Department
of Energy &
Climate Change

Potential Cost Reductions for Air Source Heat Pumps

The Scope for a Mass Market

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Any enquiries regarding this publication should be sent to us at rhi@decc.gsi.gov.uk

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REPORT COMPILED BY Delta Energy & Environment

Authors: Philippa Hardy (Delta-ee), Lindsay Sugden (Delta-ee), Chris Dale (independent consultant to Delta-ee)

Executive summary

In a UK "mass market" scenario for Air Source Heat Pumps (ASHP), we would expect an overall cost reduction of ~20% compared to current costs. This would be comprised of ~40-50% cost reduction in non-equipment costs, and up to 10% cost reduction in equipment costs. The largest share of ASHP cost (60%) in 2014 is equipment cost, and 35% is non-equipment cost (excluding VAT).

In a mass market scenario, the greatest cost-reductions would come from reductions in non-equipment costs, which today are dominated by labour costs (~60% of the total non-equipment costs):

- **The installer-base would shift from one dominated by small specialist companies installing low numbers of HPs but with high overheads**, to one dominated by larger renewables installers with lower overheads (as a result of the small specialist companies growing in scale, and the existing larger companies continuing to expand).
- **The supply chain would be consolidated** and provide UK-wide coverage more efficiently – particularly through expanding distribution networks and bringing installation capabilities closer to customer demand.
- **Sales channels would shift towards wholesaler routes** in the way boilers are sold today – reducing distribution/transport costs, tightening margins and increasing competition.
- **Installer skill level and confidence in the technology would be higher,** bringing labour cost down as jobs can be done more quickly and efficiently, and there is less need for "insurance" in the margins that installers would add.

Equipment costs would see some cost reduction in a UK mass market scenario, but not as significantly as non-equipment costs, because most of the ASHP components are already mass market products (outside the UK):

- **Many system components are already mass market products,** sold into global boiler and air conditioning industries at low price with competitive margins (including auxiliaries such as cylinders and HP parts such as pumps and fans). Though economies of scale, increasing market competition, and increased "volume buys" may still have price impacts.
- **Heat pump technology is essentially a mature technology**, despite low market penetration in the UK. 700,000 heat pumps a year are sold in Europe alone (the

majority ASHP). The impact of economies of scale on the HP unit part of the equipment cost (which makes up just over half of the total equipment cost), is not linked only to UK HP market sales, but to the wider European and global industry.

- **One factor which could drive some cost-reduction in the UK is HP manufacturers having the confidence to invest in R&D focused on UK applications.** There is high technical potential to increase efficiencies and identify lower cost materials for heat pumps – but it has to make business sense for manufacturers to invest in the necessary R&D. Such R&D into improving heat pump efficiency could in the long-run lead to lower lifetime costs for heat pumps.
- **There are unanticipated factors which could result in greater equipment cost reduction (1)** New market players from China rapidly enter the market with low cost but sufficiently efficient ASHPs. Chinese companies have entered the European market for water heating heat pumps already with lower cost products, however, getting the space heating part right at lower cost may still be a barrier to entry (designing the control system for an ASHP to match dynamic fluctuations in space heating demand is inherently more complex than designing a system only for hot water).
  (2) If the assumption that some manufacturer margins are quite high holds, margins would be forced to reduce - it is difficult to quantify if high margins currently exist, as manufacturers are not willing to share such insight. We have collected indications through our primary research that *some* large manufacturers may have sufficient gross margins to leave room for reduction.

The data we gathered had a wide range of costs per kW (as much as +/- 10% in some cases). There was not enough data for full statistical analysis but we have chosen data which was most representative of a "normal" case, based on our existing knowledge and expert opinion informed by our primary research. This report focuses on how costs may change and what cost drivers exist. It is not an attempt to improve evidence on current costs, which DECC is continually seeking to improve through scheme data. To avoid inconsistency, this report refers to relative costs (%), rather than absolute costs (£).

We do not expect to see a "mass market" by 2020, which would involve a step-change in ASHP uptake including significant penetration of the replacement gas boiler market. This is unlikely by 2020, given the market barriers to overcome.

The Scope for Cost Reductions in a Mass Market for ASHP

Introduction

ASHPs[1] in the UK are a small part of the market today, with the overall market only representing ~1% of heating appliance sales in domestic and commercial buildings. The UK is at the lower end of ASHP market share compared to other European markets – in France, market penetration is closer to 10%, and in Sweden and Switzerland, GSHP and ASHP together are at levels above 30%. Increase in market share could be one factor that can help drive cost reductions - primarily in non-equipment costs as the supply chain is optimised. There are many other factors influencing cost reduction potential (as seen in the “Scope for reduction in equipment / non-equipment costs” section).

Currently the ASHP market is dominated by large product manufacturers, either from a gas boiler or air conditioning background that have expanded their product portfolio to include ASHPs. The traditional gas boiler routes to market are being utilised already for ASHP penetration, but are having limited effect. Specialist renewables installers are leading the way on ASHP installs, with a few large firms specialising in ASHPs. Currently the supply chain is not well developed and installers generally have to travel significant distances to jobs. The following table gives an impression of what a mass market scenario could look like and how it would impact the current key stakeholders.

