Modern Energy Cooking Services: A Pathway to Mitigating Urban Heat Stress

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MECS Modern Energy Cooking Services

Policy Brief

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This policy brief highlights the findings of a comprehensive landscape study conducted under the Modern Energy Cooking Services (MECS) programme, funded by UK Aid (FCDO). It provides actionable insights into the often-overlooked role of cooking in contributing to urban heat stress in many rapidly growing cities in the global South, particularly in low-income and informal urban settlements. Targeted at policymakers, urban planners, researchers, and stakeholders in clean energy and urban resilience, this brief outlines current gaps, evidence-based recommendations, and future pathways for leveraging Modern Energy Cooking Services (MECS) to mitigate heat stress. It aims to bridge research with policy action, ensuring equitable and modern energy transitions while addressing the intersecting challenges of thermal comfort, health and sustainable urban development.

KEY HIGHLIGHTS

- **Cooking is a significant but under-recognised contributor to urban heat stress**
  Traditional cooking practices reliant on biomass and fossil fuels exacerbate thermal strain, particularly in urban areas with dense populations, inadequate ventilation, and high vulnerability to climate impacts.

- **Modern energy cooking services (MECS) offer potential for mitigation**
  Clean cooking technologies such as electric pressure cookers and induction stoves can reduce heat and pollutant emissions, improving thermal comfort and lowering health risks.

- **Gaps in research and policy highlight opportunities for targeted interventions**
  There is limited data on the thermal impacts of cooking in urban settings, and clean cooking solutions remain underrepresented in urban heat mitigation frameworks.

CALL TO ACTION

The urgency of addressing urban heat stress is clear, particularly as climate change intensifies its effect in vulnerable urban regions in the global South. Integrating Modern Energy Cooking Services into energy infrastructure, urban planning and building resilience strategies is essential to ensuring sustainable, equitable, and climate-resilient urban futures. This requires concerted action from policymakers, researchers, and practitioners to prioritise modern energy cooking solutions as a critical component of broader energy and climate agendas.

Poorly ventilated cooking space in urban informal settlements. (Source: Author)

HEAT STRESS IN URBAN ENVIRONMENTS: THE ROLE OF COOKING

Urban heat stress is a growing global challenge, exacerbated by climate change, rapid urbanisation, and the Urban Heat Island (UHI) effect. Cities, particularly in the global South, face the compounded risks of rising temperatures, increased frequency of heatwaves, and dense urban development, all of which heighten exposure to extreme heat. While much research has focused on transportation, building materials, and cooling technologies, the role of cooking as a contributor to urban heat stress remains under-recognised in building and urban resilience frameworks.

Cooking is a ubiquitous daily activity that generates significant heat in indoor and outdoor environments. Traditional cooking practices, particularly those reliant on biomass and fossil fuels, produce heat and pollutants that exacerbate thermal conditions in urban settings. The heat generated during cooking can significantly raise indoor temperatures, especially in confined and poorly ventilated spaces. In many low-income and informal urban settlements, cooking often occurs in multi-purpose rooms that frequently operate with limited ventilation, resulting in heat accumulation that exacerbates thermal discomfort and health risks. Outdoor cooking, prevalent in many regions, while offering better heat dissipation, exposes cooks to other environmental constraints such as weather exposure and contributes to localised increases in ambient temperatures.

Impacts of Cooking on Urban Heat Stress

- **Indoor Heat Accumulation:** Studies show that cooking with biomass or gas can increase kitchen temperatures by several degrees Celsius[1], with traditional stoves releasing significant amounts of residual heat into the environment. This is particularly problematic in densely populated areas with minimal cooling infrastructure.
- **Urban Heat Island Effects:** Cooking activities contribute to anthropogenic heat emissions, further intensifying localised heat in urban cores. In areas with high population density and extensive reliance on fossil-based cooking, the cumulative effect exacerbates the UHI phenomenon.

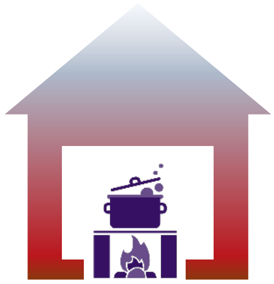
- **Health and Productivity Consequences:** Elevated temperatures in cooking environments increase the risk of heat-related illnesses, particularly for women who often spend extended hours cooking. Heat stress can lead to fatigue, dehydration, heat shock, thermal syncope (dizziness or fainting), physical and mental impairment and long-term health impacts, reducing productivity and overall well-being[2].

