Final stage impact assessment

Title:	First Phase Regulations of relevant Energy Smart Appliances
Type of measure:	Secondary Legislation
Department or agency:	Department for Energy Security and Net Zero
IA number:	…
RPC reference number:	N/A
Contact for enquiries:	…
Date:	12/11/2025

1. Summary of proposal

The first phase of Energy Smart Appliance (ESA) regulations aims to cover the parts of the Smart Secure Electricity Systems (SSES) programme that will benefit from regulation at this stage, including but not necessarily limited to:

- a smart mandate for certain Electric Heating Appliances (EHAs), including hydronic and hybrid heat pumps, storage heaters, heat batteries, and hot water storage and generation.
- minimum cyber security requirements and minimum grid stability requirements for all relevant ESAs.
- minor amendments to The Electric Vehicles Smart Charge Points (EVSCP) Regulations (2021) as recommended in the process evaluation.[1]

The aim of this is to increase Consumer-Led Flexibility (CLF) usage, reducing bills for households who are able to flex their electricity use and reducing wider electricity system costs.

[1] Electric vehicles regulations 2021: Smart charging process evaluation - main report

2. Strategic case for proposed regulation

ESAs could enable significant CLF and, in turn, deliver benefits to consumers and the electricity system, if taken up at scale. Government's 2022 Electricity Networks Strategic Framework estimates system savings of £40b-£50b from 2022 to 2050[i].

In all future scenarios we expect the electrification of heat, primarily through heat pumps, to play a significant role in decarbonising heating, and we have committed to grow the market for heat pumps to 600,000 installations per year by 2028. Over time, this will significantly increase the demand on the electricity network, causing increased requirement for generation capacity plus new network reinforcement, threatening energy security. The costs to support this are typically distributed onto consumer bills. Deploying electric heating appliances, including heat pumps, in a smart and flexible way can reduce the requirement for large increases in generation capacity and support the balancing of the electricity system, as well as reducing running costs for households. Without clear requirements set for industry, it is unlikely that the market will deliver smart heating that provides sufficient grid and consumer protection, at least in the short term.

Therefore, to ensure a more socially optimal level of deployment, government can act to address the following market imperfections: a) incomplete information - lack of awareness by consumers of the personal benefits of ESAs; b) limited consumer incentives – uptake below social optimum to realise the positive externality of the greater societal benefits; c) coordination failures which could lead to a 'first mover disadvantage' for manufacturers and suppliers; d) risks to consumer trust if cybersecurity, data privacy, and interoperability risks are not managed appropriately; e) risks to the positive externality of system stability if cybersecurity risks are not managed appropriately.

3. SMART objectives for intervention

The government is proposing to set regulatory requirements for relevant ESAs from 2028. The main objectives of this proposal are to:

- Provide certainty of government's intentions for the market in the sector, to help rectify the coordination failure between the availability of ESAs and smart tariffs, and enabling electricity system benefits and consumer rewards.
- Ensure minimum levels of functionality of ESAs to protect consumers and the system and limit grid-stability and cyber-security risks, which we anticipate becoming very large beyond 2028 if no intervention is taken.
- Enable the GB marketplace to be at the forefront of an emerging sector. This should help drive faster and higher levels of product development and uptake in the sector[2].

[2] The Smart Charging Process Evaluation for the 2021 EVSCP regulations found a significant increase of 28% to 94% in smart functionality was recorded when the regulations came into effect. Process evaluation of the Electric Vehicles (Smart Charge Points) Regulations 2021 - GOV.UK

4. Description of proposed intervention options and explanation of the logical change process whereby this achieves SMART objectives

Option 2 (preferred option): A phased regulatory approach is required to ensure smart EHA are installed ahead of mass uptake of EHAs, to avoid future would-be smart users being stuck with non-smart EHAs. This will maximise the potential of CLF to reduce the need for network reinforcement and benefit consumers by reducing energy bills.

Under this option, the Government will implement regulatory requirements for the selected relevant ESAs in GB. From the 1st January 2028, all new relevant ESAs[3] sold in Great Britain must meet device-level requirements. This includes the following:

- **Smart functionality[4]** - An ESA has smart functionality if it is able to send and receive information and respond to messages by increasing or decreasing the rate of electricity flowing through the ESA and shift the time at which electricity flows through the ESA. A relevant ESA should also be able be capable of supporting CLF services.

- **Personalised default settings** – An ESA must invite the user to set default usage hours before it is first used. The device must be pre-set with a usage schedule that does not charge the ESA at peak times.

- **Cyber and data security** – An ESA must have appropriate basic security measures to ensure that its functions are resilient to cyber-attack. Furthermore, an ESA must be designed and manufactured to provide an adequate level of protection against physical damage to the device.

- **Randomised delay function** – An ESA must be configured in a way which ensures that when it responds to information received and adjusts the rate of electricity flowing through it, it applies a randomised delay of up to a certain number of minutes; and permits the user of the ESA to override the random delay.

- **Assurance** – Any person/organisation selling an ESA must provide a statement of conformity and a technical file, at the request of the regulator.

- **Monitoring and recording energy usage** – An ESA must measure or calculate the electricity consumed, the time the event lasts and provide a method for the consumer to view this information.

- **Safety** – ESAs should operate in a way that prioritises safety over smart operating behaviour.

This regulation will require that all relevant ESAs will meet requirements around the areas listed above. We also expect the regulation to provide a signal to industry for the need and value of smart appliances in the electricity system and to increase trust and confidence of

[3] See paragraph 20 in the ‘Evidence base’ section below
[4] Only applicable for relevant Electric Heating Appliances

consumers in smart functionality. Therefore, we expect the regulation to increase significantly the percentage of appliances which are smart over a relatively short time.

5. Summary of long-list and alternatives

Option 0: Do nothing. All ESAs remain without robust regulation on interoperability and cybersecurity, and EHAs remain able to be sold without smart capability.

Option 1: A non-regulatory approach of setting voluntary standards only.

This was deemed not robust enough to provide adequate protection against the cybersecurity risks of ESAs.

Option 2: Phased approach of intervention, starting with heating appliances in the late 2020s.

This would raise awareness and trust among consumers, and thereby encourage smart appliance uptake, whilst minimising familiarisation and transition costs.

Option 3: To mandate all appliances to be smart with no phased approach.

This was deemed premature for some appliance technologies, so could stifle growth, as well as being too costly at this point.

6. Description of shortlisted policy options carried forward

Option 0: Do nothing.

Option 2: Phased approach of intervention, starting with heating appliances and batteries in the late 2020s.

7. Regulatory scorecard for preferred option

Part A: Overall and stakeholder impacts

(1) Overall impacts on total welfare		**Directional rating** **Note: Below are examples only**
Description of overall	Increased flexibility in electricity demand will lower overall electricity systems costs and will help reduce pressure on household bills. Individuals who are able to flex demand through use of ESAs will be able to reduce their bills. In	**Positive**

expected impact	addition, the avoided costs from potential cyber-attacks represent potentially great savings to the wider system.	**Based on all impacts (incl. non-monetised)**
Monetised impacts	The cost of adding smart functionality is small compared to the cost of the whole device. There would be costs related to ensuring compliance to a new regulation. Costs: • Manufacturing costs of ensuring a relevant ESA meets the regulatory requirements. • Familiarisation costs for manufacturers of appliances • Assurance costs of complying with the requirements. Benefits have not yet been monetised. We are seeking more information during the consultation process to enable us to do this. These costs lead to a **total NPSV of -£277m to -£732m** for a 10-year appraisal period.	**Negative** **Based on likely £NPSV**
Non-monetised impacts	Costs: • Transitional costs of implementing policy and enforcement costs. • ESA unit costs. Benefits: • Increased energy security, lower electricity system costs, and reduced carbon emissions. • Lower energy bills when combined with a smart tariff, other CLF offering, or solar panels.	**Positive**
Any significant or adverse distributional impacts?	No	**Neutral**

(2) Expected impacts on businesses

Description of overall business impact	We would not expect the introduction of our regulations to significantly increase the cost of manufacturing ESAs or affect sales. This is due to costs likely being passed on to consumers, and the increased competition driving innovation.	**Neutral**

Monetised impacts	The cost of adding smart functionality is small compared to the cost of the whole device. There would be costs related to ensuring compliance to a new regulation. Costs: • Manufacturing costs of ensuring a relevant ESA meets the regulatory requirements. • Familiarisation Costs • Assurance costs of complying with the requirements. From these costs, gives us our **total NPV of -£277m to -£732m** for a ten-year appraisal period**.** The Equivalent Annual Net Direct Cost to Business (EANDCB) of this policy is £32.5m. It is likely that any costs to business will be passed onto consumers.	**Negative** **Based on likely business £NPV**
Non-monetised impacts	EVSCP regulation amendments: • Costless, as the legal obligations from the EVSCP Regulations 2021 are being superseded by these ESA Regulations, for consistency, without changing the material obligations and requirements on manufacturers or importers who bring a charge-point onto the market.	**Neutral**
Any significant or adverse distributional impacts?	These regulations, together with Government-funded innovation programmes for energy storage and flexibility, will spur innovation, encouraging industry to evolve and bring interoperable and user-friendly ESAs to the market.	**Positive**

(3) Expected impacts on households		
Description of overall household impact	Where households use ESAs to engage in consumer-led flexibility, they can reduce their electricity bills, when combined with a smart tariff. We anticipate that wider energy system benefits from greater use of CLF would reduce pressure more widely on household bills.	**Positive**
Monetised impacts	The Equivalent Annual Net Direct Cost to Households (EANDCH) of the regulation is zero.	**Neutral** **Based on likely household £NPV**

Non-monetised impacts	Costs: • ESA unit costs could increase slightly, following business costs being passed onto consumers. Benefits: • Lower energy bills when combined with a smart tariff, or other CLF offering.	**Positive**
Any significant or adverse distributional impacts?	No	**Neutral**

Part B: Impacts on wider government priorities

Category	Description of impact	Directional rating
Business environment: **Does the measure impact on the ease of doing business in the UK?**	These regulations, together with Government-funded innovation programmes for energy storage and flexibility, will drive increases in: • Innovation. Industry will hence be encouraged to evolve and bring user-friendly ESAs to the market. • Competition. Industry will want to provide the best product and earn consumer trust ahead of interoperability requirements being introduced in a later phase. Consumers will be able to switch provider of CLF, and no longer be tied to the company that installed their ESA, opening opportunities for new and existing companies to supply and/or manage their ESAs.	**Supports**
International Considerations: **Does the measure support international trade and investment?**	Relevant ESAs that do not comply with our regulations can no longer be sold or installed across Great Britain. This could have implications for organisations that currently export ESAs to GB that do not comply with our regulations. But given the low cost associated with upgrading an ESA to meet our standards we would not expect the introduction of our regulations to significantly increase barriers for trade with other markets.	**Neutral**
Natural capital and Decarbonisation: **Does the measure support commitments to improve the environment and decarbonise?**	ESAs will improve the utilisation of low carbon generation, thus avoiding curtailment, and will reduce existing peaks of demand - which is largely met through fossil-fuelled generation.	**Supports**

8. Monitoring and evaluation of preferred option

The Office for Product Safety and Standards (OPSS, within DBT) will enforce the regulations after they become effective, while also undertaking market intelligence and awareness raising activities in the period between the regulations being made by Parliament and their taking effect. OPSS will take a proportionate approach on enforcement, per their longstanding enforcement policy. OPSS also undertakes enforcement activities in relation to the EVSCP regulations[ii] and so has experience in this area. DESNZ and OPSS will monitor ESA uptake (and corresponding CLF use and energy consumption) and industry compliance, by monitoring technical files of ESA models and engaging with stakeholders to understand market evolution.

