden entry of the big players to the market. The following industry giants have already set out their stalls in the EV charging space:

- Electronics giant Siemens is offering private and public charging solutions.
- GE has developed a public charging solution, the WattStation, which will be introduced to the US and Europe in 2010 / 2011. Commercial and domestic solutions will come in 2011.
- Schneider is developing a range of solutions for domestic, commercial and public applications – slow and fast. It contributed over 100 chargers to an EDF and Toyota trial in France in 2010.
- ABB is offering DC charging solutions to fully charger vehicles as little as 10 minutes.
- Eaton is introducing a family of charging solutions for domestic, public and commercial use, partnering closely with Mitsubishi to develop these.

It is clear that these companies see the industry as mass market, with huge potential for growth.

Barriers to entry – DC charging, and inductive charging
For home, workplace and even on-street charging, there are no significant barriers to entry. The big industry players are already developing solutions for each market sector.

There are however, two technology types that remain specialist, with some technical barriers to entry. They are:

- DC charging
- Inductive charging

DC charging

The design of the DC charging technology itself is not particularly complicated. However, the impact of fast charging on EV batteries is much more complex, and understanding how to manage this impact is now very specialist. For this reason, the preferred developers to date have years of experience in the fast charge of industrial vehicle batteries.

Epyon is one such company with years of experience in battery management. Epyon does not sell itself on its technology, even though it does have a novel design with potential cost reductions. The company's strength is in its knowledge of battery management in fast charging.

Therefore, it is this capability (through control software algorithms) that presents the barrier for new entrants. For this reason, the level of competition in DC charging manufacturers is likely to remain low in the early years of the EV market. This may result in less rapid reductions in final price for these technologies.

Inductive charging

This charging technology is still very much in the R&D phase. There are quite a few companies globally that are working hard to bring their solutions to market. HaloIPT is the sole UK developer, and is quite candid in the fact that it, and other such lab-based players, are not the ones to take this technology to the mass market. As with its competing conductive cousins, it needs a big player to give it the financial backing that it needs to scale up and commercialise. Companies like HaloIPT will refine and prove the technology, the big players are needed to take it further.

Officially, there have been no announcements from such players that they are stepping into the inductive charging ring, however word from within the industry is that almost every single large OEM has been working quietly on the technology for several years now. This implies that once the technology is proven, it will swiftly be brought to the mass market by those with the financial capability to do so.

What will be the impact of industry scale-up on the costs of individual components, and on the final price of charging solutions?

What does this mean for this analysis?

- AC conductive charging is already ready to scale up, with the big industry players already involved and offering systems. This will result in a strong downward pressure on the price of wall boxes and public recharging posts.
- DC fast charging is a specialist's game at the moment, due to complications in fast charging impacts on batteries. Only ABB is showing activity among the bigger players. This will not result in quick cost reduction.
- Inductive charging is still in development. Indications are that all the major OEMs are looking at this, and there is nothing inherently difficult in the engineering, so rapid cost reductions should be achieved once the technology is proven. However, IP issues may delay this reduction.

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5.2.4 Impact of commodity prices on component costs

Why is this driver important for this cost analysis?

For commoditised components, no potential for further cost reduction
Many of the components in EV charging solutions are already commoditised, and are low cost – leaving little room for further cost reduction.

Raw material costs represent only a small proportion of component costs for EV re-charging. In the very long term, rising commodity prices seem likely, but our research has not identified that this will be a significant driver of the EV component costs considered in this report. We assume that long term rises in commodity prices will feed through as a relatively minor factor on component costs, which may be largely absorbed by manufacturers through a combination of improved efficiency or lower margins – in what will be by then a highly competitive, mass market industry.

- The commodities that we have considered are Copper
- Oil

How will this driver evolve between 2010 and 2050?

Copper price – not likely to impact prices until 2030 - 2040
The price of copper is not a critical concern for component costs in the short term. Studies on global raw material availability – including copper and other metals – indicate that copper is not seen as being critically challenged until well into the 2030s, even on the most aggressive demand scenarios.

Transport is, and will continue to remain, only a small part of global copper demand. Growth in demand will be primarily driven by countries such as Brazil, Russia, India and China electrifying their building stocks.

Oil price – likely to impact some material and manufacturing costs
A key element of component cost today is the manufacturing cost. Today, most of this is spent on man-power, putting together small numbers of chargers by hand. In the future, manufacturing will become increasingly automated, on a large scale – delivering lower manufacturing cost per unit.

However, this will depend on machinery, potentially consuming large amounts of electricity. A spike in energy prices could therefore push up the manufacturing costs. We have assumed that this comes through primarily as an inflationary impact rather than an increase in component costs in real terms.

It is also possible that much high oil prices may actually accelerate the downward fall in some EV component costs, as a result of a more rapid uptake of EVs and hence the earlier realisation of volume cost benefits.

What will be the impact of commodity price on the costs of individual components, and on the final price of charging solutions?

What does this mean for this analysis?

It is very likely that the long run price of copper and oil will rise. However, Delta predicts that there will be no significant impact on component costs and stiff competition in the global, mass market charging infrastructure market will force manufacturers to absorb these price rises through a combination of efficiency improvements, or tightening their margin on sale.

5.2.5 Maintenance, warranty and lifetime

Maintenance

Due to the lack of mechanical components in charging stations, manufacturers claim that very little maintenance and servicing of systems is required.

The only components likely to suffer from wear and tear or that may require attention are:

- Sockets on wall boxes and on-street chargers
- The connector on DC chargers (Takaoka recommends changing every 3 years)
- Fans (for cooling) in DC chargers
- RCDs requiring a manual reset (but this is likely to be taken care of by on-site staff)

All other electrical components (with no moving parts) are expected to outlast the quoted lifetime of the station.

In the case of DC chargers, on-going annual servicing is always recommended.

There is no such consensus in the case of on-street stations and wall boxes. However, the majority of manufacturers suggest that annual servicing is recommended.

The alternative (where an on-going servicing is not recommended) is a call out service (as and when a fault occurs).

The servicing contracts recommended by manufacturers usually involve an annual inspection, and in some cases more frequent inspections in the first year of installation (covered in the warranty). These inspections are simply 'visual assessments' of the station to assess if there is any damage. If any damage / fault is discovered outside the warranty period, a quote for repair will be issued.

Depending on the concentration of charging points, and their location, these checks cost **£50 – 80 per station (based on servicing 10 posts in one day)**. Remote monitoring of stations and performance data provision can also be offered for around **£60 – 70 per post per year (this is for a small number of stations and will come down with increasing volumes installed)**

Some manufacturers will offer to carry out maintenance / servicing after the warranty expires for a fee per unit per year:

- ChargePoint – Maintenance and software (including remote monitoring and data feedback) package for on-street stations costs £400 per post per year – this will cover replacing an damaged components
- Charge Master – to come

Warranty

A standard warranty of 1 year on installation, parts and labour is offered in the vast majority of cases. Extended warranties are common – but the costs vary widely depending on the volume of stations purchased, and the servicing the customer requests. This also varies across manufacturers.

Table 9 below summarises the warranties offered by a number of charging station manufacturers.

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TABLE 9. TYPICAL WARRANTIES OFFERED BY CHARGING STATION MANUFACTURERS

Manufacturer	Standard warranty	Extended warranty
ChargePoint	2 years on parts and labour	Extend by 2 years for £380. This can be extended across the lifetime of the unit
Siemens	1 year	No extended warranty in place, yet, however a rolling annual maintenance contract can be developed with Siemens
Podpoint	1 year	Negotiable depending on volume of stations
Takaoka	1 year	No extended warranty in place, yet. Recommend replacing connector every 3 years
AkerWade	1 year	Extended warranties are negotiable
Epyon	1 year	Extended warranties are negotiable
Elektromotive	1 year	Extending warranties are negotiable

Source: Delta, 2011

Lifetime

Lifetime varies by the charger type (as illustrated in **Table 10**), and the trend is that lifetime shortens with the more power the system delivers. This is due to increased heat – caused by higher power flows within chargers – damaging / shortening the lifetime of key components (primarily software system and inverters).

Typical lifetimes are:

- 15 – 20 years for wall boxes
- 10 – 15 years for on-street chargers
- 8 – 10 years for DC chargers

TABLE 10. TYPICAL LIFETIMES QUOTED FROM VARIOUS MANUFACTURERS

Maunfacturer	Type of charger	Lifetime
ChargePoint	Wall box On-street	10 – 15 years 10 – 15 years
Siemens	Wall box On-street DC charger	15 – 20 years 15 – 20 years 10 years
Podpoint	Wall box On-street	>10 years >10 years
Elektromotive	Wall box On-street	>10 years >10 years
Takaoka	DC charger	8 years
AkerWade	DC charger	10 years
Epyon	DC charger	10 years

Source: Delta, 2011

Once a DC charger has reached its quoted lifetime, it is recommended that the entire system be replaced. This is due to some uncertainty around the lifetime of the inverter, and the impact that the heat generated from it has on the surrounding components.

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For on-street stations and wall boxes, replacing certain components may be sufficient to extend their lifetime. Plugs and sockets will likely need replacing due to wear and tear, as will some software systems. However, components such as the casing, cables, meters, fuses and isolation devices are expected to have a much longer lifetime. But as the overwhelming majority of the charger cost is associated with the components that need replacing, it is safe to assume for this analysis that the entire system will need replacing.

What does this mean for this analysis?

- Servicing of charging stations can, in general, be covered by an annual inspection. This is covered in the warranty in year one, but will increase operating costs of a charging station by **£50 – 80 per year** once the warranty has expired.
- Extended warranties may rule out this annual cost, however, in these early days of the market the terms and prices of these extended warranties are negotiable.
- Replacing particular components is unexpected within t he lifetime of the charging stations – with the exception of the connector on DC fast chargers. This may need replacing every 3 years.
- DC fast chargers will need complete replacement once the quoted lifetime has been reached.
- For on-street chargers and wall boxes, some of the standard components may outlive the expected system lifetime. However, the vast majority of the cost lies in the components that will need replacing, so this analysis assumes that the entire charger will need to be replaced.

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5.3 Component costs – current and forecasted

5.3.1 Off the shelf components

As discussed, we predict no movement in the costs of the off the shelf components (in real terms).

5.3.2 Key components

The detailed cost development figures for each of the key components is given in **Table 27**. In this analysis, we assume that by 2050 a flat-lined commoditised price for all key components is achieved. This flat-line price comes about as:

- Prices decline to a level that is considered feasible when mass market scale is reached
- Beyond this point, the assumption is that cost increases (e.g. in commodity price, labour) are negated by further efficiency improvements (e.g. in manufacturing processes, reduced manufacturer margins) – so prices remain flat in real terms.

