Nature of Cooking Fuel Transition: Estimates from Indian households

IAEE Online Conference, 2021

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Scheme of Presentation

01 INTRODUCTION

02 DATA & METHODOLOGY

03 RESULTS

04 SUMMARY & IMPLICATIONS

01

INTRODUCTION

❑ **Why Cooking Fuel →**

- Around 3 billion people cook using open stoves fueled by kerosene, plant and animal residue and coal (WHO, 2018)
- Households are usually unable to get rid of traditional fuels completely because of cost consideration, culture preference, or supply side considerations (Masera et al., 2000)

❑ **Indian Households→**

- About 30% of end-user fuel consumption in India constitutes the household sector making it one of the largest energy dependent-sector

THEORIES BEHIND ENERGY CONSUMPTION PATTERNS

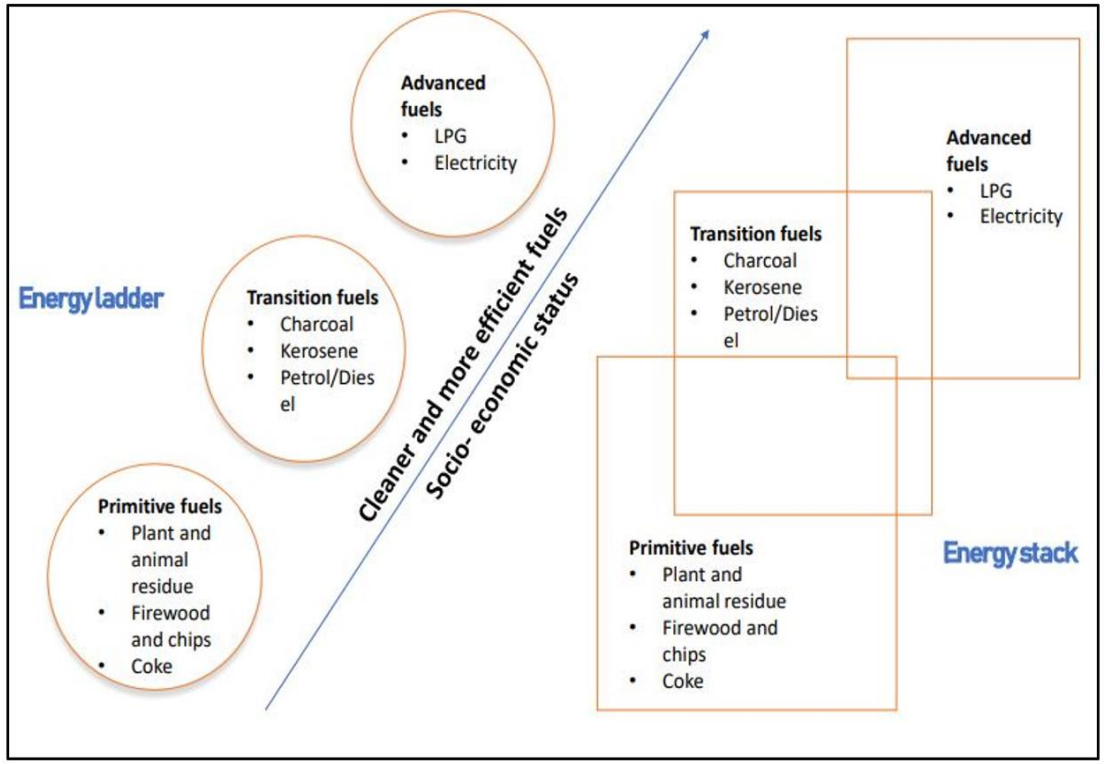


Fig.1: Energy Ladder and Fuel Stacking Models

Note: Illustration from Schlag et al. (2008)

THE CONVERGING IDEAS OF ENERGY SHIFT IN LITERATURE

- Energy Ladder Model (Leach, 1992)
- Limitations:
  - inadequate access to modern fuels,
  - high prices of efficient cooking appliances.
- Fuel Stacking Model (Masera et al.,2000)
- Mostly observed in rural regions of developing countries (Heltberg, 2004)
- Both theories agree to a standard idea about hierarchies in fuel choices.

