

Revolutionizing Cooking with Induction Heating Stovetops: Unveiling the Benefits,  
Design Considerations and Nationwide Integration Strategy

by

Sam Apigian

A thesis presented to the Honors College of Middle Tennessee State  
University in partial fulfillment of the requirements for graduation  
from the University Honors College  
Spring 2024

Thesis Committee:

Dr. Antonio Saavedra, Thesis Director

Dr. John Vile, Thesis Committee Chair

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APPROVED:

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Dr. Antonio Saavedra, Thesis Director  
*Lecturer, Engineering Technology*

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Dr. John Vile, Thesis Committee Chair  
*Dean, University Honors College*

## Abstract

Studies have been surfacing over the detrimental effect gas stovetops have on the environment and consumers. An alternative stovetop technology is needed to counteract the growing energy consumption in the United States. This thesis is an in-depth evaluation of how to best implement induction for use in stovetops and formulation of a process toward the adoption of induction cooking nationwide. Conducting a thorough analysis of the optimal design and materials for induction cooking, combined with a comprehensive evaluation of the advantages of induction stovetops over alternative cooking surfaces, can effectively persuade the public to embrace induction heating. A well-informed understanding of the most effective implementation of induction heating stovetops is crucial for a seamless transition towards a clean and efficient future in cooking. Government interventions, such as tax breaks, can further contribute to convincing individuals to adopt a more environmentally friendly stovetop solution.

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# Introduction

## *History of Induction Heating*

Induction heating is a relatively recent innovation when compared to the gas and electric heating counterparts. Induction heating involves the utilization of electromagnetic induction to heat conductive materials. Widely applied in industrial settings, induction heaters are renowned for their efficiency, precision, and speed. Michael Faraday's law of electromagnetic induction proposed in 1831 serves as the fundamental principle behind the development of induction heaters. During his experiments with two coils of wire encircling a shared iron core, he observed that closing the switch connected to the first coil resulted in a momentary current in one direction on a galvanometer linked to the second coil. Surprisingly, keeping the switch closed did not yield any current in the second coil. However, upon opening the switch, a current was once again detected in the second coil, but this time in the opposite direction to the initial measurement when the switch was closed [1]. According to Faraday's law, a conductor exposed to a changing magnetic field induces an electric current [2].

Understanding the process of induction heating necessitates comprehension of the principle of electromagnetic induction. As a charge moves through space, it generates a magnetic field. In the context of a wire with a current flow, a magnetic field is induced around the wire. When the wire is coiled, each section induces magnetic fields that align, creating a uniform magnetic field through the coil's center. Faraday's law is crucial in explaining the magnetic fields that enable induction heating [1].

Faraday's Law states that a change in magnetic flux generates an electromotive force. Magnetic flux, a product of magnetic field magnitude and cross-sectional area vector, increases with the current through a solenoid. When a ferromagnetic metal core is introduced into the solenoid, a magnetic field is generated, causing magnetic flux to enter the core [3]. This induces an electromotive force or voltage in the core, producing eddy currents that resist the solenoid current, following Lenz's law [4].

Understanding Faraday's Law and Lenz's Law is essential for comprehending how an inductor operates. While Faraday's Law defines the magnitude of the electromotive force produced, Lenz's Law initially introduces voltage across an inductor, a current encounters resistance from opposing magnetic fields. The current gradually increases until the inductor no longer resists, reaching maximum induced magnetic field. Upon removing the current source, the inductor's magnetic field resists change, allowing current to flow until the magnetic field dissipates [5].

Induction heating employs these principles to heat ferromagnetic metals in a changing magnetic field created by alternating current. The alternating magnetic field induces eddy currents in the metal, generating heat proportional to its resistance. Metals with lower resistance, like copper, exhibit lower heat compared to higher-resistance metals like iron or steel [6].

The history of induction heating traces back to Nikola Tesla's work on magnetism and alternating current, leading to the invention of powerful AC generators essential for induction heaters. Sebastian Z. de Ferranti's 1887 proposal for industrial induction heater application and F. A. Kjellin's 1891 invention marked significant milestones. Subsequent

advancements by Edwin F. Northrup, M. G. Ribaud, and Valentin P. Vologdin were motivated by wartime applications and have been applied to civilian uses since the 1980s [7].

### ***Uses in Industry***

Induction heaters are widely employed in modern industries for their efficiency, speed, precision, and repeatability. Environmentally sustainable as they do not use fossil fuels, induction heating can be repeated with high precision, contrasting with traditional methods [6]. Applications span metalworking processes like melting, forging, annealing, welding, and heat treatment. Advanced induction heaters using different frequencies enable various levels of penetration for heating irregularly shaped metals [7].

A prominent modern application of induction heating is in cooking appliances, where solenoids often take the form of Archimedean spirals [8]. This technology surpasses traditional stoves in speed and efficiency, offering safety benefits by directly heating pots and maintaining a cold stovetop when not in use. Features such as smart pot recognition and adaptive stove tops enhance user control, while the total active surface concept allows the placement of multiple pots of any shape for simultaneous heating [7].



