

Heat Pump Sector Deal

Final Report

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1. Chair's foreword

The next phase in reducing carbon emissions across the Scottish economy will be the most challenging yet. We are at the point at which net-zero policies are beginning to drive changes in our homes, our places of work and how we travel, requiring us to alter the way we live our lives. The challenges will continue to be technical, commercial and financial but more and more they will also be about people and the choices they make and will require government, industry and the public to come together in a common endeavour.

Nowhere is that need for such a common endeavour more clearly seen than in the decarbonisation of heat overall and in the heat pump sector in particular. The advice of the Climate Change Committee to the Scottish Government is clear: that the pathway to net zero for Scotland requires a very rapid large-scale deployment of heat pumps¹. It is to the credit of the Scottish Government that in response it has committed to doubling the number of zero emission heating systems installed in Scotland every year for the next 5 years. The very large majority of these systems will be individual air and ground source heat pumps, or connections to heat networks powered by larger heat pumps.

Such extremely rapid scaling in the use of heat pumps will require a massive and well-planned effort, especially as it starts from a very low base with only a few thousand heat pumps installed annually in Scotland at present. The public, as end users of heat pumps, will clearly also need to be closely engaged and supportive.

This is the sort of challenge where a sector deal involving key stakeholders in a broad partnership can make all the difference, ensuring that all the necessary building blocks are in place to drive rapid progress to a specific goal, including the necessary public engagement. The Scottish Government set up the Heat Pump Sector Deal Expert Advisory Group (EAG) to define what is needed for such a deal in this case.

In drawing up this report the group has set out what will be needed to quickly develop a high-volume heat pump supply chain in Scotland and what will need to be done to equally rapidly develop the necessary markets for this supply chain. The report also states what different stakeholders will need to do as part of such a sector deal and how consumers and householders will need to be supported as heat pump usage increases rapidly. The recommendations form an integrated suite whose elements will reinforce each other to move the whole sector forward.

The EAG includes very significant expertise and experience and has spent a good deal of time considering and drawing up the recommendations in this report. In doing so we were very conscious that this is not, like most policy areas, a matter of choice. The Scottish Government must meet its net zero targets, both for the sake of everybody in Scotland and to deliver its contribution to international carbon emission reduction efforts. It follows that it must also succeed in decarbonising heating by facilitating the rapid deployment of large numbers of heat pumps. However, we are confident that if the recommendations made are all implemented, Scotland can rise

to this challenge and that this will safeguard and create large numbers of jobs and so boost the economy.

Mike Thornton
Chief Executive
Energy Saving Trust

2. Executive summary

The Scottish Government has accepted that the pathway to net zero for Scotland requires a very rapid large-scale decarbonisation of heat. To facilitate this, the Heat in Buildings Strategyⁱⁱ sets out the Scottish Government's ambition to double the number of zero emission heating systems installed in Scotland every year for the next five years and for numbers of installations to reach 200,000 per year towards the end of this decade. The very large majority of these will be individual heat pumps and connections to heat networks supplied by larger heat pumps and so the net zero pathway requires an equally fast and widespread deployment of heat pumps.

Only some 3,000 heat pumps are currently installed each year so these contrasting figures give some idea of the eye-watering acceleration required. This does not mean it can't be done but it does mean that the Scottish Government and other key stakeholders will have to devote significant resources and work closely together to succeed. The public, as end users of heat pumps, will also need to be engaged and supportive.

The Expert Advisory Group (EAG) does not consider it likely that the upstream supply chain manufacturing heat pumps will constrain their large-scale deployment in Scotland. There is a strong global supply chain manufacturing millions of heat pumps each year, with the Mitsubishi factory in Livingston alone producing 300,000 units annually. There are however, some significant economic opportunities through creating a centre of excellence for heat pumps in Scotland which could support Scottish firms in supplying more components to the local and global tier 1 manufacturers.

In contrast, the downstream supply chain of heat pump installers is limited and fragmented; 90% of installers are SMEs and the EAG believes that it is in this area that the heart of any sector deal lies. The Scottish Government needs to provide confidence to this relatively weak downstream supply chain to allow it to commit and invest in rapid expansion.

This means the Scottish Government stimulating the market. It can do so by committing to at least its doubling targets for heat pumps within its own programmes, for example its fuel poverty programmes. It will also need to work with local authorities and housing associations to build equivalent year on year doubling of heat pump installations into their work programmes.

The Scottish Government will also need to ensure that it commits the same scale of resources to supporting wider heat pump installations by increasing the support it provides through its existing loans schemes at least in line with the annual doubling requirement. It will also need to consider establishing its own grant scheme if the UK Government's replacement for the existing Renewable Heat Incentive is not sufficiently effective to drive the market.

These measures will obviously require the Scottish Government to commit significant financial resources but the other key resource it can, and must, offer is certainty. If the supply chain is certain of the direction of travel and sustained commitment it will invest and grow, if it is not, it won't. The EAG recognises the Scottish Government's

commitment to doubling installations each year for five years as a significant contribution to supplying this certainty: incorporating this commitment into its own programmes will be another crucial waypoint and the commitment in the Scottish Green Party Cooperation Agreement to end public support for oil and LPG boilers is a useful initial step here.

However regulation will also be needed. The tightening of emissions standards in the new build market need to go further, faster and for the much larger retrofit market the Scottish Government needs to provide dates for the phasing out of fossil fuel boilers, initially in off-gas areas where heat pumps are already price competitive and then in on-gas areas. There are encouraging commitments in the Scottish Green Party Cooperation Agreement on these matters.

In return for these market-stimulating and regulatory measures and the certainty they provide, the downstream supply chain will need to commit to both re-skilling its existing work force and to invest in additional capacity by increasing the number of new recruits to its workforce, recruiting both young people and people with relevant skills from other sectors. Given the current state of the economy, this provides a clear green recovery opportunity.

In this expansion of the installation workforce, the college sector will be important in providing the necessary training courses and capacity and the Scottish Government can play its part by resourcing these and by incentivising heat pump installation training through attractive apprenticeship rates. However, the industry itself will also need to step up by agreeing clear re-skilling and expansion targets and by committing to creating the necessary number of apprenticeship places. It will also need to commit to diversity targets in this expansion in order both to meet the requirements of a just transition and to fish in the widest possible pool to ensure it can find sufficient recruits.

If all the above is done, then that will take the sector a long way in meeting the challenges of the net zero pathway. However there are also other areas where the market can be supported and other key constraints that must be addressed:

- There will need to be additional support and action from the Scottish Government to ensure installations in a rapidly expanding sector consistently meet high standards.
- There are some areas of technical innovation where government support can help support and increase the rate of deployment and there is also significant potential for business model innovation, especially in the areas of flexible tariffs tailored for heat pumps and of integrated smart systems incorporating energy storage and able to supply balancing services to the grid. Government supported demonstration projects could move the market on in these and other areas.
- Electricity network capacity is a significant constraint on heat pump deployment. The Scottish Government needs to ensure that Ofgem and distribution network operators (DNOs) have full appreciation of the planned very significant ramp up in heat pump installations in Scotland and Ofgem needs to ensure that the network receives sufficient investment to allow this. In addition, DNOs must ensure they have the necessary management and

administrative resources to support the regulated governance processes required for connecting a heat pump to the grid, as lack of such resources is already slowing down installations in some areas.

- As building fabric insulation reduces the amount of heat needing to be supplied, it allows smaller, cheaper heat pumps to be installed. This both reduces the investment needed by the householder or building owner and reduces the demands on the electricity grid, helping reduce the grid capacity issues referenced above. Accordingly, it is essential that the Scottish Government continues to invest in support for energy efficiency measures through regulation and via loans and grants to make Scottish buildings 'heat-pump fit'.
- At present heat pumps can be cost-effective compared to fossil fuel heating systems in off-gas areas but not where a gas boiler connected to the grid is an option. The different regulatory regimes for gas and electricity are part of the reason for this; most of the regulated social and environmental levies are made on electricity rather than gas, increasing electricity's relative price. A rebalancing of these costs through action of the UK Government and Ofgem is required to provide an economic as opposed to a carbon incentive for heat pumps.
- There is a strong need for government and Industry to work together to support consumer awareness and engagement on heat pumps. Most householders don't know what a heat pump is or how it works, nor do they realise that they could well be heating their home with one within the next few years. Without a major increase in consumer awareness and understanding, which will require support from the Scottish Government, the buy-in from householders which will be absolutely necessary for the success of the domestic roll-out of heat pumps will not be obtained. Again, the EAG has noted the commitment in the SGP Cooperation agreement to deliver a public communication programme to encourage home upgrades, which will provide an opportunity to raise consumer awareness and engagement on heat pumps.

Although there are many areas where action is required, the Scottish Government controls or can effectively influence most of the key levers. Most actions proposed are in this report a ramping up of existing activity, albeit at considerable pace and scale and so, whilst significant effort and resources will be required, there is much to build on. The EAG is confident that, with concerted action by all stakeholders using the route map set out in this report, the Scottish Government's ambitious goals for heat pump deployment can be met.

