Towards Methodologies for Multiple Objective-Based Energy and Climate Policy

RADHIKA KHOSLA, SRIHARI DUKKIPATI, NAVROZ K DUBASH, ASHOK SREENIVAS, BRETT COHEN

Planning for India's energy future requires addressing multiple and simultaneous economic, social and environmental challenges. While there has been conceptual progress towards harnessing their synergies, there are limited methodologies available for operationalising a multiple objective framework for development and climate policy. This paper proposes a "multi-criteria decision analysis" approach to this problem, using illustrative examples from the cooking and buildings sectors. An MCDA approach enables policy processes that are analytically rigorous, participative and transparent, which are required to address India's complex energy and climate challenges.

The authors are grateful to Veena Joshi and V V N Kishore for their valuable inputs and to the participants of the MCDA workshop held at the Centre for Policy Research in May 2015 for their feedback. Responsibility for all errors rests with the authors.

Radhika Khosla (*radhika.khosla@gmail.com*) and Navroz K Dubash (*ndubash@gmail.com*) are at the Centre for Policy Research, New Delhi. Srihari Dukkipati (*srihari@prayaspune.org*) and Ashok Sreenivas (*ashok@prayaspune.org*) are at the Prayas (Energy) Group, Pune. Brett Cohen (*brett@tgh.co.za*) is a Researcher in the Energy Research Centre, University of Cape Town.

1 Introduction

India faces a challenging decade ahead in energy and climate policymaking. The problems are multiple: sputtering fossil fuel production capabilities; limited access to electricity and modern cooking fuels for the poorest; rising fuel imports in an unstable global energy context; continued electricity pricing and governance challenges leading to costly deficits or surplus supply; and not least, growing environmental contestation around land, water and air. But all is not bleak: growing energy efficiency programmes; integrated urbanisation and transport policy discussions; inroads to enhancing energy access and security; and bold renewable energy initiatives, even if not fully conceptualised, suggest the promise of transformation. However one adds the scorecard, there is no doubt that energy decision-making is ever more complex and interconnected.

The domestic energy policy context is made further challenging by the overlay of global climate negotiations. The Paris 2015 climate conference required every country to submit its intended climate contribution. India's international pledge, submitted in early October 2015, includes a reduction of emissions intensity by 33%–35% from 2005, and an increase of the share of non-fossil fuel-based electricity to 40% of total capacity. This pledge has significant domestic energy implications, since energy accounts for 77% of India's greenhouse gas (GHG) emissions (WRI 2014). In short, India's energy future requires addressing multiple and simultaneous challenges, that together suggest great complexity.

Historically, the country's policymaking has adopted a rather straightforward supply orientation: can past trends in energy supply be reproduced and enhanced? Although recently, this is leavened by welcome attention to the demand side, the discussions typically occur in silos around energy-based ministries, which obscure linkages across sub-sectors or larger strategic considerations. Perhaps most problematic, social questions around energy have been excluded or at most received lip-service treatment, such as access to energy, distribution of consumption, and environmental impacts. A recent review of national modelling studies shows that these questions often do not even get asked by studies of India's energy future (Dubash et al 2015). The overall result is a number of disconnects: between domestic and foreign policy debates, where climate policy is often treated as a foreign policy issue, and between energy and climate policy, although in practice climate policy should be built around a sensible and well-informed energy policy.

At the same time, the consideration of the multiple dimensions of development is, formally at least, already enshrined in Indian policy. The National Action Plan on Climate Change calls for a "co-benefits" approach where the climate implications of development policies are explicitly considered. The Twelfth Five Year Plan also discusses how to implement co-benefits in the context of national energy planning. While the language of co-benefits emerged in the context of the climate debate, in the larger context of energy policy it is more usefully referred to as assessment of multiple objectives, which does not require declaring one objective as primary.

This increasing policy attention to linkages between sustainable development and climate considerations—expressed as co-benefits or multiple objectives—is backed by a growing research base. Global models provide strong evidence of substantial complementarities between climate mitigation, reduced air pollution and energy security outcomes in the South Asian region (Rao et al 2015). Indian studies, on the other hand, have paid limited attention to such linkages but a few track achievements ex post of the multiple objectives of energy policy (Dubash et al 2015). Clearly, the idea of energy policy as serving a range of economic, social and environmental objectives simultaneously is taking hold. At the same time, while the multiple objectives approach has won broad acceptance, there are few efforts, so far, to operationalise it.

This paper presents one approach, based on "multi-criteria decision analysis" or MCDA, which is a well-established framework in a range of decision-making arenas, to operationalise the idea of co-benefits. The paper builds on a slew of recent studies and particularly deepens early work done by some of us in the context of India's low carbon expert group (Dubash et al 2013). We enhance our earlier efforts by providing a clear methodological framework to consider the relationships between multiple objectives, the tools to simultaneously deal with quantitative and qualitative information, and those to aggregate and prioritise policy objectives based on different stakeholder opinions. These characteristics enable MCDA to be deeply salient to energy policy, and allow for policymaking to take into account complexities, while maintaining rigour and potentially avoiding the paralysis that complexity can bring.

To explain these points more clearly and intuitively, we apply a MCDA approach illustratively to two cases in this paper: access to modern cooking fuels and building energy efficiency. We envision the approach laid out to provide a starting point for more transparent, analytically rigorous and inclusive policymaking processes around energy and climate change. Notably, however, it could also be used for a much wider range of applications, including adaptation through the process of state action plans, as well as for other questions of social policy. The critical message, however, is that this approach is not proposed as a single decision-making tool to be used by policymakers in isolation. Rather it provides a framework for structured discussion, which can inform policy trade-offs, design and implementation. In the remainder of the paper we introduce MCDA approaches, describe their existing applications to climate and development policy, develop one specific approach and apply it to the cases of the cooking and buildings sectors, and offer some concluding observations.

2 Insights from MCDA Approaches for Policy

A growing number of global studies address the complex challenge of linking climate and development in a multiple objectives framework (Ürge-Vorsatz et al 2014; UNDP 2011; Angelou and Bhatia 2014). For instance, the Asian Co-Benefits Partnership (2014) highlights possible entry points to explicitly integrate climate and development into decision-making (IGES 2014). Co-benefits analysis to indicate synergies and optimise trade-offs has also been undertaken in the context of the Clean Development Mechanism (Sun et al 2010: 78; TERI 2012: 148). Other studies inform discussion of Low Emission Development Strategies (LEDS) which help prioritise actions based on their economic, social and environmental impacts (Cox et al 2014). The most ambitious effort to develop a multiple objective-based analysis framework for climate policy is attempted by the United Nations Environment Programme (UNEP 2011; Ürge-Vorsatz et al 2014). Several of these studies draw on MCDA to simultaneously examine policy options against multiple objectives.

Drawing on the literature, this paper develops a specific variant of MCDA approaches that offers a number of advantages when applied to Indian energy policy. It requires policymakers to explicitly state, upfront, the goals which the policy would seek to maximise. In the cooking and buildings cases which will be discussed, the economic, social, environmental and institutional objectives were explicitly laid out at the start of decision analysis. The approach also encourages consideration of factors that are often ignored, such as household drudgery in the cooking sector. And, it requires identifying relative weights for the stated policy goals, for example, in the case of the environment of minimising household air pollution versus reducing GHG emissions. This attention enhances transparency of the process and effectiveness of the final decision.

