The introduction of electric cooking in Nepal

A gender and socio-technical transition perspective

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ENERGIA INTERNATIONAL NETWORK ON GENDER & SUSTAINABLE ENERGY

MECS Modern Energy Cooking Services

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I hope you enjoy reading my thesis, and who knows, maybe it even inspires you!

Julie

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Abstract

In Nepal, 70.4% of the population does not use clean cooking fuels. Electric cooking could benefit the main users (women) by reducing the negative health effects brought by burning solid biomass and saving time by the efficient nature of cooking on induction stoves. However, gender norms prevent women, the main users, from making investment decisions that can benefit their health, such as acquiring a clean cookstove. By drawing on transition theories and gender theories, this thesis aims to give practical and policy recommendations by investigating an induction stove intervention program in Temal, Nepal, from these two perspective. This research demonstrates that transition theories can be helpful in trying to advance the world towards a more sustainable future by identifying barriers and drivers for accelerating clean cookstove adoption. However, failing to consider gender inequalities within these sustainability transitions might mean missing out on analyzing a crucial part of socio-technical transitions. By confirming and extending the literature on barriers and drivers for clean cookstove adoption to include evidence on induction stoves, three recommendations are given: 1) using networks to increase knowledge diffusion; 2) providing financial incentives to empower women and reduce the inequalities present in the clean cooking transition; and 3) making use of and improving existing knowledge and infrastructure. This might help accelerate the transition towards clean cooking in Nepal.

Executive summary

Introduction

Approximately 2.6 billion people worldwide cook on solid (fossil) fuels. This causes negative environmental impacts and health risks for users, leading to 3.8 million premature deaths each year. In Nepal, 70.4% of the population does not use clean cooking fuels. Instead, they rely on solid biomass fuels such as firewood (52.4% in 2016/2017). Electric cooking might be a feasible alternative for clean cooking in Nepal, due to the large hydropower generation potential.

Since women are responsible for cooking in Nepal, lack of access to clean cooking affects their health disproportionately compared to men. Introducing induction stoves as a clean cooking alternative can bring major benefits for women that could be arguments for the uptake of electric cooking, including improved health, increased economic opportunities, and increased well-being. However, gender norms also prevent women, the main users, from making investment decisions that can benefit their health, such as acquiring a clean cookstove, which could be barrier to the transition to clean cooking.

Understanding the (social) barriers behind the transition to clean cooking might help find ways on how to accelerate electric cookstove adoption. Using transition theories, technical, cultural, and possibly other challenges inhibiting or impeding the transition towards clean cooking can be uncovered systematically. However, neglecting existing gender inequalities in transition research could hinder the transition towards clean cooking in Nepal by overlooking a crucial part of the socio-technical system: the interaction between gender and technology. Therefore, the challenges behind the transition to clean cooking in Nepal need to be uncovered while simultaneously considering the importance of gender dynamics. In collaboration with ENERGIA's current research on gender responsiveness of electric cookstove campaigns in Nepal, an induction stove pilot program in Temal will serve as a case to provide insights on how to support sustainability transitions towards clean cooking. Accordingly, the research question is stated as follows:

What insights from gender and transition theories can contribute to improving the policy and practice of introducing electric cooking in Nepal?

Methodology

To answer the research question and related sub-questions, a literature review on transition and gender theories was undertaken. The conceptual frameworks were chosen based on this literature review and three additionally criteria (suitability of the aim, context-applicability, and research feasibility of the theories). After this selection, the conceptual frameworks were applied to a case study on induction stoves in Nepal. For this, data from ENERGIA, an international network doing research on gender and energy-related issues, was used and analyzed. The received data consisted of results from a survey by 60 Decibels consisting of 302 phone interviews (of which 145 male and 99 female respondents owned induction stoves) and 40 household interviews by Practical Action Consulting with participants of the induction stove implementation program in the municipality of Temal, Nepal. The data provided information on the implementation of the intervention program, its actors, networks, policies, financial incentives, intra-household decision-power, time used for cooking-related practices, and experiences

with the cookstove. The insights gathered through analyzing the case study from a transition and a gender perspectives were compared and combined to demonstrate the performance of the intervention program. From this comparison, recommendations are derived, and a discussion is held on what adding a gender element in transition theory might mean for advancing towards a more sustainable society.

Conceptual framework

To help understand the barriers and enablers imposed by existing structures and actors within the transition towards clean cooking, literature on transition theories was reviewed. This resulted in a list of five theories: the Social Practices Theory (SPT); the Social Construction of Technology (SCOT); the Multi-Level Perspective (MLP); Strategic Niche Management (SNM); Transition Management (TM); and Technological Innovation Systems (TIS). Second, literature on the interaction between gender and technology and the (in)equalities present within sustainability transitions explain the need for a gender perspective. Therefore, three gender theories within the energy domain are examined: the Rights-Based Approach (RBA); the Women's Empowerment Framework (WEF); and the Transformative Chance Approach (TCA). To determine which theory to apply to the case study, three criteria were considered: 1) the ability of the framework to deliver practical and policy recommendations; 2) the applicability to developing-country contexts; and 3) the suitability for the available data. The transition theory that meets all three criteria and is therefore used to analyze the case study is TIS. For the gender perspective, a conceptual framework combining WEF and TCA was used, since both approaches meet all three criteria.

Case study Nepal

Background information

Besides the traditionally used open and closed fire traditional stoves, clean(er) cookstoves include: improved cookstoves (ICSs); liquefied petroleum gas (LPG) stoves; biogas stoves; and electric stoves and appliances. The literature on clean cooking included in the review predominantly focuses on ICSs or LPG/biogas-stoves. The factors enabling or hindering clean cookstove adoption in general as identified in the literature review range from household characteristics that seem to favor clean cookstoves, to problems with infrastructure hindering uptake, and opportunities that might increase adoption, such as educational campaigns.

71.6% of the households in Nepal rely on biomass for their primary cookstoves. To reduce biomass use and benefit from reduced health problems and environmental degradation, clean cookstoves are needed. The large dependency on imports of LPG and the high potential of electricity generation through hydropower in Nepal make electric stoves a possible option. The pilot program in Temal, Nepal uses electric induction stoves. 569 households (10.2%) in Temal purchased an induction stove through the stove implementation program. The program also included information sessions, financial incentives, and upgrading of the electricity infrastructure. Six months after the purchase, 10% of the participating households used only the induction stove to cook. In other words, 90% of the households practiced fuel stacking with a traditional or LPG stove as a second stove. Not being able to cook multiple dishes at the same was one of the reasons mentioned for stacking. Furthermore, women were found to be the main users of induction stoves, with 82% of women using the stove daily to prepare meals. Men are also using

the induction stove, presenting a shift compared to LPG and traditional stoves, with 38% of men using the stove daily to prepare tea or snacks.

Applying a transition perspective

The TIS study revealed the importance of proper *knowledge diffusion* through networks such as Community Rural Electrification Entities (CREE), and self-help groups (SHGs), and a suitable *electricity infrastructure* for large-scale adoption of electric cookstoves. *Mobilization of financial resources* illustrates that the financial incentives of reducing upfront investment costs lowering the electricity tariff for the first few months helped households adopt induction stoves. Combining the finding that information did not reach all women with the fact that women are the main cooks, makes it seems that there is a mismatch hindering adoption. Functions performing well in the TIS and might help accelerate the transition are *knowledge development*, *entrepreneurial experimentation*, and *influence on the direction of search*. Each of these functions enable the TIS to learn and grow, which could eventually enable electric cooking in Nepal to be a viable option for rural areas, reaching a mature market *(market formation)*.

Applying a gender perspective

This same case study is analyzed from a gender perspective by applying the WEF. Investigating the *rights* of men and women shed light on, for example, the lack of land rights held by women, which has implications for the *social position* of women. Furthermore, analyzing the *gender ideologies*, *gender norms* and *social positions* of women in Nepal helps understand the role of women in the household, and explains that while women are the main cooks, they lack *agency on financial decisions*. The *access to social resources* such as SHGs illustrates how networks can empower women. The intervention program adds to empowerment under *access to human resources* by allowing women to *save time* (108 minutes (-42%) a day) when using the cooking device, which they can use for self-development. Furthermore, the induction stove increases the human resources of *health*, *comfort and convenience*, and *safety*.

Comparing and combining the insights from both perspectives

Both theories highlight the importance of *information diffusion* and *well-being*, while *fuel stacking* and *knowledge and infrastructure* are only mentioned in TIS. However, combining the insights from both theories also enables further understanding of the individual insights. *Financial incentives* in TIS seems to increase adoption, whereas, when looking at *agency over financial decisions*, WEF points out that women are usually not in the position to handle such large amounts of money nor take loans to be able to buy the appliance. Only by adding a gender perspective it becomes clear why adoption is lacking, since it explains the exact reason why women are not as present in buying the appliance as was hoped.

Discussion and conclusion

By extending the literature on barriers and opportunities for electric cookstove adoption, practical and policy recommendations can be given to accelerate the transition towards clean cooking. However, the recommendations are based on the results from this one case study. Thus, when implementing an induction stove program in a different region, sensitivity is required.

The most important barriers within the intervention program hindering the transition were: 1) information not reaching the intended target groups (TIS & WEF); 2) financial strain associated with purchasing/using induction stoves (TIS); 3) lack of (financial) decision-power by women to adopt induction stoves (WEF); 4) traditional cooking practices (TIS); and 5) lack of electricity infrastructure (TIS). These barriers explain that the sustainability transition to clean cooking in Nepal is difficult to achieve.

The enabling factors identified within the intervention program provide a useful basis for overcoming these barriers. Based on this, three main recommendations can be given:

1. To empower women, enable them to benefit from clean cooking, and to ensure more equal power dynamics between men and women, women need to be reached in the information spreading. Using *networks* such as SHGs can be a step towards this.
2. *Financial incentives* make it more attractive to adopt induction stoves. However, the main users of the cookstove (i.e., women) lack financial decision-power within the household. Financial incentives to make the induction stove more affordable could increase the number of women allowed to make the decision.
3. Using the existing *knowledge base* and improving the electricity generation and grid *infrastructure* might enable wide-spread implementation of electric cooking in Nepal.

This research demonstrates that transition theories can be helpful in generating insights on how to potentially advance the world towards a more sustainable future. However, failing to consider gender inequalities within these transitions means missing out on analyzing a crucial part of socio-technical transitions. Indeed, gender affects how technology is interacted with, and precisely this interaction between society and technology is what transition studies aim to investigate. Not taking into account the gender dimension of the societal context could mean a failure to transition to a sustainable society. Since women are disproportionally affected by the effects of cooking on biomass or fossil fuels, not considering gender explicitly ignores one of the essential aspects in sustainability transitions. Therefore, this study highlights the importance of taking both a transition and a gender perspective when developing intervention programs to accelerate electric cookstove adoption in an attempt to mitigate the negative environmental and health effects that cooking on traditional stoves brings.

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List of Abbreviations

ABF	Ajummery Bikas Foundation
AEPC	Alternative Energy Promotion Centre
CCA	Clean Cooking Alliance
CREE	Community Rural Electrification Entity
EJF	Environmental Justice Framework
EnDev	Energizing Development
ESMAP	Energy Sector Management Assistance Program
GIZ	Gesellschaft für Internationale Zusammenarbeit
GoN	Government of Nepal
ICS	Improved Cookstoves
IEA	International Energy Agency
LPG	Liquefied petroleum gas
MECS	Modern Energy Cooking Services
MLP	Multi-Level Perspective
NACEUN	National Association of Community Electricity Users Nepal
NEA	Nepal Electricity Authority
NPR	Nepalese Rupees
PAC	Practical Action Consulting
PEEDA	People, Energy, and Environment Development Association
RBA	Rights-Based Approach
SCOT	Social Construction of Technology
SDG	Sustainable Development Goal
SNM	Strategic Niche Management
SPT	Social Practice Theory
TCA	Transformative Change Approach
TIS	Technological Innovation System
TM	Transition Management
WEF	Women's Empowerment Framework
WHO	World Health Organization

1. Introduction

1.1 The need for clean cooking in Nepal

Approximately 2.6 billion people worldwide cook on solid (fossil) fuels. This causes negative environmental impacts, such as forest degradation and emission of CO_2, and health risks for users through (indoor) air pollution and burns. Moreover, household air pollution causes 3.8 million premature deaths each year (WHO, 2018). In Nepal, 70.4% of the population does not use clean cooking fuels (IEA, 2019). Instead, households rely on solid biomass such as firewood (52.4% in 2016/2017) (Pinto et al., 2019). Clean fuels are more widely available in urban areas, where (imported) liquefied petroleum gas (LPG) and biogas are used more often than in rural areas (54.1% vs. 16.5%) (Pinto et al., 2019). Transitioning towards electric cooking instead of increasing the use of clean fuels such as LPG would make Nepal more independent since hydropower is a domestic energy resource that Nepal has in abundance. In combination with micro-hydro grids, the generation of hydropower could enable widespread and sustainable electric cooking (Pinto et al., 2019). Unreliability of micro-hydro grids and electricity in general are examples of technical obstacles hindering the widespread use of electric cooking stoves in Nepal (Clements et al., 2020). Besides these technical challenges, culture and gender norms have been considered barriers to the clean cooking transition as well (Clements et al., 2020).

1.2 Gendered (in)equalities in sustainability transitions

Due to gender norms in Nepal, the sustainability transition to clean cooking affects women and men differently. Since women are responsible for cooking, lack of access to clean cooking affects their health disproportionately compared to men due to smoke and soot emitting from firewood cookstoves (e.g., Batchelor et al., 2019a; Chepkurui et al., 2019). Introducing induction stoves can bring significant benefits for women, which could be arguments for the uptake of electric cooking, including improved health, increased economic opportunities, and increased well-being.

Firstly, since women in Nepal have the main responsibility for cooking, they receive most of the negative health effects compared to men. Therefore, the introduction of electric cooking could benefit the health of women (and children) (Brown et al., 2017; Michael et al., 2020; Pachauri & Rao, 2013; Pinto et al., 2019; Rao et al., 2019). Secondly, the introduction of clean cooking can bring economic advantages for women due to time savings in cooking (Batchelor et al., 2019b; Pachauri & Rao, 2013; Pinto et al., 2019) and gathering fuel (Batchelor et al., 2019b; Bekchanov et al., 2019; Brooks et al., 2016). These economic benefits include job opportunities (Batchelor et al., 2019b), more time for education (Pinto et al., 2019), and because of the efficient nature of cooking on these appliances, women can cook more and sell this to others (Chepkurui et al., 2019; Clancy et al., 2012). Thirdly, time saved in cooking and collecting fuel could also increase time spent for entertainment, e.g., watching television (Pinto et al., 2019), which can help educate and empower women (Clancy et al., 2012; Pachauri & Rao, 2013).

However, gender norms also prevent the main users (i.e., women) from making investment decisions that can benefit their health, such as acquiring a clean cookstove (Pachauri & Rao, 2013; Pinto et al., 2019; Rao et al., 2019; Terry, 2009). Noticing the role of gender within energy transition discussions helps understand how the current society disempowers women in relation to men by highlighting the

dynamics of power relations and socially constructed norms that influence household electricity decisions (Osunmuyiwa & Ahlborg, 2019).

Understanding the (social) barriers behind the transition to clean cooking might help find ways on how to accelerate electric cookstove adoption. Using transition theories, technical, cultural, and possibly other challenges inhibiting or impeding the transition towards clean cooking can be uncovered systematically (Köhler et al., 2019). However, neglecting existing gender inequalities in transition research could hinder the transition towards clean cooking in Nepal by overlooking a crucial part of the socio-technical system: the interaction between gender and technology (Köhler et al., 2019; Osunmuyiwa & Ahlborg, 2019). Therefore, the challenges behind the transition to clean cooking in Nepal need to be uncovered while simultaneously considering the importance of gender dynamics.

1.3 Interactions between the different levels of the transition

The interaction between cooking technologies and social and cultural norms seems to take place on three levels: between the user and the technology; between the technology and group behavior (following culture, norms, and value); and between the technology and the established infrastructure, such as institutions, policies, and the electricity grid.

First of all, the entire cooking system, including cooking practices and behaviors, are considered determining factors in uptake and use of clean cooking (Rhodes et al., 2014). For successful adoption, the expectations of users need to be aligned with the possibilities, e.g., it should be possible to prepare traditional Nepali meals on the induction stove (Rhodes et al., 2014). Second, the interactions between behavior and existing social and cultural institutions are the main focus. These interactions include the possible role of gender norms in Nepal in inhibiting the transition to clean cooking (Clancy et al., 2012). Finally, the interaction between the overarching structures such as regulatory institutions, (electricity) infrastructure and the innovation, are possibly inhibiting the uptake on a larger scale (Köhler et al., 2019).

The role of and interaction between these levels in sustainability transitions are a gap in the literature, while understanding them could help accelerate such transitions (Köhler et al., 2019; Michael et al., 2020; Pachauri & Rao, 2013). Connecting transition literature and gender literature could potentially fill this gap by connecting the larger transition context to interrelated gender dynamics.

1.4 Research objective & research questions

This study aims to identify (gender-) related barriers to, and enablers and opportunities for clean cooking in Nepal and use these insights to support such sustainability transition towards clean cooking. In collaboration with ENERGIA[1] and their current research on gender responsiveness of electric cookstove campaigns in Nepal (Kooijman, 2021), an induction stove pilot program in Temal will serve as a case study to research this objective. Using the data gathered by the research partners from ENERGIA,

[1] ENERGIA is an international network of organizations related to gender and sustainable energy. They conduct (empirical) research on gender and energy to provide policy and practice recommendations for energy projects. Their research area mainly comprises countries in Africa and Asia. With their research, ENERGIA aims to contribute to advancing especially the UN Sustainable Development Goals (SDGs) 5 (gender equality) and 7 (affordable and clean energy) (ENERGIA, 2019).

insights can be offered on how to support sustainability transitions towards clean cooking. Accordingly, the research question is stated as follows:

What insights from gender and transition theories can contribute to improving the policy and practice of introducing electric cooking in Nepal?

To answer this question, several sub-questions will be addressed as well:

1. Which transition and gender theories can be used to investigate the opportunities for and constraints of electric cooking in Nepal?
2. Which factors are commonly seen to enable and hinder the transition towards electric cooking?
3. Which transition-enabling and -hindering factors emerge from the application of the frameworks determined in RQ1 to the electric cooking intervention in Temal, Nepal, and how might these insights lead to recommendations?
4. How can policy and practice reduce the inequalities present within the electric cooking transition?

1.5 Report outline

Chapter 2 discusses the methodology used in the research, thereby covering the literature review and the analysis of data gathered in Nepal. **Chapter 3** comprises a literature review of transition theories and gender theories. Clean cooking in Nepal and the case study background are discussed in **chapter 4**, forming the basis for the analysis presented in **chapter 5**. In **chapter 5**, the induction stove program is analyzed using a transition theory and a gender theory perspective. The chapter ends with a comparison between the two perspectives and summarizes the main insights from analyzing a case study in such a way. **Chapter 6** discusses what adding a gender element to transition theories can bring and summarizes the barriers to and enablers for the electric cooking transition in Nepal. Furthermore, this chapter includes limitations, reflections, and directions for further research. Finally, **chapter 7** concludes this thesis by answering the overarching research question, providing practical recommendations for gender-transformative intervention programs on clean cooking.

2. Methodology

A combination of a literature review and on-site data from household surveys and phone interviews were used to answer the research questions.

2.1 Framework construction

A literature review was performed to determine which theories would form the conceptual framework with which the case study would be analyzed, answering the first sub-question. First, to help understand the barriers and enablers imposed by existing structures and actors within the transition towards clean cooking, the literature on transition theories was studied. This resulted in a list of six potentially suitable theories: the Social Practices Theory (SPT); Social Construction of Technology (SCOT); the Multi-Level Perspective (MLP); Strategic Niche Management (SNM); Transition Management (TM); and Technological Innovation Systems (TIS). Second, the interaction between gender and technology and the (in)equalities present within sustainability transitions give rise to the need for a gender perspective. A justice framework and three gender theories within the energy domain were examined to match the topic of this thesis: the Environmental Justice Framework (EJF); the Rights-Based Approach (RBA); the Women's Empowerment Framework (WEF); and the Transformative Change Approach (TCA). Three criteria were considered to determine which theory (or theories) to use to analyzing the case study.

The first criterion was chosen to ensure that the used framework would be able to deliver practical and policy recommendations in line with the overarching research question. For this purpose, each theory was explained, and the main goal of each framework was summarized. Furthermore, since the theories will be applied in a developing-country context, their suitability for these contexts must be ensured (criterion 2). Especially transition theories have been developed and applied to developed countries in the past, which is why sensitivity is required when applying them to different contexts (Markard et al., 2012; Wieczorek, 2018). The third and final criterion is related to the suitability of data. Since the fieldwork in Nepal was conducted by third parties before the start of this thesis, this criterion ensured that the available data would fit the information needed for applying the specific framework. Eventually, the theories that met all three criteria were chosen to form the framework for this thesis.

2.2 Empirical analysis

Literature on clean (electric) cooking and the current cooking regime in Nepal and other developing countries were used to develop part of the case study background and the introduction, answering the second sub-question. Furthermore, literature on gender (in)equalities within sustainability transitions was consulted for the introduction as well. This information was gathered through Scopus and Google Scholar searches. Search terms included: "Electric cookstove" OR "Clean cooking" AND "Nepal"; and "Technology", "Gender", "Electric cookstove", and "Adoption" using different sequences and filtering methods, such as high citation scores, relevance, and domain. Through snowballing within articles and consulting experts in the field, a broader literature list was created. This part of the literature review followed a structured approach by including all references in a literature matrix (see *Appendix I: Literature matrix*). For each paper, the basic information, discipline, type of study, approach, area of study, and prevalent themes were noted. Furthermore, the most important insights and added value were recorded.

Besides a literature review, field data and background documents on the pilot program were used to complete the background information for the case study and to answer parts of the third sub-question. Then, the case study was carried out where the intervention program for electric cooking in Nepal was viewed from a transition perspective and a gender perspective. Most of the information for these chapters was received through ENERGIA's gender responsiveness study, aiming to understand how gender goals could be reached by supporting the uptake of electric cooking appliances through intervention programs. The research partners in the ENERGIA study were Practical Action Consulting Nepal and 60 Decibels. Both gathered data from households that were affiliated with the induction stove intervention program in Temal, Nepal. The survey was held at least six months after the purchase of the induction stove.

Practical Action Consulting (PAC) conducted interviews with 40 households affiliated with the intervention program in Temal. These interviews resulted in raw data on kitchen layouts, intra-household power relations, and time spent cooking, cleaning, and collecting fuel before and after the purchase of the induction stove. Finally, seven focus group discussions with both users and non-users were held where adoption, use, and gender norms were compared amongst different groups of women. The data received from PAC and used in this thesis as background information for the analysis and graphs is presented in *Appendix II: Data from Practical Action.*

60 Decibels conducted 302 phone interviews with 194 households on experiences with electric cookstoves (induction stoves and rice cookers), the provision of information and the purchase decisions around the electric cookstoves, and social dynamics within the households. In total, 60 Decibels' sample of induction stove users consisted of 145 men and 99 women. The data received from 60 Decibels and used in this thesis as background information for the analysis and graphs is presented in *Appendix III: Data from 60 Decibels.*

2.3 Comparing and combining the two lenses

After the data were analyzed from a transition and a gender perspective, an evaluation of the main insights and results from each perspective was made, demonstrating how the intervention program performed according to each framework. This evaluation was used to compare the perspectives and to uncover which insights were found in both perspectives and which insights only emerged for one of the frameworks, answering the final part of the third sub-question. The comparison formed the basis for the list of recommendations. Additionally, after analyzing the case study, the theoretical components from both frameworks were compared to understand why the insights from both theories were similar or different, answering the fourth sub-question: *What can a gender component add to transition theories*? Table 1 provides the methods and materials used to answer each sub-question and presents in which sections the answers are discussed.

Table 1 • Methodology & section per sub-question

Sub-question	Methodology	Data used	Section
1. Which transition and gender theories can be used to investigate the opportunities for and constraints of electric cooking in Nepal?	Reviewing transition theories	Transition literature	3.1
	Reviewing gender theories	Gender literature	3.2
	Applying three criteria to select a theory	Sections 3.1 & 3.2	3.1.6 3.2.5
2. Which factors are commonly seen to enable and hinder the transition towards electric cooking?	Reviewing literature on clean cooking	Literature on clean cooking	4.1 4.2
	Comparing the insights from the case study to the existing literature	Insights from case study results, literature on clean cooking	6.1.2
3. Which transition-enabling and -hindering factors emerge from the application of the frameworks determined in RQ1 to the electric cooking intervention in Temal, Nepal, and how might these insights lead to recommendations?	Describing the pilot project	Documents on the pilot project, data from 60 Decibels on energy sources, prevalence and reasons for fuel stacking, and who uses induction stoves	4.4 4.5
	Applying a transition theory to the case study	Policy documents, documents on the pilot project, sections 4.4 & 4.5	5.1
	Applying a gender theory to the case study	Policy documents, documents on the pilot project, sections 4.4 & 4.5, data from PAC on time saved and intra-household decision-making, data from 60 Decibels on intra-household decision-making and benefits related to clean cooking	5.2
	Analyzing the results from the case study	Outcomes presented in sections 5.1 & 5.2	5.3
	Combining and comparing the insights from both perspective	Outcomes presented in sections 5.3.1 & 5.3.2	5.3.3 6.2 7
4. How can policy and practice reduce the inequalities present within the electric cooking transition?	Using the insights from combining, comparing and analyzing the case study results	Outcomes presented throughout the thesis	6.4 7

3. Conceptual framework

The first part of the literature study focuses on the conceptual framework, discussing transition theories and gender theories. The theories that form the conceptual framework are selected based on three criteria, ensuring they can be applied to the case study.

3.1 Innovation and transition theories

Recently, sustainability transitions have received growing attention, with several papers published on the current state of affairs surrounding these types of transitions (e.g., Köhler et al., 2019; Markard et al., 2012; Wieczorek, 2018). Sustainability transitions encompass a switch from the (unsustainable) status quo to a more sustainable pathway using (sustainable) innovations. Transition theories can be used to understand how sustainability transitions come about and how they can be supported (Köhler et al., 2019; Markard et al., 2012). In this research, transition theories are used to help understand the barriers and enablers imposed by the existing structures and actors within the transition from traditional to clean cooking.

Six transition theories were considered as a potential framework for analyzing the case study: the Multi-Level Perspective (MLP); Strategic Niche Management (SNM); Transition Management (TM); Social Practices Theory (SPT); Social Construction of Technology (SCOT); and Technological Innovation Systems (TIS). In paragraph 3.1.6, a short discussion takes place to determine which transition theory is used.

3.1.1 Multi-Level Perspective

The Multi-Level Perspective (MLP) is useful for understanding the basic configuration of the ongoing transition (Köhler et al., 2019; Wieczorek, 2018). The MLP considers three different levels that are at constant interplay with each other: the landscape; the socio-technical regime; and the niches (Geels, 2002; Geels & Schot, 2007). Each of these levels has its own contribution to the transition.

Regimes are considered the current structure of institutions, rules, practices, and material infrastructure. This status quo can lead to path-dependency and technological lock-in, where the current structure is embedded in ways of life to such an extent that it becomes difficult to change directions (Breukers et al., 2017; Wieczorek, 2018). This is because transitioning to a more sustainable regime can require an overhaul of infrastructure (expensive due to sunk costs and existing power structures), and encouraging people to change their behavior can be met with resistance (Markard et al., 2012). These types of resistance to change can prove to be barriers to transition (Geels, 2002; Köhler et al., 2019; Wieczorek, 2018).

Regimes are usually stable but can develop instabilities, such as internal inconsistencies, through pressures from the external environment (the landscape). If these instabilities cannot be addressed with incremental adaptations within the regime, this can lead to its dissolution, making place for a new regime. This new regime is formed by niche technologies that grow into a regime (Geels, 2002; Geels & Schot, 2007; Köhler et al., 2019; Wieczorek, 2018). Figure 1 depicts a schematic overview of the dynamics within the MLP.

