6th floor
10 Dean Farrar Street
London SW1H 0DX
020 3031 8740
kelly.greer@theade.co.uk

Decarbonising Heat Networks in University Estates

1 Introduction

This report presents the results of a survey of University estates staff, carried out by the Association for Decentralised Energy, in co-operation with the Association of University Directors of Estates (AUDE) and the Scottish Association of University Directors of Estates (SAUDE), and a workshop to further explore and validate the findings.

The survey responses will inform ADE's work on the role of the public sector in the transition to net zero and help shape a workshop with AUDE and SAUDE members on how to further develop and decarbonise university heat networks and support the transition to net zero.

1.1 National policy context

The UK was one of the first countries to recognise and respond to societal challenge posed by climate change. The Climate Change Act (2008) committed the UK to reducing greenhouse gas emissions by at least 80% by 2050 when compared to 1990 levels.

In June 2019, Parliament passed legislation requiring the government to reduce the UK's net emissions of greenhouse gases by 100% relative to 1990 levels by 2050. The Scottish Government went further, requiring emissions of greenhouse gases to be reduced by 100% relative to 1990 levels by 2045.

In April 2021, the UK government announced that it has brought forward targets to achieve a 78% cut in emissions to keep the rise in global temperatures close to 1.5C above pre-industrial levels. These commitments, which are to become law, bring forward the current target for reducing carbon emissions by 15 years.

However, even with the recent announcements to bring forward carbon targets, there is an over-riding concern that the UK lacks the policy and programmes to implement these targets, which is a key barrier to enacting change.

We continue to await the publication of the Heat and Buildings Strategy,

1.2 University sector information – emissions, progress so far

AUDE's Higher Education Estates Management Report from 2020 highlights that the sector has and continues to deliver significant reductions in its carbon emissions. However, this does not give the whole picture of the work and challenges ahead.

The positive news is that the sector continues to see improvements in energy demand per m² (see figure 1),

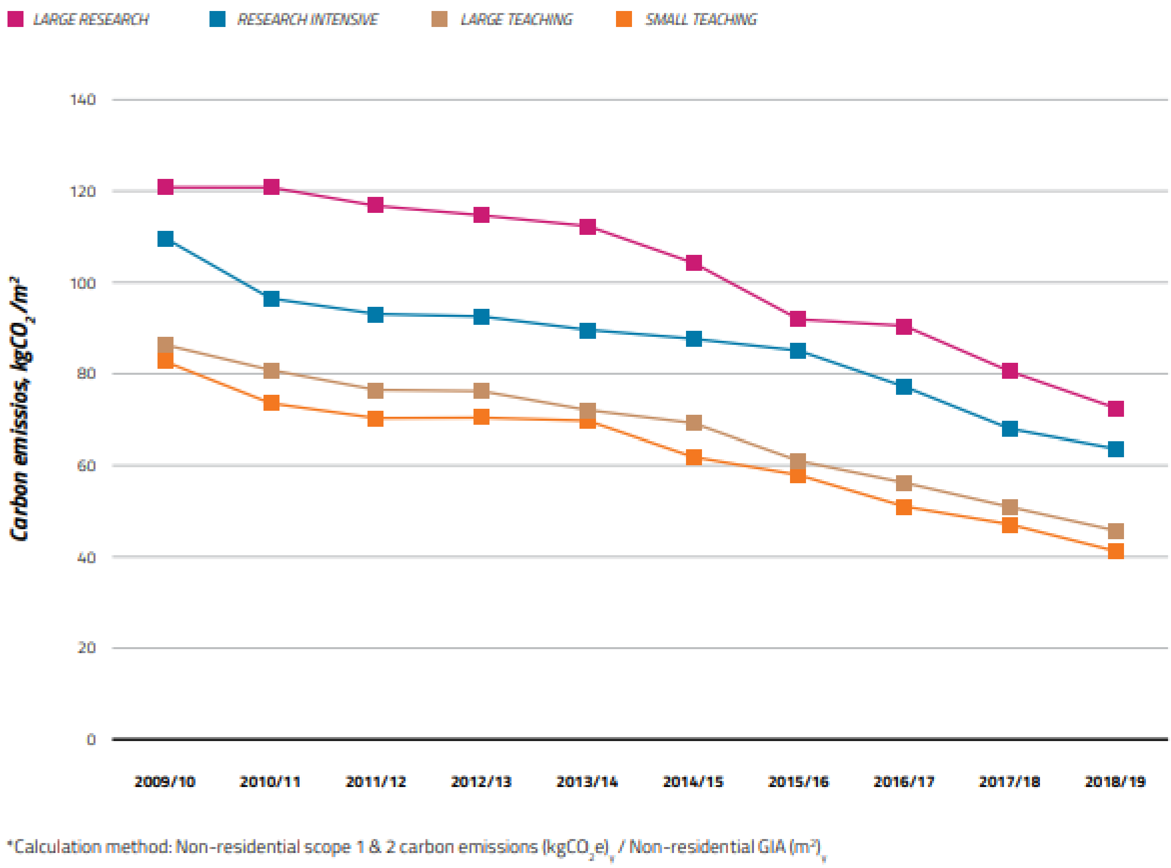
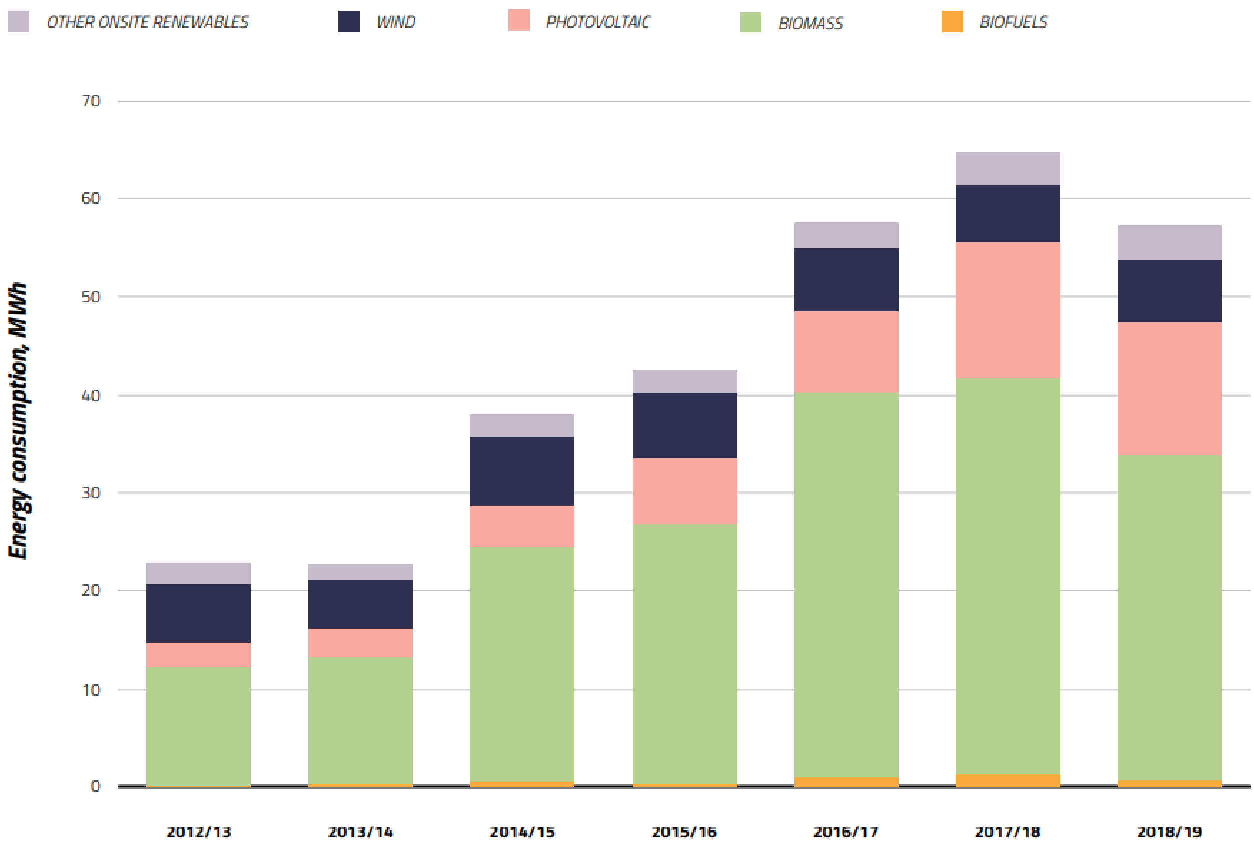