3. Summary of recommendations

Below are summarised, for the reader's convenience, the recommendations of the Expert Advisory Group, further detail on each is given in the main text.

1. The Scottish Government to provide clarification on the relationship between targets in the Heat in Buildings Strategy and the Heat Networks (Scotland) Act.

The statutory targets that have now been set for heat network growth in Scotland mean there is a need to provide maximal certainty to the industry on the size of the future markets for heat pumps sized for individual houses and buildings and for large heat pumps powering heat networks.

2. Scotland's enterprise agencies should work with industry to support Scotland as a global centre of excellence for heat pump manufacture.

With a forecast surge in installations of heat pumps as net zero pathways are taken across Europe and globally, there are opportunities for Scotland to be a strategic location for heat pump manufacture. The planned pace and scale of domestic heat pump deployment in Scotland will provide an attractive environment for manufacturers to develop an early market advantage in understanding consumer issues and in innovative solutions to technical and deployment challenges.

There is also an opportunity for Scottish industry in the tier 2 supply chain, where the local sourcing of components and parts can increase manufacturing efficiency and help minimise the carbon generated in making them.

In particular, Scotland should consider options for creating, with heat pump industrial stakeholders, a heat pump industry hub to both directly support the large-scale roll-out of heat pumps in Scotland and ensure that this drives maximal economic opportunities and jobs for Scotland.

3. The Scottish Government should commit to tracking heat pump targets in its own programmes.

The Scottish Government fuel poverty programmes (EES, area-based schemes and the national Warmer Homes Scotland) should be reconfigured to track the trajectory to which the government has committed, i.e. the Scottish Government should set targets for these programmes in line with their ambition to at least double the number of heat pumps each year for the next five years.

The Scottish Government should also commit to five years of at least year on year doubling of numbers of heat pumps installed in new properties built through the Scottish Government funded affordable housing supply programme.

Similarly the Scottish Government should work with local authorities and housing associations to ensure that there at least five years of year-on-year doubling of numbers of heat pumps installed in existing properties in the social rented sector.

The Scottish Government should commit to only commissioning or financially supporting new public buildings with zero carbon heating systems and to only supporting zero-carbon replacement heating systems in existing public buildings.

4. The Scottish Government should increase the funding available through loans and grants to support heat pump installation and provide multi-year certainty on the availability of this funding.

The Scottish Government should increase the size of its existing interest-free loan programme for heat pumps in line with the ambition to double the number of installations each year.

If a satisfactory replacement for the UK Government's Renewable Heat Initiative does not materialise, it should introduce its own grant programme for heat pump installations.

There should be at least a five-year commitment to the increased loan programme and to any grant programme put in place in order to provide clarity and certainty to the market.

5. The Scottish Government should create a definitive 'market moment' for heat pumps by clearly signalling the end point for conventional fossil fuel heating systems.

The Scottish Government should give the clearest possible signal of the coming transition by announcing this year (i.e. in 2021) a specific date by which new heating systems fitted to existing properties (both domestic and non-domestic) must be zero-carbon. Such a signal should be phased, with an earlier date in areas off the gas grid, where heat pumps are already economically competitive and a later one for areas on the gas grid.

Where it is within the devolved competence of the Scottish Parliament, the Scottish Government should seek to tighten emission standards for new domestic and non-domestic buildings with an increase in the pace of such regulation. These standards should be tightened to require new builds to achieve zero-emission heating.

6. Industry and government should work together on specific actions to ensure the growth in the skilled workforce required to support heat pump deployment.

The Scottish Government should work with downstream supply chain organisations such as SNIPEF to:

- Incentivise additional uptake of the renewables modern apprenticeship pathway.
- Create training programmes for those coming into the industry from other sectors with some transferable skills, along with financial support whilst they reskill to avoid the disincentive of a reduced income during conversion.

- Ensure the full range of skills required is covered by training provision, including advocacy and engagement skills.
- Agreeing suitable provision of courses and places with the Scottish college network.

The Scottish Government should work through the Scottish and Northern Irish Plumbers Federation (SNIPEF) and others as appropriate to agree targets for numbers of apprentices training to install heat pumps with the supply chain agreeing to host the agreed number of apprenticeship places and, importantly, provide jobs for those apprentices when they are trained. The Scottish Government and the sector should also agree diversity targets and Scottish Government support should be configured to ensure the latter are met.

7. Industry and government should work together to ensure the necessary certification and quality assurance standards are met.

To ensure transparent and consistently high standards in a rapidly expanding sector, the Scottish Government should promote certification of installers under relevant industry standards such as the Microgeneration Certification Scheme, PAS2035 etc.by:

- Requiring appropriate certification for any installer working on installations supported by public money.
- Supporting the costs of certification for SMEs through grants or loans.

8. The Scottish Government should work with Ofgem and network operators to ensure that neither network capacity constraints nor administrative processes for heat pump connection become a barrier to heat pump deployment.

A coordinated approach and collaboration between government, regulators and network providers is needed to ensure the electricity grid can supply the power required by an increasing replacement of fossil fuel boilers by heat pumps. The Scottish Government should promote and pursue such an approach, though we recognise that many of the issues are reserved.

SP Energy Networks and SSE Energy Networks should increase the resources available for grid connection governance processes for heat pumps and be able to demonstrate their robustness to ensure they do not become a limiting factor as the number of heat pumps requiring connection rises rapidly over the decade.

9. The Scottish Government should issue guidance to local authorities to ensure that the planning system plays a fully strategic and proactive role in encouraging and supporting heat pump deployment.

The requirement on local authorities to develop local heat and energy efficiency strategies puts much of the framework work in place to achieve this role and the EAG supports the proposal for a statutory duty for local authorities to develop these strategies.

10. The Scottish Government should continue to work with the UK Government to support heat pump deployment through energy market reforms.

Whilst recognising that this is not a devolved area, there is a clear need to rebalance gas and electricity prices which currently give gas an unjustified (in carbon terms) price advantage which commercially disadvantages heat pumps in on-gas areas.

The different regulatory regimes for gas and electricity are part of the reason for this; most of the regulated social and environmental levies are made on electricity rather than gas, increasing electricity's relative price. A rebalancing of these costs through action of the UK Government and Ofgem is urgently needed to address this issue.

11. The Scottish Government should commission further analysis of the housing stock to identify on-gas buildings where heat pumps are already cost-effective.

Identifying the types, numbers and location of buildings and homes on the gas grid where heat pumps are already a viable financial proposition will assist the industry as a whole by highlighting early opportunities within the on-gas market, helping progress in the early stages of the deployment curve.

12. Support for increased heat pump deployment should be accompanied by support for fabric energy efficiency measures.

As heat pumps are much more cost-effective in well-insulated dwellings, the Scottish Government should maintain or increase its current support for energy efficiency and heat pump support measures should be accompanied by parallel support for maximal fabric insulation.

13. The heat pump sector in Scotland should embrace the need for technical and business model innovation to improve heat pumps as a value proposition for consumers.

Technical innovation:

The EAG have identified specific areas of technical and process innovation which can improve consumer acceptability, reduce cost and increase deployment of heat pumps including:

- 'Plug-and-play' heat pump packages with off-site fabrication.
- A shift towards more environmentally friendly refrigerant gases for use in heat pump systems.
- Innovation to reduce the need for disruptive radiator and internal pipework upgrades to allow compatibility with heat pumps, including the development of an evidence base, standards and tools to support a more conservative approach to such upgrades.

The Scottish Government and industry should work together to identify options for supporting these approaches.

Business model/service innovation:

- The Scottish Government should work with fuel companies, the UK Government and Ofgem to promote the development of flexible tariffs suited to heat pumps.
- The Scottish Government should consider support for innovative business models based on a smart systems approach, integrating heat pumps with control systems, software, battery and heat storage, PV arrays and smart meters. In addition, the Scottish Government should work with Ofgem to remove a number of artificial barriers associated with technical requirements for flexibility contracts set by the system operator.
- The Scottish Government should work with the UK Government and Ofgem to minimise barriers to Heat as a Service or other innovative business models.
- Consumer protection and regulation will be increasingly important as such models develop and the Scottish Government should set clear policy on these areas for such business models.

14. The Scottish Government should continue to support demonstration programmes but focus this support where these will directly inform and enhance the mass deployment pathway.

The Scottish Government should work with key stakeholders to develop appropriate demonstration programmes focused on deployment issues and novel business models where these will provide data and showcase potential which supports the development of the route map to mass deployment.

15. Government and industry need to work together to ensure consumer engagement with and acceptance of heat pumps.

The Scottish Government should ensure there is trusted comprehensive information, advice and support on heat pumps available for householder and consumers.

This is essential to produce the constructive engagement by consumers which will be an absolute requirement for the success of the heat pump roll-out. It will also support the optimum operation of heat pumps by householders.

The industry and supply chain must also play their part in the engagement and support of consumers. Customer journeys need to be simplified wherever possible and common standards for the commissioning of heat pumps need to be developed by the industry. Installers will also have a key role in providing information and reassuring potential customers purchasing new heating systems so that they see heat pumps as a realistic option.