*Figure 1: An induction heating stovetop using four solenoids in the shape of Archimedean spirals.*

Presently, there exists a variety of induction heating coils utilized across a range of applications. Research indicates that induction heating is most efficient when the metal workpiece is situated within the heating coil, a setup impractical for induction heating stovetops [5]. The heating coil must instead be a flat surface capable of accommodating a pan for stovetop usage. Induction cooktop coils typically consist of ferromagnetic materials like iron for their thermal conductivity and durability. In contrast, induction cooker tops are crafted from insulative materials like glass-ceramic, chosen for their low thermal expansion and high heat resistance. Pots and pans intended for use on induction cooktops must be constructed with ferromagnetic materials, such as stainless steel, to interact with the magnetic field generated by the induction coils.

Induction cooktops are gradually gaining global acceptance. Various national governments have incentivized their adoption, exemplified by Ecuador's Ministry of

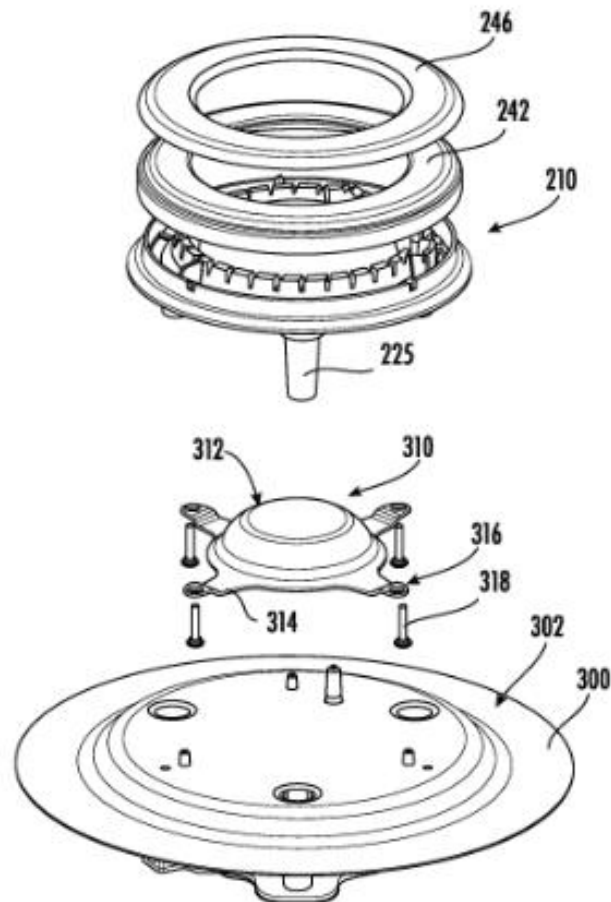
Electricity and Renewable Energy's implementation of the National Efficient Cooking Plan in 2017. This initiative aimed to promote the use of renewable and clean energies to mitigate CO<sub>2</sub> emissions, with a target of replacing 3.5 million liquified petroleum gas (LPG) cookers with induction cookers by 2018 [9]. Similar initiatives have been undertaken in Indonesia, the Netherlands, and India. A study conducted in Indonesia revealed that induction stovetops exhibit superior energy efficiency and quicker cooking times compared to alternative technologies like halogen, gas, and electric stoves. Furthermore, the study noted that 72.38% of Indonesian households relied on LPG [10]. Currently, induction stovetops are less prevalent than gas and electric models; however, it appears increasingly likely that their usage will rise in the future.

## **Methodology**

In the collecting of information for this methodology, a literature review and patent search were conducted. Through the analysis of several sources, the three major cooktop technologies, gas, electric, and induction, were compared. Comparisons were made using a cost analysis alongside the consideration of efficiency and environmental impact. After a thorough comparison of the stovetop technologies has been made, the optimal design of an induction cooktop was proposed. Observing different materials and induction coils designs was used to ascertain the optimal structure of an induction heating stovetop. Finally, a product analysis was conducted to see what induction cooktops are currently on the market and the advantages or disadvantages of each.

## *Comparing Stovetop Technologies*

Before comparing the different stovetop technologies, an in-depth understanding of each is required. A gas cooktop uses natural gas or propane as its fuel source, which is supplied to homes either through underground municipal pipes or from an outdoor propane tank. The gas flows to the stovetop, where a spark or piezoelectric igniter lights the flame. This flame directly heats the cookware, providing a responsive and visible heat source for cooking.



*Figure 2: Exploded View of a gas burner assembly [11].*

An electric cooktop relies on electricity to heat coils or heating elements under a glass or ceramic surface. When turned on, these elements glow and produce radiant heat, which transfers through the cooktop surface to the cookware above. Electric stoves are known for their even heating, but the coils or elements can take longer to cool down once the stove is off.

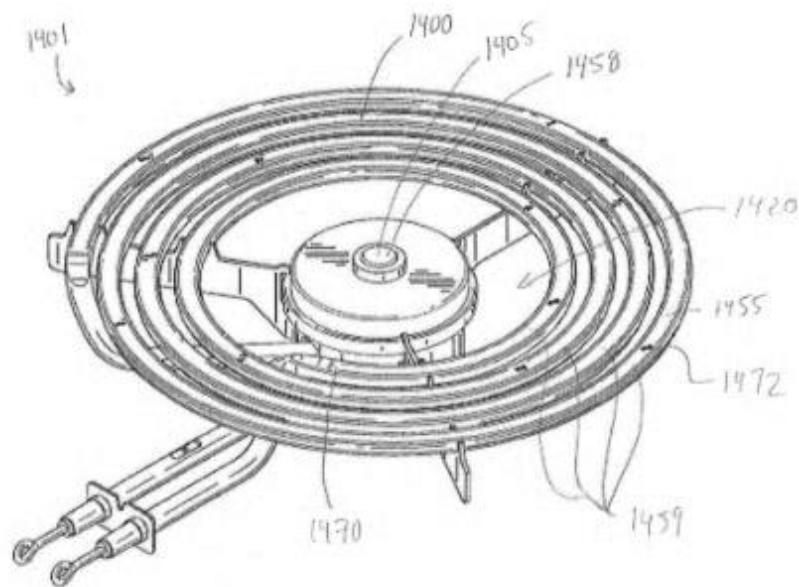


Figure 3: Depiction of an electric stovetop coil [12].