9. Minimising administrative and compliance costs for preferred option

We are offering a significant implementation period to allow time for familiarisation. The enforcing authority, OPSS, will take a proportionate approach to enforcement and will also accept enforcement undertakings, thus avoiding a one-size-fits-all approach.

Declaration

Department:

…

Contact details for enquiries:

…

Minister responsible:

…

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits, and impact of the leading options.

Signed: Sign here

Date: Date

Summary: Analysis and evidence

For Final Stage Impact Assessment, please finalise these sections including the full evidence base.

Price base year: 2024

PV base year: 2025

	0. Do nothing (baseline)	**2. First Phase regulations**
Net present social value	£0	-£277m to -£732m. The range represents the range of estimates used for cost data. This cost data is applied to the uptake of relevant Electric Heating Appliances. Benefits have not yet been monetised. We are seeking more information during the consultation process to enable us to do this.
Public sector financial costs	£0	Unquantified negligible transitional costs of implementing policy. Unquantified enforcement costs, to be taken on by OPSS.
Significant un-quantified benefits and costs	Cost to business for compliance with PSTI regulations.[5]	Increased energy security, lower electricity system costs, and reduced carbon emissions. Avoided costs from stronger cybersecurity. Lower consumer energy bills when combined with a smart tariff, or other CLF offering. Cost to business for adapting and complying to regulations for ESAs.
Key risks	Potential CLF users do not engage with CLF due to having a non-smart EHA. ESAs without cybersecurity measures leave the electricity system vulnerable to cyberattack.	Unnecessary cost to business if all regulatory requirements are already complied with, such as extra administration costs.

[5] The Product Security and Telecommunications Infrastructure (Security Requirements for Relevant Connectable Products) Regulations 2023. https://www.legislation.gov.uk/uksi/2023/1007/made

Results of sensitivity analysis	N/A	Sensitivity analysis on cost assumptions is presented in NPSV range above.

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Evidence base

i. Problem under consideration, with business as usual, and rationale for intervention

Background

1. The Government has a challenging and critical set of objectives in the energy sector: ensuring security of energy supply, keeping bills as low as possible for households and businesses, and decarbonising both cost-effectively and in a way that enables us to reap the economic benefits of this transition, as well as protecting the interests of existing and future consumers. There are important challenges ahead in delivering these objectives:

    - Electricity demand will increase as heat and transport are electrified and is forecast to at least double by 2050; significant quantities of additional generation will need to be added to our electricity system over the next few decades.

    - Electricity generation will increasingly be variable, dependent on the time of day, season, and prevalent weather conditions. Generation and storage are becoming increasingly decentralised, with solar and batteries being deployed on the distribution network, and in individual buildings and by local communities.

2. At the same time, new data and communication technologies are creating opportunities to manage the electricity system in different ways e.g. in aggregating load from smart appliances or Electric Vehicles (EVs) to use in frequency response or load shifting[6].

3. To achieve the UK's Net Zero target and Clean Power by 2030 mission while maintaining security of supply, the GB electricity system needs low carbon flexibility sources to counterbalance intermittent renewable generation and to respond to peaks and troughs in supply and demand. One way of achieving low carbon flexibility is through Consumer-Led Flexibility (CLF) - action taken by consumers to shift their energy consumption in time in response to a signal such as price.

4. Energy Smart Appliances (ESAs) could enable significant CLF and, in turn, significant benefits to consumers and the electricity system, if taken up at scale. Implementing regulations for relevant ESAs will ensure that they can be used in tandem with other ESAs and CLF services and mitigate the risks of ESAs.

Decarbonisation and Consumer-Led Flexibility

5. The Smart Systems and Flexibility Plan[iii] and the Clean Flexibility Roadmap[iv] set out how government will support achieving the UK's net zero goals through facilitating the transition to a smart and flexible energy system. A smart and flexible energy system will reduce consumer energy bills by reducing the amount of generation and network assets that need to be built to meet peak demand. It will give consumers greater control over

[6] Frequency response refers to actions taken by National Grid to ensure that system frequency is kept within specified limits. Load shifting involves moving energy demand so it can be more easily met - usually from peak times to times of lower system demand.

their energy bills through access to smart technologies and services, such as enabling participation in CLF.

6. CLF is the process of changing when electricity is used or produced by consumers in response to their preferences and the needs of the electricity system; instead of generating or curtailing at times when supply doesn't meet demand, price signals reward consumers for changing their usage to meet the needs of the system.

The Role of Smart and Flexible Heating

7. For the purpose of this policy, we have defined a smart Electric Heating Appliance (EHA) as a heating appliance for the purpose of space heating and sanitary hot water which is communications-enabled and capable of responding automatically to price and/or other signals by shifting or modulating its electricity consumption. Energy smart functionality can be achieved either through embedded connectivity, or through the use of an add-on module to enable communication and control.

8. We expect heat pumps to be the principle means of decarbonising heat over the next decade and potentially beyond. As outlined in the Smart Systems and Flexibility Plan, highly flexible use of heat pumps could enable annual demand to be shifted by up to 50TWh in 2050 and reduce peak demand by nearly 5GW[v]. Smart heating alongside storage - including thermal storage, or the thermal performance of a building's fabric - also has the potential to reduce costs for consumers by shifting demand to cheaper times through tariffs that reward flexibility and reflect generation costs, as well as potentially giving consumers the greater ability to optimise their heating for comfort, cost and carbon, based on their preferences.

Programme background

9. A smart and flexible electricity system is critical to decarbonise our economy,help manage electricity demand and reduce consumer bills.

10. In July 2022, the previous government consulted[vi] on a range of proposals that would impact appliances and organisations with a role in controlling electricity usage. The aim of the proposals was to create the regulatory foundations for a smart and secure electricity system.

11. The previous government's response[vii] to the 'Delivering a Smart and Secure Electricity System' consultation in March 2023 confirmed the intention to adopt a phased approach to the regulation of ESAs and, in addition, set out high-level aims for the first phase ESA regulations.

12. The Energy Act 2023 gave government the primary power to make regulations for ESAs. These regulations may require, for example, that devices meet minimum technical requirements for cyber security, interoperability, data privacy and grid stability. Using these powers, the government will also be able to mandate that certain electric heating appliances placed on the market must have smart functionality.

13. In April 2024, under the previous government, we consulted[viii] again, focusing on the detailed policy for ESAs, with accompanying consultations on load control licence design and tariff data interoperability.

14. The April 2025 Government response[ix] to the 'Smart Secure Electricity Systems Programme: Energy Smart Appliances' consultation again confirmed our intention to adopt a phased approach to the regulation of ESAs, with an implementation period sufficient to allow industry to update production cycles.

15. We will draw together all ESA regulations – including those for EV smart charge points – into a single set of regulations. This has the benefit of providing a consistent framework for all regulated smart devices in the longer term given the common regulatory challenges that these devices pose. We also believe that a single set of regulations will bring coherence for the benefit of industry and consumers.

First Phase of Energy Smart Appliance Regulations

16. Subject to parliamentary approval, the first phase ESA regulations will cover the parts of the Smart Secure Electricity Systems (SSES) programme that will benefit from regulation:

    - a smart mandate for certain EHAs, including hydronic and hybrid heat pumps, storage heaters, heat batteries, and hot water storage and generation.[7]

    - minimum cyber security requirements and minimum grid stability requirements for all relevant ESAs.

17. Regulations would allow for an implementation period to give industry time to adopt the new requirements. The requirements will work in harmony with other relevant policy or programmes, such as heat pump installation targets.

18. Our aim is for the first phase ESA regulations to come into force from 2028, and that they will become the foundation for second phase ESA regulations - covering a potentially longer list of relevant devices and expanding cybersecurity requirements.

19. The delivery of the first phase of ESA regulations will constitute an essential stepping stone towards the government's long-term objective of ensuring ESAs meet a standard or set of standards covering extensive requirements for cyber security, grid stability, data privacy and interoperability.

Relevant Energy Smart Appliances

20. Government is using powers to regulate relevant ESAs, which includes the following appliances:

    - Electric Heating Appliances:

[7] The April 2025 SSES Government response confirmed we will pursue a primary legislative power to establish a smart mandate in relation to Battery Energy Storage Systems (BESS) when Parliamentary time allows.

- (a) hydronic heat pumps: an appliance that uses ambient heat from an air, water or ground source and increases its temperature to feed a central heating system and/or a sanitary hot water system.
- (b) storage heaters: an appliance that uses electricity to heat a solid storage medium which can be discharged to provide heating.
- (c) heat batteries: an electrically powered device that charges a thermal store with an electric heating element, before releasing the heat into a central heating system.
- (d) hot water heat pumps: a water cylinder with a heat pump which uses electricity to transfer usable heat extracted from the air to heat hot water.
- (e) standalone direct electric hot water cylinders: a water cylinder heated by an electric immersion element only and not connected to a centralised space heating device.
- (f) hybrid heat pumps: a single heating system that comprises a hydronic heat pump and another heater.

- Battery Energy Storage Systems: a device that —
  - Has a battery pack – this refers to a set of rechargeable battery cells that are encapsulated within an outer casing to form a complete unit.
  - Has a capacity size level equal to or greater than 1kWh – this value has been selected as it is higher than the majority of current expendable/reusable consumer batteries inserted into domestic appliances.
  - Has a minimum level of maximum power output equal to or greater than 1kW.
  - Is wired into the consumer side of a meter used by a holder of a licence under section 6(1)(d) of the Electricity Act 1989 for billing purposes.
  - Has a bi-directional power conversion subsystem.
  - Has an auxiliary subsystem.
  - Has smart functionality.

21. This list will be expanded upon for the second phase ESA regulations.

Electric Vehicles Smart Charge Points Regulations (2021) Amendments

22. The Electric Vehicles Smart Charge Points (EVSCP) Regulations underwent a process evaluation[x], designed to understand how the regulations have been implemented and how industry and consumers have responded.

