The State of Energy Use in Industries and Enterprises in Nepal 2025

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LIST OF ABBREVIATION AND ACRONYMS

ADB	Agriculture Development Bank
AEPC	Alternative Energy Promotion Centre
CBS	Central Bureau of Statistics
CCI	Chamber of commerce and industry
CESC	Clean Energy for Small and Medium Enterprises in Nepal
CIM	Chamber and Industries of Morang
CNI	Confederation of Nepalese Industries
CO_2	Carbon Dioxide
CSOs	Civil Society Organizations
DKTI	Promotion of Solar Energy in Rural and Semi-Urban Regions
DoI	Department of Industry
EEC	Energy Efficiency Centre
EE	Energy Efficiency
EPIU	Energy Platform Implementation Unit
ESCO	Energy Service Company
EU	European Union
EV	Electric Vehicle
FIT	Feed-In Tariff
FNCCI	Federation of Nepalese Chamber of Commerce and Industries
FY	Fiscal Year
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GoN	Government of Nepal
GWh	Gigawatt Hour
IDA	Inter Disciplinary Analysts
IEA	International Energy Agency
IEE	Initial Environmental Examination
IPP	Independent Power Producer
IZML	Industrial Zone Management Limited
JSCCI	Jitpur-Simra Chamber of Commerce and Industries
kgoe	Kilogram of Oil Equivalent
KIIs	Key Informant Interviews
ktoe	Kiloton of Oil Equivalent
kWh	Kilowatt Hour
kV	Kilovolt

LPG	Liquefied Petroleum Gas
LUCSUS	Lund University Center for Sustainability Studies
MoEWRI	Ministry of Energy, Water Resources and Irrigation
MoICS	Ministry of Industry, Commerce and Supplies
MSMEs	Micro, Small and Medium Enterprises
Mtoe	Million Tonnes of Oil Equivalent
MGEAP	Nepal Private Sector-Led Mini Grid Energy Access Project
MW	Megawatt
NEA	Nepal Electricity Authority
NEEPF	National Energy Efficiency Platform
NGO	Non-Governmental Organization
NPR	Nepalese rupee
NREP	Nepal Renewable Energy Programme
NSIC	Nepal Standard Industrial Classification
NJCCI	Nepalgunj Chamber of Commerce and Industries
ODK	Open Data Kit
PCCI	Pokhara Chamber of Commerce and Industries
PPA	Power Purchase Agreement
PPP	Public Private Partnership
POSTED	Promotion of Solar Technology
PJ	Petajoules
RE	Renewable Energy
REEEP	Renewable Energy and Energy Efficiency Programme
RERL	Renewable Energy for Rural Livelihood
RESCO	Renewable Energy Service Company
R&D	Research and Development
SASEC	South Asia Sub-regional Economic Cooperation
SECF	Sustainable Energy Climate Fund
SDGs	Sustainable Development Goals
SEIN	State of Energy in Industries in Nepal
SME	Small and Medium Enterprises
Solar PV	Solar Photovoltaic
TA	Technical Assistance
TOD	Time-of-Day
TV	Television
UNIDO	United Nations Industrial Development Organization
VRE	Variable renewable energy
WECS	Water and Energy Commission Secretariat

PREFACE

DOUBLE ENERGY TRANSITIONS

The role of industry in energy transitions

The recent COP29 agreement recognized businesses as key drivers of the net-zero transition. The agreement highlighted the importance of engaging the private sector to achieve climate goals, including encouraging businesses to participate in developing NDCs. How is this ambition received by the industry in countries like Nepal? What does more energy accessibility and connectivity mean for businesses in the context of energy transition? This survey is the second step of a 4-year research project entitled DOUBLE TRANSITIONS: Connecting climate goals with local realities of Nepal: analyzing changing energy poverty and access patterns in the era of climate change. The project is funded by Swedish Research Council (VR) and led by me at LUCSUS. It aims to deliver high quality research on energy transitions along with relevant policy recommendations.

Our core research questions in this project are: How and to what extent is energy access achieved in the transition from fossil-fuel based energy to renewable energy and how are energy poverty and energy transitions related? By providing qualitative and quantitative evaluations of the ramifications of energy access (SDG 7) for other areas of sustainable development, this study contributes to the need to harmonize the global agreement of the Sustainable Development Goals with local realities on the ground.

The Industries and Enterprise Quantitative Survey presents a comprehensive examination of energy consumption patterns across Nepal's diverse industrial sector, shedding light on the critical role of energy in sustaining industrial operations and economic growth. The survey's findings reveal significant variations in energy use among different industries, emphasizing their dependence on primary energy sources, adoption of alternative energy options including renewable energy, and the financial implications of these choices.

Electricity emerges as the cornerstone of energy use within many industries, powering machinery, lighting, cooling systems, and other essential processes. Despite Nepal's remarkable achievement of nearly 98% electrification coverage, the reliability of the power supply and potential to move towards cleaner technology remain as pressing concerns. We trust that the insights and recommendations presented in this report will serve as a valuable resource for policymakers, industry leaders, and all stakeholders committed to building a robust and sustainable industrial energy landscape in Nepal while also informing feasibility of global climate goals in the context of Nepal.

Associate Professors Mine Islar
Lund University Center for Sustainability (LUCSUS)
June 2025

ACKNOWLEDGEMENT

This study, *The State of Energy Use in Industries and Enterprises in Nepal 2025*, is part of a research project titled *Connecting Climate Goals with Local Realities of Nepal: Analyzing Energy Poverty and Changing Patterns of Energy Access in the Era of Climate Change*. Also known as VR Double Transitions of Energy, this research is funded by the Swedish Academy. I am grateful to Associate Professor Dr. Mine Islar and Associate Professor Dr. Sara Brogaard at the Lund University Center for Sustainability Studies (LUCSUS) in taking the lead role in preparing the research project.

In 2023-24 as a part of this research project, IDA published the report, *Household Energy Consumption and Energy Transition in Nepal 2023: A Survey Report*.

In 2024, IDA commenced the research on energy use in industries and enterprises. Professors Islar and Brogaard provided inputs at various stages as this research progressed – in formulating the research questions, while working on the survey questionnaire and in providing feedback on the draft report.

The Federation of Nepalese Chambers of Commerce and Industry (FNCCI) and especially its various chapters in different parts of Nepal supported us at various stages as the work progressed. I would especially like to express my gratitude to the Morang Chamber of Industries (CIM) and its Director General, Mr. Chudamani Bhattarai, as well as past and current presidents – Suyesh Pyakurel, Rakesh Surana and Nand Kishor Rathi - for their supportive role during the pilot phase, as well as during the survey and post-survey phases. Other FNCCI chapters that played an important role are the FNCCI chapters of Jitpur-Simara, Bhairahawa, Nepalgunj, Pokhara, and Kathmandu valley i.e., the FNCCI chapters of Kathmandu, Lalitpur and Bhaktapur. Their support in providing us with the list of industries and enterprises under their jurisdiction greatly helped with sampling. Some of them also provided contact details and helped us reach out to the respective industries and enterprises.

I express my gratitude to the 614 industries and enterprises that were surveyed who, despite their busy schedule, gave time and were forthcoming in their views. Without their support and inputs, this endeavor would not have been completed. For large and medium industries, the survey interview tended to be with 3 individuals of that industry, including the top management, the energy focal person and the finance focal person. For small, cottage, and micro-industries, it was usually the proprietor who also tended to be the manager, and it was this person who was interviewed.

We had committed these different FNCCI chapters that once the data was processed, we would share the preliminary findings with them. We are grateful to the Morang Chamber of Industry and Pokhara Chamber of Commerce and Industries for organizing sessions to share the preliminary findings. We would also like to thank all the participants who attended the preliminary findings sessions in Biratnagar on December 2, 2024 and in Pokhara on December 8, 2025. (The list of participants in Biratnagar and in Pokhara are in Annex 9 and 10 respectively). Presentation and

interaction in other clusters could not take place due to the unavailability of the FNCCI focal persons in those locations.

The IDA team was fortunate to further undertake in-depth interviews with key personnel representing small, medium and large industries in various locations such as in Biratnagar, Pokhara, Bhairahawa, and Nepalgunj subsequent to the preliminary analysis of the survey report. The Key Informant Interviews (KIIs) with these industry people helped the IDA team in understanding the "why" questions while the survey sought to answer the "what" questions. We have also tried to distill the insights that were generated from the KIIs into this report. I am grateful to all of the 22 individuals for giving their time and sharing their observations on energy related issues faced by their industries. Their observations have helped us better understand the dynamics within the industries. (The list of the industry people with whom KIIs were undertaken, is presented in Annex 7.)

In addition, the IDA team undertook KIIs with experts and professionals in the sector. These 7 KIIs with experts and professionals helped us understand the broader energy terrain, institutional roles, and the direction in which the energy sector is evolving. (The list of the experts and professionals with whom KIIs were undertaken, is presented in Annex 8.)

Once the report reached its final stage, we were fortunate to hold interactions with the FNCCI headquarter team as well as the Bhaktapur FNCCI team along with industrialists, solar and hydropower developers and energy experts on June 2, 2025. (The proceedings of this interaction as well as the names of individuals who participated is in Annex 5). We are thankful to them for attending the session and providing their feedback on the main findings.

Similarly, we were fortunate to have government representatives from MoWERI, WECS, NEA, IZML, AEPC, and ERC attend our interaction on June 9, 2025. (The proceedings of this interaction as well as the names of individuals who participated is in Annex 6). This interaction made the government representatives aware of the concerns of the industrialists and FNCCI. The government representative's observations and insights helped us better understand policy-related issues and sectoral dynamics.

The survey was challenging, especially the fieldwork part. IDA team had to build rapport with the various FNCCI chapters, explain the purpose of the survey to them and to get a list of industries and enterprises affiliated to them so as to be able to sample and to interview. This needed persuasion as well as regular follow up. This crucial role was played by Hiranya Baral, Human Resource Manager at IDA. He was also the person who recruited the enumerators and supervisors for the fieldwork and monitored the fieldwork as it progressed. I would like to thank Hiranya Baral for his excellent contribution in these activities.

Within the IDA team, various individuals contributed at different stages of the work. I sincerely appreciate the efforts of Chandra K.C. and Rabina Thapa in designing the draft version of the questionnaire and to Pankaj Pokhrel for finalizing the questionnaire after feedback from piloting in Biratnagar. Dinesh Dangol and Sandeep Thapa played an invaluable role in android programming and training the enumerators and supervisors. Rabina Thapa and Himal Khanal handled the interaction programs in Biratnagar and Pokhara superbly. Moreover, it was they who undertook a majority of KIIs with the industry people. They, not only arranged the logistics and took the interview, they also transcribed the audio version which was in Nepali into the English language.

Finally, I would like to express my gratitude to Dipak Gyawali, Chairman of IDA, for his guidance and support throughout this process. His valuable feedback at various stages has been instrumental in shaping this report. I am especially grateful for his continuous insights and encouragement, and I sincerely appreciate his generosity in writing the foreword for this report.

Once again, I extend sincere thanks to all of the above-mentioned names for their dedication, expertise, and hard work. This report is a product of the inputs of all the individuals mentioned above.

Sudhindra Sharma, Ph.D.
Team Leader on behalf of IDA and Executive Director

FOREWORD

Nepal's Industrialization: Missed Opportunities and Continuing Constraints

Jung Bahadur Rana (*de facto* ruler of Nepal from 1846 to 1877) was intrigued by the question: how could a bunch of Firangi traders from across the Seven Seas come to India and overwhelm the powerful Moghul empire? As the first Nepali ruler to travel to England and meet with Queen Victoria (at the same time that Karl Marx – whom he never met or heard of – was sitting in the British library in London and writing his *Das Capital*), he spent a lot of his time there visiting mines and factories.

He did not have in his entourage (obviously because modern scientific education came to Nepal only much later) any sociologist, political economist or philosopher of science. Had there been, they could have explained to him that British technological (and thus military) prowess was not a natural gift of providence but a sequel to capitalism and Protestant reforms of old social mores (Gyawali, 2002). He returned to Nepal with a steam-powered irrigation pump to irrigate his rice fields in Kaski (which no one in Nepal knew how to operate and thus was consigned to scrap); but he did not take any initiative to establish factories. On the contrary, he ended up promulgating the caste-based Mulki Ain (civil code) in 1854, discriminatory provisions which was annulled only in 1962 by King Mahendra.

The first steps towards mechanized industrialization in Nepal was taken many decades later by Rana rulers Chandra Shamsher and Juddha Shamsher. The former built Nepal's first hydropower plant in 1911 and used that energy to power a ropeway to transport goods, first from Halchowk to Lainchaur in Kathmandu in 1924 and later in 1927 from Dhorsing to Kathmandu's Matatirtha (Shrestha, 2004). The latter followed by holding Nepal's first industrial exhibition just before the start of the 2nd World War and opening small jute and other factories. Juddha wanted the "presents" given by the British for Nepal allowing Gurkha recruitment into its army to be invested in establishing factories and hydropower plants.

A secret memo from the British embassy in Lainchaur describes why he pushed for industrialization: it was to assure jobs for the large number of Nepali youths entering the job market, in the absence of which the regime would be under threat of revolt (Gyawali, 1994). The memo argues that, while it is a good idea of its ally that Britain should support, she should be cautious that Nepali factories employing cheap Nepali labour should not undercut British India's products, that countervailing import tariffs should be imposed, and that Japanese investments should be discouraged!

With the departure of the British from India, the Rana regime fell in 1951 and this effort at the country's industrialization fell into limbo. It took King Mahendra and his Panchayat system in the 1960s to garner help from all protagonists at the height of the Cold War– Indians, Chinese, Soviet Russians and the Americans – to build Bansbari Shoe Factory, Janakpur Cigarette Factory, Birgunj Agriculture Tools Factory as well as infrastructure such as highways, power plants and electricity distribution networks. This process of import substitution – a founding principle enunciated by Nepal's founding monarch King Prithvi Narayan Shah in his *Dibya Upadesh* – continued till King Birendra who, in 1985 had the Bhrikuti Paper Factory built in Gaindakot with Chinese help.

Unfortunately, by this time several global undercurrents had come into play: the communist block had split into rival Soviet and Chinese camps, the Soviet Union was decaying (into "*zastoi*" or stagnation to use Michael Gorbachev's phrase), and the West saw no need to direct its aid efforts towards pulling Third World countries away from the communist bloc ("End of the Age of Aid": see Sharma et al, 2004). Rather, through initiatives like the structural adjustment programs, economic development was to be market-led while social aspects of development were to be taken care of by non-government organizations, limiting governments dependent on aid to a few regulatory duties. With the collapse of the Panchayat system and in the introduction of multiparty democracy in 1990, the Nepali state was made to withdraw from industrialization efforts, and to privatize the factories established earlier.

The tragic irony was two-fold. First, behind the idea of privatization and governments not running industries lies the belief that the private sector is more efficient and innovative in running enterprises than governments with their inbuilt red tape. The private sector will then definitely increase production to the benefit of the country. Sadly, contrary to these beliefs, none of the state-owned companies privatized in the early 1990s produce ANYTHING at all now, and have been shut down. Most of the new owners are just angling to sell the valuable land these factories owned to make a quick profit. This phenomenon has been characterized as de-industrialization of Nepal.

Second, contrary to what Juddha Shamsher intended when he mulled setting up factories to provide jobs for unemployed youth, with the process of privatization of Nepal's state-owned industries in the 1990s, a parallel massive outmigration of Nepali labour to Gulf countries, Malaysia, South Korea officially and to Europe, America and Australia informally began to take place. With Nepal's population stated to be about 30 million, it is estimated that about three and a half million Nepalis are working abroad[1], the number not fully including those going to open-border India where people can travel for work without the formality of visas and passports, as well as almost half a million students who hope to find work abroad after graduation. The remittances sent by these workers amounts to 25% of the country's GDP, thus enmeshing Nepal in a downward spiraling 'Dutch Disease' quandary that militates against any attempt at industrialization.[2] A further irony is that this proletarization of Nepali peasantry and citizens into the 'Satanic Mill' of the global market (Polanyi, 1944) has happened even as Nepal moved away from monarchy to a rule by socialists, Marxists and Maoists!

The reason to worry about this state of affairs is the currently roiling waves of global instability that will surely hit small and debilitatingly dependent economies like Nepal. It is the unintended side-effect of US president Donald Trump's move to "make America great again", his shutting down the foreign aid apparatus, his tariff as well as hot military wars that have put a question mark on globalization, the US polity's inability to rein it its colossal debt etc., that point to an impending global recession. A sensible countermove many economically weaker countries might have to be towards localization as a security measure. What if the millions of Nepalis find no jobs abroad and will have to return back home? What if remittances – and the entire Nepal government revenue based on taxing the consumption of families that are dependent on those monetary inflows – dry up? How will social and political instability be averted if gainful employment cannot be provided?

[1] See https://nepaleconomicforum.org/on-the-move-wither-nepali-migrants-remittances/

[2] See https://corporatefinanceinstitute.com/resources/economics/dutch-disease/

There are hopeful signs that meaningful and secure self-reliance – as opposed to unachievable economic autarchy – seems to be making a political economic comeback. The logic of market capitalism is that if you are not on the production policy table, you are probably on the menu, i.e., you are either a producer of goods or a supplier of raw material resources to produce those goods as well as a terms-of-trade disadvantaged buyer of those goods that consigns you into structural poverty. This inexorable logic of the market had been highlighted by political economists for long, from Karl Marx to Karl Polanyi and many others. Indeed, Stavrianos (1981), writing about the history of the process of "Third Worldization", describes how control over the production of necessities – and the subsequent trade in necessities (as opposed to trade in luxuries) backed by the harnessing of mechanical power for industrialization – was the driver that led to Europe's colonizing the rest of the world with the single exception of Japan.

Even with countries that did acquire some technology and manufacturing capacity under colonization to allow them to graduate upwards to being an industrialized country, things have gone horribly wrong when national politics regressed away from industrial modernization. Nepal's example has been described above; but another failed case is Pakistan. Kibria (1998) describes how, when the British left South Asia in 1947, Pakistan had one of the strongest manufacturing capacities in the region. Technology, which is nothing but science with commercial value, had been indigenized. Unfortunately, land-based feudal politics and an army that arose from that land-owning and land-dependent class took over the country and relegated its *mistris* (technicians) to the margins, thus eventually destroying its manufacturing base.

What does all this historical background have to do with this study on energy transition conducted by Inter Disciplinary Analysts (IDA) in collaboration with Sweden's Lund University Center for Sustainable Studies (LUCSUS)? Nation-wide scientific survey of energy use in industry (and earlier in households) – certainly for the first time using this methodology – give us the 'what?' answers that are generalizable across the county. The 'why?' answers have to be – and have been – sought using more in-depth but narrower key-informant interviews which provide revealing insights. These surveys showed that, with 98% electricity coverage and widespread use of both commercial and traditional fuels, energy access is no longer an issue. However, quality electricity and its service were serious concerns; but with sustainable harvesting of forest products via community forestry, continuing firewood use was no longer a problem. Nepal is still one of the lowest per capita electricity consuming countries in the world, and its small industrial sector is hamstrung by the low quality of supplied electricity.

Why this is so, and what measures need to be taken are matters for future research and policy framing. The answers most probably lie in the functioning of our energy-related institutions, which – in their goals and functioning – are but products of the history outlined above. This survey-based study, we feel, is an important first step in finding new answers through future research.