4. Introduction

The Scottish Government has a statutory target to reach net zero carbon emissions by 2045 and the pathway to this target recommended by its statutory adviser, the Climate Change Commission, requires all heating systems to be zero-carbonⁱⁱⁱ. To achieve this target will require an unprecedented rapid deployment of a technology which is mature but currently little-used in the UK, heat pumps, in both domestic and non-domestic buildings. The scale of the challenge is very great: at present only around 3,000 heat pumps are installed each year in Scotland but the country's net zero roadmap requires more than one million homes and 50,000 non-domestic buildings to convert to using zero emission heating systems by the end of this decade. Nearly all these systems will be individual air and ground source heat pumps, or connections to heat networks supplied by larger scale heat pump systems.

As stated, heat pumps are not a new technology: they are widely used in, for example, the Scandinavian countries and Japan and, as also mentioned, there is already a very limited Scottish market. There is even Scottish manufacturing capacity: Mitsubishi have a factory in Livingston producing 300,000 heat pumps and air conditioning units each year for the global market. However, for the sort of scaling up which is required to achieve net zero, there is a need to take an integrated approach involving key stakeholders in partnership and to provide clear long-term signals and support to rapidly accelerate the supply chain and markets for heat pumps in Scotland.

To take forward this approach, in the 2020/21 Programme for Government^{iv}, the Scottish Government committed to establishing an expert group to make recommendations to Scottish Ministers on the scope of a potential heat pump sector deal for Scotland. This group, formally known as the Heat Pump Sector Deal Expert Advisory Group and referred to in this report as the EAG, was formed in October 2020. The group was tasked with providing an interim report in spring 2021 and final recommendations before the Scottish Parliamentary summer recess in 2021: this document is the second of these and sets out the group's final recommendations.

The EAG includes a wide range of expertise and experience relevant to the sector. The group has members from manufacturers, trades bodies, electricity suppliers, social housing providers, consumer groups, standards organisations, the third sector and the public sector. Details of the full membership and terms of reference for the group can be found in Appendix 1. This wide range of expertise has allowed the group to consider not only the needs of the heat pump supply chain but also the consumers and property owners who will be affected by the low carbon heat transition and who will constitute the market for heat pumps. The group has also sought and received input from other stakeholders outside its own membership, for example local authorities and a full list of these is given in Appendix 2.

5. The current state of the heat pump market in Scotland

Before considering what should be in a sector deal to drive the rapid development of the heat pump market in Scotland, it is necessary to understand the present market

and the structure of the industry, as these are the starting points. This section provides background on Scotland's heat pump sector and the current rate of heat pump deployment in Scotland.

5.1 Scotland's heat pump supply chain

According to currently unpublished research by Delta EE for Scottish Enterprise, there are some 210 companies operating in Scotland's heat pump sector with approximately 5000 employees in total.

The upstream supply chain in Scotland includes manufacturers such as Mitsubishi, Star Renewable Energy and Sunamp. A number of other heat pump manufacturers such as Daiken, Vaillant, Kensa and NIBE are also present in Scotland through regional sales offices.

Mitsubishi's site in Livingston is a strategic location for the supply of air source heat pumps into the European market; it has the capacity to produce up to 300,000 units per year and employs over 1400 staff. Mitsubishi also has a European research and development centre at Livingston.

Star Renewable Energy is based in Thornliebank with over 250 staff and produces water source heat pumps available in modular capacities ranging from 50kW to 8MW. Star has significant experience in deploying heat pump solutions as part of large-scale heat network project across Scotland and Europe.

Sunamp is an East Lothian based manufacturer of heat batteries that can be integrated with heat pumps to allow them to be installed in space constrained homes and to take advantage of flexible tariffs by producing and storing heat when electricity is cheapest.

The downstream heat pump supply chain covers the businesses who offer heat pump installation and maintenance. Some firms are heat pump specialists but the majority offer heat pumps alongside conventional heating and plumbing services. This part of the supply chain contains a high proportion of SMEs and also micro businesses with less than 10 employees.

Scotland's heat pump sector also extends to other stakeholders. These include social housing providers who are introducing heat pumps into their stock, education and training providers such as Scotland's further education colleges and third sector organisations. These last include the Energy Saving Trust, which provides information, advice and support on heat pumps to consumers and organisations as well as delivering Scottish Government loan schemes which provide interest-free loans to householders and small businesses for a variety of sustainable energy measures including heat pumps. Other third sector organisations such as Changeworks, Warmworks and Zero Waste Scotland act as managing agents for Scottish Government schemes supporting heat pump installations for domestic consumers and small businesses.

5.2 Existing rate of heat pump deployment

The ability to provide an exact figure for the current number of heat pumps deployed in Scotland each year is limited by the data available. However, based on the data from the Microgeneration Certification Scheme and the new build EPC register there are 3000-4000 domestic heat pumps installed annually in Scotland with additional much smaller numbers installed in non-domestic properties and large-scale heat networks. Of these the large majority are air source heat pumps (ASHP) with almost all the rest being ground source heat pumps (GSHP).

Available data shows installations in existing properties have stayed broadly constant since 2015 but the number of heat pumps installed in new build homes has increased over the last four years as tighter emissions standards introduced in 2015 building regulations exert an effect.

5.3 Heat pump support mechanisms

The Scottish Government provides significant funding (£20m in 2020-21) for interest free loans for a variety of sustainable energy measures including heat pumps, which represent a large proportion (up to 66%) of total loans made. Loans are available to both the domestic and SME sectors.

Other Scottish Government programmes also provide support for heat pump installations including the Warmer Homes Scotland scheme, the Low Carbon Infrastructure Transition Programme and the Social Housing Net Zero Heat fund. Levels of support through these routes are quite significant, for example in 2021 the Scottish Government launched a second £30 million call through the Social Housing Net Zero Heat Fund and committed to make up to £100m available over the course of the current Parliament.

In addition the UK Government's Renewable Heat Incentive (RHI) provides grant support for domestic heat pump installation, however, this is closing in 2022. According to the UK Government's Heat in Building Strategy^v, the replacement Clean Heat Grant will provide up to £5000 per installation, less than under the RHI, making domestic heat pumps a less attractive option than at present.

6. The scale of the change

Deployment of heat pumps at the pace and scale necessary to meet the Scottish Government's 2030 and 2045 carbon emissions reduction targets is achievable but will require significant and rapid action.

Looking at the change required in terms of scaling, the Scottish Government's Heat in Buildings Strategy ambition is, as a minimum, to see the rate of zero carbon heating system installations in new and existing homes and buildings double every year from the current baseline to at least 64,000 installations in 2025, which is very rapid growth. Installation numbers will then need to continue to grow significantly to a peak of over 200,000 new systems per annum in the late 2020s.

Using a different perspective and looking at the scale of change required in terms of absolute numbers. The Scottish Government's Heat in Buildings Strategy doesn't explicitly specify the number of heat pumps needed in Scotland's future energy

system but it describes the need for at least 50% of the building stock to use zero emission heating systems by 2030. This implies around a million homes switching from fossil fuel boilers to alternative systems over the course of the 2020s as well as substantial numbers of other buildings.

The Heat in Buildings Strategy identifies individual heat pumps and heat networks with large-scale heat pumps as the source of heat as the two primary technologies which will deliver the above ambitions over the next decade. However, is not clear what proportion of buildings will follow each route. The Heat Network (Scotland) Act sets statutory targets for the supply of thermal energy through heat networks and these targets are ambitious, requiring 6 TWh by 2030. If all this heat was supplied to domestic properties then this would be equivalent to around 650,000 homes connecting to heat networks by 2030. However, in practice a significant proportion of this heat will be supplied to large industrial, commercial and public sector buildings. This will leave a very large market for individual heat pump systems, particularly in lower density areas where heat network infrastructure isn't cost effective.

Although there are some complementary aspects, the skills and supply chain required to build and service large scale heat network infrastructure are largely separate from those required to support a scaled deployment of individual systems with smaller heat pumps. Each area presents its own challenges and will require targeted investment in the supply chain and its workforce. For this reason it would be beneficial to have greater clarity as to the interactions between these various Scottish Government targets in order to provide maximal certainty to the industry as to the market size for each size of heat pump. This could be done through the Scottish Government's statutory requirement to provide a heat networks delivery plan and the proposed statutory duty for local authorities to produce Local Heat and Energy Efficiency Strategies.

Nevertheless, for the purposes of this report, one crucial point is already fully clear and drives the analysis and recommendations below. This is that irrespective of the final proportion of heat networks in the mix, very large numbers of heat pump installations will be required and so the need for rapid acceleration of heat pump installation capacity and rate remains urgent in all scenarios.

A final clear conclusion, from the scale and pace of the challenge presented by the heat pump roll-out, is that all possible levers will need to be applied simultaneously. The report makes a number of recommendations below but is important to note that whilst each will certainly result in positive change, a piecemeal approach will not meet the scale of the challenge, if there are to be hundreds of thousands of heat pumps in place by the end of the decade, all recommended actions will be required.