23. As a result of this and wider industry engagement, Government is seeking to make several minor and technical amendments as the EVSCP regulations are incorporated into the wider Energy Smart Appliance regulations. These are as follows:
    - **Measuring systems** – Seek that EVSCPs, that are within the remit of ESA regulations, be compliant with MIR Class B requirements and clarify the frequency at which a device must communicate information of energy usage to the grid.
    - **Point of Sale** – Alteration of the point at which regulations apply to a relevant device.

- **Cyber Security** – Alteration of cyber security requirements that relevant device must adhere to, to be compliant with regulations.
- **Randomised Delay** – Clarification on the application of a global override and when randomised delay should and should not be applied to a device.
- **Protection against physical attack** – Clarifying what is required regarding protection against physical attack in electric vehicle smart charge points.
- **EVSCP specific definitions** – Alteration or alignment of charge point specific definitions.
- **Technical file** – Altering to whom the technical file of a device should be made available.
- **Statement of Compliance** – Altering requirements regarding the production and provision of a statement of compliance.
- **Register of Sales** – Aligning the requirement to keepa register of sales with wider point of sale provisions made under ESA regulations.

Problem under consideration

Use of Smart Appliances

24. Having an ESA will reduce costs at the individual consumer level by enabling the consumer to shift their demand and access the ability to exploit changes in electricity prices, including through the use of smart tariffs.

25. While EHAs can offer reduced costs to individual consumers through a much better energy to heat efficiency rate compared to fossil-fuelled alternatives, they also increase the electricity demand on the system.

26. And although basic on/off functionality may be effective in encouraging some flexible behaviour (for example when electricity price patterns are predictable), non-smart EHAs will not be able to respond to short-term changes in market conditions. The more sophisticated smart-EHAs units have communication ability and are real-time responsive so they can modulate their power up and down in response to live external signals, usually in coordination with an aggregator[8].

27. In order for EHAs to partake in the smart grid of the future, appliances must be capable of communicating with, and acting on, information from third parties. There are currently no requirements for this functionality and so weaker motives for the investment and innovation which could benefit consumers.

28. ESAs (including smart-EHAs) can help consumers manage or reduce their bills by shifting electricity demand automatically to times of day when energy is cheaper or to provide grid services such as frequency response to the Electricity System and Network Operators.

[8] a company or entity that gathers and coordinates the flexibility from various small sources to make them eligible for participation in energy markets.

29. Many ESA (and smart-EHA) models in scope are suitable for both domestic and workplace installation, where load shifting solutions may be more of a priority given the lack of alternatives which can be used to engage in CLF.

30. To ensure that the benefits of ESAs are realised, consumers need to be incentivised to engage with CLF. There is limited data on current uptake of CLF offers amongst ESA owners (e.g., Time-of-use-Tariff (TOUT), aggregators), but without high-level awareness of the benefits, uptake will likely be low. Without this government intervention, it is unlikely that CLF will be taken up at the rate required to achieve the full benefits for consumers and the electricity system within the target timeframes.

Risks associated with mass uptake

31. The electrification of heat will bring significant new demand for electricity. How electric heating is used could have profound impacts on the electricity system and energy security. This is true for both heat pumps and less efficient alternative electric heating technologies, like storage heaters and infrared heating.

32. If all of the EHAs installations projected below in Figure 2 were smart, then the corresponding energy capacity of all these devices would be available to be used as part of CLF. As outlined in the Smart Systems and Flexibility Plan, highly flexible use of heat pumps could enable annual demand to be shifted by up to 50TWh in 2050 and reduce peak demand by nearly 5GW.[v9] This highlights the potential smart EHAs have to contribute to CLF, particularly if it is controlled by an aggregator.

33. However, if these EHAs are installed without smart capability, the hassle cost of replacing an EHA with a smart EHA to participate in CLF could deter consumers from being willing to engage with CLF at all. This is reflected in research into consumer attitudes which shows that running cost is a secondary consideration, compared to the upfront cost, when deciding whether to install a heat pump[xi]. Therefore, it would be best if all new EHAs were smart capable by default, and the consumer is then free to decide how much or little they engage with CLF.

34. However, a mass uptake of smart devices poses risks to the grid:
    a) **Unintentional herding** may mean many devices respond to a price signal all at once and create secondary peaks causing grid stability issues at unpredictable times throughout the day.
    b) ESAs and their aggregators may become attractive targets for **cyber-attacks** given their potential to instantaneously and dramatically shift demand. They therefore need to be protected from this threat.

35. A primary driver for regulatory intervention is **cybersecurity**. Government-commissioned risk assessments[10] indicate that without Government intervention, there is a significant risk that cyber-attackers could exploit ESAs, in aggregate, to destabilise the electricity system and attack Critical National Infrastructure. For example, cyber-attackers could seek to compromise large numbers of devices in order to simultaneously and repeatedly turn them on and off, which would cause significant challenges for the

[9] This represents between 11% to 33% of total UK demand for 2024, and equivalent to 22% of peak wind generation in 2024. https://www.neso.energy/news/britains-electricity-explained-2024-review
[10]National Risk Register 2025, https://www.gov.uk/government/publications/national-risk-register-2025

system operator in managing and balancing the grid. Risk assessments indicate that there could be enough smart devices on the system in 2025 that an attack of this type could feasibly cause local or national power outages (i.e. blackouts) in certain circumstances.

Electric Heat Appliance Uptake

36. The market availability and consumer uptake of EHAs is currently limited but expanding[xii]. The proliferation of non-smart EHAs could hamper the uptake of CLF (to its fullest extent).

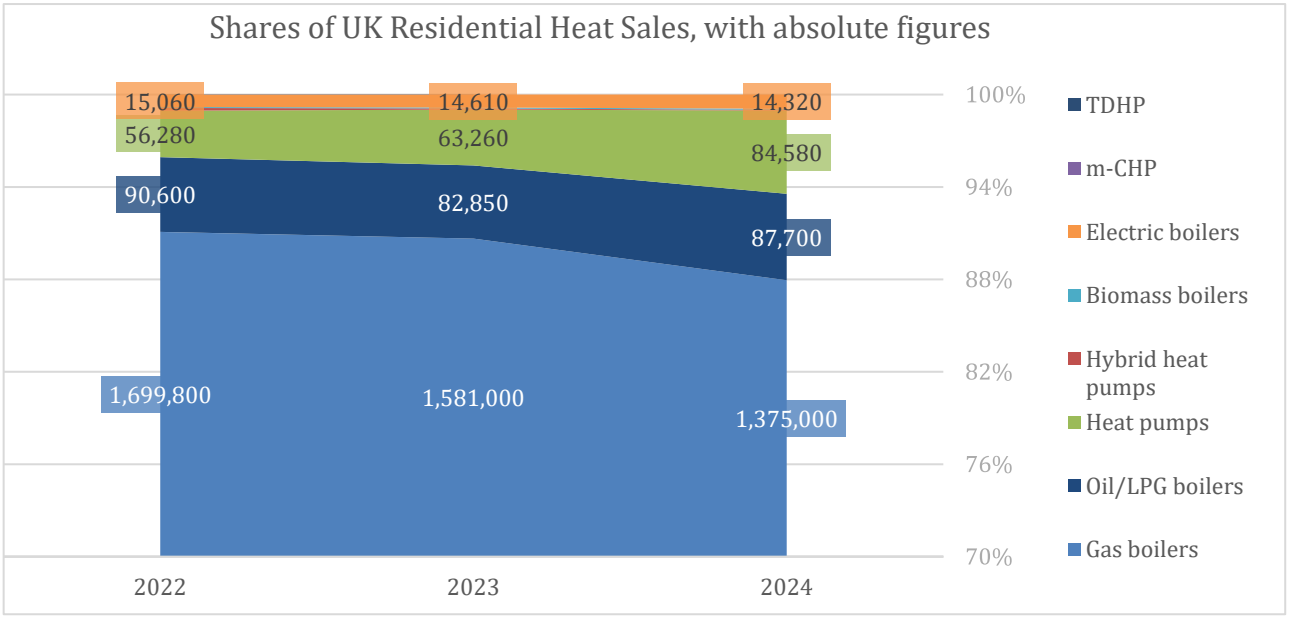

Figure 1: LCPDelta data – Share of UK sales of residential heat appliances, with absolute UK sales figures labelled.

37. ESAs could offer significant CLF potential and, in turn, significant benefits to consumers and the electricity system, if taken up at scale.

Market development

38. The uptake of EHAs is expected to increase each year, with the exception of storage heaters. NESO's FES 2024[11] Electric Engagement pathway forecasts large increases for heat pumps and low-carbon hybrid heat pumps, which together meet the Government's target of 600,000 annual heat pump installations in 2028.

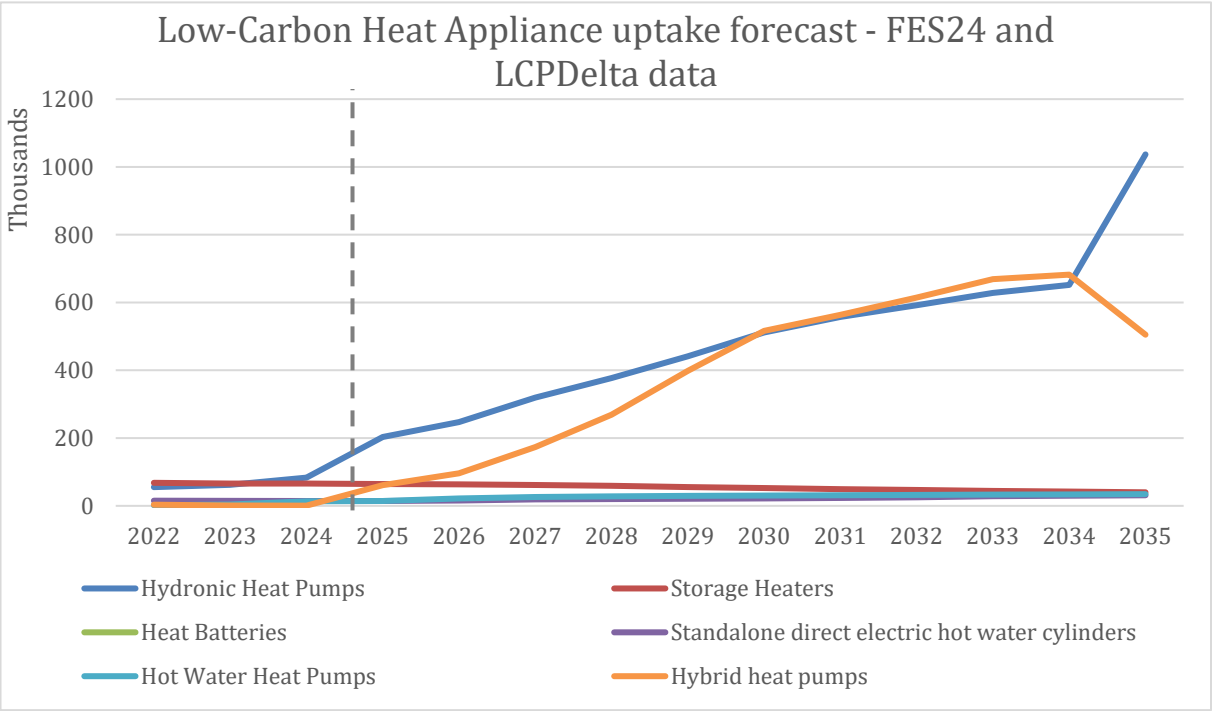

Figure 2: UK low-carbon heat appliance uptake forecast. 2025-2035 data from FES24, 2022-2024 data from LCPDelta, all Hot Water HP and Storage Heater data from LCPDelta.