AC/DC Converter

FIGURE 7: COST DEVELOPMENT CURVE FOR 50 KW AC/DC CONVERTER

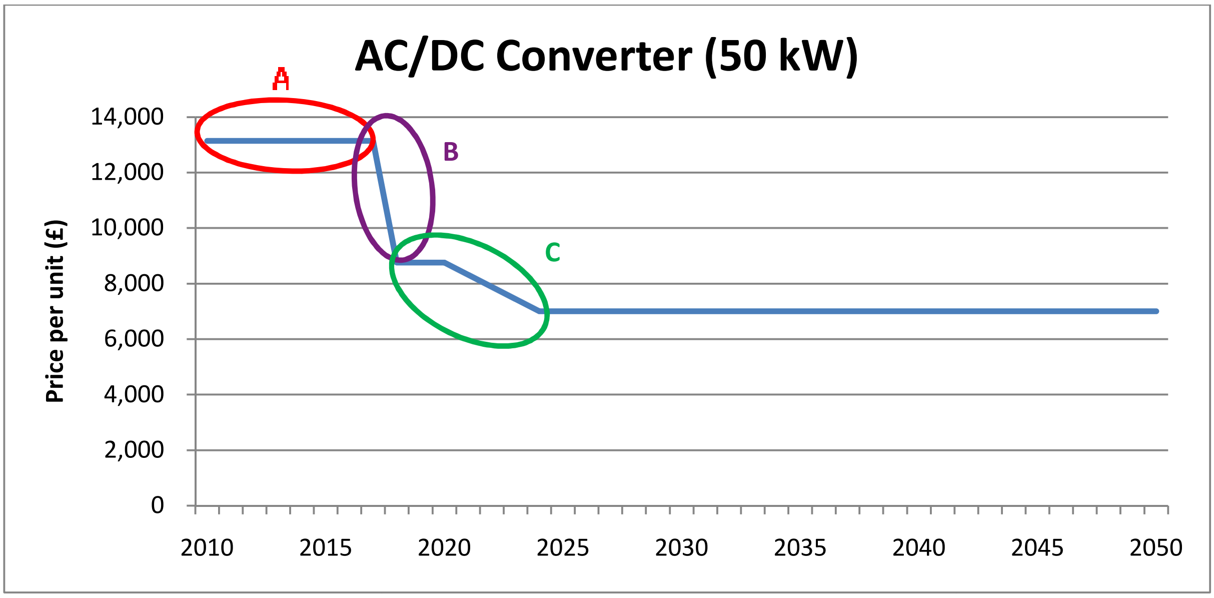

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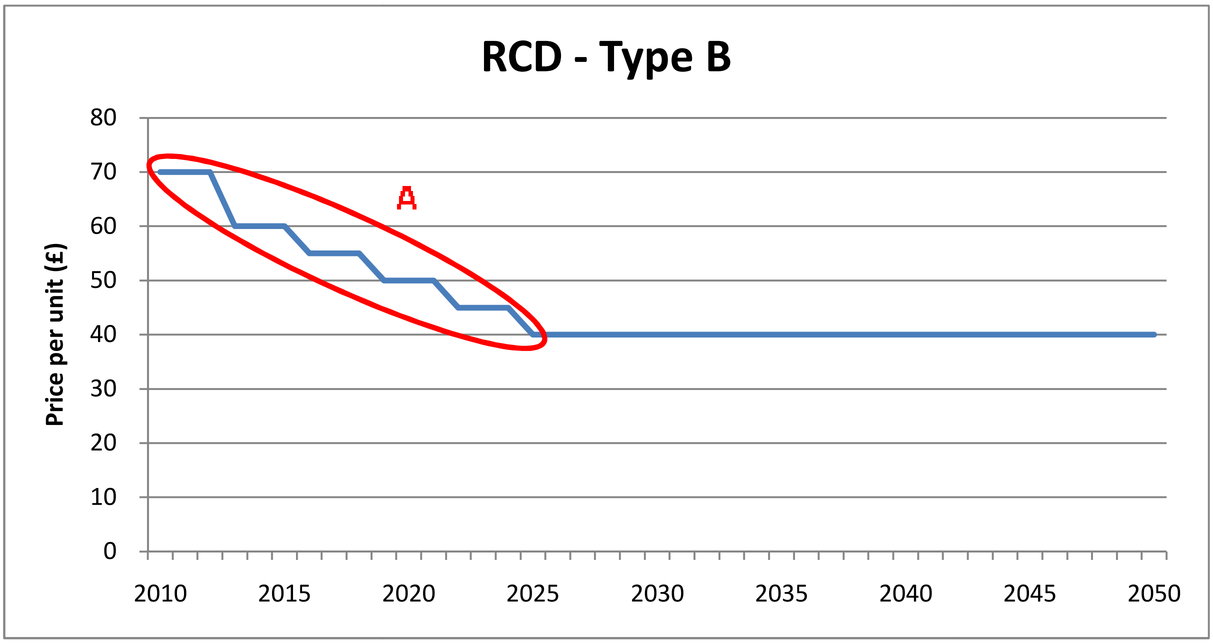
TABLE 11: DISCUSSION AROUND COST EVOLUTION OF AC/DC CONVERTER

Period	Details
A: 2010 to 2015	Immediate sourcing of component from low-cost Asian supplier means costs remain static to after 2015, as limited demand means no new competition in supply
B: 2015 to 2020	The market demand for DC chargers grows more strongly, bringing much more competition into converter manufacture, and enabling scale up, reducing manufacturing costs. Significant reduction in cost.
B: 2020 to 2025	Modest growth in demand leads to further cost reductions down to minimum cost of around £7,000

Type B RCD

FIGURE 8: COST DEVELOPMENT CURVE FOR TYPE B RCD



Delta Energy & Environment, 2010

TABLE 12: DISCUSSION AROUND COST EVOLUTION OF TYPE B RCD

Period	Details
A: 2010 to 2025	Siemens will gradually lower the cost in this period as it recoups R&D costs. IP will prevent other competition entering and driving costs down more quickly.
2025 to 2050	Floor price of £40 will not be passed.

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Smart meter

FIGURE 9: COST DEVELOPMENT CURVE FOR SMART METER

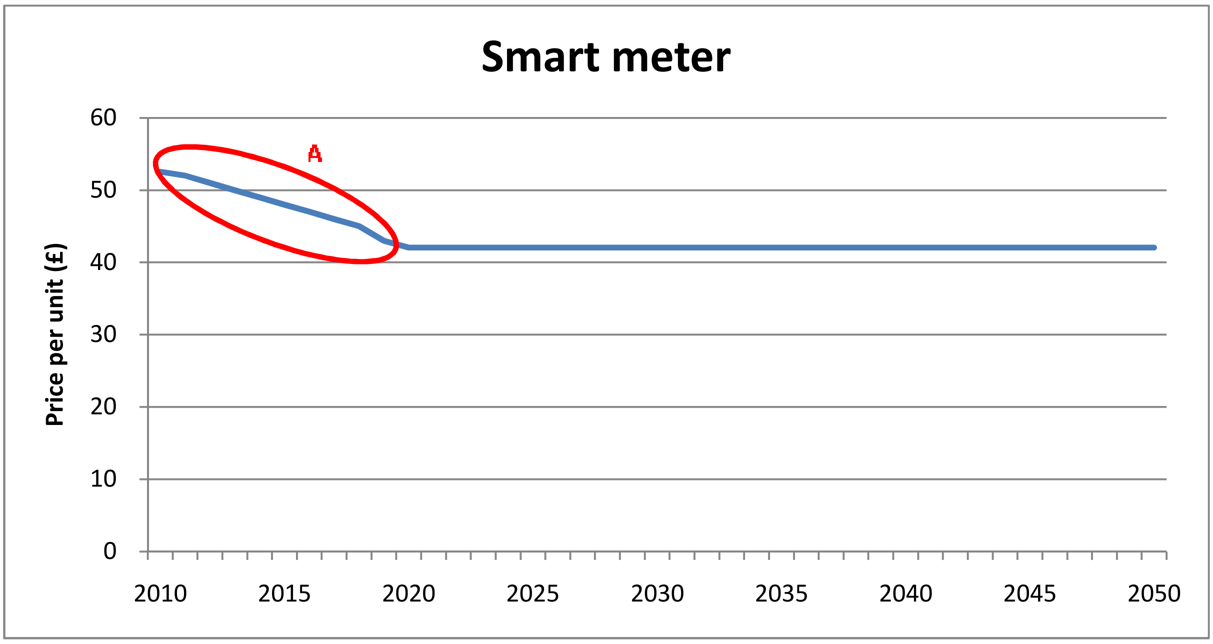

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TABLE 13: DISCUSSION AROUND COST EVOLUTION OF SMART METER

Period	Details
A: 2010 to 2020	Smart meters are already commoditised, but increased volumes of public posts will enable bulk purchasing, allowing unit costs to come down by 20% to 2020
2020 to 2050	No further cost reductions will be seen

Printed Circuit Board (PCB)

FIGURE 10: COST DEVELOPMENT CURVE FOR PCB

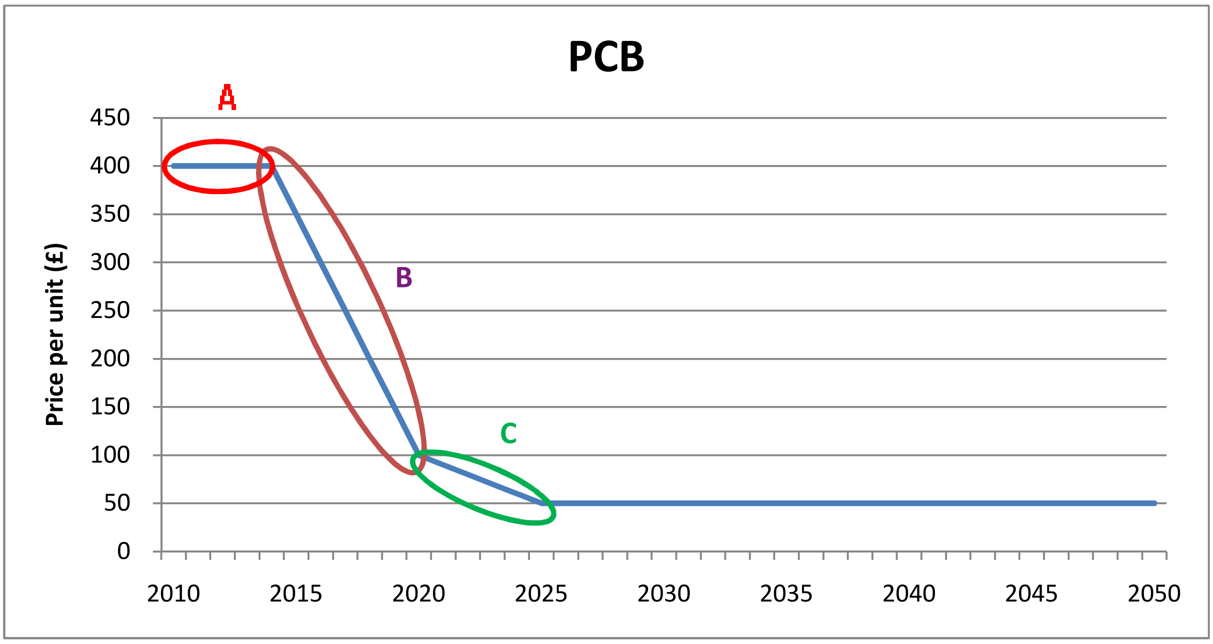

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TABLE 14: DISCUSSION AROUND COST EVOLUTION OF PCB

Period	Details
A: 2010 to 2015	Very low volumes of public recharge posts, so cost of PCB remains at high level of £400
B: 2015 to 2020	Increasing demand for public posts enables significant unit cost reduction through bulk purchasing and other economies of scale
B: 2020 to 2025	Continued market growth enable some additional cost reductions to be realised until eventually the floor price of £50 is reached