An induction cooktop also uses electricity but differs in how it generates heat. It creates a magnetic field through coils beneath a smooth glass-ceramic top, reacting with the metallic cookware placed on it. The pan heats up directly due to this magnetic reaction, while the cooktop surface remains relatively cool, offering a safe and efficient cooking method without flames or hot coils. The working coil (WC) generates the

electromagnetic force with flows through the intermediate heating element (IM) to directly heat the cookware.

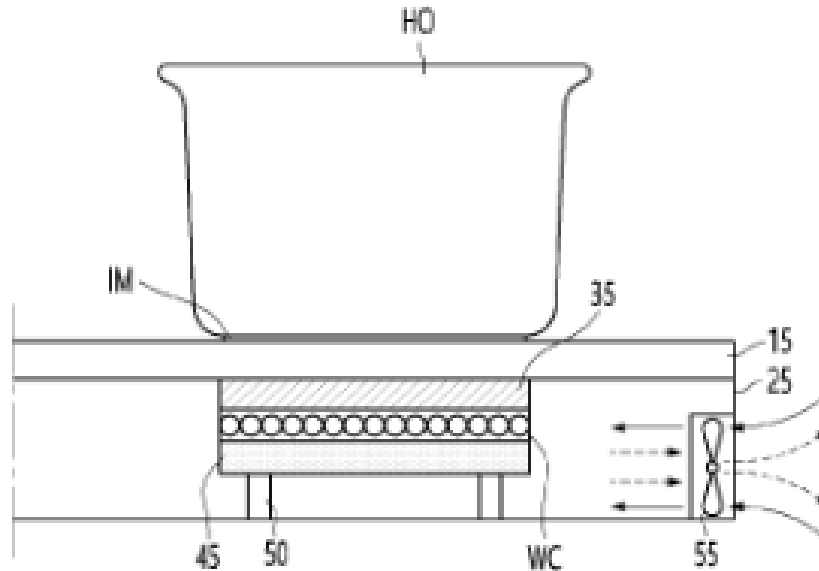


Figure 4: Diagram of an induction cooktop [13].

A comparison of gas, electric, and induction cooktops was made through the administration of a cost analysis. Observing the initial installation and annual operating cost of each of the cooktop technologies was used to measure how the costs compare over time. Comparing the environmental impacts of each of the cooktop technologies is also an important consideration that must be made.

Marketplace costs for cooktops can vary greatly across all cooktop technologies. Gas stovetops generally cost the least, but high-end gas cooktops are among the most expensive of the cooktop technologies. Gas stoves range from \$290 all the way up to \$2,250 [14]. Electric stoves range much less from their high end to low end. On average,

electric cooktops' cost ranges from \$500 to \$1,200 [15]. Induction cooktops tend to be the most expensive cooktop technology based solely on initial cost. Induction stoves cost around \$800 on the low-end and cost up to \$1,900 on the high-end [15]. Comparing the stovetop technologies purely on initial price proves gas cooktops to be the best option followed by electric then induction cooktops.

Similar to the initial cost, the installation cost for each cooktop technology can vary greatly depending on the utilities that are already present. There is no installation cost for a gas stovetop if there is already a gas line present, otherwise gas line installation costs vary from \$550 to \$2,000 [16]. For the installation of an electric cooktop the only possible costs would be to upgrade the electric outlet. Most electric stoves require a 220-volt outlet protected by 50-amp breakers which can cost anywhere from \$150 to \$400 for installation [17]. Induction cooktops would also require an electrical outlet upgrade if one were not already present. Additionally, a consumer would need to purchase compatible cookware if they do not own ferromagnetic cookware costing anywhere from \$50 up to \$300 for a full set [17]. Installing a new cooktop without any previous utilities present is cheapest with induction and electric stovetops and a bit more expensive for gas stovetops.

Once the stovetop has been installed, the main remaining expense for the consumer is the utility cost. A major influence behind the prices of each cooktop technology is the efficiency in which it cooks. According to Figure 5, gas stovetops tend to be the least efficient at heating cookware with only 43% of the heat going to the cookware with the remainder of the energy to the ambient during the heating process. This inefficiency leads to much more gas being used to cook the same amount as other

cooktop technologies. Natural gas is generally cheaper than electric utility costs, making the total expense not as substantial. The annual cost of operating a gas stovetop ranges from \$20 to \$60 depending on the area you live [18]. Since electric and induction stovetops are both operated at similar wattages using electricity, the difference in utility cost is due to the difference in efficiency. Induction stovetops tend to be around 10% more efficient than their electric counterparts [19]. Electric cooktops cost between \$30 and \$45 on average to operate for an entire year [18]. In comparison, the annual utility cost of induction cooktops ranges from \$20 to \$35.