A second advantage is that MCDA offers tools for incorporating both quantitative and qualitative information with equal rigour. In contrast with other approaches, such as cost-benefit analysis, MCDA explicitly allows for the use of qualitative information which is often hard to analyse but nonetheless crucial to consider. The underlying argument is that all objectives need to be considered, not only those that are quantifiable. For example, Indian policymaking is frequently hindered by implementation challenges of vested interests or limited bureaucratic capability, but because these are hard to quantify they are left out of policy analysis.

Third, given the careful consideration of qualitative information and subjective weighting of policy goals, MCDA approaches are necessarily underpinned by an early and continuous involvement of stakeholders. These include technical experts, policymakers, industry, end-users and civil society. For example, for policies providing access to modern cooking fuels, it is important to understand the preferences of the cook stove users themselves. This broadening of the information base beyond experts to include relevant stakeholders likely adds to the complexity of the process, but certainly enhances buy-in and enriches the analytical base by providing new insights—for example, cultural concerns around adopting different cooking solutions.

Last, the process of deliberation and repeated iteration with stakeholders improves the sectoral knowledge base and fills information gaps. For example, policy analysis for the buildings sector requires gathering data on a range of issues, from the upfront investment needed for efficiency, to the local pollution reduced from lower diesel generator use.

While traditionally MCDA has been used for discrete decisions, such as choosing between power plant sites, its application is not as well established for policy analysis where discrete options are harder to identify. However, its benefits reinforce its emerging international potential: in South Africa, the Mitigation Potential Analysis used social, environmental and macroeconomic criteria to assess a variety of GHG mitigation options (DEA 2014); and in Chile, stakeholder inputs were used to identify the most important co-benefits of mitigation actions and associated implementation conditions (MAPS 2015).

The approach developed here draws on these international experiences and extends the few other efforts to operationalise multiple objectives for Indian energy decisions. The latter include an early framework for multi-criteria analysis (Dubash et al 2013), energy dashboards (Sreenivas and Iyer 2015; SSEF 2015; Narula et al 2015), sectoral analysis of the cooking sector (Jain et al 2015), and state-specific studies using the framework of sustainable development and green growth (GGGI 2014). Adaptation work is also beginning to engage stakeholders to deliberate multiple objectives. The MCDA approach described in the next section focuses on energy-related policy issues, and can be extended to resilience and adaptation, as well as social issues.

3 Description of a MCDA Approach

We discuss the key steps of a MCDA approach in this section. Our focus is less on methodological details (which are laid out in accompanying appendices) and more on the reasoning and thought process. Each subsection describes one step of the methodology by presenting a rationale for it, the process to be adopted, and expected outcomes.

For ease of exposition we use two case studies, of the cooking and buildings sectors, to illustrate the approach. Both carry significant development implications and are currently understudied. The cooking sector is important because over 86% of rural Indian households, representing over 700 million people, used solid fuels for cooking (Census of India 2011). The adverse health effects of traditional, open-stove cooking with biomass are well documented and lead to an estimated 1 million premature deaths annually in India (Smith et al 2014). In this context, India is committed to transition to clean cooking fuels under the UN Sustainable Development Goals, and the cost and climate implications of such a transition need to be understood.

Buildings, on the other hand, represent the rapid urban transformation taking place. Buildings consume more than a third of the economy's electricity, and it is expected that two-thirds of India's 2030 building stock is yet to be built (Kumar et al 2010). Unlike traditional pathways to meeting energy goals, energy efficiency in the built environment offers multiple benefits that go beyond energy savings. The additional benefits include carbon mitigation, improved energy security, job creation, and better socio-environmental outcomes. However, if unaddressed, it is estimated that 1.2 gigatons of CO_2 emissions will be locked in as India's building energy demand increases fivefold over 2005 levels by mid-century (Urge-Vorsatz et al 2012).

We apply the proposed approach to these two cases as an illustration of MCDA's potential utility to Indian policymaking. The outcomes presented here are preliminary, notably because we relied on limited expert input and not on full stakeholder workshops. Hence, less salient than the final numerical results is the underlying thought process, method and approach. The input data for the cases, and part of the methodology in the buildings case, draw on NITI Aayog's India Energy Security Scenarios (IESS), a bottom-up energy accounting model (IESS 2015). This comprehensive database provides a useful starting point to undertake sectoral multi-objective analysis, as attempted here.

For both case studies, we define a set of national priorities and preferences, drawn from our understanding of the public discourse around Indian energy policy. In a formal decision-making context these objectives would ideally reflect clear political choices to guide energy and climate policy, while in a multi-stakeholder context, they would be arrived at through consultation and discussion. We refer to these national priorities as "branch"-level objectives (as opposed to specific objectives which we later refer to as "leaves"). Here we use four branch-level objectives:

- Economic: Economic considerations are fundamental to policymaking. India is in the midst of an urban, demographic and infrastructure transformation whose success rests on the economy's ability to grow, create jobs and secure its energy future.
- Social: It is important that the poorest and most vulnerable gain substantially from development policies that reduce poverty and inequality, improve access to quality and affordable goods and services, and also act as an engine for further development (Dubash et al 2013).
- Environmental: Development policies have environmental implications, which can have repercussions for human health and quality of life. Negative impacts need to be minimised locally, such as air pollution, and globally, as in the case of GHG emissions.
- Institutional: Ease of implementation is often neglected during policy evaluation either from oversight or because analysis is difficult. However robust policy assessment should account for implementation challenges, ex ante and ex post.

A MCDA approach provides a structured way to explicitly consider these objectives. Below are its detailed steps.[1]

Key Steps of a Policy Relevant MCDA Approach

Step 1: Define the problem. Identify the policy question's scope and time horizon by bringing all stakeholders on board at the start.
Step 2: Identify policy objectives and specific metrics for assessment. Understand national priorities and stakeholder needs.
Step 3: Identify policy alternatives to evaluate. Consider range of alternative policy options and the metrics for their success.
Step 4: Analyse the alternatives. Identify data gaps and provide a transparent analytical basis for discussions.
Step 5: Elicit stakeholder preferences and normalise quantitative and qualitative information. Integrate qualitative and quantitative information.
Step 6: Aggregate through weights and compare consequences. Capture the relative importance of policy objectives.
Step 7: Sensitivity analysis.Tests the robustness of the inputs and the process.
Step 8: Choose the preferred policy alternative. Implement the preferred alternative and evaluate results to feed back into the policymaking process.

Step 1: Define the Problem

Step 1, to carefully define the problem, serves many purposes—it ensures that the most relevant policy question is asked, that efforts are appropriately directed, and allows for defining a greater range of options for the answer. This first step should be undertaken with stakeholder input, and requires specifying the scope and time horizon of the decision question, both of which are central to articulating a clear decision problem.

