Case Studies:
Multi Criteria Decision Analysis of the Cooking and Buildings Sector

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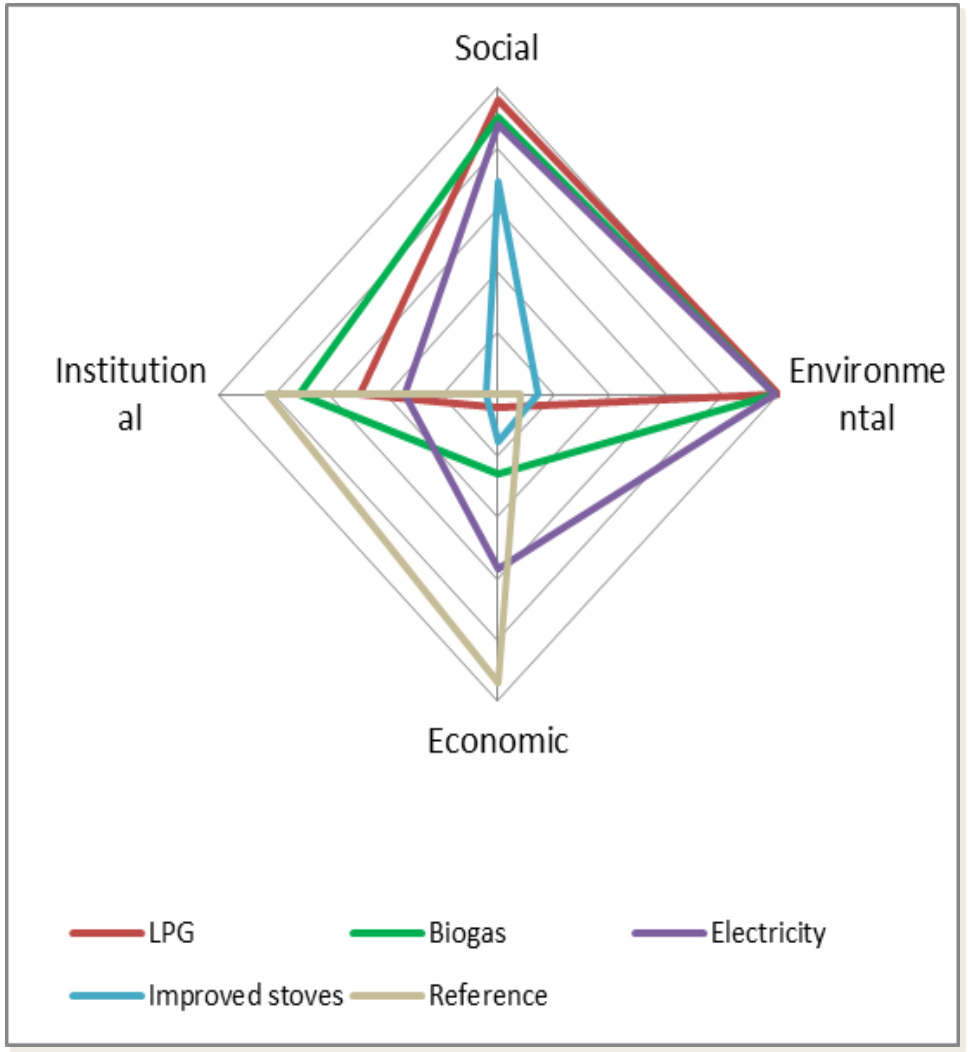
Introduction

- Collaboration between CPR and Prayas (Energy Group) with input from ERC
- Two case studies: cooking and buildings
  - Reflect development needs and understudied sectors
  - Why cooking?
  - Why buildings?
- Draw on IESS version 2, yet to be launched
- Demonstrate and test MCDA
  - Preliminary case study results
  - Vetted by experts, not from wide stakeholder consultations
- Cases have different scopes and time dimensions to show range of MCDA applicability

Case: Cooking

MCDA Question:

"Comparing different options of providing rural households with access to modern cooking fuels, in the context of achieving developmental goals in a climate constrained world"