7. Deployment

Given the screeching acceleration required by Scottish Government targets, the EAG was asked to make recommendations to support the scaling up of heat pump deployment to the necessary level over the next five years and beyond. We have identified a number of relevant factors:

7.1 Upstream supply chain capacity

The Scottish, European and global manufacturing capacity for heat pumps is large, robust and can respond quickly to increased demand. The EAG considers it unlikely that the Scottish net zero pathway will be impacted by any long-term constraints in the supply of heat pump equipment, parts and related products.

The EAG noted that there is a forecast substantial increase in demand for heat pumps across the UK and Europe in the next five years, driven by net zero requirements. There are key economic opportunities for Scotland in maximising the proportion of this demand which is sourced from Scotland.

There is a potential opportunity to persuade additional tier 1 manufacturers to locate in Scotland to supply the local, UK and European markets as these grow. There are also opportunities for tier 2 manufacturing. For example, Mitsubishi cannot source all its parts requirements in Scotland because although the capacity and capability exists to manufacture them, this is not a market on which Scottish firms are currently focused.

The global increase in demand and the projected increase in Scottish and UK installations mean these opportunities are now more attractive. The EAG also noted that the planned pace and scale of domestic heat pump deployment in Scotland will provide an attractive environment for manufacturers to develop both an early market advantage in understanding consumer issues and innovative solutions to technical and deployment challenges. The Scottish Government should use channels such as the enterprise agencies to explore and exploit these opportunities.

In particular, Scotland should consider options for creating, with heat pump industry stakeholders, a heat pump industry hub. This would bring together existing tier 1 manufacturers with a presence in Scotland, potential tier 2 partners, start-up companies in the sector and relevant academic expertise; it could also potentially include heat network stakeholders. It should have strong links to the downstream supply chain so that the latter workforce are always well trained in installing the latest technology. Such an industry-wide approach would have multiple synergies and benefits and would both directly support the large-scale roll-out of heat pumps in Scotland and ensure that this drives maximal economic opportunities and jobs for Scotland.

7.2 Downstream supply chain capacity

In contrast, if unaddressed, the downstream supply chain is likely to be a very significant constraint on heat pump deployment. The current small size and fragmented nature of this supply chain and consequent low numbers of tradespeople with the necessary skill and experience in installing and maintaining heat pumps mean that, without quick action to prepare it for the role it needs to play, this part of the supply chain will not be able to rise to the challenge of very rapid expansion.

To develop the skilled heat pump workforce required by heat decarbonisation targets is a challenge of displacement and change as well as growth. Many of the skills and capabilities involved in fitting fossil-fuel boiler heating systems are common to, or

translate well to, heat pump installation. As there are c 110,000 fossil fuel boiler replacements in Scotland annually, there is very significant capacity available, if switched, to grow the heat pump sector a significant distance towards the required levels. Indeed, some programmes and initiatives are already demonstrating that this switch can be made, working closely with a number of established installation companies and providing certainty on future heat pump work volumes.

However, there are reasons why an apparently neat and balanced route, in which the heat pump installations workforce absorbs no longer needed capacity from the fossil fuel boiler workforce as heat pumps replace fossil fuel boilers, will not be possible. This is because:

- Numbers of heat pump installations in the later years of the growth curve, at more than 200,000 annually will be greater than the current capacity of 110,000 fossil fuel installations.
- Heat pump installation is a comparatively more labour-intensive activity than conventional heating system installs, taking more person hours per installation.
- Fossil fuel installers may not have all the necessary skills for heat pump installation. This can be addressed by retraining but will make their transition path longer.
- The average age of fossil fuel installers is increasing and some are likely to choose to retire rather than retrain or adjust to a new technology.

The most likely pathway is thus of both transition of the existing workforce from fossil fuel to heat pump work and absolute growth in the workforce. Measures will be required both to encourage retraining and reskilling and to increase recruitment of new capacity into the supply chain labour force. The latter presents a significant economic opportunity as well as a challenge to the sector.

Retraining existing staff and taking on and training new employees through modern apprenticeships takes time and requires investment from employers. Ensuring that the downstream supply chain does not act as a constraint on heat pump deployment will require large-scale, rapid workforce investment ahead of time by employers.

The EAG considers that such investment by the downstream supply chain will not take place without state intervention. The SME-dominated sector will simply not have the capital resources and appetite for risk to take the required action without support. This particularly applies in the current very uncertain market and economic conditions, with post-Brexit issues of a tight labour supply in the absence of European workers and very strong demand for labour in the construction industry as a whole as the economy opens up after Covid.

There is thus a need for the Scottish Government to support the necessary development of the supply chain. This can be done both through stimulating the market to provide favourable conditions for supply chain businesses to invest (covered below) and by directly supporting expansion of the workforce. These are covered in the next two sections.

7.3 Stimulating the market

The Scottish Government has significant ability to stimulate the heat pump market through a number of complementary actions:

- Directly through its own existing programmes

The Scottish Government fuel poverty programmes already replace hundreds of domestic heating systems each year. If these programmes were reconfigured to track the trajectory the Scottish Government has committed to, by at least doubling the number of heat pumps they install each year for the next five years, this would significantly enlarge the market for domestic heat pumps and in turn stimulate investment by the supply chain.

In addition, the Scottish Government should commit to an immediate at least year on year doubling of heat pumps installed in new properties built through the Scottish Government funded affordable housing supply programme.

Similarly the Scottish Government should work with local authorities and housing associations to ensure that there is at least a year-on-year doubling of heat pumps installed in existing properties in the social rented sector.

Finally, the Scottish Government should commit to only commissioning or financially supporting new public buildings with zero carbon heating systems and to only zero carbon replacement heating systems in existing public buildings, as outlined in the Heat in Buildings strategy and in line with the Net Zero Public Sector Buildings standard and commitments in the Scottish Green Party Cooperation Agreement.

- Indirectly through subsidy

The present state of the heat pump market, at the beginning of the market transformation curve, means that heat pumps require subsidy. The Scottish Government should increase the size of its existing interest-free loan programme for heat pumps in line with the ambition to at least double the number of installations each year. If a satisfactory replacement for the RHI does not materialise, it should introduce its own grant programme for heat pump installations. Such subsidy will underpin further market growth and this in turn will stimulate investment by the supply chain. There are commitments in the Scottish Green Party Cooperation Agreement to increase the cashback element of existing loans programmes and introduce a grant scheme to support energy efficiency and zero emission heating and these will provide an opportunity to address EAG recommendations in this area.

It is important that lessons are learned from the UK Government's previous Green Homes Grant and Green Deal schemes: the loans and grant programmes put in place must be accompanied by a commitment to maintain them for a number of years. The supply chain, particularly its large SME and micro-business components, will only invest in new and retrained staff when it is clear that there will be work for them to do over a sustained period. Any stop-start approach will do active harm to the supply chain by stimulating investment that then does not yield an economic return and will make it harder to convince supply chain businesses to invest in the future.

- Through injecting certainty into the market through clear market signals

Subsidy through loans and grants will be crucial in the early part of the market transformation curve but the Scottish and UK Governments are unlikely to be able to provide the very large sums involved in subsidising a mass transition to heat pumps. However, what the Scottish Government can also do is to provide certainty into the heat pump market. Certainty here means guaranteeing predictable and continuing growth in the market in the long term by actions, stated policies and commitment.

The Scottish Government is already doing this for the domestic new build sector through building regulations and as we have seen this is having an effect. The EAG welcomes the new build heat standards proposed by the Scottish Government as a mechanism to drive demand for heat pumps but notes that the timescales for regulation are too distant to drive sufficient expansion of demand in the new build market segment in the next decade, as is needed. In particular, while regulation is proposed from 2024, it could take several years before all new build properties are required to comply with the standard, as many developments will have been consented under previous lower standards. The pace of regulation will need to be faster and we recommend that the Scottish Government continues to tighten emission standards for new domestic and non-domestic buildings to drive installation of heat pumps. The Scottish Government and local authorities should also work with new-build developers to encourage them to transition ahead of regulation.

However, whilst the new-build market is important, the retrofit market is by far the larger, the large majority of the heat pumps to be installed will be fitted to properties which have already been built.

The Scottish Government needs to send a clear signal of certainty into this market, similar to that given to the car market by announcing a date after which only electric cars can be sold. We recommend that the Scottish Government announce this year (i.e. in 2021) a date by which new heating systems fitted to existing properties (both domestic and non-domestic) must be zero carbon. Such a signal should be phased, with an earlier date in areas off the gas grid, where heat pumps are already economically competitive and a later one for areas on the gas grid. Such a clear end point for fossil fuel heating systems would introduce immediate certainty into the market and would result in backwards-facing 'regulatory shadow' from the moment of its announcement, providing a stimulus to the heat pump market which would increase over time as the cut-off date approaches. We note the encouraging commitments in the Scottish Green Party Cooperation Agreement to "phasing out the need to install new or replacement fossil fuel boilers, in off gas from 2025 and in on gas areas from 2030, subject to technological developments and decisions by the UK Government in reserved areas" and rapid and comprehensive implementation of these commitments could provide the necessary signal.