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Connector – Type 2

FIGURE 11: COST DEVELOPMENT CURVE FOR TYPE 2 CONNECTOR

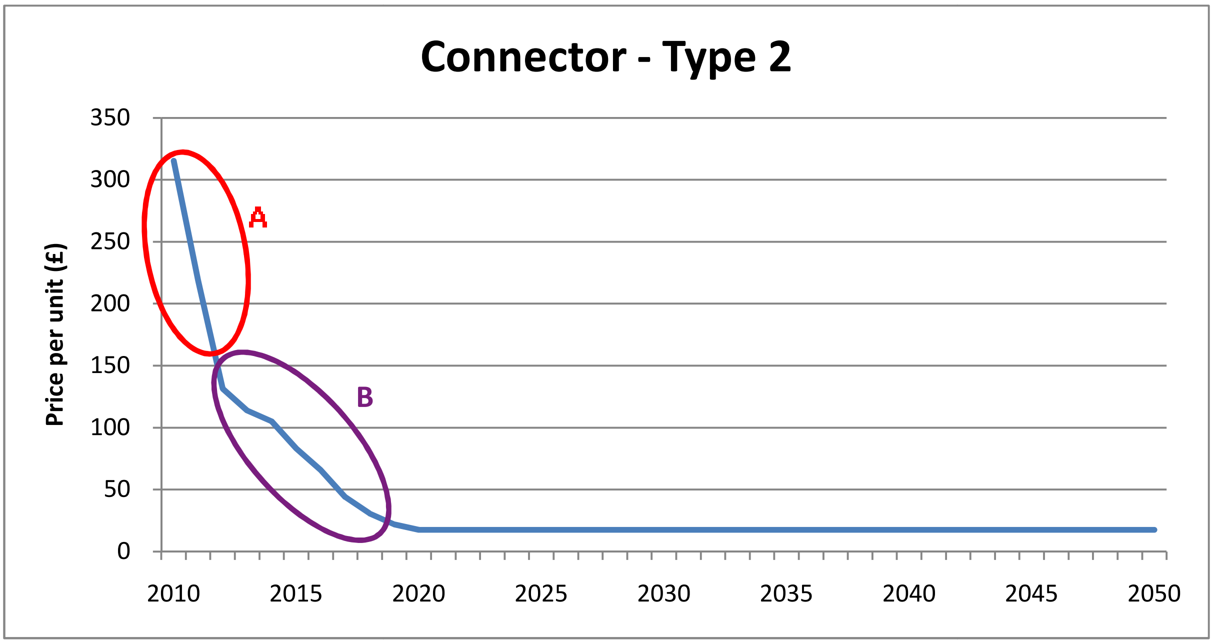

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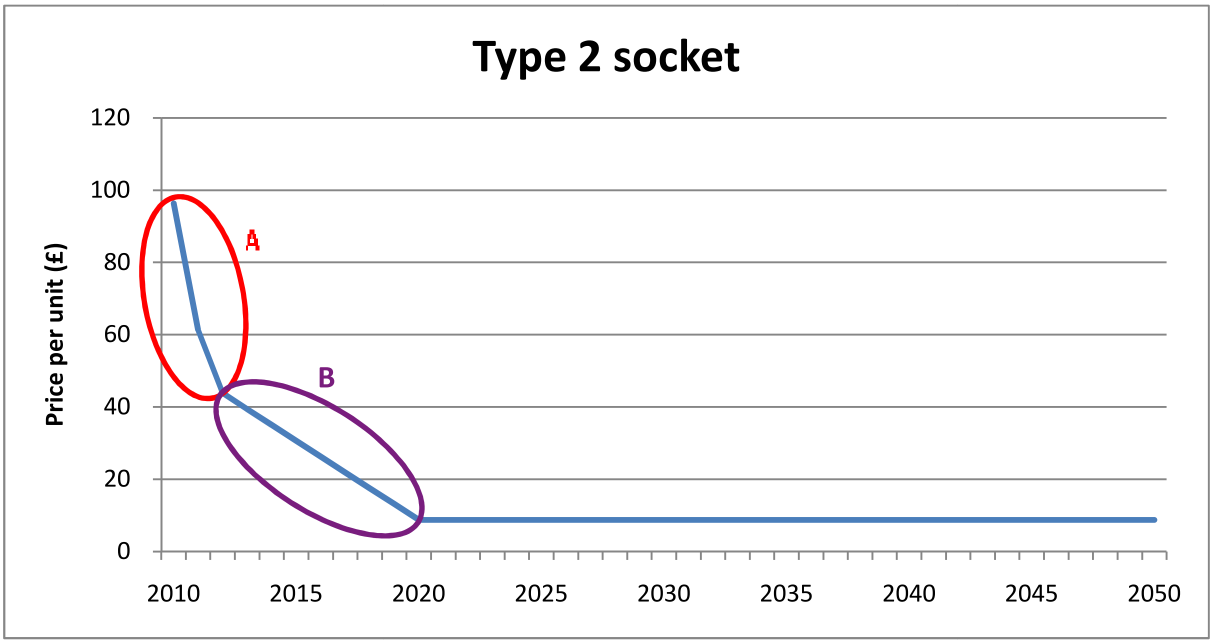
TABLE 15: DISCUSSION AROUND COST EVOLUTION OF TYPE 2 CONNECTOR

Period	Details
A: 2010 to 2013	Standardisation is set to occur before the end of 2012, this will bring much greater competition to the market, as well as bringing confidence to manufacturers to scale up. Costs will more than halve.
B: 2013 to 2020	Costs continue to steadily come down, as demand grows and product becomes mass market
2020 onwards	Connectors are now an off the shelf product, no further room for cost reduction

Socket – Type 2

FIGURE 12: COST DEVELOPMENT CURVE FOR TYPE 2 SOCKET



Delta Energy & Environment, 2010

TABLE 16: DISCUSSION AROUND COST EVOLUTION OF TYPE 2 SOCKET

Period	Details
A: 2010 to 2013	As with the connector, standardisation in 2012 will result in costs halving
B: 2013 to 2020	Costs continue to steadily come down, as demand grows and product becomes mass market
2020 onwards	Sockets are now an off the shelf product, no further room for cost reduction

Connector – DC charge

FIGURE 13: COST DEVELOPMENT CURVE FOR DC CHARGE CONNECTOR

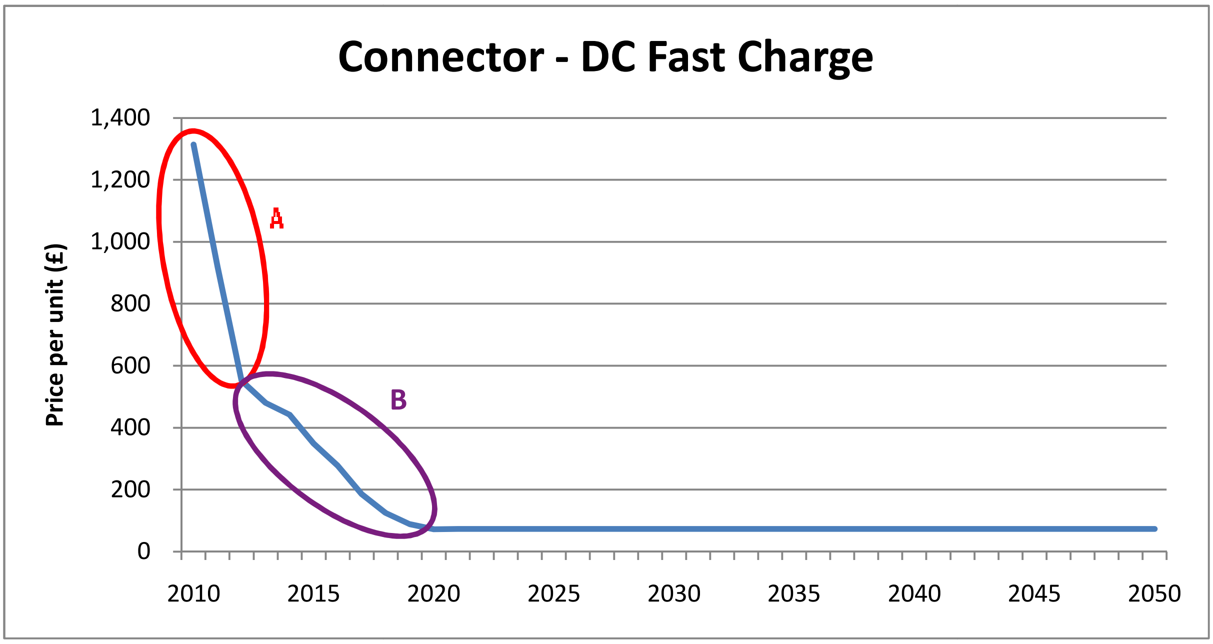


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TABLE 17: DISCUSSION AROUND COST EVOLUTION OF DC CHARGE CONNECTOR

Period	Details
A: 2010 to 2013	Similar rate of rapid cost reduction as Type 2 AC connector as standardisation is reached by 2012
B: 2013 to 2020	Costs continue to steadily come down, as demand grows and product becomes mass market
2020 onwards	Connectors are now an off the shelf product, no further room for cost reduction

Control Pilot (CP) box

FIGURE 14: COST DEVELOPMENT CURVE FOR CP BOX

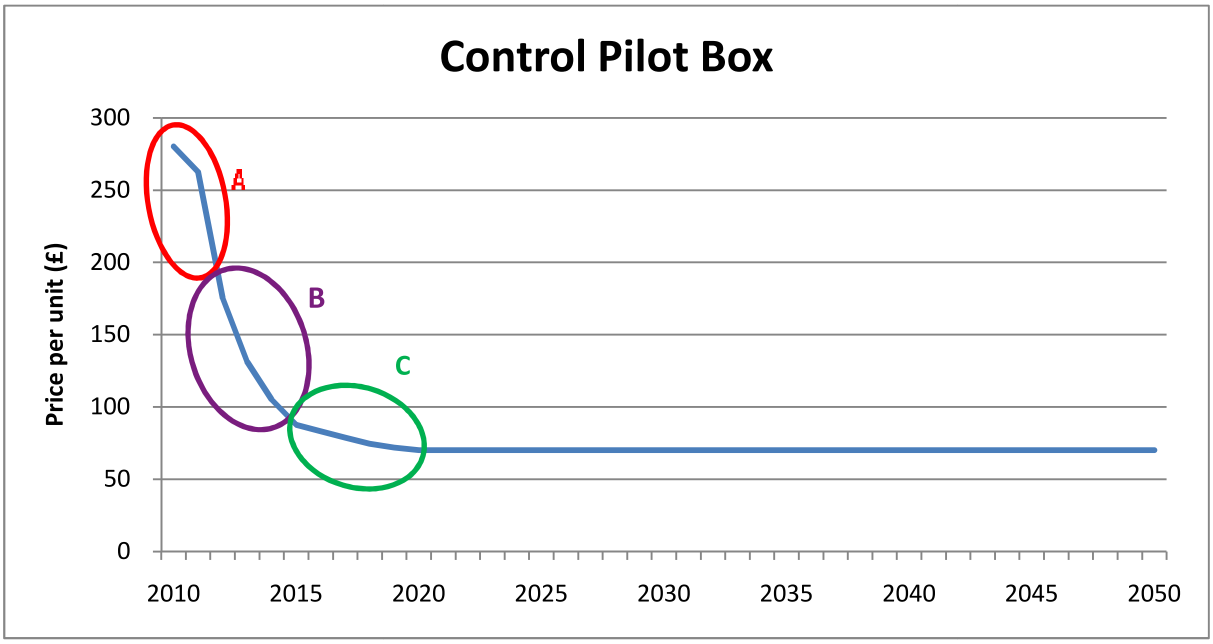

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TABLE 18: DISCUSSION AROUND COST EVOLUTION OF CP BOX

Period	Details
A: 2010 to 2012	Siemens launches its own CP box, at a price of £175
B: 2013 to 2015	Costs rapidly decline as increased competition forces margins down and manufacturing scales up
C: 2015 to 2020	Cost reduction slows to 2020 as price approaches floor of £70