Novelty of this research

01

Use of multiple-choice model for three categories of fuels to explain household's cooking fuel selection

02

Beyond typical economic factors, we investigate four different categories of factors and their underlying indicators

03

We also account for regional disparities to explain choice of fuel to cook

02

Data & Methodology

SOURCES:

i. Household Consumption Expenditure Surveys, India (HCES), 68th round of the National Sample Survey (NSS) between 2011-12 and published in 2014

ii. Human Development Index Data, 2012 (state-wise) from the “HDI Database” of the Global Data Lab

iii. Gross State Domestic Product (GSDP) data (state-wise) at constant 2011-12 prices by The Central Statistical Organization, New Delhi, India

Determinants of household fuel basket

Economic

- Fuel expenses relative to food and non-food expenses.
- Land Ownership
- Employment Status
- Type of Ration Card

Regional

- Rural or Urban Sector
- GSDP quantiles (state-wise)
- HDI quantiles (state-wise)
- Climatic zones (state-wise]

Demographic

- Household size
- Education of head
- Gender of head
- Marital status of head
- Presence of a dependent child
- Meals consumed at home

Social

- Caste status
- Religious affiliation

Methodology

- Descriptive statistics and graphical inferences
- Multinomial Logistic (MNL) Regression Analysis
- Empirical Model specification

$$\ln \Omega_{T|P}(x_i) = \beta_{0,T|P} + \beta_{1,T|P} Fuel\ expenses\ relative\ to\ food + \beta_{2,T|P} Fuel\ expenses\ relative\ to\ nonfood + \beta_{3,T|P}\ Land\ Ownership + \beta_{4,T|P} Employment\ Status + \beta_{5,T|P} Type\ of\ Ration\ Card + \beta_{6,T|P}\ Household\ Size + \beta_{7,T|P}\ Squared\ HH\ Size + \beta_{8,T|P} Education + \beta_{9,T|P} Gender + \beta_{10,T|P} Marital\ status + \beta_{11,T|P} Dependent\ Children + \beta_{12,T|P} Meals\ Consumed + \beta_{13,T|P} Caste\ status + \beta_{14,T|P} Religion + \beta_{15,T|P} Sector + \beta_{16,T|P} GSDP\ Quantile + \beta_{17,T|P}\ HDI\ Quantile + \beta_{18,T|P} Climate\ Zones$$

- Nominal outcome variables: Primary Fuels (P) , Transition Fuels (T) and Advanced Fuels (A)
- Similarly specified for Advanced Fuels w.r.t Primitive Fuels (baseline category)

Step 1

Specification of hypothesis

Step 2

Merging and cleaning the dataset

Step 3

Identification and formulation of key variables.