7.4 Skills and people

As discussed, the downstream supply chain will need to change rapidly. It will have to redirect large numbers of existing staff, currently installing fossil fuel systems, to heat pump installation and also take on and train large numbers of new staff. It is

important that skilled tradespeople do not become a limiting factor in a very rapid acceleration of the heat pump sector.

Qualified plumbers have the fundamental theoretical and practical skills and may often only need relatively quick upskilling courses to enable them to install heat pumps. As many plumbing businesses already deliver heat services, they also generally have a good understanding of heat requirements for buildings. This means there can potentially be a swift initial response from the industry to support a rapid mass deployment of heat pumps through redeployment and upskilling of existing installation staff.

This will then need to be built on in later phases of the roll-out by taking on additional staff: it will be essential that new entrants can be attracted to the heating industry. Many of these will be apprentices entering the workforce but another, supplementary route is to widen the pool for recruitment by attracting and re-training people from other industries, beyond plumbing, for example from other building trades. They will have some transferable skills and may therefore require a shorter training period.

One further point is that the skills requirement is wider than the installation skillset, with significant numbers of sales and administrative staff and system designers needed. Support and development of the supply chain will need to cover this full range of roles and skills requirements.

It is also important to note that, given that heat pumps are a novel technology for most of those who will purchase them and there will inevitably be caution by householders around relying on them for heating, tradespeople, especially those working for local, trusted small businesses, have a crucial role to play as advocates for heat pumps. It is well known from the switchover to gas condensing boilers that advocacy as opposed to neutrality or even shared caution make a major difference to the speed and scale of transition, so it is vital that engagement and advocacy skills are incorporated into the skills 'offer' for the supply chain.

To meet this triple demand for reskilling, attracting and training new workers and supporting wider roles and skills will require Scottish Government support through rapid expansion of modern apprenticeships and training courses. Training providers such as the Scottish colleges will need to commit to provide the necessary capacity for learning. From the other side of the equation, retraining existing staff and taking on new employees obviously incurs costs and imposes constraints and risks, with all of these particularly significant for SMEs.

There are also specific issues with both workers coming into the heat pump installation workforce from elsewhere and with uptake of modern apprenticeships.

It is currently challenging for an installer to employ an adult transitioning into the industry as Scottish Government funding to support them is lower than that available for those aged 16-24. This is a disincentive to those considering moving to the industry from elsewhere, as they may well face a significant cut in their income whilst re-training.

The challenge for the apprenticeship route is that at present it produces relatively few tradespeople who are trained and qualified to fit heat pumps. The Scottish and Northern Irish Plumbers Federation (SNIPEF) has shared information on the modern apprenticeship (MA) pathways for new entrants to the sector. Within the plumbing MA there are four optional fuel pathways that can be selected by the employer apprentice, the selection will usually be the pathway that most suits the needs of the employer. There are pathways for each of the following fuel options: gas, oil, solid fuel and renewables. Over the last 5 years only around 20% of apprentices at SNIPEF members have taken the renewable energy pathway, with most plumbing businesses and apprentices preferring to take a conventional heating pathway. The industry view is that this will only change when both installers and trainees are convinced that there will be continuing significant demand for heat pump installations.

This lack of apprentices currently pursuing the renewables pathway represents a key risk to the future workforce capability to support heat pump deployment. On the model discussed above of initial transition of existing tradespeople followed by absolute growth in the workforce to support latter high-volume phases of the heat pump roll-out, there is a need for immediate action if the new entrants are to be available when required. The four year timescale for apprenticeships means that new apprentices must join the renewables pathway now, in order to play a meaningful role in deployment by 2025.

These various issues will require combined rapid action from both the Scottish Government and the supply chain. Government must work with the sector to:

- Provide additional certainty for heat pump installation numbers to demonstrate the work is there, this is covered in section 7.3 above.
- Increase the number of modern apprenticeships in the renewables pathway. Although greater certainty of work will help to persuade employers and apprentice ships to commit to this pathway, this will take time and the need to start the pipeline of qualified apprenticeships flowing is so urgent that the Scottish Government should also use provide appropriate financial incentives for both employers and apprentices choosing the renewables pathway.
- Create training programmes that identify prior learning from other sectors to reduce the amount of training needed but still deliver high knowledge and competency and ensure appropriate financial support for those using them to avoid the disincentive of a reduced income during conversion.
- Ensure the full range of skills required is covered by training provision, including advocacy and engagement skills.

The downstream supply chain recognises its role in supporting the transition to heat pumps and has indicated willingness to agree aspirational targets for training and upskilling on heat pumps with the Scottish Government, including targets for apprenticeship places and importantly jobs for those apprentices when they are trained. Industry bodies such as SNIPEF have a significant role to play in moving their industry away from a focus on conventional fossil fuel systems. Industry bodies can provide strong support and signposting to employers through the transition, helping to build and manage the new relationships that will be required with training providers, certification bodies, government and ultimately, consumers.

The EAG note the significant economic opportunity for a green recovery that the above issues reflect: here is a low-carbon pathway to increasing skilled, long-term employment at a time when other industries are suffering due to the pandemic.

The EAG also considered equality and diversity in the heat pump sector and within the plumbing industry more generally. It noted that there is a lack of information available on diversity but it is generally acknowledged this is an area where industry can improve. It is important that it does so as recruitment from a wider pool of entrants is part of the answer to increasing numbers. In addition, the industry will need to consider its contribution to a just transition to a low carbon economy, recruiting amongst those on the lowest incomes etc. who are most potentially at risk of adverse impacts from such a transition. The Scottish Government should agree targets with the sector in both these areas and shape its support structures accordingly.

The Warmstart scheme, managed by Warmworks, the delivery agent for the Scottish Government's Warmer Homes Scotland scheme, provides a good example of how industry can work together to attract and support new entrants into the sector. Using funding from Kickstart, Warmworks aims to provide up to 15 placements per year for young people within their established supply chain of installers and sub-contractors. The long-term aim is for the holders of these placements, if successful, to be given longer-term apprenticeships or permanent roles in the Warmworks supply chain in business administration, domestic plumbing and heating engineering, electrical installation and wider construction skills, which is in line with the Scottish Government's Young Person's Guarantee approach. If adopted widely by installers, such schemes have the potential to quickly bring significantly augment the workforce as part of a green recovery.

Finally, the EAG discussed potential issues associated with access to installers in rural areas. Current demand for heat pumps is highest in rural areas off the gas grid and there is anecdotal evidence that lack of capacity is already a problem in some of these areas. This highlights the urgency of addressing the issue and potentially offers an opportunity to trial some of the approaches above before rolling them out more widely. One important point noted by the group is that any early action in off-gas areas has the potential to promote inclusive growth in vulnerable rural economies. If indigenous SME installers are supported to grow with the local heat pump markets, rather than additional capacity to satisfy demand being supplied to these markets from larger regional or national installers, this will strengthen local economies.

7.5 Certification and standards

Heat pumps are a relatively novel technology for most potential purchasers. Building and maintaining confidence in such a new market where consumer trust is fragile requires robust, enforceable and nationally applicable standards which consistently deliver high quality installations: any dent in confidence would have a severe effect on growth of the market. The EAG recognises the ongoing work of the Scottish Government on skills standards and also considers it important that the heat pump

supply chain commits to relevant industry standards such as the Microgeneration Certification Scheme (MCS), PAS2035 etc.

At present many installers are not certified under these schemes and the EAG recommends that installers are strongly incentivised to achieve certification by requiring appropriate certification for any installer working on installations supported by public money, this is already required for the Scottish Government loans described above. The EAG notes that many smaller installers are deterred by the significant time and financial commitment required for certification and recommend that there should be Scottish Government support for small businesses with these costs in the form of grants or loans. One way of providing such support on a de-risked basis to the recipient and at lower cost to the public purse might be for repayments of the loan to be based on a fixed repayment per heat pump installation, thus the installer only repays the loan once they are generating revenue to support repayment.

7.6 Network infrastructure and connection

Heat pumps use significant amounts of electricity and their increasing deployment will put additional demands on the electricity grid and present challenges for the companies who operate it. Even at relatively low penetration levels, organisations involved in heat pump deployment projects are encountering grid constraints and the EAG's view is that electricity grid constraints are a major potential limiting factor to large-scale expansion of heat pump deployment in Scotland.

This issue is compounded because of the regulatory constraints that prevent network investment in advance of need. Domestic and local scale energy storage (electrical or thermal) and demand side management can make important contributions to mitigating the problem in the near term, these options could potentially include the deployment of smart, integrated heat pump and storage systems. Ultimately, however, major investment in networks cannot be avoided.

The need for a coordinated approach and collaboration between regulators, government and network providers is clear and the EAG has proactively engaged with Ofgem, SSEN and SPEN on the network infrastructure challenges. One point which should be noted here is that Ofgem are clear that when assessing requests for investment under RIIO-ED2 they will be influenced by the degree of certainty in forecast demand on the grid. It is just such certainty that this report argues the Scottish Government can and should provide through co-ordinated policies and commitments.