Figure 1: carbon emissions (scope 1 and 2) per m².

However, when considering the nature of energy consumed, there are a series of challenges that the sector will face as the UK progresses towards net zero.

Grid electricity represents around 35% of energy consumed within the sector. The decarbonisation of the electricity grid (through increased renewable energy generation and reductions in coal fired power generation) has enabled the UK to significantly reduce CO_2 emissions, and for universities to reduce their scope 2 emissions.

Universities have increased the quantity of low carbon renewable energy generated on site over the past seven years to approximately 60MWh (figure 2). This includes both renewable power and heat, however this remains a relatively small percentage (0.75%) of the overall energy demand of the sector (figure 3).



Total energy consumption for whole estate, i.e. non-residential and residential

Figure 2: energy consumption - renewables.

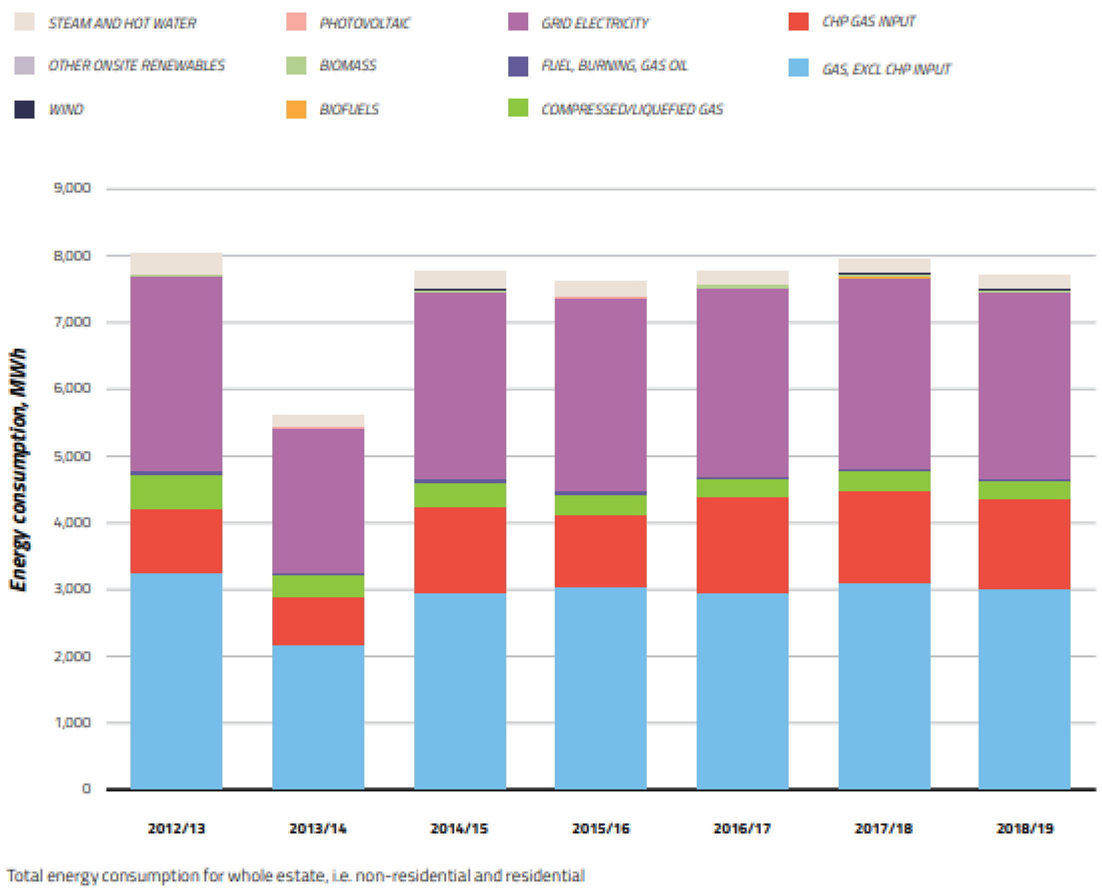


Figure 3: total energy consumption.

Natural gas continues to dominate across university estates (60%) (see figure 3 above). Approximately 50% of estates' carbon emissions are from natural gas. Universities' commitments to net zero will require a significant reduction in the consumption of gas, and investment in alternative low carbon heat sources such as air, ground or water source heat pumps, as well as biomass/biogas solutions and potentially hydrogen.

2 Summary of key findings from the survey

Appendix A presents the result of a survey of University estates staff, carried out in September 2020 and validated at a workshop. Thirty-seven universities responded to the survey. These universities are listed in Appendix B.

It should be noted the universities that responded were self-selecting rather than randomly selected. Therefore, they are not necessarily representative of universities in general and may present the views of those that have the highest level of interest in energy systems and the transition to net zero carbon. However, they are located throughout England, Scotland and Northern Ireland; some in the largest cities, some in smaller towns and others in out-of-town campuses. Their built environments encompass buildings from medieval times through to those built within the last few years.