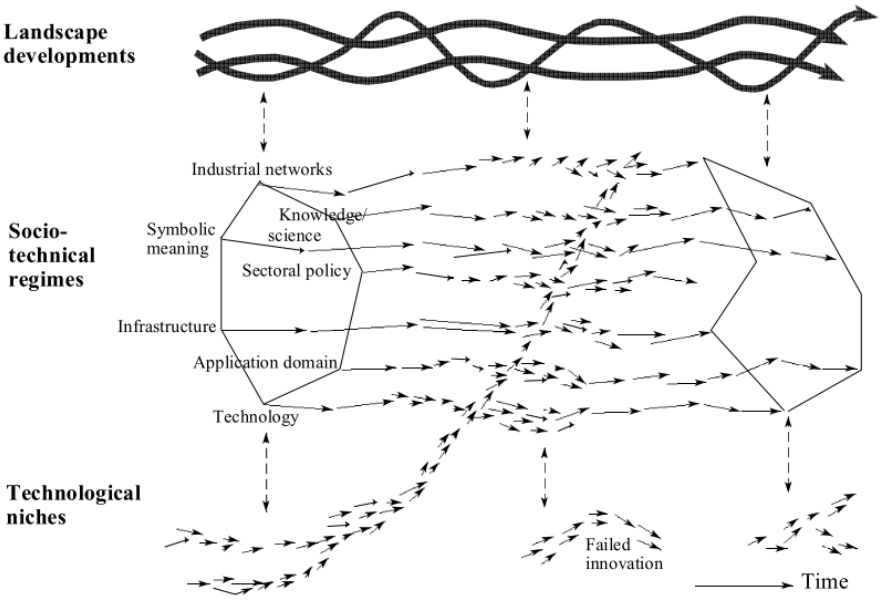


Figure 1 • Overview of the MLP (Geels, 2002)

3.1.2 Strategic Niche Management & Transition Management

The Strategic Niche Management (SNM) approach focuses on the niches in the MLP (Smith & Raven, 2012). Niches are spaces for innovations to grow to become the challengers of a regime by shielding, nurturing, and empowerment of the niches. Shielding protects the niches from external pressures, such as market forces and path dependency. Shielding is either done through geographical distance (passive) or interventions and initiatives (active) from stakeholders. Nurturing helps develop the technology through learning, aligning expectations, and developing social networks (Smith & Raven, 2012). Shielding and nurturing are necessary for technologies to grow and be empowered to become part of a new regime (Smith & Raven, 2012; Wieczorek, 2018).

Empowerment of niche technologies can happen in two ways. Either the technology needs to be fitted and conformed to slowly become competitive to the current regime, or the regime needs to be transformed to become compatible with the values of the niche technology (Smith & Raven, 2012). Still, applying SNM is not a guarantee for the niche technology to grow into the new regime; many technologies do not reach the finish line (Smith & Raven, 2012). However, identifying possible niches, subsequently shielding, nurturing, and finally attempting to empower niches to potentially become the new regime helps determine how experimental pilot projects should be set up.

Transition Management (TM) is a governance approach that helps strategically develop visions and tactical plans and operationalizes experiments to combine several niche technologies into a new, sustainable regime (Köhler et al., 2019; Loorbach, 2010; Loorbach et al., 2015; Wieczorek, 2018). In this way, it can be considered a continuation of the SNM approach (Wieczorek, 2018). Accordingly, it is used to govern transitions by influencing the direction in which they develop towards a more sustainable pathway by reflecting on the strategic, tactical, and operational activities of the transition (Loorbach, 2010; Loorbach et al., 2015; Wieczorek, 2018). Figure 2 illustrates the governing process.

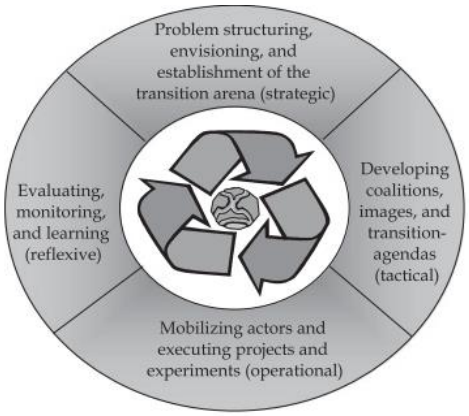


Figure 2 • Overview of the activities within TM (Loorbach, 2010)

3.1.3 Social Practices Theory

Shove and Walker (2010) argue that to fully enable a transition, it is necessary to understand the practice that goes along with the current regime, the practices that stabilize the regime, and how practices can change over time. The Social Practices Theory (SPT) was developed as an addition to the MLP to further examine how regimes manage to become stable over time (Shove & Walker, 2007). Besides the vertical levels of the MLP, it discusses the horizontal levels of how practices diffuse through the regime. SPT acknowledges that practices are a combination of technology or artifacts (material), personal meanings and conventions, and competence. This combination can hinder or enable sustainability transitions (Shove & Pantzar, 2005; Shove & Walker, 2010). As an example, Shove & Walker (2007) explain that showering became a daily activity only after companies advertised shower products, such as shampoo, as necessary for proper hygiene, which is considered to be an important convention by most. Therefore, the regime is not only formed by the artifacts but also by the practices and meanings that go alongside.

3.1.4 Social Construction of Technology

The Social Construction of Technology (SCOT) Theory from Pinch and Bijker (1987) further explains how society and technology interact and shape each other. It consists of four elements: interpretive flexibility; relevant social groups; closure and stabilization; and the broader context (Klein & Kleinman, 2002).

Interpretive flexibility explains how technology can evolve to reflect the needs of its users (Klein & Kleinman, 2002; Pinch & Bijker, 1987). Users can be a part of a larger social group, in which everyone shares the same meaning attached to the technology and aims to use it in similar ways (Klein & Kleinman, 2002). However, different social groups can have conflicting ideas on what technology means (Kanger & Schot, 2016; Klein & Kleinman, 2002). Therefore, before a dominant technology can emerge, the element of closure and stabilization must ensure that all problems between the social groups are solved or redefined (Klein & Kleinman, 2002; Pinch & Bijker, 1987). These three elements illustrate that by combining the wishes of the different relevant user groups, a single technology can evolve. This process of social construction has similarities with evolutionary design, where different ways of using a technology can determine the final design of the technology (Douthwaite et al., 2002). The final element of SCOT is the socio-cultural and political context in which the technology is developed, which seems to resemble the landscape of MLP, as it influences the social groups through norms and values (Klein & Kleinman, 2002; Pinch & Bijker, 1987).

3.1.5 Technological Innovation Systems

Technological Innovation Systems (TIS) are spaces in which innovations are developed. They consist of structural elements and functions that can influence the innovation process. According to Bergek et al. (2008), the structural elements are considered to be the actors, networks, and institutions. Actors are the stakeholders related to the innovation system, while networks are the links between different actors or tasks within the innovation process (Bergek et al., 2008). Scott (1995) distinguishes regulative, normative, and cognitive institutions. The regulative institutions form the policies and rules set by the government. Normative institutions involve norms, morals, and ethics, while cognitive institutions involve culture and other cognitive frames that informally dictate how people behave (Fuenfschilling, 2019; Garud et al., 2007; Hojčková et al., 2018). Additionally, Hekkert et al. (2007) include technology and infrastructure as a structural element, whereas Bergek et al. (2008) instead consider technology and infrastructure in the function of resource mobilization (Bergek et al., 2008; Hekkert et al., 2007).

These structural elements influence the functions, which are used to describe the activities of the TIS. These interactions form the innovative process (Bergek et al., 2008; Hekkert et al., 2007). Bergek et al. (2008) describe the seven main functions of a TIS, being: 1) knowledge development and diffusion; 2) influence on the direction of search; 3) entrepreneurial experimentation; 4) market formation; 5) resource mobilization; 6) legitimacy; and 7) development of positive externalities.

Describing and analyzing the structural components and functions of a TIS (steps 1 to 3) might help evaluate a system's performance (step 5) by identifying the performance of the individual functions (step 4) (Bergek et al., 2008; Hekkert et al., 2007). These insights can then lead to policy recommendations or interventions (step 6) to move the innovation forwards (Bergek et al., 2008), as can be seen in Figure 3.

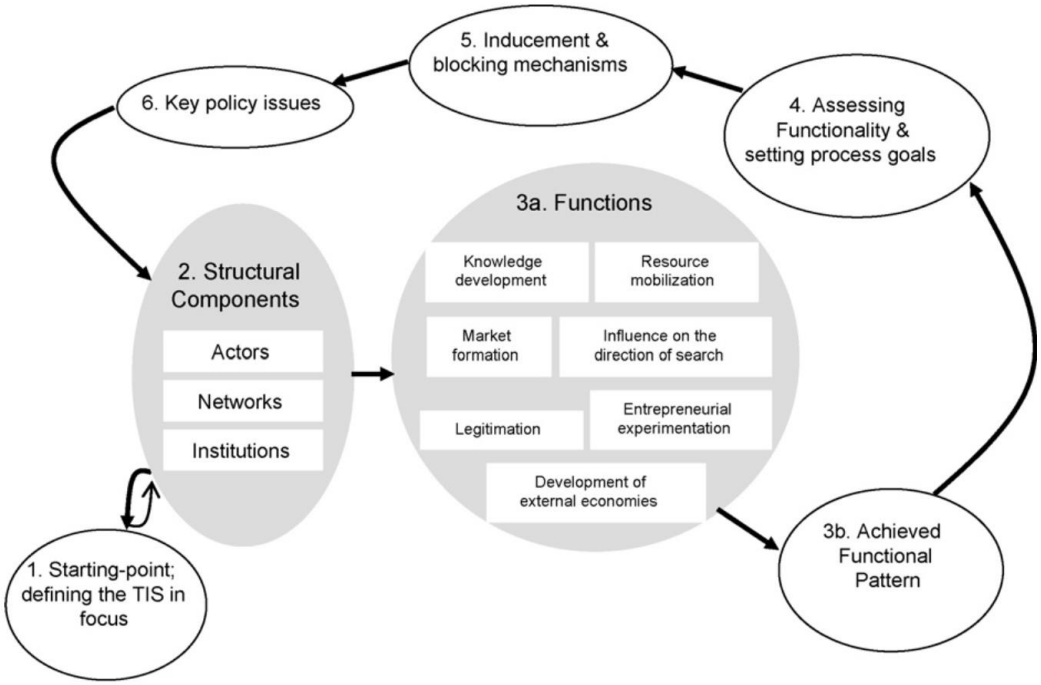


Figure 3 • Overview of the TIS analysis process (Bergek et al., 2008)

3.1.6 Conceptual framework selection: Innovations and transitions

Six transition theories have been described to serve as a framework to identify the barriers and enablers to the transition to electric cooking in Nepal. Before determining which transition theory will be used in this study, Table 2 summarizes each theory on its main characteristics and the nature of the problem it can be applied to.

Table 2 • Summary of the proposed innovation and transition theories

Theory	Main elements	Aim of the theory	References
Multi-Level Perspective (MLP)	Regime, landscape pressures, and niche formation	Analyzing the different elements of a transition, such as the forces destabilizing the regime which enable niches to break through.	Geels (2002), Geels & Schot (2007), Wieczorek (2018)
Strategic Niche Management (SNM)	Shielding, nurturing, and empowerment of niches	Provide practical strategic pointers on how to manage niches to mature so that they can start to challenge new regime effectively.	Smith & Raven (2012), Wieczorek (2018)
Transition Management (TM)	Strategic, tactical, operational, and reflexive activities	Bringing together multiple niches to build momentum for changing the direction of a transition to sustainability.	Loorbach (2010), Loorbach et al. (2015)
Social Practice Theory (SPT)	Technology, personal meanings and conventions, and competence	Analyzing which practices stabilize(d) a regime through horizontal learning and diffusion.	Shove & Pantzar (2005), Shove & Walker (2007; 2010)
Social Construction of Technology (SCOT)	Interpretive flexibility of the technology, social groups, closure and stabilization, and socio-cultural context	Understanding how technology and society interact to develop innovations for different user groups, how technologies evolve, and how dominant designs come about.	Klein & Kleinman (2002), Pinch & Bijker (1987)
Technological Innovation Systems (TIS)	Structural elements (actors, networks, and institutions) and functional elements focused on the emergence and growth of an innovation	Evaluating a TIS to uncover intervention points for policy to move the innovation forward.	Bergek et al. (2008), Hekkert et al. (2007)

To determine which transition theory to use for analyzing the Nepal case, the theories are discussed using the following three criteria: 1) focus on delivering practical and policy recommendations; 2) applicability to developing-country contexts; and 3) research feasibility. The rationale for using these criteria is explained in section 2.1.

Criterion 1: Can the theory deliver practical and policy recommendations?

Following the aim of the study, the used framework must be able to deliver practical and policy recommendations. The summary of the theories presented in Table 2 illustrates that the MLP, SPT, and SCOT do not meet this criterion, while the SNM, TM, and TIS theories do.

The MLP is a helpful framework to analyze how changes in the regime (e.g., destabilization through landscape pressures) have led to the implementation of specific technologies by looking at history, the current state of affairs, and prevalent regimes of a specific sector (Geels, 2002). Therefore, the MLP

tends to have a more academic and historic approach, rather than presenting practical recommendations for current and future implementation programs (Bergek et al., 2008; Hojčková, 2020). Consequently, MLP does not meet the first criterion. Furthermore, the goal of SPT is to comprehend the diffusion of practices and their contribution to a stable regime (Shove & Walker, 2010), while for SCOT, the aim is to understand how a particular technology became dominant through social interactions (Klein & Kleinman, 2002). The aims of these frameworks seem to be in line with the historic focus of MLP instead of the aim of this thesis to make practical recommendations on how to accelerate a transition. Hence, SPT and SCOT also do not meet the first criterion.

SNM provides guidelines through which niche technologies can be supported in growing into the new regime (Smith & Raven, 2012). Analyzing the Nepal case through this perspective would reveal whether the different elements of SNM are followed and which elements could potentially use some improvements. TM goes even further than SNM by providing techniques on how to manage these existing (unsustainable) niches, direct them towards sustainability, and become the new regime (Wieczorek, 2018). The TIS analysis takes a slightly different route and focuses on one technology within its innovation system instead of focusing on multiple niches (Wieczorek, 2018). Similar to TM, the TIS analysis tries to evaluate the performance of a TIS to potentially discover and recommend alternative routes to advance the innovation by understanding the elements of the transition (Bergek et al., 2008). Therefore, criterion 1 is met by the SNM, TM, and TIS.

Criterion 2: Is the theory applicable to developing country contexts?

Transition theories have been developed and applied many times in the developed world to understand socio-technical transitions (Markard et al., 2012; Wieczorek, 2018). However, since Nepal can be considered to belong to a developing-country context, applying transition theories might yield different insights and results and might therefore be less suitable for the aim of the research (Wieczorek, 2018).

TM was first developed and applied in the Netherlands. Therefore, Loorbach (2010) mentions that research should be done on whether the TM framework is applicable in other countries and contexts than the one it was developed in. Van Welie & Romijn (2018) followed this suggestion by gathering TM studies that have been done in developing countries. By analyzing 14 TM papers in the developing context, they concluded that TM could add value to projects in this setting, however, since TM is rather Eurocentric, it misses the complex power dynamics and inequality that stakeholders in developing countries tend to deal with more than developed countries. Combining TM with development theories could add the element of participation that is currently lacking in TM for these contexts (Van Welie & Romijn, 2018).

Similar to TM, SCOT considers social groups in its framework. However, it neglects the social dynamics between the groups (Klein & Kleinman, 2002). The cultural and historical contexts that formed these social groups are not considered (Klein & Kleinman, 2002), which might make it more challenging to identify the structural barriers to the clean cooking transition. MLP does recognize the landscape pressures, the current status quo, and the new technology, which makes it suitable for identifying barriers and enablers to a transition. However, as explained by Wieczorek (2018), it is considered more complicated to analyze contexts in developing countries using MLP since structures and rules can be

non-uniform or misaligned, and a dominant technology is often lacking. This makes it challenging to determine what belongs to the landscape, regime, and niche, and furthermore makes it unclear which parts of the system need to be destabilized for the niche to come through (Van Welie et al., 2018; Wieczorek, 2018). SNM faces the same issues because niches supposedly can only break through when the regime is destabilized. However, in the contexts where regimes can be found to be dynamic or misaligned, this instability can prove to be a barrier instead of an enabler for niches (Van Welie et al., 2018; Verbong et al., 2010).

According to Wieczorek (2018), the TIS framework is particularly useful in developing-country contexts due to its focus on technology diffusion rather than on entire regime shifts and transitions. Consequently, this theory seems to be more directly applicable to a developing-country context since it takes away the struggles with regime instability as mentioned within the MLP and SNM (Wieczorek, 2018). However, some functions should be adapted to suit the specific context. For example, instead of using R&D expenditure as a measurement of knowledge development, one could look at absorptive capacity, i.e., how technology developed in Western countries is adapted and adopted in developing countries (Bergek, 2019). Similarly, since SPT tries to analyze why regimes stabilize, it removes the insecurity found within MLP and SNM. Since SPT looks at how practices diffuse, this theory can be useful for understanding why the regimes in developing contexts are indeed not stabilizing (Shove & Walker, 2010).

To some extent, all theories meet criterion 2. However, the degree to which context-sensitivity is required differs. Therefore, the three theories that require the least adaptations when applying them to a developing-country context and thus meet criterion 2 are TIS and SPT.

Criterion 3: Is the data from Nepal suitable for the elements within the theory?

Since this thesis relies on existing data gathered in Nepal, this provides a limitation on which type of analysis can be performed. Data is present on the implementation of the intervention program, including its actors, networks, policies, financial incentives, contextual pressures, intra-household decision-power, time used for cooking-related practices, the configuration of the kitchen, and experiences with the cookstove (see *Appendix II: Data from Practical Action Consulting* & *Appendix III: Data from 60 Decibels*). The type of data available makes the application of MLP, SNM, and TIS possible. However, insufficient (qualitative) data is available on how practices have changed from using the traditional stove to the electric stove to draw conclusions on the gender responsiveness of the program, which makes the application of SPT rather challenging. Additionally, since the intervention program is singular, the TM analysis might lack data on the reflexivity of such programs. For SCOT, an overview of the actors and how they influence the design of electric cookstoves is needed, which is also not in the scope of the gathered data. The three theories that can fit the case study data and thus meet criterion 3 are MLP, SNM, and TIS.

Conceptual framework selection: Innovations and transitions

A framework is needed that not only looks at how transitions happen, how certain sustainable technologies can become a part of the regime, and how this regime unfolds, but that goes a step further in thinking about how the regime can change itself. Therefore, the six transition theories were tested on

three criteria. Criterion 1 is met by SNM, TM, and TIS, ensuring that the framework fits the aim of the thesis to provide recommendations. Criterion 2 is met by SPT and TIS, ensuring the framework is applicable to a developing context. Criterion 3 is met by MLP, SNM, and TIS, thereby assuring that the available data can be used to assess the case study. The theory that meets all three criteria is the TIS framework, as visualized in Figure 4. Therefore, TIS is used to analyze the case study.

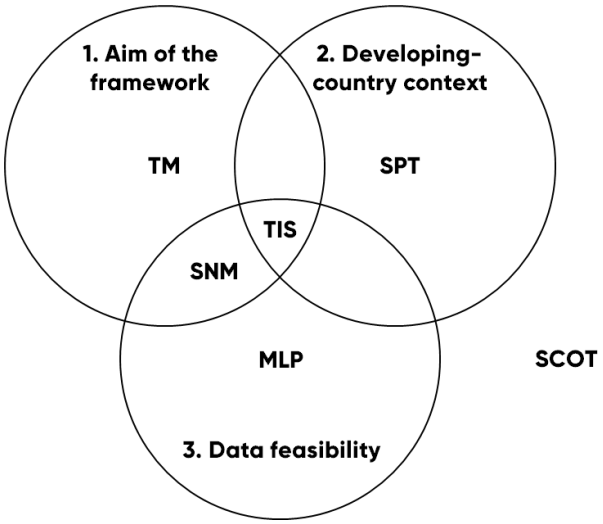


Figure 4 • Conceptual framework selection transition theories: Which theories meet which criteria?

3.2 Gender and justice theories

Since the transition to clean cooking affects men and women differently, gender dynamics should be considered when analyzing barriers and enablers to the transition (Michael et al., 2020). According to Köhler et al. (2019), gender differences are currently not considered enough in transition studies. Especially theories surrounding practices and justice mention the need for further research to fully include such inequalities and dynamics in transition research (Jasanoff, 2018; Köhler et al., 2019). Therefore, a second perspective will be taken to look at the same case study to uncover gender dynamics elements that are not considered within the TIS analysis.

For this thesis, gender theories related to change scenarios and energy transitions were selected. Several theories exist that pair gender and change, such as the Rights-Based Approach (RBA); the Women's Empowerment Framework (WEF); and the Transformative Change Approach (TCA). Furthermore, the concepts of energy, environmental, and climate justice have been coined under transition studies to ensure just transitions. In the following sections, each theory is explained in more detail, after which paragraph 3.2.5 presents the selection criteria and discusses which framework is most suited for analyzing the case study.

3.2.1 Environmental Justice Framework

According to Köhler et al. (2019) and Williams & Doyon (2019), sustainability transitions have a normative impact on society by generating or possibly reinforcing existing injustices. Multiple authors argue that without considering the injustices related to transitions, sustainable and just transitions can by definition not be attained (ILO, 2015; Jasanoff, 2018; Köhler et al., 2019; Williams & Doyon, 2019). Several approaches to just transitions exist, including climate justice, energy justice, and environmental justice (Breukers et al., 2017; Brooks & Davoudi, 2014; Jasanoff, 2018; Michael et al., 2020; Terry,

2009; Williams & Doyon, 2019). The dimensions discussed in the Environmental Justice Framework (EJF) can help understand the (in)justices present in transitions.

Several justice approaches consider the three elements of distributive justice, procedural justice, and justice as recognition (Davoudi & Brooks, 2014; Williams & Doyon, 2019). Davoudi & Brooks (2014) have expanded these definitions by dividing environmental justice into five dimensions: recognition, participation, distribution, capabilities, and responsibility (Breukers et al., 2017; Davoudi & Brooks, 2014). These dimensions are used to determine whether affected parties are treated justly regarding environmental burdens in top-down intervention programs and can also be used to discuss energy justice (Breukers et al., 2017; Davoudi & Brooks, 2014; Lacey-Barnacle et al., 2020).

3.2.2 Rights-Based Approaches

Rights-Based Approaches (RBAs) have been used to highlight politics within development work (Cornwall & Nyamu-Musembi, 2004). Danielsen (2012) concluded that most RBAs for development have three main elements that form the basis of the approach: duty bearers; right holders; and rights. Duty bearers have an obligation to give rights and fulfill legitimacy claims for right holders (Cornwall & Nyamu-Musembi, 2004; Danielsen, 2012). Applying a RBA to electric cooking in Nepal can help explain the dynamics of gender and the different rights that come with it. It can reveal which legal frameworks inhibit the opportunities for women to acquire electric cookstoves. Investigating the duty bearers, right holders, and rights enables providing recommendations on a local level that can help promote electric cooking (Cornwall & Nyamu-Musembi, 2004; Danielsen, 2012).

3.2.3 Transformative Change Approach

A way to determine whether an intervention program was successful in terms of empowerment is by determining whether the program was gender-transformative. A gender-transformative or gender-empowering intervention focuses on ensuring both genders are treated and supported as equals by inviting them, letting them participate in (designing) the program, and trying to work around the predetermined and potentially destructive gender norms (Casey et al., 2018). Gender-sensitive programs are less empowering in comparison, but do consider the differing needs of men and women. On the other hand, programs can also lead to negative effects, such as reinforcing problematic gender norms (only targeting men when selling cookstoves) or by being neutral (not targeting any gender) (Gupta, 2000).

3.2.4 Women's Empowerment Framework

The Women's Empowerment framework (WEF) developed by Winther et al. (2017) is based on a combination of empowerment theory as proposed by Kabeer (1999), socio-technical systems as defined within transition literature, and practice theory (similar to SPT). There are three dimensions that together help determine women's empowerment in the energy sector: overarching issues; gendered access to and control over resources; and agency.

Firstly, the overarching issues are described as a combination of women's and men's rights, gender ideologies and norms, and social positions (Winther et al., 2017). The first part of the overarching issues was based on the Rights-Based Approach (RBA) used in work by Danielsen (2012) on women's access to energy services in the Global South. Similarly, the WEF was originally developed for the broader theme of energy access. Consequently, the rights analysis does not match exactly with the rights

involved within the clean cooking transition. Nevertheless, looking at the overarching issues, including some of the rights that might be shared between cooking and energy access, can help explain the dynamics of gender and the different rights that come with it. Together with gender ideologies, norms, and social positions, the overarching issues provide the context for the following two dimensions, which together explain the position of women within the context of clean cooking.

The second dimension is gendered access to and control over resources and is defined as the economic, social, and human resources women have in the specific context. In particular, this dimension includes jobs and incomes, how time is spent, and accessibility to information and knowledge (Kabeer, 1999; Winther et al., 2017). Finally, determining the extent of agency is used to demonstrate how much power women have over the decisions that are made about their (everyday) life (Winther et al., 2017). Analyzing agency uncovers the power dynamics within households and makes it possible to see how cookstoves are obtained.

These three dimensions form the basis for evaluating an intervention program. When the intervention program has no negative impacts on any of the three dimensions, it is considered empowering (Winther et al., 2017).

3.2.5 Conceptual framework selection: Gender and justice

The Environmental Justice Framework and the three gender approaches have been proposed to fulfill the gender and (in)justice perspective for analyzing the barriers and enablers to the transition to electric cooking in Nepal. Table 3 summarizes each theory on its main characteristics and the nature of the problem it can be applied to.

Table 3 • Summary of the proposed gender and (in)justice theories

Theory	Main elements	Aim of the theory	References
Environmental Justice Framework (EJF)	Recognition, participation, distribution, capabilities, and responsibility	Determining the environmental (in)justices present for actors within top-down intervention programs for sustainability transitions, and make recommendations to improve such programs.	Breukers et al. (2017), Davoudi & Brooks (2014), Lacey-Barnacle et al. (2020), Williams & Doyon (2019)
Rights-Based Approaches (RBA)	Duty bearers, rights, and right holders	Include politics into development work.	Cornwall & Nyamu-Musembi (2004), Danielsen (2012)
Transformative Change Approach (TCA)	Reinforcing gender norms, gender neutral, gender sensitive, gender transformative, and gender empowering	Determine the success of an intervention program for gender equality and raise awareness to increase the number of gender-positive intervention programs	Casey et al. (2018), Gupta (2000)
Women's Empowerment Framework (WEF)	Overarching issues (rights, gender ideologies and norms, social positions), gendered access and control over resources, and agency	Investigate positive and negative effects of development work on women's well-being by analyzing the dynamics of gender relations to provide recommendations on how to increase women's empowerment	Danielsen (2012), Kabeer (1999), Winther et al. (2017)

To determine which gender theory to use for analyzing the Nepal case, the theories are discussed using the same three criteria as applied to the transition theories: 1) focus on delivering practical and policy recommendations; 2) applicability to developing country contexts; and 3) research feasibility.

Criterion 1: Can the theory deliver practical and policy recommendations?

Similar to the transition theory, the used gender framework should result in practical and policy recommendations for intervention programs. From looking at the aim of the theories in Table 3, it can be concluded that the RBA does not meet criterion 1, while the EJF, TCA, and WEF do.

The RBA is used in development work to highlight the politics of gender (in)equality (Cornwall & Nyamu-Musembi, 2004). Power relations and dynamics are emphasized, which is subsequently used to reveal the problems present within a particular development project. It does not necessarily involve gathering recommendations from these results but instead illustrates the status quo of gender (in)equality in a specific context (Danielsen, 2012).

By using the EJF, recommendations to (environmental) top-down intervention programs can be provided regarding (in)justices, which is also in line with the aim of this thesis (Breukers et al., 2017). Similarly, the TCA and WEF can be considered tools to determine how empowering an intervention currently is (Casey et al., 2018; Gupta, 2000; Winther et al., 2017). Hence, the TCA and WEF can also offer recommendations on how future programs can be more or equally empowering (Winther et al., 2017). Thus, criterion 1 is met by EJF, TCA, and WEF.

Criterion 2: Is the theory applicable to developing country contexts?

All theories were developed to highlight gender dynamics, ensuring they can be used in differing contexts. EJF focuses on the (participatory) injustices present within sustainability transitions (Breukers et al., 2017; Davoudi & Brooks, 2014; Lacey-Barnacle et al., 2020). The acknowledgment of injustices, especially for women, (lack of) participation, and being able to extract policy recommendations from this analysis seems to be especially useful in developing country contexts (Lacey-Barnacle et al., 2020).