The scope frames the larger policy problem: this includes identifying its jurisdiction, technological choices, and institutional arrangements. The impact of varying the question's scope is illustrated by our two cases. In the buildings example, one alternative is for the problem to be posed at the national level and to compare the benefits from the full range of efficiency measures between the commercial and residential sector. Or, the scope can be narrowed to examine the benefits in either the commercial or the residential sector. Similarly, the problem's technological scope can be varied: different efficiency measures, such as an efficient building envelope vs efficient appliances can be assessed; or, the focus can be on only one technology option that has a major impact. If the technological scope is limited to one efficiency measure, variability can be introduced by broadening the institutional focus through different policy instruments, all of which promote the same technology.

Since the purpose of this paper is to bring forth the different applications of a MCDA approach, we structure the questions with differing scope for the two case studies. In the buildings sector we focus on residential buildings, as 85%–90% of the new construction expected by 2030 will be for residential purposes resulting in a sharp rise in the associated energy demand (GBPN 2014). Further, we consider one technology—an energy efficient building envelope—since 70% of savings can be achieved by the envelope itself (GBPN 2014). The variation in the policy options is obtained from alternative institutional choices. The final policy problem is defined as: which policy options provide maximum benefits from India's residential real estate transformation, through new building envelope efficiency?

In the cooking case, by contrast we ask: which policy options promote access to various modern cooking fuels for rural households, in the context of achieving developmental goals in a climate-constrained world? Here, the problem's scope incorporates a broader set of technologies by highlighting the choice between alternative modern cooking fuels, all with similar institutional choices. And it also signals attention to the sustainable development context: issues such as drudgery, household air pollution and their adverse impacts on health and well-being form the context within which the analysis is undertaken. The sector is also relevant from a climate point of view as the use of modern fuels such as liquefied petroleum gas (LPG) and electricity lead to increased GHG emissions, while traditional cook stoves lead to high levels of black carbon emissions. The focus is on rural households where the energy access problem is acute, and for which various central and state modern fuel programmes exist.

The second necessary parameter of problem structuring is defining the time horizon. Policy impacts can be evaluated over the short, medium or long term, and either measured in a particular target year or aggregated over years. A shorter time frame allows for more accurate cost calculations, without assumptions of cost trajectories over the long term. On the flip side, a longer time horizon can widen possible policy choices as there is time for institutional capacity and technology choices to expand. Also, while measurement of impacts in a particular year provides straightforward comparisons with the targets set for that year, cumulative impacts can provide insight into the path taken to get there. We illustrate the use of different time scales as well as point and cumulative impacts through our case studies. The buildings case examines policy impacts in 2022 and the cooking case, by contrast, looks at cumulative impacts of policies over the period 2013–32.

Step 2: Select Specific Policy Objectives and Metrics for Assessment

After defining the policy problem, the next step is to flesh out the policy objectives. The overarching "branch" level objectives have been discussed earlier: economic, social, environmental and institutional. Step 2 requires identifying the next level of specific policy objectives, or "leaves," within these branch-level objectives.

The full objectives hierarchy is identified in three consecutive sub-steps, which results in the outcomes illustrated in Figures 1 and 2 (p 53) for the two cases. While our case studies use the two branch- and leaf-level tiers, in principle the objectives can be structured into a hierarchy with as many levels of detail as required. An alternative option is to structure a "flat" hierarchy where all the objectives are considered at the same level, although this is not explored further here.

The first sub-step of identifying objectives is to clarify, and potentially modify, the branch-level objectives which reflect a broad consensus about the type of development sought. As discussed already, we use the economic, social, environmental and institutional objectives based on our reading of energy policy priorities. In a MCDA application, these branch-level

Figure 1: Multiple Objectives and Policy Alternatives for the Cooking Sector Study

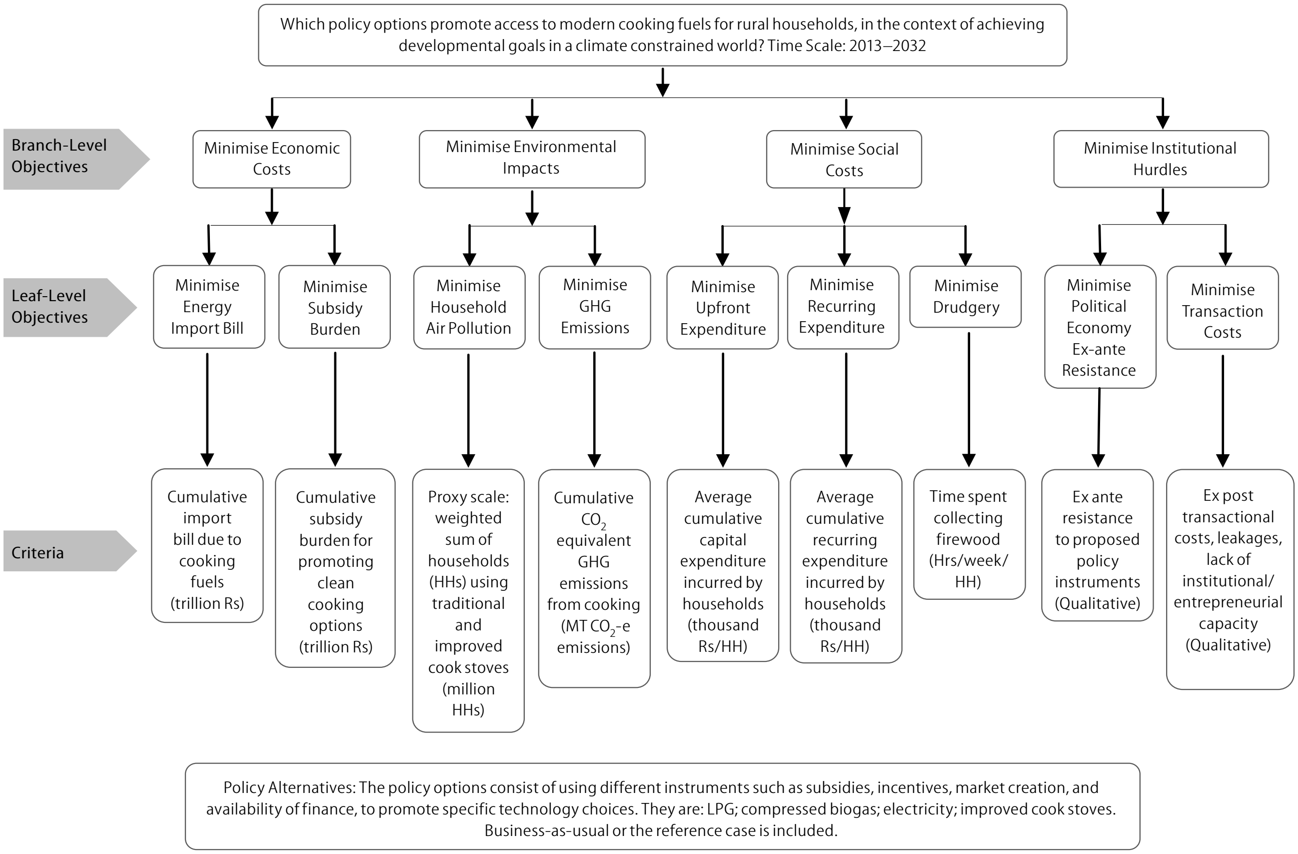
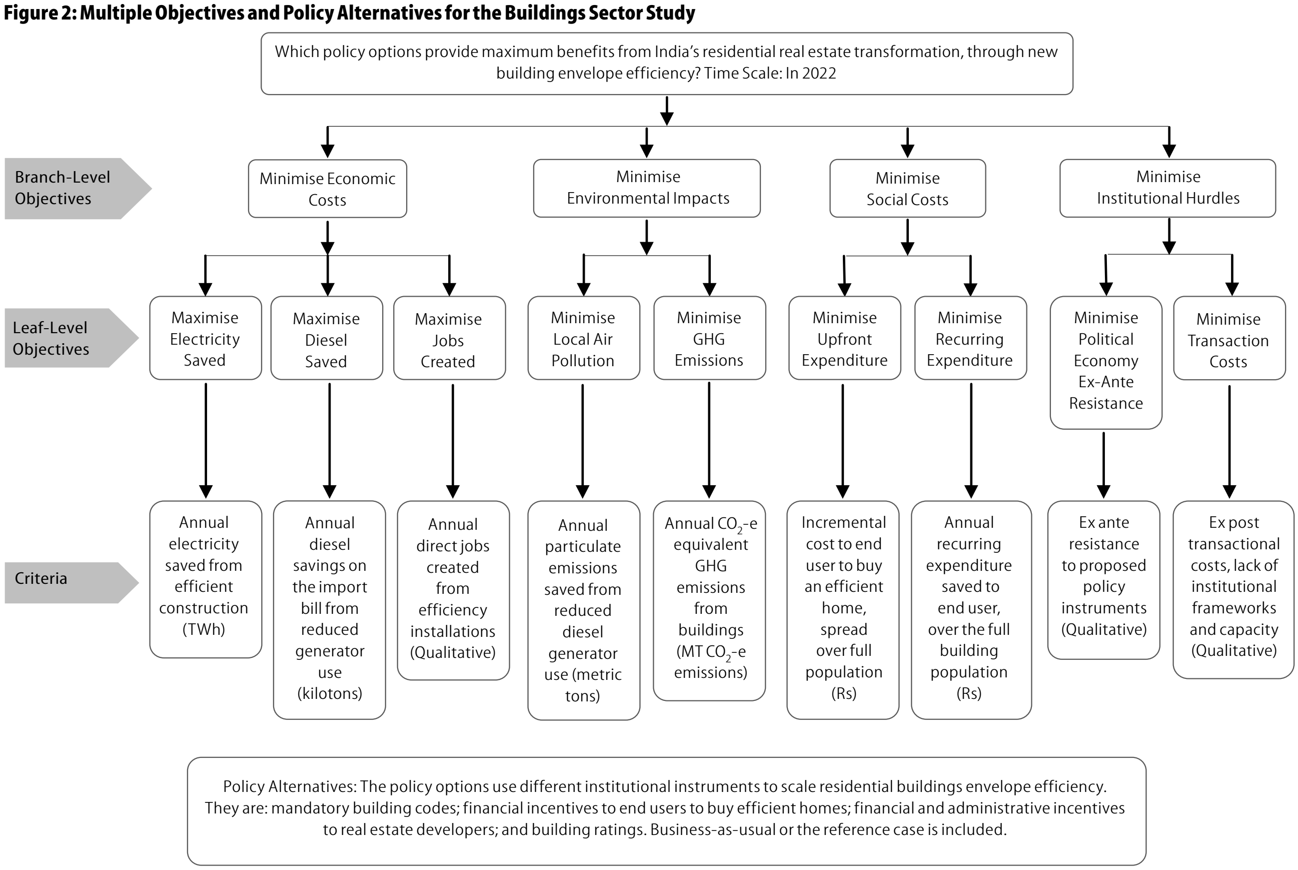