2.1 Commitment and plans to deliver net zero

Over half of those responding to the survey have agreed a net zero target (54%), whilst the remaining universities (46%) are developing targets.

Of the 20 universities with an agreed net zero target, 5 have an action plan in place to deliver it, with the other 15 in the process of developing their plans.

This leaves 17 universities still developing their net zero targets. They are developing their delivery plans and are continuing to deliver carbon emission reductions without a target in place.

There were a range of barriers to delivering net zero commitments referenced by participants. Unsurprisingly, resourcing capacity was the key barrier identified by the majority of respondents, with 85% noting that they did not have the capability of resources to deliver net zero.

Thirty-one cited lack of investment budget, sixteen (57%) cited lack of time and eight (26%) cited lack of knowledge.

Almost half of respondents (46%) highlighted other barriers to delivery or solutions to these, including:

- Lack of technical, economic and political certainty, at the national and local levels
- Not yet knowing what resources would be needed as the path to net zero was not yet fully defined
- Lack of funding strategy to deliver heat decarbonisation
- Current budget constraints in general
- The need for behaviour change amongst staff, students and the public if net zero is to be delivered
- A lack of the correct structures in place to make things happen
- Conflicting organisational priorities
- Organisational inertia

Potential solutions to some of the barriers included:

- Partnerships with private sector organisations, which can greatly increase the capabilities and resources available within estates.
- The need for systems thinking and therefore partnership with local communities and stakeholders
- Using expert help when needed, paid for via a Salix Energy Investment fund for example.

Recommendations:

- Delivering the targets set requires more resource (both finance and human) and will require both capital and revenue investment to be made available. Chief Finance Officers (CFOs) will need to consider assigning budgets to these investments as part of medium-long-term planning. CFOs may also want to position themselves with Government for grant funding (e.g. Public Sector Decarbonisation Fund) both individually or sector-wide via the British Universities Finance Directors Group (BUFDG).
- Working with the private sector, partnerships can greatly increase the capabilities and resources available to estate staff and help develop and deliver decarbonisation strategies and action plans.
- As noted below, there is a broader need for wider systems thinking around decarbonisation. Partnership with local communities and stakeholders, including local councils, businesses and the broader public sector organisations is recommended and could bring capabilities and resources available to estate staff to deliver on net zero ambitions as a result.
- Utilising expert resources, including those from support services is also recommended. Respondents noted that this could be paid for via the Salix Energy Investment fund.

2.1.1 Commitment from senior decision makers

We asked about the decision-makers on low carbon investments within universities: who they were, whether they were committed to decarbonisation and whether they listened to the estates teams' expertise.

The majority of respondents identified all or part of the senior leadership team as the final decision makers. Specific roles most often mentioned were the Vice Chancellor (or equivalent); Finance Director/CFO; and in some cases, Director of Estates. One or two referred to an additional level of approval required for particularly large investments.

There was also commentary about groups with influence on decision-making. This included estates team, along with environmental sustainability teams and/or faculty academic sustainability leads and technical experts.

Three respondents mentioned stakeholders from outside the university. These included local planning authorities, local communities, wider community partnerships and the private sector.

Recommendations:

- We would recommend that university senior leadership teams are briefed on climate change mitigation activities, but that this includes commentary on the future projections of both policy and costs of fuels, particularly natural gas. In our experience, business cases for investment in gas CHP haven't accounted for the rising costs of gas, or the likely change in taxation from electricity to gas.

2.1.2 Alignment of procurement processes in meeting net zero

We asked if procurement processes were aligned with meeting carbon targets and whether they enabled respondents to take an overall view of the university's energy system requirements.

Over half (57%) of respondents thought that procurement processes were aligned with meeting carbon targets. Out of the 15 respondents that felt that there wasn't alignment, three felt that action was being undertaken to resolve this issue.

A majority of respondents felt able to take an overview of the university's energy system requirements however, although not necessarily within procurement processes themselves.

More than half of the respondents who considered their university's procurement processes to be well aligned with carbon targets also thought that the processes enabled them to take an overall view of the university's energy system requirements, either through general procurement processes or specific, high-level mechanisms. One respondent noted that procurement processes were reviewed annually as part of the format ISO 50001 Energy Management System audits, and another that the process was managed for the university by external consultants who procure energy for all the university sites.

One commented that, although processes were aligned, the university was actively seeking new ways to ensure delivery, such as early engagement with contractors to ensure success and minimise risk.

Six respondents commented that there was some degree of silo working, although three of these mentioned ongoing works to overcome this, such as the development of a university energy master plan.

One respondent noted a capacity issue: whilst procurement processes were generally supportive, there is a lack of knowledge for what are often quite bespoke procurement arrangements.

Five respondents who did not consider procurement and net zero to be well aligned nonetheless felt they could take an overall view of energy system requirements.

Others felt there was a more mixed picture. One noted that carrying out OJEU compliant processes resulted in elements spread across multiple contractors.

Recommendations:

- Consistent alignment of net zero ambitions with procurement. This could include:
    - Reviewing procurement processes as part of ISO 50001 Energy Management System audits.
    - Early engagement with contractors to ensure success and minimise risk. This could include external consultants who procure energy for all the university sites.
    - Breaking down silo working, including through the development of a university energy master plan.
    - Upskilling staff in procurement processes to enable a greater understanding of OJEU compliant processes and bespoke procurement arrangements.

2.1.3 Support from the private sector

Our survey looked to understand what support could be sought from the private sector in order to facilitate the transition to net zero.

Fifteen respondents mentioned funding or finance (including Energy Service Company (ESCo) approaches, Energy Performance Contracts (EPC) and Power Purchasing Agreements (PPA). Linked to these were references to support in developing business cases and funding strategies.

Eleven respondents mentioned technical support, either in general or specifically related to particular technologies or solutions they were actively considering with the private sector.

Four respondents mentioned innovation or contribution to the university's vision and strategy. Also included were references to feasibility studies, better measurement of the university's carbon footprint (e.g. embodied carbon), implementation of projects, and the maintenance and management of assets.

Four respondents focused on long-term partnership working, with two of these highlighting the potential for universities to be used as testbeds for innovation in the energy sector and the fact that such partnerships could provide mutual benefits.

Recommendations:

- Partnership working with the private sector can enhance capacity and capability within teams, through technical support, as well as access to ESCO, EPC and PPA contractual models, and the development of business cases and funding strategies associated with these.
- The opportunity of long-term partnership working between universities and the private sector should not be underestimated. Such models can enable universities to be used as testbeds for innovation in the energy sector.
- ADE can act as an independent interface between universities and private sector supply chain to facilitate this interaction.