There is a further issue with grid connections due to the limited capacity of the Distribution Network Operators (DNOs) to carry out their connection governance duties. The DNO acts as a gatekeeper to the grid and is required to satisfy itself that the local grid can cope with a heat pump being installed before granting permission for connection. Experience within the EAG from heat pump pilot projects has shown that with only limited resources currently made available for this process, it is not fit even for medium volumes or moderate growth and could potentially delay heat pump roll out and impact on consumer experience. As part of any heat pump sector deal, DNOs will need to develop robust processes and commit the necessary resources to

support the large numbers of heat pumps which will have to be connected to the grid as heat pump deployment gathers pace.

Finally, it is worth noting the interaction between demand on the grid and both consumer behaviour and also installation skills and standards. The former is covered briefly below but clearly consumer operation of heat pumps can vary in efficiency and this will affect total demand from a given number of systems on a given section of the grid with limited capacity. It is also important that heat pumps are installed to a high standard to ensure they operate efficiently to limit their demand on the grid.

7.7 Planning

The EAG has discussed the role of the planning system in supporting heat pump deployment. The first requirement should be that the planning system does not unnecessarily restrict deployment. While heat pumps are covered by permitted development rights (PDR), there are persistent anecdotal examples of where PDR has been applied inconsistently between local authorities, for example around noise.

The Scottish Government needs to review its guidance to local authorities in this area to ensure that it is as clear as possible whilst local authorities need to commit to a joint proactive stance towards heat pump deployment.

The planning system can also play a positive role in strategically coordinating heat pump deployment, for example master planning for new developments should now include identification of the grid and other infrastructure requirements necessary to support heat pump deployment. Planning will also be important in managing the interplay between district heating and individual heat pumps: the development of district heating systems could be held back if too many anchor loads, for example in public buildings are served by individual heat pumps, as the remaining heat demand in an area may then no longer be sufficient for a district heating system.

The EAG recommends that guidance is issued to local authorities to ensure that the planning system plays a fully strategic and proactive role in encouraging and supporting heat pump deployment and the most efficient interplay between individual heat pumps and district heating networks. In this respect the requirement on local authorities to develop local heat and energy efficiency strategies puts much of the framework in place to achieve this role and the EAG supports the proposal for a statutory duty for local authorities to develop these strategies.

7.8 Market segmentation

The required rapid acceleration of heat pump deployment will not take place uniformly across the national housing and building stocks. There will be certain geographical areas and housing and building types where there are significant opportunities now and others where there may not be an opportunity until further developments of the market through innovation, financial support or regulation.

Given the scale of the challenge and the current market barriers that limit the attractiveness of heat pumps as a solution in many settings, the Scottish Government must take decisions on what market segments can be relied upon to

anchor the supply chain from an early stage. The EAG has discussed where the early opportunities for the first few doublings of heat pump numbers may be concentrated.

7.8.1 Off gas and on gas areas

MCS data shows that current demand for heat pump installations is significantly focused in off-gas areas. This reflects the fact that heat pumps are much more likely to be a cost-effective option for homes in off-gas areas. This cost effectiveness derives from the more expensive fuel choices in those areas, consumers are choosing heat pumps as a replacement for oil, LPG or solid fuel systems. In contrast, in areas on the gas grid, fuel costs for gas boilers are cheaper than for heat pumps, despite the latter's much greater thermal efficiency.

There is thus a case for going with the current state of the market and focusing efforts on off-gas areas. However, whilst there are some 420,000 homes off the gas grid, many are already heated by electricity (mainly storage radiators) and so are already low carbon systems. Only around 167,000 off-gas homes use fossil fuels and the natural rate of fossil fuel heating system turnover in off-gas areas is estimated to be as low as 9,000 installations per annum. As such, for the off-gas sector to contribute significantly to the Scottish Government's targets, deployment would need to be incentivised to encourage consumers to replace their oil and LPG heating systems ahead of time and even then, there are simply not enough homes with fossil fuel heating systems in these areas to meet the volumes of the later part of the net zero pathway. In addition, there are more issues of installation capacity in the relatively weak and undiversified economies of rural areas.

The EAG's view is that the rapidity of the heat pump deployment required for net zero and the above constraints mean that efforts to drive the market must not focus on just off-gas areas but must also extend to on-gas areas. However, it recognises that realistically, the majority of the very early 'doublings' in installation numbers will be in off-gas areas because here heat pumps already make financial sense for consumers and the market is more advanced. These areas should therefore be the first target for supply chain measures and others as appropriate.

Nevertheless, given the limited capacity for installation in off-gas areas without replacing heating systems before they reach end of life, they alone cannot sustain the planned rapid mass deployment of heat pumps to which the Scottish Government is committed: the later 'doublings' will need significant and eventually majority contributions from on-gas areas.

There is thus a parallel and urgent need to move the on-gas market forward, using all the levers detailed in this report, so that it is ready to play its part in the later doublings of installation numbers in two or three years' time. Otherwise the market growth in off-gas areas will be reach its limit and there will be no 'second stage' from on-gas areas to boost the market further. This will require the development, within three years of creative whole building solutions, combining heat pumps with energy storage, fabric efficiency improvements and on-site generation in order to make heat pumps attractive in the on-gas energy market along with appropriate financial support and regulation.

One key action which would help unlock the market for heat pumps in on-gas area would be rebalancing of gas and electricity prices, at present gas is artificially cheap compared to electricity because the majority of regulated social and environmental levies are on electricity. Clearly, if this were to change, the financial attractiveness of heat pumps would receive a significant boost and this would increase the market for them in on-gas areas. Whilst recognising that this is not a devolved area, action here is required within the above two to three year timeline and accordingly, governments and regulators need to address this point as a priority.

7.8.2 New build

The EAG have engaged with the new build housing sector in the preparation of this report. The group is clear that increasing the pace of regulation of carbon emissions from new homes is necessary to drive the heat pump market in this sector but there is also an opportunity for the new build sector to act in advance of such regulation. In our discussions with the sector it is clear that they have a direct interest in seeing the supply chain for heat pump products and services grow, so it is ready for proposed future homes standards at UK and Scottish levels. The Scottish Government should explore how they can work with the sector to incentivise it to procure greater numbers of heat pumps in advance of regulation and so drive such growth.

7.8.3 Retrofit – Social housing

The EAG believe the social rented sector has a key role in driving heat pump deployment through increasing retrofit installations in its own stock, building on the leadership that the sector has previously shown in delivering the Energy Efficiency Standard for Social Housing (EESH). The Scottish Government should work closely with social housing providers to develop plans that support a growth in the number of heat pumps installed in existing social stock with a focus on both early action and a long-term commitment to installations. This would help provide both the stimulus and the certainty needed to drive the market and underpin the expansion of the supply chain.

7.8.4 Other segments of the retrofit market

The housing stock is of course not uniform and even in on-gas areas there are some types of dwelling where heat pumps are already cost effective. It will be important to characterise and identify these types of housing and their prevalence and location, as where there are substantial numbers and/or geographical concentration this will represent a segment of early opportunity within the overall on-gas retrofit market. It is recommended that analysis of the housing stock is commissioned to identify these key segments.

7.9 Energy efficiency

The energy efficiency of homes is a key factor in the costs of all heating and that particularly includes heat pumps because they are designed to provide a constant output of heat rather than heating up the property for those periods when it is occupied. This is good for comfort levels as the house is always at a comfortable

temperature but means that if a home is not well insulated the heat pump must work hard 24/7 to maintain temperature against heat losses and working at its maximum output reduces its efficiency.

It follows that the fabric insulation standard of a home using a heat pump is very important to the energy bills of the householder occupying it and the key way to make heat pumps economically competitive in on-gas areas, short of regulatory price reform as discussed above, is to insulate homes to a high standard. Such insulation also has other advantages, it means a smaller capacity heat pump can be used for a given size of house, reducing the capital costs for the heat pump and it may avoid the need to replace the existing radiators and pipework.

At the system level, heat pumps in highly insulated homes will consume less energy to keep those homes warm and this will mean less need for reinforcing the grid capacity, making large-scale penetration of heat pumps into the market easier. For these reasons, it is important that programmes of support for heat pumps also consider how to maximise support for fabric insulation in buildings where they are to be installed. It is recommended that, wherever appropriate, the heat pump support measures proposed in this report incorporate support for parallel and maximal fabric insulation, in particular any regulation to require heat pumps must require high insulation standards as well.

7.10 Innovation

The EAG has considered whether there is any opportunity for innovation to drive the market and/or address some of the deployment issues discussed above.

7.10.1 Technical and process innovation

The majority view of the group was that there is unlikely to be major innovations in heat pump fundamental components which would make a significant impact in overcoming the barriers to deployment. This is because heat pump technology is well established and improvements will be incremental only. In addition, industry has sufficient resources for innovation because the market is driven by large manufacturers with significant research budgets and the Energy-related Products Directive is also a successful driver of technical innovation within the heat pump market in Europe. The group felt there was at present little scope for other government support or intervention regarding fundamental components.

