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Attitudes, Perceptions, and External Barriers to Household Clean Energy Adoption in the Fergana Valley

by Kasiet Toktogulova

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Executive summary

Household clean energy adoption in the Fergana Valley remains slow and uneven despite growing policy attention to renewable energy and widespread awareness of the harms associated with dirty fuels. Across Kyrgyzstan, Tajikistan, and Uzbekistan, many households continue to rely on coal, firewood, biomass, and other polluting fuels, especially during winter. This reflects not only environmental and health concerns, but also deeper problems of energy insecurity, unreliable supply, and unequal access to modern energy systems.

This policy brief examines the main drivers of household clean energy adoption using data from the CAREC 2023 Household Access to Energy in the Fergana Valley Survey. The analysis shows that economic and structural factors are the strongest determinants of adoption. Higher household income is associated mainly with full adoption, while high energy costs, perceived unaffordability, and ruralness of residence significantly limit the transition to cleaner fuels. In many cases, households respond to these pressures by combining modern and traditional fuels rather than fully replacing dirtier sources. This means that fuel stacking is often a coping strategy shaped by risk, affordability, and weak infrastructure rather than a simple failure of transition.

Behavioural factors, such as health and environmental concerns, energy-saving behaviour, and perceptions of technology also have an impact, but their effects are more limited and conditional. Awareness alone does not lead to clean energy adoption when households lack affordable, reliable, and practical alternatives. Country differences remain significant, reflecting variation in national energy systems and infrastructure across

the Valley. Based on these findings, the brief suggests several policy changes. Efforts to improve household clean energy adoption should focus first on affordability, reliability, and access, especially for rural households. Targeted financial support, better infrastructure, and more dependable winter energy supply are essential for reducing dependence on polluting fuels. At the same time, policy should recognize that gradual transition and cleaner fuel stacking may be more realistic in the short term than immediate full switching. Broader supply-side diversification, including renewables and other low-carbon energy developments, may improve long-term conditions, but household-level transition will depend on whether cleaner options become genuinely practical, affordable, and trustworthy for everyday use.

Keywords: Clean energy adoption, household energy transition, fuel stacking, Fergana Valley, Central Asia, energy poverty, rural households, energy affordability, energy reliability, energy policy

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Introduction

One of the most crucial challenges globally regarding sustainability is the energy transition.¹ The emergence of an unprecedented rate of climate change, the harmful impacts of non-renewable energy sources, and the declining availability of fossil fuel reserves, alongside increased energy market tensions and escalating energy consumption, all exacerbate the urgency and importance of the adoption of renewables. 2025 data from the International Energy Agency (IEA) show that energy-related emissions of carbon dioxide reached a peak of 37.8 Gt CO₂.² Since household consumption (heating, cooking, water heating) accounts for a substantial share of final energy demand (~21 percent), individual energy choices are central to achieving both energy access and emission reduction goals.³ Despite international commitments such as the Sustainable Development Goals (SDG 7, SDG 13)⁴ and the Paris Agreement, access to affordable, reliable, and modern energy remains uneven, especially in developing economies where, due to historical circumstances, infrastructure limitations and affordability constraints persist.

Central Asia's Fergana Valley presents a particularly salient case. It is a densely populated and agriculturally important region shared by Kyrgyzstan, Tajikistan, and Uzbekistan. Despite possessing substantial renewable energy potential, the population of 13 million faces critical energy problems mainly because of seasonal power shortages, outdated infrastructure, and a heavy reliance on fossil fuels. The countries differ in their dominant energy systems, but all face serious household-level pressures. Kyrgyzstan and Tajikistan primarily produce their energy through hydropower, yet both remain vulnerable to winter power shortages. Uzbekistan, despite its strong natural gas base, also faces recurring supply disruptions. Therefore, all three nations' households turn to the use of coal and wood for warming and for cooking purposes in winter. As a result, the use of dirty fuels contributes substantially to indoor and outdoor air pollution. The World Bank recognizes household

¹ The term "energy transition" is used to describe the systemic shift from a fossil-fuel-based energy sector toward one based on renewable and low-carbon energy sources, as well as the associated changes to infrastructure, markets, and consumer behaviour.

² IEA, "CO₂ Emissions – Global Energy Review 2025 – Analysis - IEA," IEA, 2025, <https://www.iea.org/reports/global-energy-review-2025/co2-emissions>

³ IEA, "Buildings," Energy System, July 11, 2023, <https://www.iea.org/energy-system/buildings>

⁴ United Nations, "The 17 Goals," *United Nations Sustainable Development Goals*, <https://sdgs.un.org/goals>

air pollution created by solid fuels as a major cause of respiratory illnesses in Central Asia, and thus a cause of a large portion of the region's total disease burden.⁵ Although all three countries have established renewable energy targets, the speed of transition remains slow, and energy poverty persists.