2.2 Estate activities

We asked respondents to detail current and planned activities in their estates. This included energy use in buildings, their plans for energy performance upgrades of both building fabric and infrastructure and current and planned expansion of on-site heat and power supply assets.

2.2.1 Energy use in buildings

All respondents noted that their universities have data on energy use in their buildings, with the majority having spatially and temporally disaggregated data.

Headline findings were that:

- 97% of respondents had energy use per building
- 92% had Energy Performance Certificate (EPC) data for their buildings.
- 94% had visibility on monthly variations of energy use in their buildings, while 84% had visibility of data throughout the day.

These statistics on data are not necessarily comprehensive. In many cases, more temporally disaggregated data may only be available for a proportion of the building stock. However, a large proportion of respondents referred to a significant and increasing proportion of energy use where half hourly, or in a small number of cases more frequent, data collection was happening.

A key finding was that there was a stark difference between the availability of disaggregated data for electricity and heat - with far more disaggregated data available for electricity.

Energy management systems are in use in many of the universities. This included ISO50001 compliant systems and broader monitoring software and exception reporting systems.

A number of respondents noted concerns about data comprehensiveness and accuracy, citing meter breakdowns and automated collection systems going offline as particular issues.

A small number of respondents noted a lack of resource to make best use of the available data to tackle energy use issues.

Recommendations:

- Resources are required to enable universities to gain better access to data to tackle energy use issues.
- Recommendation for an increase in access to disaggregated data, with a focus on heat data in particular.

2.2.2 Plans for energy performance improvement

All respondents included some information about plans for energy performance improvement. In some cases, this involved continuing or increasing existing levels of activity, while other universities were at the stage of data collection and action planning.

Investments in building fabric improvements, lighting upgrades, more efficient equipment and controls, and ventilation were all mentioned, as was fuel switching and the use of waste heat.

The need for a better understanding of energy use was noted by a minority of respondents, as were engagement of users and looking at the use of space (in one or two cases including considering the demolition of some buildings).

2.2.3 On-site heat and power supply assets

The universities responding to the survey detailed their heat and power supply assets on their campuses.

- Thirty-six (97%) of the 37 responding universities have some on-site heat and power supply assets.
- Thirty-three (89%) have solar photovoltaics and/or solar thermal plant.
- Twenty-nine (78%) have heat networks.
- Twenty-eight (76%) have combined heat and power (CHP) plant.

There were concerns raised during the validation workshop what to do with high carbon heat assets. This includes both CHP and heat networks running on natural gas, as well as diesel back-up generators, and those using energy from waste.

While several universities have begun the transition to net zero, with the installation of heat pumps and biomass technologies, there is still nervousness and confusion around what to do with high carbon assets. The delay of the Heat and Buildings Strategy (expected Summer 2021) and the review of carbon taxation by HM Treasury (date unknown) leaves asset owners in an unknown position.

Industry has responded to this, with propositions that facilitate the transition. For example, ADE member Aggreko has a loan offer on new CHP units. Rather than purchasing a new gas engine, this type of proposition provides a short stop gap for those unsure how to take the next step with decarbonisation.

Schemes such as the Public Sector Decarbonisation Scheme (PSDS), the Heat Networks Investment Project (HNIP) and Low Carbon Infrastructure Transition Programme (LCITP), and their successor programmes, will be able to support the sector in the transition.

2.2.4 Other assets

A number of other on-site assets were recorded by respondents:

- Eight operate Ground Source Heat Pumps (GSHP).
- Five operate Air Source Heat Pumps (ASHP).
- One operates Water Source Heat Pumps (WSHP).
- Five have biomass boilers.
- Two have wind turbines.
- Three mentioned thermal stores.
- One mentioned a large battery.
- Two mentioned diesel back-up generators.

2.2.5 Expansion of on-site heat and power

Twenty-seven universities (73%) have plans to increase their amount of on-site heat and power. For a number, the expansion plans are at an early stage and not detailed as yet.

We identified lack of staff resources, lack of financial resources, lack of knowledge about available options, and unhelpful contracts or relationships with energy and equipment suppliers as potential barriers to expansion. We asked respondents about these barriers specifically and also gave them the opportunity to tell us about other barriers.

All respondents identified at least one barrier.

- Lack of financial resources was the most frequently cited, with 26 respondents (70%) agreeing that it is a barrier.
- Twelve respondents (32%) selected lack of staff resources as a barrier.
- Four (11%) selected lack of knowledge about the available options.
- Two (5%) selected unhelpful contracts or relationships with energy or equipment suppliers.

2.3 Providing system services through flexibility

Two of the universities responding to our survey currently have contracts to provide flexibility services to the electricity network, and a number of others reported investigating the potential for this and/or taking part in demonstrators/trials. Twenty universities, including the two that already have contracts, plan to offer flexibility services in the future.

Commenting on existing flexibility contracts of activities, respondents mentioned contracts for Short Term Operating Reserve (STOR), Capacity Market and Triad management services and scheduling loads to avoid Distribution Use of System (DUoS) charges; and one referred to participation in trials of local flexibility markets.

One respondent mentioned that they had commissioned a feasibility study on this type of activity, but this found that the campus did not have any assets that would provide a financial return. Another noted limited ability to shed load across the campus at peak demand during the winter.

Additional comments provided in relation to future plans in this area included:

- The need for a mature market in flexibility services and availability of longer-term financial benefits.
- The fact that at the moment, this sort of action seems to require a lot of on-site resource and knowledge, which may not be available.
- The apparent complexity of the technologies and agreements involved.
- Concerns about cyber-security.
- Consideration of battery storage as a key element.

Several respondents commented that they were considering participation in flexibility markets as part of the wider development of university energy systems.

Recommendations:

- AUDE and SAUDE members should consider engaging with **Flex Assure**, which is a Code of Conduct and voluntary compliance scheme for flexibility services providers, setting standards and promoting best practice in the energy flexibility sector. They are currently working on raising awareness of the Scheme amongst energy users, to make sure energy users engaging with flexibility services providers (DSR aggregators) are aware of the resources available to them.

Essentially, Flex Assure offers energy users a set of standards against which flexibility services providers can be assessed, and provides assurance of the quality of service they can expect when engaging with companies signed up to the Scheme.

2.4 The role of universities within the wider energy system

We asked about the role of their university within the wider energy system: what role the university wished to play, and how it was acting to implement this.

We offered four pre-defined roles and the option to add other roles if appropriate.

- Thirty-four respondents (92%) said they were working with / wanted to work with the local authority / Local Enterprise Partnership (LEP).
- Thirty-one (84%) said that their role involved / should involve students and staff in the wider community.
- Twenty-two (59%) mentioned partnerships with local businesses, and 24 (65%) mentioned partnerships with other local universities.
- Other partnerships mentioned included: city regions and devolved administrations; the NHS; local Climate Change Partnerships; and local Chambers of Commerce.