EVIDENCE AND INSIGHTS

This section highlights key findings from the landscape study, demonstrating the links between cooking practices and urban heat stress. It provides evidence on the thermal and environmental impacts of cooking, the socio-demographic and spatial factors influencing heat exposure, and the potential of Modern Energy Cooking Services (MECS) to mitigate these challenges.

1. Thermal Impact of Cooking Practices

- **Heat Generation and Accumulation:** Traditional cooking methods, particularly those using biomass and fossil fuels, emit significant residual heat, raising indoor temperatures by up to 10°C above ambient levels, with radiant heat from cooking appliances further adding 5.8°C[3]. In poorly ventilated spaces, kitchen temperatures can exceed thermal comfort thresholds, even reaching extremes of 54°C, particularly during prolonged cooking sessions[4].
- **Comparative Heat Profiles of Cooking Technologies:** Biomass and gas stoves emit substantially more heat than electric cooking



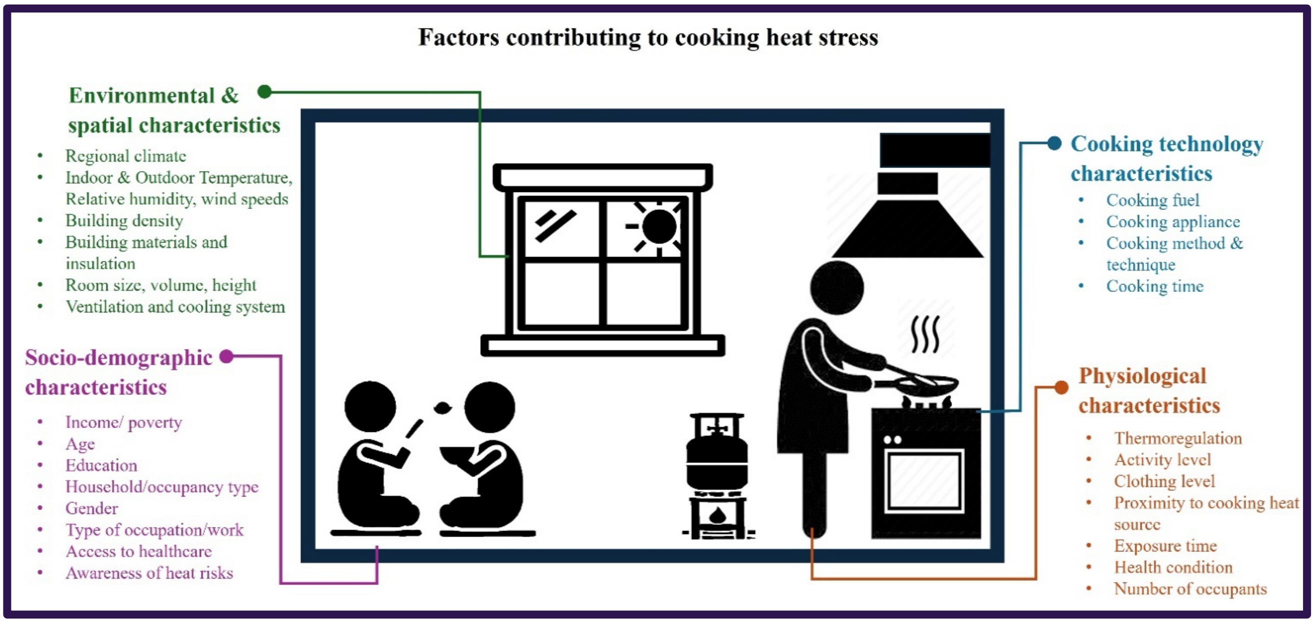
A 2022 study of low-income kitchens across 12 cities demonstrates that 87% of kitchens exceeded thermal comfort standards during cooking, with temperatures often reaching 28 ± 2°C. 43% of kitchens also violated the conditions for ideal ventilation[6].