Enclosure (wall box)

FIGURE 15: COST DEVELOPMENT CURVE FOR WALL BOX ENCLOSURE

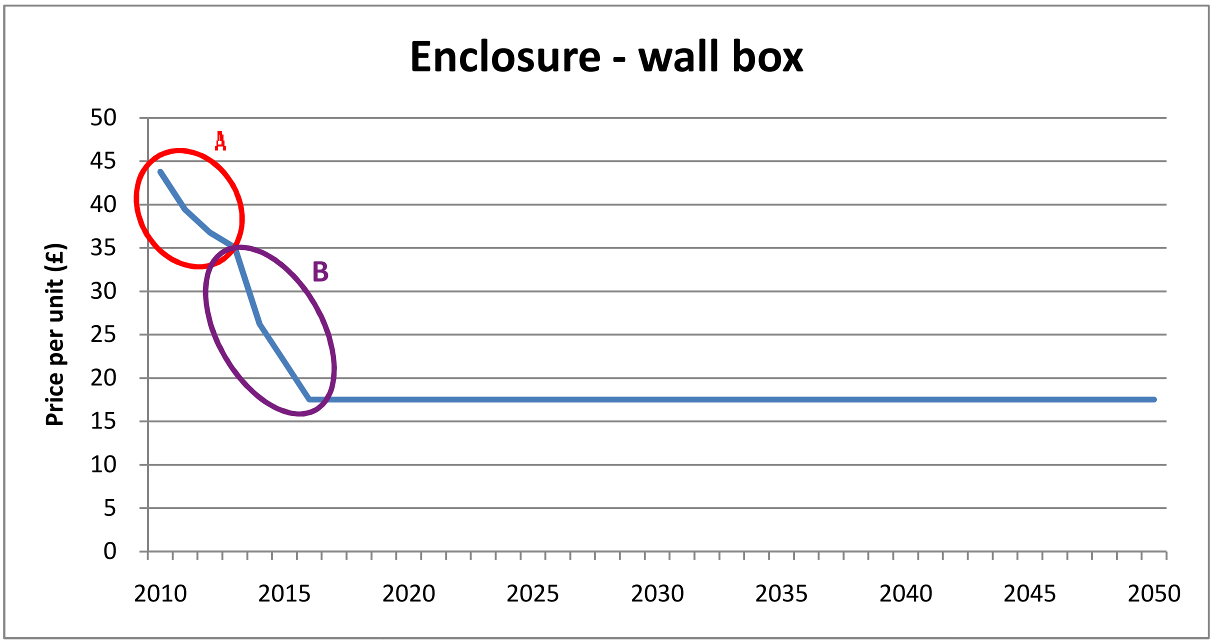

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TABLE 19: DISCUSSION AROUND COST EVOLUTION OF WALL BOX ENCLOSURE

Period	Details
A: 2010 to 2013	Manufacturing slowly ramps up, achieving economies of scale, but remaining manual and labour intensive
B: 2013 to 2016	A critical volume is reached where manufacturing is automated and significant cost reductions can be seen
2020 onwards	Enclosures are now an off the shelf product, no further room for cost reduction

Enclosure (public recharge post)

FIGURE 16: COST DEVELOPMENT CURVE FOR PUBLIC POST ENCLOSURE

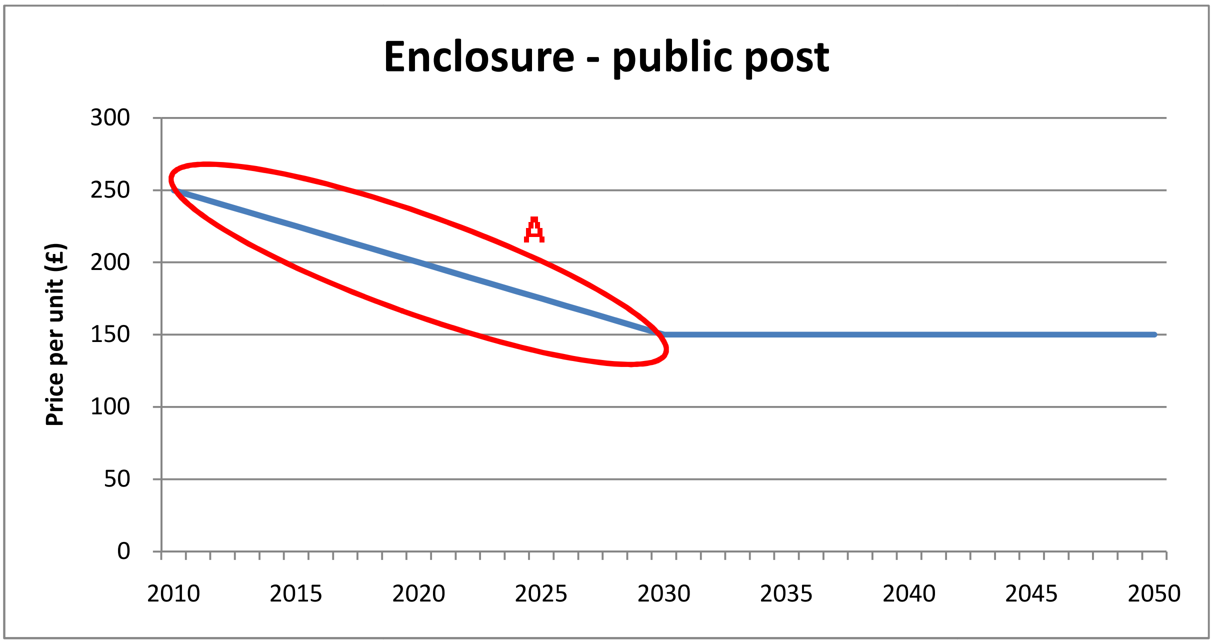

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TABLE 20: DISCUSSION AROUND COST EVOLUTION OF PUBLIC POST ENCLOSURE

Period	Details
A: 2010 to 2030	• Steady economies of scale in manufacturing costs seen through increased volumes. • The rate of reduction is assumed to be moderate, as economies of scale will be counterbalanced by rising long run metal commodity costs – in comparison to other components, the enclosure is more exposed to metal commodity costs (as it will always be manufactured from metal alloys such as steel and aluminium).
2030 onwards	• Any increased efficiencies or economies of scale in manufacturing are assumed to be counter balanced by increasing long run commodity prices.

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5.4 Final charging solution prices – current and forecasted

How the final price of a charging solution is arrived at – the issue of manufacturing costs, overheads and margins

Delta was tasked with analysing the component costs of different charging solutions, to come up with a view on how the overall cost of infrastructure will develop out to 2050. However, to know how much the infrastructure will actually cost, a view needs to be taken on the final price of the chargers themselves. On top of the individual component costs, the price of chargers will also include:

- Manufacturing costs, and overheads such as marketing, administration, etc
- Average industry manufacturer margin – to provide a return on capital employed (e.g. to recover R&D costs and other capital costs)

As the scope of this study is to analyse component costs, and not looking at various business models of manufacturers, Delta has made the following assumptions as to the current and future contributions of all other costs to the final price:

TABLE 21: ASSUMPTIONS TAKEN ON MANUFACTURNG COSTS, OVERHEADS AND MARGINS

	Wall Box	Public Recharge Post	DC Charger
Manufacturing costs and overheads	• 15% of total component cost from 2010 to 2015, as volumes are low • Reducing to 5% of total component cost in 2015 as volumes significantly increase. Remaining at 5% to 2050	• 25% of total component cost from 2010 to 2015, as volumes are low and assembly is more onerous than wall boxes. • Reducing to 15% in 2015 and remaining out to 2050	• Delta assumes the same proportion of overheads, and rate of reduction, as for public recharge posts.
Average Industry Margin	• 50% margin currently, as competition is low and R&D costs need to be recouped • Falling to 30% by 2015 as competition increases and big players enter market • Falling slowly to 25% by 2020, a typical manufacturing industry margin, remaining here to 2050	• Margins remain higher for longer, due to less competition than wall boxes. • 50% in 2010, falling to 35% by 2017. • Margins will remain at 35% to 2050 as this market will always be more niche than wall boxes.	• Delta assumes the same margins, and rate of tightening, as for public recharge posts.

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5.4.1 Wall box

Figure 17 illustrates the development of the final price of a Mode 3 wall box, out to 2050. The detailed breakdown of individual component costs, margins and other overheads is given in **Table 28**.

