BENEFITS OF MAGNETIC SOURCE INDUCTION

This section shows how cooking can be made a zero emissions activity by using electric rather than gas appliances. Options to improve energy efficiency are described. These options allow for substantial reductions in the actual energy load that needs to be transferred from gas to electrical infrastructures. The following sections examine the efficiency measures available to cooktops and ovens in more detail.

Induction Cooktops

The induction cooktop has been commercially available since the 1970s. Induction cooktops operate by using electricity to produce magnetic fields. These magnetic fields pass through the ceramic-glass surface and enter cookware (pots/pans). The magnetic field penetrates ferrous metal in the cookware, causing the *bottom* of the cookware to heat up and act as the heat source for the food to be cooked.

The cooktop itself does not become a "hot-plate" – it heats only incidentally from contact with the bottom of the heated cookware.

Benefits

The benefits of induction cooktops are compared with radiant heat electrical cooktops (including 'ceramic' and solid plate) and gas cooktops in 3.14.

Note: Electrical cooktops, induction and non-induction alike, have peak power requirements which may require a wiring upgrade for some installations.

Demand-Reduction Potential

Electric induction cooktops are approximately 50% more efficient at heating a pot/pan than gas. Replacing gas cooktops with induction will lead to a halving of energy demand from cooktop use. Induction cooktops are also 10% more efficient than standard electric cooktops, so additional energy savings would be available if these were replaced. In commercial kitchens, the adoption of induction cooktops will have the added benefit of reducing demand for space cooling due to the reduction in waste heat. The exhaust requirements can be significantly reduced allowing for quieter working environments and customer areas.

Implementation Recommendations

TABLE 3.13
Types of Cooktops

Common name of cooktop	Power-source	Technology for heating	Surface options
Induction	Electricity	Electromagnetic induction	Ceramic- glass top

Ceramic	Electricity	Radiant heat	Ceramic-glass top
Solid plate	Electricity	Resistive heating	Exposed solid plates
Gas hob	Gas	Direct flame	Gas burners

TABLE 3.14
Comparison of Cooktop Technologies

Feature	Description	Induction cooktops	Radiant heat electric cooktops	Gas cooktops
Responsiveness	How quickly does the delivered heat change when a control is adjusted?	Immediate	Not immediate	Immediate
Efficiency	How efficiently is supplied energy converted into heat in the cookware? [104]	Approximately 84% efficient	Approximately 75% efficient	Approximately 40% efficient
Precision	How precisely can the temperature be controlled?	Highest (usually 10 or more settings)	Medium (often only 4 settings)	Lowest (Mainly visual estimation)
Consistency	Heat distributed evenly in pot/pan?	Even heat	Less-even heat	Less-even heat
Hazard	Risk of burns from cooktop surface	Lowest	Mid	Highest
Health	What emissions are produced by this type of cooktop?	None	None	NO2, CO, CO2 and other waste gases
Waste heat	How much waste heat is emitted into the kitchen?	Least	Low	Most (more than 60%)
Cleaning	What is the ease of cleaning?	Easiest Can be wiped immediately after cooking as the plate is not hot and does not bake spills onto the surface.	Harder – and more finicky unless ceramic-glass.	As the hot surfaces can bake spills onto the surface, cleaning is more difficult and requires waiting until the surface has cooled down
Installation into benchtop	How easy is it to install in a benchtop?	Easiest. Induction cooktops are generally thinner than other types of cooktop	Easy	Moderate. Typically heaviest.
Electrical cabling & gas pipes	What are technical complexities associated with installation?	Conventional high-current wiring. No gas pipes required.	Conventional high-current wiring. No gas pipes required.	Gas pipes required; Standard electrical connection required for gas ignition.

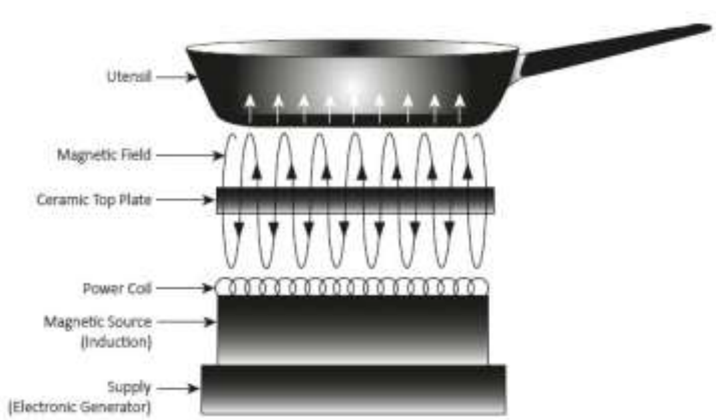

FIGURE 3.26
Operation of an induction cooktop. [Damar]

The ZCA Buildings Plan recommends the replacement of all gas cooktops with electric. In residential buildings, the proposed cooktops are induction, so as to provide those households with gas cooking with an equivalent cooking experience. Existing electric cooktops will be replaced as part of a natural replacement cycle (when they reach their end of life).