Figure 5: A comparison of domestic heating technologies: (a) heating times, (b) efficiency, and (c) surface temperature [20]

Considering the total costs of purchasing and maintaining each stovetop technology, a complete cost analysis can be made. Though adding the minimum possible annual costs and the maximum possible annual cost respectively, a low-end and high-end cost of each stovetop technology can be created. A timeline of 15 years was chosen as the lifetime of stovetop technologies is up to 15 years. The results of this cost analysis can be seen in table 1. The gas stovetop price has the highest variance making both the most and least expensive options. The variance of electric and induction cooktop costs has much less variance with the induction cooktop cost being marginally greater than the electric cooktop cost.

*Table 1: Cost analysis table of the high-end and low-end cost of each stovetop technology.*

Year	Low-End Gas	Low-End Electric	Low-End Induction	High-End Gas	High-End Electric	High-End Induction
0	\$290	\$500	\$800	\$4,250	\$1,200	\$1,900
1	\$310	\$530	\$820	\$4,310	\$1,240	\$1,935
2	\$330	\$560	\$840	\$4,370	\$1,280	\$1,970
3	\$350	\$590	\$860	\$4,430	\$1,320	\$2,005
4	\$370	\$620	\$880	\$4,490	\$1,360	\$2,040
5	\$390	\$650	\$900	\$4,550	\$1,400	\$2,075
6	\$410	\$680	\$920	\$4,610	\$1,440	\$2,110
7	\$430	\$710	\$940	\$4,670	\$1,480	\$2,145
8	\$450	\$740	\$960	\$4,730	\$1,520	\$2,180
9	\$470	\$770	\$980	\$4,790	\$1,560	\$2,215
10	\$490	\$800	\$1,000	\$4,850	\$1,600	\$2,250
11	\$510	\$830	\$1,020	\$4,910	\$1,640	\$2,285
12	\$530	\$860	\$1,040	\$4,970	\$1,680	\$2,320
13	\$550	\$890	\$1,060	\$5,030	\$1,720	\$2,355
14	\$570	\$920	\$1,080	\$5,090	\$1,760	\$2,390
15	\$590	\$950	\$1,100	\$5,150	\$1,800	\$2,425

Plotting these figures onto a graph provides a visual representation of the cost over time for each of the stovetop technologies. Following the graph in Figure 6 it can be determined that gas stovetops have the highest average cost over 15 years. Inductions

cooktops tend to cost slightly more on average than electric cooktops. The extra cost of the induction cooktop is the premium for the increased efficiency, safety, and cooking ability.

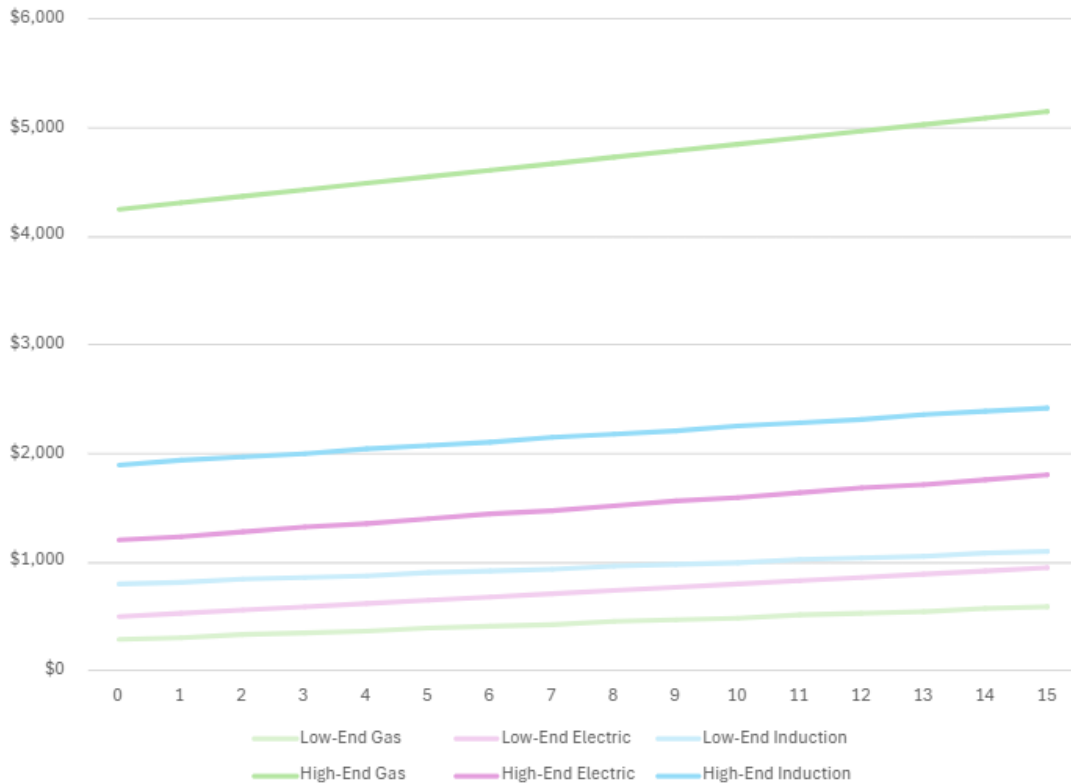


Figure 6: Cost analysis graph of the high-end and low-end cost of each stovetop technology over 15 years.