Similarly, all three gender theories consider the gender dynamics, power relations, and the contexts in which the transition happens. This makes it possible to produce context-specific recommendations for intervention programs. Moreover, RBA, TCA, and WEF have already been applied in developing-country contexts. Winther et al. (2017) use WEF to discuss the impacts of electricity access on gender in the Global South, ranging from countries such as South Africa, India, Zanzibar, and Afghanistan. Danielsen (2012) discusses energy poverty in Sub-Saharan Africa and South Asia using the RBA, and Gupta (2000) discusses the level of empowerment from HIV/AIDS intervention programs in, amongst others, India and South Africa. Therefore, all theories meet criterion 2.

Criterion 3: Is the data from Nepal suitable for the elements within the theory?

Data was gathered on the intervention program in Temal, Nepal, including its actors, networks, policies, and financial incentives. Furthermore, the household survey and focus group discussions delivered information about the contextual pressures, the gender dynamics of the intra-household decision-power, time used for cooking-related practices, and experiences with the cookstove (see *Appendix II: Data from Practical Action Consulting* & *Appendix III: Data from 60 Decibels*). This makes the application of

WEF possible, especially for the dimensions of gendered access to and control over resources and agency. For TCA, similar data to the WEF dimension of agency can be used, which includes quantifiable results on, for example, the time saved by women from making the switch to electric cooking. Additionally, information on how the actors approached the implementation program might make it possible to determine whether the program was gender-transformative.

However, the data seems to be less suitable for applying the WEF dimension of overarching issues and the RBA since the data does not include much information on the specific rights for women in the cooking regime. Similarly, the application of the EJF requires directed questions related to the justice dimensions, which becomes challenging in cases where data is gathered beforehand. Therefore, WEF and TCA meet criterion 3, while the application of EJF and RBA seems less ideal given the available data.

Conceptual framework selection: Gender and justice

The four approaches on gender and justice were tested on three criteria. Criterion 1 is met by EJF, TCA, and WEF, which means that they fit the aim of the thesis to make recommendations. Criterion 2 is met by all four frameworks, which means that all four theories are applicable to a developing context. Criterion 3 is met by TCA and WEF. The available data can therefore be used to assess the case study using both TCA and WEF. The theories that meet all three criteria are the TCA and the WEF, as visualized in Figure 5.

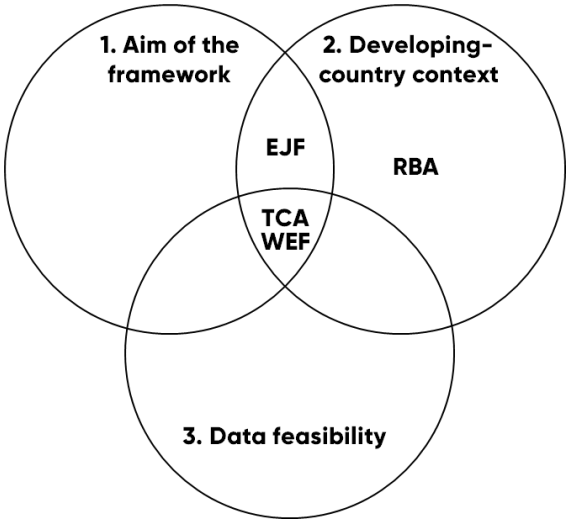


Figure 5 • Conceptual framework selection gender and justice: Which theories meet which criteria?

The limitation of the available data makes it challenging to apply the EJF to its fullest potential. Furthermore, the limitations of RBA require some sensitivity in applying WEF, as there seems to be an overlap between the RBA and the dimension of overarching issues. Therefore, to design the conceptual framework that will be used to investigate the case study from a gender perspective, the three gender theories are compared. A schematic overview of the overlap, interrelatedness, and complementarity of the three gender theories is presented in Figure 6.

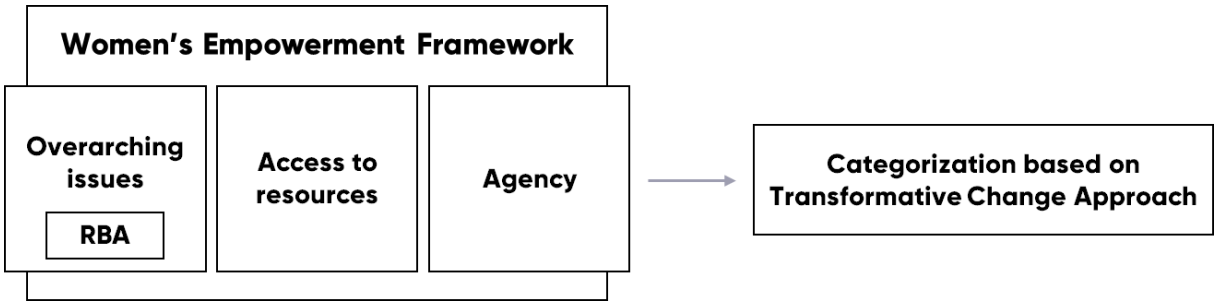


Figure 6 • Overview of the interrelatedness of the three gender theories

As explained above, the first dimension of the WEF is partly based on the RBA from Danielsen (2012). However, since RBA does not meet all three criteria, the overarching issues as proposed by Winther et al. (2017) will be followed to indicate which rights play a role within the electric cooking transition in Nepal. Moreover, the WEF framework aims to investigate whether a program is empowering, whereas the TCA tries to categorize how transformative or empowering an intervention program is. This means that the TCA could be used as a complementary theory to the WEF by labeling the result from the WEF in one of the five categories of the TCA. Therefore, the conceptual framework used to analyze the case study from a gender perspective is a combination between the WEF and the TCA. This conceptual framework is visualized in Figure 7.

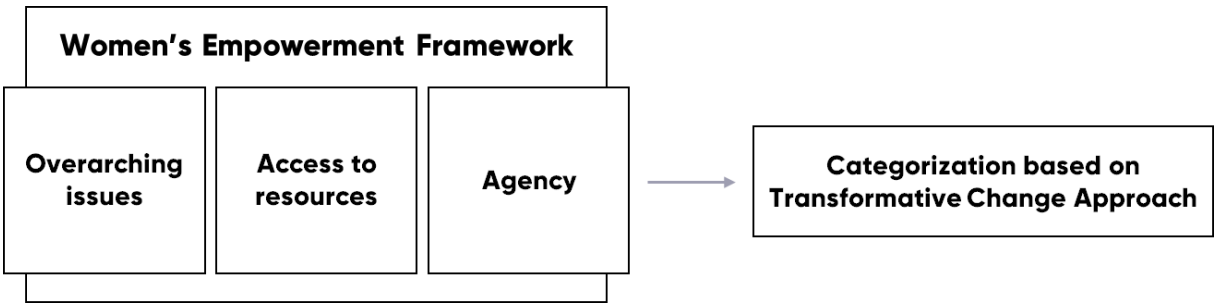


Figure 7 • Conceptual gender framework

4. Cooking in Nepal: Background information

This chapter presents background information on clean (electric) cooking in Nepal and the induction stove intervention program in the Temal municipality. First, a review of the literature on clean cooking and the factors hindering and enabling clean cookstove adoption are presented. Next, information on the current status of cooking in Nepal is provided, after which the intervention program in Temal is discussed.

4.1 Clean cooking in developing countries

Besides traditionally used open and closed fire stoves, several clean(er) cookstoves types exist, such as the improved cookstove (ICS), liquefied petroleum gas (LPG) stoves, biogas stoves, and electric stoves and appliances (CCA, n.d.).

ICSs use less biomass than traditional stoves since these are designed to be more efficient in fuel combustion. Up to 30% of fuel can be saved (Putti et al., 2015). Thereby, ICSs reduce thermal losses, indoor air pollution, fuelwood collection time, and deforestation (Dresen et al., 2014; Urmee & Gyamfi, 2014). However, most ICSs still exceed the recommended daily exposure to pollutants such as $PM_{2.5}$ and CO (Putti et al., 2015; Sambandam et al., 2015; World Bank Group, 2014).

Despite using fossil fuels, LPG stoves are considered to be clean cookstoves according to the Clean Cooking Alliance (CCA, 2019). Rosenthal et al. (2018) indeed concluded that LPG stoves bring more health and environmental benefits than ICSs by analyzing ICS and LPG cookstove intervention programs across 40 countries. Besides LPG, biogas can also be used in gas stoves. Biogas requires less firewood than traditional stoves and ICSs, as it relies on transforming dung and organic waste into gas through anaerobic digestion (Yasmin & Grundmann, 2019). Between LPG and biogas, LPG was found to have slightly less environmental impacts in terms of CO_2 emissions than biogas (Afrane & Ntiamoah, 2011). Similar to LPG, biogas reduces the negative health effects for users that burning conventional biomass in traditional stoves and ICSs still brings (CCA, n.d.; Putti et al., 2015; Yasmin & Grundmann, 2019). Both LPG and biogas seem to produce similar levels of household air pollution (HAP) improvement (>80%) compared to traditional fuels (ESMAP, 2020; Putti et al., 2015); most research on HAP even categorize LPG and biogas together (Du et al., 2018; Semple et al., 2014; Sidhu et al., 2017; Weyant et al., 2019).

Compared to LPG, biogas, and ICSs, electric cooking on induction stoves fully removes the need to gather biomass or buy gas cylinders, subsequently reducing collection time. The cost of the stove, the cost and availability of electricity, and unstable grids, however, emerge as barriers in developing countries with less reliable electricity grids (Batchelor et al., 2019b; Clements et al., 2020). Electric stoves diminish negative health effects compared to all other stoves as no fuels are combusted (Clements et al., 2020). Besides induction stoves, other electric cooking options include, for example, eCooks (rechargeable battery-powered electric stovetop) (Brown et al., 2017), rice cookers, and appliances such as the electric mitad (an electric version of the traditional flat pans to prepare injera bread) (Alem et al., 2014; Brown et al., 2017).

4.2 Factors hindering and enabling the adoption of clean cookstoves

Several meta-analyses on the costs and benefits, and the drivers and barriers to the introduction and adoption of clean cookstoves have been published in the last five years. Puzzolo et al. (2016) discuss the barriers and drivers for clean fuel (LPG, biogas, solar, and alcohol fuels) adoption and use; Bonan et al. (2017) present the barriers, drivers, and impacts of modern energy access for cooking with ICSs; and Vigolo et al. (2018) conducted a systematic literature review on the drivers and barriers of clean cooking with ICSs. These studies on clean cooking reveal that the literature on clean cooking predominantly focus on ICSs or LPG/biogas-stoves. Consequently, they refer to only two electric cookstoves studies, namely the single-country case studies on electric cooking from Alem et al. (2014) on electric mitads in Ethiopia and the research on eCook by Brown et al. (2017) in South Africa.

Recently, Clements et al. (2020) published a study on the drivers and barriers to the introduction of induction stoves in Nepal. Opportunities for electric pressure cookers and eCooks in several different countries in Africa and Asia were presented in Batchelor et al. (2018, 2019b) and Chepkurui et al. (2019). Finally, an overview report published by the Energy Sector Management Assistance Program (ESMAP) in 2020 presents the current state of clean cooking, alongside barriers and drivers for access and adoption of modern energy cooking services (MECS) (ESMAP, 2020).

Based on the currently available studies, Table 4 presents an overview of the most prominently mentioned factors enabling or hindering clean cookstove adoption in general. These factors range from household characteristics that seem to favor clean cookstoves, problems with infrastructure hindering uptake, and opportunities that might increase adoption, such as educational campaigns.

Table 4 • Factors that might hinder or enable clean cookstove adoption

	Hindering factors	Enabling factors
Financial	Investment cost of clean cooking solutions is high compared to the purchasing power (Clements et al., 2020; ESMAP, 2020; Putti et al., 2015; Puzzolo et al., 2016; Vigolo et al., 2018; World Bank Group, 2014).	Households with higher income are more likely to adopt clean cookstoves (Bonan et al., 2017; ESMAP, 2020; Puzzolo et al., 2016; Vigolo et al., 2018).
	Maintenance and repair costs (Vigolo et al., 2018).	Financial incentives such as subsidies to lower upfront costs increase clean cookstove adoption and use (Clements et al., 2020; ESMAP, 2020; Usmani et al., 2017).
Socio-demographic	Women are more willing to adopt ICS than men, but have lower decision-power (Bonan et al., 2017; Pachauri & Rao, 2013; Vigolo et al., 2018).	Increasing agency and economic power of women increases adoption of clean cookstoves (Bonan et al., 2017; Pachauri & Rao, 2013; Vigolo et al., 2018).
	Household size has a negative effect on adoption of clean cookstoves, as these types of stoves tend to be smaller than traditional stoves (Vigolo et al., 2018).	Highly educated people tend to be more willing to adopt clean cookstoves (Alem et al., 2014; Bonan et al., 2017; Pinto et al., 2019; Vigolo et al., 2018). Education of especially women could increase uptake (Yasmin & Grundmann, 2019).

Fuel availability and location	Rural areas providing more opportunities for (free) biomass collection, such as wood and dung hinder clean cookstove adoption (Vigolo et al., 2018).	Urban areas with close availability of LPG/biogas and less opportunities for (free) biomass collection increases clean cookstove adoption (Bonan et al., 2017; Vigolo et al., 2018).
	Gathering of fuel being a social activity (Vigolo et al., 2018).	High price of firewood increases adoption of clean cookstoves (Alem et al., 2014; Bonan et al., 2017).
	Lack of suppliers or distribution channels for clean cookstoves or clean fuels (World Bank Group, 2014)	
Attitude	Resistance towards technology or perceived safety risks leads to lower adoption rates (Chepkurui et al., 2019; Vigolo et al., 2018).	Confidence of users in the ability to successfully use alternative fuels drives demand (World Bank Group, 2014)
Awareness / information	Low awareness about health and environmental risks reduces adoption (Jagger et al., 2019; Vigolo et al., 2018).	Positive perceptions on the improvement of health, reduction of environmental degradation, and time savings increase willingness to adopt clean cookstoves (Bhojvaid et al., 2014; Jagger et al., 2019; Puzzolo et al., 2016).
	Lack of experience with or lack of exposure to (information on) clean cookstoves can hinder adoption (Bhojvaid et al., 2014; World Bank Group, 2014).	Educational activities instead of simple information spreading increases long-term use (Lindgren, 2020).
		Perceived efficiency, ease of use, and costs saving increase adoption – also related to quality of the product (Bonan et al., 2017; Chepkurui et al., 2019; ESMAP, 2020; Puzzolo et al., 2016; Vigolo et al., 2018).
Social and cultural influences	Practices and diets related to the local culture can be important, traditional preparations of food can hinder adoption (Clements et al., 2020; Masera et al., 2000; Puzzolo et al., 2016; Ruiz-Mercado & Masera, 2015; Shankar et al., 2020; Vigolo et al., 2018).	Cookstoves adapted to or suitable for cooking local dishes increase adoption of these types of clean cookstoves (Batchelor et al., 2019a; Dresen et al., 2014).
		Influences by peers (Bonan et al., 2017; Vigolo et al., 2018), such as seeing them use the appliance and getting recommendations from family, friends and neighbors (Bhojvaid et al., 2014; Puzzolo et al., 2016).
Energy use	Reliability of the micro grids is not high enough to rely fully on electric cooking (Clements et al., 2020).	Costs saving through use of electricity as a cooking fuel can be an argument to take up clean cookstoves (Alem et al., 2014; Batchelor et al., 2018; ESMAP, 2020).
	Traditional stoves used as space heaters might hinder adoption of electric appliances (Lam et al., 2017).	

4.3 The current status of cooking in Nepal

Cooking in Nepal is usually done on traditional firewood stoves, both on open and closed fires (Clements et al., 2020; Pinto et al., 2019). Furthermore, LPG stoves, biogas stoves, and ICSs are used as well. Figure 8 presents the distribution of primary cookstoves in Nepal, which illustrates that 71.6% of the households rely on solid biomass for their primary stove (open and closed fire stove and ICSs) (Pinto et al., 2019). To reduce biomass use and benefit from fewer health problems and less environmental degradation, clean cookstoves such as LPG/biogas and electric stoves can be considered as possible

alternatives. Given Nepal's significant dependency on imports of LPG and the high potential of national electricity generation through hydropower, electric stoves seem to be most desirable for Nepal, according to Pinto et al. (2019). However, as seen in Figure 8, currently, only 0.1% of the Nepali households use an electric cookstove. The intervention program in Temal that is used as a case study in this thesis assesses the possibilities for induction stoves in Nepal (Kooijman, 2021).

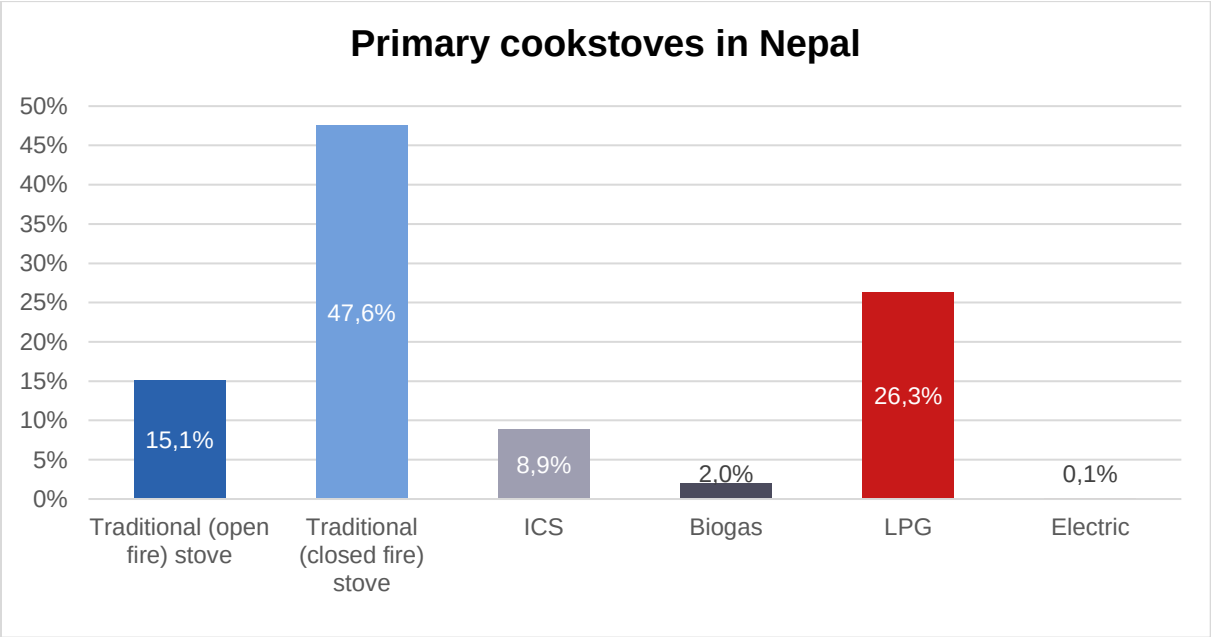


Figure 8 • Primary cookstoves in Nepal. Adapted from Pinto et al. (2019)

Switching to cleaner forms of cooking sometimes means that traditional dishes cannot be prepared in the same way. Therefore, either a simplification of meals is required (Clements et al., 2020), or multiple types of cookstoves will be used at the same time, called fuel or stove stacking (Clements et al., 2020; Masera et al., 2000; Ruiz-Mercado & Masera, 2015). In Nepal, the most common stove combinations are traditional stoves (both open and closed fire) combined with LPG stoves or ICSs (Pinto et al., 2019). However, to achieve significant health and environmental improvements, it is necessary to discourage the use of traditional stoves and prevent stacking of stoves relying on biomass instead of only promoting new stoves (ESMAP, 2020; Shankar et al., 2020).

Traditional dishes in Nepal include *dhal* with rice, *chapati* and vegetables, *dhido*, *roti*, and combinations of these meals. Meats are usually not a part of the diet. Tea is also prepared on the stoves (Clements et al., 2020; Kooijman, 2021). Since rice and dhal are usually prepared in pressure cookers (Clements et al., 2020), this meal can be prepared on most types of cookstoves. Vegetables are fried in oil (Clements et al., 2020), which when having the correct pots and pans and experience on how to use the stoves can be done on any type of stove as well. *Chapati*, *dhido*, and *roti* are considered challenging to cook on other stoves than traditional wood stoves (Clements et al., 2020; Kooijman, 2021), which is why stove stacking is common amongst those that have electric stoves or ICSs (Brooks et al., 2016; Clements et al., 2020).

4.4 The induction stove campaign in the Temal area, Nepal [2]

Nepal has started to roll out several pilots regarding electric cooking. One of these pilot projects was conducted in the rural Temal municipality in the Kavrepalanchowk district of the Bagmati province. The capital Kathmandu is located 60 km from Temal, for which access to the highway is 8km away from the municipality (see Figure 9). The market town of Banepa is at a 2.5-hour driving distance. Approximately 5513 households live in the community of Temal, with an average size of five family members. The main occupations in this community include farming and business. Ethnicity groups are varied, with the Janajati being the largest group and the Dalits being the smallest. In 2005, Temal was connected to the main electricity grid, but load shedding was common up until 2018, when the distribution network was improved.

Figure 9 • Map of Nepal. The locations of the Kathmandu (K) and Kavrepalanchowk districts, including the municipalities of Banepa (B) and Temal (T), are highlighted

The Community Rural Electrification Entity (CREE) of Temal became involved with the intervention program for electric cooking from GIZ/EnDev, NACEUN, and ABF[3]. This program was a market-led promotion of induction cooktops that took place from June 2019 to February 2020. The CREE managed the supply, maintenance, and selling of the induction stoves. In total, 569 households (10.2% of the households living in Temal) purchased an induction stove package with a single potholder induction cooktop (2000W, CG brand), a pan, and a pressure cooker for 4750 Nepalese rupees (NPR). To put this price into perspective: 73% of the households in Temal have an income of less than 28,000 NPR a month (Kooijman, 2021), which is equivalent to less than approximately €200 a month. The induction stove costs an equivalent of approximately €34.

The program further supplied information and demonstrations to both men and women on how to use the cookstove and pans as well as financial incentives for the households to purchase the package. These financial incentives consisted of a 19% discount on the market price of the induction stove package and

[2] The information presented in this section is based on the reports from (Kooijman, 2021) and (ABF & NACEUN, 2020)

[3] The GIZ/EnDev program funded the pilot in Temal that was launched by NACEUN (the National Association of Community Electricity Users Nepal) and ABF (Ajummery Bikas Foundation) in collaboration with the CREE of Temal. The roles of these actors are further explained in section 5.1.2.

a discount on the electricity tariff of 150 NPR a month for the first six months for those households with a 20kWh increase in consumption or higher. The cost of consuming 20kWh of electricity is approximately 160 NPR.

Furthermore, the electricity infrastructure was upgraded on both the regional and the household level. To ensure that all participating households would be able to cook on the electric appliance without experiencing grid instability, only 10% of the households per transformer were allowed to join the pilot program on a first-come, first-serve basis. To do so, demand had to be created in several areas where villagers were not keen on buying the cookstoves, and demand had to be reduced in other areas to adhere to this 10% limit. Households that purchased the induction stoves come from varying ethnic groups and backgrounds. Dalits and Janajati, the most disadvantaged groups in Nepal, respectively represent 1.5% and 75% of the sample, while respectively 3% and 84% of the population in Temal belongs to these group.

4.5 The current status of cooking in the Temal area, Nepal

Approximately six months after the implementation program, 60 Decibels and Practical Action Consulting Nepal (PAC) surveyed participating households on their cooking habits before and after the introduction of electric cooking, such as the used energy sources, the prevalence of fuel stacking, and who is considered the main user of the induction stove.

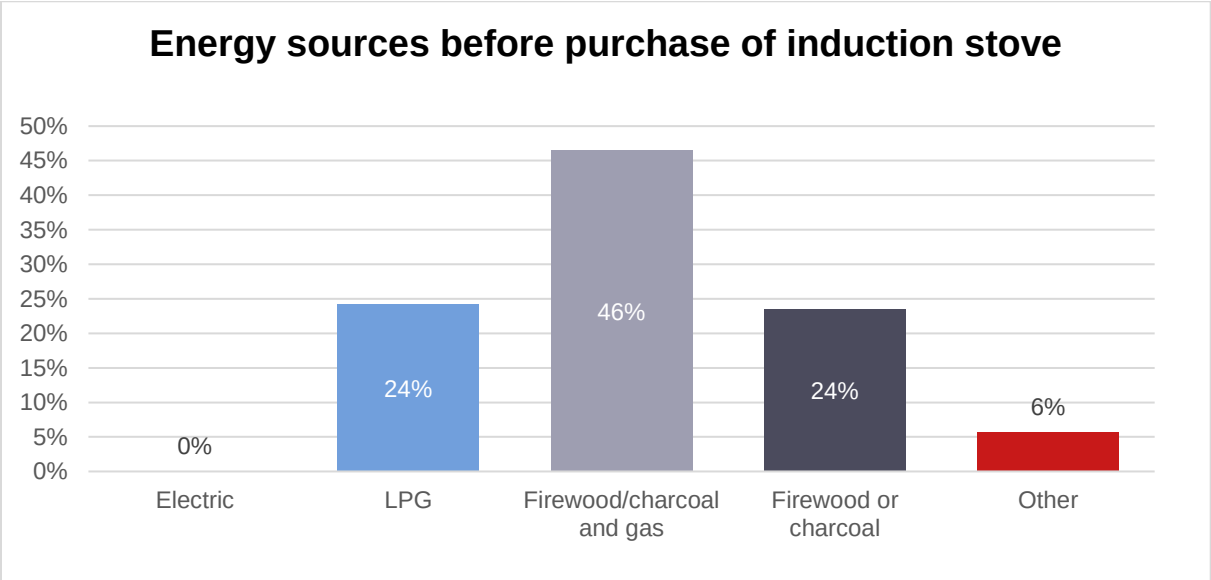


Figure 10 • Energy sources for cooking before the electric cooking intervention. Data drawn from research conducted by 60 Decibels (2020)

As illustrated in Figure 10, 70% of the sampled households in Temal used traditional stoves fueled by wood or charcoal to cook before they purchased the induction stove. The household survey by PAC (2020) illustrates that these traditional stoves are placed in the kitchen (55%), main living space (20%), or a separate room or shed (25%). Examples of traditional stove placements are presented in Figure 11a and b. Fuelwood in Temal is gathered from private areas or unclaimed land. LPG cylinders are usually bought in and delivered from Banepa or bought at (more expensive) local retailers.

Figure 11 • Traditional (a, b), induction (b, c), and LPG cookstoves (c). Photos: Mina Basnet

After the adoption of the induction stoves, many households in the sample practiced stove stacking, for example, by combining traditional stoves, induction stoves, and LPG stoves (Kooijman, 2021). Examples of fuel stacking with traditional stoves, induction stoves, and LPG stoves are provided in Figure 11b and c. Fuel stacking is also represented in Figure 12, which reveals that only 10% of the households solely use the induction stove for cooking. The other households thus also use other stoves. The respondents to the phone survey by 60 Decibels indicated that cooking needs for the habitual meal are the most common reason for stove stacking. This could be explained by the fact that most meals consist of two dishes, ideally using two potholders simultaneously, while the induction stove used in the program only has one potholder (Kooijman, 2021). Other reasons included time savings and availability of fuel (see Figure 13). The household interviews from PAC (2020) illustrate that rice and *dhal* are usually cooked on induction stoves. However, most people still preferred their traditional or LPG stove to cook vegetable curries, over using the induction stove (Kooijman, 2021).