Dipak Gyawali
Chair, Inter Disciplinary Analysts (IDA)
Pragya (Academician), Nepal Academy of Science and Technology (NAST)

EXECUTIVE SUMMARY

This report *"The State of Energy Use in Industries and Enterprises in Nepal 2025"*, provides an in-depth analysis of energy use, challenges, and opportunities across micro, small, medium, and large industries and enterprise in Nepal. The report examines fuel-wise sectoral energy consumption patterns, assesses the impact of power outages on business operations, evaluates industries' willingness to pay for reliable electricity, and identifies drivers and barriers of energy efficiency and adoption of alternative and clean energy sources. By synthesizing quantitative findings and qualitative insights, the study offers evidence-based recommendations to inform stakeholders on promoting sustainable energy uses.

Methods: The study surveyed 614 establishments across six industrial clusters: Biratnagar-Itahari, Kathmandu valley, Birgunj-Pathlaiya, Pokhara valley, Bhairahawa-Butwal, and Nepalgunj-Kohalpur. Firms were categorized into seven sectors based on the Nepal Standard Industrial Classification (NSIC): Agriculture, Forestry, and Fishing; Manufacturing; Construction; Accommodation and Food Services; Information and Communication; Health and Social Work; and Financial and Insurance Activities. They were further classified by scale of investment into micro, small, medium, and large industries and enterprises [Chapter 3.1]. In addition to the survey, interactions were held with the Chamber of Industry and Commerce in Biratnagar and in Pokhara where the topline findings were shared and feedback was solicited. In addition, 17 Key Informant Interviews were undertaken with the proprietors and senior managers of small, medium and large industries in Biratnagar, Pokhara, Bhairawa and Nepalgunj. Likewise, another 7 KIIs were undertaken with energy experts in the government and donor organizations. [Chapter 3.7].

General Information on Industries and Enterprises: The sample skewed towards manufacturing sector (50.5%) to better capture the energy usage in the industries. These firms span a broad set of activities, from heavy-industry staples like cements, metals, and ceramic/concrete products to consumer goods manufacturers of paints, plastics, textiles, furniture, food and grain milling, dairy, bottled water and beverages, and even soap and detergents. Accommodation and food services (22.0 %) cover hotels, restaurants, and catering; finance and insurance (9.1 %) include banks, savings-and-credit cooperatives, life and non-life insurers, and microfinance institutions; agriculture, forestry, and fishing (7.3 %) focus on livestock, poultry, aquaculture, and vegetable cultivation; and smaller shares represent health/social work, ICT, wholesale/retail and miscellaneous services [Chapter 4.1]. On average, an establishment provided 49 permanent full-time positions and a total of 52 full-time equivalent jobs (inclusive of seasonal and part-time employment) [Chapter 4.3].

Operational Hours: Establishments operate an average of 88 hours per week, with the accommodation and food services sector having the highest average (128 hours) and the financial and insurance sector the lowest (47 hours). Larger industries tend to operate longer (105 hours per week), while cottage industries operate the shortest hours (60 hours per week) [Chapter 5.1].

Pattern of Energy Usage: Usage of electricity is ubiquitous. nearly all establishments (99.8%) use electricity - the intensity of usage, however, varies. Over half of the establishments also use LPG (53.7%) and diesel (53.3%) indicating reliance on multiple-fuel sources. Petrol is reported by

46.1% of establishments. Biomass (6.2%) and solar PV (4.9%) are used by a much smaller share, highlighting their limited adoption [Chapter 5.2].

Energy intensity is highest in the manufacturing sector, followed by agriculture and forestry, human health, and accommodation and food services. If one were to take into account all industries and enterprises, diesel constitutes the largest share of energy use (49.01%), with fuelwood/biomass as the next most used source and grid-supplied electricity ranking third at 16.66%. However, sectoral mixes differ markedly: manufacturing industries derive 49.16% of their energy from diesel, 28.97% from fuelwood/biomass, and 15.32% from electricity; agricultural enterprises rely predominantly on diesel (70.95%), fuelwood/biomass (22.61%), and only 5.11% electricity; accommodation and food service establishments similarly depend on diesel (61.32%) and electricity (25.38%); in contrast, electricity is the dominant source in the remaining sectors – financial and insurance, wholesale and retail trade, and information and communication. [Chapter 5.3].

Expenses on Energy: The highest monthly fuel expenditure is observed in the manufacturing sector (NPR 277,000), followed by human health and social work (NPR 189,000). Large industries incur the highest average monthly fuel costs (NPR 451,000), while micro and cottage industries spend significantly less (NPR 8,000–12,000) [Chapter 5.5].

Peak Electricity Demand: Electricity demand peaks between 10 AM and 5 PM, with maximum demand at noon (77.5%). Industry-specific variations exist: agriculture peaks early (6 AM), while accommodation and food services see peak electricity demand in the evening (7 PM). Large industries consistently show the highest demand during peak hours. Regionally, Kathmandu has the highest electricity demand throughout the day [Chapter 5.7].

Waiting Time for Electrical Connection: Out of the 8.1% establishments that applied for a new electricity connection in the past two years, the average wait was 33 days. Accommodation and food service businesses experienced longest delays (54 days), while financial and insurance firms waited just one day. By size (scale of business), small industries faced the longest delays (46 days), while medium industries waited only 3 days [Chapter 6.1 and 6.2].

Load Shedding and Power Outages: Load-shedding is the deliberate shutdown of electrical power in a part or parts of the distribution system generally to prevent the failure of the entire system when the demand strains the capacity of the system. It is planned and a schedule is brought out in advance. A power outage refers to a disruption or interruption in the supply of electricity. This could be either a temporary loss of electricity in a specific area or a complete blackout. It happens unannounced and is not planned.

Reliable electricity remains a major challenge. Nineteen out of twenty establishments (95.3%) experienced power outages, while 1.0% reported scheduled load shedding, and 1.6% suffered both. Large industries saw the highest combined incidence of load shedding and outages (3.2%) [Chapter 6.3]. On average, establishments faced 21 power outages per week – highest (35 per week) in Nepalgunj-Kohalpur lowest (6 per week) in Kathmandu [Chapter 6.4]. The average outage duration ranged from 10 to 147 minutes [Chapter 6.5].

Patterns and Timing of Power Outages: Overall, 95.3% of establishments experienced power outages. The most affected time of day is midday, with peak outages occurring at 12:00 noon (71.2% of businesses affected), followed by 11:00 AM and 1:00 PM. Regional variations indicate that Nepalgunj-Kohalpur faces frequent outages throughout the day, while Kathmandu and Biratnagar-Itahari report fewer disruptions [Chapter 6.9]. Seasonally, power outages peak in Ashad and Shrawan, affecting up to 73.5% of establishments, while winter months see fewer disruptions [Chapter 6.10].

Losses due to power issues Establishments report widespread losses due to power outages and low-quality electricity. The most commonly reported losses were damage to machinery (52.6%), increased maintenance costs (51.3%), higher fuel costs for backup generators (40.5%) and spoilage of raw materials (33.4%). Large industries are most impacted – 66.4% reporting machinery damage. Regionally, Biratnagar-Itahari and Birgunj-Pathlaiya reported the highest machinery damage and increased costs. Unscheduled outages in manufacturing, dairy, and hospitality industries disrupt production (often halting operation for up to 30 minutes per event), increase repair costs and waste materials, exacerbate voltage-related damage, reduce operational efficiency. Power outages also reduce the income of seasonal and part-time workers and compromise service quality in sectors such as hospitality [Chapter 6.6].

On average, establishments report 8% loss of annual turnover due to power outages. Regionally, industries in Nepalgunj-Kohalpur and Birgunj-Pathlaiya faced 10% turnover losses compared to 2% in Kathmandu [Chapter 6.7]. Reported average annual losses due to power disruptions amount to NPR 13.7 million in lost sales [Chapter 6.11].

Adoption of Alternative Electricity Sources: To mitigate frequent power outages, 61.7% of surveyed establishment now rely on alternative electricity sources – primarily generators (70.7%). Battery backup systems such as inverters (67.3%) are among those using alternatives. However, only 6.9% use solar PV. [Chapter 6.12].

Electricity Sourced from Alternative Sources: It was reported that on average 12% of electricity came from alternative sources (14% in large industries). Key motivations for expanding alternative energy use include energy security and cost management. Power outages persist due to aging infrastructure, inefficient grids, and dependency on electricity imports [Chapter 6.14].

Satisfaction with Electricity Services: Overall satisfaction among industries and enterprises is moderate for availability (5.95 out of 10) and quality (5.55), while affordability (4.94) and support services (5.09) score lower [Chapter 6.18].

Time-of-Day Tariff Adoption and Rates[3]: Only 23.3% of establishments report having time-of-day (ToD) metering, enabling them to benefit from differential tariffs - most prevalent in manufacturing (35.5%), and human health and social work (22.0%). Large industries lead with 48.0% penetration, while micro and cottage industries show minimal uptake. Regionally, the Biratnagar-Itahari leads in ToD adoption (41.6%), whereas Kathmandu and Bhairahawa-Butwal exhibit much lower adoption rates at 13.9% and 18.0%, respectively [Chapter 7.1].

Reliable Electricity, Latent Demand and Usage: Approximately 59% of establishments anticipate increasing their electricity consumption if supply reliability improves – most notably in manufacturing (62.3%) and other service (75.0%) with wholesale and retail trade the lowest

[3] Three-phase power supply is made available exclusively to large, medium, and small-scale consumers who require higher electrical loads for industrial, commercial, or institutional purposes. These customers are billed solely under the Time-of-Day (TOD) tariff system, which means their electricity charges vary depending on the time of usage—typically categorized into peak, off-peak, and normal hours. This system encourages efficient energy consumption and helps manage demand on the power grid.

(30.0%). Large industries are the keenest (67.2%), whereas micro and cottage industries the least inclined. Regionally, the latent demand is strongest in Nepalgunj-Kohalpur (82.2%) and Birgunj-Pathlaiya (73.8%) [Chapter 7.3]. Key informant interviews (KIIs) highlight that willingness to expand electricity usage depends upon affordability, business needs, and prevailing market conditions.

Industries anticipate utilizing reliable electricity for production expansion, technology upgrades, and transitioning to energy-efficient solutions. Manufacturing and construction sectors aimed for upgrading machinery, while the accommodation and food service sectors had plans to shift from LPG to electric stoves. Agriculture and fisheries industries seek to deploy advanced processing and irrigation equipment. Similarly, the health sectors plan to add more medical equipment, and the information and communication sectors intend to expand service coverage. Among the 59% establishments willing to pay more for reliable electricity, the average premium is 4% above current rates [Chapter 7.5].

Out of the 41% of establishments not planning increase consumption even if supply were reliable, 86% feel that their current needs are already met, 15.2% cite budget constraints, and 3.6% point to infrastructure limitations [Chapter 7.6].

Trends, Investments, and Barriers in Energy Efficiency Adoption: Energy efficiency measures have been adopted by 43.5% of establishments, while an equal share have not, and 13.0% consider them unnecessary. Adoption is higher in large industries (61.6%) and sectors like human health (53.7%), but low in sectors such as information and communication (23.1%) and cottage industries (15.3%). Pokhara (78.8%) leads regionally, while Kathmandu (27.7%) lags behind [Chapter 8.1].

Common measures among the establishments that have adopted energy efficiency practices include regular maintenance (78.3%), behavioral changes (64.4%) and equipment upgrades (59.6%). However, measures such as energy audits (15.0%) and integration of renewables (16.5%) remain limited [Chapter 8.2].

When asked explicitly about the practice of periodic energy monitoring and audits, only 25.4% of industries and enterprises reported conducting periodic energy audits. Financial and insurance activities (32.1%) lead, while agriculture sector (11.1%) lags behind. Larger industries (49.6%) are more likely to conduct audits compared to micro-industries (11.1%). Regionally, Pokhara (53.8%) exhibits the highest level of engagement, while Bhairahawa-Butwal (10.0%) and Nepalgunj-Kohalpur (10.9%) report the lowest rates [Chapter 8.3].

Similarly, planned investments in energy efficiency are expected to grow from NPR 2.57 million to NPR 10.11 million on average over coming five years. Human health and social work activities anticipate the highest future investments (NPR 18.88 million), while the information and communication sector shows the most significant increase (from NPR 0.48 million to NPR 25.00 million). Large industries plan to boost investments from NPR 6.05 million to NPR 16.77 million, with the Biratnagar-Itahari cluster leading in past and planned expenditures. Larger industries tend to focus on new machinery and equipment upgrades, whereas smaller establishments prioritize maintenance and minimal infrastructure improvements. The accommodation and food services sector emphasizes business expansion, while agriculture and manufacturing invest in machinery and energy solutions. Human health and service industries prioritize medical and office equipment, with notable investments in advanced technologies [Chapter 8.4].

Key barriers to the adoption of energy efficiency include high upfront costs and limited capital, limited awareness, technical capacity gaps, and weak regulatory support [Ch8.6 to 8.9].

Impact of Shocks: Just over half (51.3%) of surveyed establishments reported that their energy needs and usage were affected by major shocks – led by the 2015-16 economic blockade (55.6%), the covid-19 pandemic (47.0%), global price rise from the Ukraine-Russia war (37.5%) and the 2015 earthquake (22.2%) [Chapter 9.1 & 9.2]. The increased price of fuel was the most common issue faced by establishments (67.9%), followed by fuel shortages (51.2%) among those impacted by these shocks. These disruptions led to decreased production (37.0%), higher costs of goods/services (29.3%), and operational halts (28.9%) [Chapter 9.3]. Key informants highlighted the fact that economic blockades forced diesel scarcity—sometimes procured illegally at double cost—while electricity-dependent firms fared better. Most establishments (65.7%) opted to absorb the increased energy costs internally, while others shifted to non-renewable energy sources (28.2%) or passed on costs to customers (22.7%) to manage rising energy costs and disruptions. A significant number of establishments also adopted renewable energy sources (20.8%) and energy efficiency measures (20.4%) [Chapter 9.4].

Resilience and Preparedness for Future Energy Shocks: Despite widespread exposure to shocks, only 4.9% of establishments consider themselves well-prepared for future energy-related shocks, while 65.0% admit they are unprepared. The most unprepared sectors include, Manufacturing and cottage and micro-industries. Geographically, Bhairahwa-Butwal (87.0%) and Nepalgunj-Kohalpur (83.2%) show the highest levels of unpreparedness [Chapter 9.5].

Anticipated Government Support: Industries overwhelmingly seek tax incentives for energy-efficient investments (59.6%), alongside policy and regulatory support (54.4%), financial subsidies (39.7%), and renewable energy support (36.8%) [Chapter 10.1].

Manufacturing and accommodation sectors prioritize tax incentives; human health and social work sector emphasize policy and regulatory support; cottage industries seek financial aid for energy-efficient technologies, and large industries look to research and development. Industries in Birgunj-Pathlaiya and Kathmandu emphasize tax incentives and policy support, while those in Nepalgunj-Kohalpur prioritize financial subsidies and renewable energy support.

Industries and enterprise report being affected by several challenges – unreliable electricity supply, high tariffs, and complex regulatory frameworks. Frequent outages, voltage fluctuations, and demand charges are particularly detrimental to operations. Stakeholders also express concerns over unfair electricity tariffs and NEA monopoly over distribution of energy.

Proposed Solutions: Industries and enterprises propose several strategies to address challenges, including improving electricity reliability and installing voltage stabilizers, reducing energy costs through subsidies and tax incentives for small and medium industries, upgrading infrastructure for stable power and market access, and streamlining import/export regulations to reduce logistical costs.

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Overview of the Industrial Sector

Industries and enterprises are vital to Nepal’s economic development, contributing significantly to GDP, employment generation, and overall economic activity. According to Nepal's Economic Survey 2022/23, the industrial sector accounted for 13.6% of the GDP. While the contribution was 14.23 percent in year 2021/22. This decrease is primarily attributed to a reduction in investment and fixed capital as a percentage of GDP (Economic Survey).

Sectoral Contributions to GDP

Nepal's economic structure is divided into three broad sectors – primary, secondary, and tertiary – each playing a distinct role in the nation's development. In 2022/23, the primary sector, which includes agriculture, forestry, fisheries, and mining, accounted for 24.42% of the GDP. The secondary sector, covering manufacturing, electricity, gas, water, and construction, contributed 13.09%. Leading the economy is the tertiary sector, comprising services, which made up a significant 62.48% of the GDP.

In FY 2021/22, the contributions of agriculture, industry, and services were 25.00%, 13.69%, and 61.30%, respectively. As compared to 2021/22, in year 2022/23, the service sector's share has continued to grow, while the contributions of the primary and secondary sectors have slightly declined. This reduction is largely linked to delays in capital expenditure, a slowdown in construction and real estate activities, and weakened domestic demand, which have collectively hindered the growth of these sectors. Although the contribution of industrial sector remains smaller (13.6%), it is an essential component of the economic framework.

Share of Primary, Secondary, and Tertiary Sectors in GDP

Sectors	As a percent of GDP								
	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24*
Primary[1]	29.00	27.38	26.24	25.57	25.75	26.35	25.00	24.42	24.56
Secondary[2]	13.51	13.97	14.53	14.36	13.06	13.26	13.69	13.09	12.53
Tertiary[3]	57.47	58.64	59.21	60.06	61.17	60.38	61.30	62.48	62.90

Source: Economic Survey 2022/23

1 Agriculture, forestry and fishery, and mining and quarrying
2 Manufacturing, Industries, electricity, gas and water, and construction
3 Services
*Estimates

Industrial Sector classification

The industrial sector has shown mixed performance over the years. While there has been growth in certain areas, others face significant challenges. The mining and quarrying sector’s GDP contribution declined from 0.54% in FY 2021/22 to a projected 0.50% in FY 2022/23. Over the years its contribution reflects a consistent downturn. Similarly, the manufacturing sector, which saw a moderate rise to 5.65% in FY 2021/22, fell to 5.15% in FY 2022/23. The water supply, sewerage, waste management, and remediation sub-sector also continued its gradual decline, reflecting persistent challenges across the industrial sector.

The construction sector, once a leading contributor, has faced growing challenges, with its GDP share dropping from 6.04% in FY 2021/22 to 5.85% in FY 2022/23, highlighting a noticeable slowdown.

In contrast, the power sector has shown substantial and consistent growth, with its contribution to GDP increasing from 1.01% in FY 2018/19 to 1.51% in FY 2021, and reaching 1.62% in FY 2022/23. This growth highlights the impact of sustained investments and increased energy generation capacity.

Share of different components in Industry Sector

Industry Sector	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24***
Mining and quarrying	0.66	0.59	0.55	0.54	0.50	0.47
Manufacturing	5.75	5.07	5.58	5.65	5.15	4.78
Electricity, gas, steam and air conditioning supply	1.01	1.17	1.13	1.51	1.62	1.81
Water supply, sewerage, waste management and remediation activities	0.59	0.58	0.55	0.49	0.45	0.44
Construction	7.00	6.22	5.99	6.04	5.85	5.40
Total	15.01	13.63	13.8	14.23	13.57	12.9

Source: Economic Survey 2022/23

*Estimates

As of the fiscal year 2022/23, a total of 9,085 industries were registered, comprising 1,370 large, 2,087 medium, and 5,628 small industries. These industries collectively contributed a capital investment of Rs. 2.84 trillion and provided employment for 680,327 individuals. In mid-March 2023, an additional 183 new industries were registered, with a planned investment of Rs. 105 billion, creating approximately 12,748 job opportunities. Among the existing industries, large enterprises generated 186,445 jobs, medium industries contributed 187,165 jobs, and small industries created 306,717 jobs.