In response to the question on what the University is doing to develop its wider role, the following activities were mentioned:

- Carrying out research relevant to the energy transition.
- Having a campus that is home to Europe's largest Smart Energy Network Demonstrator.
- Participating in trials of hydrogen in the gas grid or in demonstrator projects for smart local energy networks.
- Working with local partners on the development of heat networks, including joint bids for funding.
- Working with local public sector partners on joint energy procurement.
- Active membership of the Local Enterprise Partnership, or city energy or environment partnerships.
- Working with the local authority's climate change commission or helping to develop a local Energy Strategy.
- Signing up to local commitments to be carbon neutral by an agreed target date.

3 Moving forward

There are a range of actions for AUDE and SAUDE to take forward to support net zero and heat decarbonisation activity in the university sector.

3.1 A collective voice with lobbying

Members of AUDE and SAUDE should use their collective voice to lobby for changes to policy and programmes at a national level, and within the University sector, to ensure that policy and programmes support the university sector to decarbonise. Together – as a collective voice - you will be stronger. Collectively, universities can help deliver significant carbon reductions in the UK.

This activity needs to include advocacy on:

- Long-term heat network and heat decarbonisation policy, giving confidence to both universities and the wider industry to take action.
- Long-term heat network and heat decarbonisation support programmes, such as the forthcoming Green Heat Networks Fund, to ensure that support, grants and finance is open and made accessible to the university sector, but also that the implementation of these services are well designed (e.g. funding rounds have realistic timescales for applications, and technology choices are not restrictive).
- The increase of resourcing levels to support activity (CFOs).

3.2 Working in partnership with the ADE

The survey responses have already informed ADE's work on the role of the public sector in the transition to net zero. We thank all participants in responding to the survey.

Going forward, we would like to continue our engagement with AUDE and SAUDE, attending sustainability group and other meetings, flagging policy and programme updates, directing feedback to support schemes (e.g. Salix on the application process for the PSDS) and facilitating the introduction of the private sector (where appropriate).

In terms of policy updates, the ACE-R team needs to strike a fine balance between sharing information to the group, whilst not sharing content that is available to paid ADE members (some of which are also members of AUDE and SAUDE. With this in mind, we will summarise policy headlines and the latest ADE positions.

The team will spend 6 days per year working with AUDE and SAUDE. We feel that engagement with the group provides us with useful insights unavailable elsewhere, and therefore this support will be delivered at no cost.

Appendix A: Survey of Universities' energy systems and plans for the transition to net zero

Introduction

This annex presents the result of a survey of University estates staff, carried out by the Association for Decentralised Energy, in co-operation with the Association of University Directors of Estates (AUDE) and the Scottish Association of University Directors of Estates (SAUDE). The survey was carried out in September 2020, and 37 Universities provided responses. These universities are listed in Appendix B to this report.

Please note that the universities that responded were self-selecting rather than randomly selected. Therefore, they are not necessarily representative of universities in general and may present the views of those that have the highest level of interest in energy systems and the transition to net zero carbon. However, they are located throughout England, Scotland and Northern Ireland; some in the largest cities, some in smaller towns and others in out-of-town campuses. Their built environments encompass buildings from medieval times through to those built within the last few years.

The survey responses will inform ADE's work on the role of the public sector in the transition to net zero and help shape a workshop with AUDE and SAUDE members on how to further develop and decarbonise university heat networks.

Commitments and plans for the transition to net zero

All respondents to the survey are responding to the challenge of the transition to net zero.

- Twenty of the 37 (54%) universities have an agreed net zero target; the remaining 17 (46%) are developing one.
- Five (25%) of the universities with a target have a plan in place to deliver it; the other 15 (75%) are in the process of developing their plans.
- Two (12%) of the universities that do not yet have a target nonetheless have plans to deliver carbon emissions reductions.
- The remaining 15 (88%) are developing delivery plans.

Delivering these commitments

Only 6 respondents (16%) felt they had all the capabilities and resources to deliver net zero. Thirty one (84%) did not. We identified lack of staff time, lack of staff knowledge and lack of investment budget as potential barriers. Twenty three of the thirty one respondents (74%) who felt they did not have the capabilities and resources to deliver net zero identified cited lack of investment budget, sixteen (57%) cited lack of time and eight (26%) cited lack of knowledge. Seventeen of all respondents (46%), including three who stated they did have the means to deliver net zero, commented about other barriers to delivery, or solutions to these. The barriers included:

- Lack of technical, economic and political certainty, at the national and local levels
- Not yet knowing what resources would be needed as the path to net zero was not yet fully defined
- Lack of funding strategy to deliver heat decarbonisation
- Current budget constraints in general
- The need for behaviour change amongst staff, students and the public if net zero is to be delivered
- A lack of the correct structures in place to make things happen
- Conflicting organisational priorities
- Organisational inertia

Potential solutions to some of the barriers included:

- Partnership with private sector organisations, which greatly increases the capabilities and resources available
- The need for systems thinking and therefore partnership with local communities and stakeholders
- Using expert help when needed, paid for via a Salix Energy Investment fund.

Commitment from senior decision-makers

We asked about the decision-makers on low carbon investments within universities: who they were, whether they were committed to decarbonisation and whether they listened to the estates' teams' expertise.

The majority of respondents identified all or part of the senior leadership team as the final decision makers. Specific roles most often mentioned were the Vice Chancellor (or equivalent); Finance Director/CFO; and in some cases, Director of Estates. One or two referred to an additional level of approval required for particularly large investments. A small number of respondents referred to specific decision-making structures and processes (e.g. key university committees, such as the environmental sustainability committee and/or the estates and infrastructure committee; or internal governance route for business case approvals).

Groups identified as having influence were wide ranging. In many cases the estates team were cited, as the technical experts, together with environmental sustainability teams and/or faculty academic sustainability leads. The potential influence of academics working on energy-related themes was mentioned by a couple of respondents, in particular where investments could have potential research benefits. Three respondents mentioned stakeholders from outside the university: local planning authorities, local communities, wider community partnerships and the private sector.

Alignment of procurement processes in meeting net zero

We asked if procurement processes were aligned with meeting carbon targets and also whether they enabled respondents to take an overall view of the university's energy system requirements.

Twenty-one (57%) thought that procurement processes were aligned with meeting carbon targets whilst 15 (41%) did not. Three of the respondents who did not think processes were well aligned did think that the situation was improving, however. In both cases, a majority of respondents felt able to take an overview of the university's energy system requirements, although not necessarily within procurement processes themselves.