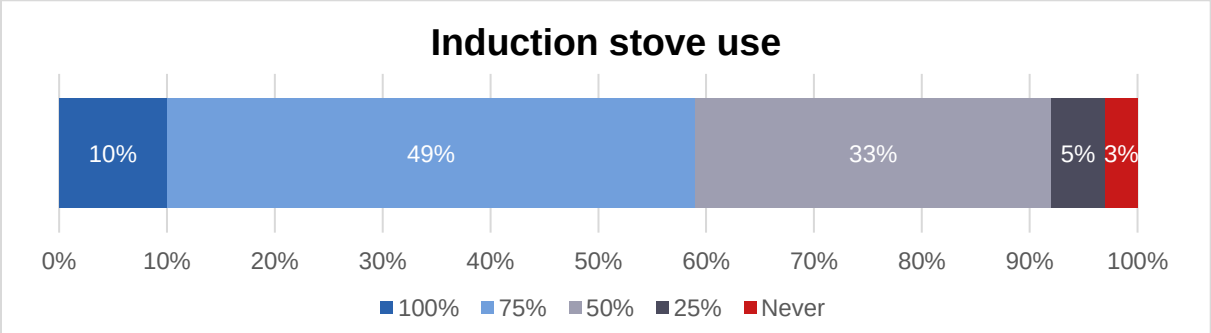


Figure 12 • Frequency of use of the inductions stove for cooking. Data drawn from research conducted by 60 Decibels (2020)

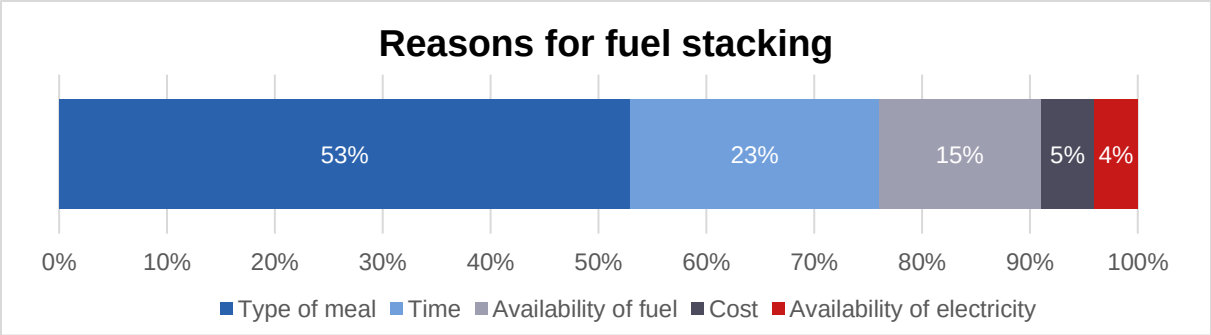


Figure 13 • Reasons mentioned for fuel stacking. Data drawn from research conducted by 60 Decibels (2020)

Furthermore, women are considered the main cooks for the induction stove since they use it more often than men (see Figure 14). The majority of the women in the sample used the induction stove at least once a day (82%), whereas only 38% of men did the same. Moreover, the men who did use an induction stove only did so to help their wives or to prepare tea and snacks. Furthermore, more instances occur in which the men in the household only rarely (less than three times a week to never) uses the appliance compared to the women (respectively 44% and 13%). Women, therefore, tend to use the induction stove much more often. This finding reveals that women are the main users of the induction stove.

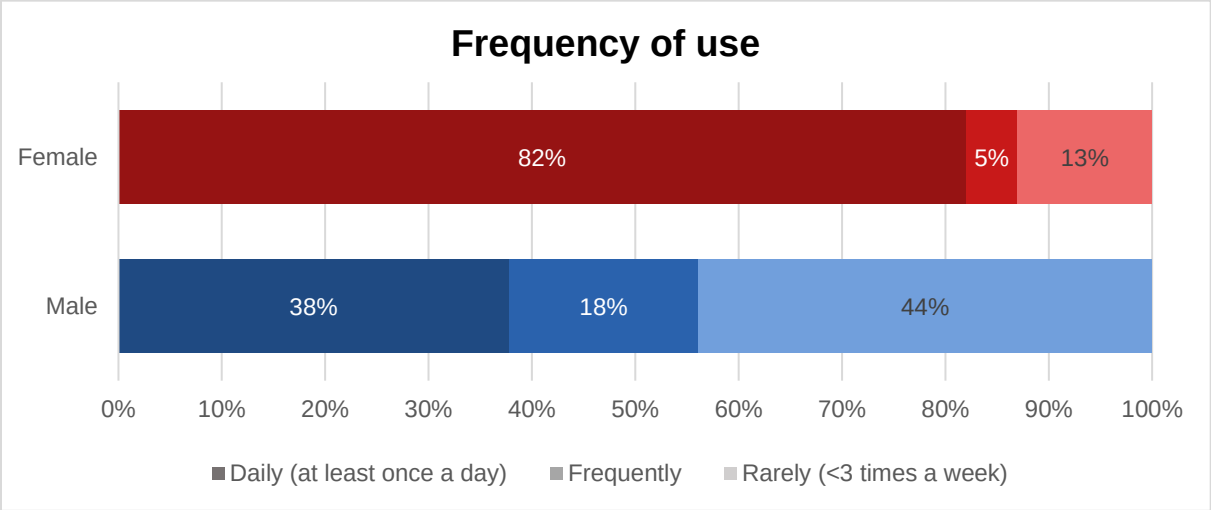


Figure 14 • Frequency of use of induction stoves. Data drawn from research conducted by 60 Decibels (2020)

It should be noted that men tend to cook more after the introduction of electric cookstoves. Out of the 40 households interviewed by PAC (2020), 15 men used a stove before purchasing the induction stove. After the purchase, the number of men using a stove (predominantly for preparing tea and snacks) increased to 32 out of 40 (Kooijman, 2021). This number reveals that men are either joining women by helping them in the kitchen or taking over the task of preparing tea and snacks.

5. Electric cooking in Nepal: Case study analysis

Chapter 5 analyzes the induction stove intervention program in Nepal as discussed in sections 4.4 and 4.5 by applying a transition perspective and a gender perspective, using the data gathered by ENERGIA, 60 Decibels, and Practical Action Consulting Nepal. The most important findings from each perspective are presented and compared, leading to insights in policy and practice for electric cooking in Nepal.

5.1 Applying a transition perspective: Technological Innovation Systems

This section discusses the first three steps of the Technical Innovation System (TIS) analysis process as described by Bergek et al. (2008) (see also Figure 3, p.8). After analyzing the structural components and the functions of the TIS, a functional pattern can be determined, and insights can be gathered on which of the functions are blocking or inducing the TIS of electric cooking in Nepal. This is done in section 5.3.1 by giving an evaluative summary.

5.1.1 The scope of the Technological Innovation System analysis

The scope of the TIS analysis is the technological innovation system of induction stoves in rural Nepal. Therefore, the TIS encompasses the process of innovation and implementation of induction cookstoves in Nepal and the actors and activities that influence this innovation and implementation process. Since innovations do not happen in isolation, several (inter)national linkages can be identified as having an influence on the innovation process as well (Bergek, 2019). Furthermore, innovation processes can develop positive externalities for actors not currently in the TIS (Bergek et al., 2008). Therefore, the analysis of the TIS for induction stoves in Nepal is focused primarily on the pilot project for induction cookstoves in the Temal area, Nepal, but further includes national documents, reports, and the sparse academic literature to include the other elements influencing this TIS. Sections 5.1.2 and 5.1.3 explore the structural components and functions of the TIS.

5.1.2 Structural components

Actors

In the TIS of electric cooking in Nepal, the Government of Nepal (GoN) sets (strategic) targets for the country to reach goals on sustainable energy and clean cooking. The White Paper published in 2018 is one example of such a strategic roadmap, in which electrification strategies for the future are discussed. Renewable energy generation through (micro-) hydropower, solar installations, and wind turbines is being increased by supporting, amongst others, the Alternative Energy Promotion Center (AEPC) and the Nepal Electricity Authority (NEA). Through these governmental institutions, the GoN wishes to achieve the implementation of an electric stove in every household (GoN, 2018). AEPC's role is to develop and promote renewable energy technologies, while NEA is the national energy distributor of Nepal and generates, operates, and maintains the entire power system (AEPC, n.d.; NEA, n.d.).

Besides AEPC and NEA, several other national actors concerned with improving access to electricity can be identified. The National Association of Community Electricity Users Nepal (NACEUN) brings together the more than 300 Nepali Community Rural Electric Entities (CREE). The CREEs buy and distribute the energy generated by NEA to these rural communities and actively promote and create awareness for modern energy services (NACEUN, n.d.). The Ajummery Bikas Foundation (ABF) is a

national research foundation from Nepal that facilitates and monitors development projects on energy, environment, and climate on behalf of the government (ABF, n.d.). NACEUN and ABF collaborated with the local CREE partner in Temal and the NEA to implement the induction stove implementation campaign (ABF & NACEUN, 2020; Kooijman, 2021). AEPC, NACEUN, CREE, ABF, and NEA therefore add to the electric cooking TIS by developing and providing energy access to rural households (NACEUN, n.d.).

Several international non-profit organizations can be identified that fund development projects for clean energy and clean cooking in Nepal. Firstly, the Clean Cooking Alliance (CCA), initiated by the United Nations Foundation (UNF) is an example of a non-profit organization that, together with a network of global actors, funds and directs research on clean (electric) cooking. To achieve their goal of creating universal access to clean cooking, the CCA has conducted several electric cooking pilots in Nepal (CCA, 2020; Kooijman, 2021). Furthermore, the CCA has developed a Clean Cooking Catalog (CCA, n.d.). Secondly, the Modern Energy Cooking Services (MECS) program from the UK researches the need for clean cooking in planning for UN Sustainable Development Goal 7 (SDG7: Affordable and clean energy) (MECS, n.d.). MECS has funded research on the electric cooking potential in Nepal in collaboration with the People, Energy, and Environment Development Association (PEEDA). The PEEDA is a Nepali NGO consisting of several organizations working on hydropower with the mission to promote this local resource in the renewable energy sector, for example, through researching the potential for electric cooking on micro-hydro grids (Clements et al., 2020; Gautam et al., 2020; PEEDA, n.d.). Finally, a collaboration between the Dutch Ministry of Foreign Affairs and the German Federal Ministry for Economic Cooperation and Development resulted in a worldwide program called Energizing Development (EnDev), which aims to contribute to SDG7 by increasing access to modern and sustainable energy (EnDev, 2018, 2019a). In 2009, EnDev launched a program specifically for Nepal to improve access to modern energy, for example, for electric cooking purposes. EnDev assisted in training and funding producers, technicians, and salespersons for both sustainable energy technologies and clean cooking solutions. By June 2019, over 300,000 people in Nepal had gained energy access[4], either through the national grid or through micro-hydropower grids, and approximately 175,000 people had received energy efficient stoves (EnDev, 2019b). Furthermore, EnDev funded the induction cookstove intervention program in Temal (ABF & NACEUN, 2020; Kooijman, 2021).

Besides these larger actors, several actors specific to the implementation program can be identified as well. To increase social support for the electric stoves, local political leaders were trained and educated on the program and induction stoves. Local people in the area were temporarily employed by the program as social mobilizers and collaborated with CREE to raise awareness amongst and provide practical information to future users, such as how to install and use the stove. Household wiring was improved by local electricians (ABF & NACEUN, 2020).

[4] Note that access to energy is defined by EnDev as access to tier 1 energy supply and services and above, according to the Multi-Tier Framework (EnDev, 2019a). This means that the reliability, capacity, affordability, duration, availability, and quality of energy might not be sufficient for electric cooking purposes (Bhatia & Angelou, 2014, 2015).

Several actors concerned with supplying stoves are identified in the TIS. Since no local retailers in Temal sold induction stoves, nor were willing to during the project, the stoves were purchased by CREE Temal with support from ABF/NACEUN from a larger supplier in Kathmandu. Maintenance and repair are conducted in workshops in Kathmandu as well (ABF & NACEUN, 2020). Participants switching from LPG stoves to electric stoves might buy less LPG cylinders in the future. This might mean that local LPG vendors could be a potential actor in the TIS as well. Furthermore, supplier actors in the TIS cover the manufacturers, producers, and distributors as well. However, from the available data it cannot be determined who these actors are and where they are based.

Finally, stove users form the final actor group. This group consists of the users of the induction stove in the induction stove program and the non-users who were not able to participate. Amongst the users, a separate group of actors can also be identified, namely the Self-Help Groups and women's credit and savings groups. These groups enable female members to receive or provide short-term loans within the group (Kooijman, 2021).

Networks

Networks in the TIS are considered those networks of actors that together complete certain tasks or are connected through other relationships with each other (Bergek et al., 2008). The first network identified within the electric cooking TIS in Nepal is related to developing electricity solutions. Several partners are working on increasing the access to electricity for (rural) households, such as the NEA, AEPC, NACEUN, CREE, and GIZ/EnDev. By working together, the electricity generation capacity was expanded (by NEA & AEPC), the electricity grid improved (because of the efforts of NEA, NACEUN, CREE, and EnDev), and the household wiring enhanced (by NACEUN & CREE).

ABF and NACEUN collaborated to implement the induction stove program in Temal. They worked closely together with CREE to receive an inside perspective of the Temal region before and during the launch of the program. EnDev financially supported the collaboration (ABF & NACEUN, 2020). Since no local retailers were available nor willing to invest in induction stoves, the implementation program team had to set up a different network to supply the induction stoves. Through an existing connection between ABF/NACEUN and a large induction stove (and accessories) supplier in Kathmandu, CREE was able to order induction stoves on credit to take the responsibility as a local retailer. At the demonstration and awareness events, interested households were connected to the CREE and paid 1000 NPR in advance, which enabled CREE to order the exact number of induction stoves needed (ABF & NACEUN, 2020).

To reach the potential future users of the induction stoves, information had to be spread to the households (ABF & NACEUN, 2020). Households with connections to the CREE received information earlier than the other households, which meant they could benefit from the first-come, first-serve regulation (Kooijman, 2021). Self-help groups and local women's networks were identified as potential networks that could help spread information to women by educating them on the negative health effects of indoor pollution (Kooijman, 2021).

Finally, to assess the success of pilot programs on electric cooking, networks for researching the effects of such implementation programs exist. In the case of this pilot program, research partners were ENERGIA, PAC Nepal, and 60 Decibels (Kooijman, 2021). ABF and NACEUN evaluated the pilot program as well (ABF & NACEUN, 2020). Figure 15 presents an overview of the identified networks and actors within the electric cooking TIS case study and how they are connected with one another.

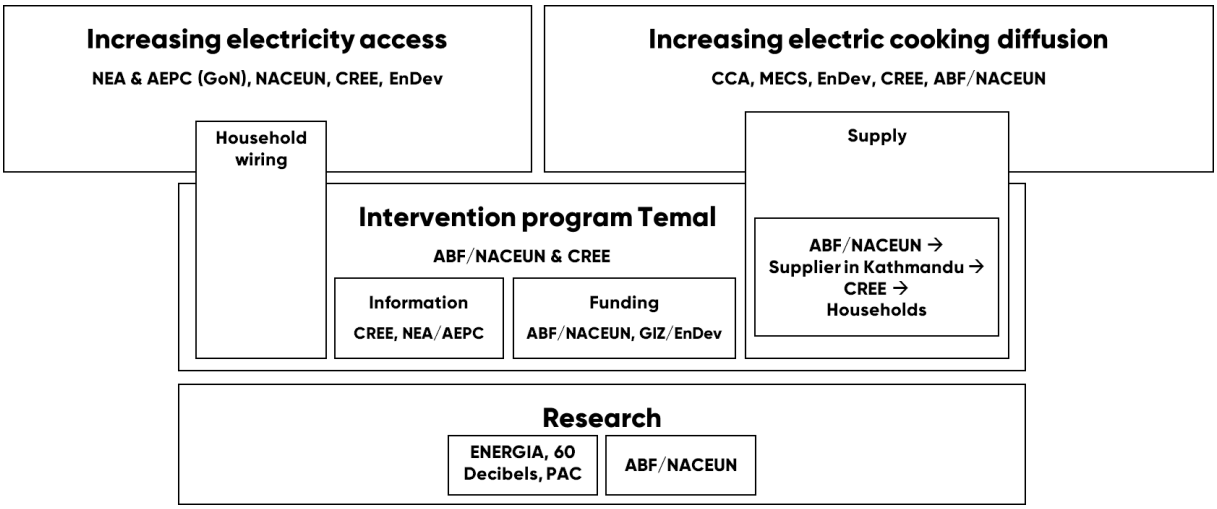


Figure 15 • The identified networks within the case study

Institutions

The institutions describe the unwritten rules within the TIS regarding strategies, internalized ideas, and deals that were made in relation to, and therefore influence, clean cooking in Nepal (Hojčková et al., 2018). Strategies can be formulated by the national Government, such as targets, plans, and strategies to move the country towards clean cookstove adoption (regulatory institutions). Moreover, informal institutions, such as the prevalent norms, morals, and ethics related to cooking in Nepal (normative institutions), and the cognitive frames that people can follow in deciding how to behave (cognitive institutions) also form part of the institutions (Blum et al., 2015; Fuenfschilling, 2019; Garud et al., 2007; Hojčková et al., 2018). An overview of the identified institutions is presented in Table 5.

Table 5 • Identified institutions and their contributions to the electric cooking TIS of Nepal

Regulatory institutions (formal)	
White Paper (2018) *SDG7: Clean and affordable energy*	Goals to improve energy access for especially the rural areas. The Energy White Paper sets goals for hydropower projects and (renewable) electrification of rural areas. These goals create incentives to support electric cookstove adoption for every household (GoN, 2018; IEA, 2019).
Biomass Energy Strategy (2017) *15th Development Plan (2019-2024)*	Target for smokeless kitchens by 2022 and reduced dependence on imported LPG. Increase distribution of ICSs and electric cookstoves (CCA, 2020).
National Energy Strategy (2013)	In 2030, cooking needs to be done on 100% electricity in urban areas, and in rural areas on 40% electricity, 50% firewood, and 10% LPG. By 2050, 80% of the population should be connected to the grid, and fossil fuel use has to be reduced by 50%

Gender Equality and Social Inclusion (GESI) approach (2017)	The GESI approach helps include users of electric cookstoves in policy plans (Bennett, 2017; GESI Working Group, 2017).
Normative and cognitive institutions (informal)	
Culture & traditions	Cooking is usually done on traditional firewood stoves or LPG stoves. Electric stoves are not always suitable for traditional dishes (ABF & NACEUN, 2020; Clements et al., 2020; Kooijman, 2021)
Social norms	Women are commonly the cooks in the household (Figure 14). However, recently men are taking more responsibilities, such as helping their wives by preparing tea when they are busy or by operating the electric appliances (ABF & NACEUN, 2020; Kooijman, 2021).

Increasing reliable, sufficient, and affordable access to electricity (in rural areas) is a crucial element of an electric cooking strategy in Nepal. The Government of Nepal has implemented several policies and strategies to achieve increased electricity generation and reduce energy poverty in rural areas, such as the White Paper and the National Energy Strategy (GoN, 2018; Pinto et al., 2019). Once the electricity grid capacity is sufficient, electric cooking in Nepal could potentially be possible on a large scale. The Government has also developed several strategies for households to adopt electric cookstoves. Policies targeting electric cooking are recent; the Biomass Energy Strategy from 2017 and the 15th Development Plan (2019-2024) mention replacing biomass and fossil fuels with electric energy to reduce indoor air pollution and import dependency (CCA, 2020). The White Paper from the Government also mentions a future campaign that will promote electric stoves for every household in Nepal (GoN, 2018).

Besides cooking practices, as discussed in section The current status of cooking in Nepal4.3, gender and social norms are part of the institutions as well. Since women are the main cooks and therefore the dominant users of the induction stoves, policies by regulatory institutions targeted towards women can be considered part of the institutional setting for the TIS of electric cooking in Nepal. The Gender Equality and Social Inclusion (GESI) approach helps formulate how gender equality and social inclusion are considered when designing policies. As a result, socially excluded groups are being included more in the realm of policies such as energy access (Bennett, 2017; GESI Working Group, 2017). The Nepal Constitution is a product of the GESI approach and states that women should benefit from economic empowerment on an equal level as men. This could be achieved by introducing electric cookstoves, which might offer women more time to spend on activities of their choice (GESI Working Group, 2017; Kooijman, 2021). Nepal is currently the only country where such an approach has been implemented at the national level (Bennett, 2017). The GESI approach could aid the electric cooking TIS in Nepal by including the users of electric cookstoves (women) in policy plans.

5.1.3 Functions

Knowledge development

Without creating, diffusing, and combining knowledge, technologies are unable to adapt and evolve. Therefore, researching and developing knowledge and technologies and the diffusion of this knowledge to other (global/local) actors in the system (suppliers, consumers, etc.) is one of the functions of the TIS (Bergek et al., 2008; Hekkert et al., 2007).

For the electric cooking TIS in Nepal, organizations such as the CCA and MECS developed a platform where research, funding, and pilot programs on clean cooking are gathered. Furthermore, for the electric cooking potential in Nepal, CCA, PEEDA, MECS, and EnDev became focused on researching possibilities for expanding and improving the electricity infrastructure and micro-hydro grids (CCA, n.d.; Clements et al., 2020; Gautam et al., 2020; MECS, n.d.).

Knowledge diffusion was done in the project by raising awareness amongst inhabitants of Nepal on the problems associated with traditional (biomass-based) cooking (ABF & NACEUN, 2020; Kooijman, 2021). Demonstrating how ICSs and electric cooking appliances can reduce indoor air pollution, improve health, and reduce the negative effects on the environment is one way of spreading the knowledge top-down from researchers to users. The CREE organized multiple events to help increase demand for electric cooking by increasing knowledge and technical, operational, and maintenance skills amongst future users (ABF & NACEUN, 2020).. Together with spokespeople from NEA and AEPC, the cookstoves were demonstrated, the costs and benefits of clean cooking were explained, after sales' service options were discussed, and households could ask questions. Similar information was also distributed through informational leaflets, videos, house visits, and Facebook groups (ABF & NACEUN, 2020; GoN & NEA, 2019; Kooijman, 2021).

CREE distributed invitations to the demonstration and awareness sessions through phone calls, house visits, flyers, and posters at the market to reach both men and women (Kooijman, 2021). However, the household survey reveals that more men than women were present at the induction stove program information session, despite the explicit invitation to both. This is especially the case in male-headed households, where only 25% of the women had received information on the electric cooking initiative through the official channels. Even when women had heard of the events, some found the three-hour duration of the event too long and decided not to attend due to other priorities, or their husbands saw more value in attending the events themselves due to the technical nature of induction stoves (Kooijman, 2021). This means that knowledge was not diffused to a large part of the population that could especially benefit from this program: the main users of induction stoves, women.

Furthermore, mostly the families with established networks to the CREE heard about the program in time. Since the transformers could only support a capacity of up to 10%, the stoves were distributed on a first-come, first-serve basis (Kooijman, 2021). Consequently, the people that heard about the program early on had an advantage over those with more limited networks and connections. Indeed, the poorest households (Dalit group) only heard about the program after it had ended (Kooijman, 2021), which reveals that knowledge diffusion not only did not reach many women, but also not the poorest groups.

The awareness and information programs were all initiated by a third party, namely CREE. However, there is also knowledge diffusion amongst users themselves. By observing family, friends, and neighbors using the induction stove, awareness is raised about the existence of such a device, how it works, and what dishes can be cooked in which particular way. This form of knowledge diffusion was especially the case for women (Kooijman, 2021).

Entrepreneurial experimentation

Through the experimentation of entrepreneurs, the technology can be adapted to the needs of consumers. Entrepreneurial activities and experiments with different versions of the technology can, for example, take place through pilot projects (Bergek et al., 2008; Hekkert et al., 2007).

Local retailers in Temal found investing in induction stoves too risky since demand is considered low (ABF & NACEUN, 2020; Kooijman, 2021). This means that no experimentation was done by local distributors. Potentially, local LPG cylinder vendors could in the future switch towards selling induction stoves when demand for induction stoves increases. However, participants mentioned that products at local stores are more expensive compared to stores in Banepa, which means they prefer to avoid buying at local stores (ABF & NACEUN, 2020; Kooijman, 2021). Moreover, maintenance and repair of the induction stoves is currently only possible in the supplier's workshop in Kathmandu (ABF & NACEUN, 2020).

However, several organizations within the TIS of electric cooking in Nepal partly fulfill the function of entrepreneurial experimentation by funding pilot projects on electric cooking. The CCA has initiated several electric cooking pilots in Nepal in collaboration with local research programs or local partners (CCA, 2020; Kooijman, 2021). Similarly, the EnDev program for improving modern energy access for electric cooking in Nepal has assisted in distributing over 175,000 energy efficient stoves since 2009 (EnDev, 2019b). The implementation program from ABF and NACEUN is but one of the pilots that EnDev has helped fund (ABF & NACEUN, 2020; Kooijman, 2021).

Before ABF and NACEUN launched the pilot, the content of the packages, the information, and the equipment needed were determined. This was done in collaboration with locals, namely employees of local CREEs. Users of the induction stove were only approached after the rollout of the induction stoves, after which it became clear that some of the pans were not appropriate (ABF & NACEUN, 2020). This is further discussed under *Resource mobilization*. However, this means that during the pilot program, the participation of users was limited and did not involve co-creation.

Market formation

The market for a technology starts with demand in experimental niches (Bergek et al., 2008; Hekkert et al., 2007). By diffusing knowledge and improving the technology and infrastructure, more consumer demand might be created, which could lead to a mature market (Bergek et al., 2008).

Only a few pilot programs have been conducted in Nepal, and no local retailers were willing to invest in the distribution of induction stoves. This demonstrates that induction stoves are still in an early or immature market phase with few adopters. The market could be curtailed due to the insufficiency of the electricity grid in rural areas, since large distributers of induction stoves are present in Kathmandu (ABF & NACEUN, 2020). Clements et al. (2020) expect that electric cooking could become available for a larger part of the population once the electricity network is sufficient. Affordable and reliable access to electricity could boost the market for electric cooking, which could push the technology into the growing phase and finally into the mature phase once the entire population has switched to electric cooking.

Influence on the direction of search

The presence of regulations, norms and values, and changes in the global and local context can be reasons to develop a new technology, and with it, a new innovation system (Bergek et al., 2008; Hekkert et al., 2007).

Increasing electric cookstove uptake requires a reliable electricity infrastructure. One of the incentives for researchers, developers, and entrepreneurs in Nepal is the White Paper (2018), which was developed with the goal to achieve SDG7. This policy document is the core of the energy strategy in the country, setting goals for widespread electrification and replacing biomass stoves with electric stoves in every household (GoN, 2018). In the 15th Development Plan (2019-2024) and the Biomass Energy Strategy (2017), the wish to replace fossil fuels and biomass by electric energy as a way to reduce indoor air pollution and import dependency came forwards, and with it, the vision of a "smokeless kitchen" through electric cooking for the entire country (CCA, 2020; GoN, 2018; Pinto et al., 2019). Other plans to tackle electrification are the Rural Energy Policy (2006), the National Energy Strategy (2013), the Renewable Energy Subsidy Policy (2016), and the White Paper (2018). All these plans aim to provide clean and affordable energy to especially rural areas by increasing (renewable) electricity generation and improving grid infrastructure (GoN, 2018; IEA, 2017a, 2017b; Pinto et al., 2019). Thus, the Government is slowly improving the electricity distribution and access to electricity, which is a key element of influencing towards the uptake of induction cookstoves.

The pilot project in Temal is influencing the direction of search towards induction stove adoption by developing technical, user-friendliness, and safety standards for the cookstoves (ABF & NACEUN, 2019). The quality of the products needs to be guaranteed, which means that standards are put into place on a national level (ABF & NACEUN, 2020). These national standards can be used as guideline for future induction stoves producers and distributors. The research from both CCA and MECS on clean cooking appliances could also contribute to standardization (CCA, n.d.; ESMAP, 2020).

Furthermore, word-of-mouth between peers, friends, and family entices individuals to also adopt electric stoves. If this word-of-mouth information is positive and includes information on how to best use the appliance and for what meals, this might increase the uptake of electric cookstoves over ICSs (Kooijman, 2021).

Considering the previously mentioned aspects, there seems to be a positive influence on the direction of search for the electric cooking TIS in Nepal where views from different entities (the government, organizations, and the population) converge into one direction of search to support the development and rollout of induction stoves.

Legitimacy

Legitimacy for a TIS is created by lobbying or by rising public interest through, for example, demonstrations and protests and acceptance of the technology by users (Hekkert et al., 2007). This can influence the standing institutions and change regulations, which provides more reasons for industries to invest in the technology (Bergek et al., 2008).

Public and private organizations have been concerned with increasing awareness on clean energy and clean cooking methods, such as the CCA, MECS, PEEDA, the Government of Nepal, and the UN (SDGs). Programs to promote electric cookstoves distribute information to raise awareness on the costs and benefits of electric cooking (ABF & NACEUN, 2020). Raising awareness could also help create societal acceptance for the induction stoves, which could further influence the adaptation of regulations and potentially accelerate induction stove adoption.