However, there are a number of other specific technical areas where innovation could aid deployment. These include:

- The integration of heat pumps into existing buildings and local energy systems. At present each heat pump installation is to at least some extent bespoke for the building into which it is installed. There is scope for government backed innovation programmes targeted at developing “plug-and-play” style heat pump packages with off-site fabrication. This could potentially decrease the time and cost of installation of heat pumps.
- Further innovation to support a shift towards more environmentally friendly refrigerant gasses for use in heat pump systems. This has the potential to

reduce the cost of heat pump systems which use F-Gas refrigerants that attract high levies.

In addition there are opportunities to innovate to reduce the need for disruptive radiator and internal pipework upgrades to allow compatibility with low temperature heat pumps. This adds significantly to total installation costs and the inconvenience involved is one of the key deterrents to consumers in installing a heat pump system.

One potentially fruitful area for technical innovation here is in improving system additives or de-aerators to remove microbubbles from the system and improve the efficiency of radiators. However there is also scope for process and data innovation which could have significant impacts.

Process innovation would mean moving away from the commonly used default assumption that all radiators and pipework need to be changed as part of a heat pump installation and instead considering each installation on a conservative basis, only replacing those radiators which need to be changed for efficient operation. Many existing radiators are oversized for a gas boiler system and could still offer adequate heat spacing performance with the lower water temperatures provided by heat pumps. Such an approach could be supported by manufacturers providing better technical guidance and by automated tools to assess properties, their heat losses and the suitability of their radiators and pipework for working with heat pumps.

Given that the disruption and expense of radiator replacement is one of the fundamental barriers to consumer acceptance of heat pumps, there is a case for developing archetype analysis or even a national database showing to what degree buildings are 'heat pump ready'. Industry and government should work together to scope the options here.

7.10.2 Business model/service innovation

Beyond innovation regarding the heat pump itself and its accompanying pipework and radiators, there is a clear innovation opportunity in taking advantage of an integrated smart systems approach, combining heat pumps with control systems, software, heat or battery storage and PV arrays to minimise running costs, maximise access to the cheapest electricity and offer grid flexibility services to generate additional revenue streams to offset heating costs. This has the potential to very significantly reduce the running costs of heat pumps and the EAG suggests that this is an area where government support for development and demonstration of such systems could be effective in taking the industry forward. The group also highlighted a number of artificial barriers associated with technical requirements for flexibility contracts set by the system operator and it is recommended that governments and regulators address these.

There is also a requirement for innovation regarding tariffs. There are limited market incentives for smart heat pumps currently because the vast majority of utility companies do not provide suitably flexible tariffs, although Economy 7 and Economy 10 can offer savings, there should be options beyond this. The EAG suggest that such flexible tariffs should be a key area of focus for government, suppliers and regulators.

The EAG discussed heat as a service (HaaS) as an innovative business model for heat pumps. However, the group felt that under the current energy market framework it will be challenging for business models like HaaS to make much impact, particularly in on-gas areas. However, it could become more prominent as energy markets develop and governments and regulators should ensure that there are no artificial barriers to HaaS or other innovative business models.

The group also noted that consumer protection and regulation will be increasingly important as business model innovation develops and that the Scottish Government should set clear policy on these for new business models.

7.11 Pilot projects and demonstration programmes

There has been a history of heat pump pilot projects and the EAG felt that while they had done a vital job and many useful lessons had been learnt, the key problem was now deployment at scale and at speed to achieve the net zero pathway. There is a danger of being stuck at the pilot or demonstration stage and losing precious momentum on the very demanding route to mass deployment.

The group did feel that there was a role for demonstration programmes which avoid this and add value by specifically addressing deployment or business model issues rather than showcasing technologies, for example:

- Area-based or housing archetype-based installation programmes to assess what economies of scale can be achieved by these approaches.
- A large-scale trial of a flexible tariff for heat pumps to demonstrate to what extent this could reduce running costs.
- A demonstration of the costs, benefits and revenues of the integrated smart systems approach referenced above.

The Scottish Government should work with local authorities, social housing providers, energy suppliers and other key stakeholders to develop such deployment-focused demonstration programmes to facilitate and define the route map to mass deployment.

7.12 Consumers

Since the mass deployment of heat pumps requires households to both accept relatively novel technology to heat their homes and to invest their own money in switching to heat pumps, consumer engagement and support for the transition to heat pumps is an absolute requirement. Consumers in effect have a veto over the transition and thus all stakeholders need to work together to achieve their engagement and support of consumers. There are a number of key actions that are required for this to happen, as described in this section.

Government and Industry need to work together to support consumer awareness and engagement on heat pumps. Heat pumps are a largely novel technology in the UK and Scotland yet the net zero pathway implies, as discussed above, a very rapid transition to heat pumps. Most householders not yet know what a heat pump is or how it works and certainly do not realise that they are likely to be heating their home

with one within the next few years. Without a major increase in consumer awareness and understanding, which will require direct support from the Scottish Government, the buy-in from householders which will be absolutely necessary for the success of the domestic roll-out of heat pumps will not be in place. The Scottish Government needs to develop and implement a strategy to engage and inform consumers about heat pumps and the communication campaign to encourage home upgrades which is included in the Scottish Green Party Cooperation Agreement is an opportunity here.

There are also clear links between consumer advice and support and efficient operation of heat pumps once installed. Experience shows that householders used to operating gas boilers (and often still using even these quite inefficiently through lack of knowledge about thermostat settings etc.) will need to adopt new behaviours, informed by a greater background knowledge of their new heating system, to maintain comfort levels and operate their systems efficiently. Accordingly, consumer information, advice and support which supports efficient use will have a dual benefit, keeping electricity bills down for heat pump owners and also minimising total electricity demand for heating, potentially reducing the need to invest in grid capacity. The Scottish Government should continue to ensure that existing advice provision in this areas through its Home Energy Scotland Network is widely available and effectively publicised.

For both the above actions, it will be important to acknowledge that consumers and householders live in a diversity of property types and vary in their resources and needs. Engagement, advice and support will need to be tailored to meet the needs of different segments of the consumer audience.

In addition, government cannot do all that is necessary for consumer engagement, advice and support. As the pace and scale of heat pump deployment expands their market into new settings and environments, heat pump manufacturers and installers will need to understand and respond to consumer concerns and experience to build confidence in heat pumps from an early stage of the roll out. Specific actions in this area that the EAG would like to see industry take are;

- As also referenced above in section 7.4 on skills and people, it is very important that installers move to act as positive informants on heat pumps to householders who have contacted them with a view to purchasing a new boiler or heating system. At present the large majority of installers are most comfortable advising householders with information about conventional boilers and do not often present a heat pump as a viable alternative with potential benefits. Given the trust householders have in the industry, particularly in local, known firms and the fact that installers are often the first or only source of information on heating system options, appropriate, technology-neutral advice is very important to ensure that when a heat pump is a viable option it is actively and objectively considered by the householder. This is a cultural issue for the industry and will require both explicit recognition that heat pumps are the (near) future of heating in very many homes and buildings and as proposed above, appropriate training for all staff in contact with consumers so they can confidently advise and support householder choices based on their own knowledge of heat pumps.

- Wide adoption of a common customer journey which is as simple and straightforward as possible, using common standards supported by manufacturers and installers. One thing which would be very helpful in taking this area forward would be an industry-mandated common commissioning standard for all domestic heat pumps, including coverage of key issues such as a clear, comprehensive information of effective and efficient usage of the system and a single point of contact to resolve any downstream issues. Standards for such a commissioning process could be developed by bodies such as the Heat Pump Association or the Microgeneration Certification Scheme (MCS).

Finally, the importance of fuel poverty has been discussed at length at the EAG as it is important that the transition to heat pumps is a just transition. As referenced, whilst heat pumps can offer significant costs saving in off-gas markets on current tariffs, the situation is less favourable in on-gas areas. There is thus a risk that the heat pump roll-out will both create new and also intensify existing fuel poverty in areas on the gas grid.

This will require careful management, particularly in moving the Scottish Government's fuel poverty programmes to progressively installing more heat pumps, as is recommended in this report. One potential solution is to increase investment in energy efficiency in fuel poor homes so that their overall energy use for heating is minimised even if the unit cost of that energy rises because they are now using electricity for heat pumps rather than gas. There are also other approaches that could be used in combination with greater energy efficiency, for example installation of solar PV to generate some of the electricity load for heat pumps and/or batteries to allow the purchase of electricity when it is cheapest and its storage for later use.

It is recommended that the Scottish Government develop and pilot appropriate measures packages which can provide heat pump solutions to the fuel poor without increasing their fuel bills. Once proven, such packages can then be adopted by Scottish Government fuel poverty programmes to allow these programmes to move to progressively move to a low-carbon basis.

8. Conclusions

The Scottish Government is committed to installing one million zero carbon heating systems by the end of the decade and as a pathway to that goal, doubling the number of such systems installed every year for the next five years. A very large proportion of these systems are expected to be heat pumps. As this report makes clear, these are very challenging targets and to achieve them will require all the levers that are available to be pulled hard in the same direction.