Step 4

Estimation and Goodness of Fit tests

03

RESULTS

I. Proportion between Expenses on Cooking Fuel and Other Expenditures

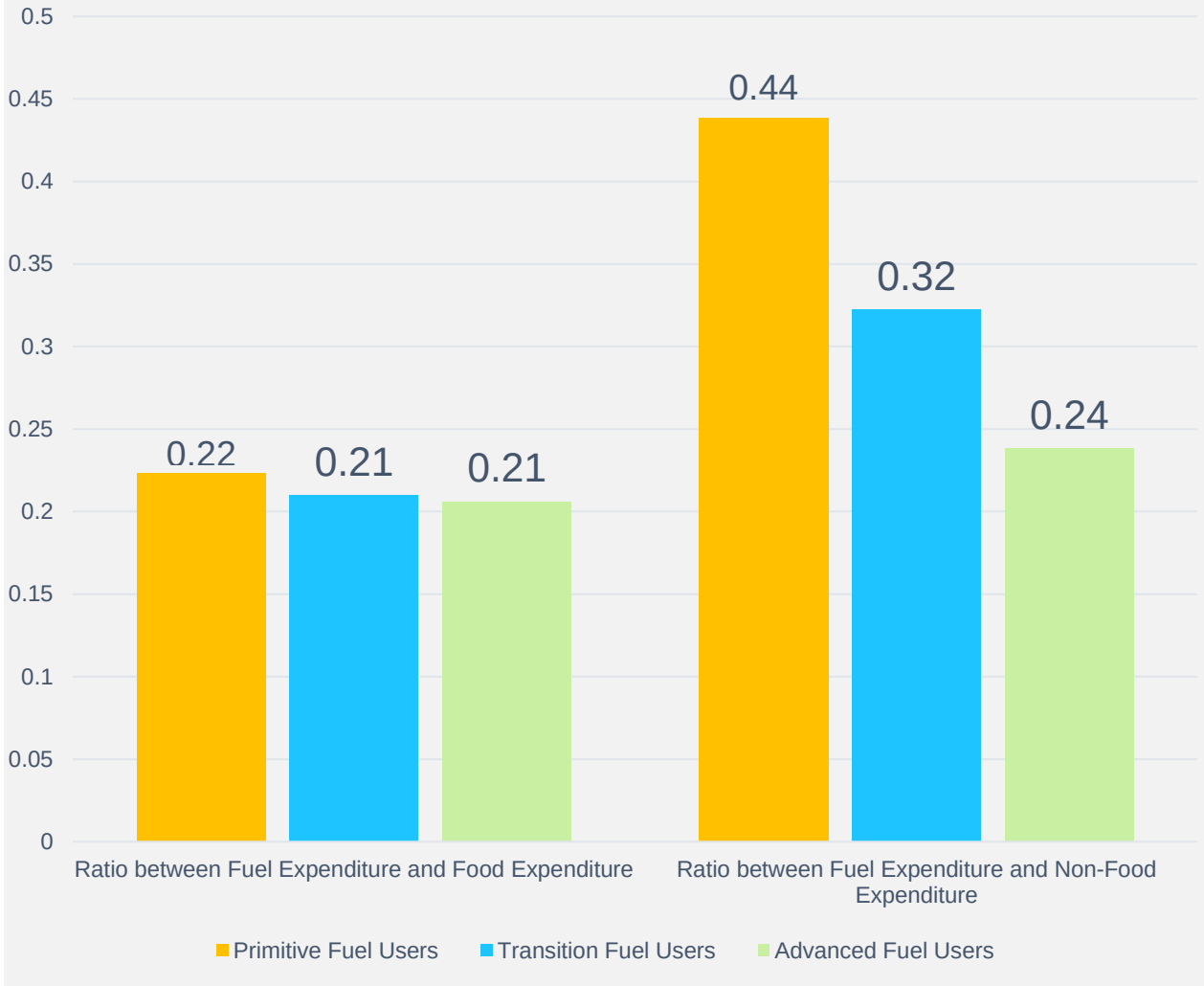
II. Distribution of Fuel Users over Monthly Expenditure Quartiles

III. Consumption of cooking fuels across states

I. Average marginal effects from MNL regression

Proportion between Expense on Cooking Fuel and Other Expenditures

Primitive fuel users exhibit lesser disposable income left for essential non-food services, compared to modern fuel users,



Distribution of Fuel Users over Monthly Expenditure Quartiles

- Only income isn't sufficient to determine the kind of fuels a HH chooses to use.