More than half of the respondents who considered their university's procurement processes to be well aligned with carbon targets also thought that the processes enabled them to take an overall view of the university's energy system requirements, either through general procurement processes or specific, high-level mechanisms. One noted that procurement processes were reviewed annually as part of the format ISO 50001 Energy Management System audits, and another that the process was managed for the university by external consultants who procure energy for all the university sites.

One commented that, although processes were aligned, the university was actively seeking new ways to ensure delivery, such as early engagement with contractors to ensure success and minimise risk.

Six respondents commented that there was some degree of silo working, although three of these mentioned ongoing work to overcome this, such as the development of a university energy master plan.

One respondent noted a capacity issue: whilst procurement processes were generally supportive, there is a lack of knowledge for what are often quite bespoke procurement arrangements.

Five respondents who did not consider procurement and net zero to be well aligned nonetheless felt they could take an overall view of energy system requirements. Others felt there was a more mixed picture. One noted that carrying out OJEU compliant processes resulted in elements spread across multiple contractors.

Support from the private sector

We asked what help universities would like from private sector partners.

Fifteen respondents mentioned funding or finance with some of these specifying interest in specific arrangements such as Energy Service Company (ESCo) approaches / Energy Performance Contract (EPC) arrangements or Power Purchase Agreements (PPAs). Linked to this were mentions of help to develop business cases and funding strategies. Eleven mentioned some type of technical support, either in general or specifically related to particular technologies or solutions they were actively considering. One respondent mentioned a specific local barrier of grid constraints that they would like the private sector to resolve.

Four respondents mentioned innovation or contribution to vision and strategy. Feasibility studies, better measurements of elements of the carbon footprint (e.g. embodied carbon), implementation of projects, and maintenance and management of assets were all mentioned by at least one respondent.

Four respondents focused on long-term partnership working, with two of these highlighting the potential for universities to be used as test-beds for innovation in the energy sector and the fact that such partnerships could provide mutual benefits.

Estate activities

Energy use in buildings

All the universities have data on energy use in their buildings, with the majority having spatially and temporally disaggregated data.

Data type	No. universities holding this type of data	% of all respondents
Energy use per building	36	97
Energy Performance Certificate ratings	34	92
Monthly variations in energy use	35	94
Daily variations in energy use	31	84
Variations in energy use within a day	31	84

These data are not necessarily comprehensive. In many cases, the more temporally disaggregated data may only be available for a proportion of the building stock. However, a large proportion of respondents referred to a significant and increasing proportion of energy use where half hourly, or in a small number of cases more frequent, data collection was happening. A number noted the difference between electricity and heat; with far more disaggregated data available for electricity.

Energy management systems are in use in many of the universities. Two respondents specifically referred to ISO50001 compliant systems; others referred to the use of monitoring software and exception reporting systems.

A number of respondents noted concerns about data comprehensiveness and accuracy, citing meter breakdowns and automated collection systems going offline as particular issues. A small number of respondents also noted a lack of resource to make best use of the available data to tackle energy use issues.

Plans for energy performance improvement

All respondents included some information about plans for energy performance improvement. In some cases, this involved continuing or increasing existing levels of activity, while other universities were at the stage of data collection and action planning.

Investments in fabric improvements, lighting upgrades, more efficient equipment and controls, and ventilation were all mentioned, as was fuel switching and the use of waste heat.

The need for a better understanding of energy use was noted by a minority of respondents, as were engagement of users and looking at the use of space (in one or two cases including considering the demolition of some buildings).

The table below summarises the number of universities mentioning each of these types of energy performance improvement activity.

Action	No. universities including it in their plans
More efficient equipment and/or controls	22
Building fabric improvements	19
Lighting upgrades	16
Fuel switching (including to use of waste heat)	14
Collecting better data	4
User engagement	4
More efficient ventilation	4
Review space usage / demolish some buildings	3

4 On-site heat and power supply assets

Universities responding to the survey detailed their heat and power supply assets on their campuses.

- Thirty six (97%) of the 37 responding universities have some on-site heat and power supply assets.
- Thirty three (89%) have solar photovoltaics and/or solar thermal plant.
- Twenty nine (78%) have heat networks.
- Twenty eight (76%) have combined heat and power (CHP) plant.

4.1 Solar PV and thermal

Twenty nine respondents gave some further information about the solar PV and thermal assets. These are summarised in the table below; each row represents one university.

PV				Thermal				
No.	Power	Energy (/y)	Used	No.	Power	Energy (/y)	Used	Other comments
4		120MWh	2 on buildings on which they are located; 2 at an off-campus botanical site					
3	165kWp							
			In buildings not on the heat network					
	50kWp							
3	(very small)		Within buildings					
	300kWp					10MWh		
5	202kWp		On site	6			In student residences	Several of these have recently been decommissioned
3	100kWp		In buildings on which they are located					
13	428kWp			1	60kW			
5	100kWp		To support campus					
		5.5MWh	Halls of residence					
8	180kWp		On site					
9	231.1kWp							Range from 8.5kWp to 45kWp
2	18kWp		Buildings					
8	192kWp		Buildings					
	268kWp		Library and accommodation blocks	1			Hot water for campus nursery	
5	60kWp							
6			Academic buildings	1			Heat for an academic building	Thermal is a PV-T array
22	787kWp		Buildings	2	55kWp		Buildings	
1	22.95kWp		Main campus building					Provides a small portion of total electricity demand for the building

	480kWp		Buildings, inc hall of residence					
3			On site					
		1% total elec cons.						1.5MW solar farm under construction, 2 new small installations awaiting commissioning
5	50kWp	0.1% ann. energy req.		3				Issues with design of thermal systems means they have not yet made meaningful contribution
	>50kWp			6			Halls of residence and science block	Multiple PV systems, largest is 50kWp
5			To supplement grid supply					
4	101kWp		Buildings on which they are located					Range in size from 4kWp to 51kWp
22		688MWh						
7	>250kWp		Buildings on which they are located					Any excess exported from buildings is used elsewhere on campus, distributed via campus HV network

4.2 Heat Networks

Twenty five of the universities with heat networks provided further details about their networks, which are summarised in the table below, where each row represents one university.