Resource mobilization

For a TIS to function, actors need resources and suppliers delivering these resources. Resources include financial resources, material resources, technology and infrastructure, and human resources (Bergek et al., 2008).

Financial

Since introducing electric cookstoves in a rural community entails a certain degree of risk, the private sector was unwilling to invest. Through an existing connection between ABF/NACEUN and a retailer in Kathmandu, CREE was able to order electric cookstoves on credit. The CREE, therefore, took the role and responsibility of a local retailer of electric cookstoves and took orders from interested households in Temal (ABF & NACEUN, 2020; Kooijman, 2021).

Financial incentives were provided for consumers to purchase the induction stove in two ways. Firstly, through reducing the price of the induction stove package by 19% (from 6850 NPR to 4750 NPR), and secondly, by proposing a fixed electricity tariff of 150 NPR a month for the first six months (ABF & NACEUN, 2020; Kooijman, 2021). 25 households were unable to pay the induction stoves at the time of delivery and were therefore allowed to pay in installments (ABF & NACEUN, 2020). CREE explained that these financial incentives helped create demand for the induction stoves. However, poorer households did question whether they would be able to pay the electricity tariff once it was restored to the original price, considering the increased electricity use the appliance brings (Kooijman, 2021).

Material resources

Besides the induction stove, households need to purchase new pots and pans to be able to cook on the electric stoves. The intervention program from ABF/NACEUN in Temal included all the necessities in one package. In consultation with the local staff of CREE, the proper utensils were identified that would match the local cooking practices (ABF & NACEUN, 2020). Since there were no local retailers and CREE took the role of mediator between the distributer in Kathmandu and the households, the product packages were delivered at the door of the households that participated (ABF & NACEUN, 2020; Kooijman, 2021).

Several participants mentioned during the program that some of the pans were insufficient and needed to be replaced by pans from the market (Kooijman, 2021). In response to this, ABF/NACEUN provided a frying pan as an optional item in the package (ABF & NACEUN, 2020).

Infrastructure

The electricity grid is currently not suitable for the large uptake of electric cookstoves since it has problems handling loads around peak times. In the community of Temal, only 10% of the household

connected to a transformer were allowed to participate in the electric cooking pilot project. This was to prevent blackouts and overall instability of the network (ABF & NACEUN, 2020; Kooijman, 2021). However, in the household interviews conducted by PAC (2020), 7 out of 40 households (18%) still mentioned blackouts as a disadvantage of using the induction stove (Kooijman, 2021).

Moreover, some households needed assistance in upgrading the wiring and placing electric sockets in the house before it was suitable for the electric stoves. CREE and local technicians aided households in this task, and the program supported the households by covering these costs (ABF & NACEUN, 2020; Kooijman, 2021). Therefore, before electric cookstoves can be a viable option for Nepal as a whole, the national grid infrastructure and individual household wiring might have to be improved.

Additionally, to ensure all households can benefit from reliable electricity, more energy needs to be generated in the country. This requires new hydropower facilities and an increase in solar and wind power generation, which are being realized under, for example, the White Paper, the National Energy Strategy, the Rural Energy Policy, and the National Renewable Energy Framework (GoN, 2018; IEA, 2017c; Pinto et al., 2019).

Human resources

CREE was responsible for gathering and educating people and teams to support the households in awareness, demonstrations, maintenance, repair, and safety. These groups consisted of, amongst others, local electricians, CREE employees, and spokespersons of NEA and AEPC. All partners aided CREE in promoting the adoption of induction stoves (ABF & NACEUN, 2020).

Development of positive externalities

Through the development and advancements in technology within the electric cooking TIS of Nepal, actors that did not help in building the TIS can take advantage of its benefits in several ways (Bergek, 2019; Bergek et al., 2008). An example of external actors that benefit from the pilot are the (in)direct users of the induction stoves. Firstly, by switching from firewood-based cooking to electric cooking, users benefit from reduced indoor air pollution, which in turn reduces the negative health effects received during cooking. Not only the main users (women) benefit from this, children and men living in these households benefit as well, as the kitchen is usually attached to the rest of the house. Secondly, through the purchase of the induction stove, households reduce the reliance on firewood and LPG. This removes the burden of collecting this fuel, both for men and women. Finally, by using the induction stove, women save time in cooking, which can increase their freedom and be used for education, pursuing job opportunities, or entertainment. Indeed, women in the focus groups have mentioned that after introducing the induction stove, they have been able to support their children by helping them do homework. These examples illustrate that the induction stove not only provides benefits for the main user (women) but also for the other people present in the household.

Moreover, the introduction of more induction stoves in Nepal can bring positive externalities for the Government by taking steps towards reaching climate goals. As seen in the function of influence on the direction of search, the Government is moving towards achieving SDG7. By following their own roadmap as presented in the White Paper, climate goals can be achieved, which benefits society and

nature. More user demand for induction stoves could also bring positive externalities for local retailers by decreasing the risks involved with investing in the technology for distribution. This might even enable them to profit from selling induction stoves.

Besides the externalities for actors in Nepal, developments in rural regions such as Temal benefit other (peri-urban and rural) regions and developing countries as well. By looking at pilots and learning from implementation programs, these countries can, for example, collaborate with other parties to attempt to introduce electric cookstoves, providing positive externalities for inhabitants.

5.2 Applying a gender perspective: Women's Empowerment framework

This chapter analyzes the same case study as in 5.1 but from a gender perspective. First, the Women's Empowerment Framework is applied. The second part of the analysis using the Transformative Change Approach takes place in 5.3.2, alongside an evaluative summary of the WEF analysis.

5.2.1 Overarching issues

Women and men's rights

Specifically looking at the formal and legal rights with respect to cooking, no differing rights between genders are found, i.e., there are no legal policies that stop women from their right to buying electric appliances. On a general legal level, policies for energy access have become more aware of the inequalities currently present regarding gender and other marginalized groups (Kooijman, 2021). For example, the Gender Equality and Social Inclusion (GESI) approach ensured that authorities include the socially excluded groups within policymaking (Bennett, 2017). Furthermore, the Nepal Constitution tries to achieve equal economic empowerment and equal rights for men and women, which could be achieved by introducing electric cooking, as this frees up time for women to engage in economic activities (Kooijman, 2021).

A right indirectly related to the purchase of induction stoves is land rights. In Nepal, land ownership has a status symbol connected to it: it radiates wealth and power (Kooijman, 2021). For women, owning land reinforces their position within the household by giving them economic security (Allendorf, 2007; IOM, 2016). However, research by the International Organization of Migration (IOM) revealed that in 2011 only a small percentage (20%) of women had independent or joint land or property ownership (IOM, 2016; Kooijman, 2021). Moreover, most of the women owning properties live in urban areas, which means that this figure is even lower for women in rural areas. Owning land is made more difficult for women by the legislative system. Even though the Nepal Constitution vouches for equal rights between men and women, in practice, this is not the case. For example, the right to inherit land is still biased towards men: land is inherited by sons and unmarried daughters. However, even by marriage, women are not legally co-owners of their husband's land; they have to register it themselves. This proves to be a challenge since, according to IOM (2016), many women do not know how to register for land (less than 13%), and administrative challenges with gender bias for women are high. Only 7% of women had earned their own land. Not owning land means that women often do not have collateral for taking credits (IOM, 2016), which might in some instances inhibit purchases of electric cookstoves, although

no such instances were found in the case study. Furthermore, the existence of the GESI has helped improve women's access to resources such as credit (IOM, 2016).

Gender ideologies and norms

Cooking is still generally done by women in Nepal (see Figure 14). However, men are seemingly taking over some of the responsibilities of women. This does not mean that men are doing all the cooking or are preparing entire meals, but they are increasingly helping women in the kitchen, for example, by making tea and snacks or by operating the cooking devices (Kooijman, 2021). This is illustrated in quotes from 60 Decibels (2020):

> *"My wife uses it more often than me, I do use sometime too while helping her if she is busy"*
>
> *"My husband also helps me with cooking 5-6 times in a week."*
>
> *"My husband uses it equally as much."*

Men taking more responsibilities than before the induction stove purchase was also seen in the household surveys from PAC (2020); the number of men using a stove after the introduction doubled, from 15 to 32 (out of 40). Here as well, the men tend to help their wives or prepare tea and snacks rather than cooking entire meals (Kooijman, 2021). The reason for this increase in perceived responsibility is unknown.

Social positions

The households in Temal that acquired the induction stove can be grouped into households with a male or female head of the household. This resulted in 518 male-headed and 47 female-headed households (Kooijman, 2021), which means that only 8% of the households participating have a female head of the household. This demonstrates that men are positioned higher than females within the household.

Furthermore, amongst the male-headed households participating in the household surveys, information reached only 25% of the women (Kooijman, 2021). Therefore, the social position of women within the household seemingly inhibits them from receiving information. Given that cooking is mainly the women's task and that women are disproportionally affected by the harms of traditional cooking, not receiving information on how to improve cooking conditions could implicate that women are disadvantaged compared to men.

5.2.2 Gendered access to and control over resources

Material resources

In the sample from Temal (n=40), two households had only female incomes, one only male incomes, and in 37 cases, both the male and female household members had incomes (Kooijman, 2021).

Social resources

Social resources reflect the ability of women to be part of a social group or network. In Temal, several social networks were identified: Self-Help Groups (SHGs) and women's savings and credit groups; and women's networks such as mother's groups, friends, family and neighbors, and health volunteers (Kooijman, 2021).

SHGs and women's savings and credit groups are groups of women that, through contributing their own money and skills, help others within the same group by, for example, giving and taking loans. Through peer pressure and social dynamics, women are held accountable for paying back or returning the favor. Over time, SHGs can form an extensive network and empower women to become more financially independent from their husbands (Atteraya et al., 2016; Kooijman, 2021). SHGs therefore helped women access financial resources in the form of credit to purchase the induction stove (Kooijman, 2021).

The other identified group are informal networks of e.g., friends, family, and neighbors. These networks enable women to receive information on experiences and on how to use the induction stove, which is part of human resources (Kooijman, 2021). Social resources, therefore, enabled women to have access to material and human resources.

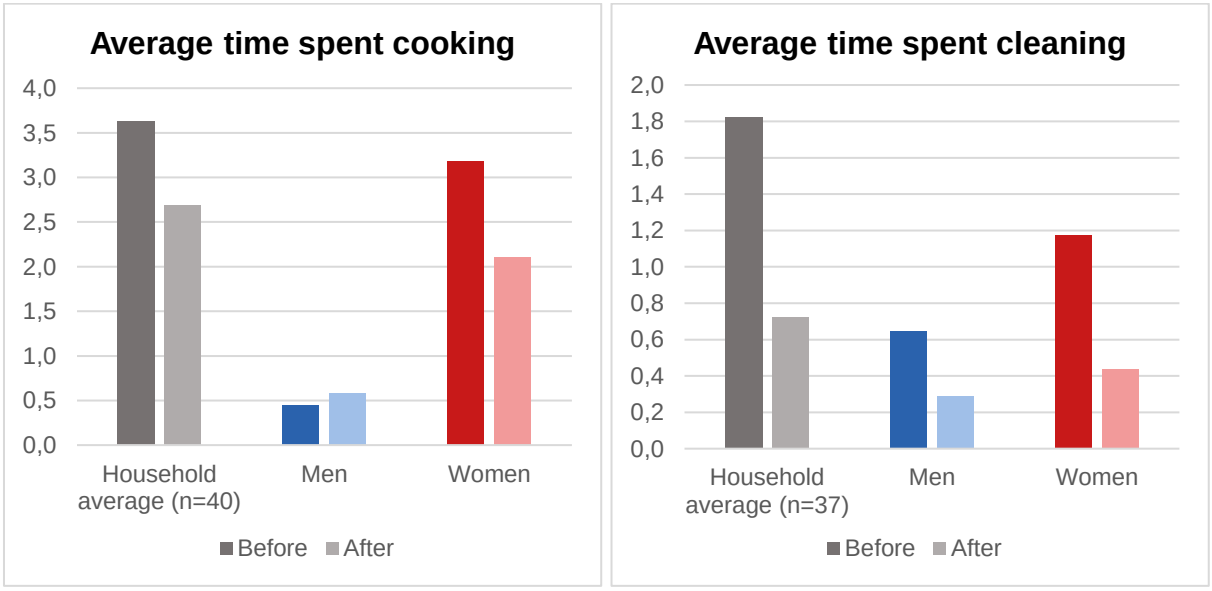
Human resources

Information

Knowledge was not fully diffused to both men and women. However, the situation was found to be worse for women; men received most of the information, whereas women usually did not know about the campaign (Kooijman, 2021). This reveals a lack of access to human resources regarding information about the campaign for women compared to men. However, it was noticed that information seemed to spread more efficiently through informal networks, such as through friends, family, and neighbors (Kooijman, 2021).

Use of time

Data from the households that were interviewed in Temal illustrates that households spent less time cooking, cleaning, and collecting fuel after the purchase of the induction stove.

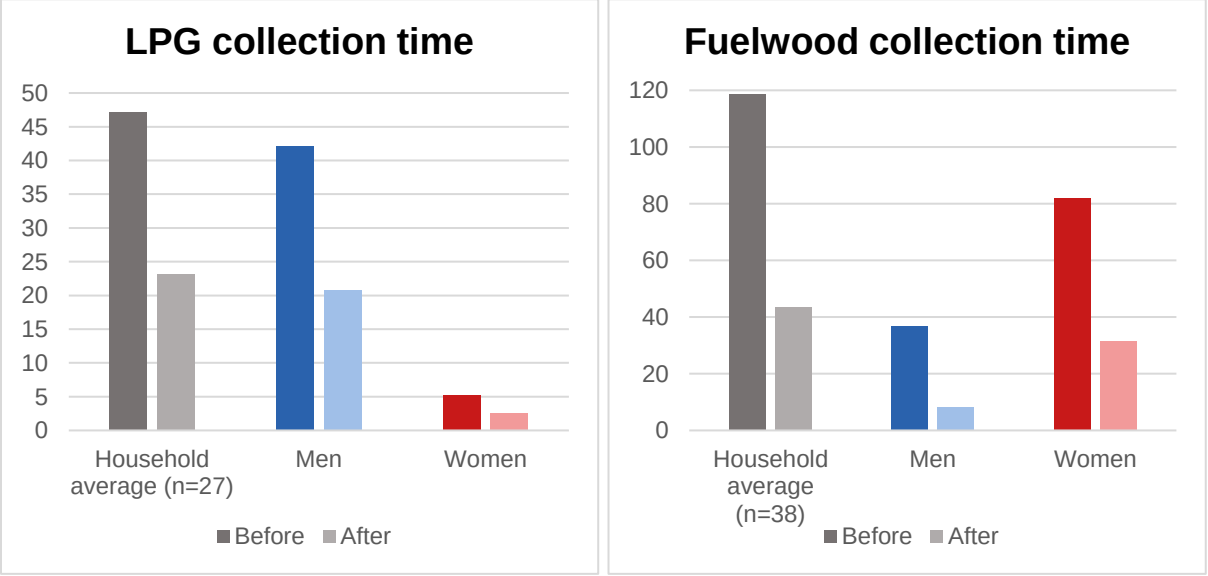


Figures 16 & 17 • Average time spent cooking (n=40) and cleaning (n=37) in Nepali households daily, measured in hours. Data drawn from research conducted by Practical Action Consulting (2020)

Although the overall time spent cooking has reduced, men started to spend more time in the kitchen than before the induction stove was purchased (from 27 min to 35 min average, +30%, see Figure 17). This can signify a shift in gender norms where men start to help their wives in the kitchen. The wives of these men all (except in 1 case) still did most of the cooking. Women spent 34% less time cooking each day, going from 3h10 to 2h6. Induction stoves enable meals to be prepared faster, allow for multitasking, and enable other household members to help in the kitchen (Kooijman, 2021). However, women still spent more time using the stoves than their husbands.

Concerning cleaning (Figure 16), both men and women spent less time on this activity. Before acquiring the induction stove, women spent 1h10 cleaning the kitchen every day; after the purchase of the induction stove, they spent a little less than half an hour (26 min) each day (a reduction of 63%). Men spent 55% less time cleaning, going from 39 minutes to 17 minutes a day.

The introduction of the induction stoves saves women on average 108 minutes a day (-42%), while men spent 14 minutes less (-20%) a day for cooking and cleaning.



Figures 18 & 19 • Average time spent monthly collecting LPG (n=27) and fuelwood (n=38) in Nepali households, in minutes. Data drawn from research conducted by Practical Action Consulting (2020)

Furthermore, time spent collecting both LPG cylinders and wood has reduced since owning the induction stove. However, not all households completely abandoned the use of wood and LPG, which reveals that fuel stacking is common. From the 40 households sampled in Temal, 27 households purchased LPG cylinders. For 24 households, this was the responsibility of men. This means only for three women collecting LPG cylinders was their responsibility (after the purchase, this went down to one). LPG cylinder collection for households costs 2 hours on average per cylinder. Before the purchase of the induction stoves, the 27 households used 4.7 cylinders a year on average (one cylinder lasts approximately 2.5 months). After the purchase, this went down to 2.3 cylinders a year (-50.8%, one cylinder every five months), with five households not using any LPG anymore. Figure 19 illustrates how the purchase of the induction stove affects the time spent monthly on collecting LPG cylinders.

38 households collected fuelwood before the purchase of the induction stoves, which took 47 minutes on average per *bhari*[5]. Women took part in collecting the fuel in all households. In 28 households, the men also collected fuelwood. Before the purchase of the induction stove, households used 30 *bhari* a year on average. After the purchase, this went down to 11 *bhari* a year (-63.5%)[6], with four households not using fuelwood anymore. Figure 18 presents how the purchase of the induction stove affects the time spent monthly in collecting fuelwood. Figure 19 and Figure 18 also illustrate that women are usually responsible for collecting fuelwood, while men are responsible for collecting the LPG cylinders.

In line with these findings, time saved was mentioned as one of the main benefits of the induction stove. Figure 20 illustrates that 68% of women and 44% of men mentioned time saved in cooking as a reason to recommend the stove to friends and family. For women, this was the most mentioned benefit. Men found the time saved in collecting fuel (17%) and preparing to cook (lighting firewood and waiting for the fire to burn) (24%) relatively important too. For women, this percentage was lower, with respectively 9% and 18% of women mentioning these benefits).

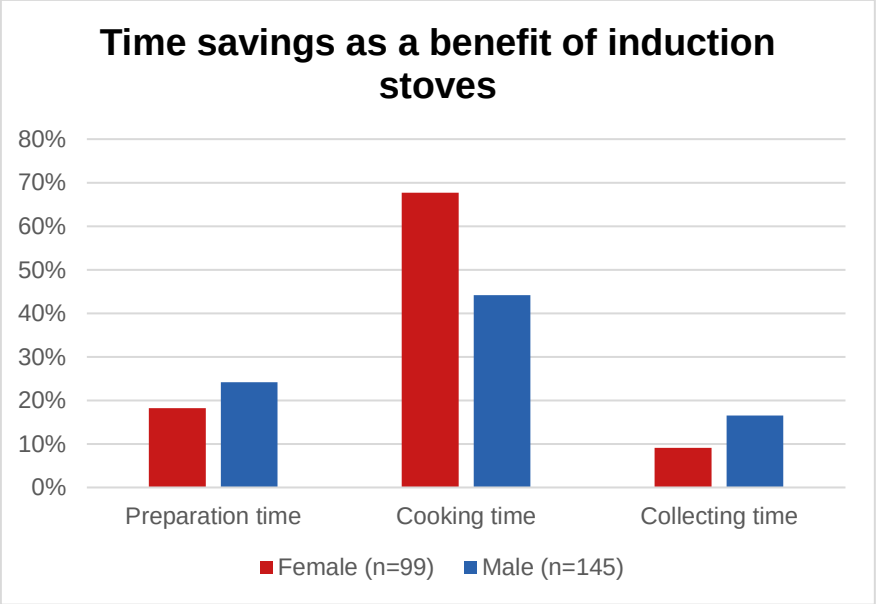


Figure 20 • Percentage of men and women mentioning time savings as a benefit of induction stoves. Data drawn from research conducted by 60 Decibels (2020)

Education, knowledge, and entertainment

Even though no data was collected on increased time for entertainment, focus group discussions did shed light on the fact that women could potentially watch more television because cooking takes less time. The reduction in time spent cooking, cleaning, and collecting fuel not only could increase free time spent on entertainment, but it could also provide opportunities for women to help their children studying and increase their own knowledge base. The free time could potentially also be spent on other household tasks or economic activities (Kooijman, 2021).

[5] The term *bhari* was used in the surveys as an indicator of firewood load, and is considered to be approximately 20 kg of firewood (Kooijman, 2021).

[6] It is important to note that the reliability of this finding is relatively low, since households collect firewood themselves instead of buying bundles at the shop, and therefore cannot measure the exact amount of firewood they collect (Kooijman, 2021).

Health benefits, comfort & convenience, and safety

> *"Everything is good about it [induction stove]. Good for health, easy and convenient to use. Even children can use easily compared to before when it was hard for them to get firewood and cook."*
>
> *"The [induction stove] is time saving, food cooks faster than before. It is also safe because there are no electric shocks. It is easy to cook food with."*

Besides the benefits of saved time, the induction stove also brings health benefits, increased comfort and convenience, and is considered safer, as presented in the quotes from 60 Decibels (2020) and in Figure 21.

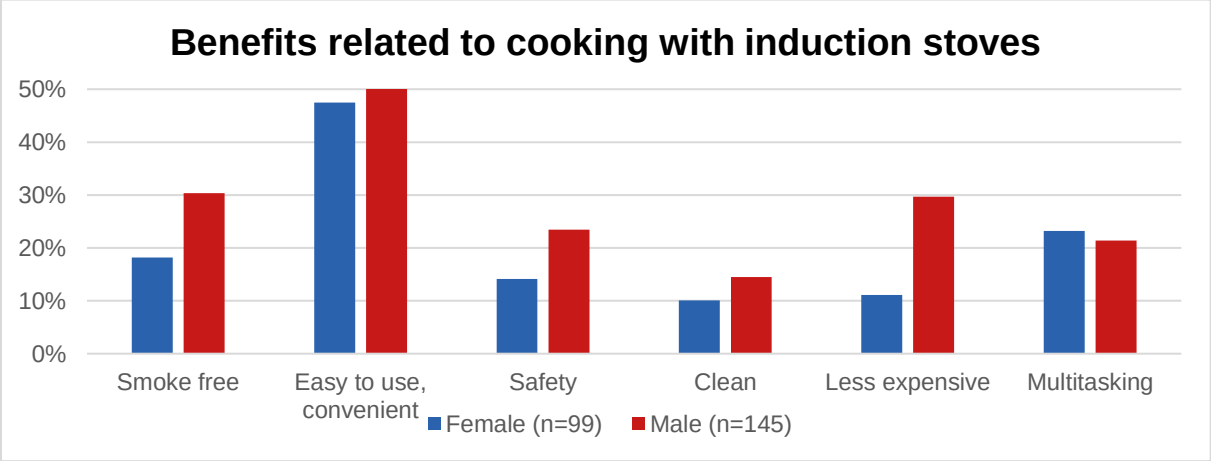


Figure 21 • Percentage of men and women mentioning benefits. Data drawn from research conducted by 60 Decibels (2020)

Since women are usually the main cooks, most improvements for health, comfort, and safety directly relate to the women (Brown et al., 2017; Pachauri & Rao, 2013; Pinto et al., 2019; Rao et al., 2019). Mentioned health benefits are related to less smoke in the kitchen, which relieves the eyes and reduces coughing and breathing problems. However, in the data gathered by 60 Decibels (2020), it seems that women perceive fewer health benefits than men (Figure 22), and only 18% of women compared to 30% of men mention it as a benefit of the induction stove (Figure 21).

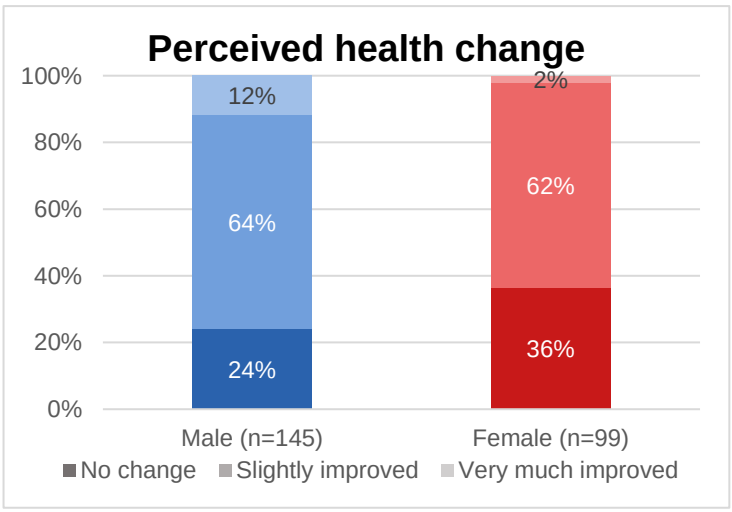


Figure 22 • Perceived health change. Data drawn from research conducted by 60 Decibels (2020)

Convenience or ease of use was the main benefit of induction stoves mentioned by male respondents (50%), and the second most mentioned benefit by women (47%) (Figure 21). The appliance was seen as more convenient since it is portable, it can be used in any room with an electric socket and appropriate wiring, saves time, and because it can be used it both standing and sitting (60 Decibels, 2020). Multitasking was also mentioned often, by 23% of the women and 21% of men (Figure 21). The induction stove allowed users to do other things while waiting for the food to be cooked, whereas with the LPG and the traditional stoves, this was not possible due to safety risks. Furthermore, multitasking helped complete other tasks quicker, saving more time to be used freely (60 Decibels, 2020; Kooijman, 2021).

Safety is mentioned as a benefit by 23% of men compared to 14% of women. Not having to worry about gas leaks and the ability for children to cook on the stove were safety reasons mentioned often (Figure 21). By introducing induction stoves, the practice of cooking has become safer compared to LPG and traditional stoves, reducing the number of burns (60 Decibels, 2020; Kooijman, 2021). Furthermore, the program ensured that all households benefit from more safety by upgrading the electrical wiring in the houses of the participating households. However, at the beginning of the acquisition, many households were scared of explosions or electrocution (Kooijman, 2021). By using the induction stoves, they slowly gathered that this would not happen, making them appreciate the safety of the induction stoves (60 Decibels, 2020; Kooijman, 2021).

5.2.3 Agency

The final element of the Women's Empowerment Framework is agency, which consists of the influence over life decisions and influence over everyday decisions. Research from 60 Decibels (2020) in the region of Kavrepalanchowk[7] demonstrates the difference in decision-making for induction stoves and rice cookers (Kooijman, 2021). As visualized in Figure 23, the majority of the decisions on purchasing induction stoves are made by male members of the household (60%). For rice cookers, the decision is usually either a collective decision between spouses (51%), or the female member making the decision (34%). The difference in price between the induction stove and the rice cooker might be an explanation for this result; induction stoves typically cost 4750 NPR, and rice cookers typically cost 2500 NPR (Kooijman, 2021).

[7] The phone survey on rice cookers from 60 Decibels (2020) was conducted in Temal and other adjacent municipalities in the same district of Kavrepalanchowk. The division of ethnicity groups and the percentage of households that are under the income threshold are comparable, which makes it likely that the results can be compared to those in Temal.