39. The majority of EHA installations are expected to be in new build homes, driven by the implementation of the Future Homes Standard in 2027.[12]

40. **Lack of interoperability requirements**: currently there are no set regulatory requirements for smart appliances internationally or at EU level. Interoperability (the ability of a product or system to work with other products or systems) is vital to enable consumer choice and ensure consumers can benefit fully from a connected home; ensuring consumers are not locked in to using certain service providers, or devices from a particular manufacturer. Interoperability also refers to the ability of an ESA to work seamlessly across any appropriate CLF service operated by any authorised energy system actor, so that owners of ESAs can freely switch the CLF service provider controlling or configuring their device. Open standards would enable interoperability, promoting competition and innovation. Creating these standards can help build trust in the nascent industry.

[11]National Energy System Operator, Future Energy Scenarios 2024. https://www.neso.energy/publications/future-energy-scenarios-fes
[12]LCPDelta, 'United Kingdom: Opportunities for low carbon heating technologies to 2035', https://research.lcpdelta.com/reports/DHS_UK-HeatReport/files/DHS_UK_HeatReport202/

Rationale for intervention

41. Having an ESA will reduce costs at the individual household level by enabling the consumer to shift their demand and access lower electricity prices. However, there is also a significant positive externality, at a societal level there will be a reduction in costs due to the avoided infrastructure expenditure that would be required in the absence of flexibility technologies, with the ability to shift peak demand. Furthermore, the introduction of standards will help protect wider society from the emerging risks associated with increased use of ESAs.

42. The uptake of ESAs increases the amount of flexible electrical demand on the system allowing electricity consumption to be shifted away from peak periods. This will result in improved energy security, and lower costs to the electricity system of meeting electricity demand, through utilising less expensive forms of electricity generation, and avoiding network reinforcement/upgrades, benefiting all electricity consumers. By 2050, illustrative scenarios for the Smart Systems and Flexibility Plan[xiii] indicate that we will need 60GW of total flexible capacity, consisting of around 30GW of combined short-term storage and Consumer-Led Flexibility. Increased flexibility could reduce system costs. Government's 2022 Electricity Networks Strategic Framework estimates system savings of £40b-£50b from 2022 to 2050[xiv].

43. If we wait for the energy tariff and aggregation market to develop first to fully incentivise uptake, then given the 10–15-year lifetime of products, the potential benefits from CLF in the 2030s might not be fully realised in time for when they may be required. This suggests that some form of intervention will be key to establishing greater use of CLF from smart appliances, compared to the business-as-usual case, in order to maximise electricity system benefits within appropriate timescales.

44. The overarching rationale behind government intervention is to support delivery of these social benefits (positive externalities) associated with the development and uptake of ESAs and provide sufficient protection against emerging risks to the electricity system and consumers.

45. Below is a list of the market failures that exist which act as barriers to maximising these social benefits.

- **Bounded rationality and uncertainty** - When purchasing an ESA, private consumers (businesses and homeowners) may only consider a finite number of factors and have a short-term focus. As such, they may not undertake a full lifetime value for money assessment that weighs up the additional upfront unit cost of a smart vs non-smart appliance against the electricity bill savings that could accrue over the lifetime of owning the product.

- **Information failure and consumer confidence** - Purchasing decisions may be complicated by the fact that ESAs are an emerging technology and there may be a lack of awareness of the value of the private benefits associated with ESAs. The variation in design and capability of existing ESAs shows that there is currently not an agreed standard for ESAs, which adds to complexity for consumers. Furthermore, consumers may have concerns over the safety (cyber and physical) of connected devices which could deter them from purchasing. Setting regulatory requirements will

provide certainty to consumers on what an appliance is offering and increase consumer trust.

- **Limited financial incentives for consumers** - Due to the significant positive externality, the societal benefits of CLF of ESAs are greater than the private benefits, therefore without government intervention the take-up of ESAs would be below the social optimum. In addition, market system developments may be required for consumers to access the full private benefits of ESAs. This includes the introduction of market-wide half-hourly settlement and electricity prices that are reflective of system costs (e.g., Time of Use Tariffs (TOUTs)).

- **Market power and co-ordination failures** - Technological fragmentation is likely to occur in the absence of government actions where firms are unable to co-ordinate effectively in the development of products and associated services. This could result in limited interoperability across products, which would further deter uptake of ESAs. Market conditions in the absence of government actions may incentivise existing firms to actively prevent compatibility across products in order to leverage market power. Together with setting minimum standards for ESAs, the proposed energy smart functionality mandate on EHAs could limit these risks.

Addressing consumer protection and cyber threat

Consumer protection

46. To protect consumers against potential risks associated with smart appliances the following points should be considered:

    a) **Data Privacy**: Data will be created by, and potentially stored in, smart appliances. Data privacy is important to protect consumers and for consumers to have confidence in choosing to participate in a smart energy system. Existing regulation on data privacy will continue to apply, in particular the Data Protection Act 2018. The Government (as part of regulatory requirements) will give additional protection, on top of existing data protection regulations. ESAs and CLF will generate large amounts of data relating to consumers' energy consumption and usage patterns. The improper storage, use or sharing of this data will lead to data privacy issues.

    b) **Cyber security for individuals**: there are potential risks to individuals from third parties controlling smart appliances without permission, or accessing consumption data or insights into a consumer's home life through their appliances. There are also risks posed to the electricity system itself (explained in more detail below), but we are also mindful that cyber security issues can adversely affect consumer confidence in, and acceptance of, smart energy applications. Therefore, there is a role for Government, Ofgem and industry to ensure the risks are addressed proportionately.

Cyber security for the electricity system

47. In the move to a smart energy system which is more complex and more driven by data and communication technologies, it is essential that cyber-security risks are effectively understood and acted upon. System stability will continue to be a key requirement of a future system and will be a priority focus in this changing environment. The Government

has undertaken significant stakeholder engagement across industry to assess the magnitude of the smart cyber-security risk up to 2030, including consideration of the increasing levels of smart electric vehicle charging and electrical heating. This risk is comparatively small now due to the low penetration and the limited types of CLF on the network; however, it could increase significantly with time as the amount of CLF grows to balance an increased amount of renewables and as the role of automated CLF becomes more prevalent in the domestic sector. The Government takes its duty seriously to ensure sufficient protections are in place to mitigate potential risks to grid stability, such as the threat from cyber attack to which smart appliances could be susceptible.

48. Without additional regulation, firms may underinvest in cyber security[13] or other measures to address grid stability, which could have significant impact, due to the existence of the following market failures:
    - **Externalities** – Firms, such as aggregators, may not fully capture the wider societal benefits of investing in cyber security or grid stability, as this exceeds their private benefit. This is because grid stability is a public good, where the benefits of security or stability are enjoyed by society as a whole, and network operators in the form of a more stable and lower cost energy system. These benefits are non-rivalrous and non-excludable[14]. Equally, the costs of insecurity or instability are also borne by the system. Therefore, firms have an incentive to free ride[15], as they operate insulated from these benefits/costs which reduces their incentive to invest. Organisations primarily view risks to themselves, and not the system, which creates problems when smaller organisations become connected, creating points of vulnerability in the wider system.
    - **Imperfect information** - Firms may not be sufficiently equipped to identify, understand, and implement sufficient cyber security or grid stability solutions as they do not fully understand the risk they present to the wider energy system. In addition, firms subject to cyber-crime may not report or may want to play down the severity of cyber security attacks to avoid potential reputational damage and associated financial impact. The aggregate impact of many load controlling devices optimising across the same time of use tariff could cause greater grid instability. However, individual organisations are unlikely to have the necessary information to be aware of this.

ii. Policy objective

49. The main objective behind minimum requirements is to:

[13] These risks are informed by the academic literature, for example “Economic aspects of national cyber security strategies” by P. Brangetto, and a DCMS IA on cyber security for consumer products, with both concluding the same market failures.

[14] Non-rivalry suggests the benefit one energy market participant receives from having a stable grid does not reduce the amount of benefit another can receive from having a stable grid. Non-excludability suggests that all energy market participants receive the benefit of a stable grid.

[15] The free rider problem is the burden on a shared resource that is created by its use or overuse by people who are not paying their fair share for it or are not paying anything at all.

- Provide certainty in the sector to help rectify the coordination failure between the availability of smart appliances and smart tariffs, enabling electricity system benefits and consumer rewards.

- Ensure minimum requirements of functionality of smart appliances to protect consumers and the electricity system.

- Enable the GB marketplace to be at the forefront of an emerging sector (including software development and smart components).

50. Government aims to ensure that all 100% of new relevant EHAs placed on the market in 2028 will have smart capability and that all 100% of new relevant ESAs placed on the market in 2028 will fulfil all device policy principles.

51. The main objective of mandating energy smart functionality for EHAs is to maximise the use of electric heating appliances that have smart functionality as the electric heating market (predominantly heat pumps) scales up over the course of this decade, to benefit both consumers and the electricity system, whilst contributing to decarbonising heating in the UK and to meeting the net zero target.

52. The powers cover all EHAs providing space heating and sanitary hot water. However, we propose to introduce requirements for energy smart functionality initially only for electric heating technologies with the greatest potential to be used flexibly, namely heat pumps as well as storage heaters and heat batteries. We propose to keep under review the case for expanding the requirements to other EHAs, including new technologies as they emerge.

53. By implementing these regulations, the relevant ESAs will then be subject to the device level requirements around interoperability, cyber security, grid stability, and data privacy, detailed below.

Device policy principles

54. The government previously established the following principles for regulation of ESAs: interoperability, cyber security, data privacy and grid stability. A summary of these principles follows below.

- **Interoperability**: The government intends that ESAs can receive and respond to time-of-use tariffs from different energy suppliers, and that they can access CLF services offered by different Flexibility Service Providers (FSPs). This will provide a minimum level of interoperability that will be essential to promoting growth in markets and building consumer demand for these services.