FIGURE 17: FINAL PRICE DEVELOPMENT OF WALL BOX

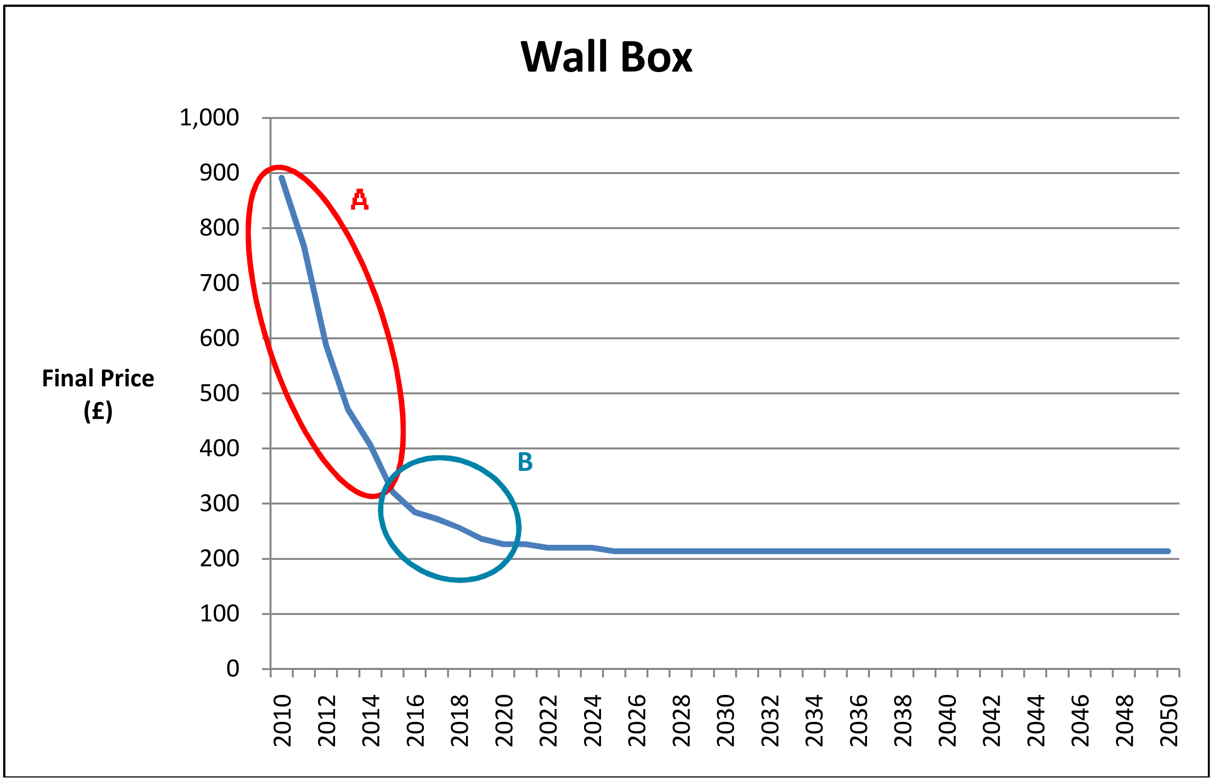

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TABLE 22: DISCUSSION AROUND FINAL PRICE EVOLUTION OF WALL BOX

Period	Details
A: 2010 to 2015	Rapid decline in cost of CP box and socket Ramping up of manufacturing reduces enclosure cost Margin squeezed due to increased competition
B: 2015 to 2020	Step-change to scale manufacturing reduces overheads
Beyond 2020	Small reductions in overall cost to 2025 as margins are squeezed further, levelling out then to 2050 as price hits mass market floor

5.4.2 Public recharge post

Figure 18 illustrates the development of the final price of a public recharge post, out to 2050. The detailed breakdown of individual component costs, margins and other overheads is given in **Table 29**.

FIGURE 18: FINAL PRICE DEVELOPMENT OF PUBLIC POST

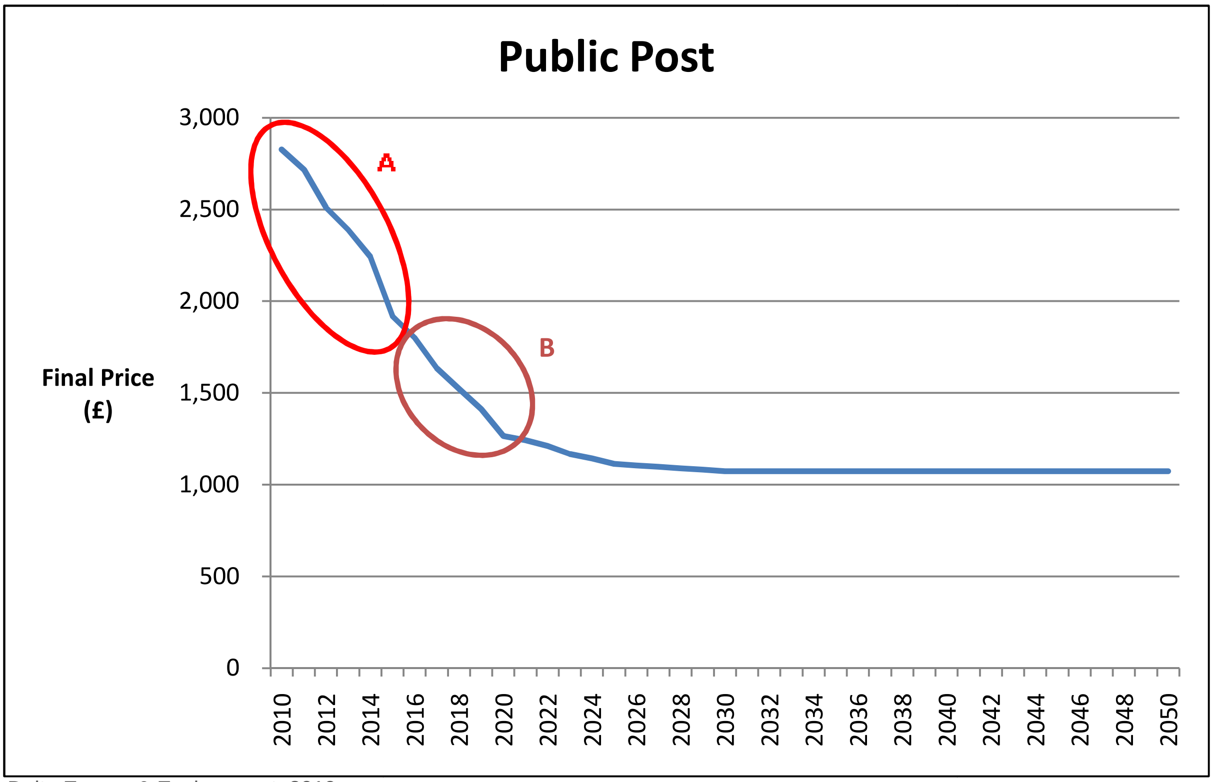

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TABLE 23: DISCUSSION AROUND FINAL PRICE EVOLUTION OF PUBLIC POST

Period	Details
A: 2010 to 2015	▸ Rapid decline in cost of CP box and socket ▸ Margin squeezed slightly due to increased competition
B: 2015 to 2020	▸ Step-change to scale manufacturing reduces overheads significantly ▸ PCB price falls by more than 70% as it is now bought in much larger volumes ▸ Margins further tightened as market competition intensifies
Beyond 2020	▸ Small reductions in overall cost to 2025 as margins are squeezed slightly further, PCB cost falls by another 50% ▸ Price then levels out to 2050 as price hits mass market floor

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5.4.3 DC charger

Figure 19 illustrates the development of the final price of an DC charger, out to 2050. The detailed breakdown of individual component costs, margins and other overheads is given in **Table 30**.

FIGURE 19: FINAL PRICE DEVELOPMENT OF DC CHARGER

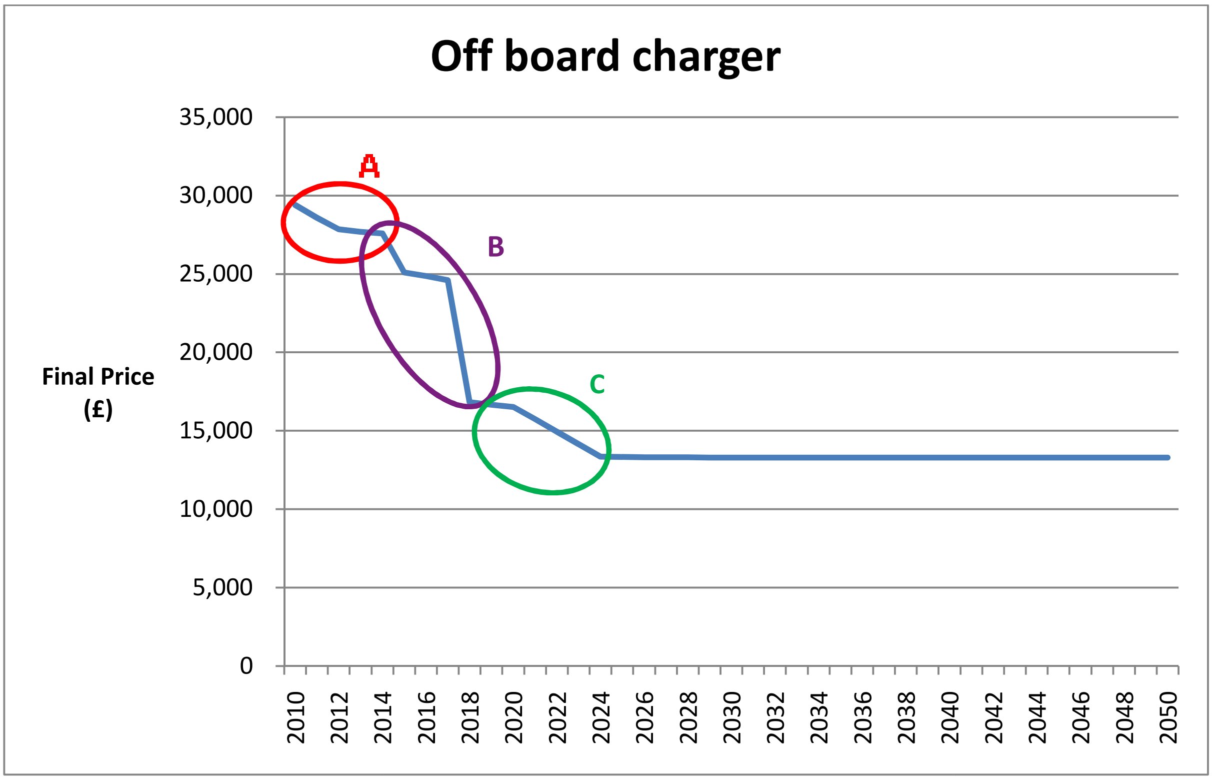

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TABLE 24: DISCUSSION AROUND FINAL PRICE EVOLUTION OF DC CHARGER

Period	Details
A: 2010 to 2015	▶ Little change in price as AC/DC converter remains at current cost, sourced from Asia ▶ Cost of post comes down, as shown in **Figure 18**, but has little impact on total price
B: 2015 to 2020	▶ Major impact here is in reduction of cost of AC/DC converter, as detailed in **Figure 7** and **Table 9** ▶ Unit manufacturing costs come down as economies of scale are reached and manufacture is automated
C: 2020 to 2025	▶ Some further efficiency improvements in manufacturing achieved ▶ Margins squeezed, as competition enters the market in the form of the bigger industry players