What makes this issue especially important is that the slow transition cannot be explained by infrastructure and affordability alone. In the Fergana Valley, household energy choices are also shaped by habit, perceived reliability, and past experience with unstable supply. Many households are aware of the health and environmental harms associated with traditional fuels yet still continue to use them because cleaner options are often too expensive or inaccessible.⁶ This is why the problem is partly behavioural: awareness of the health and environmental risks of solid fuels does not automatically lead to cleaner energy use.

This policy brief argues that the main barriers to household clean energy adoption in the Fergana Valley are affordability, reliability, and access, while behavioural factors matter when households already have the means to act on them. Consequently, this policy brief provides possible solutions to the region's critical energy challenges.

Regional Background

The Fergana Valley has one of the most distinctive energy systems: it is both energy-abundant and energy-insecure. The region's energy challenges are shaped by geography, climate, and history. Winters can fall below -20°C , and summers can rise above 35°C , creating strong demand for heating and cooling,⁷ while much of the local infrastructure remains too weak or outdated to meet household needs. In some parts of the region, electricity losses from transmission and distribution are estimated at around 20 percent,⁸ further deepening supply pressures.

⁵ World Bank, "Air Quality Management in Central Asia" (World Bank, April 2025).

⁶ Nicolas Hamelin and Ishaq M. Bhatti, "Energy Usage, Health Issues, and Pro-Environmental Behaviour: Exploring the Link and Promoting Energy Change in Kyrgyzstan," *Energies* 16, no. 19 (January 1, 2023): 6858, <https://doi.org/10.3390/en16196858>

⁷ CAREC Institute and ADBI, *Household Access to Energy in the Fergana Valley*.

⁸ M. Ardelean, P. Minnebo, and H. Gerbelova, *Optimal Paths for Electricity Interconnections between Central Asia and Europe*, EUR 30156 EN (Publications Office of the European Union, 2020), <https://doi.org/10.2760/95740>.

These problems are closely tied to the Soviet legacy. During the Soviet period, energy and water systems were coordinated across republics through an integrated regional network: upstream Kyrgyzstan and Tajikistan supplied hydropower and water for irrigation, while downstream Uzbekistan provided gas, coal, and oil. The balance failed after independence as every nation sought energy self-sufficiency, subsidies were more difficult to sustain, and regional coordination deteriorated. This led to higher winter deficits, more interstate strain on water and power, and a reliance on polluting energy sources by an increasing number of households.

Although the dominant energy systems differ across the three countries, all of them face persistent supply constraints that keep households tied to traditional fuels. Kyrgyzstan and Tajikistan generate about 90 percent of their electricity from hydropower, yet winter shortages remain severe.⁹ In rural Tajikistan, 74 percent of all citizens rely on coal or biomass stoves for cooking, and more than 65 percent of all households use wood or coal as their primary source of heat.¹⁰ Similarly, in the Kyrgyz Republic, fossil fuel makes up approximately 72 percent of the country's energy mix,¹¹ with reports indicating that more than 60 percent of households continue to rely on coal for warming during the peak winter months.¹² In Uzbekistan, natural gas accounts for nearly 80 percent of the national energy mix,¹³ but frequent supply disruptions still force many households to fall back on coal and firewood.¹⁴

At the household level, energy use in the Fergana Valley is shaped not only by infrastructure and prices, but also by everyday practices and cultural habits, as well as by risk perception and trust in energy systems. For instance, traditional cooking and heating methods, such as tandoor ovens, cauldron (“kazan”) cooking, and dual-purpose stoves, remain important because they are familiar, multifunctional, and often seen

⁹ IAE, “Kyrgyzstan Energy Profile – Analysis,” IEA (IAE, April 15, 2020), <https://www.iea.org/reports/kyrgyzstan-energy-profile>

¹⁰ UNECE, “In-Depth Analysis of Coal Demand Dynamics in Tajikistan until 2050” (UNECE, 2022), <https://unece.org/depth-analysis-coal-demand-dynamics-tajikistan-until-2050>

¹¹ UNECE, “Energy Policy Brief: Kyrgyzstan” (UNECE, 2024), <https://unece.org/sites/default/files/2024-09/kyrgyzstans%20%287%29.pdf>

¹² World Bank, *Fueling Kyrgyzstan's Transition to Clean Household Heating Solutions: Final Report* (World Bank, May 2020), Report No: AUS000150.