	2014	What would a mass market look like?
Market	**Low awareness and lack of confidence** in HP across value chain. **Cost-intensive and sub-optimal supply chain** **One-off installs:** ASHP in small number of off-gas new builds, handful of applications in retrofit. **RSLs, developers, large commercial enterprises:** ‘Early adopter market’, mainly domestic but with emergence of small commercial ASHPs.	**Awareness of and confidence in HP** across value chain. **Supply chain well-developed** across the country. **One-off installs:** ASHP the product of choice in new build and high penetration of retrofit market – capturing most of the off-gas market and displacing some gas (widespread displacement still a challenge without energy price changes). **RSLs, developers, large commercial enterprises:** “Volume” purchases of large number of ASHP at once would be standard practice and enable lower prices to be secured.
Manufacturers	**European boiler manufacturers:** Most have an ASHP in their portfolio, but sales are low. Very few pushing sales due to more lucrative sales elsewhere in the	**European boiler manufacturers** push ASHP more strongly. **Air conditioning manufacturers** create strong competition and establish themselves

[1] Not including air to air systems.

	business. **Air-conditioning manufacturers** (mainly Asian): Focused on ASHP, have created strong competition in the European HP market in Europe & supply ~70% of heat pumps sold in the UK. Total HP numbers still low but strong ambitions and the weight of large global companies behind them.	amongst Europe's biggest heating manufacturers. The unanticipated scenario is the market entry of low cost (but efficient enough) Chinese ASHP to the market, which could create a step change in price reduction and market uptake.
Installers	**Small specialist installers** - Focusing on either ASHP or renewables, regional coverage, ~5-10 employees working on HPs, installing low 100s of HPs per year. **Large specialist installers -** Importing and distributing European-manufactured ASHPs, UK-wide coverage and 10s to 100s of employees, likely installing low 1,000s per year and responsible for the majority of ASHP installations in the UK **Large air conditioning and refrigeration installers** dipping their toes in the ASHP market.	**Small specialist installers** - Some small specialists would continue as they are. Many new small specialist installers would enter the market. Some smaller companies would grow to larger specialist companies. **Large specialist installers –** Continue to grow and dominate, attracting more installers UK wide. Sales would increase by an order of magnitude. **Large air conditioning and refrigeration installers** become more important players in the ASHP market.
Renewables Specialist Distributors	**Majority of ASHP sold via specialist distributors whose main business is in renewables / HP**. Today a handful of specialist distributors design, specify and distribute HPs to installers. Typically buy direct from manufacturers and sell direct to the installer, supporting on commissioning. Often also have installation capabilities in-house, or work closely with installers.	**Half of ASHP sold via specialists who would fulfil the current role of wholesalers –** they would have (geographically) wider distribution capabilities than in 2014, acting like gas boiler wholesalers but with focus only on HP / renewables. May merge with or evolve into specialist installers above.
General Wholesalers	**Minority of ASHP sold in UK via wholesalers whose main business is in boilers** – mostly only stock the lowest capacity ASHP, with main focus on gas boilers. No after-sales support on e.g. HP commissioning.	**Half of ASHP sold via general wholesalers**, who would sell a higher proportion of HP alongside traditional boilers. They would grow their current portfolio of lower capacity ASHP today to include a wider size range.
Utilities	**Utilities dipping their toes in the water** with some partnerships with manufacturers and installers, and some with their own installation capabilities. But low sales volumes to date.	**Greater engagement from all UK utilities** across the value chain – potentially with in-house distribution and installation capabilities – ASHP become core part of energy services offering.

Table 1: Comparison of market characteristics of today's ASHP market compared to our assumption of what a mass market scenario would look like.

Current Cost Structure of ASHPs

In this report we consider a 40 kW ASHP retrofit as a base case for scoping the potential cost reductions. Lower and higher capacity systems of 12 kW and 150 kW respectively, as well as new build costs are compared to this base case. Figure 1 and 2 displays the current equipment and non- equipment cost breakdown of a 40 kW ASHP[2]. Currently the cost of a 40 kW ASHP is split 60:40 between equipment costs and non-equipment costs respectively.

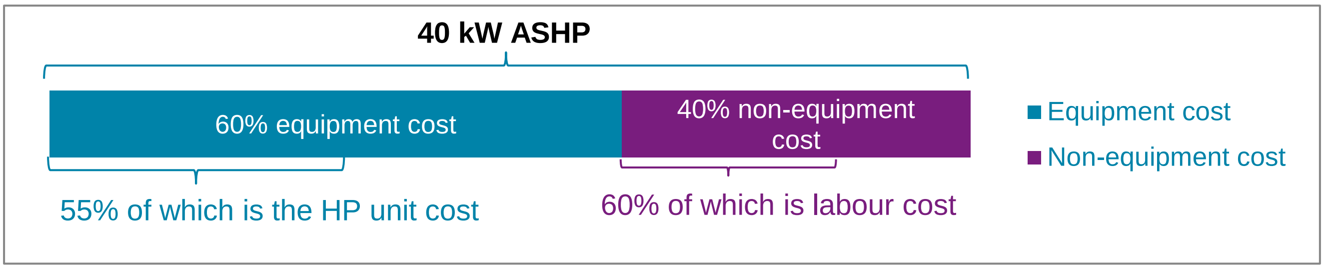

Figure 1: Current cost breakdown of a 40 kW ASHP (retrofit)