Types of industries, their numbers, total capital, and employment provided

Scale	**No of Industries**	**Total Capital (Rs in million)**	**No of Employment**
Large	1370	2,385,784.01	186,445
Medium	2,087	287,835.09	187,165
Small	5,628	163,905.36	306,717
Total	9,085	2,837,524.46	680,327

Source: Ministry of Industry, Commerce and Supplies

*Small scale industries are only foreign investment

The employment landscape within the industrial sector reveals a range of contributions: manufacturing represents 22.6%, services make up 7.2%, and trade accounts for 42.5%. The distribution of employment shows that 64.9% of jobs are daily wage roles, 28.7% are long-term positions, and 6.4% are contract-based. The average number of operational days per year is 72.

Industrial Sector Employment and Activity Overview, FY 2022/23

Title	Percentage
Manufacturing share	22.6%
Service sector share	7.2%
Trade sector share	42.5%
Registered enterprises	52.6%
Average daily working days	72
Daily wage jobs	64.9%
Long-term jobs with monthly salaries	28.7%
Contract-based work	6.4%

Source: World Bank

Despite recent developments, Nepal's industrial sector has faced fluctuating growth in recent years. This slowdown stems from several challenges, including high interest rates that raised borrowing costs and constrained industrial expansion. Import restrictions introduced in early FY 2023 further disrupted supply chains and hindered production. Decreased demand in both domestic and international markets has exacerbated the situation, and a sluggish economic environment, characterized by ongoing difficulties in construction and manufacturing, has further diminished the sector's momentum.

However, the industrial sector holds significant growth potential in Nepal. Large as well as small and medium enterprises (SMEs), which collectively employ millions, present vast opportunities for expansion. With the right policy support in areas such as financing, infrastructure development, and energy, this sector can thrive. Additionally, addressing inefficiencies in the manufacturing and construction industries could improve productivity and strengthen resilience, further boosting the sector's contribution to the economy.

With targeted policies and strategic investments in infrastructure, capital, and energy efficiency, Nepal's industrial sector can evolve into a more diversified and robust contributor to the national economy, driving sustainable growth and development.

1.2 Introduction and background of the study

The industrial sector is the second most important sector as far as energy consumption in Nepal is concerned. While there is some understanding and documentation regarding the residential sector, which plays the most significant role in overall energy consumption, there is very little in the public domain regarding energy use and consumption by the industrial sector[4].

[4] Sharma, S., K.C, C., & Shrestha, D. (2024, January). *Household Energy Consumption and Energy Transition in Nepal 2023. A Survey Report.* Interdisciplinary Analysts (IDA), Kathmandu.

A comprehensive understanding of energy usage and utilization in the industrial sector would help in crafting targeted strategies aimed at enhancing energy efficiency, cutting costs, and mitigating environmental damages. It would also help industries grow.

Nepal has a diverse array of industries and enterprises. Nepal's industrial sector encompasses a wide range of activities, including manufacturing, construction, energy production, and mining. The country's industries are primarily concentrated in urban centers, with significant clusters found in major cities such as Kathmandu, Pokhara, Butwal-Bhairawa corridor, Hetauda, and Biratnagar-Itahari corridor. Manufacturing, particularly textiles, garments, handicrafts, and agro-processing, plays a pivotal role in Nepal's industrial landscape. Additionally, the construction industry is a key driver of economic growth, fueled by infrastructure development projects and urban expansion (though its performance during the past few years has not been so good).

Nepal's entrepreneurial spirit is evident in its vibrant enterprise sector, which comprises a diverse mix of micro, cottage, small, medium, and large-scale businesses. From family-owned shops to tech startups, enterprises in Nepal span various sectors, including retail, hospitality, tourism, information technology, agriculture, and services. The resilience and adaptability of Nepali entrepreneurs have enabled the sector to thrive despite challenges such as limited access to financing, bureaucratic hurdles, covid lockdown, Indian blockade of 2015-16 and infrastructure constraints.

As the preceding section has shown, Nepal's economic landscape has undergone significant shifts. The agricultural sector's contribution to GDP has declined in relative terms, while the service sector has witnessed steady expansion. Meanwhile, the industrial sector's contribution has remained relatively stable. While two decades ago, the contribution of agriculture, industry and service sectors to GDP were 37.4%, 17.5%, and 45.1% respectively in the current fiscal year, these figures are estimated to be 23.9%, 14.3%, and 61.8% respectively[5].

One of the more updated and comprehensive studies on energy consumption across the different sectors is the one by Water and Energy Commission Secretariate or WECS. Called the Nepal Energy Sector Synopsis Report - 2022, it examines overall energy usage and consumption as well as usages across various sectors.

In Nepal, the six major energy-consuming economic sectors in the year 2021, as depicted by figure1 (WECS, 2022, p. 51) include residential, commercial, industry, transport, agriculture, and construction & mining. The paragraphs that follow explain the top three energy consuming sectors in Nepal - residential at 63.2%, industrial at 18.3%, and transport sector at 9.0%[6] - with a major focus on the consumption of energy and the transition of energy in the residential sector.

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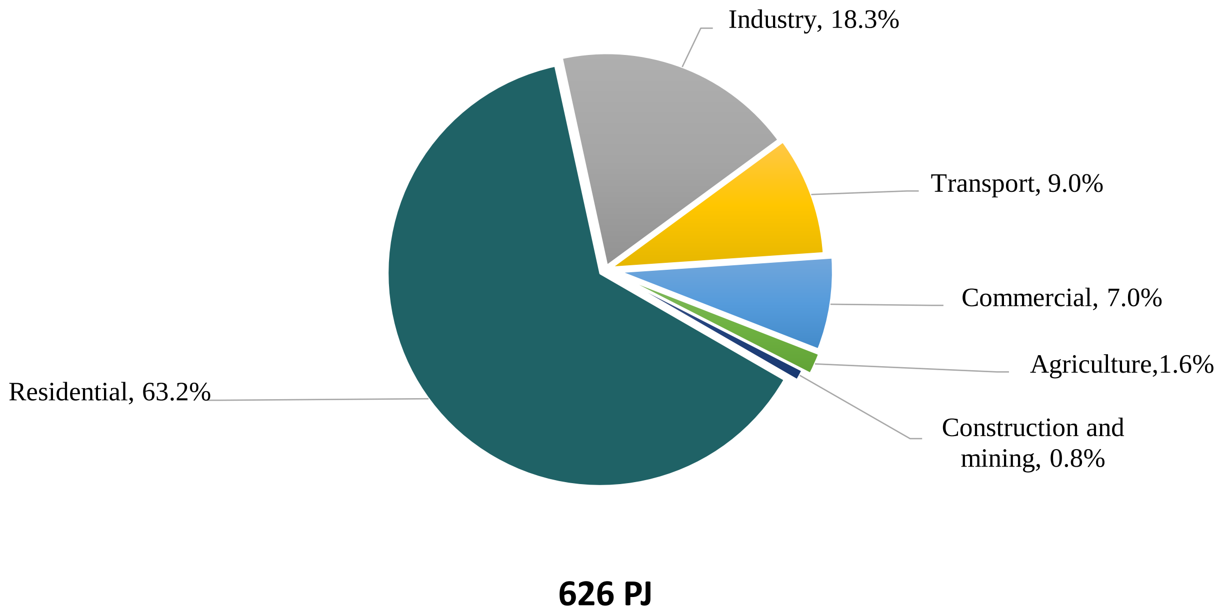
[5] https://www.mof.gov.np/uploads/document/file/1674635120_Economic_Survey_2022.pdf

[6] The figures presented in this section are drawn from *Nepal Energy Sector Synopsis Report – 2022* published by Water and Energy Commission Secretariat in 2022.

***Figure 1**: Sector-wise energy consumption in 2021*



Note: From "Nepal Energy Sector Synopsis Report- 2022", by WECS, 2022, p. 51. Retrieved from https://wecs.gov.np/source/Energy%20Sector%20Synopsis%20Report%2C%202022.pdf

The residential sector in Nepal stands out as the most energy-consuming sector. According to the Nepal Energy Sector Synopsis Report (2022), in the year 2021, this sector consumed a total of 396 petajoules (PJ) of energy. Fuelwood, agricultural residue, animal waste, and biogas are the major sources of energy used in the residential sector. Among these, fuelwood is the most used energy type at 84.87%. However, compared to 2009 when the fuelwood usage accounted for 87%, in 2021, its usage has slightly declined. Over the past decade, the consumption of LPG gas in the residential sector has increased to 2.76% -- more than double the usage a decade ago. The promotion of alternative energy sources has also helped increase the share of biogas usage to 2.46% and solar energy to 0.51%. Furthermore, the use of electricity as an energy source has witnessed an increase from 1% in 2009 to 2.95% in 2021.

While the WECS study of 2022 shows that of the total energy consumed by the residential sector, 85% constitutes of fuelwood, IDA's nationwide survey on residential energy use shows that 74% report cooking using fuelwood. Likewise, while according to the WECS study, LPG constitutes 2.7% of the total household energy consumed, the IDA study shows that the prevalence of LPG is much more widespread - 62% report using LPG. Multiple options were provided in the IDA study[7]. The fieldwork for the IDA nationwide survey on energy use among households was undertaken in July and August, 2023.

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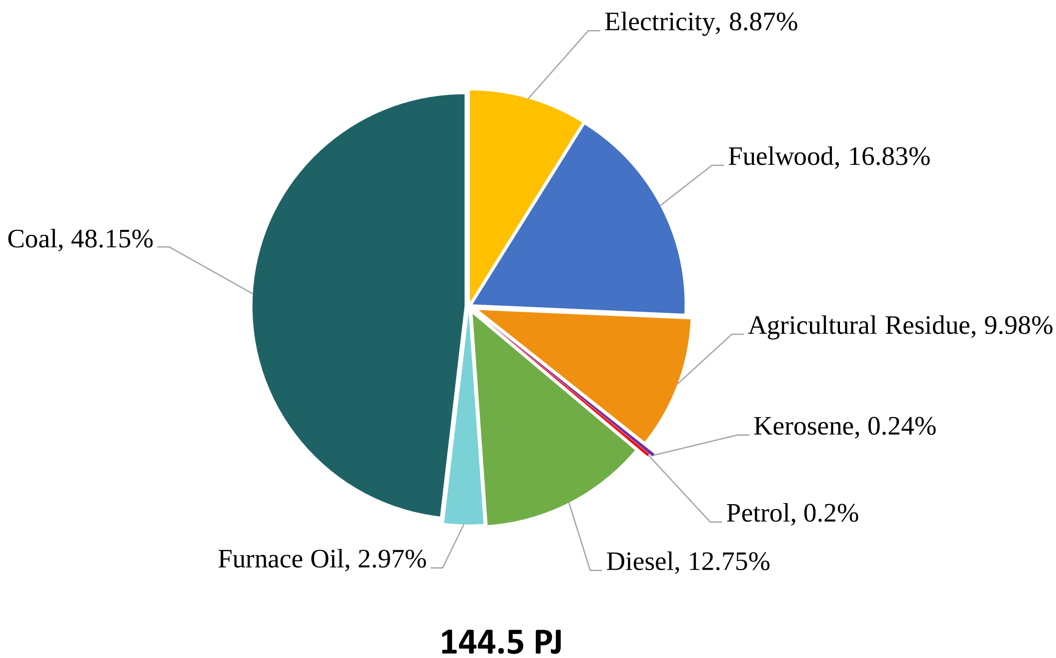
[7] Sharma, S., K.C, C., & Shrestha, D. (2024, January). *Household Energy Consumption and Energy Transition in Nepal 2023. A Survey Report.* Interdisciplinary Analysts (IDA), Kathmandu.

After the residential sector, the industrial sector ranks as the second- largest consumer of energy in the country, consuming a total of 114.5 PJ of energy. Figure 4 (WECS, 2022, p. 54) below shows the breakdown of the fuel types used in the industrial sector. Thermal purposes primarily drive the use of energy in this sector. Coal represents the most extensively used energy source for furnaces at 48%, followed by fuelwood at 17%. Additionally, for boilers, agricultural residue is extensively used. Diesel consumption is also quite evident in this sector, which is primarily used for power and running generators. In recent years, the trend of using electricity for thermal purposes is slowly increasing due to the presence of modern technologies; however, it appears that the use of old technologies is going to persist unless the pace of replacing them increases.

Figure 4: *Energy consumption by fuel types in Industrial sector in 2021*



Note. From "Nepal Energy Sector Synopsis Report- 2022", by WECS, 2022, p. 54. Retrieved from https://wecs.gov.np/source/Energy%20Sector%20Synopsis%20Report%2C%202022.pdf

Though this report by WECS gives certain insights into the different types of fuels used by the industrial sector, a lot of information remains unknown. For instance, what is the type of fuel used by industries that are at different scales – ranging from micro and cottage to medium and large? What is the extent of electricity used? To what extent does load-shedding or power outages exist? What is the current energy consumption patterns? What is the willingness to pay among industries if more reliable electricity is to be ensured? Is there a transition taking place in industries and if yes, to what extent? What kind of government support do industries anticipate?

A major issue for the past few years has been the ongoing tussle between the national utility, Nepal Electricity Authority (NEA) and Nepal's major industries. Nepal suffered a decade of crippling load-shedding due to generation shortfall with power cuts of up to 18 hours a day.[8] It ostensibly ended in May 2018 and the current Managing Director of NEA was lionized by the media for it. The term "ostensibly" is used with due consideration as it was clear that this was true only for domestic consumers of major urban centers where media (TV, radio, print etc.) were located. Far-flung settlements continued to suffer erratic supply and frequent cuts, and industries faced some 400 MW of power cuts so as to supply domestic consumers (and thus gain popularity for the move).

Because industries had to install expensive diesel, the then government decided that if industries were willing to pay more premium price to the grid (and less than what their expensive captive generation cost them), it would provide them uninterrupted supply. While a good decision that took into account the fact that well-functioning of industries was important both for government revenues and for the livelihood of the many workers they employed, the problem was with its implementation. To understand the complications, one has to begin from the nature of Nepal's grid and its expansion which was mostly done with household lighting in mind.

The current controversy revolves around what are called "dedicated feeders" and "trunk lines". The former supply uninterrupted power to mostly state services such as the Central Secretariat and government buildings, telecommunication offices, hospitals etc.[9] Practically no industries are supplied from them, and there are currently no unpaid tariff issues with them. Industries asked for similar arrangements from them, but given the way the grid was designed, such supply was not possible. So, what was done instead was to allow them to tap into transmission trunk lines between sub-stations in the industrial corridors and to establish a mini-substation within the industry's premises. They were to pay an additional 67% tariff.

Difficulties arose from several aspects.[10] For populist reasons, NEA announce the end of load shedding in May 2018 but did so by cutting off supplies to all industries, including those on trunk lines to supply domestic consumers, and importing massive amounts of power from India. Industries said they would now no longer pay the premium price as the basic understanding of uninterrupted power has been violated. Compounding the problem, NEA did not bill industries for almost two-and-a-half years for the premium (industries insist they are paying their regular meter-read monthly bills). Then NEA suddenly billed them for what they said was industries' delinquency and included 25% fine for late payment which increases every month of non-payment. The original amount of some 10 billion rupees has now ballooned to over 20 billion and increasing usuriously. The litigation between certain large industries and the national utility, NEA, is currently in the Supreme Court.

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[8] See: https://www.sciencedirect.com/science/article/abs/pii/S1364032121004007#:~:text=After%20a%20decade%20of%20severe,and%20industrial%20customers%20%5B5%5D.

[9] A dedicated feeder system supplies electricity through a separate line directly from a substation, ensuring continuous power even during load shedding by switching to an alternative line. In contrast, a trunk line delivers electricity from the transmission line to an industry, with a transformer installed within the industry itself.

[10] For details, see: NEA v Industries: Dedicated feeders and trunk lines controversy explained - OnlineKhabar English News

The matter also continues to be muddled by a host of decisions by the Tariff Fixation Commission and the recommendations of the government-formed Lal Commission under the chairmanship of a former justice of the Supreme Court (which the NEA is actively lobbying against11), in addition to unilateral decisions by the NEA. The NEA has also been unable to provide exact metered readings of electricity consumption of industries it claims from them, the matter, it is said, resulting from the software used by NEA where old readings past a year or a year and a half are automatically deleted.[12] NEA's difficulties now lies with the fact that they have recorded this massive amount in their audited balance sheet as income when it is still questionable whether it is really a total loss.

1.3 Objectives of the Study

In the light of the above, the objective of this survey is to describe and analyze energy consumption patterns in industries and enterprises in Nepal. The specific objectives of the study are:

- Identify the various types of fuel used by industries and enterprises at different levels of scales i.e., micro, cottage, small, medium and large.
- Document the extent of electricity used by the industries and enterprises.
- Document the extent power outages in industries and enterprises.
- Ascertain current energy consumption levels and patterns in industries and enterprises.
- Assess the willingness to pay among industries and enterprises for more reliable electricity.
- Identify areas for improving energy efficiency and reducing energy costs.
- Document energy transitions taking place among the industries and enterprises.
- Ascertain the areas in which industries and enterprises anticipate government support.

1.4 Organization of the Report

The organization of this report is structured to provide a comprehensive analysis of energy use, supply, and resilience within the study area. Chapter 1: Introduction and Background outlines the purpose, objectives, and scope of the study, offering essential context and definitions for understanding the broader energy landscape. Chapter 2: Institutions Relevant for Industries and Energy Transitions discusses the major institutions responsible for variable renewable energy (VRE) and government entities responsible for managing industries. Chapter 3: Methods and Procedures of the Study details the research design, data collection methods, sampling strategy, and any challenges or limitations encountered, ensuring transparency in the study's approach. In Chapter 4: General Information, key demographic and socioeconomic characteristics of the study area are presented.

[11] See: NEA discontent over inquiry committee's report on clearance of dues of dedicated feeders and trunk lines - myRepublica - The New York Times Partner, Latest news of Nepal in English, Latest News Articles (nagariknetwork.com)

[12] On this and other issues, see series of articles in this and its threads: अदालतलाई प्राधिकरणको जवाफ : टीओडी मिटरको तथ्यांक मेटिइसक्यो – Online Khabar (Reply of NEA to the court: "ToD meter readings have been erased already".

Chapter 5: Operations and Energy Use examines current energy consumption patterns across various sectors, analyzing the specific energy needs and demands. Building on this, Chapter 6: Energy and Electricity Supply provides an assessment of existing energy sources, infrastructure, and supply reliability, identifying the challenges faced in meeting demand. Chapter 7: Energy Pricing and Willingness to Pay explores the pricing structures of energy, analyzing perspectives on affordability and their willingness to pay for services.

In Chapter 8: Energy Efficiency, the focus shifts to evaluating current energy efficiency practices, identifying opportunities for improvement, and addressing barriers to adopting more efficient technologies. Chapter 9: Shocks and Resilience assesses the impacts of various shocks—such as natural disasters or economic changes—on the energy supply, along with the resilience measures in place to mitigate these disruptions. Chapter 10: Closure, much of which is based on open-ended responses in the survey concludes the study. Chapter 11 provides conclusion and recommendations. It synthesizes the key findings from each chapter, concluding with final insights and recommendations for future research and policy directions, aimed at strengthening the energy sector's sustainability and resilience. This organization ensures a logical flow that guides the reader through a comprehensive examination of energy-related challenges and potential solutions.