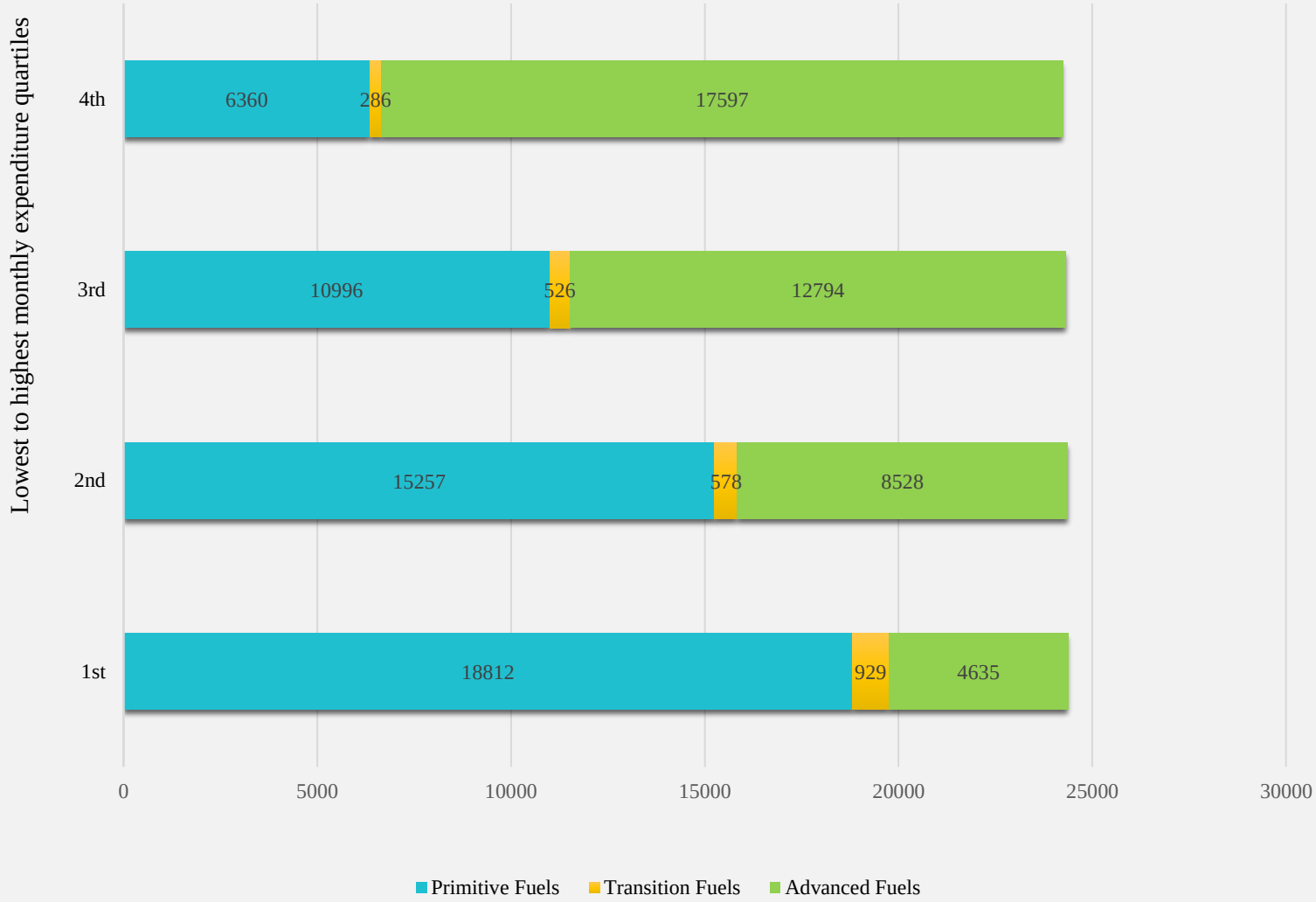


Fig.4: Consumption of Cooking Fuels in Low GSDP States

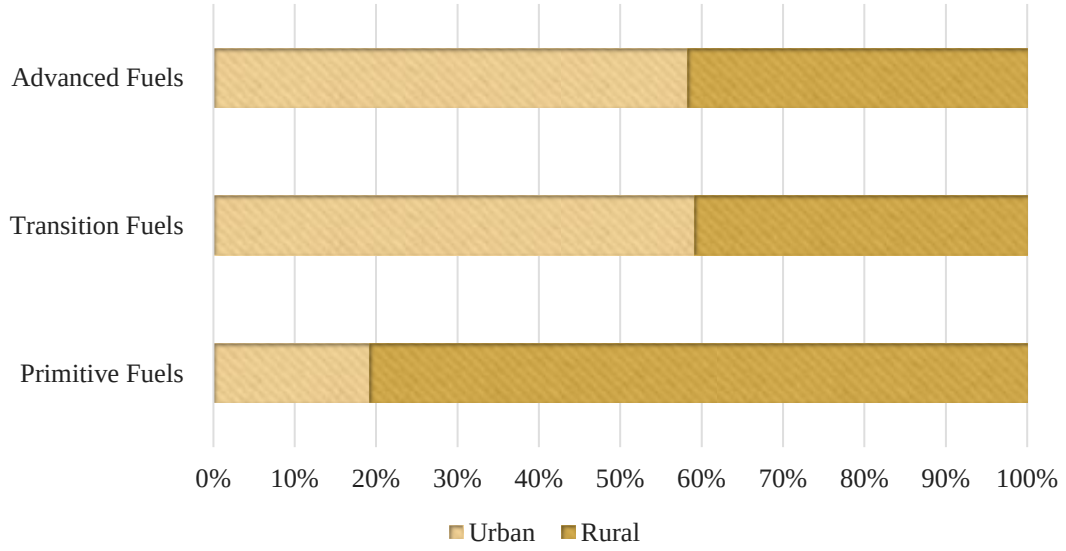


