Cooking Appliances

HIGHLIGHTS

PROCESS AND TECHNOLOGY STATUS – In developed countries, cooking appliances are mature technologies with very high market penetration. In the US, virtually every household possesses an oven and cooktop, and in the EU most households have at least one oven. Appliances generally use electricity or gas (natural gas or LPG), whilst biomass is also an important fuel in developing countries. A wide variety of devices exist that largely serve the same cooking requirements; recent trends in product innovation have moved towards increased integration and functionality. In recent years, domestic cooking accounted for 7.5% of total EU residential electricity consumption, 8% of US residential electricity and 50% of the natural gas consumed by US domestic appliances. Domestic equipment can be broadly categorised into ovens, grills, hobs and microwaves. These are often integrated into cookers or ranges. Electric ovens dominate the EU domestic market and are owned by 77% of EU households and 64% of US households. Commercial appliances tend to have significantly higher power ratings and are used more intensively, with a wider range of appliances to serve more specific needs. Key technologies include ovens, grills or broilers, hobs and microwaves as well as ranges, fryers, griddles and steamers. In the US marketplace, stock is well split between the different devices, with gas ovens accounting for the largest share with 16.6% of 2008 stock. In the EU-27, combi-steamers dominate the market: in recent years, 41,000 electric and 9,200 gas combi-steamers were sold. In developing economies, cooking energy is a more important end-use compared to developed economies: in India, cooking accounts for 90% of domestic energy consumption, with 75% of this provided by biomass. Appliance types vary significantly, but in rural areas they are often basic stoves.

PERFORMANCE AND COSTS – The performance of common cooking appliances varies widely depending on device type, fuel type and user behaviour. Real-life efficiencies differ substantially from standardised test values due to the impact of idle consumption, pre-heat input and user behaviour. With equivalent equipment, user behaviour can produce a variation in consumption of up to 30%. Annual consumption figures show that electric and gas hobs consume the most energy, with domestic devices using an average of 190-250 and 333-996 kWh per year respectively. Microwaves can offer substantial efficiency savings due to considerably shorter cooking cycles. Domestic appliance costs range from €50-1,500 with cheaper equipment generally being less efficient. Limited energy labelling schemes exist: in the EU, domestic electric ovens are rated A-G, and this qualification scheme has been credited with increased EU uptake of efficient electric ovens. In the commercial sector, gas appliances offer test efficiencies ranging from 25-50% and electrical appliances vary from 50-75%. The US Energy Star programme offers a voluntary qualification scheme for commercial fryers, ovens, steamers and griddles. Qualified appliances can save up to 14,650kWh per year compared to the equivalent conventional device. All commercial devices have shorter lifetimes of around 10 years; costs vary significantly with size and features, and fall within the range of €1,000-30,000. In developing economies like India, cooking devices consume much more energy, with efficiencies of 5-45% and lifetimes of around 3-7 years.

POTENTIAL AND BARRIERS – A range of opportunities for technology evolution exist, some of which are broad and apply across fuel-devices, whilst others are fuel or device-specific. Estimates of potential energy savings for domestic appliances vary; conservative assessments suggest potential long-term gains of 6-7% for ovens and 4% for microwaves. Product innovation of gas appliances could yield the largest energy savings. In the EU, technology could be transferred from electric appliances and commercial gas devices; in the US, the replacement of pilot lights with electric ignition systems will significantly reduce annual energy consumption. In the commercial sector, a number of existing technologies have yet to be implemented. These are estimated to offer an overall technical potential saving of 31% in the US marketplace. In both the domestic and commercial sector, significant savings could be made by switching to more efficient devices and adopting more efficient behaviours; however, barriers associated with capital costs, inertia, fuel choice, consumer information, convenience, fashion and usability all contribute to limit progress. Perhaps the most significant opportunity for global cooking efficiency exists in the developing world: improved biomass stoves and fuel switching promises large energy savings, but substantial cost and availability issues exist at present.

PROCESS AND TECHNOLOGY STATUS

There are four heating mechanisms used for food cooking: conduction, convection, radiation and induction. **Conduction** refers to the heat transport from an energy source to the material. **Convection** occurs when fluids become less dense on heating, setting up convection currents that physically transfer heat and hot fluid to the material. **Radiation** refers to the energy propagation as an electromagnetic wave, which can heat the surface of a material. **Inductive heating** involves the induction of a current in a material due to a changing electromagnetic field, which then produces heat due to resistive losses. In general, cooking processes involve a combination of these mechanisms.

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