After conducting a thorough total cost analysis, each stovetop technology can be objectively evaluated using a decision matrix. The criteria used in the matrix were chosen based on the primary factors that consumers prioritize when selecting a new stovetop. The weight assigned to each criterion reflects the overall influence of each factor on purchasing decisions. The final criteria, shown in Table 2, include initial cost, utility cost, evenness of cooking, efficiency, and safety. Scored on a ten-point scale, higher values

were assigned to stovetop technologies that best met each criterion. For example, a technology with a lower initial cost received a higher value for that category.

According to the decision matrix, induction cooktops emerged as the best overall choice. Although induction cooktops generally score lower on initial cost, they excel in efficiency and safety, making them a strong contender for consumers seeking a long-term, sustainable cooking solution. This approach underscores induction cooking as a promising technology with considerable benefits despite its upfront cost disadvantage.

*Table 2: Decision Matrix determining the best stovetop option between gas, electric, and induction.*

	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	
CRITERIA DESCRIPTION	Initial Cost	Utility Cost	Evenness of Cooking	Efficiency	Safety	
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	WEIGHTED SCORE
WEIGHT	2	3	1	2	2	10
	20%	30%	10%	20%	20%	100%
OPTIONS	Criteria 1 SCORES	Criteria 2 SCORES	Criteria 3 SCORES	Criteria 4 SCORES	Criteria 5 SCORES	
Gas	7	6	8	4	6	6
Electric	6	7	6	7	8	7
Induction	4	8	8	9	10	8

Each type of stovetop technology has its unique set of drawbacks, which influence consumer choice based on lifestyle, budget, and environmental or health considerations. Induction cooktops, for instance, require ferromagnetic cookware, meaning consumers who do not already own compatible pots and pans may face an added expense in purchasing new cookware. Additionally, some models of induction cooktops produce a buzzing or humming noise when operating at full power, which can be bothersome in a quiet kitchen setting. One of the primary deterrents for potential buyers, however, is the initial cost of induction cooktops, which is often higher than that of gas or electric alternatives [17]. The surface of induction and electric stovetops, typically made from glass ceramic, is also vulnerable to scratches from cookware, which can diminish the cooktop's aesthetic and functional quality over time.

Induction and electric stovetops share another drawback: the need for a dedicated 220-volt outlet protected by a 40-to-50-amp breaker. This requirement can lead to additional installation costs if the necessary wiring and outlet are not already present. Furthermore, while induction cooktops transfer heat directly to cookware through magnetic fields, electric cooktops heat indirectly. This indirect heating process, where the stovetop surface heats up and then transfers heat to the cookware, leads to lower energy efficiency for electric stovetops compared to induction. Consumers also report that electric cooktops often struggle to heat cookware evenly, and it can be challenging to gauge the precise heat level in use [18].

Gas cooktops, while valued for their affordability and performance, pose significant environmental and health risks. Methane and nitrogen oxides are emitted

during use, polluting indoor air and posing respiratory risks. Alarming, more than 75% of methane emissions occur even when the stove is off, often due to leaks or poor connections in gas lines [21]. A 2022 study linked gas stove emissions to 12.7% of childhood asthma cases in the United States, highlighting the severe health implications of using gas as a fuel source [22]. Consumers must weigh the pros and cons of each cooktop type in relation to their priorities, whether they be health and safety, energy efficiency, environmental impact, or initial and ongoing costs.

### ***Optimal Design for Induction Heating Stovetops***

When discussing induction heating, it is essential to explore the optimal design and material selection for induction stovetops to maximize efficiency and usability. Key factors such as resilience, ferromagnetism, and efficiency play a crucial role in determining the most suitable materials. These factors collectively inform the electromagnetic compatibility (EMC) of the system, which is its ability to operate effectively while emitting minimal electromagnetic interference into its surrounding environment. EMC is essential in designing an efficient induction system, as it allows the device to function without disrupting or being disrupted by other nearby electronic systems [23].

*Table 3: Inductance (L) of materials calculated using measured quantities Current (I) and Resonant Frequency ( $f_r$ ) [24].*

Circuit Parameters.					
Work-pieces	Measured Quantities		Calculated Parameters		
	$I_{rms}(A)$	$f_r(kHz)$	L (mH)	R ( $\Omega$ )	Q
Iron	2.31	33.11	0.516	27.56	3.90
Stainless Steel	5.76	39.37	0.365	11.05	8.17
Brass	9.11	40.32	0.348	6.99	12.61
Copper	10.3	39.68	0.359	6.18	14.48

The inductance of materials such as stainless steel can be calculated using a resonant capacitor (C) value and measured resonant frequency, as shown in Table 3. A higher inductance value in ferromagnetic materials correlates with increased compatibility for induction heating. This property makes ferromagnetic materials with high inductance particularly suitable for induction stovetops, as they can generate the magnetic fields needed for effective heating.

$$C = 44.8 \text{ nF} \quad f_r = 39.37 \text{ kHz} \quad f_r = \frac{1}{2\pi\sqrt{LC}} \quad \sqrt{LC} = \frac{1}{2\pi f_r}$$

$$L = \frac{1}{C} \left( \frac{1}{2\pi f_r} \right)^2 \quad L = \frac{1}{44.8 \text{ nF}} \left( \frac{1}{2\pi(39.37 \text{ kHz})} \right)^2 \quad L = 0.365 \text{ mH}$$

Using the outlined equations, it is determined that ferromagnetic materials with both high resonant frequencies and inductance values are ideal for cookware used in induction heating systems. However, this criterion does not apply to nonferromagnetic materials such as brass or copper, which lack the magnetic properties necessary for efficient induction heating.