¹³ IEA – Uzbekistan Natural Gas Profile International Energy Agency, “Uzbekistan: Natural Gas,” *IEA Country Report*, <https://www.iea.org/countries/uzbekistan/natural-gas>

¹⁴ International Energy Agency (IEA), *Uzbekistan 2022* (IEA, 2022), <https://www.iea.org/reports/uzbekistan-2022>

as more reliable than cleaner alternatives. Across the three countries, households often rely on fuel stacking not only as a response to external constraints but also as a behaviour rooted in everyday routines, familiarity, and perceptions of reliability.

All three states have introduced policy measures aimed at diversifying their energy systems, though progress remains uneven. Kyrgyzstan adopted the “Law on Renewable Energy Sources”¹⁵ and has promoted small hydropower and pilot solar projects, while large hydropower expansion, especially around Kambarata, has regained attention. Tajikistan has also adopted the “Law on Utilization of Renewable Energy Sources,”¹⁶ but in practice continues to rely mainly on hydropower and large-scale projects such as the Rogun Dam. Uzbekistan has moved furthest in formal diversification, adopting the “Law on the Use of Renewable Energy Sources” in 2019,¹⁷ setting targets for 5 GW of solar and 3 GW of wind by 2030,¹⁸ and more recently launching the construction of a small modular nuclear power plant, expected to generate about 17.2 billion kWh annually, or roughly 14 percent of national energy demand.¹⁹ These efforts show that governments are actively seeking alternatives, even though household-level energy insecurity remains widespread across the Valley.

Methodology and Theory

The study builds on two key theoretical perspectives from the literature on household energy transitions. As per the Energy Ladder Model developed by Leach, an increase in income is expected to lead to a transition to modern fuels.²⁰ However, this purely linear framework has been widely challenged by the Energy Stacking Model by Masera et al.,

¹⁵ Kyrgyz Republic, *Law on Renewable Energy Sources*. No. 283, December 31, 2008; amended by Law No. 155, July 25, 2019; Bishkek

¹⁶ Republic of Tajikistan, *Law on the Use of Renewable Energy Sources*. No. 524, July 26, 2010; amended by Law No. 1233, December 26, 2015; Dushanbe

¹⁷ Republic of Uzbekistan, *Law on the Use of Renewable Energy Sources*. No. ZRU-539, May 21, 2019; amended 2024. Tashkent

¹⁸ IEA, *Solar Energy Policy in Uzbekistan: A Roadmap*, International Energy Agency, 2021.

¹⁹ World Nuclear News, “Uzbekistan and Russia Mark SMR Construction Progress,” World Nuclear News, March 24, 2026, <https://www.world-nuclear-news.org/articles/uzbekistan-russia-mark-smr-construction-progress>

²⁰ Gerald Leach, “The Energy Transition,” *Energy Policy* 20, no. 2 (1992): 116–123, [https://doi.org/10.1016/0301-4215\(92\)90105-B](https://doi.org/10.1016/0301-4215(92)90105-B)

which argues that households tend to use multiple fuels simultaneously depending on cost, availability, and reliability.²¹ Empirical evidence from Central Asia confirms the latter: despite an increase in income, households continue to be dependent on coal and biomass because of infrastructural problems and seasonal shortages, resulting in energy stacking.^{22,23}

This analysis is based on the CAREC 2023 Household Access to Energy in Fergana Valley Survey²⁴ data that covers 1,339 households in the three countries. The findings highlight the adoption of clean energy as a multi-dimensional decision-making process, as many households do not fully replace traditional fuels all at once, but instead combine cleaner and dirtier sources across heating and cooking – that is, they fuel-stack. Instead of assuming that households either adopt clean energy or not, this brief distinguishes between no adoption, partial adoption, and full adoption, which better reflects the reality of household energy use in the Fergana Valley. For that reason, the analysis uses a multinomial probit (MNP) model as the main specification. MNPs are well suited to analysing discrete and correlated household energy choices, and complements this with average marginal effects and ordered probit robustness checks, in line with existing household energy literature by Sabyrbekov and Ukueva²⁵ and Elasu et al.²⁶

The dependent variable is built from households' main heating and cooking fuels, and classifies these according to whether they use clean energy for neither end use, for one end use only, or for both. The explanatory variables include economic and structural factors such as household income, energy expenditure, rural residence, and country fixed effects, as well as attitudinal and perceptual variables such as health and environmental concern, energy-saving behaviour, perceived