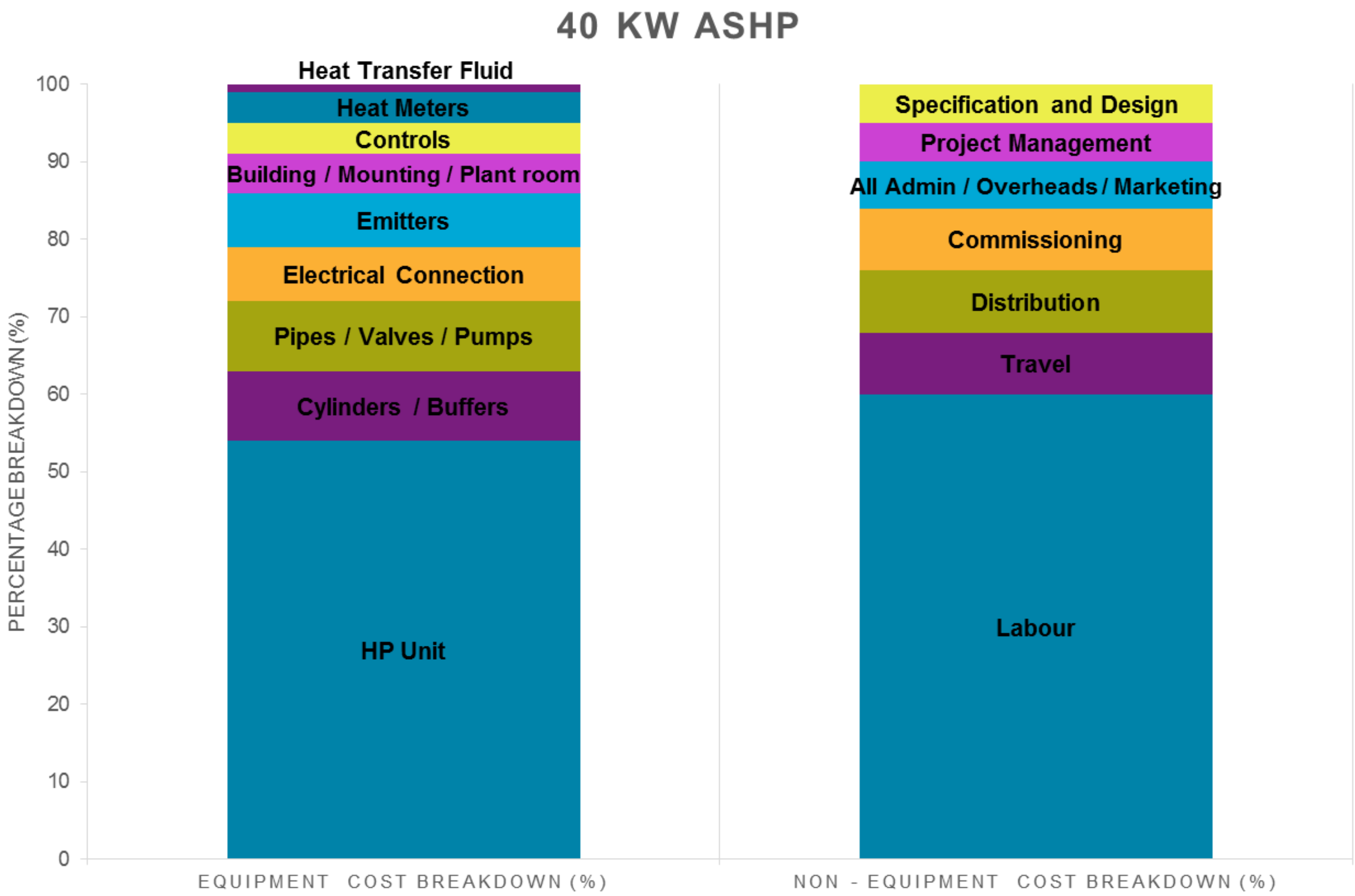

Figure 2: Detailed average equipment and non-equipment cost breakdown of a 40 kW ASHP for retrofit.

[2] Current data and future scenarios are expert opinion from primary research (27 phone interviews with industry stakeholders, i.e. product manufacturers, installers, distributors, industry groups), our several years of heat pump market research through our Heat Pump Research Service and consultancy work into the heating market globally.

Commentary – Figure 2

Central estimates for equipment and non-equipment cost: A single ‘typical’ 40 kW heat pump does not exist in today’s market – there are few installed and they vary from case to case according to the some of the sensitivities described below, with costs ranging at least +/- 10%.