Figure 2: Multiple Objectives and Policy Alternatives for the Buildings Sector Study



objectives should be informed by political choices (such as policy or legal documents) and ideally be reinforced through stakeholder input from policy experts to ensure that they capture the current multiple and simultaneous demands of development. If needed, it is also possible to refine the branch-level objectives. For example, in some contexts it might be useful to explicitly include energy security as an objective. If such modification is made, however, it is important that the branch-level objectives transcend particular sectoral interests. That is, energy security could feasibly be included, but the decision should not be driven by the resultant implications for any one specific sector or policy.

The second sub-step requires identifying the next level of detail of the objectives, or the "leaves" within each branch. For example, in the buildings case, the branch-level objective of minimising social costs involves leaf-level objectives of affordability (based on upfront cost, which tend to be high) and recurrent expenditure from the use of energy efficiency measures (which tend to be low). Splitting affordability into these two subcategories captures two related, but distinct, elements of affordability.

The leaf-level objectives also need to be relevant to the particular policy problem being considered. Returning to the buildings case, we considered, but ultimately rejected, including a leaf-level category for indoor occupant comfort, even though it is valued socially. This is because the framing of the policy problem (in Step 1) focuses on a single technology (the buildings envelope) as a result of which all policy options, in spite of their different institutional choices, will result in the same level of occupant comfort. If the question was structured to allow for multiple technologies, then different policies could result in varying occupant comfort levels, which would have made it an important leaf-level objective.

The third sub-step is to convert the leaf-level objectives to specific criteria to assess the policy question. The criteria can be either quantitative or qualitative, as decided during stakeholder consultations. For example, the environmental branch for both cases includes a leaf-level objective of minimising GHG emissions, measured by estimating the CO_2 equivalent emissions from the respective sectors. The institutional branch, on the other hand, has leaf-level objectives of political economy and transaction costs, both of which are qualitatively determined. Political economy captures the possibility of likely ex ante challenges to implementing a policy in the form of interests who mobilise for or against a policy. Transaction costs captures elements salient to policy implementation ex post, which include capacity and skills required, scope for rent seeking, and the availability of specialised institutions.

There is a further important consideration when selecting objectives. In order to subsequently assess trade-offs across them, MCDA approaches require that the leaf-level objectives are "preferentially independent."[2] Put simply, this means that a judgment about how a policy option does in one leaf can be made without a priori knowledge about how the same policy fares in any other leaf (Basson 2004). For example, in the cooking case, the two leaf-objectives of minimising the subsidy burden and minimising household fuel cost are preferentially independent because evaluating a policy against one leaf-objective requires no knowledge of how the same policy does in the other leaf.

Step 3: Select Policy Options to Evaluate

The policy options to evaluate are selected *after* determining the objectives hierarchy (Step 2). This sequence allows for a greater range of options to be considered, with input from relevant stakeholders who are asked to identify wide-ranging policy options.

Since the policy problem for the cooking case is framed around alternative fuels, each policy option represents the promotion of a particular fuel or technology choice, through sets of policy instruments. For each option, it is assumed that best efforts will be made to increase adoption of clean cooking fuels by overcoming technological, economic and capacity challenges and through creation of new markets if needed.[3] The policy options considered for the cooking case are:

- To promote LPG as a cooking fuel by increasing rural LPG availability and affordability;
- To promote biogas by enabling an efficient feedstock market, encouraging entrepreneurial activity in biogas bottling operations and improving affordability through subsidies;
- To promote electricity for induction-based cooking through improved rural electricity access, combined with quality day and evening supply, and affordable tariffs; and
- To promote improved cook stove adoption through availability of clean burning, efficient and user-friendly cook stoves, and a diverse sustainable feedstock (fuel pellet and wood chip) market.