1.5 Limitations of the Study

This report is primarily descriptive. As the data has been processed, cleaned, and presented in terms of means, frequencies, or percentage distributions. There has been some attempt at analysis especially by linking the survey findings with insights generated from Key Informant Interviews (KIIs). However, more analysis needs to be done.

CHAPTER 2: INSTITUTIONS RELEVANT FOR INDUSTRIES AND ENERGY TRANSITION

2.1 Alternative Energy Promotion Center (AEPC) – General Introduction

The Alternative Energy Promotion Centre (AEPC), established in 1996 (BS 2053), is Nepal's central agency for promoting renewable energy. Operating under the Ministry of Energy, Water Resources, and Irrigation, AEPC is committed to expanding energy access and driving sustainable solutions through innovative partners programs and strategic collaborations with international donors, private sector stakeholders, and local governments[13]. Its initiatives are designed to promote the use of variable renewable energy (VRE) technologies, enhance energy efficiency, raise living standard of rural people, promote environmental sustainability and develop commercially viable renewable energy industries in Nepal. Its initiatives focus on promoting the use of renewable energy technologies, enhancing energy efficiency, improving rural livelihoods, promoting environmental sustainability, and fostering a commercially viable renewable energy sector in Nepal.

AEPC's mandate covers a broad spectrum of renewable energy development, both off-grid and on-grid. By addressing the energy needs of ultra-remote areas, it facilitates the establishment of off-grid systems, such as solar mini-grids and small hydropower projects, ensuring electricity access in regions where traditional grid expansion is impractical. Similarly, to bridge the energy access gap it actively promotes rooftop solar installations in commercial and industrial sector, fostering clean energy adoption while encouraging private investment.

AEPC ensures alignment and coordination among various renewable energy policies and programs, creating a unified approach to sustainable energy development. Additionally, it provides essential technical expertise to provincial and local governments, offering guidance on renewable energy projects while fostering capacity building within communities.

Major Programs of AEPC

i. *Renewable Energy for Rural Livelihood (RERL)*

The Renewable Energy for Rural Livelihood (RERL) program, a pioneering initiative of AEPC, supported by UNDP and other development partners. Launched when rural electrification rates ranged between 30% and 49% (i.e., around 2000-2010) the program aimed to bridge the energy access gap in underserved communities through renewable energy solutions.

RERL was initially a separate entity under UNDP, operating through district-level units to implement renewable energy projects. One of its key achievements was bringing renewable energy into national and local discussions, significantly raising its importance at the grassroots level. Eventually, RERL's model was replicated across all 75 districts, solidifying its role in Nepal's renewable energy development.

[13] When it was established and for the next two decades or so it used to be under the Ministry of Science and Technology.

ii. Nepal Private Sector-Led Mini Grid Energy Access Project (MGEAP)

The Nepal Private Sector-Led Mini Grid Energy Access Project (MGEAP), supported by the World Bank, is aimed at empowering private entities to develop off-grid energy solutions in underserved regions. The program seeks to expand energy access in remote areas where grid connectivity is not feasible, utilizing private developers' expertise and resources.

MGEAP operates on a funding model where private developers cover 40% of the project cost through equity or loans, while 60% is subsidized. This encourages private investment and promotes collaboration in renewable energy development. However, the program faces challenges that have limited its broader adoption. High risks in remote areas, logistical complexities, and limited infrastructure increase costs and uncertainty.

iii. South Asia Subregional Economic Cooperation (SASEC)

The South Asia Subregional Economic Cooperation (SASEC), an ADB-supported program, has played a crucial role in advancing renewable energy alternatives in Nepal. By supporting AEPC's initiatives—such as mini-hydro projects, solar mini-grids, and hydro-related transmission infrastructure—SASEC has significantly improved energy access in off-grid rural areas. Its overarching goals include strengthening Nepal's renewable energy infrastructure, promoting sustainable development, and empowering rural and marginalized communities.

Solar Mini-Grids: SASEC has developed solar mini-grids ranging from 150 kW to 60 kW, electrifying around 300 to 400 households per grid. These grids, supported by battery storage technology, ensure reliable power, especially during the night, meeting the energy needs of domestic and community users.

Mini-Hydro Projects: The program has also funded mini-hydro projects with capacities up to 1 MW, primarily aimed at off-grid communities. While these projects currently operate independently, plans are in place to integrate them into the national grid for enhanced utility and scalability.

The solar components have been successfully completed as per the target, while some hydro projects are still ongoing.

iv. Clean Cooking Solutions

AEPC seeks to promote the adoption of clean cooking technologies to improve health outcomes, enhance energy efficiency, and reduce environmental degradation. The initiative focuses on rural and semi-urban areas, where reliance on firewood and inefficient stoves remains widespread, negatively impacting health and the environment. Supported by the Green Climate Fund (GCF), the program seeks innovative, sustainable solutions tailored to the needs of diverse communities.

By promoting the technologies such as Biogas Systems, Improved cooking stoves and Induction Stoves, AEPC seeks a sustainable alternative to firewood and fossil fuels.

v. Promotion of Solar Technology (POSTED)

The POSTED program, supported by GIZ and KFWJI, focused on promoting solar technology across various sectors. Officially concluding on December 31, 2024, the program focused on building solar rooftop systems in urban and semi-urban areas, increasing energy access while reducing dependence on traditional electricity sources. It also targeted solar irrigation systems to boost agricultural output, providing farmers with a sustainable energy solution for their irrigation needs. Additionally, solar mini-grids were deployed to serve off-grid settlements, ensuring reliable energy access in remote areas.

vi. Promotion of Solar Energy in Rural and Semi-Urban Regions (DKTI)

The Promotion of Solar Energy in Rural and Semi-Urban Regions (DKTI) initiative is a strategic program designed to accelerate the adoption of clean energy in Nepal. Supported by the German federal government, the program plays a crucial role in advancing Nepal's renewable energy transition, especially in rural and semi-urban areas. DKTI encompasses both on-grid and off-grid solar systems, including solar irrigation pumps, mini-grids, and solar PV for off-grid applications. The on-grid systems primarily concentrate on rooftop solar installations within the commercial and industrial sectors aiming to install 15 MW of rooftop solar capacity across the country.

The program outlines two implementation models for on-grid solar installations. The first is the Renewable Energy Service Model (RESCOs), where energy service firms manage the entire installation process and provide end-to-end solutions for commercial and industrial enterprises. The second model, Assessed Own Modality (Capex), enables industries to independently handle the application and installation processes while still benefiting from subsidies and retaining full control of their solar assets. A notable example of this approach is a mall in Lalitpur district called LABIM Mall, which has successfully implemented the concept.

The application process is open to all interested commercial and industrial companies, as well as qualifying Energy Service Companies. The program operates under a subsidy modality, offering a 50% interest subsidy for a period of five years as outlined in the Renewable Energy Subsidy Policy of 2022. This subsidy is directly applied to the banks where firms have taken loans, making rooftop solar systems more affordable and financially viable for industries. In addition, the industries also benefit from a 28% customs tax and VAT exemption (for which an official letter from AEPC is required).

The initiative provides significant opportunities for businesses to adopt clean energy solutions, reduce energy costs, and promote sustainability across Nepal.

vii. Nepal Renewable Energy Programme (NREP)

Nepal Renewable Energy Programme (NREP), introduced by the Government of Nepal in February 2019, is a collaborative initiative between the UK Government and the Government of Nepal. It is implemented by the Alternative Energy Promotion Centre (AEPC), with technical support from a consortium contracted by the British Embassy. DAI Global UK leads this consortium, with Winrock International as a key partner. SECF is a challenge fund mechanism promoted by the Government of Nepal through the Alternative Energy Promotion Centre/ Central Renewable Energy Fund with technical assistance from the NREP and financial support from the British Embassy in Kathmandu.

NREP targets three main areas to support Nepal's energy transition:

- *Developing distributed sustainable energy:*

NREP basically focuses on the distributed sustainable development of energy extending beyond production to promote equitable consumption and efficient use. It aims to meet the energy needs of cooking and other essential uses, especially in remote regions like Karnali, where energy security is a significant challenge and distribution lines are long. Having the generation plant closer to the consumption area enhances energy security, stabilizes voltage, and improves energy quality. This emphasis on distributed production, consumption, and efficiency shapes the program's vision for sustainable energy development.

Moreover, the rise of energy democracy raises the question of who should control the energy resources people depend on. Is it solely the responsibility of NEA, or should the management be decentralized? The initiative, thus promotes energy democracy by encouraging innovation and efficiency in energy generation.

- *Promoting private sector participation:*

NREP encourages private sector involvement, recognizing it as essential for scaling sustainable energy development. The private sector brings efficiency, innovation, investment, and long-term sustainability, as demonstrated in other sectors.

- *Bridging viability gaps:*

Although the private sector is willing to engage in sustainable energy development, they are hesitant due to the significant viability gap, viewing the risks as greater than the potential returns. To address this, NREP is providing viability gap funding to help attract more private sector participation. A Sustainable Energy Challenge Fund is established to support this initiative with the help of government. Managed by the Central Renewable Energy Fund (CREF) under AEPC, this fund initially received support from the UK Government. The UK Government continues to provide funding to the Government of Nepal (GON). Additionally, a year ago, GIZ introduced German and EU funding into the challenge fund, further strengthening its impact.

The Sustainable Energy Challenge Fund promotes distributed energy systems through eight distinct funding windows, each designed to support specific energy initiatives. These windows include models such as public-private partnerships (PPP), demand aggregation, mini and micro-grid projects, interest rate buy-downs, incentive-based energy generation, innovative approaches, reverse auctions, and loan guarantees. The fund emphasizes key projects, including bio-pellets, electric cookstoves, solar pumps, mini-hydro systems, solar mini-grids, EV charging stations, and biogas plants, each operating through tailored approaches.

Of the eight funding windows in the Sustainable Energy Challenge Fund, two are dedicated to rooftop solar projects under 1 MW. The financial support mechanisms offer two options: a 5% interest subsidy on loans with a five-year repayment term under the Interest Rate Buy-Down scheme or a Generation-Based Incentive of NPR 1.50 per unit for self-financed electricity generation. Industries can choose the option that best suits their needs. To date, 8 MW of rooftop solar systems are operational under this program, with an additional 6–7 MW in the pipeline.

Under the generation-based incentive window, the program offers two distinct implementation models similar to the approach of DKTI, for on-grid solar rooftop installations: The Self-Investment (Capex) Model and the Renewable Energy Service Company (RESCO) Model.

The RESCO Model is particularly attractive for industries that want to avoid upfront investment. Energy service providers, such as Gham Power and Simple Energy, handle the installation and maintenance of rooftop solar systems. In this model, industries purchase energy at a rate 3–4 NPR lower than grid electricity, with the application process also managed by the service provider. Additional benefits under this model include discounted customs duties on solar panels and inverters.

Box Item 1: Solar-as-a-Service — A Business Model Innovation

‘We realized that the solar, or any kind of energy solution cannot just be a product, it needs to be a service, with a specific business model having a long-time horizon for it to make economic sense for the end use customer. So, instead of trying to sell the product, we offered the product as part of a service where, instead of paying for the system upfront, our clients pay a monthly rate for the solar electricity kWh output.

We reach out to prospective clients, conduct energy audit and offer a contract to them, which is cheaper than what they're currently paying to the utility, thus beating the NEA price. Indeed, it is even more profitable for them than their backup diesel generator. If clients have unused roof space, they get green solar energy at a cost that is less than that of the NEA, and also save money on diesel backup. We provide the financing, technology and design usually for a 15-to-20-year period, after which we hand over the system that has a life of 30 years to the clients.

If convincing prospective clients was a problem (many of them thought this was too good to be true), a bigger challenge was convincing the regulatory authorities that are only hydro-focused. To register our company, we had to specify where our project location was, which is very specific for hydro, but ours are all over the country. We are not even sure where our project will be until a client signs off on the contract. Convincing the banks was just as difficult, which became possible only after projects were built, they saw the revenue stream, and then only agreed to refinance a portion of the project.

Another great advantage of this solar approach is that it is bringing production back to the consumption centers. When you build a hydropower plant, you also have to build long, expensive transmission lines, which with solar PVs that mostly take advantage of unused rooftops is minimal. In major consumption centers (urban areas), electricity demand last year went up by thirty percent mostly due to increase in electric vehicles and electric cooking. Solar fulfils that demand *in situ* without the need to wheel electricity from afar, thus significantly reducing transmission loss and improving voltage.

Challenges in the operational phase relate to scale: unlike 10 or 100 MW projects, these are small in the kW range and spread out, which makes monitoring difficult and adds to operating expenses. However, with smart digitization, we have been able to have a “war room” where across big television screens our team experts are monitoring 25 sites. If the production drops (due to something loose, dust on panels, cloud cover etc.) we know immediately and take action. If we were merely selling a product (where we can forget everything after installation and we are paid), in this model, we are invested in the system and have to make sure everything is functioning optimally for the years before we hand the system over to the client.'

Source: KII with Anjal Niraula, CEO, Gham Power Pvt. Ltd.

In contrast, the Self-Investment (Capex) Model requires industries to manage the entire process—from applying for subsidies to owning and maintaining the solar assets. According to the NREP's data, with the declining costs of solar technology, industries with the capacity to invest are increasingly leaning toward this model. Many recognize the long-term profitability of ownership and are opting to generate their own solar energy, which provides them with greater control over their energy consumption.

Net Metering for Industrial Solar; Policies and Requirements

Under the net metering clause for rooftop solar, industries need to consume at least 50% of the energy generated and can sell the remaining 50% to the grid for systems of 1 MW capacity. In other words, projects must self-consume at least 51% of the annual photovoltaic energy generated. For installations exceeding 1 MW, entities must seek prior approval from the Nepal Electricity Authority (NEA). A notable example of this is Reliance Spinning Mills, which successfully installed a 3 MW rooftop solar system, demonstrating the viability of large-scale self-investment in solar energy. Despite progress, a critical gap remains in government awareness and engagement in rooftop solar adoption.

Nepal's renewable energy landscape is evolving, with AEPC playing a pivotal role in advancing rooftop solar adoption through subsidy policies and viability gap funding models. Programs like DKTI and NREP have made strides in supporting the industrial and commercial sectors by offering innovative and financially viable solutions for solar integration. These initiatives are driving the transition to renewable energy, making it more accessible and sustainable for businesses and communities alike.

However, despite these efforts, a significant gap remains in awareness and engagement. While the government and AEPC have laid a strong foundation for enhancing energy access and security, many industries remain uninformed. Additionally, the Nepal Electricity Authority (NEA) and other key stakeholders have yet to fully recognize and actively promote these opportunities.

For Nepal to fully embrace sustainable energy development and energy security, it is crucial to bridge this gap through targeted policies, extensive outreach, education, and dedicated support mechanisms.

2.2 Industrial Zone Management (IZML) Limited

Industrial Zone Management - General Background

Industrial Zone Management Limited (IZML) was established in July 1988 with the mission of promoting industrial growth and development across Nepal. Initially, it operated as an Industrial Service Center (ICS) under the Government of Nepal. Under ICS, two entities worked collaboratively: The Nepal Industrial Development Corporation (NIDC) and the Department of Industries. The management of the Balaju and Hetauda industrial zones was undertaken by the NIDC, while the Patan, Dharan, Nepalgunj, and Pokhara Industrial Estates were managed by the Department of Industries/Government of Nepal.

As the number of industrial zones grew and their activities expanded, management responsibilities were formally handed over to ICS in 1975, under the oversight of the His Majesty's Government of Nepal (HMGN). Later, to streamline and strengthen the management of industrial zones, the Government formally established Industrial District Management Limited (IZML) under the Company Act in 2045 B.S. During this transition, the two entities parted ways: NIDC was restructured as the Nepal Productivity and Economic Development Centre Limited (NPEDC), while ICS transitioned into Industrial District Management Limited now known as Industrial Zone Management Limited (IZML), which took on the responsibility of managing all activities within industrial areas across the country.

IZML currently oversees 10 industrial districts across Nepal, including Balaju, Patan, Hetauda, Pokhara, Dharan, Nepalgunj, Bhaktapur, Butwal, Birendranagar, and Gajendranarayan Singh Industrial Areas. While each district operates with a degree of autonomy, IZML provides centralized management and oversight.

As a separate corporate entity, IZML generates revenue from multiple sources, including land leases, utility services, entry and renewal fees, and electricity distribution. Land lease rates vary by location, with rates set at NPR 98,000 per ropani per year inside Valley, NPR 21,600 outside the valley, and NPR 12,000 in Surkhet. Utility services, such as water and electricity, also contribute significantly to its revenue stream.

For electricity, IZML purchases power in bulk from the Nepal Electricity Authority (NEA) at a 10% discounted rate. NEA supplies electricity through separate feeders to substations near industrial areas, while IZML manages the distribution. IZML imposes demand charges on industries, which contributes to its revenue. In cases where industries do not have Time-of-Day (TOD) meters, IZML apply its own TOD rates, which differ from those set by NEA. Industries with TOD meters are charged according to NEA's TOD rates. The management in each industrial area is responsible for operating the electricity distribution systems, ensuring a reliable power supply, and expanding the distribution network as needed.

Meanwhile the collective revenue generated by IZML is used to provide the various services to industries, namely, (1) Infrastructure development: construction and maintenance of roads (2) Utilities: supply of electricity and water (3) Operational support: facilitating industry operations within the industrial areas including staff salary. Each branch offices undertakes the responsibility, supporting operations within their respective areas.

Potential for Solar PV Initiatives in Industrial areas

Industrial areas managed by IZML offer substantial potential for renewable energy integration, particularly solar photovoltaic (PV) systems in its various location. These areas have large rooftops (including those of factories and parking facilities) and significant unused land, which could collectively generate approximately 300–400 MW of solar power[14]. Solar PV installations within industrial zones would allow electricity to be generated and consumed on site, reducing line losses (which currently stand at 18–19% during distribution), improving voltage stability, and eliminating the need for costly voltage stabilizers.

If only individual industries install solar systems independently without the support of IZML, they face several limitations:

No Feed-In Tariff (FIT): Industries cannot sell excess electricity back to the grid without IZML's permission for reversible meter agreements. This reduces the net metering benefit that they are supposed to get and the generated energy goes to waste decreasing attractiveness of adopting solar energy within the area.

For instance, a Polymer industry in Hetauda has independently installed a 300KW solar system. As a result, the industry is regarded not eligible for a Power Purchase Agreement, leading to any excess solar energy generated during holidays to go to waste.

Organizational resistance: Current organizational practices of IZML discourage industries from adopting solar energy independently due to the absence of feed-in tariffs or reversible meter agreements. IZML may perceive these independent initiatives as a threat to its electricity revenue, potentially leading to conflicts or a lack of management support for other initiatives.

If IZML Takes the Initiative:

IZML's leadership in solar rooftop initiatives could catalyze a transformative energy shift in Nepal's industrial sector. They can be a large solar producer producing approximately 300-400 MW of energy across its 10 industrial districts. This initiative would lower energy bills and maintenance costs by improving voltage stability within industries. Additionally, it would enhance energy security by increasing reliability during peak demand, reducing reliance on external energy sources, and ensuring a stable and sustainable power supply.

Through proactive advocacy, IZML could also negotiate feed-in tariff (FIT) agreements with the Nepal Electricity Authority (NEA), enabling surplus electricity generated within industrial areas to be sold back to the grid. This would create a new revenue stream for IZML, supporting Nepal's broader sustainability goals. Centralized solar projects under IZML would also ensure that excess electricity is efficiently managed, with benefits shared among industries.