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5.4.4 Inductive charger

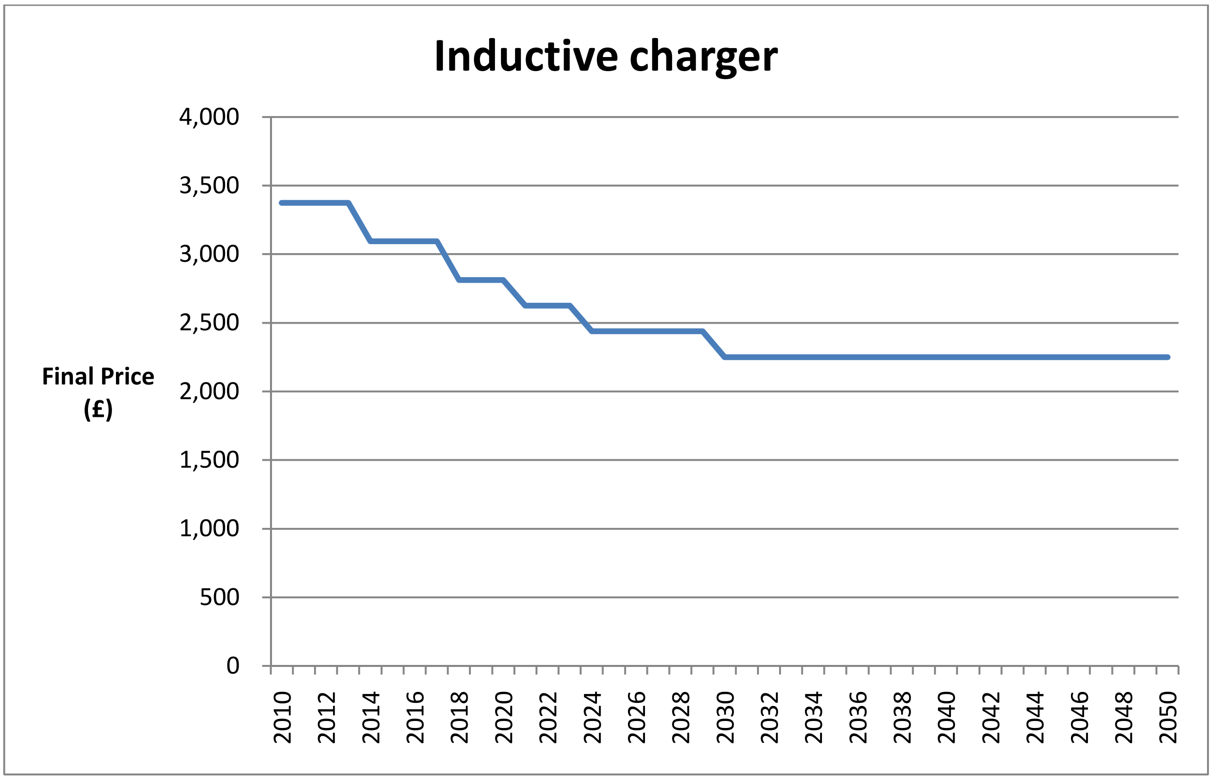
Figure 20 illustrates the development of the final price of an inductive charger, out to 2050.

This solution is simply made up of a power supply, and a transmitting charging pad. This technology is still under development.

The industry consensus is that the current final price of just over £3,000 for a 3 kW unit will come down by approximately one third by 2030. Figure 20 illustrates this consensus.

The detailed breakdown of individual component costs, margins and other overheads is given in **Table 31**.

FIGURE 20: FINAL PRICE DEVELOPMENT OF INDUCTIVE CHARGER



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5.4.5 Examples of currently available final charging solutions

There are many conductive charging solutions now available on the market. Table 25 gives details of some such systems, with current list prices as quoted by the manufacturers.

TABLE 25: EXAMPLES OF CONDUCTIVE CHARGING SOLUTIONS AVAILABLE ON THE MARKET TODAY

	Company	Model / Part Number	Details	List price
Domestic Wall Box	Pod Point	Pod Point Home	Domestic wall box, Mode 3, tethered cable	£800
	Charge Point	Not available	Domestic wall box, 3 pin socket	£500
	Charge Point	Not available	Domestic wall box, 7 pin socket	£950
Public Recharge Post	Pod Point	POD Point Twin charge	2x13A sockets	£2,000 - £2,750
	Pod Point	POD Point Power 32	1x13A, 1x32A	£2,250 - £3,000
	Charge Point	Not available	Public wall box	£2,500
	Charge Point	Not available	Single headed post, Mode 3, single phase	£4,500
	Charge Point	Not available	Double headed post, Mode 3, single phase	£6,000
DC Charge	EPYON	TERRA Charge Base and Station	50 kW DC charger with single public post outlet	£20,000 - £25,000

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5.4.6 Tables of component costs – current and forecasted

Off the shelf components

TABLE 26: OFF THE SHELF COMPONENT COST DEVELOPMENT 2010 TO 2050

No change in cost assumed as already mass market and at lowest prices. Note that all values from this point are in GBP, and assume 0% inflation figures

Component		Details	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
External cable	SWA XLPE Insulated Single Phase 2 core twin and earth	1.5 mm2, 14.0 A, 3.3 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		2.5 mm^2, 18.5 A, 4.4 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		4.0 mm^2, 25.0 A, 6.0 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		6.0 mm^2, 32.0 A, 7.6 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		10.0 mm^2, 43.0 A, 10.3 kW	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	SWA XLPE Insulated Three Phase 3 or 4 Core depending on earthing arrangement	1.5 mm2, 14.0 A, 3.3 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		2.5 mm^2, 18.5 A, 4.4 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		4.0 mm^2, 25.0 A, 6.0 kW	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		6.0 mm^2, 32.0 A, 7.6 kW	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		10.0 mm^2, 43.0 A, 10.3 kW	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Internal cable	2-core twin and earth cable, Insulated and Sheathed	1.5 mm2, 14.0 A, 3.3 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		2.5 mm^2, 18.5 A, 4.4 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		4.0 mm^2, 25.0 A, 6.0 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		6.0 mm^2, 32.0 A, 7.6 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		10.0 mm^2, 43.0 A, 10.3 kW	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Feeder pillar (external)	4 to 24 Way 100A to 200A (DB) Max Incomer	Single Phase	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312
		Three Phase	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312

	Rating DIN Rail Mounting Lockable door																	
Consumer Unit	4 to 8 way, 100A max incomer rating, DIN rail mounting	Single phase	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Distribution board	5 to 24 way, 125 to 200A max incomer rating, DIN rail mounting, lockable door	Single phase	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69
		Three phase	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305
MCCB Panel Board	400 to 800A max incomer rating, 6 to 12 way		706	706	706	706	706	706	706	706	706	706	706	706	706	706	706	706
Disconnect or / Isolator	100 to 200A		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
RCD	Type A	Single phase: 2 pole	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
		Three phase: 4 pole	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72
MCB	DIN rail mount, single pole, Type B	Single phase, 16A	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
		Single phase, 32A	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
		Single phase, 63A	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
		3- phase, 16A	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
		3- phase, 32A	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
		3- phase, 63A	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
		3- phase, 100A	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
MCCB	20A to 250A		90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
External socket	UK 3 pin switchable socket with integrated RCD		34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
	Industrial socket single phase.	IP rating according to installation, Blue, 240V, 16A or 32A rating.	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

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	Industrial socket three phase.	IP rating according to installation, Red, 415V, 16A/phase rating.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Component		Details	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
External cable	SWA XLPE Insulated Single Phase 2 core twin and earth	1.5 mm2, 14.0 A, 3.3 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		2.5 mm^2, 18.5 A, 4.4 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		4.0 mm^2, 25.0 A, 6.0 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		6.0 mm^2, 32.0 A, 7.6 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		10.0 mm^2, 43.0 A, 10.3 kW	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	SWA XLPE Insulated Three Phase 3 or 4 Core depending on earthing arrangement	1.5 mm2, 14.0 A, 3.3 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		2.5 mm^2, 18.5 A, 4.4 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		4.0 mm^2, 25.0 A, 6.0 kW	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		6.0 mm^2, 32.0 A, 7.6 kW	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
		10.0 mm^2, 43.0 A, 10.3 kW	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Internal cable	2-core twin and earth cable, Insulated and Sheathed	1.5 mm2, 14.0 A, 3.3 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		2.5 mm^2, 18.5 A, 4.4 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		4.0 mm^2, 25.0 A, 6.0 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		6.0 mm^2, 32.0 A, 7.6 kW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		10.0 mm^2, 43.0 A, 10.3 kW	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Feeder pillar (external)	4 to 24 Way 100A to 200A (DB) Max Incomer Rating DIN Rail Mounting Lockable door	Single Phase	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312
		Three Phase	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312
Consumer Unit	4 to 8 way, 100A max incomer rating, DIN rail	Single phase	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18

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	mounting																
Distribution board	5 to 24 way, 125 to 200A max incomer rating, DIN rail mounting, lockable door	Single phase	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69
		Three phase	305	305	305	305	305	305	305	305	305	305	305	305	305	305	305
MCCB Panel Board	400 to 800A max incomer rating, 6 to 12 way		706	706	706	706	706	706	706	706	706	706	706	706	706	706	706
Disconnector / Isolator	100 to 200A		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
RCD	Type A	Single phase: 2 pole	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
		Three phase: 4 pole	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72
MCB	DIN rail mount, single pole, Type B	Single phase, 16A	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
		Single phase, 32A	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
		Single phase, 63A	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
		3- phase, 16A	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
		3- phase, 32A	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
		3- phase, 63A	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
		3- phase, 100A	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
MCCB		20A to 250A	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
External socket	UK 3 pin switchable socket with integrated RCD		34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
	Industrial socket single phase.	IP rating according to installation, Blue, 240V, 16A or 32A rating.	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	Industrial socket three phase.	IP rating according to installation, Red, 415V, 16A/phase rating.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Component		Details	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
External cable	SWA XLPE Insulated Single Phase 2 core twin and earth	1.5 mm2, 14.0 A, 3.3 kW	1	1	1	1	1	1	1	1	1	1
		2.5 mm^2, 18.5 A, 4.4 kW	1	1	1	1	1	1	1	1	1	1
		4.0 mm^2, 25.0 A, 6.0 kW	1	1	1	1	1	1	1	1	1	1
		6.0 mm^2, 32.0 A, 7.6 kW	1	1	1	1	1	1	1	1	1	1
		10.0 mm^2, 43.0 A, 10.3 kW	2	2	2	2	2	2	2	2	2	2

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	SWA XLPE Insulated Three Phase 3 or 4 Core depending on earthing arrangement	1.5 mm2, 14.0 A, 3.3 kW	1	1	1	1	1	1	1	1	1	1
		2.5 mm^2, 18.5 A, 4.4 kW	1	1	1	1	1	1	1	1	1	1
		4.0 mm^2, 25.0 A, 6.0 kW	2	2	2	2	2	2	2	2	2	2
		6.0 mm^2, 32.0 A, 7.6 kW	2	2	2	2	2	2	2	2	2	2
		10.0 mm^2, 43.0 A, 10.3 kW	3	3	3	3	3	3	3	3	3	3
Internal cable	2-core twin and earth cable, Insulated and Sheathed	1.5 mm2, 14.0 A, 3.3 kW	1	1	1	1	1	1	1	1	1	1
		2.5 mm^2, 18.5 A, 4.4 kW	1	1	1	1	1	1	1	1	1	1
		4.0 mm^2, 25.0 A, 6.0 kW	1	1	1	1	1	1	1	1	1	1
		6.0 mm^2, 32.0 A, 7.6 kW	1	1	1	1	1	1	1	1	1	1
		10.0 mm^2, 43.0 A, 10.3 kW	2	2	2	2	2	2	2	2	2	2
Feeder pillar (external)	4 to 24 Way 100A to 200A (DB) Max Incomer Rating DIN Rail Mounting Lockable door	Single Phase	312	312	312	312	312	312	312	312	312	312
		Three Phase	312	312	312	312	312	312	312	312	312	312
Consumer Unit	4 to 8 way, 100A max incomer rating, DIN rail mounting	Single phase	18	18	18	18	18	18	18	18	18	18
Distribution board	5 to 24 way, 125 to 200A max incomer rating, DIN rail mounting, lockable door	Single phase	69	69	69	69	69	69	69	69	69	69
		Three phase	305	305	305	305	305	305	305	305	305	305
MCCB Panel Board	400 to 800A max incomer rating, 6 to 12 way		706	706	706	706	706	706	706	706	706	706
Disconnector / Isolator	100 to 200A		11	11	11	11	11	11	11	11	11	11
RCD	Type A	Single phase: 2 pole	68	68	68	68	68	68	68	68	68	68
		Three phase: 4 pole	72	72	72	72	72	72	72	72	72	72
MCB	DIN rail mount, single pole, Type B	Single phase, 16A	6	6	6	6	6	6	6	6	6	6
		Single phase, 32A	6	6	6	6	6	6	6	6	6	6
		Single phase, 63A	7	7	7	7	7	7	7	7	7	7
		3- phase, 16A	50	50	50	50	50	50	50	50	50	50
		3- phase, 32A	50	50	50	50	50	50	50	50	50	50
		3- phase, 63A	53	53	53	53	53	53	53	53	53	53
		3- phase, 100A	110	110	110	110	110	110	110	110	110	110
MCCB		20A to 250A	90	90	90	90	90	90	90	90	90	90