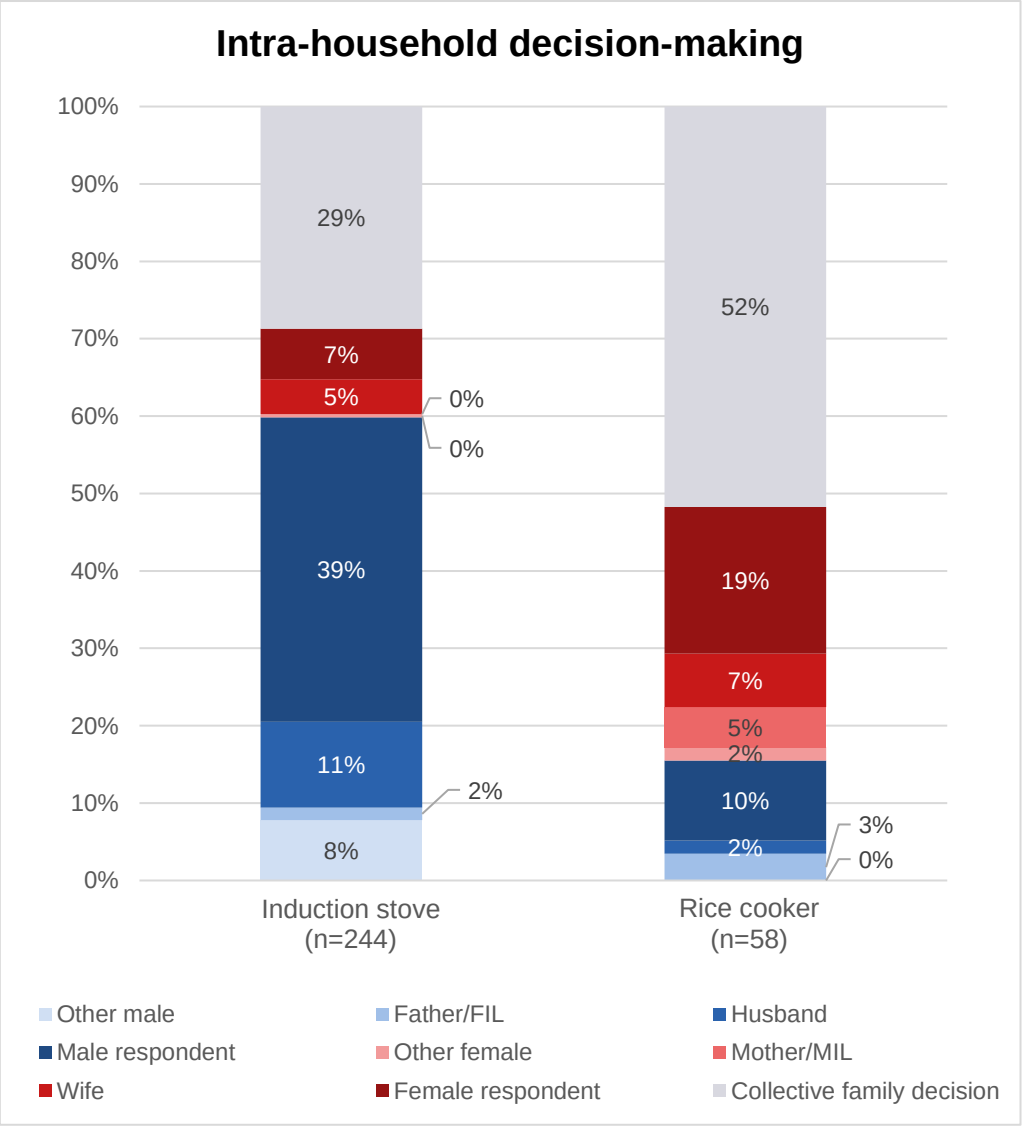


Figure 23 • Intra-household decision-making on clean cookstoves. Data drawn from research conducted by 60 Decibels (2020)

Indeed, data from PAC (2020) presented in Figure 24 illustrates that large purchases can generally be considered the male's decision in the household. Smaller purchase decisions, such as (daily) decisions on purchasing fuel, are either done collectively or by women.

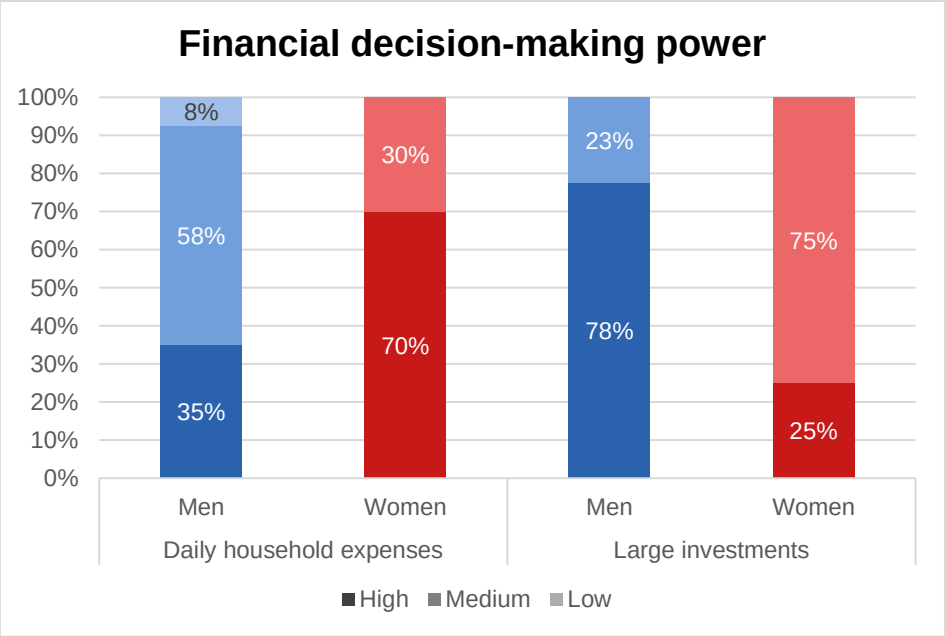


Figure 24 • Intra-household decision-making power[8] on small and large investments (n=40). Data drawn from research conducted by Practical Action Consulting (2020)

Figure 25 indicates that men have more power when large loans are concerned. However, for small loans, men and women have approximately the same decision-power. Data from PAC (2020) reveal that the women from 4 out of the 14 low to middle-income households took out a loan from a savings and credit group to purchase the electric appliance. Loans from SHGs have the advantage that they do not require collateral and are short-term. Loans only being taken by women affiliated with savings and credit groups might indicate that women that are not affiliated SHGs do not have the same opportunities for resources as their non-SHG peers (Kooijman, 2021).

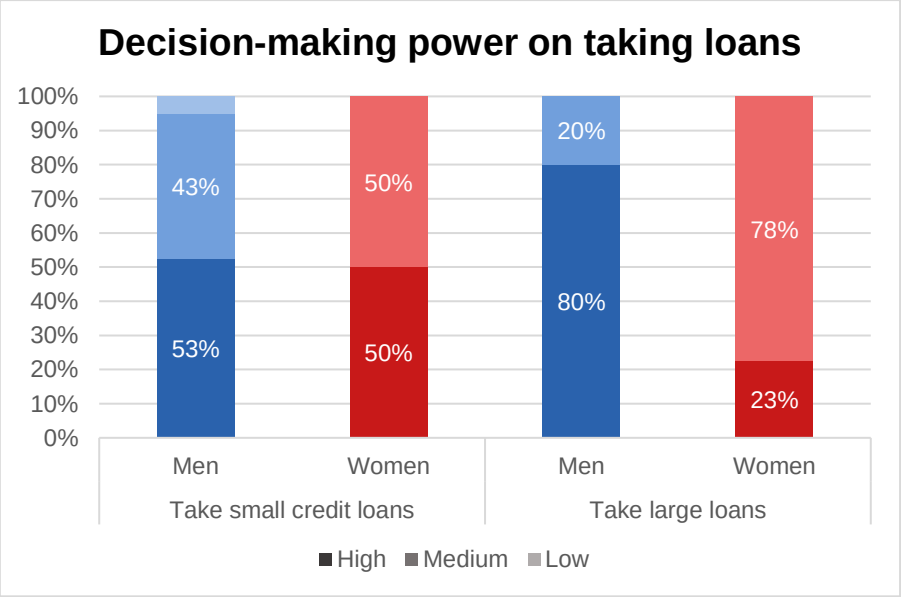


Figure 25 • Intra-household decision-making power on taking small and large loans (n=40). Data drawn from research conducted by Practical Action Consulting (2020)

[8] Decision-making power has been appointed by the households themselves, on a scale from high-low. See *Appendix II: Data from Practical Action Consulting* for a detailed explanation.

Figure 23 to Figure 25 could indicate that men in Nepal have more power when it comes to financial resources in general than women. However, women do seem to have more power in making decisions on daily household expenses (Figure 24) and smaller investments, such as rice cookers (Figure 23), and have as much power as their husbands when it comes to taking small loans (Figure 25). Another example of this can be seen in Figure 26, where it is clear that women have more decision-power on everyday decisions, e.g., what to cook than do men (80% of women have high decision-power in this domain compared to 24% of men).

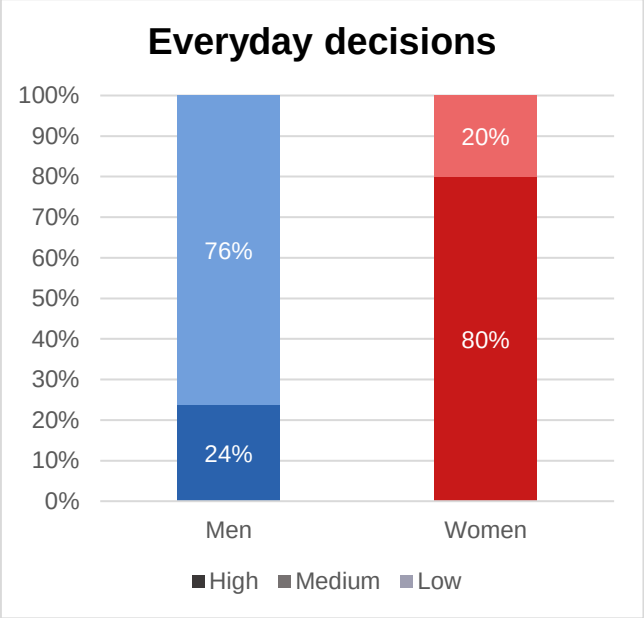


Figure 26 • Intra-household decision-making power on everyday decisions (n=40), e.g., what to cook. Data drawn from research conducted by Practical Action Consulting (2020)

In short, women tend to have more instances of high decision power than men when it concerns smaller (everyday) decisions and less power when it concerns larger decisions on, for example, investments. Figure 27 summarizes this by presenting the percentage of men and women with high decision power on a specific subject within their household. This illustrates that women have less intra-household decision power for large (investment) decisions, and therefore might have less control over making choices that benefit their health, such purchasing a clean cookstove. This is often mentioned as a concern within the literature (Pachauri & Rao, 2013; Rao et al., 2019; Terry, 2009).

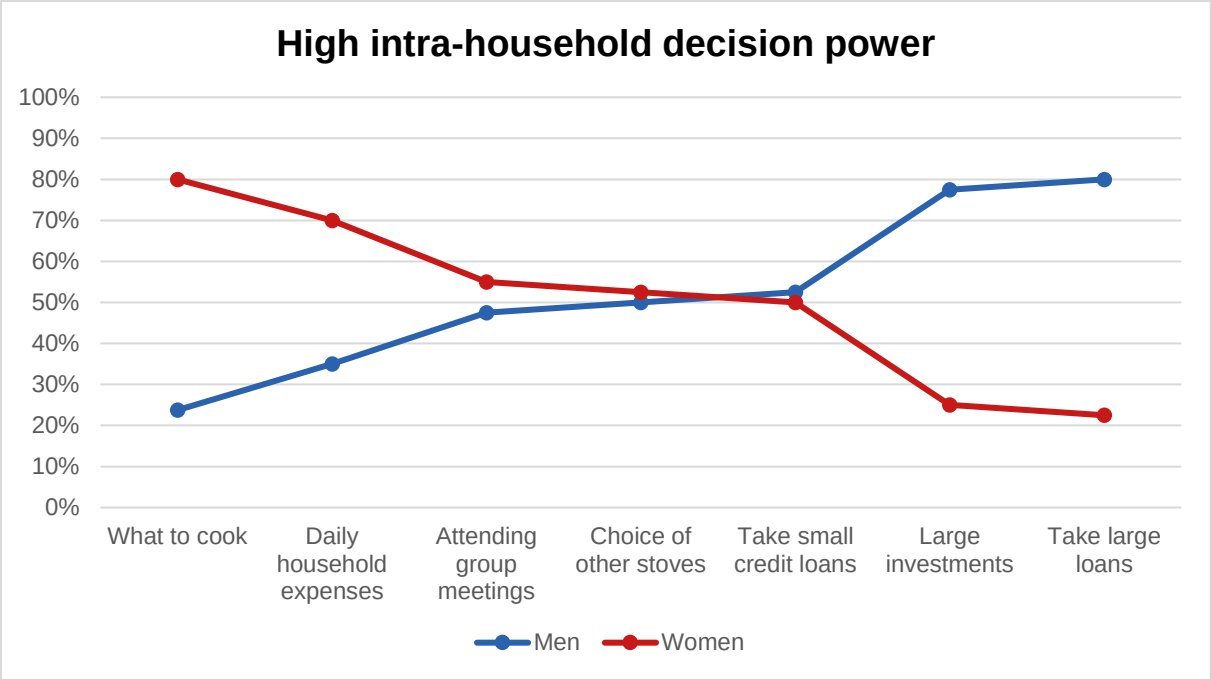


Figure 27 • Percentage of men/women (n=40) with high intra-household decision-power in differing situations. Data drawn from research conducted by Practical Action Consulting (2020)

5.3 Analysis of the results from the Nepal case

Section 5.1 and 5.2 provided analyses on the Nepal case study from two different perspectives. This section elaborates on these findings by comparing the perspectives to find what insights can be extracted from each and both of these perspectives. This will provide the basis for making recommendations for policy and practice for electric cooking programs in rural Nepal.

5.3.1 Insights from an innovation and transition perspective

In chapter 5.1, the first three steps of the scheme of analysis from (Bergek et al., 2008) (see Figure 3, p.10) have been discussed. Step 4: *Assessing the functionality of the TIS* and step 5: *Identifying blocking and inducing mechanisms to development* are discussed in the current chapter. Finally, step 6: *Identify key policy issues* is presented in sections 5.3.3 and 7.

Looking at the case from a TIS perspective sheds light on which functions could be strengthened to accelerate the transition to electric cookstoves. The structural component of **regulatory institutions**, and the functions of **knowledge development**, **influence on the direction of search**, and the **infrastructure resource mobilization** demonstrate that the existing knowledge base on energy access and electric cooking provided a useful basis and made it possible for the intervention program to be launched to help achieve the development goals from the Government (and SDG7). Granted, there are still some improvements to be made to complete the transition to electric cooking. Policies for electric cooking are few, and the transformers in Temal could not handle more than 10% of the households. However, for the success of the pilot program, this was not an issue, but for the market to grow out of the formative phase, these are issues that should be addressed.

The function of **knowledge diffusion** illustrated the problems of spreading information. Information about the intervention program for induction stoves did not reach certain segments of society, such as women and poorer households, even though the program intended to include them. Families affiliated with CREE had information before the rest of the households, which meant they had an advantage in the first-come, first-serve strategy that only allowed 10% of the households to participate. This ties in with the structural component of **networks** and reveals the importance of the CREE network in (unevenly) spreading knowledge to the households.

Resource mobilization of finances proved that the financial incentives to reduce the price of the induction stove package and lower the electricity tariff for the first few months helped the adoption of induction stoves. However, households did mention that the increase in electricity use could mean that they cannot afford to use the appliance, which is why the reduction of the electricity tariff could remain important to ensure long-term use. Furthermore, the need for a replacement of all pots and pans adds another financial burden on households. CREE has already mentioned that they will not be able to keep the subsidies and tariffs in place after the end of the program.

The top-down distribution of the induction stove packages by ABF, NACEUN, and CREE, as discussed in **resources mobilization of material resources**, could indicate that participants were not directly involved with the design of the package before the rollout of the pilot project. Participation of users within this process could have prevented the complaint from several participants who mentioned that occasionally the pans were insufficient and needed to be replaced by pans from the market.

Analyzing the structural components of **normative** and **cognitive institutions** reveals that women are the main cooks in Nepal. Combining this with the lack of participation in the design phase, and the lack of information reaching women, it seems that there is a mismatch present that is hindering adoption. Furthermore, from the analysis it becomes clear that the traditional way of cooking (and the unreliability of the electricity grid) prevents full adoption of electric cooking. Fuel stacking is therefore common when electric cooking is adopted. This demonstrates that understanding normative and cognitive institutions such as traditions, culture, and (gender) norms (contextual factors) could help understand why the transition is difficult to achieve.

Functions that perform well in the TIS and might help accelerate the transition are **knowledge development**, **entrepreneurial experimentation**, and **influence on the direction of search**. Each of these functions enables the TIS to learn and grow, which might eventually enable electric cooking in Nepal to be a viable option for rural areas, reaching a mature **market**.

5.3.2 Insights from a gender and justice perspective

The WEF analysis started with the **overarching issues**. Investigating the **rights** of men and women shed light on, e.g., the lack of land rights held by women. This has implications for the **social position** of women as well, as land rights indicate wealth and status and could empower women within the household. Since only 19% of women in Nepal have land rights, this might indicate that women are not in a position of power.

Furthermore, analyzing the **gender ideologies**, **gender norms**, and **social positions** that women hold in Nepal helps understand the role of women in the household. Figure 14 explains that women are the main cooks in the household; however, after the introduction of electric cooking, men are starting to take responsibilities for cooking too (primarily by preparing tea and snacks). This ties in with another element that stood out within the WEF analysis, being the low decision power of women on the purchase of induction stoves as presented in **agency on financial decisions**. Men are found to be the main decision-makers when it comes to large investments. Some women were able to receive loans through SHGs, but this was only done by those that were affiliated with these groups, illustrating that this **access to social resources** enabled women's empowerment. This combination of lack of intra-household decision-power regarding large purchases while being the main person responsible for cooking needs to be considered in future programs. **Agency on everyday decisions** was found to be higher than for larger decisions.

The intervention program adds to empowerment under **access to human resources** by allowing women to **save time** when using the cooking device, which they can use on, e.g., self-development. Having more spare time can increase the time women spend on educational activities, entertainment, children, and economic activities. Additionally, the induction stoves also increase the amount of time men spent cooking, which demonstrates a shift in gender norms and balances the time spent cooking between men and women. Furthermore, the induction stove increases the human resources of **health**, **comfort and convenience**, and **safety**.

All in all, gender norms are being challenged since men are increasingly starting to use the cookstoves. However, in other places, gender norms are still being conformed within the intervention program, such as intra-household gender dynamics on (large) purchases. Since the intervention program did not support the empowerment of women's rights, social positions, gender norms, and agency over financial decisions, the program cannot be considered to be fully gender transformative following the Transformative Change categorization. However, because of the nature of cooking being the job of women, the program did empower women as users, especially in human resources, by saving time, increasing health, convenience, and safety.

5.3.3 Comparing the insights from the two perspectives

Before comparing the insights from the two perspectives, an overview of the insights from both perspectives should be given. Table 6 therefore summarizes the main points mentioned in 5.3.1 and 5.3.2. The statements are ordered from contextual factors *(knowledge and infrastructure, fuel stacking,* and *gender norms*), to program elements affecting the outcomes (*financial incentives* and *information diffusion*), to outcomes of the program (*well-being*). After that, the dimension or element from which framework this insight was gathered is presented, and whether this insight proved to have a positive impact (enabling) or negative impact (hindering) on the adoption of electric cookstoves.

Table 6 • Comparing the insights from the two perspectives

Program insights from the analyses		From which element is this insight gathered?		Impact on adoption
		TIS	**WEF**	
Knowledge and infrastructure	Knowledge base clean cooking and energy access provides a useful basis for the program to be set up	*Regulatory institutions* *Knowledge development* *Resources* – infrastructure *Influence on the direction of search*		Enabling
	Lack of proper energy infrastructure makes large-scale adoption for the entirety of Nepal difficult	*Resources* - infrastructure		Hindering
Fuel stacking and cooking practices	Traditional ways of cooking hinder full adoption of electric cookstoves	Partly: *cognitive and normative institutions*		Hindering
Gender norms	Women being the main cooks, but not being responsible for purchases	Partly: *cognitive and normative institutions*	*Gendered access to and control over resources* – material resources *Agency* – decision-power	Hindering
Financial	Lack of (financial) decision-power of women making it difficult to induce cookstove adoption		*Rights, gender ideologies & norms* *Agency* - financial decision-power	Hindering
	Financial incentives making it more attractive to adopt induction stoves by lowering upfront costs and electricity tariff	*Resources* - financial		Enabling
	Replacement of pots and pans and increased electricity use	*Resources* – material		Hindering
Information	Information did not reach all parts of the population equally	*Knowledge diffusion*	*Access to human resources*	Hindering
	Use of CREE networks for effective information diffusion	*Networks*		Enabling
Well-being	Well-being of women (and men and children) increases with the adoption of the cookstove	*Positive externalities*	*Gendered access to and control over resources* – human resources, time use	Enabling

The main insights were gathered from analyzing the program elements *(financial incentives* and *information diffusion*) in relation to the contextual factors and program outcomes. The first element affecting the outcome of the intervention program **information diffusion**. One of the goals of the pilot program was to reach all parts of society and to involve both men and women in demonstration sessions surrounding the electric cooking campaign. However, in the analyses from both perspectives it became clear that this information spreading did not reach its intended goal (although this was more explicitly mentioned in TIS – knowledge diffusion, than in WEF – access to human resources). Women were not always present at these events, and an unequal representation of ethnic groups reveals that not all minority groups were involved equally. The structural component **networks** within the TIS highlighted this inequality by demonstrating that the households that had affiliations with CREE had an advantageous position over the other households in joining the program. This means that knowledge was distributed and that networks effectively distribute this information, but that at the same time, people who are not part of a network are disadvantaged in comparison.

When comparing the insights regarding financial structures present in the intervention program, it becomes clear that the theories deepen each other's understanding of some elements. Within TIS, it seems that the **financial incentives** included in the program had a positive effect on the adoption of electric cookstoves. This was also confirmed in the literature where it was found that financial incentives help increase ICS and electric cookstove adoption (Bonan et al., 2017; Vigolo et al., 2018). However, when looking at gendered access to & control over material resources and agency over financial decisions, WEF points out that women are usually not in the position to handle such large amounts of money, nor take loans to be able to buy the appliance. While both theories mention that women are the main cooks (**gender norms**), only WEF takes this contextual fact to highlight that even though women are the main cooks, they are not the main decision-makers. This means that women cannot invest in improving their health, which was also mentioned in the literature (Pachauri & Rao, 2013; Rao et al., 2019). This difference in looking at a similar topic reveals the differences in the two theories and where their value lies. It explains that while from a TIS perspective it might seem like the intervention is doing a proper job (also since it is confirmed in literature); only by adding a gender perspective it becomes clear why adoption could potentially be lacking in those households with non-users, since it explains the exact reason why women would be less present in buying the appliance as was hoped.

Finally, the topics of **well-being**, **fuel stacking**, and **knowledge and infrastructure** were highlighted. Well-being was a program outcome referred to in both TIS and WEF (albeit more explicitly in WEF), while fuel stacking and knowledge and infrastructure were contextual factors that were only mentioned in TIS. Both theories provide points on topics that could either hinder or accelerate the transition to electric cooking in Nepal. Section 6.1.1 aims to uncover the theoretical differences between the theories that explain this differing focus.

6. Discussion

This discussion chapter is divided into four parts. The first part discusses what this thesis adds to the existing academic literature on transitions related to clean cooking. This is done by comparing the gathered data to existing literature and discussing what a gender perspective might add to transition studies. Together with the case study results, these theoretical insights lead to practical implications for similar intervention programs in Nepal (or other developing countries). This leads to the final parts of the discussion, reflecting on the limitations encountered during the thesis and presenting directions for future research.

6.1 Theoretical implications

Following the analysis of chapter 5, this section includes a discussion where the theoretical background of the transition and gender theories are compared on their differences and similarities, which can help determine what is missing within transition studies when omitting the gender perspective. Furthermore, section 6.1.2 elaborates on the analysis by discussing how this research confirms, extends, or counters the existing literature on the topic.

6.1.1 Comparing the two lenses: What do we find when adding a gender component to a transition theory?

From Table 6, it becomes clear that there are several elements of the intervention program that both theories mention, such as the importance of information diffusion and access to such resources across society (including minority groups and women). This illustrates that the approaches identify similar elements of the intervention program that could be improved or that are doing well. From a theoretical standpoint, it then also becomes clear that the theories have many elements in common.

First of all, the structural components (mainly the **institutions**) of the Technological Innovation Systems (TIS) framework seem to have much in common with the three components under the **overarching issues** as described by the Women's Empowerment Framework (WEF). Both frameworks use these components and dimensions to look at the broader context, taking a step back from the case itself. This context is discussed with reference to the policies, structures, and (in)formal institutions that affect the case study. The fact that both theories start by addressing the context in which the analyzed technology is situated demonstrates that both theories are sensitive in how technologies, people, and interactions between them are affected by their surroundings. This contextual importance has been noted previously in transitions literature (Breukers et al., 2017; Köhler et al., 2019; Wieczorek, 2018). Examples of theories that include context are the Multi-Level Perspective (MLP) with its regime and landscape (Geels & Schot, 2007; Köhler et al., 2019; Wieczorek, 2018), the Social Construction of Technology (SCOT) discussing how technologies and society shape each other (Klein & Kleinman, 2002), and the Social Practices Theory (SPT) noting that habits can inhibit transitions (Shove & Walker, 2010). Technologies can become locked-in, and transitions are path-dependent due to the historical evolution of the socio-technical system (Breukers et al., 2017). This stresses the importance of context in explaining why certain transitions succeed, lag behind or fail.

Besides this similarity, the **functions** from TIS also resemble the dimension **access to and control over resources** from WEF. However, where TIS tries to uncover the components that through mutual

interaction form the innovation system, WEF looks at the individual consequences technologies have on society. It seems that TIS takes a more socio-technical point of view, while WEF is focused on the social dynamics only. Considering the background from which both theories have emerged, this seems to make sense. Socio-technical transition theories indeed focus on the interaction between society and technological systems (Geels & Schot, 2007), while gender theory instead addresses how technologies influence gender norms/dynamics and societal problems (Winther et al., 2017).

The background of the theories could also explain why some lacking (or positive) points in the intervention program are only discussed by one theory and not the other. For TIS, important elements within the intervention program are related to the **knowledge** base, **policies** that are in place, and the importance of **infrastructure**, all of which are contextual elements that interact with technological systems. In contrast, WEF focuses more on explaining why the adoption is lagging by revealing the **social dynamics** in relation to the new technology and misses the feedback loops and interaction mechanisms from TIS between its individual elements.

Looking back at the way institutions are discussed in both theories, it also becomes clear that even though the intentions behind these parts of the theories are the same (looking at the broader picture), TIS looks at all elements of the socio-technical system, while WEF only looks at the elements of the system that have a connection with gender. The **institutions** from TIS discuss phenomena such as gender norms, fuel stacking, and daily practices, to policies and regulations on renewable energies. The **overarching issues** from WEF, however, do not. Instead, they look at the cultural elements that reflect these gender norms, ideologies, and behaviors that are connected to the technology.

These different viewpoints from both theories also suggest that the theories deepen each other's understanding of certain elements. This can be confirmed by looking at how resources are discussed in both theories. In TIS, **resources** are considered general resources, such as electricity infrastructure, financial support, material resources such as pans, etc. However, for WEF, **resources** are analyzed on the gender dynamics involved within access to these resources. It provides a deeper understanding of why these resources are, for example, not available for the intended target group. Therefore, from a TIS perspective, it might seem like the pilot program has a positive impact due to the financial incentives and infrastructure improvements. However, only by adding a gender perspective (e.g., WEF), it becomes clear why adoption is lacking since it provides hypotheses for the underlying reason why women are not able to buy the appliance. This illustrates the usefulness of combining both theories to understand why the transition is lacking and the underlying reasons hindering adoption.