In the buildings case, since the question's scope requires all policy alternatives to promote a single technology, each policy considered has a different institutional focus. These are:

- To develop and adopt a mandatory energy code for new residential buildings;
- To provide financial incentives to consumers who buy efficient homes, to absorb the higher upfront costs;
- To provide administrative and financial incentives to real estate developers of efficient homes such as lower interest rate loans, increased floor–area ratio, and expedited processing; and
- To promote a voluntary rating system for efficient homes to motivate end users and developers to put a premium on energy efficiency.

The business-as-usual or reference case is considered in both case studies to benchmark against the current scenario.

Both sets of policy options were chosen after an iterative process with defining the decision question in Step 1. In practice, it is not uncommon to return to the first step and refine the decision problem in light of the policy options to evaluate. For example, for cooking the available policy options were spread across technologies and policy instruments. However, given the limited understanding of the trade-offs among the different technology choices, it was decided to focus on policy options that vary only by technology. The building energy policy context, on the other hand, is constrained by serious data gaps, making it evident at the outset that results would be more rigorous if the question in Step 1 assessed a single technology choice with institutional variability among the policy options. Iterations of this nature between clarifying the decision problem and the policy options allow decision makers to be guided by what is practically useful, as opposed to being bound to a theoretical methodology.

Step 4: Analyse the Policy Options

The next step is to assess each policy option along each objective. Depending on the objective, policies can either be assessed quantitatively (e g, quantum of CO_2-e reductions) or qualitatively (e g, institutional objectives). This equal emphasis on quantitative and qualitative metrics is important as policy decisions often have informal implications which cannot be immediately reduced to a number. Step 4 and the subsequent steps on normalising and weighting are the most technical, and below we only allude to the method to provide some intuitive understanding of the approach.

A visual assessment of the different policy options, per objective, is possible by creating a matrix with the policy options as rows and the leaf-level objectives as columns. Each cell of the matrix represents a policy's score for a particular leaf. We use the cooking case to illustrate the methodology for calculating the quantitative and qualitative cells within the matrix.

In some cases, a quantitative criterion is simply assessed using available data and literature. For example, GHG emissions from cooking for each fuel are derived from a combination of the annual average useful energy requirement for cooking per household, fuel calorific value, stove efficiency, and the fuel emissions factor. In other cases, a leaf-level objective that is difficult to measure could be quantified using a proxy. For example, health impacts of household air pollution are difficult to measure as they depend on often unknown factors such as the habitation type or the provisions for ventilation. Hence, we use a proxy scale by considering the number of households exposed to pollution, which is calculated as a weighted sum of the number of households using traditional and improved cook stoves, with higher weight for households with traditional stoves.[4]

Qualitative criteria, which entail value judgments and cannot be easily calculated, require a constructed scale that allows systematic scoring based on judgment. We construct a scale in the cooking case for the institutional leaf-level objectives of political economy (ex ante resistance) and transactional costs (ex post implementation costs). Specifically, a constructed scale of three levels (low, medium and high) is used. Scoring on this scale requires thinking through, assessing and providing rationale for the scores. For example, promoting LPG requires improving rural LPG adoption through subsidies, increased rural dealerships and improved cylinder availability. We argue there would be minimal ex ante resistance to such a policy because a large number of voters would benefit, and hence we assign a "low" score for political economy implying low resistance. On the other hand, given smaller habitations and lower rural population density, costs for transportation, operating dealerships and bottling plants would be high (World LP Gas Association 2005). A "high" score (implying hard to implement) is thus assigned for transactional costs.

Appendix 1 shows the analysis matrix for the social, economic and environmental branches in the cooking case (Table A1, p 58), and the institutional branch in the buildings case (Table A2, p 58).

Step 5: Normalising Quantitative and Qualitative Information

The matrix created in Step 4 makes explicit the quantitative and qualitative scores of different policy options across leaf-level objectives, in their respective units. Any assessment of trade-offs and synergies, however, requires the scores to be brought to a common scale or normalised. Moreover, the common scale cannot be assumed as linear but rather must reflect the preferences of stakeholders. The next step of the MCDA approach discussed in this paper uses "value function" analysis to achieve both these goals. Other MCDA approaches can use different methodologies for this step.

The different quantitative and qualitative policy scores at the leaf-level are mapped on to a common 0-100 scale by creating value functions. Technical details of arriving at a value function are given in Appendix 2 (pp 58–59), where we illustrate the process with an example from the cooking case. The process of producing value functions is designed to account for differing stakeholder preferences regarding the additional benefits from the policy at different levels.[5] This differing value to stakeholders, of marginal benefits at the lower end of the scale vs the higher end of the scale, determines whether the scale is linear or not—it is linear if the marginal benefits at all levels are the same, and non-linear if they are not.

At the end of this step, all scores (e g, the qualitative "high/medium/low" scores and the quantitative scores in their respective units) are mapped, and translated, to values between 0 and 100. These values make leaf-level objectives comparable and possible to aggregate.

Working through the value function exercise facilitates greater understanding about the decision problem, its challenges, and mutual learning about the preferences of those involved. It rests heavily on consultations, and often brings forth the competing perceptions of relevant stakeholders. Ways of dealing with differing stakeholder perceptions are discussed at the end of this section.

Step 6: Aggregation through Weights

Value functions provide a normalised score for each policy option across all the leaf-level objectives. The next step of decision-making is to aggregate these value scores to capture how a policy does at the branch level. In order to aggregate, however, the relative importance or weight of each leaf-level objective needs to be deliberatively determined. In other words, one cannot assume, for instance, that the gains to stakeholders from minimising household or local air pollution are valued equivalently to the gains from minimising global GHG emissions.

Answer difficult questions about which objectives stakeholders value most is central to weighting. For example, in the cooking case, is minimising upfront expenditure more valued than minimising a recurring expenditure, and how do these compare with minimising drudgery? These trade-offs are often made implicitly by policymakers and may not accurately reflect stakeholder perceptions. As in previous steps, weighting requires facilitation across stakeholders as different groups could rank objectives differently and/or be willing to trade them off differently.

One technique to determine the relative importance of leaf-level objectives is trade-off weighting (Basson 2004). Its first stage is for stakeholders to identify the most important leaf within the branch. Then, through the weighting exercise, stakeholders identify how much of the benefit from the most important leaf they are willing to trade, to obtain the maximal benefit from another leaf within the same branch. Technical details of the weighting process are presented in Appendix 3 (p 59). The method results in the relative weights of the leaf-level objectives per branch, which enables aggregation of leaf-level scores within a branch. The process can be extended iteratively to obtain the relative weights of the branch-level objectives too. In our case studies, we do not weigh the branches against each other. Instead, we obtain one score per branch or a 4-dimensional score for each policy option to better visualise the trade-offs among the social, economic, environmental and institutional objectives. These results are discussed in the next steps.