In non-residential buildings, a standard electric cooktop is sufficient for slow cooking, but if immediate responsiveness is required induction cooktops are necessary. Therefore, in non-residential buildings a mixture of induction and electric ceramic cooktops are proposed.

Costs

Induction cooktops have come down substantially in cost in Australia with the arrival of low-cost options, such as the Ikea model priced at $699 in 2013. Prices are expected to fall further as volumes increase and they shift from being marketed as high-end luxury products to general use. In comparison, radiant heat electric cooktops start at around $400 for ceramic glass top or $350 for solid plate hobs. Gas cooktops start at $200.

Specific product issues

Cookware

Induction cooking requires cookware – pots and pans – with a ferrous (iron) content.

Some cookware used on radiant heat electric cooktops and gas cooktops is not suitable for use on an induction cooktop as it does not contain an appropriate iron content and will therefore not heat up. To test if cookware is suitable for use on an induction cooktop, a magnet can be held to the base of the cookware – if the magnet and the base are attracted, the cookware is suitable. Any cookware that does not respond to magnetism will need to be replaced with induction-compatible cookware or will need an adaptor which acts as a hot-plate. However, adaptors reduce the benefits of induction cooking.

To optimise efficiency, the size of the cookware should be matched to the induction cooktop's plates to minimise overlap of the cookware beyond the perimeter of each induction plate.

Woks

When woks with a convex base are used on a flat induction cooktop, not much of the convex base is close to the electromagnetic field and therefore only a small part of the base will heat up. Therefore, a flat-base wok should be used on a flat induction cooktop.

Alternatively, a convex-base wok should be used on an induction cooktop with a matching concave indentation. Concave induction cooktops also come in standalone, portable units and are available for non-residential use (5 kW and 8 kW) as well as residential use (3.6 kW). The heating delivered with these units is often superior to gas-powered burners [107].

Electromagnetic interference

Some cardiac pacemakers are susceptible to magnetic interference from devices such as mobile phones [108]and induction cooktops. Studies [109, 110] have shown that, unless the pacemaker is brought to within approximately 35cm of an in-use induction cooktop, there is no magnetic interference and maintenance of a distance of more than 50cm is recommended. People with pacemakers should be aware of this risk and may choose radiant heat electric cooktops instead.

Electric Ovens

Although electric ovens are around twice as efficient as gas ovens, they are often only 14% efficient and there are some significant opportunities for improving efficiency to as much as 24% [106].

Technology Benefits

Compared to gas ovens, electric ovens:

- Heat faster

- Offer more consistent heating
- Offer more precise heating measurements
- Have multiple functions (e.g. grill, fans, etc.)
- Have a lower installation price
- Produce lower emissions.

Demand-Reduction Potential

Reducing thermal mass of oven models is one of the simplest changes used to increase oven efficiency. Because energy is absorbed by all oven components during use, reducing the amount of material in the oven will increase efficiency [106]. Similarly to improving household insulation, improving insulation in oven cavities can significantly reduce the annual cooking energy consumption of both gas and electric ovens. The performance of insulation depends on the thickness, density and thermal conductivity of the oven. With longer cooking times, improved insulation can decrease energy consumption by 5-6% [106].

Convection ovens are often more energy efficient because they continuously circulate heat throughout the oven cavity with a fan. This continuous circulation allows for faster, more even cooking at lower temperatures, decreasing energy consumption anywhere from 6-20% [106]. For commercial purposes, convection electric ovens can reach up to 70% efficiency, leading to dramatic decreases in energy consumption, and savings.

Heat is lost through glass windows in oven doors faster than through lack of insulation. Ideally, oven doors should possess no glass window to achieve maximum energy savings; however, users of such ovens tend to compensate by more frequently opening the door. Use of low-emissivity glass and three to four layers of glass panels in the oven door improves insulation and efficiency.
Some implementation recommendations listed above require oven replacement. However, replacing leaking door seals allows electric oven users to achieve energy savings with existing equipment.

Implementation Recommendations

Gas ovens should be replaced with high-efficiency electric ovens. The efficiency of existing electric ovens should be improved through either equipment upgrade or replacement.

Costs

Basic multifunction electric residential ovens with double-glazed doors start from approximately $400, triple-glazed from approximately $900 while quadruple-glazed door ovens with improved insulation and even pyrolytic self-cleaning are available from approximately $1500. Details about further insulation are often not provided in manufacturers' specifications. Non-residential high-efficiency electric ovens can offer an attractive payback related to their frequency of use.

Source: http://decarboni.se/publications/zero-carbon-australia-buildings-plan/4-electrical-appliances-and-services