²¹ Omar R. Masera, Barbara D. Saatkamp, and Daniel M. Kammen, "From Linear Fuel Switching to Multiple Cooking Strategies: A Critique and Alternative to the Energy Ladder Model," *World Development* 28, no. 12 (2000): 2083–2103, [https://doi.org/10.1016/S0305-750X\(00\)00076-0](https://doi.org/10.1016/S0305-750X(00)00076-0)

²² Rahat Sabyrbekov and Nurgul Ukueva, "Transitions from Dirty to Clean Energy in Low-Income Countries: Insights from Kyrgyzstan," *Central Asian Survey*, 38, no. 2 (2019): 255–74, <https://doi.org/10.1080/02634937.2019.1605976>

²³ Dina Azhgaliyeva et al., "What Determines Coal Consumption for Residential Heating in Kazakhstan and the Kyrgyz Republic?," *Australasian Journal of Environmental Management*, 28, no. 4 (2021): 410–32, <https://doi.org/10.1080/14486563.2021.1989328>

²⁴ CAREC Institute and ADBI, *Household Access to Energy in the Fergana Valley*.

²⁵ Sabyrbekov and Ukueva, "Transitions from Dirty to Clean Energy," 261.

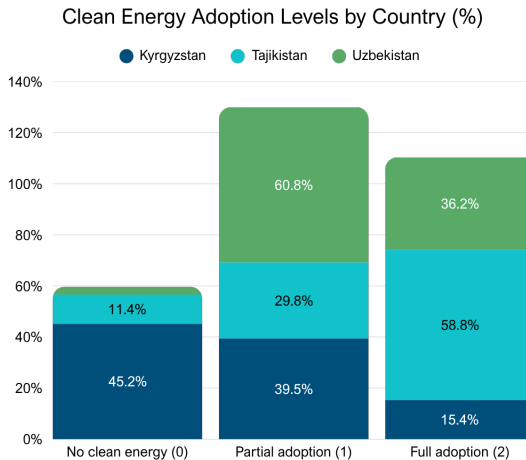
²⁶ Elasu, Richard, and Adaramola, "Cooking Fuel Choices of Households," <https://doi.org/10.1108/IJBPA-12-2020-0112>

unaffordability, unreliability of supply, and infrastructure or technology-related motivations to switch. Together, these variables allow the study to capture both the financial barriers households face and the ways they perceive and respond to those barriers when making everyday energy decisions.

What Drives Clean Energy Adoption

The descriptive results show that clean energy adoption in the Fergana Valley remains uneven and is still largely characterized by a partial rather than complete transition, which reflects the continuing importance of fuel stacking. Across the full sample, the average adoption level is slightly above partial adoption but still below full adoption, suggesting that many households use clean energy for only one end use while continuing to rely on traditional fuels for others. The descriptive graphs in Figures 1 and 2 help illustrate this pattern clearly.

Figure 1. Clean Energy Adoption Levels across Kyrgyzstan, Uzbekistan, and Tajikistan (in percent)

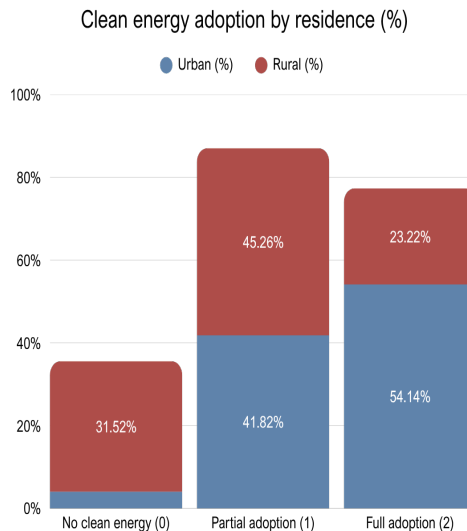


Source: Authors' calculations using data from the 2023 Household Access to Energy in the Fergana Valley survey.

Figure 1, which presents clean energy adoption levels across Kyrgyzstan, Tajikistan, and Uzbekistan, shows substantial cross-country variation. Kyrgyzstan has the highest share of households with no clean energy adoption, Tajikistan has the largest share of full adopters, and Uzbekistan is concentrated more strongly in partial adoption. These differences reflect variation in infrastructure, fuel supply, and national energy systems across the three countries.