- **Cyber security**: The government will set out requirements to protect against cyber security risks at both the device and system levels, which will inform future technical and regulatory frameworks for ESAs. These requirements will be in addition to cyber security requirements for organisations remotely controlling electrical load, and subject to licensing requirements.

- **Data privacy**: Any future technical solutions for ESAs (such as ESA standards) will need specific data privacy requirements to ensure that data privacy and data security

risks are mitigated, particularly when data is shared between devices, systems, and organisations. Government will ensure that these requirements are fully compatible with UK data protection laws.

- **Grid stability and energy security**: The government has proposed that future policy should mitigate risks posed to the grid by ESAs, such as synchronised changes in load ('herding') of ESAs at scale, unexpected step-changes or ramps in electricity usage at scale, oscillation in energy usage or production by ESAs at scale, and an inability to provide the flexibility necessary to the energy system when necessary.

iii. Description of options considered

55. This section sets out the assessed policy option and the counterfactual.

Option 0 – Do nothing (the counterfactual)

56. Government takes no action to implement regulatory requirements for ESAs. Consumers will benefit from the cyber security requirements placed on these devices via the Product Security measures overseen by DSIT[16]. With regard to ESA's 'energy smart functionality' for CLF, industry will continue to rely on PAS 1878 and PAS 1879 to guide the technical requirements for ESAs. Although we expect the standards to provide a definition and guide for manufacturers of smart appliances, they remain voluntary, and as of yet, no appliances have been manufactured to comply with PAS 1878. Additionally, we do not expect they will have a significant impact on the uptake of smart appliances.

Option 1 – Voluntary ESA standards only

57. Government issues guidance to the ESA industry to the effect of the device level requirements around interoperability, cyber security, grid stability, and data privacy, detailed above. However, participation remains voluntary only to avoid any additional administrative burden.

58. This was deemed not robust enough to provide adequate protection against the cybersecurity risks of ESAs, particularly given the lack of compliance with the voluntary PAS standards.

Option 2 – Phased regulatory requirements for ESAs

59. Under this option, the Government will implement regulatory requirements for the selected relevant ESAs in GB. From the 1st January 2028, all new relevant ESAs sold in Great Britain must meet device-level requirements. This includes the following:

- **Smart functionality**[17] - An ESA has smart functionality if it is able to send and receive information and respond to messages by increasing or decreasing the rate of

[16] The Product Security and Telecommunications Infrastructure (Security Requirements for Relevant Connectable Products) Regulations 2023. https://www.legislation.gov.uk/uksi/2023/1007/made
[17] Only applicable for relevant EHAs

electricity flowing through the ESA and shift the time at which electricity flows through the ESA. A relevant ESA should also be able be capable of supporting CLF services.

- **Personalised default settings** – An ESA must invite the user to set default usage hours before it is first used. The device must be pre-set with a usage schedule that does not charge the ESA at peak times.

- **Cyber and data security** – An ESA must have appropriate basic security measures to ensure that its functions are resilient to cyber-attack. Furthermore, an ESA must be designed and manufactured to provide an adequate level of protection against physical damage to the device.

- **Randomised delay function** – An ESA must be configured in a way which ensures that when it responds to information received and adjusts the rate of electricity flowing through it, it applies a randomised delay of up to a certain number of minutes; and permits the user of the ESA to override the random delay.

- **Assurance** – Any person/organisation selling an ESA must provide a statement of conformity and a technical file, at the request of the regulator.

- **Monitoring and recording energy usage** – An ESA must measure or calculate the electricity consumed, the time the event lasts and provide a method for the consumer to view this information.

- **Safety** – ESAs should operate in a way that prioritises safety over smart operating behaviour.

60. This regulation will require that all relevant ESAs will meet requirements around the areas listed above. We also expect the regulation to provide a signal to industry for the need and value of smart appliances in the electricity system and to increase trust and confidence of consumers in smart functionality. Therefore, we expect the regulation to increase the percentage of appliances which are smart. Details of this assumption are provided in the section on monetised benefits.

Option 3 – Smart mandate for all appliances

61. Government implements requirements for a much-expanded list of relevant ESAs with no phased approach. This would give the strongest signal to industry that government aims to ensure that all 100% of new ESAs placed on the market will have smart capability and will fulfil all device policy principles.

62. This was deemed premature for some appliance technologies, so could stifle growth, as well as being too administratively costly at this point.

iv. Summary and preferred option with description of implementation plan

63. Government intends to implement Option 2. A phased regulatory approach is required to ensure smart EHA are installed ahead of mass uptake of EHAs, to avoid future would-be smart users being stuck with a non-smart EHAs. This will maximise the potential of CLF to reduce the need for network reinforcement and benefit consumers by reducing energy bills.

64. This impact assessment concludes that there is a clear case for government intervention given the significant CLF potential ESAs could offer. If taken up at scale, these would provide benefits to consumers and the electricity system in the form of bill and system savings and increased energy security. Without intervention, a large uptake of ESAs might not be incentivised until the energy tariff and aggregation market is mature;the potential for CLF to deliver system benefits in the 2030s may not otherwise be realised. Intervention will be key to establishing greater use of CLF from ESAs, compared to the business-as-usual case, in order to maximise electricity system benefits within appropriate timescales. Regulation is also required to ensure that appropriate cyber security mitigations and consumer protections are in place ahead of time.

65. The regulations will come into force by the beginning of 2028. The Office for Product Safety and Standards (OPSS, within the Department for Business and Trade) will enforce the regulations after they become effective, while also undertaking market intelligence and awareness raising activities in the period between the regulations being made by Parliament and their taking effect. OPSS will take a proportionate approach on enforcement, per their longstanding enforcement policy. OPSS also undertakes enforcement activities in relation to the Electric Vehicles Smart Charge Points (EVSCP) Regulations (2021) [ii] and so has experience in this area.

v. NPSV: monetised and non-monetised costs and benefits of each shortlist option (including administrative burden)

66. At this stage, only high-level estimates and inferences can be drawn. All monetised impacts should therefore be understood as giving a sense of scale of the possible impacts rather than a robust estimate. We have only been able to monetise the costs; the benefits have not yet been monetised. We are seeking more information during the consultation process to enable us to do this.

Table 1:Monetised and non-monetised costs

Monetised costs	Non-monetised costs
Business/Industry • Manufacturing costs of making a relevant ESA meet the requirements • Assurance costs of complying with the requirements • Familiarisation Costs	**Wider Society** • Transitional costs of implementing policy and enforcement costs **Business/Industry** • Complying with PSTI regulations[16] • Complying with amended EVSCP regulations. **Consumers**

	• ESA unit costs

Table 2: Monetised and non-monetised benefits

Monetised benefits	Non-monetised benefits
	Wider Society • Increased energy security, lower electricity system costs, and reduced carbon emissions • Stronger cybersecurity **Consumers** • Lower energy bills when combined with a smart tariff, or other CLF offering

Costs

67. Regulatory requirements for ESAs will result in a cost incurred by business: these costs will consist of:

    a) The on-going costs of manufacturing ESAs which are compliant with having smart functionality (smart costs)

    b) Initial and ongoing costs of complying with the technical standards (assurance costs)

    c) Familiarisation costs

68. These are the key monetised costs reflected in this appraisal. Over time, we would expect significant scale and development of competition in the market to lower costs, in particular where aligned with international requirements.

69. The key benefits of ESAs are to the electricity system, from lower peak demand lowering costs of generation capacity, network and balancing costs, and enabling greater use of low carbon technologies.

70. Both costs and benefits are expected to be passed through to consumers, who may face higher costs for an ESA (as the manufacturing costs are passed through the supply chain), and who also benefit from the use of smart functionality and lower electricity bills over the lifetime of the device.

Smart costs

71. Where EHAs are not already smart, the additional cost of smartening a relevant EHA is expected to be small[18]. There would be additional costs around developing the smart technology (for manufacturers who only produce non-smart EHAs), app support, cloud storage and computing, and the additional smart hardware.

[18] They only need additional communication hardware.

72. Manufacturers may also be faced with small costs for ensuring relevant ESAs meet other requirements around cyber security, data security, and safety[19].

73. These costs are expected to vary by manufacturer and the unit cost would depend on sales volume[20]. There is limited evidence on costs at this stage. The assumptions below are based on the estimates used in 'The Electric Vehicles (Smart Charge Points) Regulations' 2021[xv], and adjusted based on feedback from the 2024 SSES consultation[xvi].

74. The cost of additional smart hardware would be expected to decrease over time in line with a learning rate as shown in Figure 3. We assume this learning rate to be 0.9, again based on the estimates used in 'The Electric Vehicles (Smart Charge Points) Regulations' 2021[xv], and adjusted based on feedback from the 2024 SSES consultation[21][xvi].

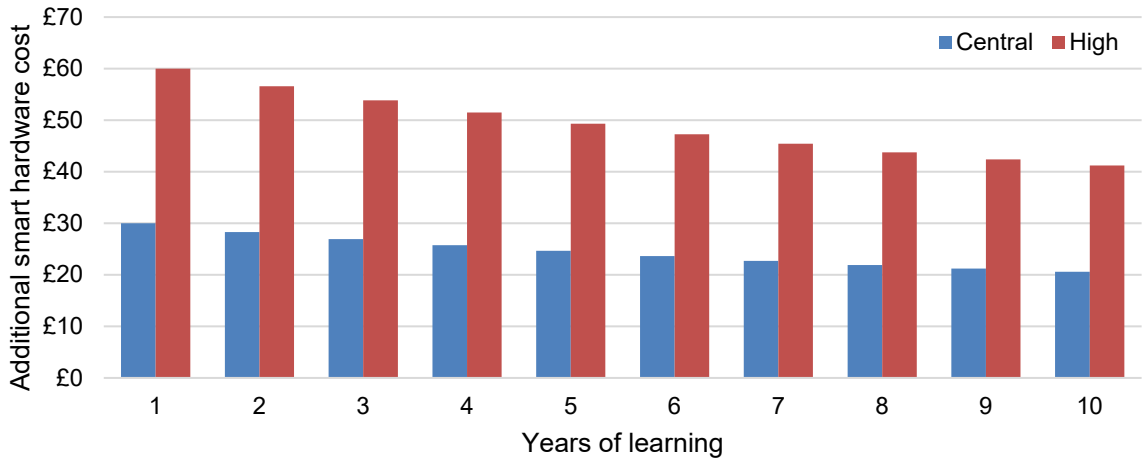

Figure 3: Chart showing the effect of the learning rate on the cost assumptions for additional smart hardware

Assurance costs

75. The assurance costs to business will consist of assurance and demonstrating compliance[22]. The cost assumptions are listed in Table 4 below.

