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BEIS Select Committee inquiry – decarbonising heat in homes

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The Centre for Research into Energy Demand Solutions (CREDS) is a five-year programme funded by UK Research and Innovation, comprising more than 20 UK academic institutions and over 140 researchers. Managing energy demand will help us achieve our goal to become a low carbon society, and CREDS' work addresses a broad range of issues to transform the energy demand sector.

CREDS responds to consultations and calls for evidence from government, agencies and businesses, providing insight and expertise to decision-makers.

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Summary – for more detailed evidence and discussion, please see pages 5-14.

Q1

- There has been no consistent policy approach to heat in the UK to date. A strategy for long-term commitment to heat decarbonisation is needed – CREDS hopes that the forthcoming Heat and Buildings Strategy will address this.
- A heat decarbonisation strategy should provide key actors with sufficient certainty to invest money/careers in businesses and technologies that will contribute to heat decarbonisation.
- Whatever policies are implemented, they will need to be amended periodically to take account of evolving relationships between different parts of the energy system.
- Transaction and financing costs for district energy investment are higher than in countries where there is established municipal provision.

Example: Greater London Authority has used its range of powers to implement a more co-ordinated approach.

Q2

- CREDS supports establishing targets for low-carbon heat technologies up to 2030; removing barriers to market-led deployment and identifying market segments and geographical areas where the market is capable of sustaining significant growth.
- Delays in deciding the future of the gas grid is holding back investment in new heat technologies (including hybrid heat pumps).
- There should be a clear ambition to reduce energy demand in the supply of heat, at the same time facilitating the deployment of low/zero carbon heat[1].

Q3

- Area-based strategies are likely to offer the best route to delivering low-carbon with a focus on the societal benefits of heat decarbonisation.
- The appropriate technology mix will vary, depending on the types, tenures and locations of UK housing.
- Appropriate approaches will include: district heating networks, heat pumps (including in communal and small-scale district heating applications), hydrogen and hydrogen-derived fuels, coupled with the integration of thermal and other forms of energy storage and new business models to open up flexibility services to households that wish to participate,

[1] The term low/zero carbon heat applies to technologies such as electric heat pumps and hydrogen-ready boilers, which, while not zero carbon now, have a high probability of becoming so before 2050.

while not excessively disadvantaging those households that are unable to, or do not wish to participate.

Q4

- The existing gas supply system is a challenge to the development of a low-carbon heat market. Clear decisions and a strategic approach to the future of the gas grid is needed.
- Potential medium-term constraints on the electricity system may be a barrier to the scaling-up of electric heating. Demand-response products and services, and technologies such as hybrid heat pumps, heat networks and energy storage could reduce the burden on the electricity network.
- A local system model for investment planning would help to reduce energy transition costs.
- Local and regional authorities can lead the delivery of low-carbon heat, with the engagement of energy network operators (including heat networks).

Q5

- Levies on energy bills without other actions are likely to be punitive for those on low incomes: the tax and benefits system is likely to offer a fairer way to share the cost burden.
- Targeting low carbon interventions in social housing is likely to benefit lower-income households, but low-income private renters will miss out.
- Heat-as-a-Service models may benefit households that cannot make up-front capital investment or that do not wish to participate in markets for flexibility services.

Q6

- The variety of UK housing stock needs to be acknowledged in any regulatory scheme, including the need to address existing problems such as damp.
- There needs to be trust in the low-carbon heat installation sector which should be supported by accreditation and training.
- Low interest loans (grants for low income households) will stimulate take up of new heating technologies.
- Local authorities should be given resources to manage the delivery of low carbon heat.

Example: Energy Efficient Scotland and Home Energy Scotland.

Q7

- Clearer consumer communication about low-carbon heating systems is needed.
- High standard low-carbon heat installations and good after-care are essential to build public confidence in these new technologies.

- Mandatory action will provide a clear direction of travel to stimulate the development of this market.
- New business models for heating services should be explored.

Q8

- Responsibility for low-carbon heat should be distributed appropriately across all levels of governance.
- Central government should take the lead in setting a multi-year policy framework, while local/regional authorities have experience of planning and co-ordinating policy delivery.

Example: Scottish Government's Local Heat and Energy Efficiency Strategies (LHEES).