In addition to material selection, optimizing the cooktop design is essential to achieving effective EMC. Historically, the Archimedean spiral has proven to be the most effective design for induction cooktops, but enhancements can be made by incorporating multiple spirals. Placing these coils side by side allows the electromagnetic forces radiating from each working coil (WC) to combine, creating a smooth transition across the cooktop surface [13]. This design innovation enables the entire cooktop, rather than a

limited set of burners, to be utilized as a cooking surface. If the Archimedean spirals were placed too close or overlapped, electromagnetic interference would occur, reducing system efficiency. Instead, positioning an intermediate heating element (IM) between the coils, as shown in Figure 7, allows electromagnetic forces from one WC to blend with adjacent WCs, maintaining consistent and stable temperature control across the entire cooking surface.

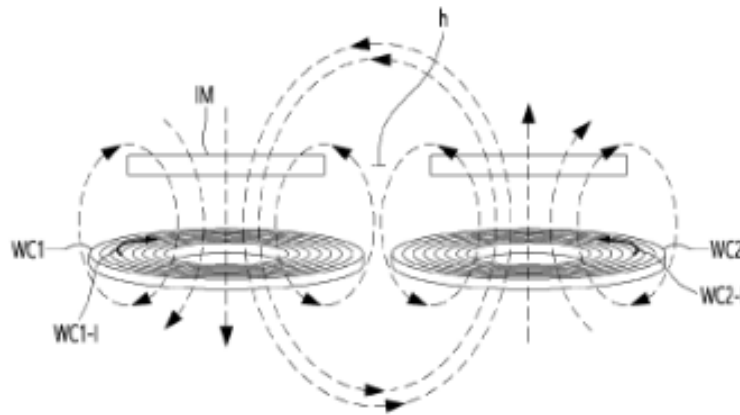


Figure 7: Design of an induction stovetop to optimize magnetic current between coils [13].

### ***Existing Induction Heating Stovetops***

When it comes to induction cooktops, several models stand out for their distinctive features, catering to various budgets and culinary needs. The Thermador Freedom Series Induction Cooktop represents the high-end segment of the market. It offers a fully flexible cooking surface powered by 56 individual heating elements that can adjust to the size and shape of any cookware placed on it. Thermador's unique MoveMode feature lets users shift pots between different heating zones without adjusting temperature manually, enhancing user convenience. It also includes a Teppanyaki mode for specialized cooking, while built-in WiFi allows remote control. However, these

advanced features come with a premium price of approximately \$6,099, making it ideal for those willing to invest significantly in their cooking appliances [25].

A more mid-price range option for induction cooking is the Frigidaire 4-Element Slide-In Induction Range offers solid functionality at a lower price point. Ranging between \$999 and \$1,699, it includes a bridge burner, allowing two elements to combine for larger cookware, and several cooking modes like air fry and steam roast, enhancing its versatility [26]. While it lacks the advanced smart capabilities of higher-end models, it delivers reliable performance, making it a practical option for cost-conscious buyers who want the benefits of induction technology without a large investment.

Finally, the Duxtop 9600LS Portable Induction Cooktop is a portable, budget-friendly option, ideal for those who want induction cooking capabilities without committing to a full-size cooktop. Priced between \$110 and \$152, it provides 20 power levels, an automatic shut-off feature, and a keep-warm function [27]. Its compact, single-burner design is well-suited for occasional use or smaller kitchens, making it a flexible addition for those who might not need a full cooktop.

Overall, induction cooktops offer various features and price points, catering to different levels of cooking needs and budgets. High-end models like the Thermador Freedom Series provide unmatched flexibility and smart features but come at a premium cost, while mid-range options like the GE Profile balance advanced capabilities with a more accessible price. Budget options such as the Frigidaire 4-Element Slide-In provide essential functionality at a lower cost, making them ideal for newcomers to induction cooking. For compact or portable needs, the Duxtop 9600LS offers induction

technology's efficiency without the commitment of a full-size cooktop. Buyers should assess their cooking habits, need for control, and budget constraints to select the induction cooktop that best aligns with their kitchen needs.

## **Implementation**

### ***Current State of Induction Cooktops***

Induction cooktops have been growing in market share and are trending to continue growing over the coming years. The induction cooktop market in North America was valued around \$22 billion as of 2023 and is projected to increase to \$35 billion by 2030 with a compound annual growth rate (CAGR) of 7.2%. While the induction cooktop market is growing in North America, it still only accounts for 21.3% of the global induction cooktop market as of 2023 [28]. This data shows that induction stovetops have already been gradually increasing in popularity though they remain far behind the electric and gas counterparts. This claim is supported by the findings from a 2020 study that almost 70% of people would consider induction for their next range or cooktop [19]. In Figure 8 the induction cooktop market value is expected to more than double by 2030 and the U.S. cooktop market value is projected to have a CAGR of 6.7%.