Fig.5: Consumption of Cooking Fuels in High GSDP States

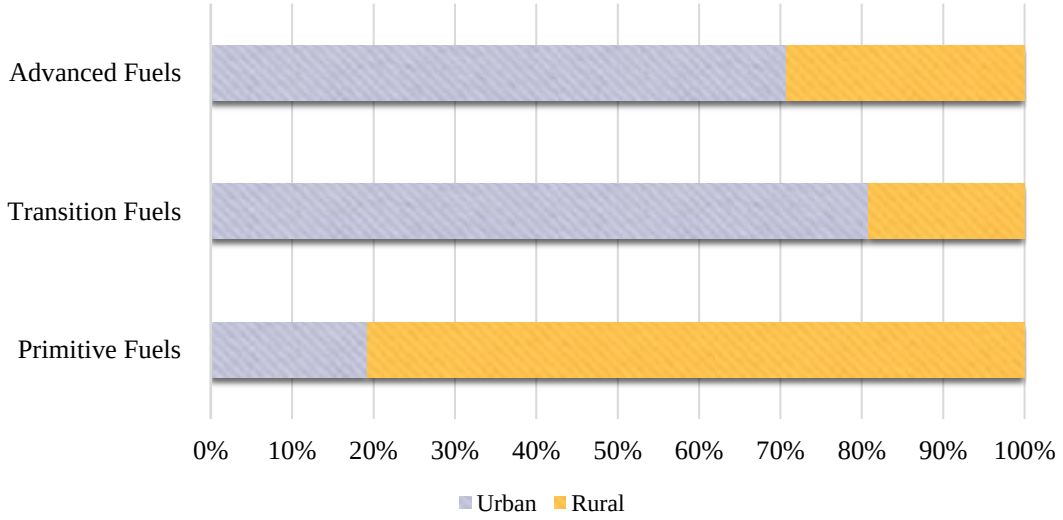


Fig.6: Consumption of Primitive Fuels across HDI quantiles (state-wise)