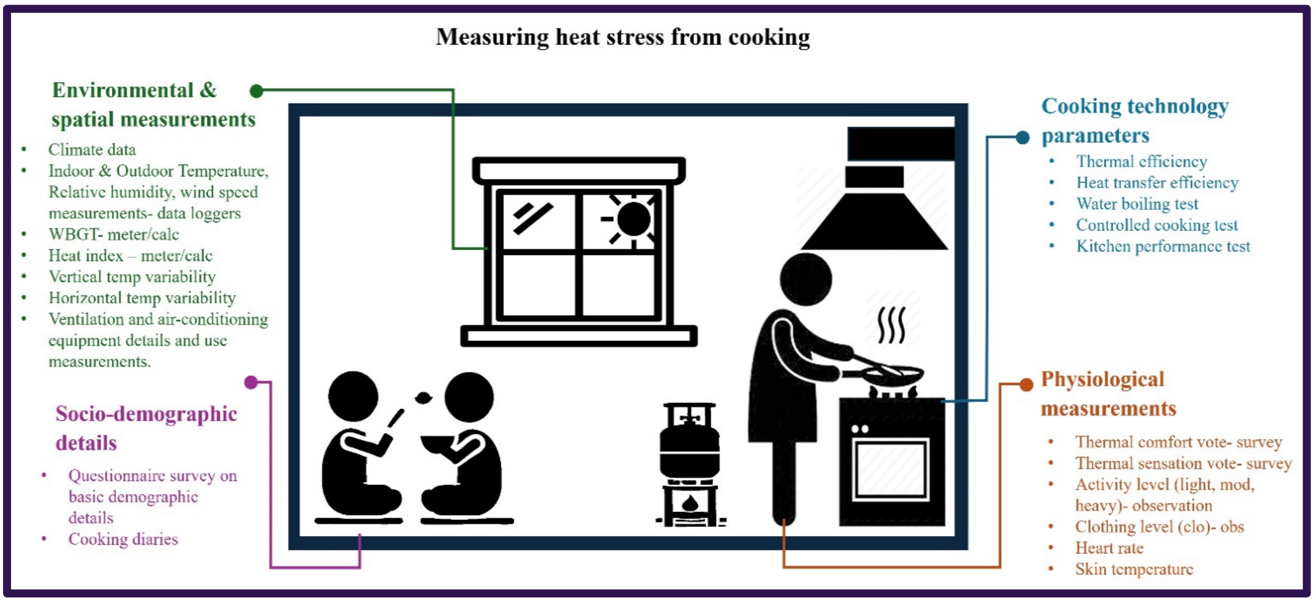
appliances. For example, gas stoves can raise kitchen air temperatures by up to 8–9°C even with ventilation, while electric pressure cookers and induction stoves release minimal residual heat, resulting in temperature rise of only 1-2°C[5].

- **Institutional and Commercial Settings:** Cooking in institutional settings (e.g., schools and community kitchens) often involves larger-scale operations, amplifying heat stress for workers and contributing to localised heat accumulation. For example, a study of school kitchens in New York showed that 80% of kitchens exceeded heat exposure thresholds for heavy work scenarios[7].

2. Socio-Demographic and Spatial Factors

- **Gendered Heat Exposure:** Females generally sweat less, have lower heat tolerance, and experience higher heart rates and body temperatures than males during physical work, making them more prone to heat stress[8]. Women often spend more time cooking, preparing an average of 8 more meals per week





than men in many countries in the global South[9], and hence are disproportionately exposed to higher indoor temperatures, leading to increased thermal strain. This becomes particularly acute in low-income settings, where cooling options are limited.

- **Vulnerability in Informal Settlements:** Residents of informal or slum settlements face heightened risks due to substandard housing, inadequate ventilation, and reliance on biomass fuels. These environments often lack the infrastructure needed to mitigate heat stress effectively. Studies show that residents in urban slums are over four times more likely to experience dangerous heat index levels (≥ 45°C), compared to rural residents[10].

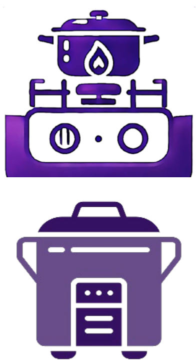
3. Linking Health and Heat Impacts in Cooking

Cooking activities—particularly those involving high temperatures—generate both heat and pollutants that can pose significant health and environmental risks, although the links between heat and pollutant emissions can be complex. High-heat cooking methods such as grilling or frying often require greater temperatures and cooking durations, driving up levels of particulate matter, volatile organic compounds, and polycyclic aromatic hydrocarbons, impacting indoor air quality[11]. Varying temperature and humidity levels can influence how particulates form, disperse, and linger, ultimately affecting occupants' health and comfort. Further, prolonged exposure to elevated temperatures during cooking has been linked to heat-related illnesses, reduced labour productivity, and mental fatigue.

Biomass fuels can emit up to five times more harmful particulates compared to cleaner fuels[11], heightening both pollution and heat exposure in enclosed spaces. Additionally, both the stove design and combustion process impact efficiency and emissions, underscoring the importance of field testing for fully understanding how cooking methods, fuel choices, and technological improvements intersect with human health and heat stress.