76. Due to assurance schemes in this area not being sufficiently developed, we cannot measure the impact of mandating specific conformity assessment procedures. Instead, we use the estimates in 'The Electric Vehicles (Smart Charge Points) Regulations' 2021[xv], adjusted based on feedback from the 2024 SSES consultation [xvi].

[19] The Smart Charging Process Evaluation for the 2021 EVSCP regulations found that most manufacturers reported a cost increase of up to 5%. Process evaluation of the Electric Vehicles (Smart Charge Points) Regulations 2021 - GOV.UK

[20] Current and projected sales volumes can be found in Figure 1 and Figure 2.

[21] Consultation feedback was that the cost was expected to be around £20 after 10 years, so the learning rate has been reverse engineered to fit this for the central assumption.

[22] We estimate this to be between £22.4m and £179.4m for a 10-year appraisal period, see Table 7.

Familiarisation costs

77. Manufacturing businesses will need to spend time familiarising themselves with and adapting to the new rules and requirements. We will consult on secondary legislation in advance of it becoming effective in order to give industry appropriate time to familiarise with the requirements and build changes into supply-chain lead times.

78. Manufacturers are typically large multinational companies that would be engaging with EU and other international regulatory bodies irrespective of GB regulation. We therefore expect the additional familiarisation costs of GB regulation to be low[23]; however, this is dependent on the extent to which the UK aligns with international requirements. We use the estimates in The Electric Vehicles (Smart Charge Points) Regulations 2021[xv], adjusted based on feedback from the 2024 SSES consultation [xvi]. The cost assumptions are listed in Table 4.

79. Table 3 below sets out the number of businesses in scope of the first phase ESA regulations we have assumed for the appraisal. The high assumption is derived by doubling this central assumption to reflect the uncertainty on the estimate of the number of firms in the future.

Table 3: Number of businesses in scope of the first phase regulations.

Appliance	Number of firms affected (central)	Number of firms affected (high)	Source
Hydronic Heat Pumps	30	60	BSRIA: 30 firms for 95-99% of the market[xvii]
Storage heaters(space)	10	20	Element Energy Report [xviii]
Standalone electric storage water heaters	8	16	BSRIA: 8 firms for 98% of the market [xvii]
Standalone Heat Pumps for DHW	8	16	BSRIA: 8 firms for 95-99% of the market [xvii]
Hybrid Heat Pumps	10	20	Indicative business estimate

Cost assumptions

80. The cost assumptions detailed below in Table 4 use the estimates in The Electric Vehicles (Smart Charge Points) Regulations 2021[xv], adjusted based on feedback from the 2024 SSES consultation [xvi].

Cost	Occurrence	Central assumption	High assumption
Smart development costs	One-off	£100,000	£1,000,000

[23] We estimate this to be between £1.2m and £9.5m for a 10-year appraisal period, see Table 7.

Personalised defaults	One-off	£20,000	£30,000
Cyber and data security	One-off	£25,000	£100,000
Randomised delay	One-off	£20,000	£20,000
Familiarisation	One-off	£20,000	£80,000
Assurance	Annual	£50,000	£60,000
Cyber and data security	Annual	£12,500	£50,000
App support	Annual	£35,000	£35,000
Cloud storage and computing	Annual, Per device	£1.50	£1.50
Additional smart hardware	One-off, Per new device	£30 [24]	£60 [24]

Table 4: Cost assumptions for businesses (nominal)

Relevant Energy Smart Appliance Deployment

81. For the purposes of this cost analysis, we have used data from LCPDelta for UK EHA installations from 2022 to 2024, and FES24 Electric Engagement[11] and LCPDelta Reference scenario[12] forecasts of installations out to 2040 and 2035 respectfully.

82. As LCPDelta forecasts end in 2035, we have extrapolated the rate of change in annual installations to project out to 2040 to encompass the entire appraisal period of 10 years[25].

83. From the FES24 Electric Engagement pathway, we use data for the following EHAs: Hydronic Heat Pumps, Low-Carbon Hybrid Heat Pumps[26].

84. From the LCPDelta Reference scenario, we use data for the following EHAs: Storage Heaters, Standalone Direct Electric Hot Water Cylinders[27], Hot Water Heat Pumps, High-Carbon Hybrid Heat Pumps[28].

[24] These 2024 figures have the learning rate applied (illustrated in Figure 3) for every year in the appraisal period.
[25] 10 years after the anticipated start date of January 2028 for the ESA regulations, also the first date where a smart EHA mandate could be introduced.
[26] ASHP + Biofuel boiler, ASHP + Electric resistive, ASHP + Hydrogen boiler
[27] Data used is for Electric Boilers, so real figures may be lower.
[28] Gas hybrid heat pumps, Oil hybrid heat pumps

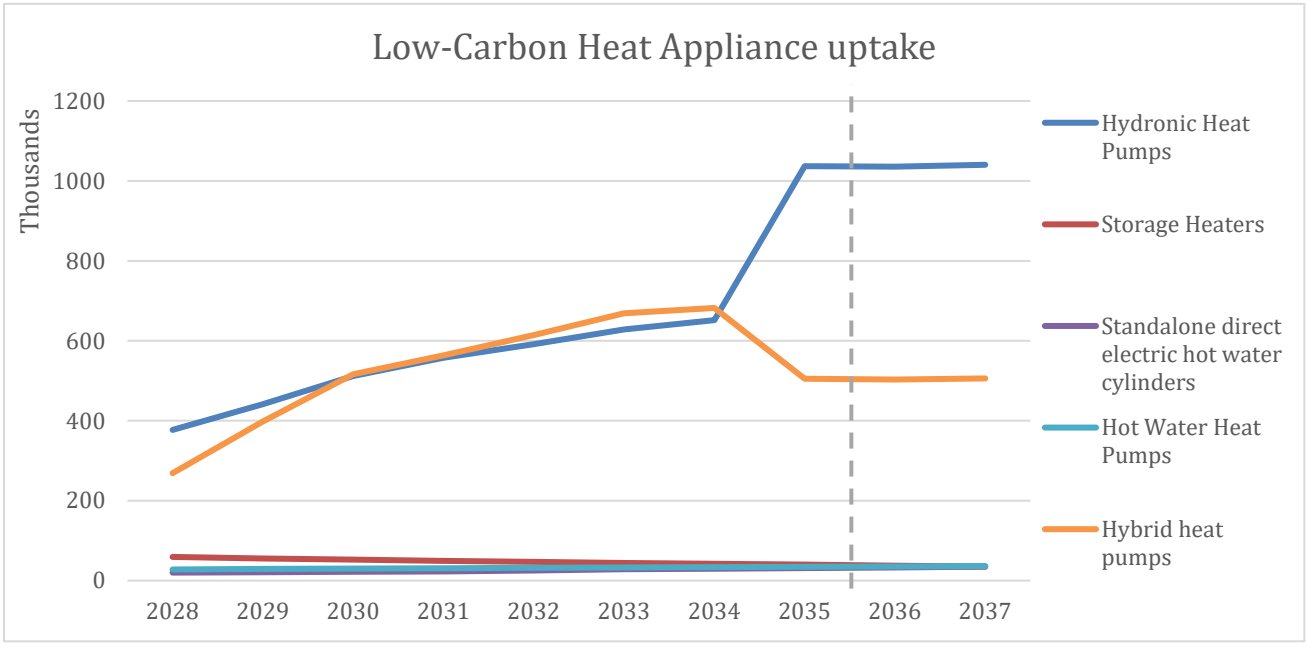

Figure 4: Electric Heating Appliance annual uptake forecasts. Based upon data from FES24 EE, and data and projections from LCPDelta Ref.

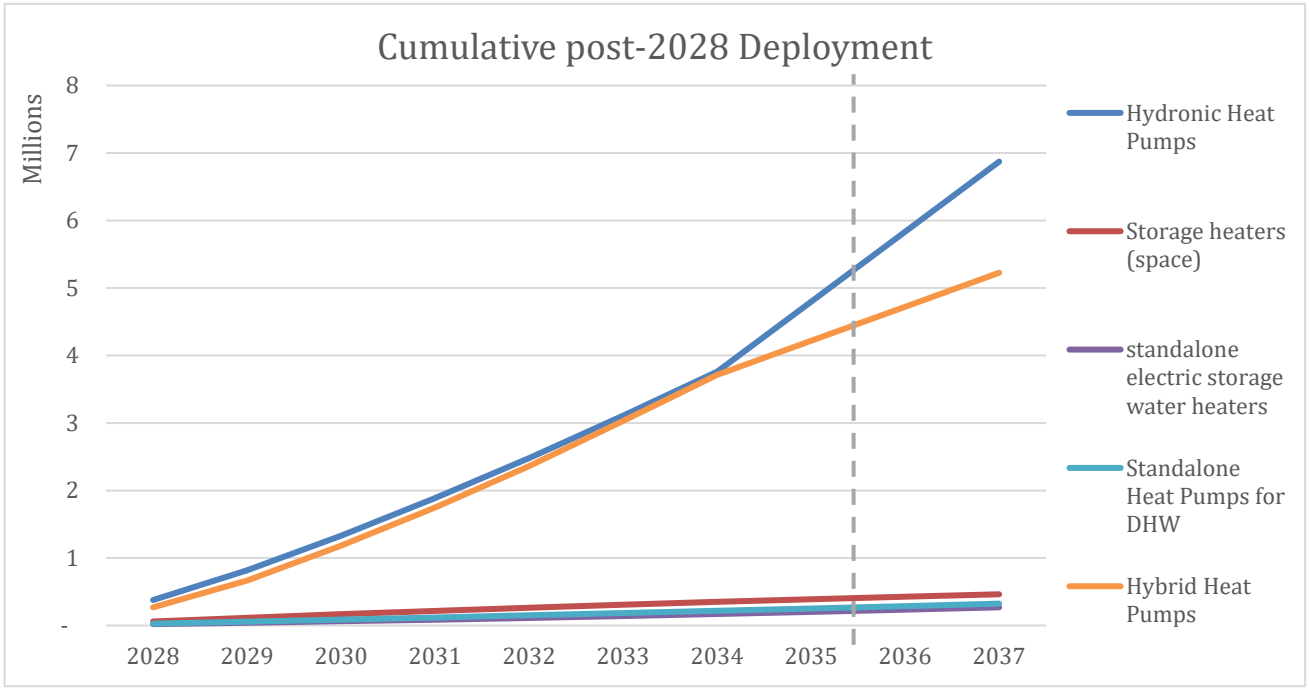

Figure 5: Electric Heating Appliance cumulative annual uptake forecasts. Based upon data from FES24 EE, and data and projections from LCPDelta Ref.