[14] This is the authors' guestimate. A more realistic estimate would require more data such as the total land area under IZML in the ten locations.

Although IZML has mentioned efforts to promote solar energy in collaboration with NEA and has conducted various studies, including considering partnerships with solar companies like Gham Power and Simple Energy to facilitate solar adoption. Meanwhile IZML has yet to provide adequate awareness or support for the installation of TOD meters. Most industries are unaware of the TOD rates within the industrial area, unknowingly paying higher electricity prices. Thus, without tangible action in these areas, the promotion of solar energy risks remaining an aspiration and not becoming a reality.

There is also a reluctance on the part of NEA to see industries installing solar PVs on their rooftops under net metering arrangements. This is because the NEA sees industrial users as an important source of revenue who pay a higher price per unit of electricity. Moreover, given that the revenue generated from industries helps to cross-subsidize the costs of rural electrification, NEA feels that if industries were to install their own rooftop solar, it would lead to a loss of revenue for NEA. It would then be saddled with a net loss-making rural electrification sector[15].

Box Item 2: Key Challenges for Industries Served by IZML

Industries and Enterprises operating within Industrial area are dependent on the Industrial District Management Limited (IZML) for electricity supply, as IZML purchases electricity wholesale from NEA and retails it in industrial area. However, this arrangement has created multiple layers of inefficiency and frustration for industrial consumers.

'We receive electricity from the IZML, which purchases it wholesale from NEA and distribute it to industries, meaning we do not deal with NEA directly. Whenever we experience power tripping, which is the biggest issue for us, we complain to the management, but they always respond by saying "the system is down" and do very little about it. In reality, it is a problem with the incoming NEA feeder with many step-down transformers along the way before coming to the industrial area, which results in low voltage and frequent tripping that results in equipment damage, raw material wastage and labour time lost. Also, poles or lines are often damaged due to a truck accident or other external factors. If an alert message was provided to us indicating a system failure and specifying the time for recovery, it would be easier for us to operate the backup generator.

Respondent also raised concerns about paying additional charges while being forced to rely on diesel generator during outages. One of the informants mentioned, "If electricity is unreliable and we are forced to rely on diesel generators during power outages, why are we still being charged a demand fee? Currently, we pay for electricity based on the Time of Day (ToD) readings. However, we also pay the NEA demand charge[16] and a transformer

[15] For details, see Annex 11.

[16] A demand charge is levied by utility provider (NEA) to cover the cost of ensuring that power is immediately available on demand. This is essentially a 'spinning reserve' – there should always be a reserve available with the utility to instantly supply an increased demand that can arise any time. However, when there are power outages or unscheduled load shedding, this obligation of providing electricity is not fulfilled. In such cases, the question arises: Why should industries still be paying a demand charge? If the power provider cannot supply electricity when demanded, then they should not charge a demand fee. This is a matter for industries, especially through their chambers of commerce and industry, to raise and seek a fair resolution. – Authors.

loss charge [17] despite suffering from outages and tripping. I have raised this issue with the concerned authorities of IZML, but no action has been taken".

Installing ToD meters was a significant challenge for us. We had to handle the entire process on our own. Most industries are unaware of the (ToD) pricing system, and even those who are aware face significant challenges in getting a ToD meter installed by the NEA. We only learned about ToD pricing system after participating in a training provided by SPS. Despite being informed that ToD meters were available, one NEA official refused to provide it, citing their boss's denial. After using various connections and resources, we were finally able to obtain a ToD meter, but the entire process took 5-6 months, and we had to go to Hetauda to acquire it ourselves. Why should industries bear such burdens when IZML should be providing these services instead of being profit extracting?'

Source: KII with a medium-sized food processing industry in Pokhara.

Achieving this vision will require overcoming internal resistance to change and fostering a culture of innovation that prioritizes renewable energy integration and long-term profitability.

[17] Upon closer examination of the electricity tariffs for industries, based on IZML and NEA documents published on their respective websites, it is evident that demand and transformer loss charges are imposed in accordance with NEA rules and regulations. IZML does not have the authority to regulate these charges independently.

CHAPTER 3: METHODS

3.1. Sampling Design

The survey on energy use among industries and enterprises in Nepal employed a quota sampling method with a planned total sample size of 600—split equally between industries and enterprises. The sampling frame comprised a comprehensive list of registered establishments from government databases, industry associations, and trade directories, representing both enterprise and industrial levels.

Six key cities were strategically selected to cover Nepal's major industrial- urban corridors: Biratnagar-Itahari, Kathmandu valley, Birgunj-Pathlaiya, Pokhara valley, Bhairahawa-Butwal, and Nepalgunj-Kohalpur. In each cluster, it was planned that there would be a sample of 100 industries and enterprises.

The sample that was planned is summarized below.

Table 3.1 *Planned sample size and its distribution across clusters*

Size	Biratnagar-Itari	Birgunj–Pathlaiya	Kathmandu	Bhairahawa–Butwal	Pokhara	Nepalgunj–Kohalpur	Total
Large	20	20	20	20	20	20	120
Medium	20	20	20	20	20	20	120
Small	20	20	20	20	20	20	120
Cottage	20	20	20	20	20	20	120
Micro	20	20	20	20	20	20	120
Total	100	100	100	100	100	100	600

Furthermore, the industrial sample was divided into seven sectors, following the Nepal Standard Industrial Classification (NSIC), with samples proportionally distributed based on the economic census of Nepal. These sectors included agriculture, forestry, and fishing; manufacturing; construction; accommodation and food services activities; information and communication; health and social work activities; and financial and insurance activities.

Enterprises were further categorized by size—micro, cottage, small, medium, and large—based on employee count, investment size, or production capacity.

Quotas were established to capture diversity across sectors and sizes, enabling analysis of varied energy consumption patterns.

Quota cells were created for each sector and enterprise size, for instance, in the Biratnagar-Itari corridor, the 100-sample quota included 20 samples each from micro, cottage, small, medium, and large industries/enterprises. Within each quota, the plan was to select through systematic or simple random sampling, with replacement implemented in case of unavailability or refusal to participate.

3.2. Pre-Test and Research Plan Adjustments

Between July 16-20, 2024, IDA conducted a pre-test in Biratnagar, an industrial hub in eastern Nepal, to interview industrialists, test survey tools, and measure the relevance of the questionnaire.

The team engaged with the Morang Chamber of Industries (MCI) on July 17, 2024 to discuss energy challenges, introduce the survey, and obtain feedback on the questionnaire. MCI supported the pre-test by providing a categorized list of industries and notifying relevant participants.

Two research teams conducted face-to-face interviews with 10 industries of varying sizes (1 large, 2 medium, 2 small, 1 cottage, and 4 micro) using hard-copy questionnaires. Despite appointments, interviews with large and medium enterprises were often rescheduled or canceled due to time constraints, while smaller enterprises were more accommodating. Thus, a high likelihood of non-response was anticipated mostly in the larger and medium industries. This also underscored the need for preparing the groundwork prior to the survey.

The pre-test also indicated a need to revise the sample strategy, particularly for large and medium industries and the need to supplement the survey with a number of Key Informant Interviews (KIIs). KIIs was deemed crucial in obtaining important insights from senior industry leaders, led by senior IDA researchers.

Additionally, collaboration with industry bodies like the Federation of Nepalese Chamber of Commerce and Industry (FNCCI) was also regarded important in order to obtain the aimed sample and to get a support in field coordination and industry engagement.

Additionally, feedback from the pre-test emphasized the need for a shorter, sector-specific questionnaire to accommodate industry/entrepreneur's limited time availability. Certain questions were irrelevant for specific sectors, such as construction companies with dispersed operations and branch offices using shared energy resources. A tailored approach for each sector and concise, and adding a few open-ended questions was employed to improve response rates and data accuracy.

3.3 Preparatory Field Visit

To streamline the fieldwork process for the survey, a preparatory cluster visit approach was adopted in key industrial areas across Nepal. The objective was to compile a comprehensive list of industries and enterprises using the Nepal Standard Industrial Classification (NSIC) and to engage with regional chambers of FNCCI for support.

IDA's Human Resource Manager then undertook a visit to the six major industrial clusters: Biratnagar-Itahari, Birgunj-Pathlaiya, Bhairawa-Butwal, Nepalgunj-Kohalpur, Pokhara, and Kathmandu beginning from September 3 to 13, 2024. In each of these locations, meetings were held with local chamber officials for purposes of building rapport, mentioning about the objectives of the survey, specifying the date in which the actual survey work will probably be undertaken, and more importantly, obtaining a list of industries and enterprises which would function as the "list" from which the industries and enterprises will be selected for the interviews.

Each cluster visit included presenting the survey’s objectives to the chamber representatives and securing their support for accessing local industry information. In Biratnagar-Itahari, the Chamber of Industries Morang (CIM) agreed to provide the list of industries and enterprises and also committed to support data collection activities by facilitating communication with sampled industries and enterprises. Whereas, in Birgunj, there was some initial hesitation. Jitpur-Simra Chamber of Commerce and Industries (JSCCI) agreed to facilitate and to offer the necessary assistance. Similarly, in Bhairawa-Butwal, the Siddhartha Chamber of Commerce and Industries (SICCI) provided the list of industries and enterprises and committed to support the survey once it begins. In Nepalgunj-Kohalpur, the Nepalgunj Chamber of Commerce and Industries (NJCCI) agreed to share industry data and also promised to assign an official to assist the survey team during data collection. Although the Pokhara Chamber of Commerce and Industries (PCCI) was initially unavailable due to election activities, a supportive member provided the required industry list, facilitating field activities.

Thus, a preparatory visit by an IDA staff to these locations help build up trust with the local chamber of commerce and industry, which would play a crucial role in facilitating the process.

3.4 Training

An intensive four-day training session was conducted from September 15-18, 2024, to equip field staff with the necessary skills and knowledge for effective data collection.

Prio to the training, since the survey would be administered in android Tablets, the survey questionnaire had been programmed into ODK.

The training involved 18 enumerators and 6 supervisors, each carefully selected based on prior research experience, including involvement in the 2023, Household Energy Survey. The training curriculum was designed to enhance understanding of Nepal's energy sector, research ethics, and teamwork, and to develop rapport-building skills essential for engagement with industry representatives.

The training began with an overview presentation by Dr. Sudhindra Sharma, IDA’s Executive Director, on the project’s goals and IDA’s collaboration with Lund University’s Center for Sustainability Studies. This was followed by detailed instructions from Mr. Dipak Gyawali, IDA Chairman, who outlined the historical and current dynamics of Nepal’s energy landscape, including energy supply challenges. Additionally, he shed light on the current dispute between the NEA and major industries regarding "trunk lines" and “premium price”.

Participants received hard copies of the Nepali questionnaire along with a brochure highlighting the major findings of the 2023 Household Energy Survey. The participants were instructed to use this as an example of the kind of research that IDA does when beginning the fieldwork and seeking appointments with industry and enterprises respondents.

Then each question was explained in detail, offering a general understanding of the industries' size, functions, operations, and energy consumption patterns. The differences between various types of industries were clarified based on their nature and capital structure. Additionally, each survey question across different sections was thoroughly reviewed and practiced, with examples for better clarity.

Subsequent sessions included hands-on practice with Android tablets used for data collection, facilitated by IDA programmers who explained technical aspects such as question types, skip patterns, uploading data after survey completion, swiping, powering on/off, accessing Wi-Fi, using GPS, typing in the message box, and troubleshooting in case of tablet malfunctions. Role-playing exercises allowed enumerators to simulate interviews and navigate the digital questionnaire, while mock sessions helped address real-time challenges.

Each day participants provided feedback, enabling immediate updates and improvements to the Android-based questionnaire. On the final day, enumerators and supervisors were informed about the field protocols, data quality standards, and strategies for engaging with local Chambers of Commerce. Subsequently, teams were deployed to their assigned clusters. Before deployment on September 19, 2024, all participants were thoroughly briefed on their roles and equipped with finalized questionnaires and logistical materials.

3.5 Field Work

After training, survey teams—each comprising one supervisor and three enumerators per cluster—commenced fieldwork on September 19, 2024. Upon reaching their respective clusters, the teams first met with the Secretary of the Chamber of Commerce and Industry (CCI), shared the sample list and the IDA letter (which mentioned the objectives of the survey and requested the concerned chamber of commerce and industry for their assistance), and ensured they received a formal letter from the respective CCI before proceeding with their work.

In each cluster, teams worked closely with CCI officials, who assisted in scheduling appointments with industry representatives. In Nepalgunj, as committed earlier, the NJCCI deployed an officer to accompany the survey team, which greatly facilitated the process of making appointments and conducting interviews.

Following the sample protocol, supervisors scheduled initial appointments via phone calls. In cases of non-response or refusal, they sought assistance from local CCI members to reschedule with industries that had initially declined. Supervisors also directly requested interview appointments from managers or owners. Meanwhile, enumerators focused on data collection, conducting interviews with pre-coordinated industries or establishments.

The formal letter and prior notification from the CCI played a key role in improving the survey teams' access to industry representatives. This support enabled better engagement, ensuring a smooth and efficient data collection process through structured interviews.

Through these mechanisms, the field teams were able to meet the sample as planned. The actual sample size that was completed is summarized below. The actual sample more or less matched the targeted sample.

Table 2.2 Actual sample covered in all the six locations – distributed by scale/size and clusters

Size	Biratnagar-Itari	Birgunj–Pathlaiya	Kathmandu	Bhairahawa–Butwal	Pokhara	Nepalgunj–Kohalpur	Total
Large	21	20	26	19	19	20	125
Medium	17	18	17	19	18	19	108
Small	33	34	36	33	26	47	209
Cottage	12	18	15	13	14	0	72
Micro	18	17	7	16	24	18	100
Total	101	107	101	100	101	104	614

3.6 Challenges during fieldwork

There were various challenges in undertaking the fieldwork. These primarily related to selecting a relevant sample and accessing key industry contacts. Initially, there was no comprehensive list of industries organized by sector and size which complicated efforts to adhere to the planned sample. There were only lists for the particular cluster (from which sample needed to be drawn). The list provided by the local chamber of commerce and industry was limited, they often did not align with the specific survey requirements, such as industry size categories. Additionally, the limited availability of data in the agriculture sector required researchers to substitute part of the intended agricultural sample with data from industrial sector to meet the target sample size.

Furthermore, accessing industry contacts was somewhat difficult across all the clusters. However, officials of the local chambers of commerce and industries played a vital role in mitigating this by providing support and facilitating appointments. For instance, in Biratnagar, the CIM supported the team by securing the necessary contacts despite the absence of a sector-wise industry list. Similarly, in the Nepalgunj cluster, two members from the NJCCI made early contacts on the team’s behalf, accompanying the team to industrial sites and arranging meetings with relevant personnel. In Kathmandu, despite receiving contact lists from the CCI, many contacts either did not respond or were unwilling to participate. As a result, the team had to go beyond the provided support and collected the industries list for the survey independently.

Time management was another challenge. Surveys were limited to office hours, and speaking with relevant personnel often required long waiting periods, especially in larger industries. Survey durations ranged from 30–40 minutes for smaller industries to up to three hours for larger ones. This variation in time requirements impacted overall survey efficiency and presented logistical difficulties.

Additionally, many medium and large industries required an official authorization letter to proceed with the survey. For example, an important industrial conglomerate, Hulas Nepal, permitted the survey only after receiving the original letter, declining a photocopied version. These kinds of practices delayed the process but reduced non-response rates for larger industries. Smaller industries were generally more accessible.

Despite these challenges, strong collaboration with local chambers of commerce and industries, along with proactive efforts by the research team, ensured that the target sample size was largely achieved.

3.7 Activities subsequent to the fieldwork and after preliminary analysis of survey data

The report on the survey findings was developed in multiple stages, with the first draft completed on November 23, 2024, followed by the second draft on December 13, 2024. These findings were then used to create a PowerPoint presentation aimed at disseminating the insights to a broader audience.

The presentation was first shared with the Morang Chamber of Industries on December 2, 2024, and later, an interaction program was held with the Pokhara Chamber of Commerce on December 8, 2024, the aim of the interaction was not only to disseminate the findings but also to gather the feedback from the participant. The list of participants of the two interactions are presented in Annexes 9 and 10 respectively.

To gain deeper insights into the energy-related challenges faced by industries and enterprises, a series of qualitative interviews (Key Informant Interviews - KIIs) were conducted. A total of 17 KIIs with industry people was undertaken between December 2, 2025 and January 12, 2025. The list of KIIs with industry people is presented in Annex 7. KIIs offered in-depth insights on the energy issues affecting Nepal's industrial sector.

Besides the industry people, KIIs were undertaken with experts and professional between August 29, 2024 and January 5, 2025. The list of experts and individuals with whom KIIs were undertaken is presented in Annex 8.

By combining both qualitative and quantitative approaches, the study aimed to provide a comprehensive understanding of the prevailing energy issues in Nepal’s industrial sector.

Once the report integrating the survey findings from the insights generated by KIIs was completed in June final rounds of interactions were undertaken with the industrialists and the government.

Once the report was completed interactions were held with the FNCCI headquarter team as well as the Bhaktapur FNCCI team along with industrialists, solar and hydropower developers and energy experts on June 2, 2025. The proceedings of this interaction as well as the names of individuals who participated is in Annex 5.

Likewise, an interaction program was held with the government representatives from MoWERI, WECS, NEA, IZML, AEPC, and ERC on June 9, 2025, during which occasion the feedback from the industrialists was also shared with them. The proceedings of this interaction as well as the names of individuals who participated is in Annex 6. This interaction made the government representatives aware of the concerns of the industrialists and FNCCI. The government representative’s observations and insights helped better understand policy-related issues and sectoral dynamics.

Date and timeline	Activities
November 23, 2024	First Draft of Preliminary Report
December 2, 2024	Interaction about the findings at Morang Chamber of Industries.
December 8, 2024	Interaction about the findings at Pokhara Chamber of Commerce and Industries.
December 13, 2024	Second Draft of Preliminary Report
December 2, 2024 to January 12, 2025	17 KIIs with industry people in Biratnagar, Pokhara, Nepalgunj and Bhairawa
August 29, 2024 to January 5, 2025	7 KIIs with experts and professionals
February 2, 2025	Preparation of Qualitative report based on KIIs with industry people and with experts
June 2, 2025	Interaction with the FNCCI headquarters, industrialists, hydropower
June 9, 2025	Interaction with government agencies including MoEWRI, WECS, NEA, IZML, AEPC, and ERC

CHAPTER 4: GENERAL INFORMATION

4.1 Sample Distribution across sectors, industry sizes, and regional clusters

A total of 614 establishments were surveyed, representing a diverse range of economic sectors. Of these, 50.5% come from the manufacturing sector, followed by the accommodation and food service sector (22.0%) and the financial and insurance sector (9.1%). Agriculture, forestry, and fishing account for 7.3% of the establishments, while 6.7% fall under the human health and social work sector. Relatively small proportions come from the information and communication sector (2.1%), wholesale and retail trade (1.6%), and other services (0.7%). An overview of the sectors, including the average full-time equivalent workers per establishment and the main products or activities of the industries or enterprises in each sector, is provided in the table below.