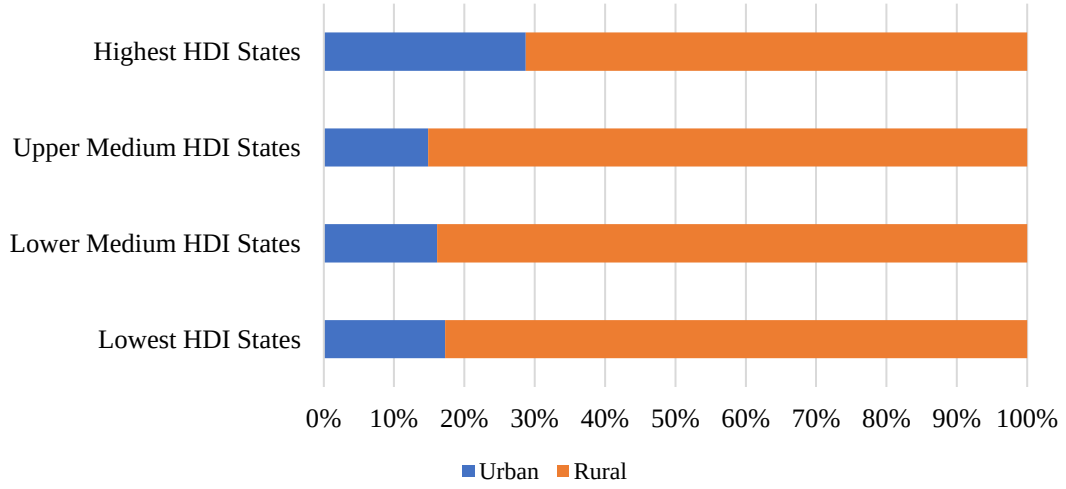
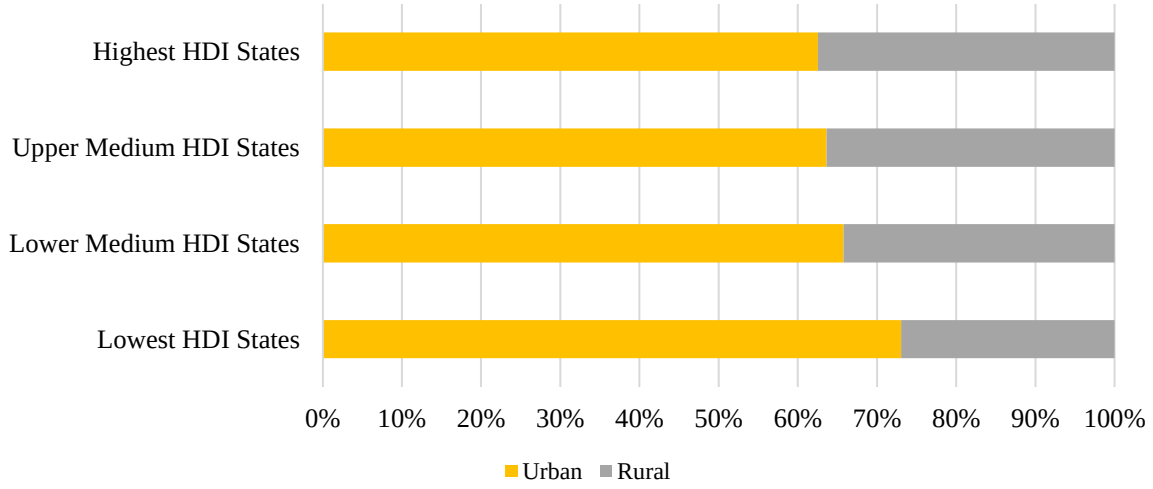
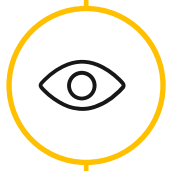


Fig.7: Consumption of Advanced Fuels across HDI quantiles (state-wise)



Diagnostic tests

Akaike's and Bayesian Information Criteria supported MNL model over Ordered Logistic Regression model.



The MNL model has been tested for Independence of Irrelevant Alternatives (IIA) Assumption, using the Hausman test and also passes the Likelihood Ratio test and Wald test.

Table: Average Marginal Effects from Multinomial Logit Regression for three kinds of Cooking Fuel			
Explanatory Variables	**Primitive Fuels**	**Transition Fuels**	**Advanced Fuels**
Energy Expenditure per Food Expenditure	-0.015	-.052***	.067***
Land Ownership (Owns land=1)	.023***	-.025***	.001
Holder of BPL/Antodaya Ration Card (Yes=1)	.127***	.008***	-.135***
Education of the Head of Household (Yes=1)	-.139***	-.007***	.146***
Gender of the Head of Household (Female=1)	-.013**	-.005***	.018***
Households with Dependent Children (Yes=1)	.024***	.003**	-.027***
Caste Background (Lower castes=1)	.079***	.001	-.080***
Religion Affiliation (Minorities =1)	-.001	.007***	-.006*
High GSDP state	.030***	-.025***	-.004
High HDI State	-.254***	-.014***	.268***
Montane	-.078***	-.027***	.105***

Empirical Findings

Economic

- **Lesser monthly expenditure on food items WRT fuel expenses**
  ↑ Probability of consuming Advanced fuels by 7%
- **Ownership of land**
  ↑ Probability of consuming Primitive fuels by 2.4%
- **Holding a Below-Poverty-Line (BPL) Ration or Antyodaya Card**
  ↑ Probability of using Primitive Fuels by 13%