Cost sensitivities:

- It is possible that some of the smaller non-equipment cost components (e.g. admin, design) may be “hidden” in the labour costs, meaning that the actual time for admin and design is often higher than indicated in Figure 2. It is difficult to assign these percentages as, based on our research with stakeholders in the UK market, this sort of information is rarely recorded / aggregated on a project basis in this precise way. We have also assumed some emitter replacement work, but not full replacement of all emitters.
- Project design and admin costs are dependent on the complexity of the project. Design time is quite variable and ranges from half a man hour for a simple domestic solution to a day or more for more complex projects and is not always relative to the kW thermal output. Design time depends on the requirement for and availability of the necessary prerequisite data required such as heat losses, heating and cooling loads, emitter types, cooling and DHW requirements, control strategies etc and whether this is supplied to the installer or if the installer has to gather the required data as part of the project.
- Heat pump system costs can vary depending on whether a “Rolls Royce” type product with maximum efficiency is chosen, or a more basic system, and whether additional optional add-ons are included such as buffers or sophisticated control systems and interfaces. There are also cheaper but poorer quality systems which are unlikely to perform at the same level. These factors become particularly variable in the commercial sector due to the wider range of possible needs in commercial buildings compared to domestic. We have presented in Figure 2 the cost breakdown for a basic system (which we have asked for in our primary research), but we expect that this cost could increase in the order of 10-20% if a more complex / sophisticated system were chosen.
- There are regional differences in non-equipment costs: In more remote regions travel and logistic costs would be higher because installers have to travel further to the site, which could be 1-2 days additional ‘cost of time’ per installation. On a domestic heat pump, this could equate to doubling the cost of the time on the installation (which may take 1-2 days in itself). On a larger scale heat pump, the additional travel days may add an additional third to the cost of the time.
- There could be regional differences in equipment costs: For example, for coastal regions equipment costs are likely to be more expensive if special anti-corrosion coatings are specified, or for higher altitude or northerly locations, premium products may be selected which have better performance at lower outdoor air temperatures.

How do costs vary for larger and smaller installations?

	12 kW	**150 kW**
Overall Cost	**Overall cost is approximately ~10-20% per kW higher** than the 40 kW system. **The split of equipment / non – equipment cost is the same** as a 40 kW system (60% equipment / 40% non-equipment).	**Overall cost is approximately ~5-10% per kW higher** than the 40 kW system. **The split has a higher proportion of non-equipment costs** (55% equipment cost / 45% non–equipment).
Equipment costs	**Higher:** Price / kW is higher for a 12 kW system than for a 40 kW unit	**Lower:** Price / kW is lower for a 150 kW ASHP than a 40 kW unit because

	because many of the same parts are used in a smaller system as in a larger – but are then proportionally a larger part of the total cost.	proportionally the same sized parts are used in a larger system.
	Biggest Cost Component: HP Unit	**Biggest Cost Component: HP unit**
Non-equipment costs	**Higher:** Total non-equipment costs are higher for a 12 kW ASHP than a 40 kW because of more parties in the supply chain taking a margin for a lower 'total cost' system.	**Higher:** Total non-equipment costs are higher for a 150 kW ASHP than a 40 kW system because of a more complex designing and project management. A larger system may involve additional contractors which capture additional margins.
	Biggest Cost Component: Labour	**Biggest Cost Component: Design, project management, commissioning and labour**.

How do costs vary in new build?

The overall split between the equipment and non-equipment costs in new build is estimated to be weighted towards the equipment side (~65% of the total cost rather than 60%), because of the additional costs of heat emitters in new build. The total impact of drivers detailed below show that costs are ~10% lower in new build, all costs impacts shown per kW.

<u>Non-equipment costs are estimated to be 10% lower in new build than for retrofit</u> because of the avoided costs of additional labour to remove the current heating system. Also installer margins per heat pump (including costs associated with transport, admin and any after-sales care) are likely to be lower where many heat pumps are installed together at the same site (more likely in a new build than retrofit scenario).

<u>The Heat Pump unit part of the equipment cost is estimated to be 5-10% lower in new build</u> because a more standardised system which can be easily repeated can be used in new builds, rather than more bespoke solutions. Further, volume purchase discounts are generally agreed in a new build where several HPs are installed at once (today the cost reduction for volume buying is ~5-6% - we could imagine this discount reaching 10% in the future).

<u>Equipment costs for heat emitters in new build are higher (adding as much as 10% to the equipment costs)</u> because they are bought new in full, compared with retrofit where typically only a third to a half of radiators are replaced. Where underfloor heating is installed as a type of heat emitter in new build this is significantly more expensive than the standard radiators (or fan coils) – underfloor heating would not be installed in retrofit due to the disruption caused. Because it is not likely to be in retrofit, we do not consider underfloor heating in this report in our cost estimates, to ensure we are comparing like for like.

Future Cost Structure of ASHP in a Mass Market Scenario

The majority of future cost reductions would come from the non-equipment costs – and in particular, labour costs, which make up the majority of non-equipment costs. Figure 3 presents the future cost reduction potential under a mass market scenario – the characteristics of which are described in Figure 2[3]. Under this mass market scenario, based on our primary research, equipment costs could reduce by up to 10% and non-equipment costs could reduce by ~40-50%. Margins across the supply chain and installation labour costs create the biggest cost-reduction potential in non-equipment costs, whereas limited cost reduction is available from ASHP equipment costs.