Table 4.1: *Sample Distribution across sector, average workers and major products or services.*

Sector of the industry/enterprises	Sample	Average workers	Main products/activities
Agriculture, forestry, and fishing	45 (7.3%)	18.3	Rearing of livestock for milk and meat; poultry farming for meat, hatchery and egg; aquaculture; growing of vegetables
Manufacturing	310 (50.5%)	51.4	Fabricated metal products; basic metals, iron and steels; cements; paints; Ceramic and concrete products; electrical equipment; furniture; footwears, textiles; plastics and related products; food and grain mill products; bottled water and beverages; dairy and related products; soap and detergents; printing activities
Accommodation & food service activities	135 (22.0%)	29.6	Provision of accommodation, meals and drinks; restaurant services; catering and event management
Information and communication	13 (2.1%)	18.9	Television and radio broadcasting; wired and wireless telecommunication activities; cable television and internet services
Human health and social work activities	41 (6.7%)	205.1	Human health services; laboratory services; dental care services; specialized services
Financial and insurance activities	56 (9.1%)	29.3	Banking services, savings and credit services by cooperatives, life and non-life insurance services; micro-financing
Wholesale and retail trade activities	10 (1.6%)	100.2	Wholesale trade of motor vehicles and battery; wholesale and retail trade of pharmaceutical and medical goods
Other service activities	4 (0.7%)	4.1	Tailoring services; dry cleaning
Overall	**614**	**52.2**	

The following table highlights the distribution of sample across industry sizes, and regional clusters in Nepal. Small industries make up the largest portion at 33.9%, with large industries at 20.4%, medium industries at 17.9%, and micro-industries at 16.1%. Cottage industries represent 11.7% of the total. The regional clusters show a relatively even distribution, with Birgunj-Pathlaiya leading at 17.4%, followed closely by Pokhara at 16.9%, and the Kathmandu, Biratnagar-Itahari, Nepalgunj-Kohalpur, and Bhairahawa-Butwal clusters, each ranging from 16.3% to 16.4%. This breakdown reflects the diverse industrial landscape across Nepal's sectors and regions.

Table 4.2: *Sample Distribution across, industry sizes, and regional clusters*

Size[18]		**Cluster**	
	Percent		**Percent**
Large industry	20.4%	Biratnagar-Itahari	16.4%
Medium industry	17.9%	Birgunj-Pathlaiya	17.4%
Small industry	33.9%	Kathmandu	16.4%
Cottage industry	11.7%	Pokhara	16.9%
Micro-industry	16.1%	Bhairahawa-Butwal	16.3%
Total	**100.0%**	Nepalgunj-Kohalpur	16.4%
		Other specify	0.0%
		Total	**100.0%**

4.2 Current legal status

The majority of firms are sole proprietorships, accounting for 49.7% of the total. Private limited companies make up 35.7%, while public limited companies constitute 10.3%. Partnerships represent a smaller segment at 3.7%, and limited partnerships are the least common, at only 0.7%.

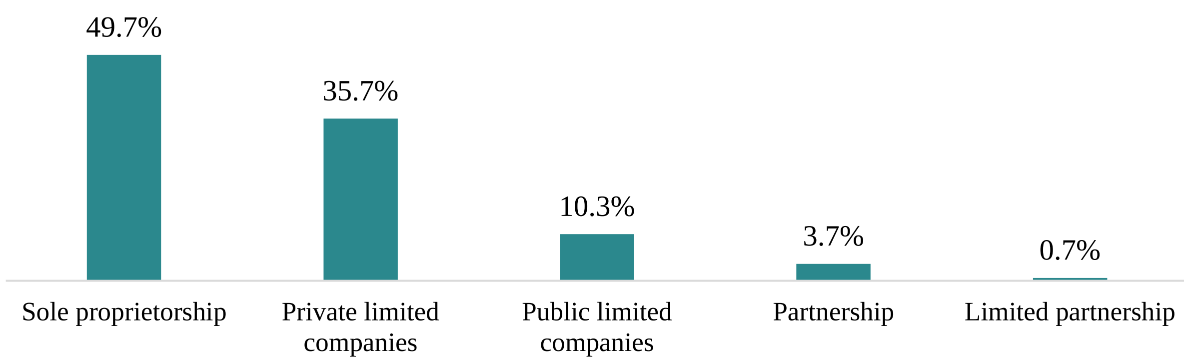


Figure 4.2: *What is this firm's current legal status? [N = 614]*

[18] A large industry is defined as having fixed capital exceeding five hundred million rupees, while a medium industry has fixed capital between one hundred fifty million and five hundred million rupees. A small industry is one with fixed capital under one hundred fifty million rupees, excluding micro enterprises and cottage industries. A cottage industry is based on traditional skills and technologies, and a micro-industry is defined as having fixed capital not exceeding two million rupees, excluding the value of house and land.

4.3 Workforce Composition and Employment Characteristics in Fiscal Year 2080/81

At the end of fiscal year 2080/81 B.S., the industries and enterprises in the sample employed an average of 49 permanent, full-time workers. Additionally, the number of part-time workers was relatively low, averaging 8 per establishment among those employing part-time workers or staff. Seasonal workers accounted for an average of 34 per establishment (among those hiring them), indicating a significant reliance on temporary labor for specific periods. On average, permanent, part-time workers were employed for approximately 20 hours per week. Furthermore, the average length of employment for full-time seasonal workers was 4 months, highlighting the typically short-term nature of these positions within the establishment. Moreover, an industry/enterprise in Nepal provided 52 full-time-equivalent jobs on average.

Table 4.3: *Workforce Composition and Employment Characteristics in Fiscal Year 2080/81*

	N	**Mean**
At the end of fiscal year [FY 2080/81], how many permanent, full-time individuals[19] worked in this establishment?	614	49
At the end of fiscal year [FY 2080/81], how many permanent, part-time individuals'[20] workers worked in this establishment?	87	8
At the end of fiscal year [FY 2080/81], how many seasonal workers worked in this establishment?	138	27
How many hours in a week were the permanent, part-time individuals employed on an average in fiscal year [FY 2080/81]?	87	20
What was the average length of employment of all full-time seasonal workers in fiscal year [FY 2080/81]?	138	4
Average full-time equivalent jobs[21] created by the industries/enterprises	614	52

There are some significant variations in employment characteristics for fiscal year 2080/81, categorized by sector, industry size, and geographical clusters in Nepal. Among sectors, human health and social work activities employed the highest number of permanent full-time workers (199) on average, followed by manufacturing (54). Seasonal workers were most prominent in manufacturing industries (32), while part-time employment peaked in human health and social work activities (17). Industry size showed a similar trend, with large industries employing the most full-time workers (167), followed by medium industries (46). Seasonal employment was highest in large industries (57). By region, Biratnagar-Itahari recorded the highest full-time employment (71), while seasonal employment was highest in Nepalgunj-Kohalpur (67). Average weekly hours for part-time employees ranged from 12 in information and communication to 27 in construction, with seasonal workers typically employed for 4 months annually.

[19] Permanent, full-time workers are defined as all workers that work for a term of one or more years and/or have a guaranteed renewal of their employment and that work a full shift.

[20] Part-time workers are defined as all workers that work for a term of one or more fiscal years and/or have a renewal of their employment but work for less than a full shift.

[21] For the part-time and seasonal workers, a firm is defined to have one equivalent job if a firm provides 40 hours of work in a week in a year. This definition is followed by the International Labor Organization.

CHAPTER 5: OPERATIONS AND ENERGY USE

5.1 Average operating hours of establishment in a normal week

The overall average number of operating hours per week for establishments is 88 hours. Operating hours vary across sectors, with accommodation and food service activities having the highest average at 128 hours per week, followed by human health and social work activities at 127 hours. The financial and insurance sector has the lowest average operating hours, at 47 hours per week.

By industry size, large industries operate the longest at 105 hours per week, while cottage industries have the shortest working hours, averaging 60 hours per week. Among different regional clusters, establishments in Pokhara operate the most hours per week, averaging 100 hours, while those in Bhairahawa-Butwal have the lowest at 77 hours.

Table 5.1: *What is the total number of operating hours for this establishment in a normal week?*

		Average hours of operation in a normal week
Overall		88
Sector	Agriculture, forestry, and fishing	95
	Manufacturing	72
	Accommodation and food service activities	128
	Information and communication	96
	Human health and social work activities	127
	Financial and insurance activities	47
	Wholesale and retail trade activities	92
	Other service activities	80
Size	Large industry	105
	Medium industry	99
	Small industry	88
	Cottage industry	60
	Micro industry	76
Cluster	Biratnagar-Itahari	90
	Birgunj-Pathlaiya	85
	Kathmandu	84
	Pokhara	100
	Bhairahawa-Butwal	77
	Nepalgunj-Kohalpur	93

5.2. Type of Energy Sources Used by Establishments for Operational and Supporting Activities

The types of fuel consumed by the establishment to support their primary as well as secondary activities were recorded. Results show that out of 614 establishments, nearly all—specifically 99.8%—use electricity to support their industrial or related activities. Additionally, more than half of the industries and enterprises use Liquefied Petroleum Gas (LPG) (53.7%) and Diesel (53.3%). Petrol is used by some 46.1% of the establishments while wood/bio-mass (6.2%) and solar PV (4.9%) are utilized by relatively fewer establishments.

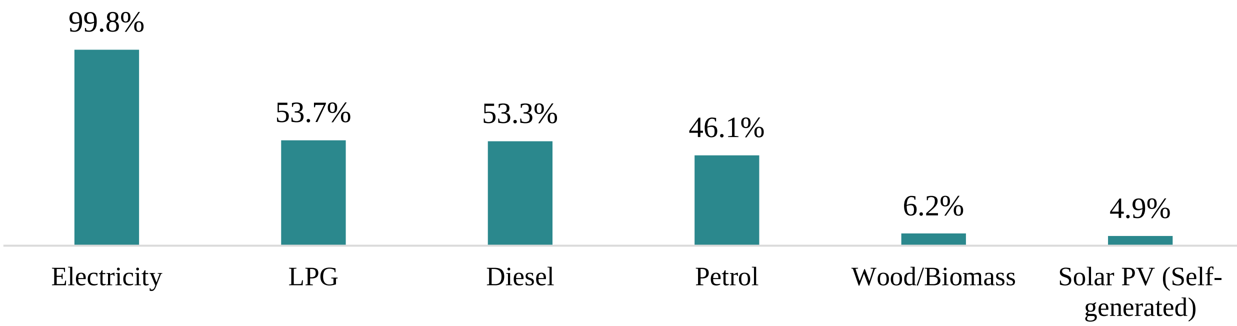


Figure 5.2: *Distribution of Fuel and Energy Sources Used by Establishments for Operational Activities*

While electricity is utilized by industries and enterprises across all sectors, 100% of establishments – except those in manufacturing sector, where the figure is (99.7%) use this energy source. Most of the establishments in accommodation and food service sector (97.0%) also use LPG. Diesel is also commonly used by the establishments across all sectors – with 70.8% of the establishments in human health and social work services, 61.5% of the establishments in accommodation and food services, and 53.9% of the establishments in manufacturing sector. Petrol also sees high usage among establishments in information and communication sector (76.9%), financial and insurance sector (64.3%), human health and social service sector (61.0%), and wholesale and retail trade sector (50.0%). Wood/biomass (except agri-residue) is mostly used by establishments in agriculture (26.7%) and manufacturing (7.1%) sectors. Solar PV adoption is low across all sectors. Notably, solar PVs are adopted by approximately one-tenth (9.6%) of establishments in the accommodation and food services sector, slightly fewer (8.9%) in the agriculture, forestry, and fishing sector, and 7.7% in the information and communication sector. Solar PV adoption is even lower among establishments in other sectors.

Electricity is used by nearly all establishments across all sizes, with 100% of large, medium, small, and micro industries using electricity, and 98.6% of cottage industries also utilizing it. LPG is used by the majority of establishments in large (66.4%) and medium industries (66.4%), while its usage drops in smaller establishments such as micro industries (43.4%) and cottage industries (25.0%). Diesel is used by the majority of establishments in large (80.8%) and medium industries (80.9%), while its usage is less common among cottage (18.1%) and micro industries (15.2%), reflecting its role in powering industrial machinery. Petrol is used by the majority of establishments in large (68.0%) and medium industries (55.5%), but its usage decreases substantially among establishments of micro industries (27.3%) and cottage industries (13.9%). Wood/biomass is relatively less common, though it is used by a higher percentage of establishments in cottage industries (11.1%) compared to other sizes. Solar PV adoption remains limited, with 6.4–8.2% of larger industries using it, and no usage reported among micro industries.

5.3. Fuel consumption among industries and enterprises

Various types of energy sources (fuels) consumed by the establishments were recorded in physical units. Solid fuels – coal and wood/biomass (including traditional biomass and agricultural residue) – were recorded either in either in kilogram (kg), quintal (100 kg), or tonne (1000 kg). Liquid fuels – diesel, petrol, kerosene, furnace oil, etc. – were recorded either in liter, or kilo-liter. Electricity usage was recorded in watt-hour units (watt-hour, or kilowatt-hour, or megawatt-hour). LPG were primary used in the form of cylinders with each cylinder equivalent to 14.5 kg of solid fuel.

The fuel usage was transformed to the energy units based on the density and heating values as shown by the adjoining table.

Table 5.3.1: *Density of different types of fuel and their heating values*

Type of fuel	Density		Heating Value	
	Unit	Value	Unit	Value
Coal	-	-	Kcal/kg	6,000
Diesel	kg/l	0.839	Kcal/kg	10,236
Electricity	-	-	Kcal/kWh	860
Furnace Oil	kg/l	0.858	Kcal/kg	9,929
Kerosene	kg/l	0.8	Kcal/kg	10,500
LPG	kg/l	0.510	Kcal/kg	11,778
Petrol	kg/l	0.737	Kcal/kg	10,450
Wood/Biomass	-	-	Kcal/kg	3,820

The average annual fuel consumption of the sampled industries and enterprises in each sector are shown in the following table. It highlights the total annual energy usage of the establishment (in petajoules) and the percentage share of various fuel sources across the sectors. The manufacturing sector emerges as the most energy intensive sector with an average annual consumption of 0.03 Peta Joules (PJ) per establishment, equivalent to 0.698 kilotonnes of oil equivalent (ktoe). Other relatively energy intensive sectors include agriculture, forestry, and fishing (0.0048 PJ or 0.115 ktoe), human health and social service activities (0.0040 PJ or 0.097 ktoe), and accommodation and food service activities (0.0035 PJ or 0.084 ktoe). Conversely, sectors like wholesale and retail trade (0.0012 PJ or 0.029 ktoe), financial and insurance activities (0.0012 PJ or 0.029 ktoe), information and communication (0.002 PJ or 0.004 ktoe) are relatively less energy intensive.

It is also seen that usage of different types of fuel varies across the sectors. The usage of diesel dominates in sectors like agriculture, forestry and fishing (71.0%), accommodation and food services (61.3%) and manufacturing (49.1%).

Findings from the KIIs largely corroborate the quantitative data, indicating that diesel is one of the most commonly used fuel sources along with petrol and LPG. Diesel generators are the most *commonly used and primarily employed as a backup solution rather than a primary energy source, particularly in large and medium-scale industries during power outages. However, informants emphasized that while these generators are essential, they come with significant operational costs due to the high price and continuous need for diesel.*

For instance, a medium-scale hospital operating two generators (200 kVA and 62 kVA) reported spending around NPR 500,000 annually on diesel. Likewise, a medium-sized factory consumes approximately 100 liters of diesel per week, amounting to around NPR 63,000 per month solely for fuel.

Fuelwood, including biomass and agricultural residue comprises a significant portion of the fuel source for establishments in manufacturing (49.2%) and agriculture (23.0%). However, fuelwood and biomass are negligible in other sectors.

KIIs provided further insight into this trend, with many industries confirming the utilization of agricultural byproducts such as rice husk and wheat husk as a cost-saving boiler fuel. One food processing industry shared: "As a food processing industry, rice and wheat husk (bhusa) are common byproducts for us. Instead of selling them at low prices, we utilize these husks as boiler fuel within our own factory. This approach helps us reduce costs by decreasing our dependence on costly external fuels."

Similarly, noodle manufacturing industries were also found to use husk-fired boilers, which are both economical and locally available.

Electricity is a significant source of energy for establishments across all sectors. In the financial and insurance activities sector, electricity accounts for 98.1% of the total energy portfolio. Similarly, electricity constitutes a substantial share of energy consumption in wholesale and retail trade (80.3%) and information and communication (60.0%). However, grid-supplied electricity forms a smaller share of the energy portfolio in sectors such as agriculture, forestry, and fishing (5.1%), manufacturing (15.3%), accommodation and food service activities (25.4%), and human health and social work services (29.0%).

LPG is heavily utilized in the human health sector, with minor contributions in the accommodation and trade sectors. Notably, LPG accounts for only 1% of the energy portfolio in establishments within the accommodation and food service activities sector while kerosene accounts for 12%. Petrol is prominently used in the human health and information and communication sectors. Coal and furnace oil are also used by industries in manufacturing sectors. Solar PV (self-generated) usage remains minimal across all sectors, with its most notable contribution observed in the human health sector (12.0%).

Solar photovoltaic (PV) systems are gradually gaining traction among a limited number of large and medium-sized industries in Nepal. Insights from Key Informant Interviews (KIIs) revealed that key industry stakeholders are increasingly recognizing the dual benefits of solar PV—not only as a reliable and renewable energy source, but also for its potential to stabilize the grid when properly synchronized with the national electricity supply.

Despite this promising shift toward energy efficiency and sustainability, the overall adoption of solar PV remains low, particularly among small, micro, and cottage industries. Implementing financial incentives, offering technical training, and investing in infrastructure development could greatly accelerate the transition toward more sustainable industrial energy practices. (See the box item on page ….)

Table 5.3.2: *Average annual fuel consumption of an establishment and share of different fuel sources – across sectors*

Sector	**Annual energy usage (PJ)**	**Fuel Share (%)**							
		Diesel	**Fuelwood/ biomass**	**Electricity**	**Furnace-oil**	**Coal**	**LPG**	**Petrol**	**Solar PV**
Agriculture, forestry, and fishing	0.00482	70.95	22.61	5.11			1.09	0.24	0.00
Manufacturing	0.02924	49.16	28.97	15.32	4.63	1.37	0.33	0.19	0.03
Accommodation & food service activities	0.00354	61.32	0.07	25.38	0.00	0.06	1.00		0.20
Information and communication	0.00018	17.40		59.85			3.62	19.09	0.04
Human health and social work activities	0.00408	16.80	0.02	28.88			30.53	11.73	12.04
Financial and insurance activities	0.00120	0.47		98.06			0.31	1.12	0.03
Wholesale and retail trade activities	0.00121	11.80		80.26				0.79	7.16
Other service activities	0.00003			100					
Overall		**49.01**	**27.07**	**16.66**	**4.27**	**1.26**	**1.15**	**0.38**	**0.19**

To further illustrate and compare the share of different fuel sources used in the energy portfolios of industries and enterprises, the major energy-intensive sectors—manufacturing, agriculture, forestry and fishing, human health and social work activities, and accommodation and food services—are presented in the following figures.

It is important to note that coal's share in our manufacturing sample (1.37 %) differs markedly from the 30.21 % reported in the WECS Energy Synopsis Report 2024. This discrepancy likely reflects several methodological limitations—our survey may have inadvertently under represented large, coal intensive factories, and there may have been under reporting of coal use during data collection. Additionally, WECS's coal consumption data is primarily derived from records of the Customs Office of Nepal, and is difficult to disaggregate coal use by sector. In reality, besides the industries, a significant portion of coal is consumed by road construction, which could be the reason why coal consumption data is much higher in the WECS report. Despite this difference, our estimates for diesel, fuelwood, electricity, and other fuels closely mirror WECS's national figures, underscoring the robustness of our overall fuel mix analysis.