No. networks and total power	Energy supplied	Fuels used	Via	Buildings supplied	Other comments
2 HN HN1: 12 MWth	35% of campus heat demand (HN1) and 15% of campus (HN2)	Gas		Academic and residential (HN1); halls of resident (HN2)	University operated
3 HN		Gas		30	One university owned, two landlord owned
2 HN HN1: 6.5MW		HN1:Wood chip; HN2 gas	HN1:Boiler HN2: CHP/boiler	HN1: 45 HN2: 5	More than 27km pipes
Use of 2 HN (other users also)	HN1: 11,000 MWh/ year HN2: 350 MWh / year (est.)	HN1: Waste incineration HN2: waste wood	HN2: 4-stage fluidised bed combustion	HN1: 17, total floor area of 120,000m2 (60%+ of university total). HN2:	HN1 serves city centre; HN2 operated by energy supplier, serving wider area

				New 4,500m2 research centre	
6HN	82,000MWh (approx. 57% of total heat demand)				Four networks operated by a university arms-length company; one operated by the university; one is an NHS heat network
3HN HN1:13.5MW	HN1: 21,267 MWh/year HN2: 945 MWh/year HN3: 48 MWh/year	HN1: gas/oil HN2: biomass HN3: gas	HN1: boilers/CHP HN2: boiler HN3: boiler	HN1: residences, offices, teaching spaces, swimming pool, commercial spaces HN2: 37 off campus town houses HN3: 11 town houses and 9 flats on campus	
1HN			CHP	9	Part of city HN
2HN	HN1: 10 GWh / year HN2: 2.5 GWh / year	HN2: gas	boilers	HN1: 4 HN2: 2	
7HN		gas		Academic and residential buildings	
1HN		Gas with oil for back-up			
2HN		gas	CHP / boilers		
2HN; 96MW total		gas	boilers		
1HN; 3.5MW		gas	CHP / boilers		
1HN; 45.8MW		gas	Boilers / CHP		
2HN	7 GWh / year	gas	boiler		
1HN	4 MWh / year	Wood chips	boiler	On site halls of residence	
1HN	19GWh / year	Gas / wood chips		Approx. 60% of buildings on campus	
1HN; 11.7MW	6 GWh / year	gas	Boilers / CHP	17. Academic, administrative, scientific	3.3km network
1HN		gas	CHP	Majority of site heating and hot water	
2HN HN1: 8MW HN2: 4.3MW		gas	HN1: boilers HN2: boilers/CHP	HN1: 13, academic, catering, office, residential	HN2 also has a thermal store

				HN2: large teaching building plus 700 bed residential building	
1HN			Reciprocating engine CHP	Majority of main campus	
1HN			CHP	Majority of main campus	
1HN; 27.3MW		gas	CHP/boilers	18 buildings	Also has 100m3 thermal store
2HN HN1: 7.5MWe HN2: 3.5MW		gas	CHP / standby boilers		Owned by Uni's wholly owned subsidiary energy company

4.3 CHP Plant

Twenty four respondents provided further information about their Combined Heat and Power assets. These are summarised in the table below, where each row represents one university.

No.	Total output	Fuel	Use	Other comments
1	200kWth; 140kWe	Gas	Heat in primary campus heat network; electricity on site via campus HV network	
9	1,605kWe	Gas	All on-site, predominantly with the building	2 x 50kWe, 3 x 140kWe, 3 x 240kWe, 1 x 365kWe
2		Gas	One serving a residence, one serving 5 buildings	
5			One feeding a heat network, together with gas boilers	Largest is 501kWe
5	8,044kWth; 7,773kWe	Gas		
1	1,500kWth; 1,500kWe	Gas	Heat in main campus heat network; electricity on-site via private HV network	
3	2,081kW		Heat network, single building and 10 buildings	1,200kW; 50kW; 380kW
7	2,200kWth; 1,700kWe	5 gas, 2 bio oil	All in on-site buildings	
5		gas	Academic and residential buildings	
5	12,500kW		Heat network and private wire systems	Approx 66% of heat and electricity is used by the university
1	1,700kWth; 1,600kWe		Via heat network	

4	2,714kWe	gas	Buildings	Under construction. 2,000kWe; 345kWe; 229kWe; 140kWe
3	3,200kWe		Via heat network	Expect to get approx. 3,500kWth
1	3,400kW	gas	Via heat network	
3	293kWth; 255kWe	gas	Academic buildings	150kWth/152kWe; 38kWth/25kWe; 105kWth/78kWe
2	334kWe	gas	Electricity to displace input; by-product heat to supplement gas via heating system	
1	2,000kWth 1,900kWe	gas	On campus	
1	1,200kWth		Heat network	
2	3,000kW	gas	Heat network	1,000kW; 2,000kW. Managed by 3rd party and heat(could be typo, may mean electricity) is sold to external parties
4	700kWth; 501kWe	gas	Heat network; teaching buildings and residences; sports centre, including pool	295kWth/250kWe; 271kWth/185kWe; 2 x 67kWth/33kWe
4			Heat network and individual buildings	
			Heat network serving majority of campus, plus individual buildings	
1	3,300kW	Gas	Buildings; heat is through heat network	
5	11,000kWe	gas	Heat networks, and on-site electricity network	

4.4 Other on-site assets

A number of other on-site assets were recorded by respondents:

- Eight operate Ground Source Heat Pumps
- Five operate Air Source Heat Pumps
- One operates Water Source Heat Pumps
- Five have biomass boilers
- Two have wind turbines
- Three mentioned thermal stores and one mentioned a large battery
- Two mentioned diesel back-up generators

5 Expansion of on-site heat and power

Twenty seven universities (73%) have plans to increase their amount of on-site heat and power. For a number, the expansion plans are at an early stage and not detailed as yet. For those where there are details, the information provided about these plans is summarised in the table below, with each row representing one university.

Solar PV/thermal	Heat networks	CHP	Other on-site assets	General comments
5.5MWp	Heat supply being increased; focus on low C heat sources and connection to existing HN; feasibility study on new low C HN to replace existing, but not yet fully costed or approved		1.8MW wind and 2MWh battery	Solar, wind and batteries in on-site renewable energy park, due to be generating by Aug 2021
	Procuring a HN	Procuring CHP for HN		Likely to produce 20GWh heat per year
	New town centre HN recently created; both HN being expanded; investigating low C heat provision for the networks			
	Evaluating development of new HN with local public sector partners	Likely to transition away from CHP to heat pumps to 2040		H2 opportunities will be assessed, particularly when there are R&D opps.
			Looking to heat new campus predominantly with waste heat from servers	May export heat in the summer via local HN
Exploring additional PV as part of net zero plan				
22MW solar farm with private wire to one Uni site	Feasibility study for HN on main sites underway		GSHP for new buildings, inc one with ~ 200 boreholes to meet heat demand of 2,793MWh	
2MW ground-based PV business case prepared	Significant investment in HN is in development		Wind? Subject to planning and nearby airport may be an issue	
Aim to use as much of city centre roof space as possible for PV		Decarb. of heat supply, beginning with bio-fuel CHP project		Exploring heat pump / electrification feasibility
			Assessing the feasibility of heat from water source heat pump	

		There is capacity to fit a CHP unit into the main campus		
		Removing gas fired wet heating systems and increasing GIA fed by CHP; replacing end of life CHP		
Exploring significant additional capacity, possibly as much as 5MW	Exploring extension of HN to all remaining buildings on campus		Exploring water source heat pumps to replace gas to feed HN	
250kWp in next 12 months; likely more after this				Plans for heat still in development
Further roll-out planned				Plans for heat still in development
Plans to increase 'considerably'	Feasibility underway			
		Plans to increase output are currently under review		
About to tender phase 1 of PV array (90kWp). Phase 2 will be 500kWp				Working on tech feasibility studies for heat decarb.
Some small plans to extend PV	No current plans to extend			

We identified lack of staff resources, lack of financial resources, lack of knowledge about available options, and unhelpful contracts or relationships with energy and equipment suppliers as potential barriers to expansion. We asked respondents about these barriers specifically and also gave them the opportunity to tell us about other barriers.