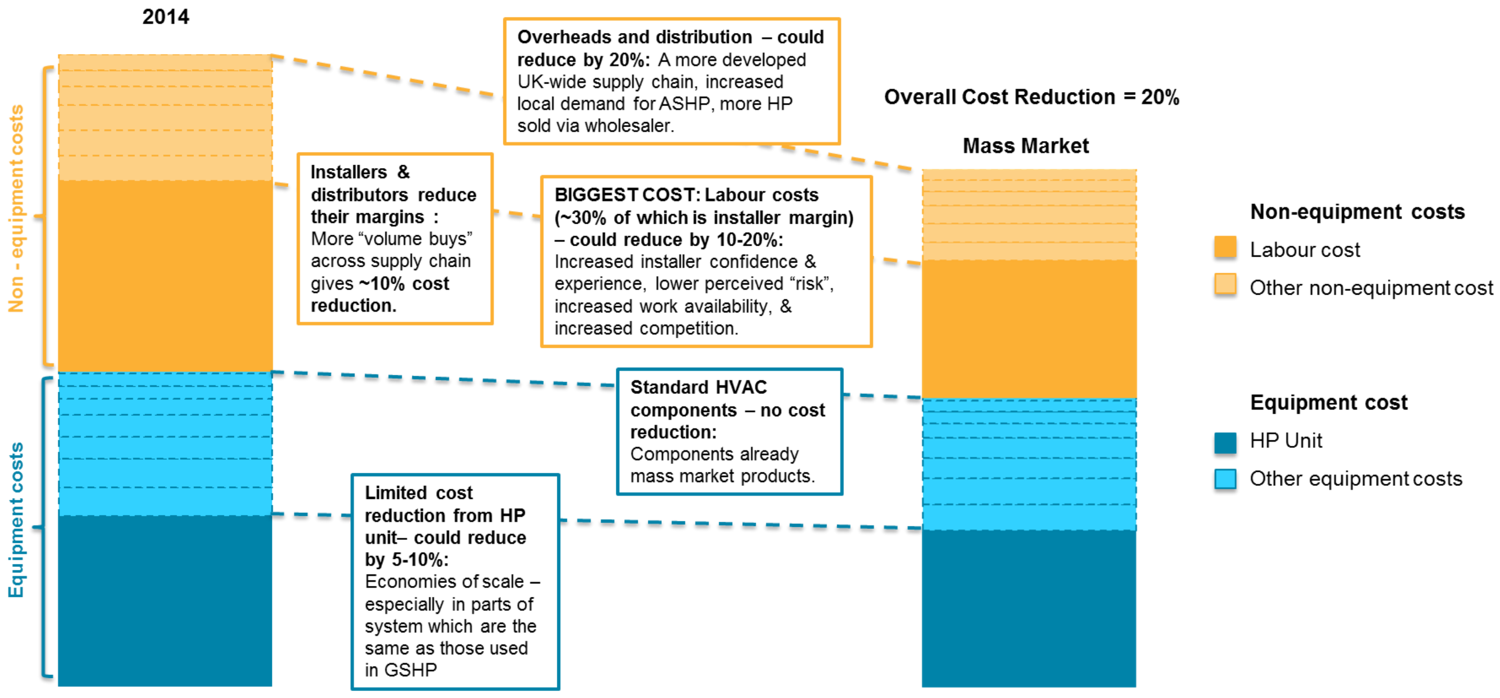

Figure 3: Future scope for equipment and non-equipment cost reduction for a 'typical' 40kW retrofit ASHP. 'Typical' refers to a "central estimate" reduction based on our view of the most likely cost reduction following analysis of the range of data collected on cost-reduction potential.

Commentary – Figure 3

Range of data and developing a central estimate: The percentage changes are based on a central cost breakdown which was developed through primary research – interviews with 27 stakeholders in the UK industry – combined with existing insight from the project team. We captured data showing a spread of total costs of at least +/- 10%. However, it is important to note that the focus of the report is on the cost reduction potential (percentage changes) and not the actual cost itself. Regarding future cost reduction potential, nearly all respondents in the interviews indicated very minimal future cost reductions were possible in equipment costs, but significant cost reduction could occur in non-equipment costs. This insight combined with our existing knowledge of equipment cost developments in other more developed heat pump markets, leads us to conclude that cost reduction of up to 10% is possible for the UK (though there are sensitivities as described below). In the future we expect that the normal distribution (range) of

[3] Current data and future scenarios reflect expert opinion informed by primary research as part of this project (27 phone interviews with industry stakeholders, i.e. product manufacturers, installers, distributors, industry groups), as well as the project team's several years of heat pump market research through Delta-ee's Heat Pump Research Service and consultancy work into the heating market globally, and through Chris Dale's experiences managing the UK business of one of Europe's major heat pump manufacturers.

costs may narrow due to the market starting to use more standardised products (more like the gas boiler market today). Use of more standard products is beginning to happen in the domestic sector today, but there is a long way to go for standardisation of larger products.

What could increase equipment cost reduction in a mass market? Delta-ee has defined in Table 1 what the characteristics of a mass market scenario would look like. Current ASHP equipment costs are unlikely to radically change. HP equipment costs in more developed HP markets in Europe such as Sweden and Switzerland (where HPs have more than 30% share of the heating market) are not significantly lower than they are in the UK today.