Figure 5.3.1: *Energy consumption portfolio of industries and enterprises: Manufacturing sector*

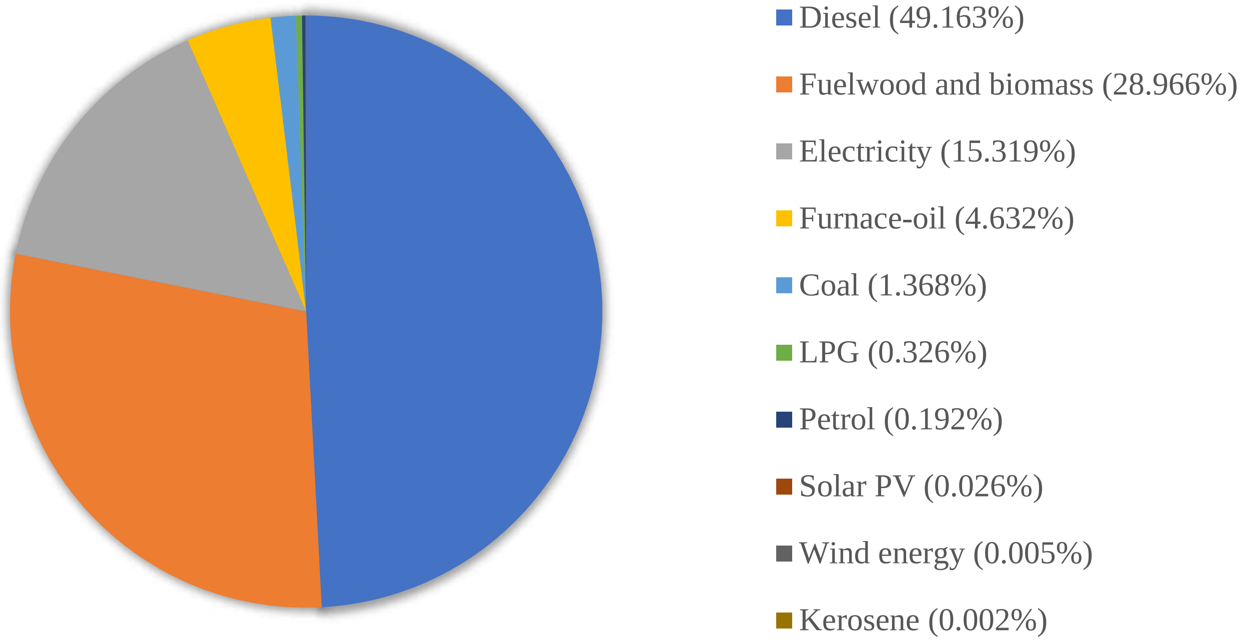


Figure 5.3.2: *Energy consumption portfolio of industries and enterprises: Agriculture, forestry and fishing*

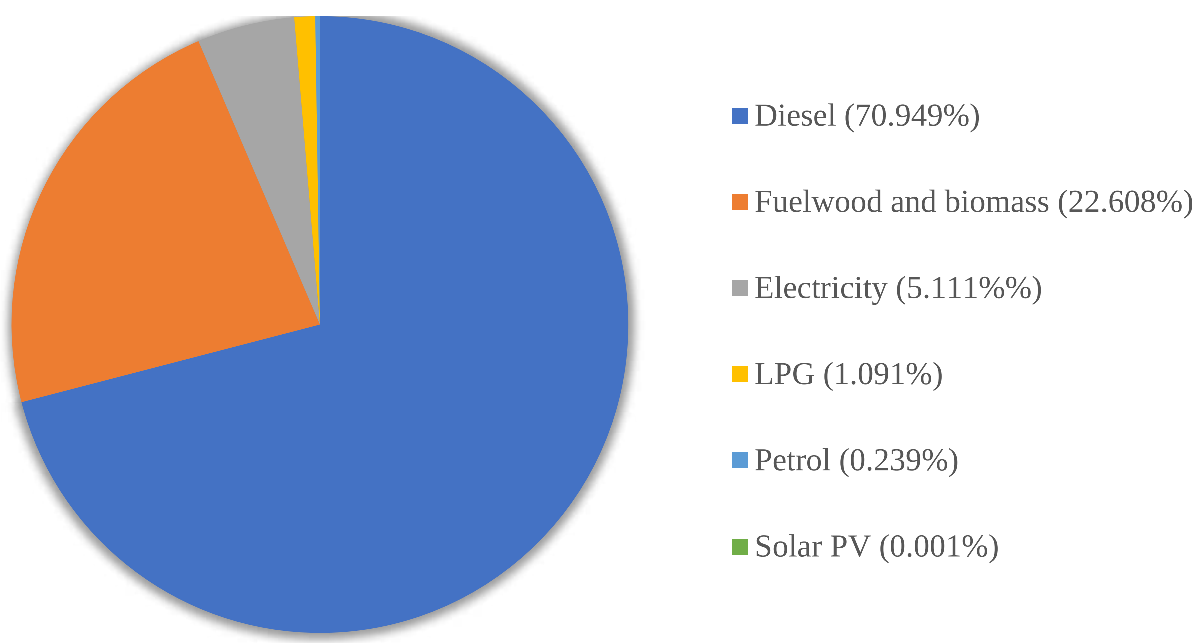


Figure 5.3.3: *Energy consumption portfolio of industries and enterprises: Human health and social work activities*

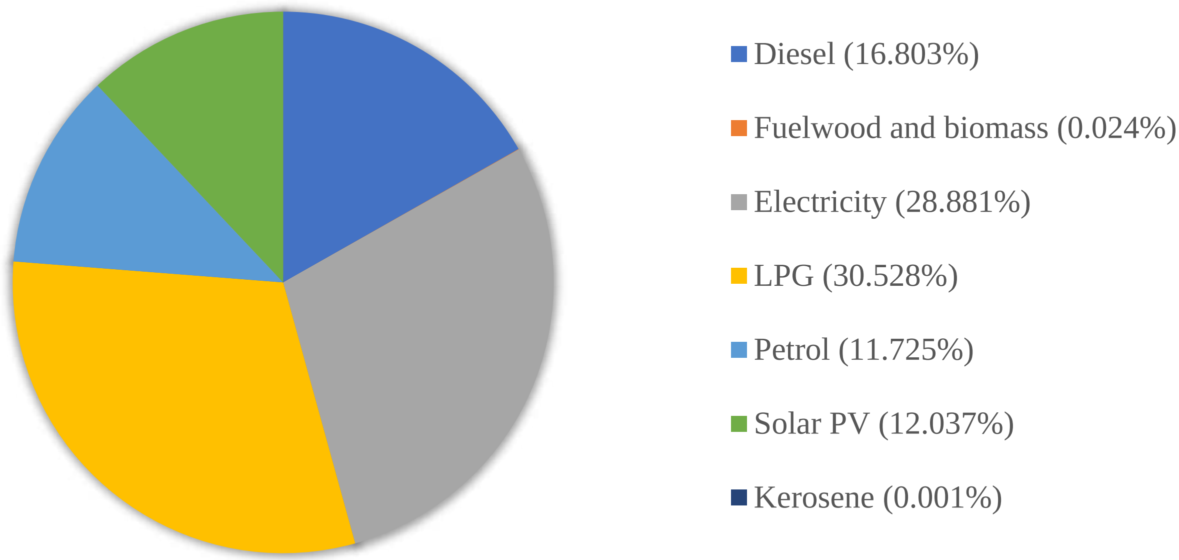
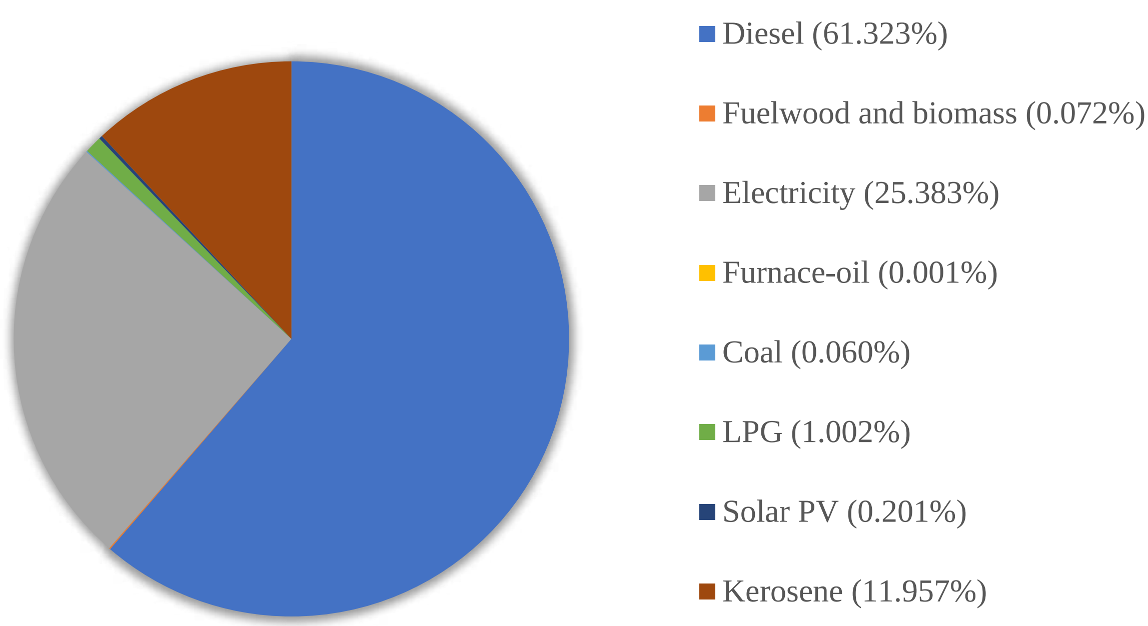


Figure 5.3.4: *Energy consumption portfolio of industries and enterprises: Accommodation and food service*



5.4. Energy intensity across sectors

Table 5.4.1 illustrates energy intensity, measured as fuel consumption (PJ) per million NPR of sales, across sectors in FY 22/23. Manufacturing emerges as the most energy-intensive sector (0.000138 PJ/million NPR), more than double that of Agriculture, Forestry, and Fishing (0.000048 PJ/million NPR), despite the latter contributing the largest GDP (1,133,329 million NPR). Accommodation & Food Services (0.000060) and Information & Communication (0.000029) exhibit moderate to low intensities, while Human Health and Social Work (0.000014) is the most energy-efficient, achieving the lowest intensity despite high annual turnover (292 million NPR). Notably, sectors like Health and Information & Communication demonstrate that lower energy intensity can coexist with substantial economic contributions (GDPs of around 90,992–92,741 million NPR), contrasting with Manufacturing's higher energy demands relative to its GDP (244,514.7 million NPR). This highlights disparities in energy efficiency and economic output across industries.

Table 5.4.1: *what was the average unit/quantity of [fuel] used by this establishment in a month?*

Sector	Avg annual fuel consumption PJ	Avg annual sales (FY 22/23) Million NPR	Intensity PJ/million of NPR	sector GDP (FY 22/23) Million NPR
Agriculture, forestry, and fishing	0.0048	100.2435	0.000048	1133329
Manufacturing	0.0292	212.5630	0.000138	244514.7
Accommodation & food service activities	0.0035	58.6447	0.000060	92682
Information and communication	0.0002	6.2385	0.000029	92741.29
Human health and social work activities	0.0041	292.0308	0.000014	90992.65

5.5. Average Monthly Expenditure on Fuel

The table below presents a structured breakdown of average monthly fuel expenses (in thousand NPR) incurred by industries and enterprises across various sectors and across different types of fuel.

Survey data reveals that industries in manufacturing sector have the highest average monthly fuel expenses – NPR 277 thousand per month. This is followed by establishments in the human health and social work sector (NPR 189 thousand) followed by the establishments in human health and social work activities (NPR 189 thousand) and those engaged in Wholesale and retail trade activities (NPR 144 thousand), accommodation and food service activities (NPR 88 thousand) and agriculture, forestry and fishing (NPR 51 thousand). In contrast, enterprises in the information and communication sector (NPR 26 thousand), as well as those in financial and insurance activities (NPR 17 thousand), and other service activities (NPR 7 thousand), have relatively lower fuel expenses.

The table also presents the average monthly expenditure on different fuel types, representing the cost incurred by establishments that use each specific type of fuel. Industries that use furnace oil incur a very high monthly expense of NPR 1,893 thousand followed by those using fuelwood (which includes traditional biomass and agricultural residue) at NPR 511 thousand per month.

Similarly, industries relying on coal incur an average monthly expense of NPR 490 thousand, while those using electricity spend around NPR 231 thousand. The expenditures for diesel (NPR 197 thousand), petrol (NPR 48 thousand), and kerosene (NPR 10 thousand) are comparatively lower. However, it is evident that an industry may use a combination of different types of fuel for its operational and other activities.

A detail break-down of average expenditure on different fuel types for each sector is also provided in the adjoining table.

Table 5.5.1: *What was the average expenditure on [fuel] used by this establishment in a month? [NPR]*

	Average fuel expenses of establishment: By types of fuel across sector (‘000 NPR)								**Average across sector**
Sector	**Coal**	**Diesel**	**Electricity**	**Fuelwood**	**Furnace-oil**	**Kerosene**	**LPG**	**Petrol**	
Agriculture		78.0	41.4	143.8			22.1	10.3	51.3
Manufacturing	603.0	301.7	331.9	726.8	1892.8	13.2	54.7	46.7	277.2
Accommodation & food	73.7	69.1	148.6	11.3		2.0	65.3	30.5	88.0
Information & communication		24.0	44.6				3.2	18.1	26.4
Human health		213.3	328.7	20.0		1.0	5.0	84.3	189.1
Financial & insurance		11.7	25.7			2.3	4.5	19.1	17.0
Wholesale & retail trade		165.0	206.1					8.0	144.2
Other service			6.8						6.8
Average across fuel	**489.6**	**197.5**	**230.8**	**510.8**	**1892.8**	**10.3**	**47.9**	**39.0**	**175.9**

Table 5.5.2 presents the average monthly fuel expenses (in thousand NPR) incurred by industries and enterprises categorized by their size. Large industries have the highest average monthly fuel expenses at NPR 451 thousand, followed by medium industries at NPR 161 thousand. Small industries incur an average of NPR 69 thousand per month, while cottage industries and micro industries have significantly lower fuel expenses, at NPR 12 thousand and NPR 8 thousand, respectively.

The table shows monthly fuel expenses (in thousand NPR) across industry sizes, with varying spending patterns across the scale/size of the establishments. Overall, large industries spend the most (average of NPR 451 thousand per month) – and for those industries using furnace and fuelwood – expenditure of fuel driven by furnace oil (NPR 2,365 thousand) and fuelwood (NPR

1,239 thousand), far exceeding sector averages. While the medium-sized industries have an average monthly fuel expenditure of NPR 161 thousand per month the similar sized industries using furnace oil tend to spend NPR 1,757 thousand more and those using coal tend to spend NPR 1,350 thousand more on these particular fuel sources.

Overall, the data reveals that electricity – recognized as a clean and cost-effective energy source – does not constitute a major part of the total energy expenditure.

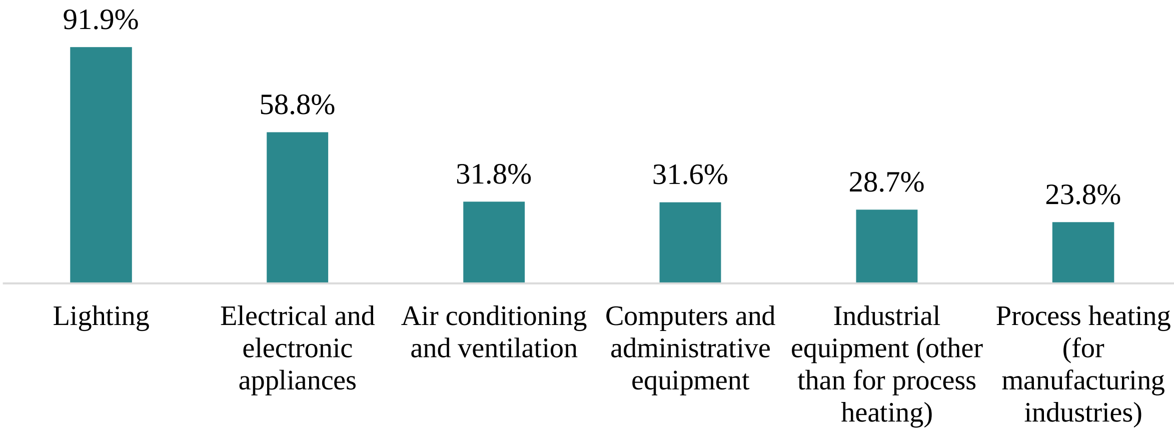
Table 5.5.2: *What was the average expenditure on [fuel] used by this establishment in a month? [NPR]*

	Average fuel expenses of establishment: By types of fuel across size of establishment (Per month in Thousand NPR)								
Size of Industry	**Coal**	**Diesel**	**Electricity**	**Fuelwood**	**Furnace-oil**	**Kerosene**	**LPG**	**Petrol**	**Overall, across size**
Large	1022.0	421.5	717.1	1237.8	2365.9	44.6	118.0	80.4	451.0
Medium	1350.0	117.2	275.7	259.8	1757.4	1.0	51.3	33.5	161.0
Small	10.0	101.7	93.5	254.0	371.9	5.0	16.8	19.7	69.2
Cottage	8.1	16.5	14.9	14.4		1.0	5.1	4.8	12.4
Micro		12.6	9.2	1.8		2.7	7.0	6.1	8.3
Overall, across fuel	**489.6**	**197.5**	**230.8**	**510.8**	**1892.8**	**10.3**	**47.9**	**39.0**	**175.9**

5.6 Primary Energy-Intensive Activities and Fuel Consumption in Establishments

The survey also outlines the major energy-intensive activities within establishments and highlights where most fuel is consumed. Lighting is the most significant energy-consuming activity, used by 91.9% of establishments, indicating its fundamental role in daily operations. Electrical and electronic appliances follow, with 58.8% of establishments using substantial energy for these devices, likely for various operational tasks. Air conditioning and ventilation consume considerable energy in 31.8% of establishments, suggesting a moderate reliance on temperature control. Computers and administrative equipment account for 31.6% of energy use, underscoring their importance in office-based activities. Industrial equipment (excluding process heating) is used by 28.7% of establishments, reflecting its role in production processes. Lastly, process heating, mainly relevant for manufacturing industries, is used by 23.8% of establishments, indicating its specific but significant energy requirements. This data reveals that lighting and electrical appliances are the primary energy-intensive activities, while specialized industrial equipment and process heating are vital for certain sectors.

Figure 5.6: *List out the major energy intensive activities of this establishment? What are the activities in which the majority of the fuel is consumed? [N = 614]*



The data provides insights into major energy-intensive activities across various sectors, highlighting where the majority of fuel is consumed. Lighting is essential in almost all sectors, with high usage in accommodation and food service activities (98.5%), financial and insurance activities (98.2%) and, human health and social work (97.6%). Electrical and electronic appliances are also significant energy consumers, especially in human health and social work (92.7%) and information and communication (76.9%). Air conditioning and ventilation are prominent in accommodation and food services (63.0%) and financial activities (60.7%), indicating a need for climate control in these environments. Computers and administrative equipment consume substantial energy in financial and insurance activities (89.3%) and information and communication (84.6%), reflecting the technology dependence in these fields. Industrial equipment is heavily used in manufacturing (53.6%), critical for operational processes in this sector. Process heating is notably energy-intensive in manufacturing 43.6%), underscoring its role in production. This data reveals a sector-specific variation in energy consumption, with lighting, appliances, and specific equipment types dominating the energy needs.