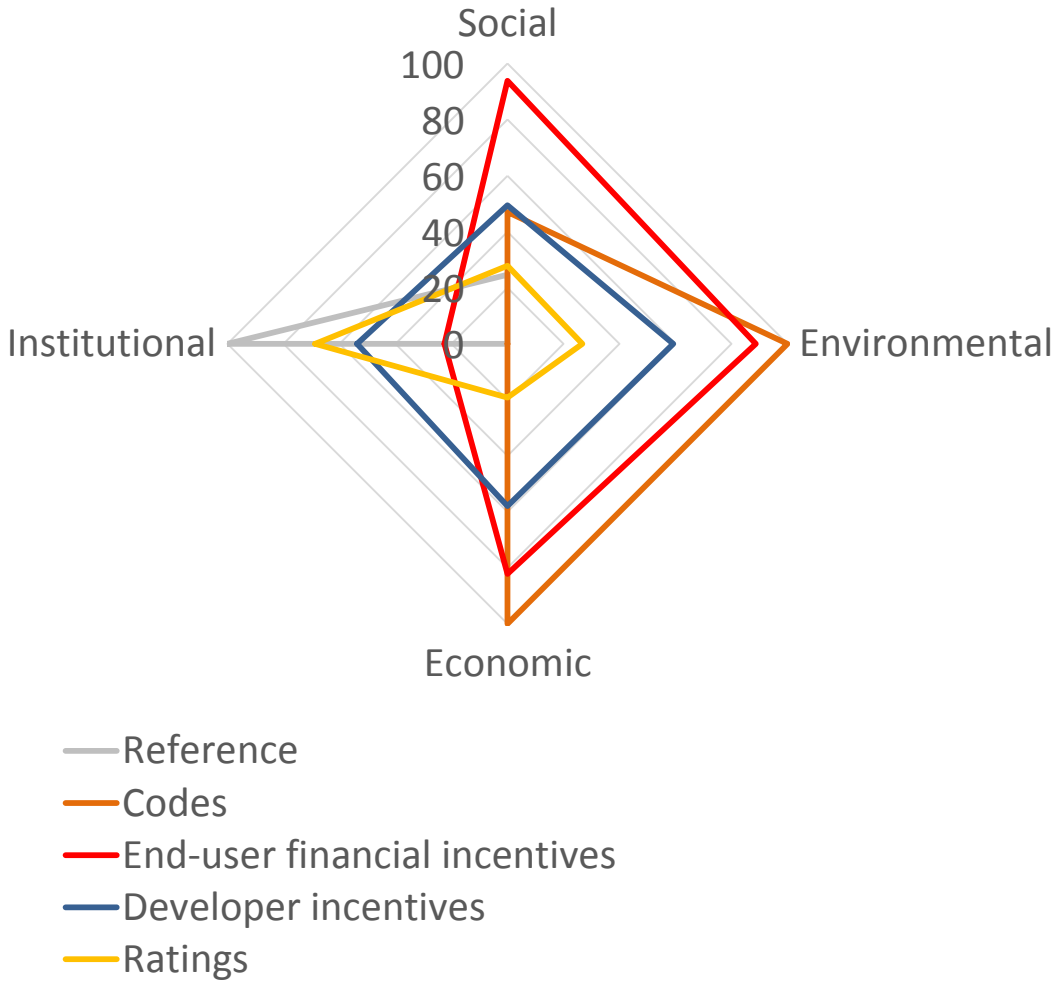


Case: Buildings

MCDA Question:

"Which policy options, focused on building envelope efficiency, provide maximum multiple benefits from India's residential real estate transformation?"

- Policy options: Same technology with different policy choices
- Timeframe: 2022



Steps towards Multi Criteria Analysis

- Step 1: Structure the **question**
- Step 2: Select objectives or **criteria** for evaluation
  - "Branches:" economic, social, environmental, institutional
  - "Leaves:" cost saved to the economy, impact on import bill, GHG saved
- Step 3: Select possible policy **options** to address the question
- Step 4: Construct **matrix** to evaluate each policy against chosen criteria at the leaf level
  - Quantitative or qualitative
- Step 5: Create "value functions" to **normalize** across criteria
- Step 6: **Weight** criteria to aggregate values and rank policy options

Case: Cooking

- MCDA Question (Step 1)