What could drive larger cost reductions in a mass market? In order to drive an unanticipated scenario where a step change in equipment cost was possible, ASHP would need to have a much larger share (=>50%) of the boiler market – and the mass market would have to be felt not only in the UK but in the whole global market. In such an unanticipated scenario, we may expect to see the strong influx of low cost products (e.g. from China), which could potentially drive a step change in ASHP cost reductions, more in line with the current Air Conditioning unit costs in today's markets (possibly in the range 30-50% reduction). The cost reductions would come from manufacturers being forced to reduce their margins to compete. Our primary research showed a very wide range for what manufacturer margins are today – from as high as ~40% for *some* larger manufacturers, to some smaller companies saying they actually make a loss today. In a truly mass market scenario, the fact that margins at least for larger companies could be high, indicates that there could be room for further "squeezing" of margins than has been included in our analysis (potentially resulting in margins of 20% or less).

Regional differences in non-equipment costs: Currently rural areas are driving the HP market, hence when considering the mass market it is evident that the transport costs would reduce, as heat pumps more successfully penetrate increasingly urban areas.

Retrofit vs new build: Even under a mass market scenario ASHP retrofits would remain 5-10% more expensive than new build due to the need to remove old heating components and design in solutions to 'fit' to client and building requirements.

Margins included: "Equipment cost" includes manufacturer margins on the equipment. "Non-equipment cost" includes the margins from the distributor / wholesaler / installer.

Scope for Reduction of Equipment Costs

ASHP equipment costs are not likely to significantly reduce under the mass market scenario due to the maturity of the technology. ASHP already use similar components to the air conditioning industry, which is already a global mass market. The majority of auxiliary components used, i.e. cylinders, electronic controls, pipes and valves, are already at mass market and are dependent on world commodity prices, the manufacturing price of which are unlikely to decrease in the future. Some lowering of price could be possible for the HP unit and auxiliaries due to the more widespread negotiation of "volume" buys by installers to meet increasing demand. Today, volume buys are not common across the market (less than 10% of HP unit sales), and where volume buys occur, the cost reductions are ~6-7% – when considered as an average cost reduction across all units sold, this equates to <1% cost reduction. We assume a greater number of volume buys occur in a mass market, with discounts of up to 10% possible, but such discounts would not be found across all unit sales. A fairly optimistic view is that one out of two heat pumps has a "volume buy" reduction, which would mean an average equipment cost reduction of less than 5% across all installations. The key drivers for cost reduction are outlined below, but are likely to only have a small impact on equipment costs. As described above, an unanticipated scenariois that we see the emergence of new competition from markets such as China, targeting Europe, and selling much cheaper products which have acceptable efficiencies.

Key drivers for cost reduction of a retrofit 40 kW ASHP equipment costs

Driver	Description	Cost component affected / Impact	Influenced by DECC / trade body?
Manufacturers having confidence to invest in R&D	To produce HPs better suited to UK retrofit, or in order to ultimately find lower cost production materials / methods.	Whole system	✓
Economies of scale	Enabling industrialisation of production, which is less labour intensive and more automated (though the ASHP industry is already more automated than the GSHP industry).	HP Unit and HP specific components	✓
Increasing market competition	Continued growth of global air-conditioning companies in the ASHP market, with large R&D budgets and offering increasingly efficient products; and emergence of new companies from e.g. China and Europe. Lower cost new entrants may force existing manufacturers to squeeze their margins.	Mainly HP unit, but also fan coil emitters, UFH, manufacturer margins	✓
Increased "volume buys" leading to decreased manufacturer & wholesaler margins	Today, "bulk buys" of ASHPs typically get ~6-7% price reductions compared to the standard price. Wholesalers, distributors, installers sourcing ASHP can secure better deals on the price per unit if they are buying a larger volume of heat pumps. Bulk buys today are not widespread throughout the supply chain - in a mass market, increased demand would mean 'volume buys' would be more commonplace across the supply chain.	Whole system – especially HP unit, tanks and heat emitters, manufacturer margins	✓
Shift to wholesaler route to market rather than direct	Wholesalers reduce the 'cost of sale' for manufacturers, enabling heat pump units to be purchased at lower cost by the installer – this route only works as installer confidence & skill grows sufficiently, and depends on manufacturers reducing their margins when their costs come down.	Manufacturer margins and HP unit cost	✗
Increasing availability of lower cost OEM components	Meaning manufacturers can source components more cheaply and manufacture less themselves.	HP specific components	✗
Sourcing cheaper raw materials	Raw materials account for 90% of the HP production cost. A shift to e.g. use of more plastics would ultimately lead to lower prices (although may drive costs up initially to cover R&D costs to investigate lower cost materials	HP unit	✗

	and methods). The extent of possible cost reduction is dependent on market prices for raw materials (see below).		

KEY: *Impact of drivers – high / medium / low - 'High' meaning that the drivers are crucial for growth in the market and 'low' meaning that they would add value but not critical.*

How would the influence of these drivers change with smaller or larger ASHP capacity?