1. **What has been the impact of past and current policies for low carbon heat, and what lessons can be learnt, including examples from devolved administrations and international comparators?**

There are multiple technological routes to low/zero carbon heat. The most important in the UK context make use of decarbonised electricity via electric heat pumps or hydrogen[2] (or hydrogen-derived fuels) via boilers or combined heat and power systems[3] including fuel cells, with potential contributions from solar thermal, industrial waste heat, biomass. A key question for deployment concerns the relationships between energy conversion technologies, energy vectors such as the electricity transmission and distribution system, the gas grid and heat networks, and end use systems such as individual dwellings. These relationships define a significant portion of the architecture of the whole energy system, and will be of critical significance in integrating very large inputs of renewable electricity generation and large stores of energy that will be needed, by the middle of the century, to achieve net zero emissions and ensure resilience and continuity of energy supply. All of the above results in a large number of potentially interesting configurations, only some of which have been actively considered.

The UK has lacked a consistent policy framework across the whole of this space. As an example, successive UK governments have been criticised for an intermittent approach to district heating development that undermines local capacities to deliver heat network infrastructure (Bolton & Foxon, 2015; Hawkey et al., 2016). Frequent changes to district heating policy have in the past 'undermined the development of schemes seeking to tackle fuel poverty and disincentivised long-term planning' (Bush et al., 2016: 94). This included curtailing the Community Energy Programme in 2006, the only significant UK public funding stream for local authority district energy development in the 2000s (Hawkey et al., 2016). More recently, it includes scaling back Energy Company Obligation budget and eligibility. The annual ECO budget (from December 2018 until March 2022) was halved from a previous projected £1.3 billion to around £640 million (2017 prices), and is now entirely directed to fuel poor households. Local authorities can work with energy suppliers to define eligible households, but there is no dedicated resource, or requirement, for area-based action (Wade et al., *forthcoming*).

London is a partial exception, due to the Greater London Authority utilising its particular powers and resources in order to: incorporate heat mapping into the *London Plan*; retain a zero carbon homes policy for new build (despite UK Government 2015 cancellation), and for non-residential from 2019; and introduce a carbon offset fund for borough authorities.

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[2] One of the consequences of the UK's adoption of a Net-Zero emissions target is hydrogen will need to be produced electrolytically, rather than from natural gas.

[3] Combined heat & power systems include fuel cells, reciprocating engines and gas or steam turbines, which are deployable across a six order of magnitude range of scale, from kW to GW.

The Heat Networks Delivery Unit, set up in 2013, provides funding and support for district heating planning (covering England and Wales) (Ambrose et al., 2016), but the associated £320 million Heat Network Investment Project (HNIP), announced in 2014 was delayed and has struggled to allocate funding. HNIP funding requirements mean that local authority-led projects (over £2.4m capex) drawing on HNIP lending do not add to national accounts (Triple Point Heat Networks Investment Management, 2018: 26). This has required new 'special purpose vehicle' (SPV) structures to be established, with potential for additional development costs.

Overall, there is need for a much stronger, long-term and consistent policy framework for heat networks (as well as wider heat decarbonisation). This provides long-term certainty to key actors including local authorities, finance and investors, and supply chain and contracting agents (who provide critical services such as operation and maintenance contracts) (for elaboration see Wade et al., 2019a). Transaction costs for district energy investment are higher than in countries where there is established municipal provision (Pöyry Energy, 2009) and more concerted effort in policy support is needed to bring down costs.

2. **What key policies, priorities and timelines should be included in the Government's forthcoming 'Buildings and Heat Strategy' to ensure that the UK is on track to deliver Net Zero? What are the most urgent decisions and actions that need to be taken over the course of this Parliament (by 2024)?**

With the publication of the CCC's Net Zero report in 2019, and the breakthrough in offshore wind and PV prices that has taken place since 2016, the UK has taken a decisive step towards the large-scale deployment technologies capable of delivering zero carbon. The key to sustaining and accelerating rates of change across the economy and in the mission-critical heat sector is:

- To set clear and measurable targets for the major low carbon heat technologies. We would suggest that these be set out to 2030 and then reviewed; and that they should be compatible with the expected 5th Carbon Budget. These targets should be backed by training and transitional support arrangements designed to support the necessary expansion of supply chains.
- To clear away or bypass obstacles to market-led deployment of low carbon heat technologies, both individually and in combination. One of the most important of these is the artificially low price for natural gas in the domestic sector (see e.g. Vivid Economics 2019) which will otherwise hold back deployment of all other options, including hydrogen.
- To identify market segments capable of supporting significant growth in rates of deployment of heat pumps and district and communal heat to 2030, without impacting

on the extent and viability of the existing gas grid. Off-gas grid homes and all new homes can in principle sustain most-or-all of the growth in heat pumps and heat networks over this period.