Figure 2, which compares adoption by residence, highlights a strong rural–urban divide. Rural households are much more likely to fall into the no-adoption and partial-adoption categories, while urban households are much more likely to achieve full adoption. This suggests that access, affordability, and infrastructure remain significantly more favourable in urban areas than in rural communities.

Figure 2. *Clean Energy Adoption Levels by Residence (in percent)*



Source: Authors' calculations using data from the 2023 Household Access to Energy in the Fergana Valley survey.

1. Economic and Structural Barriers

The empirical findings indicate that external factors are the most significant determinants of clean energy adoption in the Fergana Valley. Household income has a strong and positive association with full adoption, while higher energy costs significantly reduce the likelihood of transitioning to cleaner energy sources, as well as making households more likely to remain in partial adoption mode rather than fully switching. The findings are robust to specifications and consistent with previous empirical research that has focused on the role of affordability as a key constraint in developing countries. Rural residence is also a major barrier. Even after accounting for income and other factors, the adoption of clean energy is much lower for rural households compared to urban ones, particularly at the highest level of adoption. This reflects structural disadvantages, including limited access to energy infrastructure, and continued dependence on locally available fuels.

2. Attitudinal and Perceptual Factors

Behavioural factors matter, but their influence is limited and appears to be stronger at higher levels of adoption. In particular, health and environmental concerns and energy-saving behaviour are more closely associated with full adoption than with partial adoption, suggesting that behavioural drivers help support deeper transitions once basic structural barriers are less binding. In addition to energy cost, perceived affordability stands out as one of the clearest obstacles, suggesting that both objective and subjective financial constraints influence household behaviour. Even when cleaner technologies are available, households that believe that new solutions are too costly are less likely to adopt them. Overall, these results suggest that attitudes and perceptions are relevant, but not necessarily easily convertible into action without the presence of affordable, reliable, and accessible clean energy options for the household. These results also confirm the Theory of Planned Behaviour²⁷ in which attitudes determine behaviour through intention, but are moderated by perceived control (affordability, infrastructure constraints, etc.).

²⁷ Icek Ajzen, "The Theory of Planned Behavior," *Organizational Behavior and Human Decision Processes* 50, no. 2 (1991): 179–211, [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)

3. Country Differences

Country context remains important. Households in Kyrgyzstan are less likely to use clean energy compared to Uzbekistan and are more reliant on coal use as well. In Tajikistan, the adoption pattern is more complex, with lower partial adoption but a higher tendency toward full adoption relative to Uzbekistan, possibly due to the general use of hydroelectricity, even though supply risks remain. The differences highlight the role of national energy systems and infrastructure as key determinants of household energy choices.

Overall, the results show that the main factors in the adoption of clean energy are economic and structural. Although behavioural and perceptual factors remain important, they mainly serve to enhance energy transitions as barriers are lowered. It is clear that the energy systems in their current form restrict household choices, making fuel stacking reflect not just a preference for traditional fuels, but also the necessity of adapting to current energy systems and hedging against risk.

Policy Recommendations

There are several policy implications arising from these findings. Firstly, improving the predictability and reliability of the power supply should be a key priority. Cleaner energy cannot replace traditional fuels if households do not trust it to be available when it is needed most. This has particular relevance during the cold months, when disruptions to power or gas lead to a reliance by households on dirty fuels such as coal, firewood, and biomass. Policymakers should thus focus on improving grid reliability, reducing the number of power outages, and improving local infrastructure for heating and cooking. Enhancing the reliability of these newer systems also provides additional benefits by eliminating the necessity for homeowners to retain dirty fuel sources as backup systems.

At the same time, affordability remains the most critical constraint. Many households are unable to move beyond partial adoption due to the cost of cleaner heating and cooking options being too high relative to household income, especially when energy expenditures are already

burdensome. Governments should, therefore, expand targeted financial support for vulnerable households through seasonal heating assistance, low-interest loans, instalment-based payment schemes, and carefully designed subsidies for cleaner heating and cooking technologies. Such support should reduce both upfront investment costs and the recurring cost burden of energy use, which findings identify as one of the main reasons households remain in the partial adoption phase. World Bank analysis shows that subsidy reform is more likely to succeed when it is gradual, paired with compensatory social policies, and clearly communicated in advance. This is especially important because poorer households may bear the greatest proportional burden of energy price increases, even where broad subsidies mainly benefit higher-income groups.²⁸ Abrupt price increases could deepen energy poverty and trigger public dissatisfaction before cleaner alternatives become realistic. Consequently, targeted cash transfers, lifeline support, and other transitional measures can play a more effective role than universal subsidies in protecting vulnerable households during the transition.