12 kW	**40 kW**	**150 kW**
10-15% reduction in equipment cost in a mass market scenario compared to 2014	**10%** reduction in equipment cost in a mass market scenario compared to 2014	**10-20%** reduction in equipment cost in a mass market scenario compared to 2014

12 kW: In a mass market scenario, the drivers above would have a greater impact on a 12 kW system than on a 40 kW system, meaning the potential cost reduction from 2014 to a mass market scenario is greater for the 12 kW than the 40 kW. Equipment costs (primarily the HP unit) could lower faster for a 12 kW in the period between now and a mass market than for a 4 kW, because economies of scale, and the chance for "volume buys" may have a greater influence on the 12 kW than the 40 kW system. This is because domestic scale ASHP would be installed in greater numbers than commercial scale (compare ~1.5 million boilers replaced annually in the domestic sector and only ~50,000 in the commercial sector – so a 20% share of ASHP installed in domestic dwellings would equate to around 300,000 domestic installations, compared with a 20% share of non-domestic dwellings which would equate to 10,000 installations of 40 kW or above).

150 kW: In a mass market scenario, the drivers above would have a greater impact on a 150 kW system than on a 40 kW system, meaning the potential cost reduction from 2014 to a mass market scenario is greater for the 150 kW than the 40 kW. The heat pump unit part of the equipment cost could come down in cost faster than the 40 kW because the larger scale HP market is much less mature, and therefore there is scope for more quickly advancing manufacturer R&D. For example, most 150kW systems are cascaded of several units rather than a single individual unit. R&D into developing a single system may increase the cost in the short term – but reduce it in the long-term. Some costs, however, would not be driven down - the biggest cost difference between the 40 kW and 150 kW reflects the scaling up of pipes/valves and plant room components. All of these components currently exist so cost reductions here are very limited.

Forces which may drive costs up:

Short Term impact

- Manufacturer focus on increases in efficiency to comply with e.g. Ecodesign Directive, is more likely to drive costs up to cover R&D costs. In the long-term, some such developments could of course reduce ASHP lifetime costs.
- Shortage of refrigerants driven by F-Gas regulation may drive refrigerant prices up. New refrigerants tend to be more expensive initially due to covering the R&D cost.

- Demand for more sophisticated controls in heat pumps is another factor which could drive costs up to some extent in the short-term – particularly having connectivity to communicate with Building Energy Management Systems, which are increasingly used in the commercial sector. However, the costs associated with this are not that significant, and many companies already offer this.

Long Term impact

- Oil prices have a large effect on the cost of plastics and these are anticipated to increase in the long term. Similarly the price of metals may increase due to the commodity market. This could be off-set if ASHP companies sourced alternative lower cost materials (see above).
- The characteristics of UK buildings means there is a need to use larger capacity and high temperature ASHPs in retrofit - keeping costs high, until the retrofit housing stock thermal efficiency increases (converting the building stock thermal efficiency is a long-term challenge).
- In the wider energy environment, in the longer-term, the ability of heat pumps to be used in load management applications may require investment to optimise control systems to provide flexibility, whilst also maintaining comfort in the building. This could increase technology costs (though there is also a scenario where most of the "intelligence" to enable this is actually within a Building Energy Management System rather than within the heat pump, so would not impact so much on heat pump costs).

How would the influence of these drivers change in new build?

The equipment cost reduction potential is higher in new build than in retrofit, assuming that new build regulations are much stricter in the future mass market scenario than they are today. Where 5-10% equipment costs are expected between now and a mass market in retrofit, this could be >30% in new build. The impact is that lower capacity systems can be used for new build, due to lower heat demand, which would lead to reduced equipment costs for new builds in comparison to retrofit (predominantly the heat pump part of the equipment costs, which is the largest part of the cost). Heat pump costs are linked to capacity more strongly than for example a boiler, so the costs differential between a 90 kW heat pump and a 450 kW heat pump is much larger than the cost differential between the equivalent boilers. This heat pump cost differential may narrow in a mass market scenario, but would still be expected to have a strong impact.

Scope for Reduction of Non-Equipment Cost

There is likely to be more potential for ASHP non-equipment costs to reduce, compared to the equipment costs. Currently, margins taken by installers are kept high as "insurance", due to installers' low confidence and experience in installation of ASHP, and low sales volumes also mean high overheads are needed. This would change in a mass market, and could be achieved to a considerable extent with very high regional penetration. There is scope for cost reductions also through the increased demand for bulk buying of heat pumps by e.g. developers, RSLs or large commercial enterprises – the lower cost of sale means that installers' or wholesalers' margins can be smaller, and passed on as "volume" discounts to the buyers.

