

Electrifying the kitchen: product standards in context

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Research Report

1 Introduction

The BEIS Heat and Buildings Strategy marks a shift towards decarbonising the domestic sector. Most policy and research attention is focused on heating, and replacing gas boilers with heat pumps. The decarbonisation of cooking has received relatively little policy or research attention.

This evidence review provides an overview of international policies and measures designed to phase out cooking with gas, and, using relevant case study material, draws out some important insights and issues for policymakers to consider.

2 Approach

The evidence was reviewed in two stages:

- A “bottom up” literature review to understand how similar product-related policies work, for example by addressing barriers and drivers of change; and
- A more considered, “top down” case study analysis of how product policy sits within a wider decarbonisation policy framework.

The review assessed evidence from academic sources and international experience using the peer-reviewed academic literature and three main sources of written evidence:

- International policy databases: the EU Odyssee/Mure database, the JRC, the OECD and the International Energy Agency.
- Research bodies including the European Centre for an Energy Efficiency Economy (ECEEE) and its American counterpart (ACEEE).
- Policy and trade NGOs including the Building Decarbonization Coalition, the Regulatory Action Project (RAP) and the UK Green Building Council.

Key evidence was also discussed with colleagues in the Universities of Oxford, Leeds, Edinburgh and UCL, and with the UK Energy Systems Catapult, the Carbon Trust, the US National Resources Defense Council and officials from US State bodies in California.

3 Product policy programmes

Literature review

Sophisticated product efficiency standards first emerged in the US following the first oil crisis in 1973 ([Nadal 1996](#)), and as a result the general literature is extensive and covers both the underlying principles and detailed reviews for specific product classes. EU product policy emerged in the early 1990s and in 2021 the EU/JRC published a [comprehensive review](#) of product policy standards in preparation for a review of the ecodesign regulations. Standards specifically for induction cooking appliances arrived in the mid-2010s as the technology matured ([US DoE](#)).

Emissions of combustion pollutants such as nitrogen dioxide and carbon monoxide are difficult to control directly unlike from other domestic sources such as boilers, so cooking does not tend to be part of the building control regime except as part of broader ventilation and extraction standards. The literature is particularly strong on the health effects of the pollution from gas cooking with many US studies covering indoor air pollution and health ([Harvard](#), [UCLA](#)). A recent report by [the Rocky Mountain Institute](#) showed that levels of these pollutant can reach levels that would breach ambient air quality guidelines outside the home and considered to be dangerous particularly to children.

The technical performance and economics of induction hobs is also well covered, both by studies looking at the overall approach ([Sweeney et al 2014](#)) and more specifically by comparing the relative efficiency of induction hobs in [the EU](#) and [the UK](#). The recent technology-based literature assesses broader, non-energy benefits such as [smart controls](#), ease of cleaning and speed of cooking. There is also a very wide range of industry-led information such as [buyer's guides](#) and – [strong advocacy](#) for induction hobs from professional chefs.

Finally one of the most comprehensive general studies of the socio-economic aspects of the decarbonisation of cooking was actually carried out in the UK by UKERC in 2020 ([Khalid & Foulds 2020](#)) by an author that had been seconded into BEIS. The report covers a wide range of issues, including gaps in the research, barriers and drivers of change, trends in cooking practice, including cultural aspects and key recommendations for policy.

Gaps in the literature

There is much less research into the socio-economic side of cooking and particularly into public perceptions of the various cooking technologies. The EU/JRC study makes no mention of social or behavioural aspects at all. The literature is stronger for [G77 countries](#) such as Asia, Africa and South America. However these studies are predominately focused on equity issues or on situations where electricity is displacing fossil fuel burning (wood, animal dung, coal) which has limited applicability for Western markets.

There is also very little pure, publicly available market research looking at potential future markets for induction hobs. The EU JRC study examines current technology markets, but does not model the future in any meaningful way. There are what appear to be significant trade association reviews covering potential market share of the various technologies but these reports tend to be behind paywalls (see for example [EPRI](#)).

There are some modelling assessments of the actual or potential carbon or energy savings that scale deployment of induction cooking could generate. However these tend to be part of *post hoc* impact assessment studies (for example from the [California Public Utilities Commission](#)) and are, again, difficult to extrapolate to the UK.

4 Product policy in context

Energy efficiency policies do not operation in isolation, but as part of complex, interactive “policy mixes” designed to ensure that policies are complimentary and address barriers and

drivers effectively, and most importantly, in the right order. There is a rich academic literature on how to get these mixes right both generally ([IEA 2017](#)) and specifically for buildings policies ([Rosenow et al 2016](#)).

In this context some programmes, particularly at the US State level, have for some years focused more strategically on the [electrification of buildings](#), which attempts to draw together a number of policies into an overall decarbonisation strategy. UK policies for domestic heat pump deployment in the Heat and Buildings Strategy are moving in this direction.