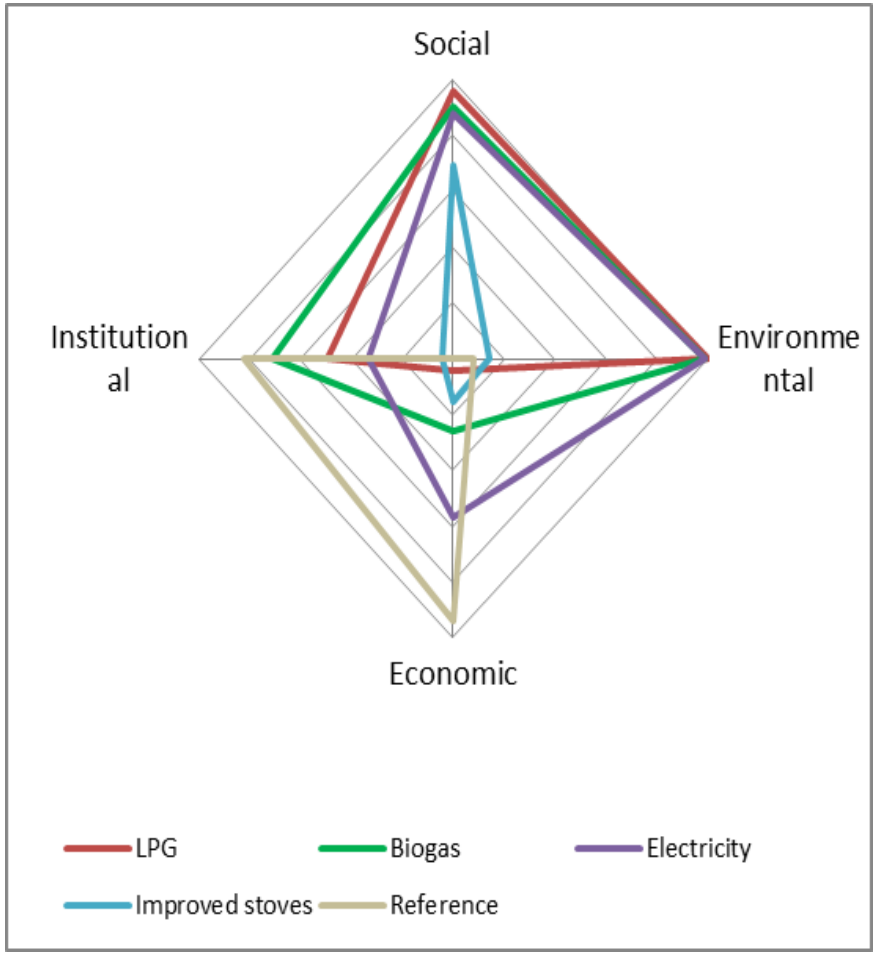
  "Comparing different options of providing rural households with access to modern cooking fuels in the context of achieving developmental goals in a climate constrained world"