Key drivers for cost reduction of a retrofit 40 kW ASHP non-equipment costs:

Driver	Description	Cost component affected / Impact	Influenced by DECC trade body?
Labour costs decrease	Decrease in installer costs and margins because of; 1. Increased installer confidence and expertise in HPs and their ability to install it with no return visits required 2. Increased installer skill level means more efficient and quicker installations 3. Availability of more HP products which are easier to install 4. Stronger after-sales support available to installers 5. Increasing availability of remote fault diagnostics 6. Greater customer demand increasing competition squeezes margins	Installer margins Reduced 'insurance' margins Reduced time costs	✔
More developed and consolidated distribution channels in the UK	Increasing availability of products in the UK (e.g. more UK-based "manufacturer depots" where HPs are stored, some companies even opening manufacturing in the UK) – reducing import & distribution costs and 'internal transfer costs' in large global companies. UK-wide geographical coverage – reduces travel costs (local jobs).	Distribution margins Travel costs	✔
More efficient sales process	For example, increased use of wholesalers, and the increasing scale of distribution / installation businesses (e.g. from <10 to 100s) allows fixed overheads for office space, admin etc to reduce.	Admin and overheads	✔

KEY: *Impact of drivers – high / medium / low*

How would the influence of these drivers change with smaller or larger ASHP capacity?

12 kW	**40 kW**	**150 kW**
50-60% reduction in non-equipment cost in a mass market scenario compared to 2014	**40-50%** reduction in non-equipment cost in a mass market scenario compared to 2014	**25-30%** reduction in non-equipment cost in a mass market scenario compared to 2014

12 kW: In a mass market scenario, the drivers above would have a greater impact on a 12 kW system than on a 40 kW system, meaning the potential cost reduction from 2014 to a mass market scenario is greater for the 12 kW than the 40 kW. All three drivers are likely to have a stronger influence on cost reduction potential for the 12 kW ASHP than the 40 kW, because 12 kW systems would be deployed in greater numbers e.g. through housing associations and developers (who are likely to install up to 100s of HPs). The wholesaler route to market would dominate for these smaller systems which can be more 'plug and play' than larger systems. Therefore we would expect labour margins, distribution margins and admin/overheads to lower more quickly for the 12 kW systems.

150 kW: In a mass market scenario, the drivers above would have a lesser impact on a 150 kW system than on a 40 kW system, meaning the potential cost reduction from 2014 to a mass market scenario is smaller for the 150 kW than the 40 kW. This is because they would be installed in lower numbers and are inherently more bespoke systems. Costs for admin and project management are likely to remain higher for 150 kW systems because such a large project is inherently more complex to manage, and design cannot be repeated in the way a smaller project can. Labour costs may well be lowered similar to for a 40 kW system, but the sales channels would not be as consolidated (a wholesaler channel is much less likely for a more bespoke system).

Forces which may drive costs up

Short Term

- **Manufacturers cost of sales staying high** because of limited volume of sales - today manufacturers margins are already low, with most large manufacturers breaking even and in some cases making a loss due to lack of market pull.
- **Installers take larger margins in the shorter term –** Currently installers consider themselves 'financially squeezed' and would like to see higher margins for ASHP installations.

Long Term impact

- **Cost of grid connection** – not included in the costs presented here because they are very regionally specific, but can add in excess of £8,000 for domestic installs to more than £50,000 in commercial installations. This is already an issue today, but is unlikely to get smaller in the long-term. These costs are likely to increase in the future as distribution grid congestion and managing peaks becomes a greater issue.

How would the influence of these drivers change in new build?

Cost reduction potential in a mass market compared to 2014 could be 50-60% for new build compared with 40-50% for retrofit. Reduction of labour costs and the increased efficiency of distribution channels could be a stronger cost reduction driver in new build than retrofit because of (1) more efficient 'repeat' installations, and no removal of old equipment, (2) lower transport costs (several installations at the same site), (3) lower margins due to competition with other installers bidding for the same job, and (4) lower design costs as the parameters do not have to be measured in situ.

Outlook by 2020

With the current market conditions it is very unlikely that ASHPs would reach mass market by 2020, but we do expect to exceed 50,000 units, with ~30% penetration of the off-gas market and possibly some penetration of the on-gas market by 2020. We do not expect "mass market" until nearer to 2030 - and only if the market conditions change, i.e. building regulations and legislation become more focused on meeting robust targets for carbon dioxide savings in existing buildings and new buildings, so conditions become less favourable to the cheaper gas boiler. In markets such as Switzerland or Sweden, where heat pumps are now mass market, conditions have been tipped in favour of heat pumps through e.g. an oil tax or heat pump tariffs.

Two key factors would elongate the journey to mass market. Firstly, there is a long-term challenge to tackle in the UK in the quality of our building stock – high heat losses mean at best that higher capacity (=> more expensive) heat pumps are needed, and at worst, heat pumps are not economically viable at all. Secondly, installation of ASHPs, especially for retrofit, is more complex than gas boilers, and the supply chain is less developed. Expertise is likely to come from a ‘new generation’ of installers but this would take at least 5-10 years to emerge, given that heat pumps are only just being incorporated into national training curriculum.

In terms of cost reduction, it is likely that some of the non-equipment costs may have reduced by a small fraction (<5% of 2014 non-equipment costs) if sales numbers continue to increase as expected. This is likely to come from installer’s margins as confidence and experience in ASHPs grows. ‘Volume buys’ are already happening today but with more growth out to 2020, it is probable that they continue to gain momentum, for RSL and domestic-sized commercial contracts. At best this may equate to about a quarter of the way to mass market by 2020. Equipment cost reductions by 2020 are highly unlikely.

Department of Energy & Climate Change
3 Whitehall Place
London SW1A 2AW
www.gov.uk/decc
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