Among the most pressing and urgent decisions are those that concern the future of the gas grid, investment in 'no-regrets' district heating networks (which are heat source agnostic) (see for elaboration Hawkey et al., 2018), and radical new policy support for reducing energy demand in buildings (Eyre & Killip, 2019). **Lack of decisions about future of the gas grid is delaying other necessary investment in heat decarbonisation** (Rosenow et al., 2020). This delay will make it more expensive overall to decarbonise heat (Committee on Climate Change, 2019). Therefore, action must be prioritised now, without any further delay. Reducing energy demand, especially in buildings (new and existing), complements the decarbonisation of heat and may be a cost-effective alternative, for example to increasing radiator sizes to accommodate heat pumps and increase the efficiency of district and communal heating. It may also facilitate the deployment of hydrogen, by offsetting the reduction in energy transmission and distribution capacity that will result from conversion of the gas grid from methane to H_2. A major objective of all energy efficient retrofit should be:

- to fit or connect dwellings to low/zero carbon heating systems wherever this is feasible;
- where it is not, to ready them to be so equipped or connected in the future, for example by making it possible to heat them with heat at lower temperatures, and…
- building-in options to facilitate connection to low/zero carbon heating systems in the future.

3. Which technologies are the most viable to deliver the decarbonisation of heating, and what would be the most appropriate mix of technologies across the UK?

Because building types, thermal efficiency standards, tenures, etc vary, area-based strategies are likely to be one of the most suitable routes for planning and implementing heat decarbonisation and informing the technology mix in a given area (see for example, development of Local Heat and Energy Efficiency Strategies (LHEES) in Scottish policy) (Wade et al., 2019a, 2020b, *forthcoming*). Across all local areas, a heat hierarchy (see ADE, 2020: 14) should be the cornerstone, with socio-economic (rather than lowest short-term cost) assessment informing the technology mix. See for example the proposed multi-criteria socio-economic assessment tool for planning LHEES[4]. In short, the latter means the narrative around heat and hot water needs to change from focusing on the *business* case for low carbon heat to the *societal* case for heat decarbonisation (see Hawkey et al., 2018).

[4] https://www.gov.scot/publications/guidance-strategy-level-socio-economic-assessments-draft-methodology/

In relation to district heating networks, for example, using a societal case, with social rates of return in line with Treasury Green Book guidance, can secure better carbon and cost efficiencies, serving more diverse heat loads and circa 50% more heat demand from a single heat source (Bush et al., 2019; Hawkey et al., 2018). In some cities with high demand for heat and older buildings, multi-phase heat networks could be carbon and cost effective. Increasing investment in heat networks (which are heat source agnostic and can turn 'waste' heat from air, water and ground sources into a resource) could thus play a significant role in heat decarbonisation (Tingey & Webb, 2020a: 10), supporting economies of scale in energy conversion and storage, enhancing flexibility and resilience, and delivering high quality employment across the UK. In dense urban areas, serving multiple buildings from a single heat source connected to a heat network is generally more cost and carbon effective than using individual heating technology for each house/flat/office (such as individual domestic boilers or heat pumps). Heat networks can also reduce individual building maintenance costs, and improve air quality.

In low population density areas that are not connected to the gas grid, heat pumps are very likely to be the best option and should be committed to without delay. DSOs may need to be support to ensure that the capacity of the electricity distribution system is expanded in a targeted and cost-effective way. Hybrid heat pumps, both on and off the gas grid may well play a role by enabling the deployment of heat pumps while avoiding or delaying the need to reinforce the distribution grid. The demonstration of single-dwelling hybrids capable of operating on hydrogen or hydrogen-derived fuels would transform the long-term prospects of this technology.