- Policy options

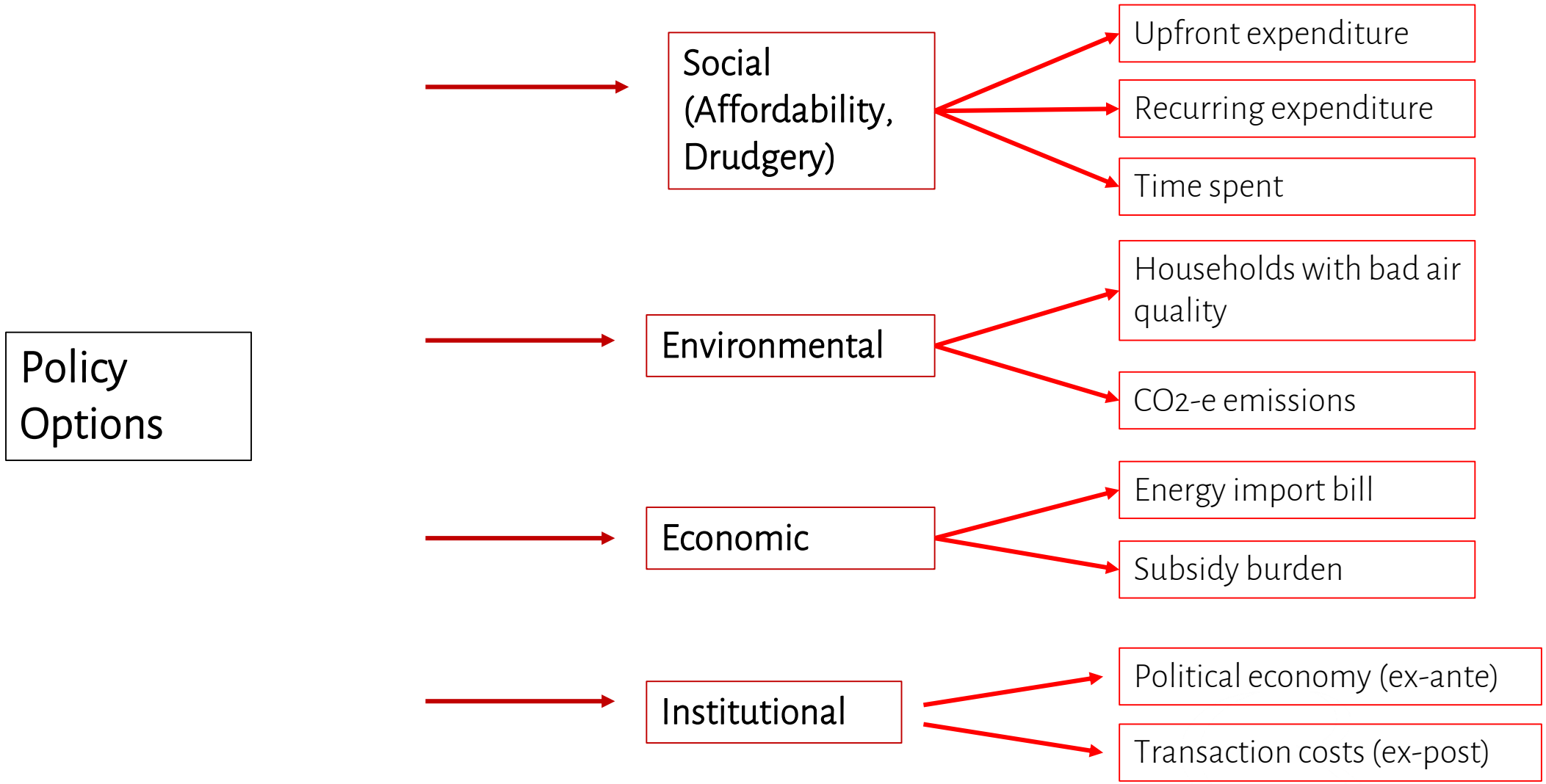
  Promotion of different (relatively) clean cooking fuels – one policy option for each fuel