85. In the counterfactual scenario we assumed that a proportion of the devices in Figure 4 would be smart without regulation. For modelling purposes, we have made the conservative assumption that the following proportions of the current market sales have energy smart functionality, see Table 5 below. This assumption is likely to be conversative as the market share of smart heat pumps is expected to grow.

Table 5: Assumptions of the current proportion of appliances that are already smart.

Appliance	% smart compliant	Comment
Hydronic Heat Pumps	50%	Based on interviews with manufacturers
Storage heaters (space)	0%	Based on interviews with manufacturers
Standalone electric storage water heaters	33%	BSRIA Report [xvii]
Standalone Heat Pumps for DHW	0%	Could not identify any reliable sources so therefore for the purposes of this analysis we assume no compliance and therefore the maximum costs.
Hybrid Heat Pumps	50%	Assume same as hydronic heat pumps

Present value costs for policy options

86. Table 6 and Table 7 set out the present value costs over a 10-year appraisal period for the policy options under different cost reduction scenarios. Estimated costs are partial and only cover the additional costs to the manufacturer (as outlined in the section above) and the indicative transition and familiarisation costs. We expect cost to Government to be negligible.

Table 6: PV costs £m 2024 prices, 2025 base year.

Policy option	PV costs £m (2024 prices, 2025 base year)	
	Central assumptions	High assumptions
Option 0 – Do nothing	**0**	**0**
Option 2 – First Phase ESA Regulations	**277**	**732**

Option 2 Cost breakdown	PV costs £m (2024 prices, 2025 base year)	
	Central assumption	High assumption
Smart development costs	**3.9**	**77.9**
Personalised defaults	**1.2**	**3.6**
Cyber and data security	**11.9**	**47.4**
Randomised delay	**1.2**	**2.4**
Familiarisation	**1.2**	**9.5**
Assurance	**22.4**	**179.4**
Cyber and data security	**25.4**	**60.9**
App support	**17.8**	**35.6**
Cloud storage and computing	**69.4**	**69.4**
Additional smart hardware	**123.1**	**246.2**

Table 7: Policy option 2 PV costs breakdown £m (2024 prices, 2025 base year)

Non-Monetised Costs

Complying with PSTI regulations

87. The counterfactual Option 0 would likely have a cost to business regarding compliance with PSTI regulations[16]. This may not necessarily apply to the assessed policy Option 2, so we may be overestimating the cost difference between the options.

Transitional and enforcement costs

88. There would be a cost to Government for transitioning to implementing the policy, however we expect this to be negligible because the staff working in this area to design the policy can be expected to then work on its implementation.

89. The enforcement of the policy is to be carried out by OPSS, who are expected to take on the enforcement of the first phase of ESA regulations. The addition of this policy will incur additional enforcement costs.

Complying with EVSCP Regulations amendments

90. Most of the amendments are costless as the legal obligations from the EVSCP Regulations 2021 are being superseded by these ESA Regulations, for consistency, without changing the material obligations and requirements on manufacturers or importers who bring a charge point onto the market.

91. There are however two areas where there are material changes:
    a) **Cyber Security** – currently, “the consumer IoT device or an associated service should check after initialization whether security updates are available.” This is being changed so that “it checks, when it is first set up by the owner, and periodically thereafter, whether there are security updates available for it.” Additionally, “if an unauthorised change to the software is detected, it notifies the owner and does not connect to a communications network other than for the purposes of this notification.” Lastly, “a relevant charge point must be configured so that if there is an attempt (whether or not successful) to breach the tamper-protection boundary, it notifies the owner.”
    b) **Randomised Delay** – currently, a charge point applies a randomised delay between 0 seconds (i.e. zero delay) to 30 minutes. There was a lack of clarity in the original regulations as to how this should be implemented, with some manufacturers opting to apply this randomised delay always, including when consumers would plug in the car for immediate charging. This led to confusion for some customers who thought their EV or charge point was faulty. This was identified in the process evaluation[xix]. This was intended to remove “shocks” to the power system from thousands of EVs starting to charge simultaneously; instead, EVs would gradually start within that time period. The regulatory amendments clarify that a randomised delay should only apply to scheduled charging events (e.g. when an EV is plugged in earlier than the intended charging time, scheduled for some later time).

92. We have not monetised the costs of implementing and maintaining the amended cybersecurity and randomised delay requirements on businesses. However, it is likely that several existing charge points already conform to the proposed amendments as best practice and/or aligning with the intention behind the EVSCP Regulations 2021. Furthermore, software and firmware cybersecurity updates are already included as part of the costs within the EVSCP Regulations Impact Assessment [xv] which we believe covers the costs of maintaining and updating these as a result of the amendments.

Unit costs

93. The cost of adding smart functionality is small compared to the cost of the whole device. As detailed above, there would be costs related to ensuring compliance to a new regulation. This cost would likely be passed on to consumers. However, our conclusion is that we would not expect the introduction of our regulations to increase the retail cost of an ESA significantly. This is due to the evidence of the costs of EV Charge Points, following their own smart mandate in 2021, showing that the costs have remained close to what they were before the smart mandate, after an initial small price increase [xix].

Benefits

Cybersecurity

94. Cybersecurity is a primary driver behind this regulatory intervention. There is a significant risk that cyber-attackers could exploit ESAs, with the number of attacks potentially increasing with the uptake of appliances. There are a wide range of costs from cyber-attacks which can affect individuals and wider society - from destabilising the

electricity network or Critical National Infrastructure to power outages, loss of personal data, and loss of internet access and operation of internet connected devices.

95. One type of potential cyber-attack is causing a loss of service to the user by occupying the bandwidth of their network and overloading the computational resources of the system. A study by the University of California[29] quantified the costs occurred by consumers from this type of attack, known as a distributed denial of service attacks[30]. It estimated the cost to consumers of increased energy and bandwidth consumption. It considered different scenarios outlined in Table 8 below.

Table 8: University of California (2018) Quantifying Consumer Costs of Insecure Internet of Things Devices

Scenario	Details	Total electricity and bandwidth consumption costs
KrebsOnSecurity	A 77-hour long attack against the KrebsOnSecurity website in 2016, which compromised 24,000 devices.	$324,000
Dyn, Inc.	An attack against the company's domain name system infrastructure in 2016, which compromised over 100,000 devices.	$115,000

96. Alternatively, there is a significant risk that cyber-attackers could exploit ESAs, in aggregate, to destabilise the electricity system and attack Critical National Infrastructure. For example, cyber-attackers could seek to compromise large numbers of devices in order to simultaneously and repeatedly turn them on and off, which would cause significant challenges for the system operator in managing and balancing the grid. Government-commissioned risk assessments[31] indicate that there could be enough smart devices on the system in 2025 that an attack of this type could feasibly cause local or national power outages (i.e. blackouts) in certain circumstances.

97. Recent large-scale blackouts, while not necessarily caused by a cyber-attack, offer us an indicative sense of scale of an attack of this nature. Some examples are outlined in Table 9 below.

Table 9: Indicative estimates of large-scale electricity network outages.

Example	Details	Indicative system cost
9th August 2019[xx]	Over 1m consumers affected for up to an hour	£15million (2019 prices)
2003 North America[xxi]	55m consumers affected for up to a few days	$6billion (2008 prices)
Cambridge 2016 analysis[xxii]	Scenario1: up to 9m consumers affected for up to 3 weeks	£12billion (2016 prices)

[29]University of California (2018) Quantifying Consumer Costs of Insecure Internet of Things Devices.
[30]A distributed denial of service attack is where a number of devices (which have previously been infected, for example by malware) communicate with each other at the same time to create a host which causes a network resource (such as a web resource) or targeted device to be significantly slower to respond or cease to function.
[31]National Risk Register 2025, https://www.gov.uk/government/publications/national-risk-register-2025

98. The cybersecurity measures included in these regulations aim to minimise these potential costs. However, the uncertainty around the likelihood and severity of cyber-attacks means only an uncertain proportion of these costs can be seen as a system benefit.

Energy bills benefits

99. As noted previously for cost, the policy is still in development and given the complex, wide-ranging and innovative nature of the benefits of this policy, we are unable to fully quantify the benefits of a smart EHA over a non-smart EHA at this stage. However, we do have an understanding that the introduction of smart devices can enable more CLF, due to their ability to respond to price signals rapidly, typically via aggregators[32].

100. All households indirectly benefit from lower infrastructure costs through ESA-related CLF due to the following:

i. Reduced demand at peak times[33] means the most expensive forms of generation may not be needed, which would reduce the wholesale price of electricity. Government's 2022 Electricity Networks Strategic Framework estimates system savings of £40b-£50b from 2022 to 2050[xiv].

ii. Using the otherwise wasted electricity from renewables at non-peak times means reduced curtailment costs. The total for 2024 curtailment costs exceeded £1billion[xxiii,xxiv]

101. Both of these ultimately influence the price of household bills, so a reduction in both should lead to a reduction in tariff price. The scale of this saving as a result of this measure has not been quantified due to the lack of quality information and data.

Ecodesign analysis and energy security

102. The EU Ecodesign study[34] investigated how future flexibility provided by smart energy appliances can unlock potential domestic CLF and support the electricity system and energy security. The study estimates the value of the economic and environmental benefits potentially provided by the flexibility of ESAs to the electricity system. The focus is on the impacts for where CLF is used in the day-ahead market[35], however the study notes that additional use cases exist where the flexibility of ESAs would have significant value (such as using CLF to manage imbalances or use by Distribution System Operators to solve local grid congestion constraints).

103. The study calculates two indicators which are relevant to this impact assessment - economic savings and emission savings:

[32] a company or entity that gathers and coordinates the flexibility from various small sources to make them eligible for participation in energy markets.
[33] As outlined in the Smart Systems and Flexibility Plan, highly flexible use of heat pumps could enable annual demand to be shifted by up to 50TWh in 2050 and reduce peak demand by nearly 5GW[9]. **Error! Bookmark not defined.**
[34] European Commission (2018) Ecodesign Preparatory Study on Smart Appliances, https://eco-smartappliances.eu/en
[35] The day-ahead market is the main arena for trading power. Here, contracts are made between seller and buyer for the delivery of power the following day, the price is set, and the trade is agreed.

a) **Economic value in terms of total electricity system costs**. This indicator quantifies the avoided costs related to the more efficient use of the electricity system following the introduction of the flexibility from smart energy appliances. The model captures benefits in terms of: avoided or deferred transmission network reinforcements; avoided generation build; avoided curtailment of low carbon generation; and better operation of the electricity system. It does not model savings to the distribution network from smart.

b) **Total amount of CO2 emissions avoided to 2030**. This indicator quantifies part of the environmental benefits of decreased utilisation of the less efficient and more CO_2-emitting peaking power plants in the electricity system.

vi. Costs and benefits to business calculations

104. We have produced an initial estimate for Equivalent Annual Net Direct Cost to Business (EANDCB) for the first phase of regulation. Based on the available evidence this reflects the direct costs incurred by product manufacturers from the proposed policy, but at this stage we are not able to quantify any direct benefits. Non-monetised benefits include, for example, additional profit generated from ESAs. As a result, these estimates are considered partial, and subject to uncertainty. In particular, there is uncertainty around the extent to which costs are likely to come down with time given assumptions on competition, learning rates and volume of sales/ uptake under different policy options. All these costs are also assumed to be transferred to consumers.