POTENTIAL OF MODERN ENERGY COOKING SERVICES (MECS)

- **Reduced Heat Loss and Improved Thermal Comfort:** MECS technologies, such as electric pressure cookers (EPCs), induction stoves, and slow cookers, offer transformative potential for enhancing thermal comfort in cooking environments. eCooking technologies eliminate the inefficiencies associated with combustion-based cooking by converting electrical energy



A study of commercial kitchens in Japan showed gas kitchens exhibited significantly higher ambient temperatures (29.6°C), compared to electric kitchens (25.7°C), with men workers showing 5x increase and women workers a 10x increase in perceived thermal strain compared to workers in electric kitchens[13].

A 5.5°C increase above neutral thermal conditions in commercial kitchens could result in a 30% loss of productivity[15].

directly into thermal or radiant energy for cooking. Induction hobs achieve thermal efficiencies of approximately 90% by using magnetic induction to heat cookware directly, rather than transferring heat through conduction[12]. This method minimises heat loss to the surrounding environment, reduces cooking times, and maintains cooler ambient conditions in the kitchen. EPCs are among the most efficient cooking technologies, minimising heat loss through insulation and controlled cooking mechanisms. These devices utilise micro-controllers to automate cooking, reducing energy consumption by up to 50% compared to traditional cooking methods[14].

- **Health Co-Benefits:** MECS technologies not only mitigate heat stress but also yield significant health co-benefits by addressing the intertwined challenges of indoor air pollution, thermal strain, and cooking-related health risks. This is particularly beneficial in densely populated urban areas, where poor ventilation exacerbates heat accumulation. In commercial kitchens, studies report that a 5.5°C increase above neutral thermal conditions can result in a 30% loss of productivity[15], highlighting the need for reduced heat losses from cooking processes. Additionally, the faster cooking times offered by MECS technologies, while saving energy, also minimise prolonged exposure to heat for cooks— as does automation in many devices— thus significantly improving overall health, comfort and sustainability.
- **Integration with Urban Resilience:** eCooking is shown to be more compatible with mechanical ventilation and air-conditioning systems[16], offering a less energy-intensive alternative for maintaining indoor comfort. Thus, MECS technologies align with broader urban heat mitigation efforts by reducing cooling loads for buildings, lowering energy demand, and ensuring sustainable energy transitions. Their potential for scalability in institutional settings, such as schools and community kitchens, enables broader systemic impacts on urban heat management.

GAPS IN RESEARCH & POLICY

The landscape study identifies critical gaps that hinder effective integration of cooking-related heat stress into urban resilience strategies and clean energy policies. Addressing these gaps is essential for creating equitable and sustainable energy transitions and urban environments, as outlined below.

Limited Recognition of Cooking's Role in Urban Heat Stress: Cooking is a significant yet overlooked contributor to urban heat accumulation. Current urban heat resilience frameworks focus predominantly on transportation, building materials, and cooling technologies, neglecting the significant micro-environmental impacts of domestic and institutional cooking to urban thermal loads. This results in missed opportunities to align clean cooking solutions with broader urban heat resilience strategies.

Lack of Thermal Data for Cooking Practices: There is insufficient field-based data quantifying the thermal impacts of cooking technologies and their contribution to urban heat emissions and the UHI effect. Further, research on indoor environments primarily addresses air quality concerns arising from biomass cooking but often neglects the heat stress caused by cooking practices. Investigations into thermal comfort in kitchens are scarce and focus primarily on HVAC interventions. Data on cooking heat stress is especially critical in diverse urban contexts such as informal settlements and institutional kitchens.

Outdoor institutional cooking with high concentration of wood smoke. (Source: Nsengiyaremye and Khalifa, 2023)[17]

Distributional and Gendered Impacts Remain Underexplored: Heat stress is disproportionately distributed across geographies and socio-economic groups and influenced by infrastructural and spatial inequities. Low-income households in informal settlements, for instance, often rely on poorly ventilated spaces, limited cooling options, and inefficient cooking fuels, compounding the harmful effects of high temperatures. The disproportionate exposure of women to cooking-related heat stress, driven by traditional gender roles, remains inadequately addressed in research and policy, limiting the development of gender-sensitive and gender-responsive interventions.

Insufficient Focus on Co-Benefits: The health, productivity, and environmental co-benefits of clean cooking technologies—such as reduced pollutant emissions and improved thermal comfort—are not fully explored or integrated into energy and urban development policies. Additionally, the heat-related health impacts associated with cooking remain underexplored, despite heat being one of the leading causes of weather-related deaths, leaving a critical gap in developing health-centric clean cooking policies.

Socio-technical challenges to MECS Adoption: Economic, infrastructural, social and cultural barriers to adopting Modern Energy Cooking Services (MECS) persist in many developing countries in the global South, particularly in low-income urban areas where clean energy access is limited due to precarious infrastructure, affordability issues, lack of availability of adequate clean cooking technologies, fuels and supply chains, and the persistence of traditional cooking practices and fuel-stacking. These challenges force households to rely on traditional methods that generate excessive heat and emissions in enclosed, poorly ventilated spaces.