- Timeframe

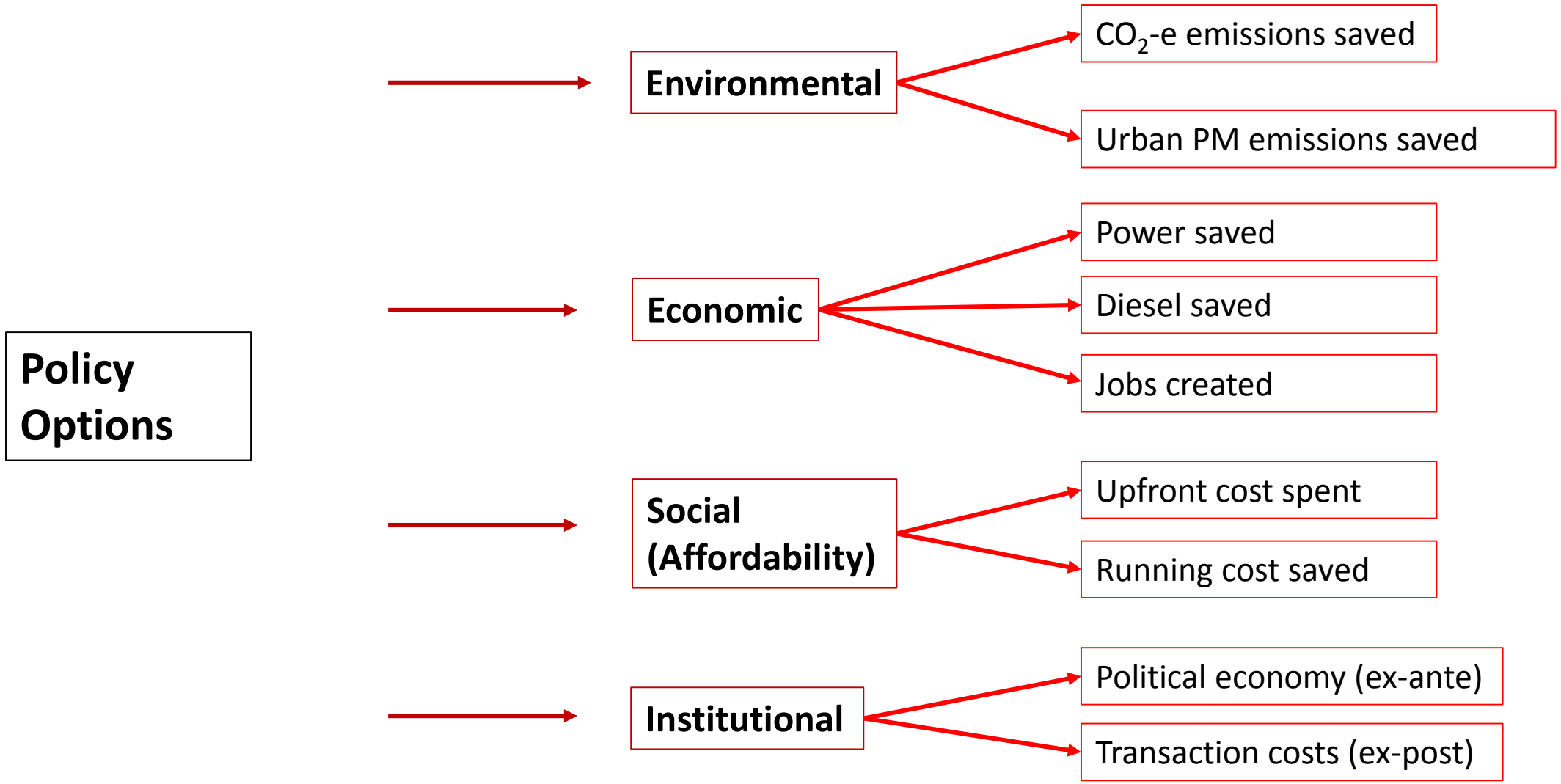
  2013-2032 (Base year: 2012)



Cooking: Objectives Hierarchy



Buildings: Objectives Hierarchy



Cooking Step 3: Policy Options

Policy Options	Description
Reference	Policies continue as they have over the past decade or so Subsidies taper off over 20 years
LPG	Increased rural dealerships/Ease of getting connections/LPG Availability LPG subsidy to continue at current levels, stove subsidy for 30% households Smaller cylinder sizes
Biogas	Promote compressed biogas / livestock and feedstock market Local entrepreneurs/servicing Plant/Fuel Subsidy
Induction	100% Access Quality day/evening supply Subsidized tariffs, Subsidy on stoves, utensils for 30% households
Improved Cookstoves	Local entrepreneurs/servicing Functioning pellet/woodchip market

Cooking Step 4: Constructing the Matrix

- Build the reference (BAU) scenario
  - Assumptions
    - Fuel penetration trajectories
    - Fuel and O&M costs (2012)
    - Annual useful energy requirement
  - Determine how scores for each criterion will be calculated
    - Upfront and running costs to the consumer aggregated over 20 years
    - Drudgery hours averaged over number of households
- Construct each policy scenario
  - Determine inputs that need to change across policies
    - Penetration levels and subsidies
  - Calculate scores for each criterion similar to reference scenario

Cooking Step 4: Constructing the Matrix

Objectives	Criteria	Units
Social	Upfront costs	ooo Rs/HH
	Running costs	ooo Rs/HH
	Hours of drudgery	Hrs/week/HH
Environmental	Households affected by indoor air quality	Million HH
	CO_2-e Emissions	MT
Economic	Impact on subsidy burden	Trillion Rs
	Impact on import bill	Trillion Rs
Institutional	Political economy – stakeholder will/opposition	High, med, low
	Transactional/Institutional costs incl. capacity/leakages	High, med, low