Socio-demographic

- **Having dependent children**
  ↓ Probability of using cleaner fuels by 3%
- **Female-headed households and households with educated heads**
  ↑ Probability of Adv. fuels by 2% and 15%
- **Belonging to backward caste**
  ↑ Probability of using Primitive Fuels by 8%, but not so for minority religions

Regional

- **Belonging to a mountainous region**
  ↓ Probability of using Primitive Fuels by 8% than from an arid or semi arid region
- **HH from a high GSDP state**
  ↑ Probability of consuming Primitive fuels by 3% than a low GSDP state
- **But HH from a high HDI state**
  ↓ Probability of consuming Primitive fuels by 25.3% than a low HDI state

Summary

01

Economic condition is not the only determinant behind energy transition through an energy ladder.

02

For big households with free resources that could be used as/for burning primitive fuels, using clean fuels to cook may not be a pressing need or a voluntary choice.

03

Essential food expenses, rather than non-food expenses, actually end up experiencing greater trade off for increased probability of cleaner fuels' use within households.

Policy implications

01

- Rural households are major consumers of primitive fuels both across all GSDP and all HDI state quantiles. But odds of choosing one over another fuel are different for both.
- Rural-sector specific bottle-necks in implementing policies for access to cleaner fuels needs attention
- Differentiated subsidies on modern fuel and appliances can alleviate difficult trade offs and choices

02

- Women may have substantial reasons to use efficient fuels than men, because of their involvement with cooking and its impact on her health and time
- Education as well as awareness about Government schemes aimed for women.
- Incorporating women's say in designing surveys etc. to decide policy levers.

05

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FIN

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TableY
Average Marginal Effects from Multinomial Logit Regression for three kinds of Cooking Fuel

Explanatory Variables	Primitive Fuels	Transition Fuels	Advanced Fuels
Energy Expenditure per Food Expenditure	-0.015	-.0515959***	.0670782***
Energy Expenditure per Non-Food Expenditure	.255***	.0159192***	-.2704766***
Land Ownership (Owns land=1)	.0234589***	-.0248413***	.0013824
Regular wage	-.0889169***	.0043799***	.084537***
Casual Labour	.1225635***	.0119839***	-.1345475***
Others	-.0670806***	-.0020254	.069106***
Holder of BPL/Antodaya Ration Card (Yes=1)	.1270545***	.0075878***	-.134642***
Household Size	.0066335***	-.0066142***	-.0000193
Squared Household Size	.0001004	.0003419***	-.0004423***
Education of the Head of Household (Yes=1)	-.1392223***	-.0068947***	.1461171***
Gender of the Head of Household (Female=1)	-.0132036**	-.0045844***	.017788***
Marital Status (Currently married)	-.0124535	-.0140967***	.0265502**
Marital Status (Widowed)	-.0112293	-.007166	.0183953
Marital Status (Divorced/Separated)	.0188305	.0047987	-.0236292
Households with Dependent Children (Yes=1)	.0241293***	.0031628**	-.0272922***
Whether all meals taken at home (Yes=1)	.0298787***	-.0089056***	-.0209731***
Caste Background (Lower castes=1)	.0791196***	.001331	-.0804506***
Religion Affiliation (Minorities =1)	-.0008145	.0069014***	-.0060868*
Sector (Rural =1)	.3557985***	-.0222075***	-.333591***
Lower medium GSDP State	.1297759***	-.001222	-.1285539***
Medium GSDP State	.0211274**	-.0253756***	.0042481
Medium high GSDP State	-.0229725**	-.0368997***	.0598722***
High GSDP state	.0295108***	-.0251976***	-.0043132
Lower medium HDI State	-.1737754***	.0015633	.1722121***
Upper medium HDI State	-.2020461***	.0125817***	.1894644***
High HDI State	-.2534954***	-.0140224***	.2675178***
Tropical wet	.108319***	.037***	-.145***
Tropical wet and dry	-.070***	-.009561***	.0798289***
Humid subtropical	-.013888***	-.02121***	.0351***
Montane	-.0777561***	-.0270129***	.104769***

Note:
•Significant at 10% level, ••Significant at 5% level, •••Significant at 1% level.