In addition, rural households face stronger barriers to clean energy adoption than do urban households and, therefore, require more targeted interventions. A uniform policy approach is unlikely to work across the Valley since infrastructure, reliability of supply, and access to technology is often weaker in rural communities. Policies should thus be designed to reflect these differences by prioritizing rural areas for infrastructure improvements, financial support, and technology access. Moreover, it is necessary to take into account the multi-purpose use of stoves in certain residences, where heating and cooking are often closely linked.

Additionally, fuel stacking should be explicitly included in policy design as a transitional measure, rather than beginning with a demand for full substitution. Policies should consider that fuel stacking is often a household risk-management strategy and not a failure to transition. Rather than pushing for a full energy transition from the outset, governments should formulate policies aimed at gradually transitioning towards cleaner fuel mixes. This might involve improving the efficiency with which electricity or gas is used for heating, encouraging technologies that provide alternatives to the dirtiest fuels first, and increasing access to cleaner cooking fuels. By adopting this transitional

²⁸ Maria Vagliasindi, "Implementing Energy Subsidy Reforms. An Overview of the Key Issues" (World Bank, July 2012).

pathway, policies will be more practical and aligned with the real-life situations of households.

As affordability and reliability of fuels increase over time, it will become more possible to gradually shift away from solid fuels without pressuring households into making risky or unsustainable energy choices. At the same time, trust-building events should occur concurrently. Information campaigns, youth engagement initiatives, and education/awareness raising programmes regarding the environmental and health risks related to the burning of solid fuels will likely be most effective if households already had reasonable alternative energy choices. Therefore, public messaging regarding the negative impacts of dirty fuels should be paired with a narrative that highlights the feasibility, usability, and reliability of cleaner energy alternatives. When combined with affordability and infrastructure enhancements, such strategies would assist households in moving from awareness to active utilization of cleaner energy.

In addition, recent efforts to increase the diversity of electricity generation in the region through solar/wind development and new nuclear projects in Uzbekistan and Kyrgyzstan may contribute to improving the longer-term conditions for the use of cleaner household energy by reducing the likelihood of seasonal shortages and increasing the overall share of low-carbon electricity. However, this increased diversity alone will not lead to an increase in cleaner household energy usage unless accompanied by increases in affordability, reliability, and access to modern technologies at the local level. As a result, financial reform initiatives need to be carefully sequenced.

While the policy challenges are regional, there is still a need to tailor priorities across the three countries. The biggest priority in Kyrgyzstan is the reduction of dependence on coal for winter heating by improving the reliability of supply and providing targeted financial and non-financial support for cleaner household heating. For Tajikistan, improving the reliability of winter electricity and reducing load-shedding is critical, since supply interruptions continue to drive households toward solid fuels. In Uzbekistan, greater diversification (including into renewables and nuclear) must be accompanied by more consistent household energy access to modern energy and carefully designed subsidy reforms, particularly in rural areas.

As a result, a combination of affordability-enhancing strategies, improving the reliability of energy supply, targeted rural outreach,

realistic transitional paths toward clean energy adoption, and diversifying the energy mix would likely represent the most effective clean energy approach for the Fergana Valley. Unless these fundamental barriers are addressed, households will continue to employ “fuel stacking” as a rational means of coping with uncertainty, regardless of whether they have knowledge of the advantages of utilizing cleaner forms of energy.

Conclusion

Household clean energy adoption in the Fergana Valley remains uneven and incomplete, shaped far more by affordability, infrastructure, and reliability than by awareness alone. Many householders understand the health and environmental disadvantages of burning coal and wood; however, due to high costs, unreliability, and/or lack of availability, there has been very little uptake of clean energy sources. As a result, fuel stacking should not be viewed solely as a form of resistance to change from one energy source to another. Instead, it is an alternative method of managing daily risks resulting from energy uncertainty.

This brief illustrates the need for policy solutions that address the actual barriers households experience in order for them to move towards cleaner energy usage. Increasing household ability to affordably purchase clean energy options, ensuring the reliable delivery of clean energy during the winter months, providing assistance to disadvantaged populations living in rural areas, and assisting households through the transition to cleaner energy options are all necessary steps in increasing the feasibility of transitioning away from dirty fuels. Thus, an efficient energy transition process within the Fergana Valley must involve investments in new cleaner energy technology and the creation of policies that align with how households currently decide on energy consumption methods, given the barriers present in their everyday lives.

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