Qualitative criteria in colour

Cooking Step 4: Constructing the Matrix

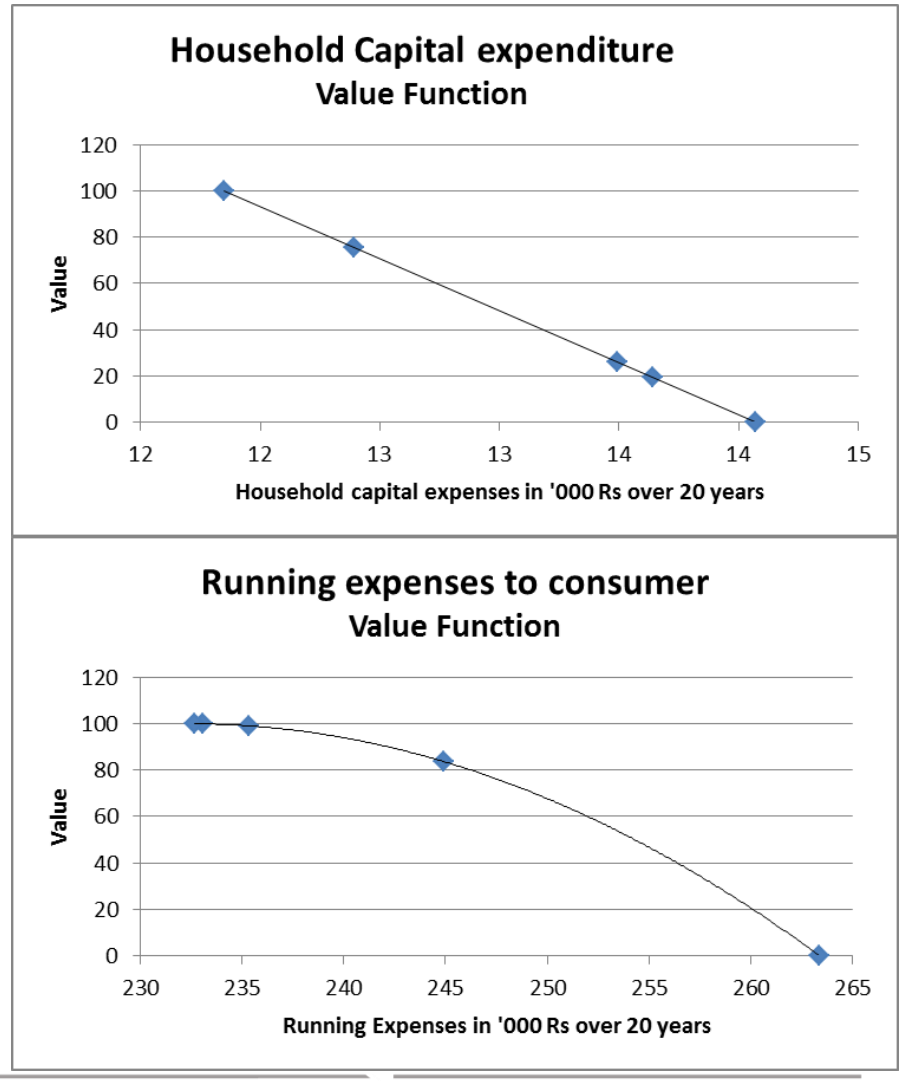
	Social			Environmental		Economic		Institutional (Normalized)	
	Capital Expenditure (000 Rs/HH)	Running expenses (000 Rs/HH)	Time spent (hrs/wk/ HH)	HHs affected by air pollution (Million)	GHG emissions (CO_2-e MT)	Subsidy burden (Rs Trillion)	Energy import bill (Rs Trillion)	Political Economy	Transactional/Institutional Costs
Reference	14.1	263	2.25	316	5783	6	16	47	53
LPG	12.4	233	1.88	237	5394	16	22	9	91
Biogas	11.8	245	1.88	237	5481	14	15	28	69
Induction	13.5	233	1.88	237	5477	10	16	70	75
Improved Cook stoves	13.6	235	2.16	346	5484	16	12	67	100

Cooking Step 5: Value Functions and Normalization

- Normalize criteria scores to a common range – 0-100
- For each criterion,
  - Assign value of 0 to the policy option with the worst score (say A1) and 100 to the policy option with the best score (say B1)
  - Draw the function graph mapping scores to values between 0 and 100
    - Pick the halfway point between the worst and best scores (say C1)
    - Then ask how going from A1 to C1 compares with going from C1 to B1
    - If both are the same, then C1 gets a value of 50
    - If A1 to C1 is more valuable, C1 gets a value between 50 and 100, say 70
    - If C1 to B1 is more valuable, C1 gets a value between 0 and 50, say 30
    - Iterate through these steps for subsequent halfway points (between and A1-C1, and C1-B1 and so on)
  - Apply the value function graph to the criteria scores
  - Similar process for qualitative criteria as well