But communal heating and small-scale district heating have the potential to transform the economics of heat pumps in these areas, through economies of scale in energy conversion, and technical support for design, installation and operation (see above), at the same time providing a platform for hybrid operation. Conversely, the fact that heat pumps can be deployed in unit sizes from kW to 10s of MW, coupled with economies of scale in heat storage, has the capacity to transform the viability of communal heating and small-scale district heating, and in the longer term, to provide a platform for deployment of a large number of heat- and co-generation technologies. Settlement density outside of dense urban areas is essentially scale-independent across a large fraction of the UK, which, among other things, opens up much of the off-gas area to heat pumps in combination with small-scale district and communal heating.

As noted above, thermal storage is likely to play a critical role, because it can provide grid flexibility services at lower cost than battery storage (Committee on Climate Change, 2019). Related to this point, electric heating systems should be installed with communicating

thermostats to permit operation of demand response programmes (i.e. users should at least have the technical potential to participate).

4. What are the barriers to scaling up low carbon heating technologies? What is needed to overcome these barriers?

The main barriers to scaling up low carbon heat stem from the highly established methane gas network, which provides the majority of heat to buildings and industry; competitively priced gas and reliable gas appliances enable building owners to use gas-fired central heating, which is widely taken for granted. New gas connections also continue to be installed. The effective price subsidy for domestic gas supply (VAT rate 5%), and reliance on gas heating as counterfactual in low carbon heat technical-economic feasibility studies, renders alternatives non-competitive. In addition, heat is unregulated, further weakening the business case for low carbon heat systems. Policy uncertainty, limited consumer protections for heat network customers, and limited supply chains, skills and expertise for alternatives to gas add to the difficulties (Hawkey et al., 2018; Wade et al., 2019a; Webb et al., 2017a). The poor performance of many existing district and communal heating systems is unfortunately a major problem. It is unlikely that this will be solved without significant development of regulatory and governance systems. Support should be provided for upgrading such systems so as to minimise reputational damage to heat networks more generally.

To overcome the barriers, government now needs to adopt a strategic approach, particularly over the future of the methane gas grid. This will minimise the potential for stranded assets. Adopting a whole local systems model for investment planning, including cost savings from building retrofit and demand management, is needed. This would help to reduce costs of the heat transition, by avoiding the potentially very high costs of electrification of all heat, resulting from the need to meet daily and seasonal demand peaks. It would also support use of large-scale waste, or residual, heat sources via heat networks, with thermal storage.

Local and/or regional authorities should have the following remit:

- powers to support area-based high standards of energy efficiency retrofit in all buildings;
- the ability to zone areas for specific heating systems where appropriate;
- the obligation, in designated heat network areas, to connect public buildings first, followed by larger commercial and domestic heat loads as buildings are refurbished;
- to ensure consistency and synergy between planning and building regulations;

In addition, gas, electricity and heat network operators need to engage systematically with local/regional authorities in network planning to ensure co-ordinated regional and national progress (Tingey & Webb, 2020a: 28).

This must be backed up with stable central government policy across electoral cycles, simple and multi-year funding programmes, and co-investment opportunities between public and private finance (such as regional energy efficiency funds – see Mayor of London's Energy Efficiency Fund (MEEF) as an example).

While not currently a significant problem, it is anticipated that constraints on the electricity network are likely to prevent a barrier to scaling up of electric heating in the medium term, and maybe sooner for the most acutely constrained localities (Western Power Distribution, 2020). It will be important that competitive demand response products and services are available on the market to help mitigate such challenges. Developments such as the introduction of market-wide half hourly settlement will make this more likely, but a watching brief is required so that further action is taken in good time if such challenges appears more imminent.

5. **How can the costs of decarbonising heat be distributed fairly across consumers, taxpayers, business and government, taking account of the fuel poor and communities affected by the transition? What is the impact of the existing distribution of environmental levies across electricity, gas and fuel bills on drivers for switching to low carbon heating, and should this distribution be reviewed?**

The systematic under-pricing of natural gas with respect to other energy carriers is a barrier to the deployment of hydrogen, heat pumps and increasingly to low carbon district heating. Dealing with this will be politically difficult, but ignoring it risks being self-defeating. There is scope for protecting vulnerable groups through coordination of taxation and benefits policies with energy pricing policy, and for example, making imaginative use of the principle of Winter Fuel Payments to offset the impact of higher gas prices on the less well-off.