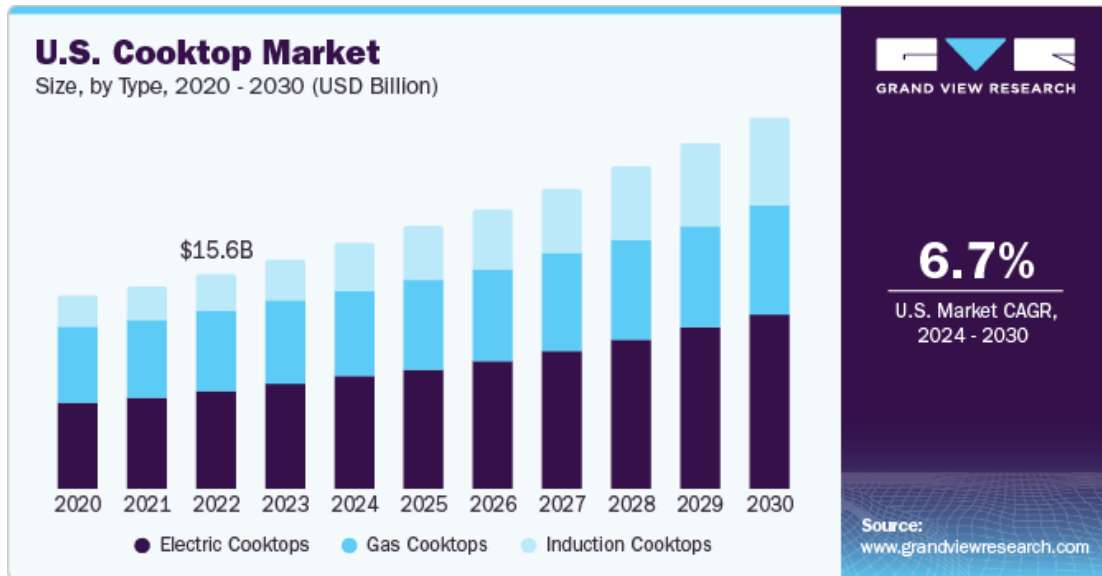


Figure 8: Projected U.S. Cooktop Market Value from 2020-2030 [28].

As the induction cooktop market value increases, the induction cookware market increases alongside it. Observing the induction cookware market is a good indicator of the current state of induction cooktops. Figure 9 shows the U.S. induction cookware market is projected to be one of the fastest growing markets with a CAGR of 7.4% from 2024 through 2030. If these projections are held, it is likely induction cooktops will be

much more commonplace by 2030 and on route to eventually take over as the primary cooking technology used in North America.

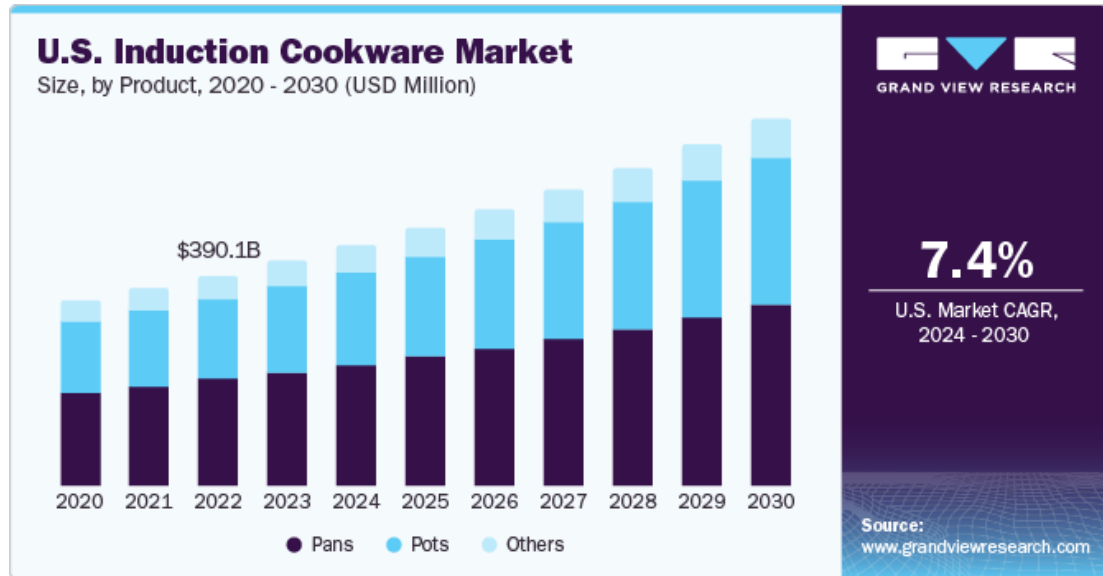


Figure 9: Projected U.S. Induction Cookware Market Value from 2020-2030 [29].

### ***Existing Implementation Strategies***

In recent years, the U.S. government has implemented various incentive programs aimed at encouraging the adoption of environmentally friendly alternatives to traditional technologies. These strategies often include direct financial incentives, such as tax credits and rebates, which serve to promote consumer uptake of new, cleaner technologies.

Examining the mixed outcomes of these programs offers valuable insights into optimal approaches that might be employed for the widespread adoption of induction stovetops.

One prominent example is the federal support for electric vehicles (EVs), particularly through the Inflation Reduction Act (IRA). The federal government offers tax credits of up to \$7,500 for qualifying EVs and plug-in hybrids [30]. This incentive has

significantly driven EV adoption, resulting in increased EV sales and the growth of charging infrastructure nationwide. With the IRA of 2022, tax credit eligibility requirements were updated to support domestic EV manufacturing, connecting tax credit eligibility to American-assembled vehicles and battery sourcing. Alongside these credits, the IRA also supports the EV infrastructure expansion through the establishment of additional charging stations and public education on EVs, making them more accessible to consumers [31]. While successful in expanding EV accessibility, this tax credit program presents certain limitations; only select vehicles now qualify, potentially restricting consumer choice and possibly slowing adoption while supply chains adjust.