Cooking Step 5: Value Functions and Normalization (Social)

	Capital Expenditure (Rs/HH)		Running expenses (000 Rs/HH)		Time spent (hrs/wk/HH)	
	Score	Value (50)	Score	Value (70)	Score	Value (50)
Ref	14.1	0	263	0	2.25	0
LPG	12.4	76	233	100	1.88	100
Biogas	11.8	100	245	84	1.88	100
Induction	13.5	26	233	100	1.88	100
Improved	13.6	19	235	99	2.16	25



Cooking Step 6: Weighting

- Combine values of different criteria to arrive at a score for the next higher branch using trade-off weighting
  - Identify the "most important" criterion. Say, C_2.
  - For each of the other criteria, assuming C_2 is at normalized value 100 and C_x is at value 0, how much of C_2 are you willing to give up to get C_x all the way to 100.
  - If the amount you are willing to give up is g_x, then basically a value of g_x for C_2 is equal to a value of 100 for C_x
  - This trade-off is typically done using actual values as substitution may not make sense with normalized values
  - Weight of C_x is calculated thus: $w_x = g_x / \Sigma g_x$, where $g_2 = 100$
  - Score for each policy option: $\Sigma (v_x w_x)$, where v_x is normalized value for C_x

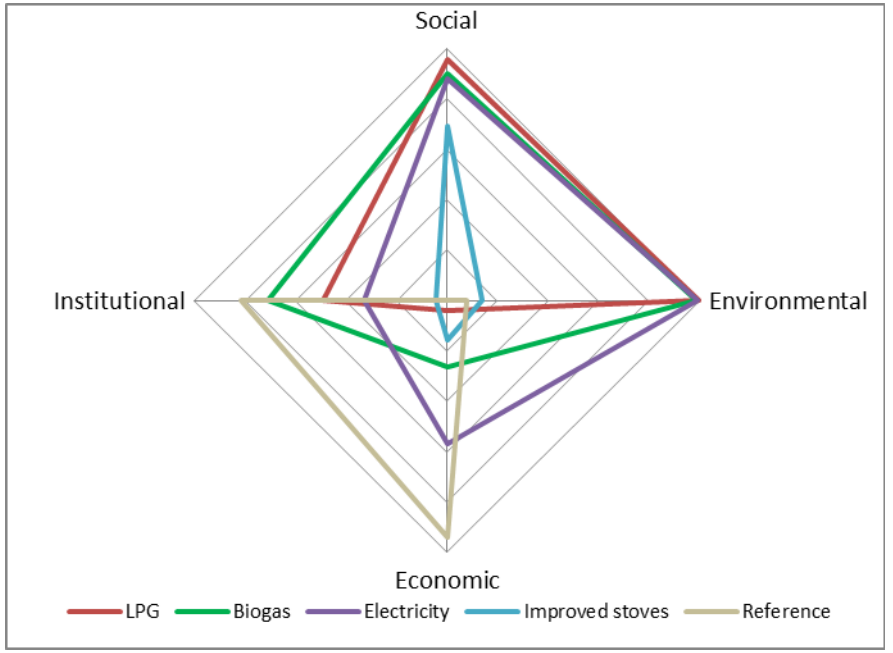
Cooking Step 6: Weighting (Social)

	Capital Expenditure (000 Rs/HH)		Running expenses (000 Rs/HH)		Time spent (hrs/wk/HH)		Branch Score
	Score	Value	Score	Value	Score	Value	
Ref	14.1	0	263	0	2.25	0	*0*
LPG	12.4	76	233	100	1.88	100	*96*
Biogas	11.8	100	245	84	1.88	100	*90*
Induction	13.5	26	233	100	1.88	100	*88*
Improved	13.6	19	235	99	2.16	25	*69*
g_x	*27*		*100*		*36*		
w_x	*0.16*		*0.61*		*0.22*		

- Willing to pay Rs 15000 in running expenses over 20 years to save Rs 2200 in upfront expenses
- Willing to pay Rs 19000 in running expenses to reduce drudgery by 0.37 hrs/week (or 380 hrs)