However many programmes are becoming very sophisticated, with the most advanced explicitly [linking supply-side decarbonisation and demand-side energy efficiency policy](#). These include, for example:

- Energy system planning to encourage electrification by co-ordinating policies and aligning the interests of the various State-level actors.
- Building codes and standards that facilitate electrification e.g. by requiring wiring upgrades for appliances and electric vehicle charging.
- Product policies, primarily focused on heat pumps, but including cooking technologies such as induction stoves.
- Research, development and demonstration policies to improve the efficiency and useability of electric technologies.
- Innovative use of electricity time-of-use tariff structures and other demand-side response approaches.
- Incentive and subsidy programmes that lower the cost of electric technologies.
- Awareness, outreach and education programmes.

In the US building electrification is most advanced in California and a number of North-eastern states, including Massachusetts and New York ([ACEEE 2018](#)). [Australia](#) has introduced net zero building codes at State level, and other countries, notably [Canada](#) and [Germany](#), have published net zero strategies similar to the UK Heat and Building Strategy that include some degree of building decarbonisation.

However, for the purposes of this study, California's programmes are the most relevant because product policy, and cooking in particular, are embedded in the Public Benefit Fund programmes run by the State government and the energy utility companies. California's experience covers both the delivery of policies and programmes and the design of the overall policy landscape.

The US State policy model

State-level energy efficiency and renewable energy programmes are funded by [Public Benefit Funds](#), (PBF) set up when the US energy markets were restructured in the 1990s. PBFs raise money from a small levy on energy bills (and occasionally on energy company profits) to pay for a range of subsidy programmes [run by the energy companies](#).

The overall design and scope of PBF policies is beyond the scope of this report; there are several excellent synoptic reviews that provide useful background (see especially [ACEEE 2018](#)). However PBF programmes can be very significant. In 2020 California [spent over \\$1.5bn](#) in 2020 on electrical efficiency programmes, equivalent to \$38 per person.

Two public bodies manage PBF programmes and the policies that relate to them:

- The [California Energy Commission](#) (CEC) sets overall energy and emergency planning policy, including renewables and energy efficiency, and regulates power plants.
- The [California Public Utilities Commission](#) (CPUC) regulates the energy company PBF programmes, sets net zero standards and runs the emissions trading scheme.

Policy design and appraisal

One of the central features of PBF programmes is that they are highly visible at a political level given that they are funded by a levy on energy bills. This means that States have evolved sophisticated impact assessment methodologies to demonstrate that levy funding is being used properly. Officials from the CEC point to a number of key areas:

- Policy design: how programmes are designed and implemented, including detailed policy design aspects such as [cost-effectiveness and additionality](#).
- Policy co-ordination: how policies fit together, principally through regulatory structures such as [the building codes](#) managed by the CEC.
- Impact assessment: evaluations of [programme outcomes at State level](#) and exhaustive *post hoc* [statistics](#) for each energy utility programme.
- Individual technology rebate and other public subsidy programmes, mainly for [households and the fuel poor](#) but also for [commercial premises](#).

Policies specifically related to cooking

Given the plethora of State publications it can be hard to find material specific to programmes relating to cooking. However one organisation, [the Building Decarbonization Coalition](#) (BDC) brings together a number of public and private organisations with an interest in decarbonisation. Their website has aggregated a wide variety of resources, with a page specifically covering [kitchen decarbonisation](#). For example:

- Research into the [health effects of gas hobs](#).
- Detailed research on the [costs and benefits of kitchen electrification](#).
- Detailed market research [into public attitudes to induction hobs](#).
- Public attitudes to [decarbonisation](#) and [energy efficiency appliances](#).
- [Appliance loans](#) and market research on the [take up of the loans](#).
- Financial incentives for [domestic appliances](#) and [construction projects](#).
- Appliance incentive programmes aimed at [non-domestic kitchens](#).

5 Conclusions

From a product policy perspective, the decarbonisation of cooking is still a relatively recent research area compared to the displacement of gas boilers by heat pumps. Nonetheless the literature is strong on technical and economic barriers and drivers of change, and especially on the energy performance of hobs and on the health impacts of gas cooking. There is also a strong evidence base covering existing markets for the various cooking technologies especially in Europe.

The social side of the issue is less well covered. The recent EU JRC review of product policy standards was almost silent on public attitudes and the potential impact on real-world technology markets. Studies of Asian households have limited applicability to a western policy applications given that the incumbent technology is wood or coal. Modelling evidence on the potential for induction cooking is also lacking, particularly in Europe. There are no publicly available studies in the UK on the carbon, energy or market penetration potential of induction hobs.

What is very clear from the evidence is that product policy is rarely seen as an end in itself, but part of a wider set of policies designed to decarbonise the household. This approach is particularly evident at US State level, where sophisticated decarbonisation programmes have emerged in the last 5 years or so that attempt to merge the socio-technical and regulatory aspects. Similar approaches are being developed in Australia and Canada. There is a very distinct difference in approach between these programmes and the technocratic view taken in the EU.