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External socket	UK 3 pin switchable socket with integrated RCD		34	34	34	34	34	34	34	34	34	34
	Industrial socket single phase.	IP rating according to installation, Blue, 240V, 16A or 32A rating.	4	4	4	4	4	4	4	4	4	4
	Industrial socket three phase.	IP rating according to installation, Red, 415V, 16A/phase rating.	5	5	5	5	5	5	5	5	5	5

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5.4.7 Table of key component costs – current and forecasted

TABLE 27: KEY COMPONENT COST DEVELOPMENT 2010 TO 2050

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
AC/DC converter	13,139	13,139	13,139	13,139	13,139	13,139	13,139	13,139	8,760	8,760	8,760	8,322	7,884	7,446	7,008	7,008	7,008	7,008	7,008	7,008
RCD (Type B)	70	70	70	60	60	60	55	55	55	50	50	50	45	45	45	40	40	40	40	40
Smart meter	53	52	51	50	49	48	47	46	45	43	42	42	42	42	42	42	42	42	42	42
PCB	400	400	400	400	400	350	300	250	200	150	100	90	80	70	60	50	50	50	50	50
Screen	20	20	20	20	20	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Connector (Type 2)	315	219	131	114	105	83	66	44	31	22	18	18	18	18	18	18	18	18	18	18
Connector (DC charge)	1314	920	552	480	442	349	277	186	125	88	73	73	73	73	73	73	73	73	73	73
Socket (Type 2)	96	61	44	39	35	31	26	22	18	13	9	9	9	9	9	9	9	9	9	9
CP box	280	263	175	131	105	88	83	79	74	72	70	70	70	70	70	70	70	70	70	70
Enclosure - wall box	44	39	37	35	26	22	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Enclosure - public post	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250

	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
AC/DC converter	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008
RCD (Type B)	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Smart meter	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
PCB	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Screen	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Connector (Type 2)	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18

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Connector (DC charge)	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73
Socket (Type 2)	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
CP box	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
Enclosure - wall box	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Enclosure - public post	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250

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5.4.8 Tables of final charger prices – current and forecasted

Wall Box, Mode 3 enabled charging

TABLE 28: WALL BOX, KEY COMPONENT COSTS AND FINAL PRICE FORECASTS

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Domestic Wall Box MODE 3 CHARGING	CP box	280	263	175	131	105	88	83	79	74	72	70	70	70	70	70	70	70	70	70	70
	RCD	70	70	70	60	60	60	55	55	55	50	50	50	45	45	45	40	40	40	40	40
	Enclosure	44	39	37	35	26	22	18	18	18	18	18	18	18	18	18	18	18	18	18	18
	Socket	96	61	44	39	35	31	26	22	18	13	9	9	9	9	9	9	9	9	9	9
	Timer	26	26	26	26	26	26	26	26	22	22	22	22	22	9	9	9	9	9	9	9
	TOTAL COMPONENT COST	**517**	**460**	**352**	**292**	**253**	**226**	**208**	**200**	**186**	**174**	**168**	**168**	**163**	**150**	**150**	**145**	**145**	**145**	**145**	**145**
	Other[1]	375	307	235	178	154	95	76	73	64	56	53	53	51	47	47	45	45	45	45	45
	FINAL SALE PRICE	**891**	**767**	**587**	**470**	**407**	**321**	**284**	**272**	**251**	**231**	**221**	**221**	**214**	**197**	**197**	**190**	**190**	**190**	**190**	**190**

		2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Domestic Wall Box MODE 3 CHARGING	CP box	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
	RCD	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
	Enclosure	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
	Socket	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
	Timer	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
	TOTAL COMPONENT COST	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**	**145**
	Other	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
	FINAL SALE PRICE	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**	**190**

[1] 'Other' includes manufacturing costs, margin and other overheads

Public recharging post

TABLE 29: PUBLIC RECHARGING POST, KEY COMPONENT COSTS AND FINAL PRICE FORECASTS

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Public post	CP box	280	263	175	131	105	88	83	79	74	72	70	70	70	70	70	70	70	70	70	70
	RCD	70	70	70	60	60	60	55	55	55	50	50	50	45	45	45	40	40	40	40	40
	Enclosure	250	245	240	235	230	225	220	215	210	205	200	195	190	185	180	175	170	165	160	155
	Socket	96	61	44	39	35	31	26	22	18	13	9	9	9	9	9	9	9	9	9	9
	Timer	26	26	26	26	26	26	26	26	22	22	22	22	22	9	9	9	9	9	9	9
	Smart meter	53	52	51	50	49	48	47	46	45	43	42	42	42	42	42	42	42	42	42	42
	PCB	400	400	400	400	400	350	300	250	200	150	100	90	80	70	60	50	50	50	50	50
	Screen	20	20	20	20	20	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	Feeder pillar	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312
	TOTAL COMPONENT COST	**1,508**	**1,449**	**1,338**	**1,274**	**1,237**	**1,150**	**1,080**	**1,015**	**946**	**877**	**815**	**800**	**780**	**752**	**737**	**717**	**712**	**707**	**702**	**697**
	Other[2]	1,319	1,268	1,171	1,115	1,005	767	721	619	577	535	450	442	431	415	407	396	393	390	388	385
	FINAL SALE PRICE	**2,827**	**2,718**	**2,509**	**2,389**	**2,243**	**1,917**	**1,801**	**1,634**	**1,523**	**1,412**	**1,265**	**1,242**	**1,211**	**1,167**	**1,144**	**1,113**	**1,105**	**1,097**	**1,089**	**1,082**

		2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Public post	CP box	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
	RCD	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
	Enclosure	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
	Socket	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
	Timer	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
	Smart meter	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
	PCB	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Screen	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

[2] 'Other' includes manufacturing costs, margin and other overheads

Feeder pillar	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312	312
TOTAL COMPONENT COST	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**	**692**
Other	382	382	382	382	382	382	382	382	382	382	382	382	382	382	382	382	382	382	382	382	382
FINAL SALE PRICE	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**	**1,074**

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DC charger

TABLE 30: DC CHARGER, KEY COMPONENT COSTS AND FINAL PRICE FORECASTS

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
DC charger (50 kW)	Public post (less CP box)	1,227	1,187	1,163	1,143	1,132	1,062	997	936	871	805	745	730	710	682	667	647	642
	AC/DC converter	13,139	13,139	13,139	13,139	13,139	13,139	13,139	13,139	8,760	8,760	8,760	8,322	7,884	7,446	7,008	7,008	7,008
	Connector	1,314	920	552	480	442	349	277	186	125	88	73	73	73	73	73	73	73
	TOTAL COMPONENT COST	**15,681**	**15,246**	**14,854**	**14,762**	**14,714**	**14,550**	**14,413**	**14,262**	**9,756**	**9,653**	**9,577**	**9,124**	**8,666**	**8,200**	**7,747**	**7,727**	**7,722**
	Other[3]	13,721	13,340	12,998	12,917	12,874	10,549	10,450	10,340	7,073	6,999	6,943	6,615	6,283	5,945	5,617	5,602	5,599
	FINAL SALE PRICE	**29,401**	**28,586**	**27,852**	**27,679**	**27,588**	**25,099**	**24,863**	**24,601**	**16,828**	**16,652**	**16,520**	**15,740**	**14,950**	**14,145**	**13,364**	**13,330**	**13,321**

		2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
DC charger (50 kW)	Public post (less CP box)	637	632	627	622	622	622	622	622	622	622	622	622	622	622
	AC/DC converter	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008
	Connector	73	73	73	73	73	73	73	73	73	73	73	73	73	73
	TOTAL COMPONENT COST	**7,717**	**7,712**	**7,707**	**7,702**	**7,702**	**7,702**	**7,702**	**7,702**	**7,702**	**7,702**	**7,702**	**7,702**	**7,702**	**7,702**
	Other	5,595	5,591	5,588	5,584	5,584	5,584	5,584	5,584	5,584	5,584	5,584	5,584	5,584	5,584
	FINAL SALE PRICE	**13,312**	**13,304**	**13,295**	**13,286**	**13,286**	**13,286**	**13,286**	**13,286**	**13,286**	**13,286**	**13,286**	**13,286**	**13,286**	**13,286**

[3] 'Other' includes manufacturing costs, margin and other overheads

		2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
DC charger (50 kW)	Public post (less CP box)	622	622	622	622	622	622	622	622	622	622
	AC/DC converter	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008	7,008
	Connector	73	73	73	73	73	73	73	73	73	73
	TOTAL COMPONENT COST	**7,702**	**7,702**	**7,702**	**7,702**	**7,702**	**7,702**	**7,702**	**7,702**	**7,702**	**7,702**
	Other	5,584	5,584	5,584	5,584	5,584	5,584	5,584	5,584	5,584	5,584
	FINAL SALE PRICE	**13,286**	**13,286**	**13,286**	**13,286**	**13,286**	**13,286**	**13,286**	**13,286**	**13,286**	**13,286**

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Inductive charging

TABLE 31: INDUCTIVE CHARGER, KEY COMPONENT COSTS AND FINAL PRICE FORECASTS

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Inductive charger	Power supply	1,200	1,200	1,200	1,200	1,100	1,100	1,100	1,100	1,000	1,000	1,000	900	900	900	900	900	900	900	900	900
	Transmitter pad	600	600	600	600	550	550	550	550	500	500	500	500	500	500	400	400	400	400	400	400
	TOTAL COMPONENT COST	**1,800**	**1,800**	**1,800**	**1,800**	**1,650**	**1,650**	**1,650**	**1,650**	**1,500**	**1,500**	**1,500**	**1,400**	**1,400**	**1,400**	**1,300**	**1,300**	**1,300**	**1,300**	**1,300**	**1,300**
	Other	1,575	1,575	1,575	1,575	1,444	1,444	1,444	1,444	1,313	1,313	1,313	1,225	1,225	1,225	1,138	1,138	1,138	1,138	1,138	1,138
	FINAL SALE PRICE	**3,375**	**3,375**	**3,375**	**3,375**	**3,094**	**3,094**	**3,094**	**3,094**	**2,813**	**2,813**	**2,813**	**2,625**	**2,625**	**2,625**	**2,438**	**2,438**	**2,438**	**2,438**	**2,438**	**2,438**

		2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Inductive charger	Power supply	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800
	Transmitter pad	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
	TOTAL COMPONENT COST	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**	**1,200**
	Other	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050
	FINAL SALE PRICE	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**	**2,250**

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6 Conclusions – Overall Cost to Deploy Infrastructure

The information provided in this report provides the component costs for expected PiEV charging infrastructure today, and out to 2050.