POLICY RECOMMENDATIONS

To unlock the potential of Modern Energy Cooking Services (MECS) in addressing urban heat stress, policymakers, practitioners, and researchers must prioritise targeted actions across multiple dimensions. These recommendations focus on integrating MECS into urban planning, advancing health and heat research, and promoting socio-technical transitions that improve thermal comfort, health, and energy efficiency in urban environments.

1. Quantify and Address Contribution of Cooking to Urban Heat

- **Develop Data-Driven Policies:** Invest in research to quantify the heat contributions of cooking practices, particularly in regions vulnerable to extreme heat events, comparing traditional and modern cooking technologies across diverse urban settings.
- **Thermal Efficiency Metrics:** Evaluate the thermal efficiency profiles of emerging cooking technologies, such as Electric Pressure Cookers (EPCs) and induction stoves, and assess their potential to reduce indoor and urban heat loads.
- **Institutional and Commercial Focus:** Expand studies on the thermal impacts of large-scale cooking in institutional and commercial settings to develop tailored interventions.

2. Leverage Health and Gender Co-Benefits

- **Promote Health-Centric Policies:** Align MECS adoption with public health initiatives to address indoor air pollution, reduce heat-related illnesses, and enhance thermal comfort, especially in densely populated and under-developed urban areas with vulnerable populations.
- **Address Gendered Impacts:** Design gender-responsive policies to alleviate the disproportionate exposure of women to pollutants, heat, and thermal stress in traditional cooking environments. Emphasise the role of MECS in improving gender equity and women's socio-economic empowerment.
- **Target Vulnerable Populations:** Focus on low-income, slum and informal urban settlements where the adoption of clean cooking technologies can significantly improve health outcomes and reduce heat exposure.

3. Integrate Cooking Solutions into Urban Heat Mitigation Strategies

- **Urban Planning Alignment:** Incorporate MECS into sustainable urban planning frameworks, emphasising their role in reducing heat stress and cooling loads in residential and institutional buildings.
- **Link with Building Spatial Design:** Investigate how different cooking technologies interact with varying kitchen spaces and cooking spatial configurations to impact cooking heat stress.

Promote MECS as part of building design and technologies that improve ventilation, insulation, and layout optimisation to minimise heat accumulation.

- **Supportive Infrastructure:** Develop infrastructure that supports clean cooking technologies, such as reliable electricity grids and renewable energy systems to enable broader adoption.
- **Link to Cooling Strategies:** Highlight the synergy between clean cooking solutions and UHI mitigation strategies, positioning MECS as part of broader urban resilience efforts.

4. Design Socio-Technical Interventions

- **Expand Cooking Efficiency Metrics:** Broaden existing definitions of cooking efficiency to include thermal comfort and heat stress considerations, providing a more holistic evaluation of MECS technologies.
- **Tailored Adoption Strategies:** Design social and behavioural interventions that address barriers to MECS adoption, including affordability, cultural practices, and accessibility.
- **Institutional Transitions:** Support the shift to clean cooking technologies in institutional and commercial spaces, ensuring operational efficiency while reducing worker heat stress.
- **Innovation in Technology Design:** Encourage the development of next-generation cooking technologies with enhanced thermal efficiency, reduced pollutant and heat emissions, and automated features to optimise energy use and comfort.
- **Integrating Health, Gender Equity and Clean Energy Policy Incentives:** Align health, gender equity, and clean energy policies to drive the adoption of Modern Energy Cooking Services (MECS) and address the intertwined challenges of heat stress, public health, and social inequality. Provide targeted gender subsidies, tax benefits, and micro-financing options to make MECS technologies accessible and affordable, particularly for vulnerable women and low-income communities.

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FURTHER READING

The full report on the landscape study, 'Harnessing Modern Energy Cooking Services to Mitigate Urban Heat Stress' can be found here.

Key Contents:

- Factors influencing heat vulnerability
- Measuring heat stress from cooking
- Heat loss and thermal performance of cooking technologies
- Linking health and heat impacts in cooking
- Literature review: Mapping thermal comfort and cooking heat in domestic settings
- Literature review: Cooking heat beyond the house-Institutional and commercial settings
- Comparing Electric and Gas Cooking: Implications for Heat Stress
- Theoretical perspectives: Social Practice Theory and Multi-Level Perspective
- Theoretical perspectives: Feminist approaches to cooking and heat stress

For further comments, feedback, or to contact the author, please email: MECS@lboro.ac.uk

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