105. The costs we have monetised which have direct impact on businesses are additional costs of manufacturing ESAs which meet the regulatory requirements, transition costs and familiarisation costs. We consider these costs for the stock of appliances affected by the regulation in the first 10 years from when the regulations become effective. This gives a present value net **(NPV)** cost to business of **-£277m** (2024 prices, 2025 base year). To calculate the EANDCB, we use this 10-year period. This gives an **EANDCB** (Equivalent Annual Net Direct Cost to Business) of **£32.5m** (2024 prices, 2025 base year, Government 3.5% real discount rate).

106. The cost of adding smart functionality is small compared to the cost of the whole EHA device. There would be costs related to ensuring compliance to a new regulation. We do not expect the introduction of our regulations to increase the cost of providing ESAs significantly. However, manufacturers may be faced with small costs for ensuring the relevant ESAs meet other requirements around cyber security, data security, and safety. This cost would likely be passed on to consumers.

107. However, our conclusion is that we would not expect the introduction of our regulations to increase the retail cost of ESAs significantly. This is due to the evidence of the costs of EV Charge Points, following its own smart mandate in 2021, showing that the costs have remained close to what they were before the smart mandate, after an initial small price increase [xix].

108. Furthermore, the amendment to the EVSCP regulations clarifies which businesses will be in scope of ensuring charge points are compliant with these regulations.

Currently, all businesses who sell charge points are subject to the regulations, including re-sellers. In the process evaluation, businesses identified that this was overly burdensome [xix].

- This regulatory amendment will clarify that only those businesses who introduce models to the market for the first time either through manufacturing within GB or importing to GB, will be obligated to provide technical files and a register of sale, and will be subject to enforcement by the Office for Product Safety and Standards (OPSS). Additionally, first-to-market businesses will be obligated to provide technical files to OPSS only. Currently all consumers are legally entitled to request this, and as a result, businesses submit much thinner and less useful technical files to protect their intellectual property.

- The regulatory amendment entails no additional enforcement costs as OPSS have confirmed that they already undertake enforcement actions in line with the intended changes to be made. They do this as enforcing compliance of charge points from businesses who first bring charge points onto the market is the most cost efficient and effective way to ensure compliance - as re-sellers and businesses downstream of these will therefore also sell compliant charge points. Additionally, businesses will volunteer to OPSS much more detailed technical files to demonstrate compliance with the regulations.

109. As a result, we do not anticipate there to be any additional administrative costs or burdens to business beyond the status quo from these amendments, and have not monetised them. However, it is possible that there will be very small one-off familiarisation costs for businesses as a result of the relevant regulation for charge points changing from the EVSCP Regulations 2021 (to be revoked) to these new wider scope ESA Regulations.

110. Table 6 sets out the present value costs over a 10-year appraisal period for the policy options under different cost reduction scenarios. Estimated costs are partial and only cover the additional costs to the manufacturer (as outlined in the section above) and the transition and familiarisation costs.

vii. Impact on small and micro businesses

111. The exact number of small or micro businesses that the proposed provisions will affect, is uncertain. There are around 175 manufacturers of electric domestic appliances in Great Britain[xxv] and we expect that a small proportion of these produce ESAs, most of which (66%) are foreign businesses with locations in GB. 27% of electrical equipment manufacturers (the sector under which energy smart appliance manufacturers fall) in GB are micro and medium sized businesses[xxvi], and we expect that the large majority of ESA manufacturers in GB are large businesses (for example, Whirlpool and Bosch).

112. The costs on smaller businesses like local retailers should be small as manufacturers should incur most of the costs of compliance. These types of businesses may face some small costs in regard to familiarisation and adding labelling if not already integrated by the manufacturer.

113. The supply chain will face costs in training their workforce to sell and service appliances that are more complex than non-smart appliances, however, it is likely that this would occur anyway and not as a result of this policy as a degree of smart roll-out is expected anyway. It is important also to recognise that appliances are continuously changing and evolving, and that supply chain businesses are continually developing their practices. Our initial assessment is that the additional costs related to the smart element of new product ranges are likely to be small, and not dependent on the additional uptake of ESAs.

114. We have considered how these businesses could be supported, and costs could be mitigated:

- Long implementation period - requirements can be introduced gradually, in order to provide a sufficient timeframe for manufacturers, including small businesses, to redesign their products and services in accordance with the requirements.

- Awareness campaigns - the UK Market Surveillance Authority is required to raise awareness of the Ecodesign and Energy Labelling Requirements, so industry and small businesses will be made aware of the consequences of placing non-compliant products on the market. Specific information campaigns provided through this channel could be used to mitigate any disproportionate demands in respect of understanding what compliance looks like and what is required. This would be carried out by OPSS.

- Specific information campaigns or user guides, training, and dedicated support for smaller businesses. As noted above, this would be an essential method of cost minimisation and would be carried out by OPSS.

viii. Costs and benefits to households' calculations

115. All households indirectly benefit from lower infrastructure costs through ESA-related CLF due to the following:

i. Reduced demand at peak times means the most expensive forms of generation may not be needed, which would reduce the wholesale price of electricity.

ii. Using the otherwise wasted electricity from renewables at non-peak times means reduced curtailment costs.

116. Both of these influence the price of household bills, so a reduction in both would see a reduction in tariff price. This saving has not been quantified for household bills.

117. The cost of adding smart functionality is small compared to the cost of the whole device. There would be costs to business related to ensuring compliance to a new regulation. This cost would likely be passed on to consumers. However, our conclusion is that we would not expect the introduction of our regulations to increase significantly the cost of an ESA. This is due to the evidence of the costs of EV Charge Points, following their own smart mandate in 2021, showing that the costs have remained close to what they were before the smart mandate, after an initial small price increase [xix].

ix. Business environment

118. This policy is intended to promote competition. For example, the interoperability principle, expected to be introduced in a later phase of regulations, would aid competition between manufacturers and service providers, as it allows customers to choose different appliances and services, avoiding the risk of consumers being locked in to using devices from a particular manufacturer and services from a certain provider.

119. By establishing a clear set of requirements (based on well-understood international standards) plus a sufficient implementation period we create a better investment climate in GB[36].

120. These regulations, together with Government-funded innovation programmes for energy storage and flexibility, will spur innovation, encouraging industry to evolve and bring interoperable and user-friendly energy smart appliances to the market.

121. The Government is working with the Northern Ireland Executive to explore opportunities for GB-NI ESA regulatory alignment, where practicable.

x. Trade implications

122. These regulations set requirements for all relevant ESAs sold in Great Britain. This will have implications for businesses selling to Great Britain and those exporting ESAs abroad.

123. If requirements for the GB market are different to those of other markets, businesses selling to GB and other markets could face additional costs. Businesses will have to familiarise themselves with the different requirements and may have to provide separate assurance processes (e.g., conformity assessment) to demonstrate their products are compliant for each market. We expect the manufacturing costs to be limited because the technologies which could be needed for ESAs to be compliant are fairly homogenous across different appliances and across countries.

124. When developing the specific GB requirements, we consulted with industry to understand whether these would create additional costs for businesses manufacturing products for multiple markets. For example, we took into account that mandating cyber security requirements based on ETSI[37] standards (established international standards), devices developed for the GB market could also be sold internationally.

xi. Environment: Natural capital impact and decarbonisation

125. Smart appliances will improve the utilisation of low carbon generation, thus avoiding existing peaks of demand - which is largely met through fossil-fuelled generation. This

[36] This will be further enhanced with 2nd phase regulation plans, which goes even longer term.
[37] European Telecommunications Standards Institute

could make significant savings in the traded sector. The environmental benefits per appliance could be larger in the GB due to the relatively high expected share of generation coming from renewable energies in GB.

xii. Other wider impacts (consider the impacts of your proposals)

Impact on rural areas

126. Average broadband speeds in rural areas tend to be slower than those in urban areas. This is because there is less superfast broadband, and rural premises are typically further away from cabinets with longer line connections which can slow performance. Additionally, rural areas have lower coverage from 4G and 5G coverage. The smart functionality of ESAs requires internet connection via broadband or mobile data. Therefore, reduced broadband and network coverage could act as a disincentive for consumers in rural areas to purchase an ESA, or they might experience diminished performance of ESAs. The disparity in broadband and network across UK regions is being addressed by policies such as the Shared Rural Network programme[xxvii] and the Gigabit project[xxviii]. The uptake and consumer experience of ESAs across regions can be included in the evaluation framework for the regulations.

Public Sector Equality Duty Assessment

127. The Phase 1 ESA regulations have been drafted with the equality duty in mind. They recognise how the needs of people that share a protected characteristic can differ, such as requiring the ability to change default operational hours and set heating preferences. The key barriers to participating in CLF are income, differences in working patterns and digital exclusion. However, there is no disproportionately negative impact on people who share a protected characteristic. Equality of opportunity in the energy market is advanced through the reduction in energy bills from lower infrastructure costs. Moreover, the inclusion of manufacturer guidance packs seeks to ensure digital-excluded households can participate in CLF. The government's Digital Inclusion Action Plan[xxix] also seeks to address the 'digital skills gap'. Further views in relation to distributional impacts will be sought in the consultation to inform an updated PSED accompanying the final regulations.

xiii. Risks and assumptions

Policy risks

128. The risks associated with this policy are set out below:

- Non-compliance by industry - the nature of this risk varies between the policy options. If regulatory requirements or technical standards are not clear or strictly enforced, there may be non-compliant products on the market undermining confidence and consumer protection.

- Increased energy consumption - smart appliances may use more energy on standby or by deviating from the most energy efficient operation point, e.g. by cooling deeper or heating higher.

- Regulation does not drive uptake and/or use of smart functionality is low - this could be driven by multiple factors such as additional cost of smart appliances, media push back and general consumer disengagement with energy issues.

- Regulation does not drive smart tariffs and services - there is a risk that regulation comes at the wrong time or is insufficient to incentivise smart tariffs and services from suppliers/aggregators meaning that the smart functionality is not used to manage the electricity system.

- Vulnerable consumers are left behind - if they are unable to afford smart appliances or have inflexible load, they may be faced with higher energy costs.

129. Given the risks outlined, it is important that we monitor these risks when the regulations become effective so that we can take appropriate policy actions such as adjusting the regulations or providing support to incentivise compliance and engagement if needed.

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