6.1.2 Barriers and enablers for increasing the adoption of electric cookstoves

This thesis aimed to present insights for policy and practice for electric cooking in Nepal. Before diving into the gathered data, a literature review was performed in section 4.2 to provide some background information, which resulted in an overview of the opportunities and barriers as identified by the literature (see Table 4, p.21). After analyzing the data, it can be determined whether the data confirms or contradicts the existing studies covered in the literature review from section 4.2 and how this research has extended the existing literature base. Table 7 presents the results

Table 7 • Barriers to and opportunities for electric cookstove adoption in Nepal

Program insights from the analyses		Does it confirm or contradict literature?		Impact on adoption
		Confirms, contradicts or extends	Reference	
Knowledge and infrastructure	Knowledge base clean cooking and energy access provides a useful basis for the program to be set up	Extends, illustrates the importance of establishing proper knowledge, etc.		Enabling
	Lack of proper energy infrastructure makes large-scale adoption difficult in Nepal	Confirms literature	Clements et al. (2020), Pinto et al. (2019)	Hindering
Fuel stacking and cooking practices	Traditional ways of cooking hinder full adoption of electric cookstoves	Confirms literature: particularity of traditional dishes requiring different types of fuel	Clements et al. (2020), Masera et al. (2000), Puzzolo et al. (2016), Ruiz-Mercado & Masera (2015), Shankar et al. (2020), Vigolo et al. (2018)	Hindering
Gender norms	Women being the main cooks, but not being responsible for purchases	Confirms literature	Bonan et al. (2017), Pachauri & Rao (2013), Vigolo et al. (2018)	Hindering
Information	Information did not reach all parts of the population equally	Extends, illustrates the importance of awareness	World Bank Group (2014)	Enabling
	Use of CREE networks for effective information diffusion	Confirms the social influence of peers	Bhojvaid et al. (2014), Bonan et al. (2017), Puzzolo et al. (2016), Vigolo et al. (2018)	Hindering
Financial	Lack of (financial) decision-power women making it difficult to induce cookstove adoption	Confirms literature	Bonan et al. (2017), Pachauri & Rao (2013), Vigolo et al. (2018)	Hindering
	Financial incentives making it more attractive to adopt induction stoves by lowering upfront costs and electricity tariff	Confirms literature	Clements et al. (2020) ESMAP (2020), Putti et al. (2015), Puzzolo et al. (2016), Usmani et al. (2017), Vigolo et al. (2018), World Bank Group (2014)	Enabling
	Replacement of pots and pans and increased electricity use	Extends, illustrates that cooking technology is a *system* of interrelated elements		Hindering
Well-being	Well-being of women increases with the adoption of the cookstove	Confirms literature: more time saved (more time for entertainment, education, or financial activities), less negative health impacts, etc.	Batchelor et al. (2019b), Bekchanov et al. (2019), Brown et al. (2017), Chepkurui et al. (2019), Pachauri & Rao (2013), Pinto et al. (2019), Rao et al. (2019)	Enabling

The data from Nepal have helped extend the existing literature base by providing empirical evidence on the barriers and enablers of **induction cookstoves** by taking both a transition and a gender perspective. Where previous research has mainly been focused on ICSs and LPG/biogas stoves, this research investigated induction stoves. Therefore, several of the insights presented in Table 4 can now be

confirmed to be valid for induction cookstoves as well as ICSs, LPG/biogas stoves, and other clean cookstoves discussed.

Insights that were not necessarily discussed in the literature review did emerge during the data analysis. Examples are the importance of knowledge diffusion on the presence of an intervention program, the fact that switching stoves also means financial strains regarding replacing pots and pans and increased electricity use (i.e., cooking technology is a system of interrelated elements), and how an established knowledge base on electric cooking and existing infrastructure helps in implementing intervention programs.

6.2 Practical implications

By extending the literature on barriers and opportunities for electric cookstove adoption, practical and policy recommendations can be given to accelerate the transition towards clean cooking. These recommendations are presented in chapter 7 (Conclusion) by answering the main research question.

At this stage, it is important to mention that the recommendations are based on the results from the case study. The choice of the used frameworks based on selected criteria reflects that the theories are suitable for use within a broad range of settings in different developing countries. However, this research is still context-dependent, the results reflect the specifics of the situation in Temal, i.e., women have low intra-household decision-making power. Therefore, the results are most probably generalizable to some extent towards other regions in rural Nepal or developing countries with similar contextual situations (regarding institutions, culture, norms, and existence of electricity infrastructure). For example, applying the same intervention program and using the recommendations presented in this thesis for the urban areas of Nepal might require sensitivity since institutions, culture, and women's intra-household decision-making might differ, and the access to electricity and supply of induction stoves is higher than in rural Nepal.

Therefore, when trying to implement a similar induction stove program in another region, sensitivity is required. Taking this into account when following the recommendations made based on this program might result in better applications to those specific contexts. The recommendations do provide some cues for which elements could be important to consider in induction stove programs and could be used as a basis to build upon.

Following the theoretical implication, using a single framework might result in missing crucial insights in evaluating an intervention program. Practically, this implies that for future programs, it might be important to not only look from one perspective but taking multiple, as was done in this thesis. Especially in developing countries where the existing regime and structures are not always clear (Wieczorek, 2018), looking from different and distinct perspectives can highlight new insights on how to tackle such programs. However, taking multiple perspectives might not always be possible, given the background of the researcher. Therefore, striving towards taking a perspective that covers as many relevant elements as possible while still adhering to the expertise of the researcher, and selectively complement this perspective by borrowing additional elements from other fields of literature, depending on the background of the researchers, might be a useful compromise.

6.3 Limitations

Following the practical recommendations, a limitation that can be identified is related to the background of the researcher. In this thesis, a gender perspective was added as an additional perspective besides the transition perspective. However, for a researcher with a background in the field of gender, it would make more sense to start analyzing from a gender perspective, instead of a transition perspective. This could then also lead to a different methodology, a different framework selection, a different theoretical discussion, and ultimately might even lead to different recommendations and conclusions.

This is in line with the next limitation, namely that the nature of this type of research (literature review and case study) means that there is always some subjectivity through interpretation involved (Montuori, 2013). From the selection of which frameworks to use, to the interpretation of the separate elements of these frameworks, the selection of what elements from the case study are important, and the recommendations that are made using the insights from the case study all involve choices that are made by the researcher. Furthermore, since part of the data was qualitative but has been processed in order to be presented in a quantitative format, this could involve researcher bias, since coding and categorizing qualitative answers includes some form of subjectivity. Even the same research questions could result in different answers when asked by a different researcher.

As touched upon in section 3.1.6, the Technological Innovation System (TIS) framework has been developed in developed countries, and might therefore be more suitable for developed-country contexts. Indeed, some functions had to be adapted to suit the specific context. For example, instead of using R&D expenditure as a measurement of knowledge development, the adaption and adoption of technology developed in Western countries is used (Bergek, 2019). However, the TIS has also been applied in multiple developing-country contexts, such as the research from Blum et al. (2015) in Laos, Tigabu et al. (2015) in Rwanda, and Agbemabiese et al. (2012) in several African countries. Furthermore, as mentioned by Wieczorek (2018), the TIS framework might be particularly useful in developing-country contexts due to the focus on technology diffusion rather than on entire regime shifts and transitions. However, applying a framework in a context it was not intended for might provide limitations during the analysis, and should, therefore, be kept in mind when looking at the recommendations presented following the analysis.

Furthermore, another limitation is related to the current situation within the world (COVID-19 pandemic), which prevented the lead researchers from conducting fieldwork research or interviewing local people in Nepal itself. This was especially relevant for the household surveys and focus group discussions from Practical Action Consulting, while the phone survey by 60 Decibels was not impacted. Risks of misinterpretation of findings that may have been induced by the increased number of communication steps were mitigated through iteration between team members and informants (Kooijman, 2021).

The sample size of the induction stove program households that were surveyed by Practical Action Consulting Nepal was 40 households, and the phone surveys from 60 Decibels were conducted with 244 induction stove users. The total number of households that purchased the induction stove in Temal was 569, which means this research covered 28% of the participants. The sample was chosen carefully

through representative sampling of the participating households, as presented in the ENERGIA report (see Kooijman, 2021). At first, the surveys from 60 Decibels did not cover a representative distribution of gender, which was corrected in the subsequent phases of the interviews (Kooijman, 2021). Moreover, sampling per definition implies that not the entire population is covered. Efforts by the research partners from ENERGIA ensured generalizability, however, it should be kept in mind that there are always possibilities that certain sub-groups are under- or over-represented in the sample, no matter how small these possibilities are.

On a final note, this study was based on data from an induction stove implementation program in rural Nepal, specifically from the municipality of Temal located in the Kavrepalanchowk region. Therefore, the recommendations presented as a result of this case study reflect the situation in this region. Applying these recommendations to other contexts might require sensitivity, as this study also illustrates that the success of such programs is context-specific. However, most results can probably be generalizable to other rural regions in Nepal, and to some extent probably also other rural regions in developing countries with similar institutional and infrastructural contexts.

6.4 Direction for future research

This research aimed to contribute to closing the research gap on electric cooking in Nepal. However, there are still many more interesting topics to discuss and research following this current research. First of all, even though this research tried to answer some of the barriers and opportunities related to electric cooking, more diverse research should be done. For ICSs, several different studies have been performed in varying countries and regions. Conducting more research on electric cooking might help validate the results presented in this study. Furthermore, meta-analyses similar to those done for ICSs could provide a clear overview of the current state of research on electric cooking.

Next, one of the barriers to adoption that requires more research before it can be overcome is how to cook traditional food on electric stoves. Possibilities include a shift of diets (which from a user-perspective might be undesirable) or designing a type of pot/pan that can potentially imitate the conditions of a traditional stove. Examples of such designs can be found in Ethiopia (Alem et al., 2014; Dresen et al., 2014) and Kenya, Peru, and Nepal (Rhodes et al., 2014), where ICSs were developed that allowed the local type of meal to be made on this stove. For example, flatbreads need an equal distribution of heat, which requires targeted design of the stove (Dresen et al., 2014). By including women in the design process of induction stoves, this barrier could potentially be overcome. As presented, this pilot program was rather top-down since ABF, NACEUN, and CREE together assembled the induction stove package and only received feedback after rollout. However, by including users (women) from the beginning, the lack of a frying pan could have been notified earlier. Bond & Hulme (1999) and many scholars since have pointed out that participation through experimenting, mutual learning, and adaptation can aid development projects in succeeding. One of the proposed frameworks for this thesis, the Environmental Justice Framework, includes this process of *participation* in their dimensions (Breukers et al., 2017). By investigating the pilot project from this lens, a possible conclusion could be that user participation could have prevented the problems experienced with the design (one potholder, insufficient variation of pans, not suitable for traditional meals) and information

diffusion as mentioned in the TIS analysis. To research future pilot programs from this angle, fieldwork is necessary to ask future users directed questions on their needs and their participation within the pilot.

Besides improving the design of induction stoves, participation could empower women by recognizing their needs and actively engaging them in the process. The WEF analysis demonstrated how women could be empowered through their role as a user, but not on how giving them a voice in the design process could potentially empower them as well. This leads to two interesting research directions: 1) How does participation empower women besides the empowerment they receive in their role as a user, and 2) Could the WEF be expanded to take into account this element of participation in empowering women?

Furthermore, what should not be forgotten is to research whether electric cooking in Nepal will be feasible on a large scale and in what time frame. This could be important for determining whether different interventions need to be considered simultaneously to achieve climate goals. Especially interesting would be to research if the electricity grid could support every household to cook on electric stoves and if Nepal can generate enough green electricity through hydropower, solar power, and wind power in a national setting.

Finally, future research should examine what a shift in gender norms within cooking can mean for women concretely. Does it empower them, and how? Moreover, what does it mean for intra-household decision power, gender (in)equalities, and gender dynamics?

7. Conclusion

The objective of this thesis was to identify barriers to, and enablers for, electric cookstoves in Nepal. Furthermore, it set out to investigate the additional value of adding a gender component to transition theories. By answering the proposed sub-questions throughout the thesis, an answer is provided to the overarching research question:

What insights from gender and transition theories can contribute to improving the policy and practice of introducing electric cooking in Nepal?

The conceptual framework used to analyze the induction stove program in Temal, Nepal, was based on three criteria, ensuring that the framework would be fitting to analyze the case study with the data available. Technological Innovation Systems (TIS) was used for the transition perspective, and a combination of the Women's Empowerment Framework (WEF) and the Transformative Change Approach (TCA) formed the gender perspective.

Both perspectives highlight different elements of the case study. Induction stoves are found to enable the transition by bringing benefits to (especially) women. The analysis based on the TIS theory illustrates the importance of a supporting knowledge base and networks for knowledge diffusion, influence on the direction of search, and existing infrastructure for the diffusion of induction stoves. Insights from the WEF confirm existing literature by demonstrating that clean cooking improves women's health, reduces safety risks, and saves time compared to cooking on traditional (firewood) stoves. The introduction of electric cookstoves saves the women in the surveyed households 108 minutes (-42%) a day on cleaning and cooking and reduces the need for collecting other fuels, such as firewood and LPG cylinders. Time savings can empower women by allowing them to spend more time on entertainment, education, and financial activities (Batchelor et al., 2019b; Chepkurui et al., 2019; Pachauri & Rao, 2013; Pinto et al., 2019; Rao et al., 2019).

Moreover, the introduction of induction stoves seems to be a catalyzer for a shift in gender norms. Data reveals that after introducing these types of stoves, men spend more time in the kitchen and perceive being responsible for using the stove more than before, for example, by preparing tea or snacks. WEF also highlighted the lack of intra-household decision-power that women in Temal, Nepal, hold. Therefore, a well-implemented, gender-transformative intervention program could shift gender norms, increase women's well-being, and thereby empower them to gain more intra-household decision-power. This demonstrates that policy and practice might be able to reduce the inequalities present within the clean cooking transition.

The most prevalent barriers within the intervention program hindering the transition are: 1) information not reaching the intended target groups (TIS & WEF); 2) financial strain associated with purchasing and using induction stoves (TIS); 3) lack of (financial) decision-power by women to adopt induction stoves (WEF); 4) traditional cooking practices (TIS); and 5) lack of electricity infrastructure (TIS). These barriers explain that the sustainability transition to clean cooking in Nepal is challenging to achieve. It not only requires a transition of simply replacing the stoves, it also includes an overhaul of pots and pans, changes in cooking practices (e.g., preparing dishes differently or not preparing certain dishes at

all to prevent stove and fuel stacking), improving wiring within the houses, installing transformers of sufficient capacity, a solid and reliable electricity grid infrastructure, and enough capacity to generate electricity on a national level. This illustrates that cooking technology could be considered as a *system* of interrelated elements.

The enabling factors identified within the intervention program provide a sound basis for overcoming these barriers. Based on this, three recommendations are presented: 1) using networks to increase knowledge diffusion; 2) providing financial incentives to empower women and reduce the inequalities present in the clean cooking transition; and 3) making use of and improving existing knowledge and infrastructure.

First of all, the observation from both the TIS and WEF analysis that CREE networks were effective in spreading information to the households affiliated with the community proves that information can be spread efficiently to households. This can be used to solve the information diffusion problem, where information did not reach all parts of the population equally. Only 25% of the women belonging to male-headed households knew about the induction stove program, despite both men and women explicitly being invited to the demonstration sessions; information did not reach the women in the same way it reached men. Combining this finding with the efficacy of networks, a recommendation can be made to involve existing women's networks for information spreading.

Furthermore, both literature and the TIS analysis demonstrate that financial incentives help increase clean cookstove adoption (Clements et al., 2020; ESMAP, 2020; Putti et al., 2015; Puzzolo et al., 2016; Usmani et al., 2017; Vigolo et al., 2018; World Bank Group, 2014). However, one of the barriers of the program identified in both the literature and the WEF analysis is the lack of women's financial decision-power within the household, even though they are the main users of these cookstoves (Bonan et al., 2017; Pachauri & Rao, 2013; Vigolo et al., 2018). In other words, while women might want to purchase the cookstoves, they are not in a position to do so, since cookstoves are out of their price range for decision-making. On the other hand, the WEF analysis does reveal that women are in the position to purchase rice cookers, either by themselves or as a communal decision with their husbands, and that women are allowed to make decisions on smaller household purchases. Combining these insights illustrates that when induction stoves are cheaper (e.g., by giving financial incentives to reduce upfront investment costs of induction stoves), the investment could fall within the range of women's decision-power. This might increase women's ability to make decisions on purchasing such an appliance and subsequently increase induction stove adoption.

Finally, the knowledge base, policies present, and the interest in clean cooking and renewable energy in Nepal can prove to be an opportunity in upcoming programs. Knowledge is already present, which allowed the intervention program to exist. However, much is still to be gained. With the existing plans for increasing the hydropower capacity and improving the electricity grid, large-scale adoption of electric cookstoves in Nepal could potentially become feasible in the future. For this intervention program, it was already clear that only 10% of the households could join the program. The knowledge that the electricity grid was not suited for more helped develop plans to increase the capacity. Furthermore, in some neighborhoods, the cookstoves were so popular that the electricity demand from

the households in relation to the capacity of the transformers was too large, which might indicate that households are keen on adopting the stoves. Literature reveals that adoption and long-term use could be hindered by an unstable electricity grid (Clements et al., 2020), which therefore should not be neglected. However, with the ambitions, goals, and programs that the Government has already lined up, electric cooking for every household in Nepal could be feasible somewhere in the distant future. A stable grid could also reduce one of the reasons for fuel stacking, as it might remove the uncertainty of being able to use the induction stove. This could furthermore ensure that women receive all the intended benefits of the fuel switch from (solid) biomass to electric cooking, such as improved health, fewer safety risks, and more time savings.

This research demonstrates that transition theories can be helpful in generating insights on how to potentially advance the world towards a more sustainable future by helping understand the (social) barriers behind the transition to clean cooking. However, failing to consider gender inequalities within these transitions means missing out on analyzing a crucial part of socio-technical transitions. Indeed, gender affects how technology is interacted with, and precisely this interaction between society and technology is what transition studies aim to investigate. Not taking into account the gender dynamics within the societal context could mean a failure to transition to a sustainable society. Since women are disproportionally affected by climate change (Denton, 2002; Kaijser & Kronsell, 2014; Pachauri & Rao, 2013; Terry, 2009), not considering gender explicitly ignores one of the essential aspects in certain sustainability transitions. Therefore, this study highlights the importance of taking both a transition and a gender perspective when developing intervention programs to accelerate electric cookstove adoption in an attempt to mitigate the negative environmental and health effects that cooking on traditional stoves brings.

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Appendix I: Literature matrix

The literature matrix was used to categorize academic literature according to theme. This categorization helped during the writing of the literature review by making it easy to find which papers belong to which category, and what their main results were. First, for each paper the general information was noted in an excel sheet. Each article had its own row, and each of the questions had their own column. The general information included: *author(s); year of publishing; title; link to the article; type of publication (journal article, book, website, report, conference proceeding, etc.);* and *how did I find the literature?* (See Figure 28)

	A	B	C	D	E	F	G	H	I
1	**Author**	**Year**	**Link**	**Title**	**Type of publication**				**Found where?**
2					*Journal*	*Book*	*Website*	*Report, Conference, etc.*	
3									

Figure 28 • Screenshot of the literature matrix: General information

Then, by reading the article, information about the contents of the literature was noted down, including the: *discipline; type of study (theoretical, empirical, both); approach (model or framework design, case study, experiment, meta-analysis);* and *region in which the research was conducted (Nepal, Global South, Western)*. (See Figure 29)

	J	K	L	M	N	O	P	Q	R	S	T
1	**Discipline**	**Type of study**			**Approach**				**Region**		
2		*Theory*	*Empirical*	*Both*	*Model/framework*	*Case study*	*Experiment*	*Meta-analysis*	*Nepal*	*Global South*	*Western*
3											

Figure 29 • Screenshot of the literature matrix: Context of the literature

The thematic analysis consisted of 8 different identified themes, of which some were further divided into several subthemes. The 8 identified themes were: *transition theory; gender x technology; gender; energy access; (electric) cookstoves/cooking; behavior changes; climate change;* and *Nepali context*. (See Figure 30)

	U	V	W	X	Y	Z	AA	AB
1	**Theme**							
2	*Transition theory*	*Gender x technology*	*Gender*	*Energy access*	*(Electric) cookstoves*	*Behavior changes*	*Climate change*	*Nepal context*
3								

Figure 30 • Screenshot of the literature matrix: Thematic analysis

Gender was subdivided into the themes: *time-use; investment; access to information; norms;* and *power relations*. Cooking was subdivided into: *food (taste); time; fuel gathering; role division;* and *behavior change*. Energy was divided into: *energy access; micro-grid;* and *fuel prices*. Finally, the theme of transition theories made a distinction between: *the Multi-Level Perspective; Social Practice Theory; Social Construction of Technology; Strategic Niche Management; Technological Innovation Systems;* and *Participation Theory*. (See Figure 31)

	AC	AD	AE	AF	AG
1	**Gender**				
2	*Time-use*	*Investment*	*Access to information*	*Norms*	*Power relations*
3					

	AI	AJ	AK	AL	AM
1	**Cooking**				
2	*Food (taste)*	*Time*	*Fuel gathering*	*Role division*	*Behavior change*
3					

	AN	AO	AP	AQ	AR	AS	AT	AU	AV
1	**Energy**			**Transition theory**					
2	*Energy access*	*Micro-grid*	*Fuel prices*	*MLP*	*SPT*	*SCOT*	*SNM*	*TIS*	*Participation*
3									

Figure 31 • Screenshot of the literature matrix: Thematic analysis, expanded

Finally, the main take-aways from the papers was identified. While reading, the column *notes* was used to write down thoughts. The *intention* of the authors from the paper was, when mentioned, written down as well. A summary of the main findings from each paper was inserted into *results*, and as a note to myself I wrote down what the main take-aways were from the paper that I could use in my own thesis. This final part of the literature matrix is shown in Figure 32.

	AW	AX	AY	AZ
1	**Notes**	**Intention**	**Result**	**Take-away for thesis**
2				
3				

Figure 32 • Screenshot of the literature matrix: Final notes

Appendix II: Data from Practical Action Consulting

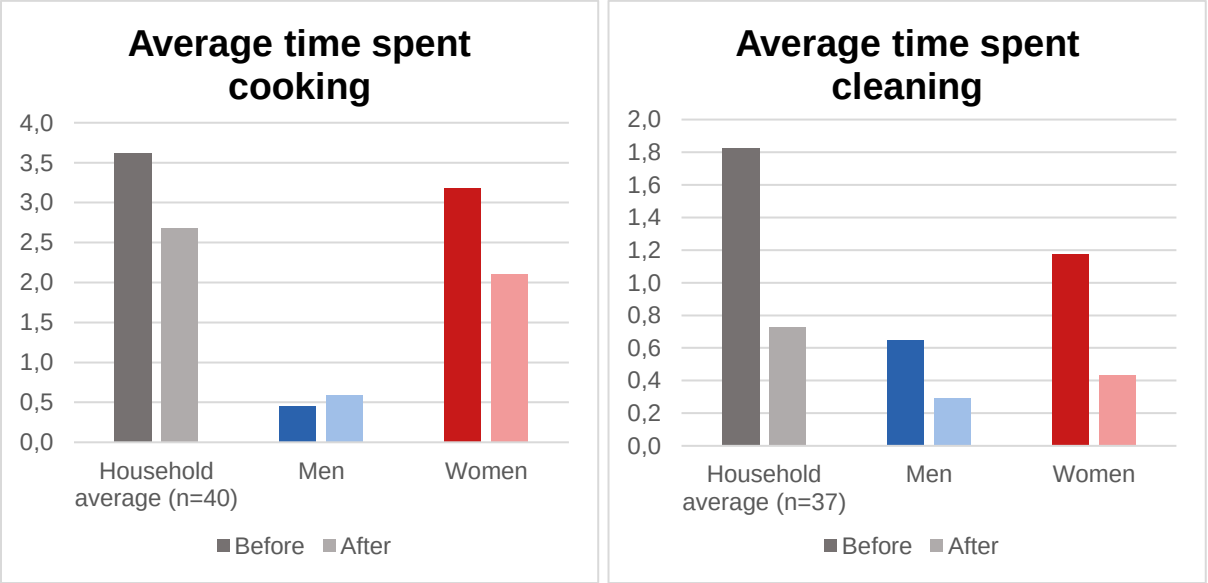
The data used from Practical Action Consulting (PAC) Nepal is presented in this appendix. It consists of the raw data delivered by PAC following their household surveys, conducted with 40 households that purchased the induction stove through the intervention program. The data used is presented following the figures as appearing in this thesis.

Figure 17 & Figure 16: Average time spent cooking and cleaning

PAC conducted 40 household surveys in Temal. Households were asked how much time men and women spent a day on cooking and cleaning before and after the purchase of the induction stove. For the data on cleaning, values were missing from three households, and were therefore omitted. The data used for Figure 17 & Figure 16 is presented in Table 8.

Table 8 • Data on the average time per day spent cleaning and cooking

Average time spent cooking (hours/day)					**Average time spent cleaning (hours/day)**			
n=40	*Household*	*Men*	*Women*		n=37	*Household*	*Men*	*Women*
Before	3,63	0,45	3,18		***Before***	1,82	0,65	1,18
After	2,68	0,58	2,10		***After***	0,73	0,29	0,43
		30%	-34%				-55%	-63%



Figures 16 & 17 • Average time spent cooking (n=40) and cleaning (n=37) in Nepali households daily, measured in hours. Data drawn from research conducted by Practical Action Consulting (2020)

Figure 19 & Figure 18: Average time spent collecting fuel

Similarly to Figure 17 & Figure 16, Figure 19 & Figure 18 were developed based on the 40 household surveys from PAC. Households were asked on firewood and LPG consumption, how much time they spent on collecting this fuel, and who collects it (men or women), before and after the purchase of the induction stove. First, the average consumption before and after the purchase was calculated for the households, which is presented in Table 9.

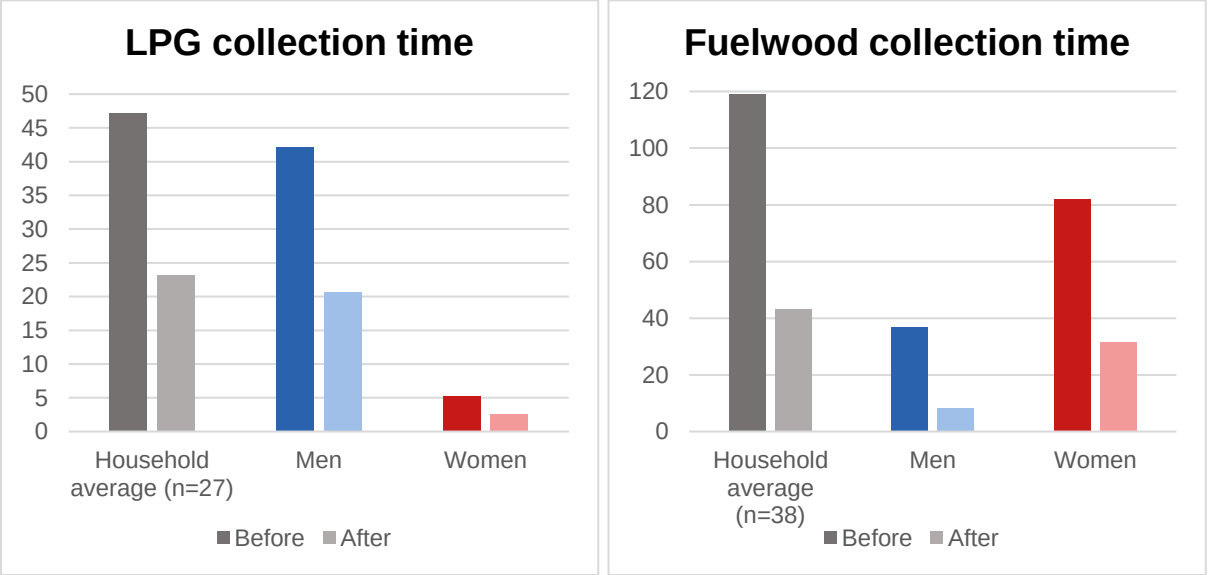
Table 9 • Data on average household consumption of fuel before and after induction stove purchase

	Before	After	Difference
Average number of cylinders per year	4,714	2,321	-51%
Average number of *bhari* per year	30,282	11,051	-64%

Then, the time spent collecting the fuel was calculated for the entire household. This was done by taking the average of the answers to the question: *Time spent collecting LPG/firewood*. This resulted in 2 hours on average collecting LPG cylinders and 47 minutes collecting firewood. In 24 out of 27 households the collection of LPG was the responsibility of the men (89%), and in 3 households it was the responsibility of the women (11%). In 28 out of 38 households, both men and women in the household collect firewood. However, the division of how much firewood is collected by whom shows that firewood collection is more often the responsibility of women: 69% of the firewood is collected by women and 31% of the firewood is collected by men. This information resulted in the data presented in Table 10, which is visualized in Figure 19 & Figure 18.