Costs need to be distributed across society in an equitable manner so that we protect those who are living in fuel poverty and may be in hard to treat homes, to avoid them paying for policies that they cannot access themselves due to infrastructure constraints. General taxation is the fairest distributional system in the UK. By comparison, levies on energy bills are a regressive form of taxation, and punitive for those on low incomes.

Targeted energy efficiency interventions mean that a much higher proportion of social housing is in the top performing bands (A-C) than other tenures (48%, compared to 24% for owner occupied and 26% for private renters) (Tunstall & Pleace, 2018). Two key observations follow from this. First, similar targeting around low-carbon heating would likely allow both cost-savings (due to economies of scale) and potentially heating cost and comfort benefits to occupants who are likely to be on lower incomes. Second, private renters on low incomes are

particularly at risk of exposure to any bill increases associated with funding low-carbon heating, without the ability to take advantage of this funding themselves.

The introduction of business models such as Heat-as-a-Service, where the costs of new heating systems can be covered over time through bills, makes installation potentially more affordable to those with little access to upfront capital. This has been tried before in Great Britain, with the Budget Warmth tariff (introduced in the 1980s) offering heating system installation and constant heat for pensioners on low incomes. While that product did not ultimately endure (albeit attracting thousands of participating households at one point), advances in digital technology and user-centred design make it more likely (in principle) to succeed today.

6. **What incentives and regulatory measures should be employed to encourage and ensure households take up low carbon heat, and how will these need to vary for different household types?**

Any support scheme needs to take into consideration the UK's varied housing stock and that some buildings will have space restrictions on installing low carbon heat technologies. There are also interlinked problems such as dealing with damp **before** energy efficiency measures are in place and before low-carbon heating technologies have been installed. These incentives should be in place for the long-term to avoid stop-start programming that has makes it difficult to embed sustained progress.

Installations should be done by accredited installers, which will require support to secure necessary skills and sustain the supply chain. Easy to access interest free loans (self-funding/higher paid households) and grants (low income households) are needed; these also give certainty to the supply chain that investing in skills development is worthwhile. This must be coupled with reform of training for installers of low carbon technology, heating, and building tradespeople more generally. Crucially, this training must incorporate a 'whole house' understanding of building energy and low carbon heat (Clarke, Gleeson & Winch, 2017), and an advocacy role for supporting and encouraging the uptake of low carbon heat (Killip, 2020).

Local or regional authorities, with their partners, are well placed to coordinate retrofit programmes, secure economies of scale, and ensure a coherent local whole systems approach to heat decarbonisation. This could, for example, allow area-based social housing retrofit to extend to include nearby privately-owned homes and other buildings. Local authorities need appropriate funding, resources and powers to make this possible. Directly funding local authorities and their partners to provide retrofit works may reduce the transactions costs associated with requiring every single household independently to secure finance to decarbonise their own home (Gouldson et al., 2015).

There should be requirements for all public, private and third sector landlords to upgrade their buildings to meet net zero requirements. Information about and access to local networks of installers and area-based schemes (such as insulation programmes, district heating networks, and whole house retrofit) are essential to allowing all household to participate and to access simple and cost-effective routes to reducing the need for energy use to heat their homes. The recently-launched Green Homes Grant in England has experienced early challenges (short time frame, lack of accredited installers to meet demand) and is yet to demonstrate its effectiveness. In Scotland, Energy Efficient Scotland is the long-term policy to improve access to and delivery of energy efficiency and low carbon heat. Home Energy Scotland helps people to access information and support for domestic energy efficiency, including area-based schemes operating where they live, such as internal wall insulation schemes.

There needs to be stronger consumer regulation around heat-related products and services so that customers feel they can advance into a market in which they have little experience with confidence and protection. There is evidence of frustration with the lack of regulation around heat networks (McGrail, 2018) (currently being addressed). Government cannot afford to let similar frustration and mistrust develop around new heat offerings intended to support uptake of low-carbon heat.