Step 7: Sensitivity Analysis

The outcomes of a MCDA exercise should be subject to sensitivity analysis to evaluate the robustness of the inputs and process followed. As discussed, there may be widely varying inputs during consultations which result in different value functions or weights. Similarly, changes to assumptions, e g, fuel penetration trajectories under different cooking fuel policies, can dramatically alter final scores. The robustness of inputs can be evaluated by choosing alternative inputs and checking for any inordinate changes in the final ranking of policy options against each objective. If the ranking changes, the corresponding inputs need to be interrogated and the process repeated. For example, changing the trade-offs between recurring expenses, upfront expenses and drudgery time within a reasonable range does not change the final order of the cooking policy options on the social branch, suggesting that the ranking is fairly robust.

Step 8: Choosing the Preferred Policy Option

The above steps lead to an evaluation of each policy option across each objective, and make explicit the complementarities and trade-offs between objectives.

The preliminary results for the two case studies are shown in Figures 3 and 4. For the cooking case (Figure 3), all policy options do well in comparison with the reference case on the social branch-level objective. This is primarily due to the increased subsidy to clean burning fuels or technologies resulting in reduced costs and drudgery. The options promoting modern cooking fuels do better environmentally as they reduce household air pollution and marginally lower GHG emissions.[6] For institutional and economic objectives, however, the reference case does better since it is a path of least institutional resistance

Figure 3: Illustrative MCDA Results for the Cooking Sector Study

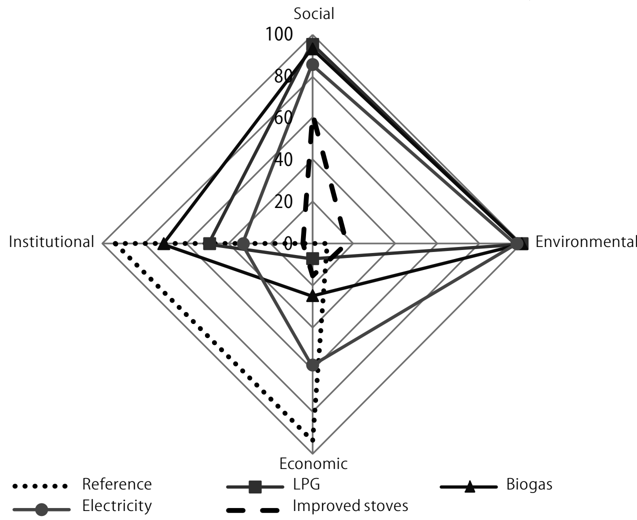
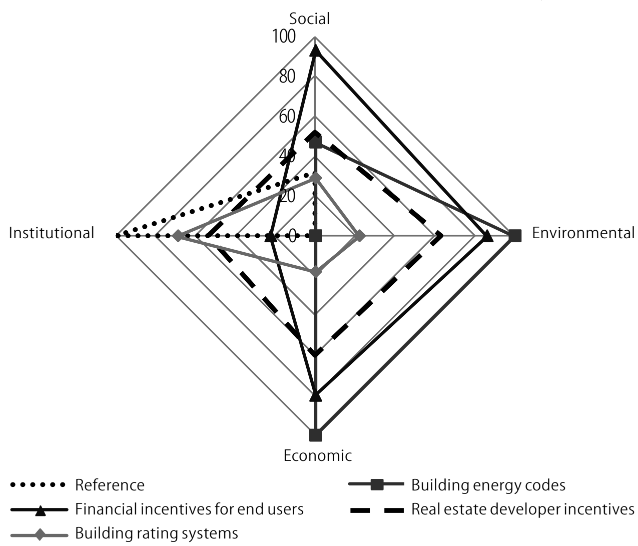


Figure 4: Illustrative MCDA Results for the Buildings Sector Study



and requires minimal additional subsidies, making the trade-offs primarily with respect to both these branches. In essence, the analysis concludes that policies pushing modern fuels achieve better social and environmental outcomes but require institutional and financial commitment.

The buildings case results are presented in Figure 4. The policy option targeting end-users scores well on the economic, social and environmental branch objectives, but with significant institutional challenges. As end user incentives are targeted to home owners who would invest in horizontal construction (as opposed to the real estate developer incentives which are more geared towards high rise construction), the results suggest that in the short term, horizontal construction offers more opportunities from energy efficiency than high-rise buildings. The trade-offs which emerge are mainly institutional and often social. For instance, while the building codes policy scores highly on most fronts, unless the institutional issues of ineffective code compliance structures and inadequate technical capacity are addressed separately, the option is not feasible. For the social objective, higher upfront costs make efficiency adoption difficult, except when end user financial incentives are provided. Ratings and the reference case perform poorly on most branches, but with least institutional resistance as they require little change from the status quo.

Dealing with Differing Preferences amongst Stakeholders

The approach presented in this paper assumes a relatively homogeneous stakeholder group that will be able, albeit with some negotiation, to reach consensus on all aspects of the decision cycle: from determining the objectives, to the shape of value functions and weighting for scoring policy options. If however, no clear winners or losers emerge from policy options because of conflicting stakeholder views, the approach can be used to facilitate further deliberation on the trade-offs and ways to improve the policy options. For instance, a potential option can be identified, ranked second or third by each group that will be acceptable to everyone. Where there is potential, compensation can also be given to parties to overcome a blockage. This ability to interrogate the transparent decision process is one of the prime advantages of MCDA techniques.

4 Conclusions

Development policymaking, which incorporates energy and climate considerations, is a complex undertaking. It involves multiple objectives and various actors with differing agendas. The MCDA approach proposed in this paper offers a potentially useful way to work within this complexity, requiring decision-makers to ask policy relevant questions and identify complementarities and trade-offs. At the same time, MCDA approaches can be perceived as complicated and are not trivial to implement. Our intent is to put forward a multi-criteria approach less as a rigid decision tool, and more as a framework to facilitate structured discussion.

This intent is motivated by the need for rigorous judgment embedded within a process of transparent discussion to overcome the pathologies in our current decision-making processes. For instance, policy decisions routinely involve implicit trade-offs as a default, but which are not articulated either in the decision process or outcome. The recent target of increasing domestic coal production from 600 MT to 1,000 MT by 2019 is a case in point. While accelerating growth rates of domestic production can increase energy security and perhaps provide cheaper electricity in the short to medium term, this is only one aspect of the necessary policy context. The local environmental consequences of coal use on air pollution and water stress should be equally presented as outcomes of the policy decision. Another example is India's stated co-benefits basis for climate policy, which is conceptually promising but not yet backed by an explicit methodology. The absence of the latter opens the country up to questions of credibility and locks us into long-term energy decisions that are not informed by comprehensive analysis.

MCDA approaches do not provide an easy answer to these complex issues. However, they offer a way to focus on a good process as the starting point for a good answer, and refine understanding over time starting from our current benchmark. If MCDA approaches are to be taken forward in policymaking, they raise a few considerations. The first is the need to involve stakeholders from the start with a commitment to deliberation. This can require working against current policymaking processes which may not foster engagement across groups with differing agendas. Second, executing a MCDA approach requires time, capacity and resources. Often it is data intensive, requiring extensive input from decision analysts and stakeholders. As a starting point, the approach could be led by policymakers, think tanks, universities or civil society groups. A ratcheting strategy can be used to introduce MCDA principles into policymaking, such as starting with an identification of all stakeholder groups and explicitly using the information gathered in the discussions for decision-making. Subsequently, more structure can be introduced to the process by moving towards explicit identification of objectives, then gradually towards value function and weighting exercises. An identification of enabling conditions and supporting tools (for example, the IESS) will also be needed to deliver credible results. A MCDA expert can also be brought into the process to assist with technicalities.