System prices – rapid decline in price to 2020, levelling off after 2030.

Charging infrastructure prices are expected to fall rapidly for all technologies out to 2020 (Table 32), with a further (but much less significant) decline to 2030. After this, prices level off going out to 2050.

TABLE 32: CURRENT AND FUTURE PRICES FOR CHARGIGN INFRASTRCUTRE SOLUTIONS

Charging infrastructure prices are very high today, with significant cost reductions expected by 2050.

Solution	Current price (£)	2020 price (£)	2050 price (£)
Wall Box	891	221	190
Public Post	2,827	1,265	1,074
DC Charger	29,401	16,520	13,286
Inductive Charger	3,375	2,813	2,250

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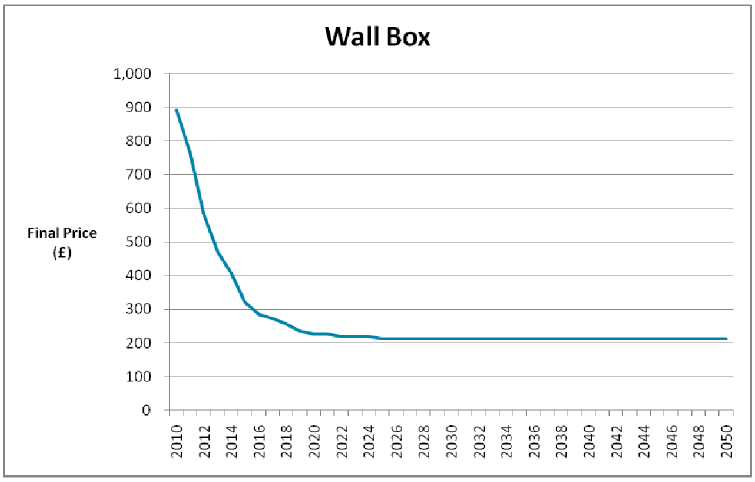
The price reduction path for each technology varies (illustrated in Figures 21 – 24 below).

FIGURE 21: FINAL PRICE DEVELOPMENT OF WALL BOX



In 2010 to 2015 there is a rapid decline in the cost of Control Pilot (CP) box and socket. Manufacturing scale reduces enclosure cost and margins are squeezed as competition increases.

In 2015 to 2020 there is a step-change to scale manufacturing which reduces overheads.

Beyond 2020 there is a small reduction in overall cost to 2025 as margins are squeezed further, levelling out to 2050 as the price hits mass market floor.

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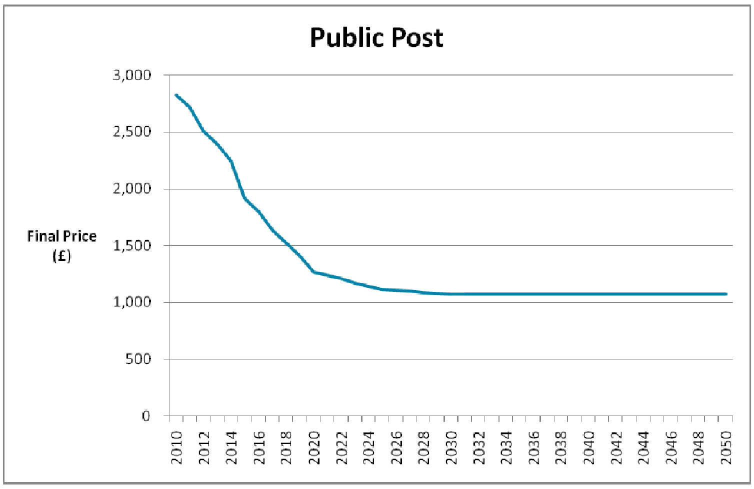
FIGURE 22: FINAL PRICE DEVELOPMENT OF PUBLIC RECHARGE POST



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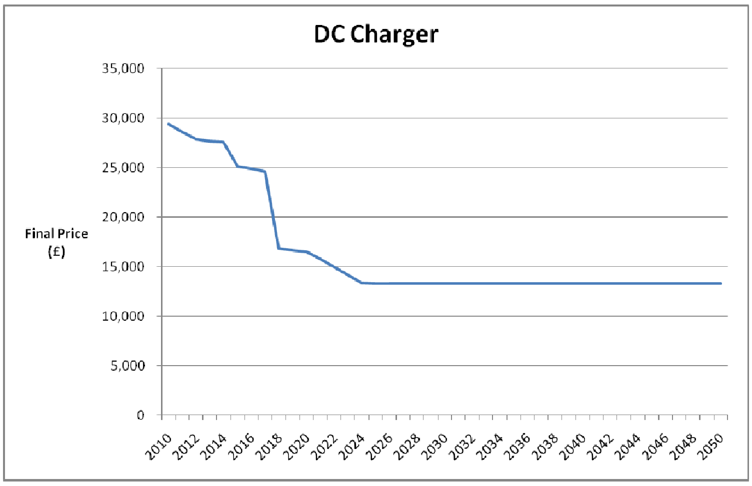
In 2010 to 2015 there is a rapid decline in the cost of CP box and socket. Some margin reduction.

In 2015 to 2020 there is a step-change to scale manufacturing which reduces unit costs significantly. Printed Circuit Board (PCB) price falls by more than 70%. Further margin reduction as market competition intensifies.

Beyond 2020, PCB cost falls by another 50% and margins continue to decline, levelling out from 2025 to 2050 as price hits mass market floor.

FIGURE 23: FINAL PRICE DEVELOPMENT OF DC CHARGER



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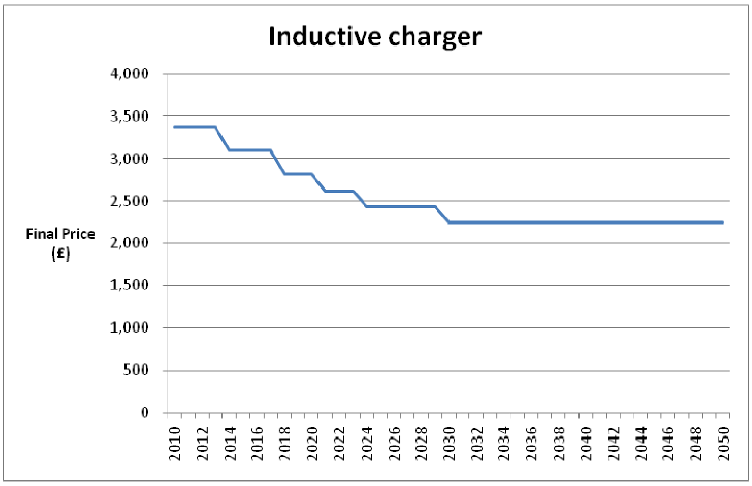
In 2010 to 2015 there is little change in price as the AC/DC converter remains at current cost, sourced from Asia. The cost of the post falls, but has little impact on total price.

In 2015 to 2020 there is a major impact from a cost reduction of the AC/DC converter. There are also unit cost reductions from scale manufacturing.

In 2020 to 2025 there are some further efficiency improvements in manufacturing and margins are squeezed competition intensifies.

FIGURE 24: FINAL PRICE DEVELOPMENT OF INDUCTIVE CHARGER



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In 2010 to 2015 there is only a small decrease in price in inductive chargers as the market demands only low volumes.

After 2015, when demand and manufacturing capacity grows, prices will fall quickly. The industry consensus is that the current final price of just over £3,000 for a 3 kW unit will come down by approximately one third to £2,250 by 2030.

Beyond 2030, costs and margins are low, and the final system price remains constant.

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Impact of the main cost drivers

There are several cost drivers that will influence the future evolution of key component costs and system prices. Some of these will have a more significant impact than others as highlighted below:

- **Volume** – the key driver for reducing system and component costs as buying power improves, economies of scale push manufacturing costs down and big players entering the space drive R & D breakthroughs.
- **Components with a critical supply chain** – a handful of key components add a considerable expense to solutions today. As demand grows, and more players manufacturer these components – easing supply constraints, these costs will fall rapidly.
- **Ability of the industry to scale up, and become self sustaining** – AC charging manufacturers are ready to scale up production so wall box and on-street charger prices will fall rapidly in the short term. DC and inductive charging manufacturers are only beginning to ramp up activities, so it will take some time before these prices fall.
- **Rising commodity price (e.g. oil, copper)** – this is likely to have no significant impact on component costs, and stiff competition in the global, mass market charging infrastructure market will force manufacturers to absorb any price rises
- **Lifetime, and maintenance and servicing costs** – will increase the overall lifetime costs of different systems – to differing degrees, as described below

Key components become a 'commodity' by 2050 - prices typically level-off after 2030

In this analysis, we assume that by 2050 a flat-lined commoditised price for all key components is achieved. This flat-line price comes about as:

- Prices decline to a level that is considered feasible when mass market scale is reached
- Beyond this point, the assumption is that cost increases (e.g. in commodity price, labour) are negated by further efficiency improvements (e.g. in manufacturing processes, reduced manufacturer margins) – so prices remain flat in real terms.

Therefore, overall system prices follow a similar trajectory, levelling off before 2050.

Lifetime, maintenance and their impact on lifetime costs

The lifetime charging solutions, standard warranties and typical maintenance & servicing costs will all have an impact on the total cost of an infrastructure rollout. This must be considered when arriving at the total cost of the UK-wide rollout. Key points to note are:

- Servicing of charging stations can, in general, be covered by an annual inspection. This is covered in the warranty in year one, but will increase operating costs of a charging station by **£50 – 80 per year** once the warranty has expired.

- Extended warranties may rule out this annual cost, however, in these early days of the market the terms and prices of these extended warranties are negotiable.

- Replacing particular components is unexpected within t he lifetime of the charging stations – with the exception of the connector on DC chargers. This may need replacing every 3 years.

- DC chargers will need complete replacement once the quoted lifetime (8 – 10 years) has been reached.

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- For on-street chargers and wall boxes, some of the standard components may outlive the expected system lifetime. However, the vast majority of the cost lies in the components that will need replacing, so this analysis assumes that the entire charger will need to be replaced. This is 10 – 15 years for on-street chargers, and 15 – 20 years for wall boxes.

So, when looking out to 2050, charging stations installed today will mostly likely have been replaced twice, plus accrued servicing and maintenance costs. These additional costs should be considered when looking at the cost of an overall rollout.

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