7. **What action is required to ensure that households are engaged, informed, supported and protected during the transition to low carbon heat, including measures to minimise disruption in homes and to maintain consumer choice?**

It appears that around 82% of people in the UK are happy with their heating system (Sovacool et al., in review): gas boilers are easy to use, quiet and controllable, but the contentment appears to generalise to other technologies, provided they are competently installed (Lowe et al. 2017). This suggests that consumer choice need not be a dominant factor in the transformation of heating provided installations are completed to high standards and that after-care is supported by competent supply chains.

All low-carbon heating technologies will require some disruption for the householder. Public engagement has been limited to date (Wade et al., 2019a). Energy literacy, engagement, willingness and 'prosumerism' should not be relied on as the basis for meeting energy and climate policy goals. National and local campaigns about the opportunities and routes to upgrading homes are required. This includes need for much clearer communication about upgrading homes to improve warmth, aesthetics, comfort and property value (for homeowners) (Brown, 2018). Local 'one-stop-shop' providers that are able to coordinate retrofit are one useful route to making it straightforward for households to access information from a single source and secure a single supplier/contractor to complete their retrofit (including managing any sub-contracting) (Brown, 2018).

Action needs to be mandated for owner occupiers, social housing, and private landlords. Consultation by BEIS on action in the private rented sector in England and Wales is a step in the right direction. Mandatory action, with a sufficient lead in time, will provide a clear direction of travel and momentum, acting as stimulant for market development. This will be important for homeowners, but also for businesses and supply chains, who will be motivated to engage because of the certainty associated with forthcoming mandatory action. Supply chain actors (for example, salespeople and those involved in the installation and maintenance of technologies) are trusted by homeowners (Wade et al., 2017), and with certainty about future mandatory action, they would be well positioned to promote retrofitting amongst their homeowner customer base (for elaboration see Wade et al., 2019a).

There should be greater promotion of different heating-related business models. These include Heat-as-a-Service (where customers pay for heat outcomes such as a warm home rather than units of energy) and heat-specific energy tariffs (which may come bundled with a heating system). Both options may be more attractive to customers for whom the upfront costs of installing a new heating system is a barrier. However, it is important that any such promotion is accompanied by strong regulatory protection, such as how the costs of new heating systems which are being paid for in instalments through bills are dealt with if a customer would like to switch supplier.

8. **Where should responsibility lie for the governance, coordination and delivery of low carbon heating? What will these organisations need in order to deliver such responsibilities?**

Responsibility should be shared between central and local or regional governments. Central government (e.g. BEIS, MHCLG, HMT) has an essential role in providing a clear multi-year policy framework with commensurate funding, a strong regulatory framework for consumer protection, equal treatment of heat network operators with other energy utility providers (gas and electricity), and developing (in partnership with local authorities) new statutory powers and responsibilities for local heat decarbonisation planning and implementation.

Local and regional authorities are then well placed to take responsibility for planning and co-ordinating delivery with cross-sector partners (Webb & Hawkey, 2017). Local authorities already have experience of retrofitting buildings and developing heat networks (Tingey and Webb 2020b; Wade et al., 2020; Webb et al., 2017b). However, they have struggled to assemble capacity to invest in a long-term strategic programme of heat decarbonisation in the absence of supportive public policy, powers, resources and expertise. Central government has a responsibility to address these issues, including empowering local authorities, and providing new resources, to develop and implement local heat plans. Local powers need to

include zoning areas for certain technologies such as heat networks (Hawkey et al., 2018: 8-9; Webb et al., 2017a: 15-19).

One approach piloted by Scottish Government is Local Heat and Energy Efficiency Strategies (LHEES). Evaluation of the LHEES pilots (Wade et al., 2019b) found that local authority officers believed that their authorities were well-placed to undertake energy planning, and supported LHEES becoming a statutory duty, on condition that resourcing and technical support are established. Strategic local energy planning would be prioritised in the council only through a statutory duty.

It will be important that regulatory responsibility with regard to heat-specific products (rather than simply electricity or gas) is clear, and it is reasonable that this should reside with Ofgem. This is important because products which involve payment for heating technologies through bills may come with long contracts that are difficult for customers to get out of or otherwise challenge (e.g. if promised levels of service or cost are not being adhered to), and clarity is needed on how such situations are regulated.

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