Irrespective of the details of how the approach is operationalised, MCDA fosters more transparent policymaking about underlying assumptions, sensitivities, and trails of argument that lead to a particular result. This emphasis on communication and audit trails regarding decisions can benefit our status quo and is relevant across timescales. In the immediate climate context, it would strengthen coherence between India's domestic and international position on climate change which rests on the principle of not compromising development objectives. Further, it can be employed to distinguish between additional climate actions that India could undertake with external aid which fall outside the scope of co-benefits. In the longer term, it can be used for other opportune planning purposes and gradually be introduced into other spheres of policymaking such as health and education, amongst others.

Ultimately, successful implementation of the approach will likely generate evidence to build capacity within and outside the government to have a more open, considered, and involved approach to policymaking. Such a robust policy-planning framework can allow for India's energy and climate actions to be compatible with its broader social, economic and environmental goals.

NOTES

1 Note that these steps need not be linear, and there could be iteration between some steps.

2 Preferential independence is *not* the same as mathematical independence.

3 Promotion of one particular fuel does not imply negative growth in the adoption of the other clean cooking options.

4 As modern fuels do not lead to household air pollution they have zero weight in the proxy scale calculation, and hence do not contribute to the final sum. Greater the proxy score, greater the impact of household air pollution.

5 That is, if the range of possible savings is Rs 100 to Rs 500, stakeholders need to determine whether increasing savings of Rs 200 from Rs 100 to Rs 300 is more, or less, or as valuable as increasing savings of Rs 200 from Rs 300 to Rs 500.

6 GHG emissions are lower in these cases due to reduced black carbon emissions.

7 Subsidies in the reference scenario taper off over the 20-year period starting from the current

base of government programmes. Subsidies for each fuel remain at current levels. A full subsidy for upfront costs is assumed for all BPL households under each policy scenario. Trend analysis for population, technology penetration rates, electricity generation mix, and fuel imports is based on IESS. Annual energy requirement for cooking, emission factors, stove and fuel costs are from Jain, Choudhary and Ganesan (2015) and fetching time for biomass is from IHDS (2010).

8 If the relative value of going from A_i to C_i is the same as going from C_i to B_i (and so on, iteratively), the value function acquires a linear form.

9 The actual difference of Rs 2,220 translates to Rs 15,170 when an additional discount rate of 4% is applied.

REFERENCES

Angelou, Nicolina and Mikul Bhatia (2014): "Capturing the Multi-dimensionality of Energy Access," Live Wire Knowledge Note Series; No 2014/16, Washington DC: World Bank Group, available at http://documents.worldbank.org/curated/en/2014/06/19670596/capturing-multi-dimensionality-energy-access.

Basson, Lauren (2004): "Context, Compensation and Uncertainty in Environmental Decision Making," doctoral thesis, University of Sydney.

Census of India (2011): Houselisting and Housing Census Data, available at: http://www.censusindia.gov.in/2011census/hlo/HLO_Tables.html.

Cox, S, J Katz and Laura Würtenberger (2014): *Assessing Development Impacts Associated with Low Emission Development Strategies: Lessons Learned from Pilot Efforts in Kenya and Montenegro.* Technical Report, National Renewable Energy Laboratory.

DEA, Republic of South Africa (2014): *South Africa's Mitigation Potential Analysis*, Pretoria: Department of Environmental Affairs.

Dubash, Navroz K, D Raghunandan, Girish Sant and Ashok Sreenivas (2013): "Indian Climate Change Policy: Exploring a Co-Benefits Approach," *Economic & Political Weekly*, Vol XLVIII, No 22, pp 47-61.

Dubash, Navroz K, Radhika Khosla and K Rahul Sharma (2015): *Informing India's Energy and Climate Debate: Policy Lessons from Modelling Studies*, New Delhi: Centre for Policy Research.

GBPN (2014): *Residential Buildings in India: Energy Use Projections and Savings Potentials*, Global Buildings Performance Network.

GGGI (2014): *Green Growth Strategy for Karnataka*, Seoul: Global Green Growth Institute.

IESS, India Energy Security Scenarios 2047 (2015): Available at: indiaenergy.gov.in.

Institute for Global Environmental Strategies (IGES) (2014): *Bringing Development and Climate Together in Asia,* Asian Co-benefits Partnership (ACP) White Paper 2014, Tokyo: Ministry of Environment, Japan.

IHDS (2010): "Household Assets and Amenities." *Human Development in India: Challenges for a Society in Transition*, 64–66, Oxford.

Jain, Abhishek, Poulami Choudhary and Karthik Ganesan (2015): *Clean, Affordable and Sustainable Cooking Energy for India- Possibilities and Realities beyond LPG*, New Delhi: Council on Energy, Environment and Water.

Kumar, S, R Kapoor, R Rawal, S Seth and A Walia (2010): *Developing an Energy Conservation Building Code Implementation Strategy in India*, New Delhi: USAID India.

Mitigation Action Plans and Scenarios-Chile (2015): Available at http://www.mapschile.cl.

Narula, K, B S Reddy and S Pachauri (2015): *Sustainable Energy Security for India: An Assessment of Energy Demand Sub-System*, Mumbai: IGIDR, available at http://www.igidr.ac.in/pdf/publication/WP-2015-013.pdf.

Rao, Narasimha D, David McCollum, Navroz K Dubash and Radhika Khosla (2015): *Development and Climate Policy Synergies: Insights from Global Modelling Studies*, Policy Brief, New Delhi: Centre for Policy Research.

SSEF (2015): *An Energy Security Index for India*, New Delhi: Shakti Sustainable Energy Foundation.

Smith, Kirk R et al (2014): "Millions Dead: How Do We Know and What Does It Mean? Methods Used in the Comparative Risk Assessment of Household Air Pollution," *Annual Review of Public Health*: 185–206.

Sreenivas, Ashok and Rakesh K Iyer (2015): "A 'Dashboard' for the Indian," *Economic & Political Weekly*, Vol L, No 11, pp 13–16.

Sun, Qie, Bo Xu, Ronald Wennerstern and Nils Brandt (2010): "Co-benefits of CDM Projects and Policy Implications," *Environmental Economics*, Volume 1, Number 2.

TERI (2012): *Assessing Impact of the Clean Development Mechanism on Sustainable Development and Technology Transfer*, New Delhi: The Energy Resources Institute.

UNEP (2011): *A Practical Framework For Planning Pro-Development Climate Policy*, Nairobi: United Nations Environment Programme.

Urge-Vorsatz, Diana, Ksenia Petrichenko, Miklos Antal, Maja Staniec, Michael Labelle, Eren Ozden and Elena Labzina (2012): "Best Practice Policies for Low Energy and Carbon Buildings. A Scenario Analysis," research report prepared by the Center for Climate Change and Sustainable Policy (3CSEP) for the Global Buildings Performance Network.