Energy-efficient home appliances have also benefited from incentive programs, including the Energy Star certification managed by the Environmental Protection Agency (EPA) and the Department of Energy (DOE). This certification promotes energy-saving models of common appliances, such as air conditioning units and refrigerators [32]. The federal government and some states offer rebates for purchasing Energy Star-rated air conditioning units, which are designed to use significantly less electricity than standard models, reducing both utility costs and environmental impact. This approach has had measurable success: studies indicate that appliances with the Energy Star label have helped save Americans more than \$500 billion in energy costs since the program's inception [33]. However, the high upfront costs of many energy-efficient units can remain a barrier for low-income households, even with rebates.

Additionally, the shift toward energy-efficient air conditioning has been encouraged through the U.S. Department of Energy's efficiency standards, which set

minimum efficiency requirements for new units. The Department of Energy has also set up rebates for up to \$840 toward an electric or induction heater through the Inflation Reduction Act [34]. While these standards have spurred innovation and reduced energy consumption, compliance with these regulations has also raised product costs. This can pose challenges for manufacturers and may slow down adoption rates, particularly in areas where economic constraints affect purchasing decisions.

Overall, government efforts to promote cleaner, more efficient commodities have made important strides but also highlight ongoing challenges. The shift toward EVs has demonstrated notable progress but faces limitations in accessibility and supply chain adaptation. Similarly, energy-efficient appliance programs have improved efficiency standards nationwide, yet barriers like high initial costs and complex eligibility requirements indicate that program refinements may be necessary to maximize impact.

### ***Implementation of Induction Heating***

By analyzing past implementation strategies for other commodities and considering current plans to promote induction stovetops globally, we can devise an effective approach to their widespread adoption. Learning from the successes and pitfalls of other initiatives allows us to create a well-structured plan and estimate a realistic timeline for nationwide implementation.

In Ecuador, the Ministry of Electricity and Renewable Energy (MEER) launched the National Efficient Cooking Plan with the goal of replacing 3.5 million liquefied

petroleum gas (LPG) stoves with induction stoves. Implementation began in 2014, with a target completion date of 2018. To encourage the transition, tariffs were imposed on LPG stoves in 2016, and free electricity for cooking was offered to those who purchased an induction stove [9]. By the end of 2017, approximately 740,000 induction stoves had been sold, falling short of the target primarily due to weak electrical infrastructure and high initial costs for induction stove purchases [35].

Indonesia faced a similar challenge, as high LPG subsidies were costing the government over \$4.9 billion while excess power from local plants went unused [10]. Before implementing its induction stove initiative, the Indonesian government conducted a literature review of similar programs in countries like Ecuador and India. In 2021, the Ministry of Energy and Mineral Resources (MEMR) set a goal to replace LPG stoves in 8.2 million households by 2025.

Effective implementation strategies for promoting induction stovetops would require a multi-faceted approach that addresses infrastructure, affordability, and consumer awareness. A national rebate program, modeled after the EV tax credits, could make induction stovetops more accessible to a broader range of consumers, especially low-income households. Additionally, investing in electrical grid improvements would ensure the infrastructure can meet the increased demand for electricity, as demonstrated by Ecuador's initiative. To further encourage adoption, these financial incentives could be paired with public education campaigns highlighting the health and environmental benefits of induction cooking. By balancing cost subsidies, infrastructure support, and information outreach, a comprehensive national plan could drive widespread adoption of

induction stovetops. This would provide Americans with a more sustainable cooking solution while helping reduce reliance on fossil fuels.

## **Conclusions**

Induction cooktops are well-positioned to become the leading stovetop technology both nationally and globally. As research continues to reveal health and environmental risks associated with gas stovetops, induction emerges as the clear path forward. Induction cooktops are already more efficient, cleaner, and safer than traditional electric models, and their popularity will only continue to grow as advancements are made and affordability improves. By leveraging optimized design principles, manufacturers can further reduce production costs, making induction cooktops more accessible to a broader audience. Government support through subsidies and rebates could accelerate this transition, making widespread adoption of induction cooktops a near-term reality. A thorough understanding of effective implementation strategies is essential to ensure a smooth transition toward a cleaner, more efficient future in cooking.

If unlimited time and resources were available, this research could be expanded significantly to include an even broader and more detailed approach to the global adoption of induction heating in stovetops. This would involve evaluating and addressing cultural preferences, infrastructure requirements, and socio-economic factors across diverse regions to form a global implementation model for induction cooking. Additionally, it would allow a detailed comparison of government interventions

worldwide, assessing the efficacy of varying incentives, regulations, and educational campaigns in increasing the adoption rates of induction stovetops.

Access to proprietary data—such as unit sales, user satisfaction metrics, and design methodologies protected as trade secrets—would further enhance this study’s impact by providing more precise metrics for comparing induction stovetops with other heating methods. This data would enable an accurate projection of future trends and deeper insights into the design decisions that optimize both consumer satisfaction and environmental benefit.

Finally, addressing limitations in data availability would provide a clearer picture of the economic and environmental impacts of induction heating on a global scale. This includes overcoming data barriers in sales figures, design specifications, and patent-restricted technology comparisons, allowing for a more comprehensive and conclusive analysis. With these expanded resources, this research could establish a globally relevant, adaptable model for induction stovetop adoption, aiming to expedite the shift towards more sustainable cooking practices worldwide.

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