All respondents identified at least one barrier. Lack of financial resources was the most frequently cited, with 26 respondents (70%) agreeing that it is a barrier. Twelve respondents (32%) selected lack of staff resources as a barrier; 4 (11%) selected lack of knowledge about the available options; and 2 (5%) selected unhelpful contracts or relationships with energy or equipment suppliers.

Twenty respondents (54%) wrote about other barriers. These are collated in the table below, where we have also indicated which of the types of on-site heat and power assets we think they may apply to.

Barrier	Solar PV and thermal	Heat Networks	CHP
Physical / technical barriers			
Lack of space	x	x	x
All suitable buildings already connected		x	
Having used most of the geographical scope already	x	x	(x)
Understanding how to implement low carbon options in a dense urban environment	x	x	x
Solar thermal is too small scale and difficult to integrate	x		
Lack of demand for heat (no residential properties and no swimming pool)			x
Local grid capacity constraints mean we cannot export electricity to the local grid	x		x
Legacy of systems that operate at higher temperature than that of heat pumps		x	
Policy/regulatory/organisational barriers			
Planning issues	x	x	x
All university demand met, and no desire to supply to external customers	x	x	x
Constantly changing government policy and incentives / lack of policy visibility	x	x	x
Lack of certainty over future use of some buildings	x	x	x
Infrastructure needed for city-scale HN is not something the university can deliver on its own		x	
Need for Environment Agency permission related to use of water-source heat pumps			
Financial barriers			
Already have the most cost-effective system	x	x	x
Local grid capacity constraints mean that options other than CHP need to be considered for HN, and this can have cost implications	x	x	x
Combination of installation costs, diversity of building use, thermal losses and large central plant running costs mean that HN not cost effective or carbon saving without a free heat source		x	
The relatively low price of gas	x	x	x
Environmental barriers			
Concerns about carbon emissions from CHP (but other options likely to be prohibitively expensive)		(x)	x

6 Providing system services through flexibility

Two of the universities responding to this survey currently have contracts to provide flexibility services to the electricity network, and a number of others reported investigating the potential for this and/or taking part in demonstrators/trials. Twenty universities, including the two that already have contracts, plan to offer flexibility services in the future.

Commenting on existing flexibility contracts of activities, respondents mentioned contracts for STOR, Capacity Market and Triad management services and scheduling loads to avoid DUoS charges; and one referred to participation in trials of local flexibility markets. One respondent mentioned that they had commissioned a feasibility study on this type of activity, but this found that the campus did not have any assets that would provide a financial return. Another noted limited ability to shed load across the campus at peak demand during the winter.

Additional comments provided in relation to future plans in this area included:

- The need for a mature market in flexibility services and availability of longer-term financial benefits
- The fact that at the moment, this sort of action seems to require a lot of on-site resource and knowledge, which may not be available
- The apparent complexity of the technologies and agreements involved
- Concerns about cyber-security
- Consideration of battery storage as a key element

Several respondents commented that they were considering participation in flexibility markets as part of the wider development of university energy systems.

Over the past months, they have been engaging with a wide variety of associations to raise awareness of the Scheme through presentations, webinars and written content, and were wondering if this might be of interest to the SAUDE/AUDE membership, given many universities' involvement with energy flexibility.

Recommendations:

- AUDE and SAUDE members should consider engaging with **Flex Assure**, which is a Code of Conduct and voluntary compliance scheme for flexibility services providers, setting standards and promoting best practice in the energy flexibility sector. They are currently working on raising awareness of the Scheme amongst energy users, to make sure energy users engaging with flexibility services providers (DSR aggregators) are aware of the resources available to them. Essentially, Flex Assure offers energy users a set of standards against which flexibility services providers can be assessed, and provides assurance of the quality of service they can expect when engaging with companies signed up to the Scheme.

7 The role of universities within the wider energy system

We asked about the role of their university within the wider energy system: what role the university wished to play, and how it was acting to implement this.

We offered four pre-defined roles and the option to add other roles if appropriate. Thirty four respondents (92%) said they were working with / wanted to work with the local authority / Local Enterprise Partnership; 31 (84%) said that their role involved / should involve students and staff in the wider community; 22 (59%) mentioned partnerships with local businesses, and 24 (65%) mentioned partnerships with other local universities.

Other partnerships mentioned included: city regions and devolved administrations; the NHS; local Climate Change Partnerships; and local Chambers of Commerce.

In response to the question on what the University is doing to develop its wider role, the following activities were mentioned:

- Carrying out research relevant to the energy transition
- Having a campus that is home to Europe's largest Smart Energy Network Demonstrator
- Participating in trials of hydrogen in the gas grid or in demonstrator projects for smart local energy networks
- Working with local partners on the development of heat networks, including joint bids for funding
- Working with local public sector partners on joint energy procurement
- Active membership of the Local Enterprise Partnership, or city energy or environment partnerships
- Working with the local authority's climate change commission, or helping to develop a local Energy Strategy
- Signing up to local commitments to be carbon neutral by an agreed target date

Appendix B: Universities responding to the survey and attending the workshop

We would like to thank all universities taking part in this research project. This includes the 37 universities that took part in the survey, and those that inputted into the workshop.

University of Aberdeen

Aston University

University of Bath

University of Bedfordshire

University of Bradford

University of Bristol

University of Cambridge

Coventry University

University of Dundee

Durham University

University of Edinburgh

University of Glasgow

Keele University

Kings College London

Lancaster University

University of Leeds

University of Liverpool

Liverpool Hope University

University of Manchester

Newcastle University

University of Northampton

University of Nottingham

University of Oxford

Oxford Brookes University

University of Reading

University of St Andrews

Sheffield Hallam University

University of Stirling

Solent University

South Bank University

University of Sunderland

University of Strathclyde

University College London

Ulster University

University of Warwick

University of West London

University of Westminster