However, as the Scottish Government controls many of these levers, it can make this alignment happen. One immediate thing it can do is use its powers of regulation and planning to drive installation of zero carbon heating in both old and new buildings, including creating a definitive 'market moment' by announcing an end date for fossil fuel heating installation. A further action which can be taken rapidly is to directly incorporate the ambitious targets in its own programmes. This will not in all cases require additional funds, the government can redirect some of the funds it already spends or controls in many cases, for example in mandating zero carbon heating in new public buildings and through the affordable housing programme.

These actions will provide volume and, crucially, certainty to the Scottish heat pump market and so drive its growth. However, with growth the constraints of the downstream supply chain installing heat pumps will become crucial and there will be a need for further measures to develop the supply chain, which is unlikely to grow quickly enough without such support.

If these things are done, accompanied by other interventions to support targeted innovation, maintain high standards of work in a rapidly growing industry and ensure electricity grid access then the building blocks will be in place to reach the required numbers of heat pumps. However, there is a crucial further step, to engage consumers so that they understand and buy into the transition to heat pumps as without consumer engagement and support the transition cannot occur.

Overall, the key conclusion of the EAG is that the Scottish Government's targets are achievable. Significant effort and resources will be required but most actions proposed are a ramping up or extension of existing activity, albeit at considerable pace and scale and so there is much to build on. If the Scottish Government follows the recommendations set out in this report, we are confident that their ambitious goals for heat pump deployment can be met.

Appendix 1 – Expert Advisory Group Terms of Reference and Membership

Background

1. Heat pumps will be a strategically vital technology to deliver low carbon heat in buildings as part of the Scottish Government’s statutory target to meet net zero emissions by 2045. Heat pumps have been strongly advocated by the Committee on Climate Change as a “low regret” option for buildings in off-gas rural areas alongside up to 10 million homes on the gas grid in the UK transitioning to heat pumps and hybrid heat pumps by 2035.
2. In the context of the green economic recovery, it is essential that we transition towards net zero in a way that maximises employment opportunities and value to the Scottish economy. Decarbonised heat is an essential part of the net zero pathway and, whilst we recognise that there is a range of relevant technologies and the Scottish Government’s Heat in Buildings Strategy will provide further detail on the breadth of technologies required, heat pumps will play a key role. The deployment of heat pump technologies goes hand in glove with ‘fabric first’ improvements to building energy efficiency and an initial focus in these areas is useful given the scale of deployment challenge and their role in “low-regret” areas.
3. The challenge of rapidly scaling up heat pump deployment is complex and far reaching with impacts on a range of issues including fuel poverty, consumers, place, skills, supply chain, manufacturing, infrastructure and finance. There is work already ongoing across these areas by industry, researchers and governments. However, given the breadth of these challenges, the Scottish Government has brought together a group of experts to provide recommendations on the potential scope and content of a heat pump sector deal.

Remit of Group

4. The group will provide a series of recommendations to Scottish Ministers on the potential scope of a Heat Pump Sector Deal. These recommendations will be focused on sector-specific issues, creating opportunities to boost deployment, employment, innovation and skills. The group will consider challenges across all forms of heat pump technology, including large scale heat pumps and district heating. Recommendations will consider:
 - Actions that Scottish Ministers can take to support the heat pump sector within their devolved competency
 - Complementary actions that the heat pump industry and wider stakeholders should take forward with the support of the Scottish Government
 - Actions that Scottish Ministers should call upon the UK Government to take forwards

Objectives

5. The Scottish Government propose that the group will work to deliver the following objectives. These objectives will be discussed and agreed at the first meeting of the group in October 2020:

Deployment

6. Recommend a clear pathway for scaling up heat pump deployment over the next five years across domestic and non-domestic heating, considering;
 - Evidence for meeting Scotland's 2045 net-zero emissions target
 - The Scottish Government Heat in Buildings Strategy
 - Scottish heat pump sector deployment capacity and capability
 - Existing incentives and support mechanisms (including Scottish Government support through national programmes)
 - The benefits, costs and challenges of integrating heat pumps into electricity networks
 - The non-financial barriers to heat pump deployment
7. Consider options for how best to transition support for the sector away from government subsidy in the longer term, making recommendations for actions the Scottish Government need to take in this area.

People

8. Review the sector skills base and existing capacity and provide recommendations on how to support a sustainable increase in capacity across the heat pump supply chain to support deployment.
9. Review evidence on diversity and youth employment across the sector, making recommendations on how to maximise each of these respectively.

Innovation & demonstration

10. Consider how innovation can be used to support deployment of the technology, particularly in the context of Scotland's existing building stock and including innovative approaches to financial feasibility, providing recommendations on how this can be progressed industry and supported by government.
11. Review previous and ongoing demonstration activity, considering what gaps exist and how these can be best supported.
12. Investigate how a heat pump sector deal can support cost reductions for heat pump installations.

Place

13. Consider the specific challenges for heat pump deployment across Scotland's regions, such as specific remote, rural and island issues as well as urban areas, and make recommendations on how these could be overcome at a local level to support inclusive growth.

Consumers

14. Review the consumer perspectives on heat pump deployment, existing industry standards and certification schemes and the information, advice and support available, to agree actions on how the industry, government and other stakeholders can work to increase uptake through improving consumer confidence and perceptions of the desirability of the technology.
15. Consider how the industry, utilities and wider stakeholders can work together to support appropriate tariffs for heat pump users which enable deployment.
16. Although powers relating to energy market regulation and also consumer protection are reserved, the sector deal will consider what actions can be taken within this context and may highlight where further action is needed by UK Government.

Structure and Reporting

17. The expert group shall be chaired independently and supported by the Scottish Government. The group will work through a programme aligned to the themes above where they will be presented with evidence compiled by the Scottish Government and other group members, as appropriate. The draft programme below provides indicative timescales:

Session	Date	Time
Introduction to Heat Pump Sector Deal	29 th October 2020	15:00 – 17:00
Innovation and Demonstration	30 th November 2020	11:00 – 14:00
Deployment pathway	27 th January 2021	10:00 – 13:00
People and Place	18 th February 2021	10:00 – 13:00
April 2021 – Consumers and development of recommendations	29 th April 2021	10:00 – 13:00

18. To supplement the work of the expert group, the Scottish Government will support a parallel workshop session with heat pump installers and suppliers to provide broader input.
19. We will also invite the Scottish Energy Officers Network/Housing Officers Network to provide written submissions for the expert group to consider.

Membership

20. Membership to the group is by invitation from the Scottish Government. The core membership of the group is as below:

Organisation	Contact
Association of Decentralised Energy	Caroline Bragg
Energy Consumers Commission	Lewis Shand Smith
Energy Saving Trust	Mike Thornton (Chair)
Energy Systems Catapult	Paul Jordan
Heat Pump Association	Phil Hurley
Lloyds Banking Group	Andy Mason
Microgeneration Certification Scheme	Ian Rippin
Mitsubishi	Rodney Ayre
Octopus	Clementine Cowton
Scottish Renewables	Helen Melone
SNIPEF	Martyn Raine
Star Refrigeration	Dave Pearson
Sunamp	Andrew Bissell
TIG	Stewart Wilson
Warmworks	Ross Armstrong
West Highland Housing Association	Graeme Bruce

21. Additional invitees may be suggested by the group to offer advice in specific sessions.

Observers

22. Representatives of the Scottish Government and, where appropriate, its enterprise agencies and delivery partners.

Appendix 2 – Stakeholders consulted

The Chair wrote to a selection of stakeholders to gain insight on their perspective of the heat pump deployment challenge. A list of these stakeholders is provided below.

- Scottish Federation of Housing Associations
- Scottish and Southern Electricity Networks
- SP Energy Networks
- Ofgem
- Homes for Scotland
- COSLA
- Scottish Energy Officers Network

References

- ⁱ Climate Change Committee (2020) – Reducing emissions in Scotland – 2020 Progress Report to Parliament - <https://www.theccc.org.uk/publication/reducing-emissions-in-scotland-2020-progress-report-to-parliament/> (last accessed 12/05/2021)
- ⁱⁱ Scottish Government (2021) – Heat in buildings strategy - achieving net zero emissions: consultation – <https://www.gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings-consultation/> (last accessed 12/05/2021).
- ⁱⁱⁱ Climate Change Committee (2020) – Reducing emissions in Scotland – 2020 Progress Report to Parliament - <https://www.theccc.org.uk/publication/reducing-emissions-in-scotland-2020-progress-report-to-parliament/> (last accessed 12/05/2021)
- ^{iv} Scottish Government (2020) – Protecting Scotland, Renewing Scotland: The Government's Programme for Scotland 2020-2021 - <https://www.gov.scot/publications/protecting-scotland-renewing-scotland-governments-programme-scotland-2020-2021/> (last accessed 12/05/2021).
- ^v [Heat in Buildings Strategy - achieving net zero emissions in Scotland's buildings - gov.scot \(www.gov.scot\)](https://www.gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings-consultation/)



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