Table 10 • Data on the average time spent collecting fuel before and after the induction stove purchase within the household

Time spent collecting LPG per month				**Time spent collecting wood per month**			
	Total (n=27)	*Men*	*Women*		*Total (n=38)*	*Men*	*Women*
Before	47,14	42,12	5,24	*Before*	118,8701315	36,85	82,02
After	23,21	20,74	2,58	*After*	43,38002191	8,24	31,67



Figures 18 & 19 • Average time spent monthly collecting LPG (n=27) and fuelwood (n=38) in Nepali households, in minutes. Data drawn from research conducted by Practical Action Consulting (2020)

Figure 24-Figure 27: Intra-household decision-power

Figure 24-Figure 27 use the raw data from the household surveys (n=40). Decision-power was appointed by the respondents themselves for both the male and the female in the household as low, medium or high. Some households gave both the female and the male high decision power, which in theory is not possible: in the case that both members have equally as much decision power, they should both be appointed medium. Many times a combination of high & medium was given as well, whereas the combination high & low was almost never given. Still, when keeping this bias in mind, these figures represent quite well how for smaller decisions women tend to have more power, and for larger decisions it is usually the men holding the power.

Table 11 • Data on intra-household decision-power

	What to cook		**Daily household expenses**		**Choice of other stoves**		**Attending group meetings**	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
High	10	32	14	28	20	21	19	22
Medium	30	8	23	12	16	19	19	18
Low	0	0	3	0	4	0	2	0
	Large investments		**Take small credit loans**		**Take large loans**			
	Men	*Women*	*Men*	*Women*	*Men*	*Women*		
High	31	10	21	20	32	9		
Medium	9	30	17	20	8	31		
Low	0	0	2	0	0	0		

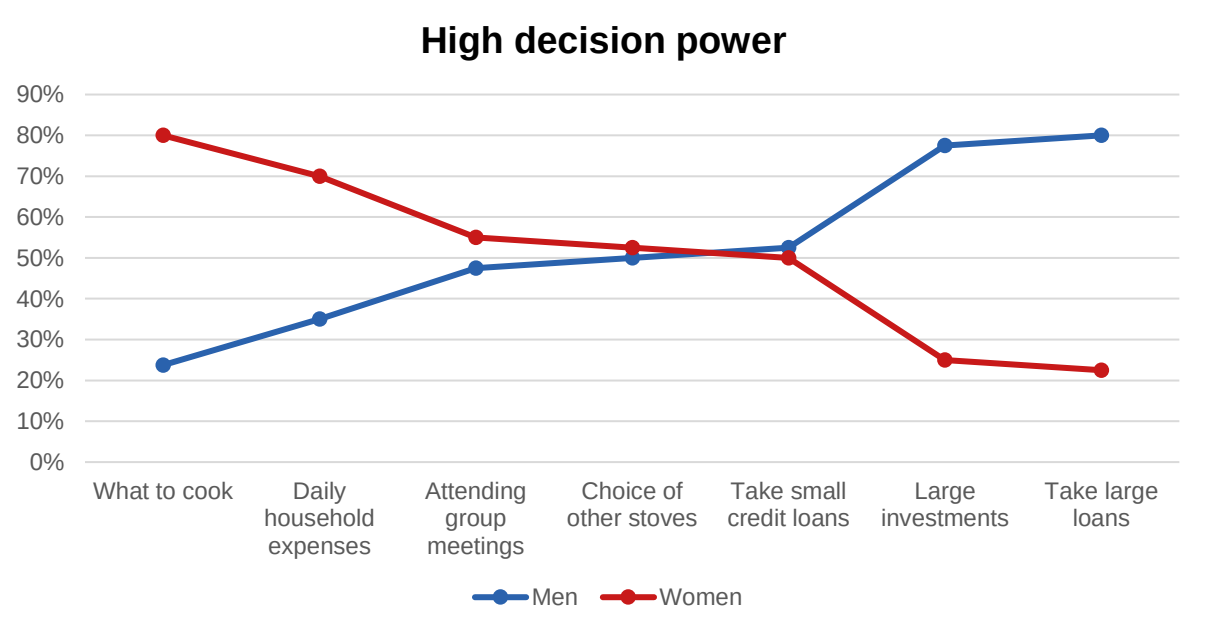


Figure 27 • Percentage of men/women (n=40) with high intra-household decision-power in differing situations. Data drawn from research conducted by Practical Action Consulting (2020)

Appendix III: Data from 60 Decibels

The data used from 60 Decibels is presented in this appendix. It consists of the raw data delivered by 60 Decibels following the phone surveys conducted with the households (145 male and 99 female respondents) purchasing an induction stove through the intervention program. The data used is presented following the figures as appearing in this thesis.

Figure 10: Energy sources

Figure 10 was made using the raw dataset of 60 Decibels following the question: *What source(s) of energy or fuel were you using for cooking before you [purchased] the [induction stove]*? The participants could select between the options: *biogas, charcoal, electricity, firewood, kerosene or paraffin,* and/or *LPG*. The data is presented in Table 12.

Table 12 • Data on previously used energy sources by households now owning an induction stove

Energy sources	Number of households	% of total	Energy sources	Number of households	% of total
Biogas	4	2,5%	*Firewood, Biogas*	3	1,9%
Charcoal, Firewood	2	1,3%	*Firewood, LPG*	62	39,5%
Charcoal, Firewood, LPG	2	1,3%	*Firewood, LPG, Other*	1	0,6%
Charcoal, LPG	1	0,6%	*Kerosene/ Paraffin, Firewood*	1	0,6%
Electricity	0	0,0%	*LPG*	38	24,2%
Firewood	35	22,3%	*LPG, Biogas*	5	3,2%
Firewood, LPG, Biogas	3	1,9%	**Total**	**157**	**100%**

This data was grouped into smaller sub-categories. The category *firewood/charcoal/gas* consisted of those households combining traditional stoves (*firewood and/or charcoal*) and LPG and/or biogas. The category firewood or charcoal includes those households that rely solely on traditional stoves. The category "*other*" consists of the households using only biogas or a combination between biogas and LPG. This resulted into the following division (see Table 13) as represented in Figure 10.

Table 13 • Categorized data on previously used energy sources

	Number of hhs	% of total
Electric	0	0%
LPG	38	24%
Firewood/charcoal/gas	73	46%
Firewood or charcoal	37	24%
Other	9	6%
Total	**157**	**100%**

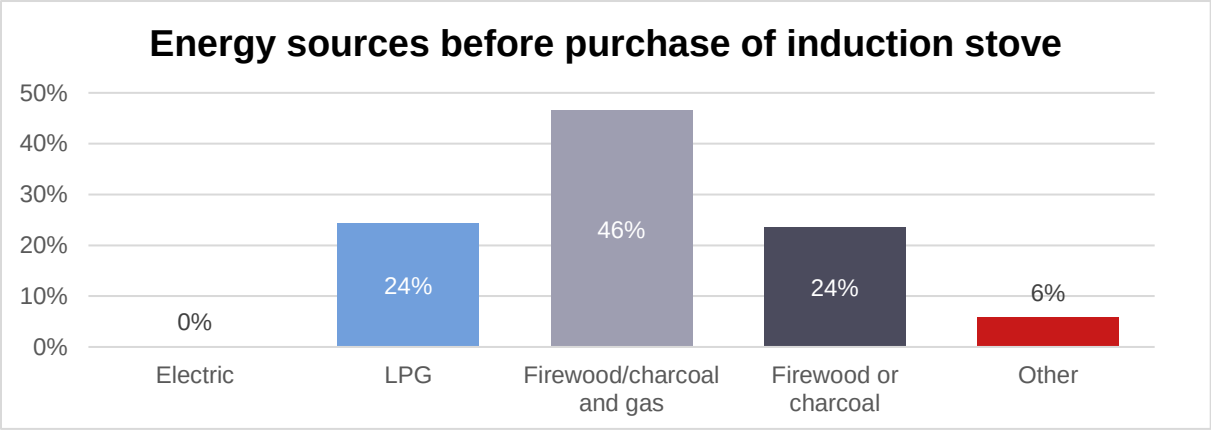


Figure 10 • Energy sources for cooking before the electric cooking intervention. Data drawn from research conducted by 60 Decibels (2020)

Figure 14: Frequency of use

Figure 14 was developed using the raw dataset delivered by 60 Decibels. The answers to the following questions were used:

1. *How often do you use the [induction stove/rice cooker] in a week?*
2. *Is there anyone else who uses the [induction stove/rice cooker]?*
3. *How often do they use it?*

For the respondents, the gender is known. For other users in the households, answers from the second question were used when the gender of these users were explicitly mentioned, such as wife, husband, daughter, mother, etc. This resulted in a sample of 82 men and 100 women (n=182). To analyze frequency of use, answers to questions 1 and 3 were gathered and categorized in three groups. "**Daily**" consists of the respondents using the appliance once or multiple times a day. "**Frequent**" are those using the appliance somewhere between 3 and 6 times a week. Those categorized as "**rarely**" use the appliance less than 3 times a week. The results are presented in Table 14 and Figure 14.

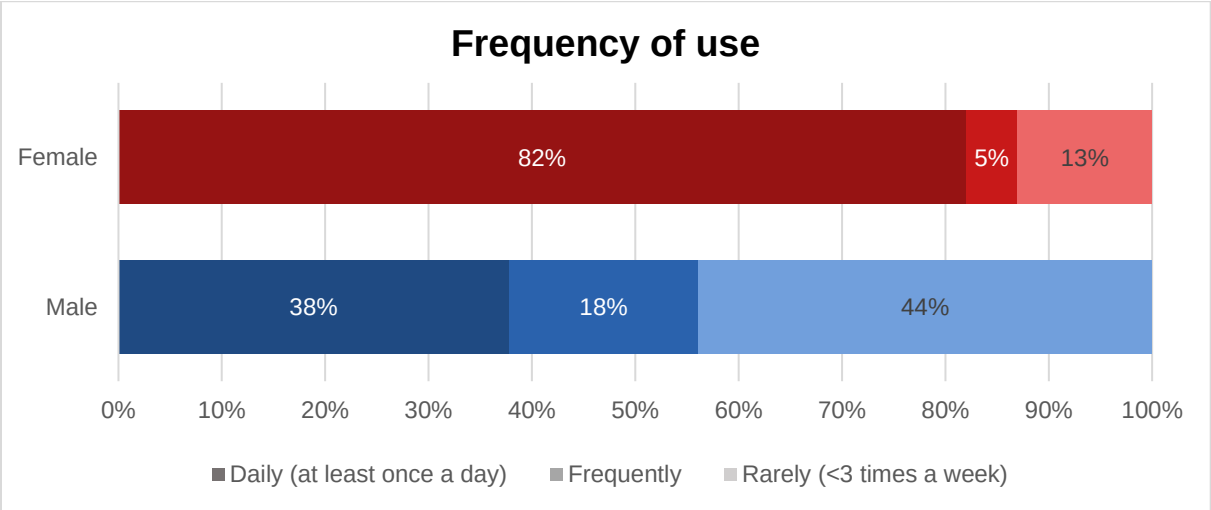


Figure 14 • Frequency of use of induction stoves. Data drawn from research conducted by 60 Decibels (2020)

Table 14 • Data on frequency of use of induction stoves, sorted by gender

	Daily	Frequently	Rarely	**Total**
Male	31	15	36	**82**
Female	82	5	13	**100**
Total	**113**	**20**	**49**	182

Figure 20 & Figure 21: Benefits related to cooking with induction stoves

For Figure 20 & Figure 21, the answers to the following questions were used:

1. *Has your quality of life changed because of the [induction stove]? Please explain.*
2. *What specifically about the stove [would cause you to recommend it]?*

Respondents gave detailed answers, sometimes covering multiple topics on why their quality of life improved (or not), and why they would recommend the stove (or not). The topics can be grouped in *health benefits*, *convenience*, and *time savings*. Table 15 represents how many respondents mentioned a specific benefit.

Table 15 • Data on the perceived benefits of the induction stove

n=244	*Female (n=99)*		*Male (n=145)*	
	What are the health benefits?	**How has your life improved? Why would you recommend?**	**What are the health benefits?**	**How has your life improved? Why would you recommend?**
Smoke free	40	18	74	44
Watery eyes	17	1	38	1
Breathing, coughing, asthma	18		37	3
Bending, back, pain	10		1	
Not as hot	2	3		
Easy to use, convenient		47		73
Flexible		5		7
Time to rest		1		
Safety		14	4	34
Clean		10		21
Less expensive		11		43
No food waste		1		
Preparation time		18		35
Cooking time		67		64
Collecting time / struggle		9		24
Multitasking		23		31
Multiple stoves		6		5
No need to be in the kitchen		3		8
Socializing		1		

Figure 22: Perceived health change

The dataset from 60 Decibels provided the input for Figure 22 through the question: *"Have you noticed a change in the health of household members since you started using your [induction stove]?"* Participants could select options in the range *very much decreased* to *very much increased*. The data is presented in Table 16 and visualized in Figure 22.

Table 16 • Data on perceived health change

	Male		Female	
No change	35	24%	36	36%
Slightly improved	93	64%	61	62%
Very much improved	17	12%	2	2%
Total	145	100%	99	100%

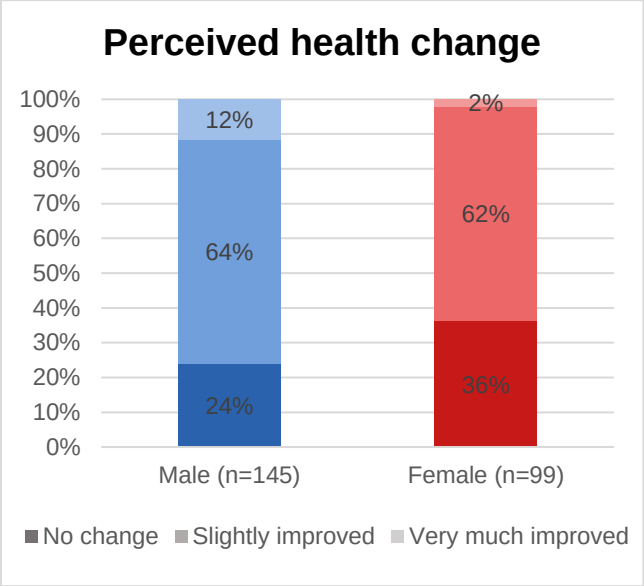


Figure 22 • Perceived health change. Data drawn from research conducted by 60 Decibels (2020)

Figure 23: Intra-household decision-making on clean cookstoves

To make the graph from Figure 23, three different types of data were used. First, this graph was based on the graph presented by 60 Decibels in their report with results from the phone surveys to ENERGIA. This graph presented the final purchase decision according to males and females. This graph did not differentiate between induction stoves and rice cooker, which, for the purpose of the intended graph was necessary. The data 60 Decibels used to make this graph was received (cells marked in grey in Table 17) was divided in: *collective family decision; father(-in-law); mother(-in-law); other female; other male; respondent;* and *spouse.* To differentiate even further within these categories, *respondent* and *spouse* were divided into *male respondent; female respondent; wife;* and *husband*, using the raw dataset from 60 Decibels (cells marked in pink) and the graph presented by 60 Decibels (cells marked in blue).

Table 17 • Data on the purchase decision of clean cookstoves

	Induction stove		Rice cooker		Total	
Collective decision	70	29%	30	52%	100	33%
Father/FIL	4	2%	2	3%	6	2%
Mother/MIL	0	0%	3	5%	3	1%
Other female	1	0%	1	2%	2	1%
Other male	19	8%	0	0%	19	6%
Respondent	**112**	**46%**	**17**	**29%**	**129**	**43%**
Female respondent	16	7%	11	19%	27	9%
Male respondent	96	39%	6	10%	102	34%
Spouse	**38**	**16%**	**5**	**9%**	**43**	**14%**
Husband	27	11%	1	2%	28	9%
Wife	11	5%	4	7%	16	5%
	244	*100%*	*58*	*100%*	*303*	*100%*

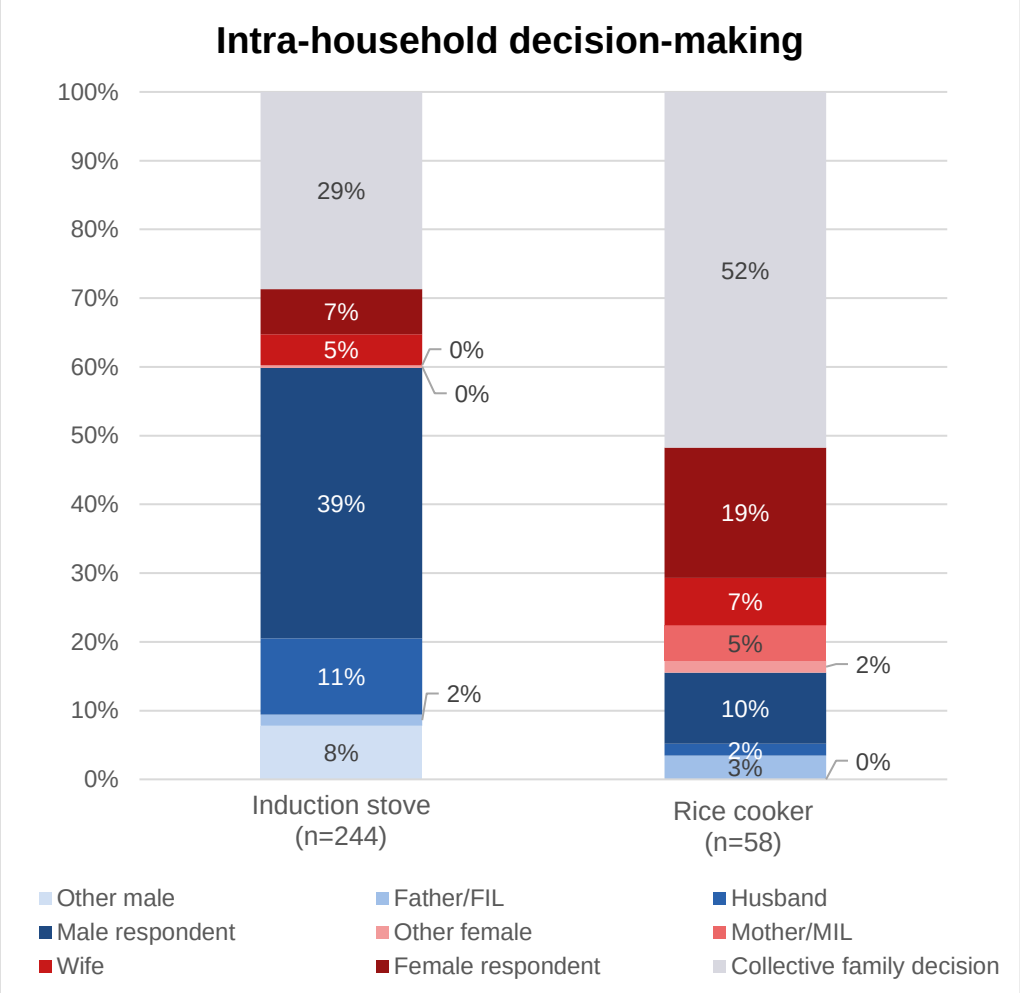


Figure 23 • Intra-household decision-making on clean cookstoves. Data drawn from research conducted by 60 Decibels (2020)

Appendix IV: MSc Theses in the field of Technology for Global Development

This section includes a list of the Master theses that have been written in the field of Technology, Development, and Globalization at the Eindhoven University of Technology since 2010. They can be found on the TU/e Library website.

2021

21.02 Julie Marchand: The introduction of electric cooking in Nepal: A gender and socio-technical transition perspective.

21.01 Wout van Hemmen: Change agency by grassroots entrepreneurs: an exploration of the transformative impact on sustainable development in Sub Saharan Africa.

2020

20.05 Attabik Awan: Darts for the renewables' bullseye? Sustainable business models in the electricity sector of Indonesia.

20.04 Henjo Jagtenberg: The local production of cleaner cookstoves: supporting the growth of stove producers in a local market context.

20.03 Sukrit Aravind Patil: Socio-technical feasibility analysis and assessment of resource recovery through anaerobic digestion from sludge at municipal scale wastewater treatments plants in Bangalore, India.

20.02 Wahyu Ardie Nugroho: Feasibility Study of Integrated Green Refinery in Indonesia.

20.01 Edda van Teeffelen: Circular economy in the global south: A multi-level perspective case study analysis of waste-to-briquettes emerging technology in sub-Saharan Africa.

2019

19.06 Mariana Tapia Gutierrez: Electricity access provision and then what? An investigation on the effects of electricity access in rural Mexico.

19.05 Nataraj Balasubramanian: Studying sustainability transitions achieved through cross-sector collaboration in underserved contexts.

19.04 Sasinipha Chucherd: Pathways towards sustainability: An analysis of Bangkok's public transportation system through sustainability assessment and niche explorations.

19.03 Paul Bierling: The potential of hybrid floating pv-hydropower plants in Vietnam. An energy justice perspective.

19.02 Tanai Potisat: Successful governance of mini-grids: A perspective from community-based island electrification in Thailand.

19.01 Merlijn Borneman: An investigation of the sustainability trade-offs of the cocoa supply chain connecting the Netherlands with the main and most interesting cocoa supplying countries (Ghana, Côte d'Ivoire and Ecuador) between circa 1975-2015.

2018

18.07 Jeroen van Hemmen: Governing rural waste - A case study of the implementation of the eight design principles to solid waste management in Bali.

18.06 Milou Derks: Challenges for sustainable performance of government initiated rural microgrids. Analysis of incentives and policy framework for Indonesia.

18.05 Jaara Bijvoet: Energy access for enterprises in developing countries. Exploring the role for renewable energy technologies to address the energy issues in Kenya.

18.04 Dion Visser: Sorting it out: An analysis of waste management provisions and realities on Bali.

18.03 Micky van Gemert: The Influence of contextual factors on "last-mile" distribution models for solar home system distributors in East Africa.

18.02 Santiago Angel Nieto: Barriers and solutions to scale up green microfinance, Insights from a case study in Colombia.

18.01 Mercedes Fuentes Velasco: Use of Mangrove Wood as a Raw Material for Renewable Energy; Case Study on a Small Island in Indonesia.

2017

17.08 Britte Bouchaut: Rural sanitation facilities and quality of life: A mixed methods analysis of the contribution of Safe Water Gardens to the quality of life in Bintan, Indonesia.

17.07 Benedicte van Houtert: Cultural differences hampering turning e-waste to gold in Africa: Intercultural cooperation for sustainable handling of e-waste in sub Saharan Africa.

17.06 Arturo Daniel Salinas Galvan: Drivers of stove stacking in the cooking system: A case study on the adoption of advanced clean cooking stoves in Northern Vietnam.

17.05 Muhammad Husni Mubarok: Capacities and accountabilities of stakeholders in Indonesia's rural electrification program. A view from Responsible Innovation and learning approaches.

17.04 Laura Wong Sagel: Women interaction with biogas technologies in rural areas. A case study in Narino and Huila, Colombia.

17.03 Jiayi Zeng: When micro-grids meet the central grid: The emergence of grid interconnection as innovation to address the reliability issue of rural electrification.

17.02 Ana Gabriela Dávila Gavilanes: Feasibility analysis of electric road transportation. Introduction in Santa Cruz, Galapagos Islands.

17.01 Ellen Hoefsloot: Buying into the Kenyan solar market; Exploring user perspectives on investing in solar electricity.

2016

16.05 Mutia Prabawati: Sustainability of rural electrification projects: Case study of private sector intervention in Indonesia.

16.04 Si Liu: Jatropha biofuel development in cultivation and processing In China from 2007 to 2012: A field study.

16.03 Rodrigo González López: Identifying enabling and hindering factors to design better business models for rural electrification: Rural Uganda case study.

16.02 Hasna Afifah: Evaluation of a state-sponsored rural electrification project in Indonesia: A case study of Pengantap Hamlet, West Nusa Tenggara and lessons from process and learning-based approaches.

16.01 Joaquin Corella Puente: Augmenting the SNM framework as a practical tool for sustainable innovation in the South. Design and implementation of technologies for small-scale farmers in Northern Mexico.

2015

15.03 Jonathan Rodriguez Polit: Exploration of the user-value of rural electrification through Solar Home Systems in Southwestern Uganda: A case study.

15.02 Mara van Welie: NGOs' transformative approaches. Exploring how Cordaid can contribute to a fundamental change of the sanitation system in urban informal settlements in low-income countries.

15.01 Peter Kuin: No view from nowhere; studying diverging stakeholders' framework to reduce conflict over water resources in Loitokitok

2014

14.06 Eric Gold: Minimizing implementation failure in rural energy projects in development. A Responsible Innovation approach.

14.05 Bipashyee Ghosh: Sustainability appraisal of emerging trajectories in solar photovoltaic and urban systems in India and Thailand. A multi-criteria mapping analysis.

14.04 Ariane Biemond: African cotton production in transition; requirements for achieving a breakthrough of sustainable cultivation in the Ethiopian cotton sector.

14.03 Iliana Lykissa: A socio-technical evaluation of Solar Home Systems in Uganda: A case study with SolarNow.

14.02 Benedikt Wirmer: A functional approach to guide sustainable innovations in the sanitation chain. Malawi.

14.01 Maro Roussou: The application of participatory methods to co-develop sustainable solutions for domestic hot water and filtration of grey water. Promotion of effective participation of an indigenous school in rural Mexico.

2013

13.07 Joep de Boer: Building a brickmakers' cooperative in Lubuk Alung, Indonesia; an analysis of justifications and conflict situations emerging in the process of building the cooperative.

13.06 Julian Vargas Talavera: Exploring the potential of small biodigesters for electricity production in developing countries. A multi-level analysis on possible adoption in Uganda and Bolivia.

13.05 Sander Dikken: Socio-economic assessment of niche opportunities for sustainable fish- and shellfish cultivation with micro algae. Cases in the Netherlands and Tanzania.

13.04 Joosje Oosterbaan: Housing towards prosperity: an actor-network analysis of the enactment of an urban redevelopment policy and grassroots vision in the Beetham, a neighbourhood of Port of Spain, Trinidad and Tobago.

13.03 Roché Mahomedradja: The role of expectations and the societal impact regarding the use of Jatropha as a biofuel feedstock: Insights from India in pursuit of a biodiesel industry.

13.02 Kristine van Tubergen: Partnering up in Base of Pyramid projects.

13.01 Martijn Pastoors: *Jatropha*mania: A multi-perspective evaluation of Jatropha initiatives in Tanzania and Lombok, Indonesia.

2012

12.07 Todo Hotma Tua Simarmata: Developing transition paths toward sustainable solar PV development for rural electrification in Indonesia.

12.06 Arina Schoonbeek: Sustainable Business Models: Analyzing the Activities of Renewable Energy Organizations for Poverty Reduction in Indonesia and the Great Lakes Region in Africa.

12.05 Harini Challapally: Clean Development Mechanism's (CDM) contribution to clean energy technology development in India.

12.04 Willem Giesbers: Dutch private sector-driven development cooperation policy. An institutional analysis.

12.03 Fernando Flores Gallegos: Social capital: the linking piece for a sustainable development puzzle? Mexico.

12.02 Frans van Herwijnen: Prepaid water in Namibia: Understanding the ongoing transition.

12.01 Lisanne Saes: Prepaid water in Namibia: The impact of prepaid household water meters on the inhabitants and the municipality of Otjiwarongo.

2011

11.04 Rosa Kuipers: Success factors for the logistics of human nutrients in urban areas for use in agriculture. Philippines/India.

11.03 Naomi Baan Hofman: Cultivating under contract. An actor-network perspective on the socio-technical shaping of farmers' practices in north India.

11.02 Jacqueline Kooij: Micro-hydropower in Indonesia. Reflecting on learning processes.

11.01 Bart Hellings: Using carbon credits for Social Entrepreneurship: A case study at Diligent Tanzania Ltd.

2010

10.06 Otto Maria Jandl: Barriers for the employment of floating invasive weeds for biogas production in local communities in West African developing countries.

10.05 Michiel Roks: Size and sustainability: The treatment of smallholders in sustainability certification of biomass for energy purposes. Tanzania.

10.04 Ishil Kahraman: Analyzing the barriers and opportunities for the Turkish PV Market.

10.03 Sanne Heijnen: The impact of small-scale renewable energy projects in least developed countries - a baseline study. Tanzania.

10.02 Souliman Nnafie: Assessing political responsibility of transnational advocacy networks through social network analysis. An empirical study

10.01 Suyash Jolly: Upscaling of niche experiments in PV solar energy for transition to sustainability in India.