Preliminary Results: Cooking

- Modern fuels score higher considering all criteria
- Tradeoffs are primarily with respect to institutional and economic considerations
- All policy options score well in social criteria with respect to reference
  - Due to subsidies assumed and time saved
- Policies promoting modern fuels score well in environmental criteria
  - Household air pollution weighted higher than GHG emissions
- All policies score lower than reference on economic and institutional
  - BAU is path of least resistance and lowest subsidies



Criteria → / Policies	Social	Environmental	Economic	Institutional
Reference	0	8	94	82
LPG	96	100	4	49
Biogas	90	99	26	71
Electricity	88	99	57	33
Improved stoves	69	14	16	4

Preliminary Results: Buildings

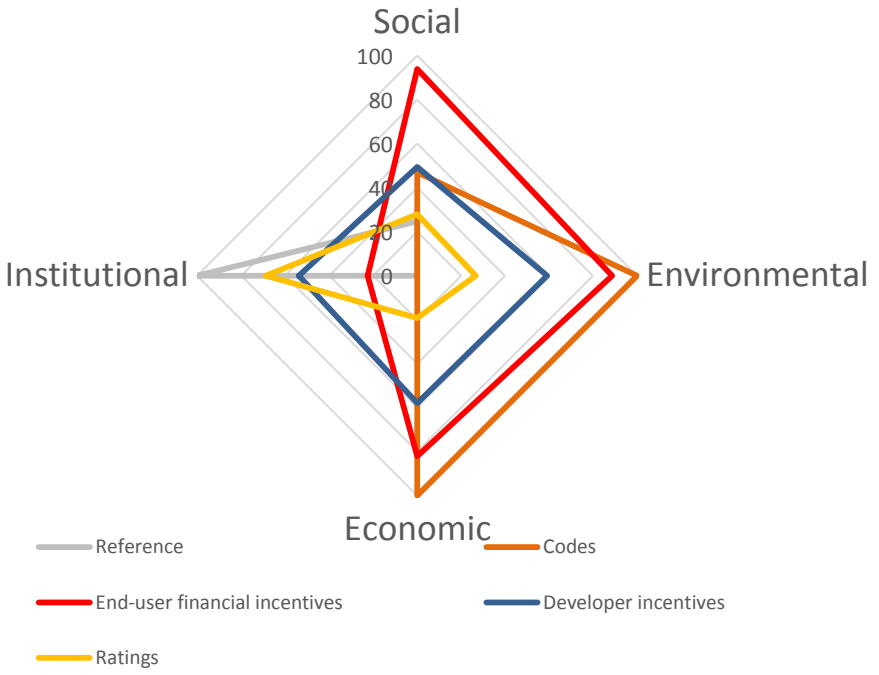
- *Question Structuring*: Single technology choice with different policy options. Can extend to evaluate across technologies and building sectors.

– End-user financial incentives score high on three objectives, but with significant institutional challenges

  - Requires some sacrifice of economic and environmental performance – an enhanced weighting exercise would identify priorities between objectives
  - In short term, horizontal construction offers more opportunities than high-rise buildings

– Trade-offs are mainly institutional and social

- Codes do well, but unless the institutional issue is addressed separately are not feasible
- Ratings and BAU perform poorly, with least resistance



	Social	Environmental	Economic	Institutional
Reference	25	0	0	100
Codes	47	100	100	0
End-user financial incentives	94	89	82	23
Developer incentives	49	59	58	54
Ratings	28	27	19	69

Using MCDA to Inform Policy

- MCDA provides a structured process to operationalize a multiple objectives approach
- Forces us to ask policy-relevant questions, identify implicit trade-offs and complementarities
- Based on a deliberative and transparent stakeholder-driven process
- Internalizes quantitative and qualitative criteria, and feasibility of implementation
- Allows for differences in scope of question, timescales, relative vs. absolute analysis

Looking Forward

Challenges in context of taking MCDA forward

- What role does MCDA have in informing multiple objectives based policy?
  - At what scale? National or sub-national?
- Who are the likely users?
- What supporting tools and enabling conditions are required?
  - Technical and data requirements
- How feasible is a stakeholder consultation dependent process?
- How are the results used and communicated?