Ürge-Vorsatz, Diana, Sergio Tirado Herrero, Navroz K Dubash and Franck Lecocq (2014): "Measuring the Co-Benefits of Climate Change Mitigation," *Annual Review of Environment and Resources*, 39: 549–82.

World LP Gas Association (2005): *Developing Rural Markets for LP Gas: Key Barriers and Success Factors.*

WRI (2014): Climate Analysis Indicators Tool (CAIT), World Resources Institute, available at: http://cait2.wri.org/wri.

Appendix 1

Table A1 shows the matrix from Step 4 for the cooking case, for the social, environmental and economic objectives (all quantitative). The scores are all aggregated for the period 2012–32. For the social objective, scores are averaged at a household level, and the aggregate time spent in fetching firewood is averaged to number of hours spent per week for each household (HH).[7]

Table A1: Elements of the Cooking Case Analysis Matrix

Policy Options	Social			Environmental		Economic	
	Capital Expenditure (000 Rs/HH)	Recurring Expenses (000 Rs/HH)	Time Spent (Hours/Week/HH)	Household Air Pollution (Million HH Years)	GHG Emissions (MT CO_2-e)	Subsidy Burden (Rs Trillion)	Energy Import (Rs Trillion)
Reference	14.1	197	2.3	316	5,226	4	12
LPG	12.4	174	1.9	237	4,476	11	16
Biogas	11.8	182	1.9	237	4,513	11	11
Induction	13.5	174	1.9	237	4,732	7	12
Improved stoves	13.6	175	2.2	346	4,780	12	9

Table A2, provides the matrix column resulting from the institutional objective of the buildings case. We select the buildings case to demonstrate the qualitative assessments across policies as each buildings policy option is defined by a different policy instrument (as opposed to the cooking case where each policy option employs a variety of policy instruments, making its institutional assessment less straightforward).

Table A2: Elements of the Buildings Case Analysis Matrix

Policy Options	Institutional	
	Political Economy ex ante Resistance	Transactional ex post Costs
Reference	Low	Low
Codes	High	High
End-user incentives	Medium	High
Developer incentives	Medium	Medium
Ratings	Low	High

The "low" scores in Table A2 imply that the policy option has low costs either ex ante or ex post to its implementation. For example, continuing with the status quo in the reference case invites little opposition and thus does well on these two institutional leaf objectives. A "high" score, on the other hand, means that the policy will have high resistance to it and be difficult to implement. Building codes, because of the upfront resistance to them from real estate developers, and the low state and technical capacity to implement them even if they are made mandatory, score poorly on both leaf objectives.

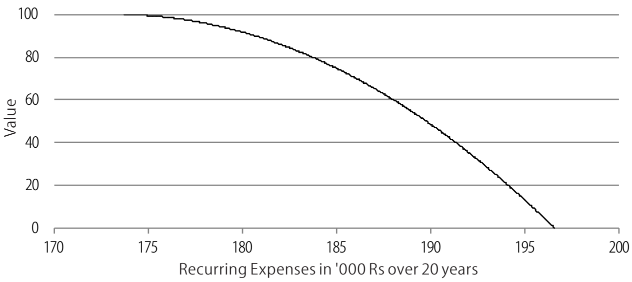
Appendix 2

The analysis matrix from Step 4 (Appendix 1) can be normalised with value functions where each policy's score (or matrix cell) is mapped to a value between 0 and 100. For each leaf objective (i), a value of 0 is assigned to the worst score (A_i), and of 100 to the best score (B_i). A value function that internalises stakeholder preferences can then be drawn between the best and worst scores for each leaf. This is done by selecting the midpoint (C_i) between the worst (A_i) and best (B_i) scores.

The value of C_i (between 0 and 100) corresponds to the relative value, to the stakeholders, of going from A_i to C_i and from C_i to B_i. The process is iterative for subsequent midpoints between A_i and C_i and between C_i and B_i until a value function is constructed with sufficient resolution.

For example, in the cooking study, the recurring household expenditure ranges between Rs 1,74,000 and Rs 1,97,000 aggregated over 20 years, which translates to a yearly range of Rs 8,700 (best) to Rs 9,850 (worst). Their midpoint is approximately Rs 9,275 per year. Consultations, especially with poorer households, could reveal that reducing running expenses from Rs 9,850 to Rs 9,275 is more than twice as valuable as reducing them from Rs 9,275 to Rs 8,700—because poor households tend to have fixed budgets beyond which any expenses are difficult to meet. The preference would translate to a value score of 70 for the Rs 9,275 data point, as reducing expenses at the higher end is valued more than at the lower end. This process is iteratively repeated to construct the value function shown in Figure A1.[8]

Figure A1: Value Function for Recurring Household Expenses for the Cooking Study



Appendix 3

One of the MCDA techniques to understand the relative importance of leaf-level objectives is trade-off weighting, described here. First, the most important leaf objective within the branch is identified (D_1). The weight for each leaf, D_x, is arrived at by determining how much of D_1 can be traded for increasing the value of D_x from 0 to 100. The trade-off value (g_x) for each leaf is determined through consultations.

The weight for each leaf-level objective, D_x, is calculated as: $w_x = g_x / \sum g_x$. The branch-level score for each policy option is calculated as $\sum (v_i * w_x)$, where v_i is normalised value of the policy option for the leaf-level objective, D_i.

A short example from the cooking social objective follows. The most important social leaf objective is assumed to be recurring household expenses. Another social leaf objective, upfront expenditure, varies from a maximum household cost of approximately Rs 14,000 (value of 0) to the lowest cost of Rs 12,000 (value of 100) (Table A1). Since the rural poor exhibit high discount rates we estimate that to reduce upfront cost by the difference of Rs 2,000, households would be willing to increase their recurring costs by Rs 15,000 over the 20-year period.[9] This increase of Rs 15,000 corresponds to a value of 73 according to the recurring expenses value function, determined in the previous step (Figure A1). That is, stakeholders are willing to give up a value of 27 on a scale of 100 in recurring expenditure to make the maximum possible reduction in upfront costs. A similar process is followed for leaves within the social branch: drudgery is traded against recurring household expenses by monetising the average time spent collecting firewood using minimum wages.

The illustrative trade-off calculations are presented in Table A3. In the absence of extensive stakeholder consultations, the numbers demonstrate the steps involved in a multi-objective analysis and are not intended to replace actual deliberations. However, such methodological insights could be useful to inform deliberations and arrive at a consistent approach to resolve differences.

Table A3: Illustrative Weights for the Social Branch-level Objective of the Cooking Case

Leaf-level objective →	Capital Expenditure (000 Rs/House)		Running Expenses (000 Rs/House)		Time Spent (Hours/Week/House)		Branch Score
Policy Options ↓	Cost	Value	Cost	Value	Cost	Value	
Ref	14.1	0	197	0	2.25	0	0
LPG	12.4	76	174	100	1.88	100	95
Biogas	11.8	100	182	86	1.88	100	93
Induction	13.5	26	174	100	1.88	100	86
Improved cook stoves	13.6	19	175	99	2.16	25	62
Trade-off value (g_x)	38		100		58		
Weight (w_x)	0.20		0.51		0.29		