The energy consumption patterns across various industries show notable differences in the major energy-intensive activities. For lighting, all industry sizes consume a significant portion of their energy, with cottage industries at 95.8%, followed closely by small industries at 93.3%. Electrical and electronic appliances also account for substantial energy use, particularly in large and small industries, consuming 61.6% and 60.1% of their energy, respectively. Air conditioning and ventilation systems are more energy-consuming in larger industries, with large industries using 46.4% of their energy, while smaller industries like micro and, cottage industries consume far less, at 20.2% and, 8.3% respectively. The use of computers and administrative equipment contributes notably to energy consumption, particularly in large industries (54.4%), but it drops significantly in smaller industries. Industrial equipment, excluding process heating, also represents a considerable share of energy use across industry sizes, with large industries consuming 29.6%. Finally, process heating for manufacturing is a major energy use in cottage and, medium industries, consuming 30.6% and, 29.1% of their energy, respectively, while micro industries rely less on this activity (10.1%).

5.7. Time of the Day (ToD) Electricity Demand

The following Figure illustrates the 24-hour temporal distribution of peak energy demand across industries and enterprises, revealing distinct demand phases aligned with operational cycles. During early morning hours (midnight to 5 AM), peak load incidence remains subdued, with only 16–19.4% of establishments reporting demand, reflecting minimal activity. A gradual escalation begins at 6 AM (25.2%), rising steadily to 55.2% by 9 AM as workflows commence. Peak demand intensifies sharply between 10 AM and 5 PM, with 69–77.5% of establishments experiencing maximum load, peaking at noon (77.5%) during core operational hours. After 5 PM, the demand attenuates steadily, declining to 56.7% by 6 PM and further to 21.8% by 11 PM, signaling reduced industrial activity. This pattern of peak load demand in the industries and enterprises demand for energy management strategies on part of the utility provider and the establishment themselves to optimize grid resilience and operational efficiency.

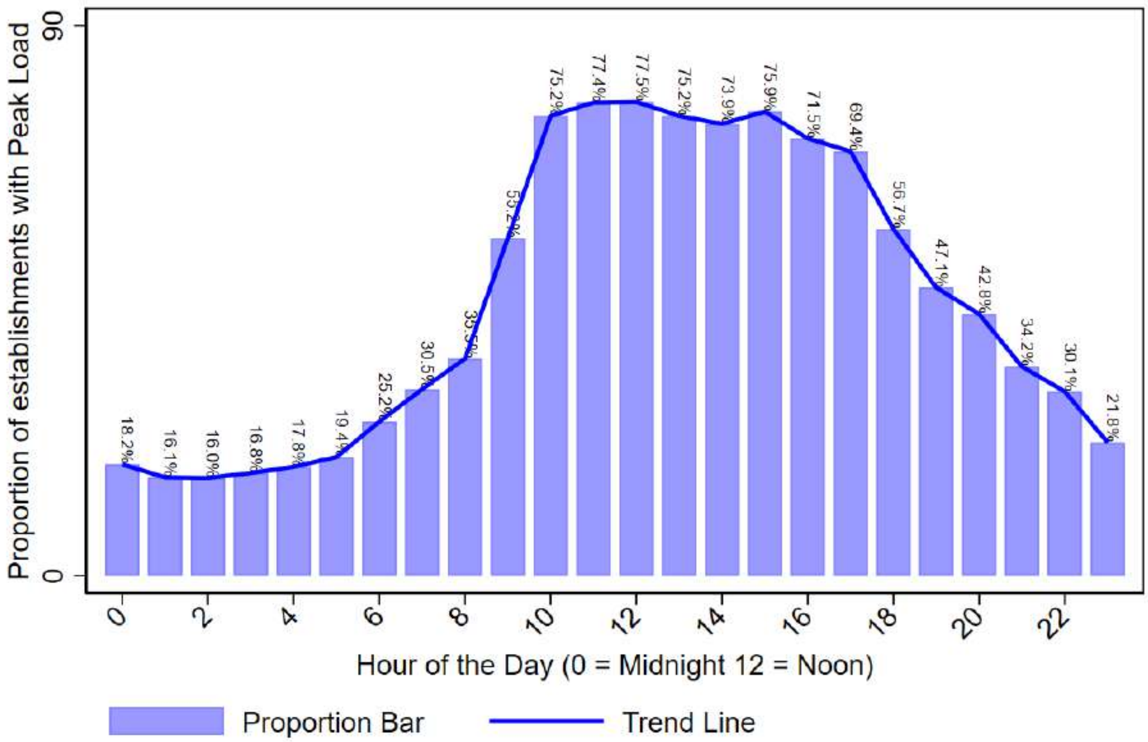


Figure 5.7.1: *Generally, at what time of the day does this establishment have electricity demand (electricity or other fuel sources)? [N =614]*

Establishments in agriculture sector peaks early (around 6 AM), with 53.3% participation at 6 AM. Accommodation and food service surge later in the evening by 7 PM. Manufacturing, Information & Communication, and Health/Social Work sectors hit their highest demand during 10 AM to 4 PM. Electricity demand declines sharply after 4 PM for the establishments in most of the sectors with Manufacturing and Wholesale and retail trading nearing minimal load by late evening. Financial and Insurance and Information and communication sectors drop to near-zero demand after business hours.

The Electricity demand across different industry sizes varies throughout the day, with large industries generally showing the highest demand. Large industries experience their electricity demand between 10:00 AM and 12:00 noon, reaching up to 82.4%, while medium and small industries show somewhat similar patterns with peaks between 10:00 AM and 3:00 PM, fluctuating from 66.4% to 77.4%. Cottage and micro industries tend to have lower electricity demands overall, with their highest values occurring around midday (83.3% for cottage industry at 11:00 AM and 12:00 noon) and slightly varying in the afternoon. All sectors, regardless of size, experience a significant drop in demand after 6:00 PM, with micro and cottage industries showing the sharpest decline during the evening and early morning hours.

The Electricity demand across the different clusters shows both similarities and subtle variations (shown in the adjoining figure). Kathmandu consistently exhibits the highest electricity demand, reaching 96.0% at 10:00 AM and maintaining high values in the late morning and early afternoon. In contrast, Biratnagar-Itahari and Bhairahawa-Butwal show relatively lower electricity demands, with their highest values occurring between 9:00 AM and 3:00 PM, peaking at 66.3% and 77.0%, respectively. Nepalgunj-Kohalpur stands out with the highest overall electricity demand across all clusters, with values surpassing 90% between 9:00 AM and 3:00 PM, particularly peaking at 91.1% at 10:00 AM. Pokhara and Birgunj-Pathlaiya show mid-range electricity demand, with values generally fluctuating around 70% to 80% during the late morning and afternoon hours. All clusters, regardless of peak times, experience a significant drop in demand after 6:00 PM, with the lowest values typically observed during the early morning hours.

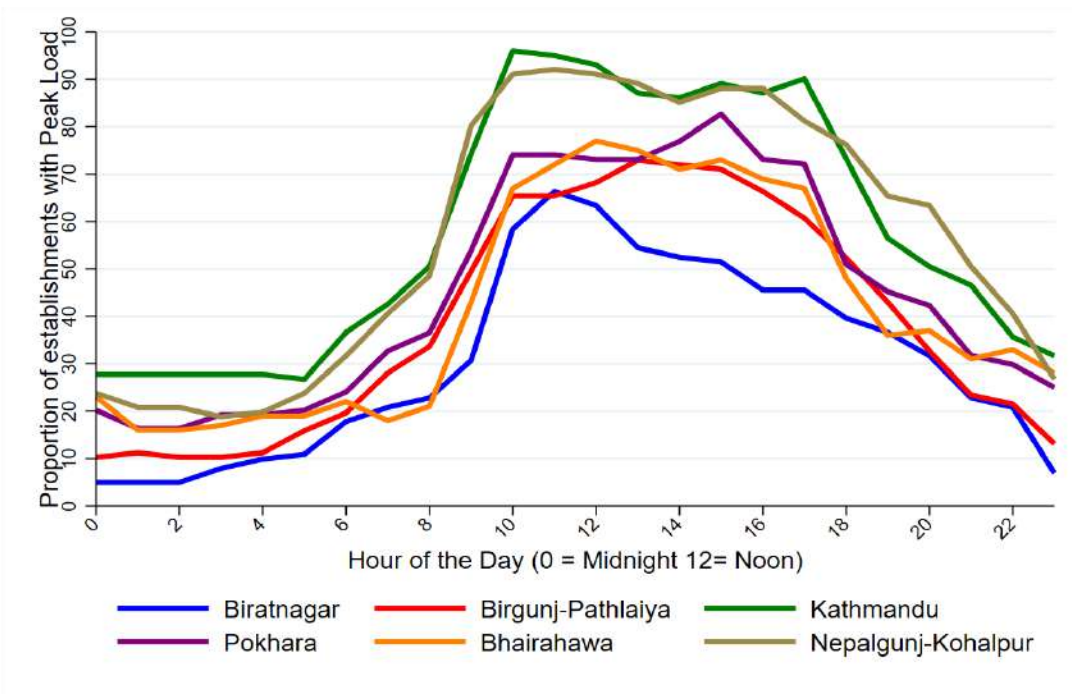


Figure 5.7.2*: Generally, at what time of the day does this establishment have peak load demand (electricity or other fuel sources)? [N =614]*

5.8. Month of the Year Electricity demand

The establishments experience their peak electricity demand during the months of Baisakh, Jestha, and Ashad, with demand percentages of 76.9%, 74.6%, and 69.4%, respectively. These months, typically falling in the spring and early summer, see the highest energy consumption. Demand slightly decreases in Shrawan, Bhadra, and Ashwin, but remains relatively high, ranging from 61.6% to 65.0%. The demand further dips in the later months of the year, with Kartik experiencing the lowest peak at 50.2%. (This could be because the main holiday season, Dasain and Tihar, fall during this time). However, from Mangsir to Chaitra, the load demand remains steady, fluctuating between 53.6% and 60.7%. This pattern suggests that the highest load demand occurs during the warmer months, while the demand tends to decline as the year progresses.

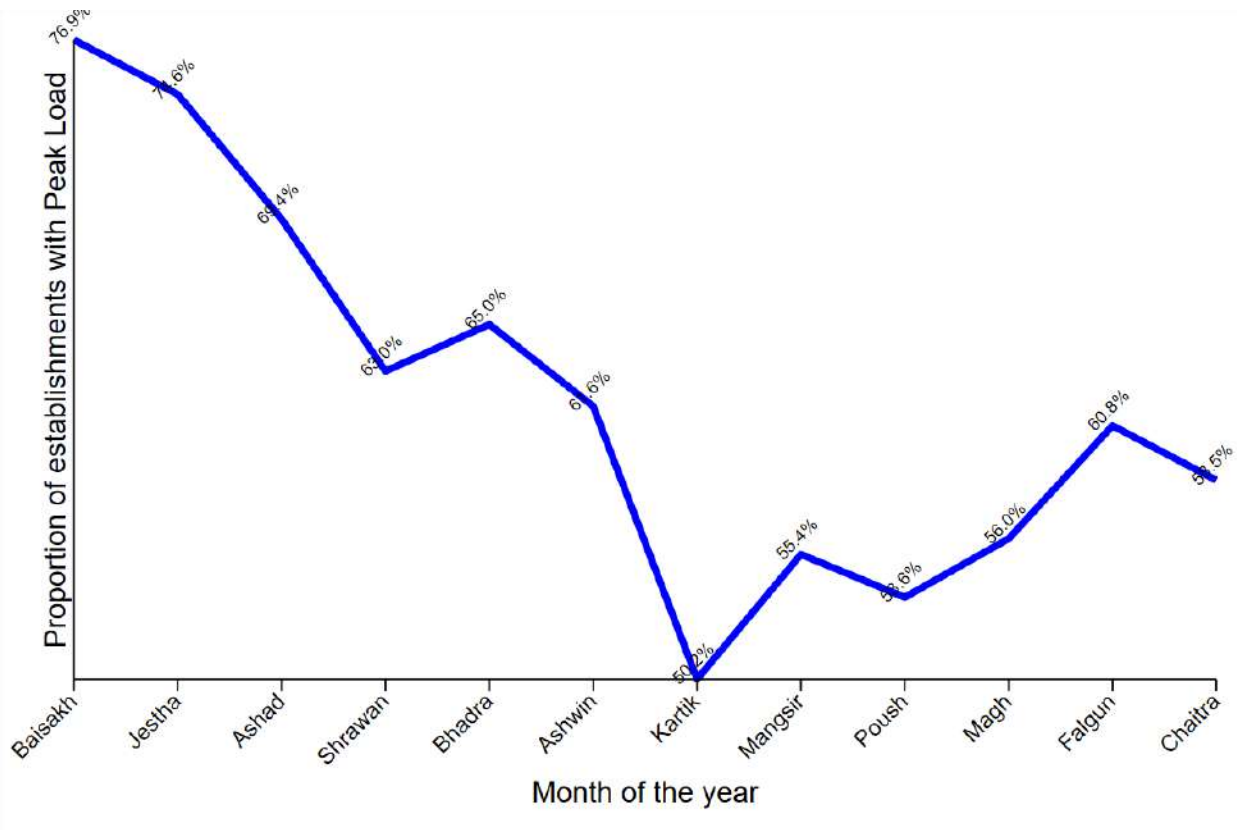


Figure 5.8: *During which months of a year does this establishment have Electricity demand (including electricity and all other fuel sources)? [N =614]*

CHAPTER 6: ENERGY AND ELECTRICITY SUPPLY

6.1. Application for Electrical Connection by Establishments

Over the past two years, only 8.1% of establishments applied for an electrical connection, while a significant 91.5% did not, and 0.3% were unsure. Among different sectors, the human health and social work activities sector had the highest application rate at 9.8%, while financial and insurance activities showed the lowest at 5.4%.

The application rates also varied by establishment size, with small industries leading at 12.0%, whereas micro industries had the lowest rate at 5.1%. Regionally, the Biratnagar-Itahari cluster had the lowest application rate at 2.0%, while Kathmandu and Birgunj-Pathlaiya had relatively high rates at 11.9% and 11.2%, respectively. This data highlights varying levels of demand for electrical connections across sectors, sizes, and clusters, reflecting the specific needs and infrastructural challenges in each category.

Table 6.1: *Over the last two years, did this establishment apply to obtain an electrical connection? [N = 614]*

		Over the last two years, did this establishment apply to obtain an electrical connection?		
		Yes	No	DON'T KNOW (SPONTANEOUS)
Overall		8.1%	91.5%	0.3%
Sector	Agriculture, forestry, and fishing	8.9%	91.1%	0.0%
	Manufacturing	8.4%	91.0%	0.6%
	Accommodation & food service activities	8.9%	91.1%	0.0%
	Information and communication	7.7%	92.3%	0.0%
	Human health and social work activities	9.8%	90.2%	0.0%
	Financial and insurance activities	5.4%	94.6%	0.0%
	Wholesale and retail trade activities	0.0%	100.0%	0.0%
	Other service activities	0.0%	100.0%	0.0%
Size	Large industry	6.4%	93.6%	0.0%
	Medium industry	7.3%	92.7%	0.0%
	Small industry	12.0%	88.0%	0.0%
	Cottage industry	5.6%	91.7%	2.8%
	Micro industry	5.1%	94.9%	0.0%
Cluster	Biratnagar-Itahari	2.0%	97.0%	1.0%
	Birgunj-Pathlaiya	11.2%	87.9%	0.9%
	Kathmandu	11.9%	88.1%	0.0%
	Pokhara	5.8%	94.2%	0.0%
	Bhairahawa-Butwal	7.0%	93.0%	0.0%
	Nepalgunj-Kohalpur	10.9%	89.1%	0.0%

6.2. Average Waiting Time for Electrical Connection

The establishments applying for an electrical connection were also asked how many days it took from the date of application to the day the service was received. The following table shows the average number of days establishments waited to obtain an electrical connection after application. Overall, the average waiting time was 33 days. By sector, accommodation/food service activities had the longest wait at 54 days, while Financial and Insurance activities experienced the shortest wait of just 1 day. In terms of size, small industries faced the longest delays, averaging 46 days, whereas medium industries experienced the shortest wait time of only 3 days. Geographically, the Bhairahawa-Butwal cluster had the longest average wait of 85 days, while the Biratnagar-Itahari and Pokhara clusters had the shortest, with average waits of 1 and 2 days, respectively. These variations highlight differences in waiting times across sectors, industry sizes, and geographic locations, indicating possible disparities in service delivery efficiency.

Table 6.2: *In reference to that application, approximately how many days did it take to obtain it from the day of the application to the day the service was received?*

		Average Number of Days
	Overall	33
Sector	Agriculture, forestry, and fishing	30
	Manufacturing	30
	Accommodation & food service activities	54
	Information and communication	
	Human health and social work activities	19
	Financial and insurance activities	1
	Wholesale and retail trade activities	
	Other service activities	
Size	Large industry	10
	Medium industry	3
	Small industry	46
	Cottage industry	9
	Micro industry	19
Cluster	Biratnagar-Itahari	1
	Birgunj-Pathlaiya	51
	Kathmandu	14
	Pokhara	2
	Bhairahawa-Butwal	85
	Nepalgunj-Kohalpur	11

6.3. Impact of Load Shedding and Power Outages on Establishments

The survey data shows the prevalence of load shedding and power outages experienced by establishments over fiscal year 2080/2081. Overall, 95.3% of establishments experienced power outages, while only 1.0% reported experiencing load shedding, and 1.6% experienced both. A small percentage (2.1%) reported no issues.

The data for fiscal year 2080/2081 reveals notable differences across sectors in their experiences with load shedding and power outages. The vast majority of establishments faced power outages, with information & communication and other service activities sectors experiencing a full 100% rate of unplanned outages. Agriculture, forestry, and fishing reported the highest combined rate of load shedding and outages, with 4.4% of establishments facing both. The accommodation and food service sector saw 94.8% experiencing outages and 1.5% facing both load shedding and outages, while wholesale and retail trade activities had a slightly higher rate of establishments unaffected by power issues, with 10.0% reporting no issues at all. The financial and insurance activities sector also saw minimal disruptions, with 3.6% unaffected.

The data for fiscal year 2080/2081 shows variations in power disruption experiences across industries of different sizes. Most establishments, regardless of size, experienced power outages, with cottage industry reporting the highest rate at 98.6%, followed closely by small industry (95.7%) and medium industry (95.5%). Large industry had the highest incidence of both load shedding and power outages combined, at 3.2%, also showed a relatively high rate of establishments experiencing load shedding (2.4%). Medium industry establishments were the least affected by load shedding, with 0.0% reporting planned power reductions. Small and micro industries saw slightly more issues, with 1.0% in each experiencing load shedding alone. The data also shows that a small proportion of establishments in each size category experienced no power issues, with small industry having the highest rate of unaffected establishments at 2.9%.

The data for fiscal year 2080/2081 reveals differences in power disruption experiences across various regional clusters. In Biratnagar-Itahari, every establishment reported experiencing power outages (100%) without any incidence of load shedding or a combination of both issues. Birgunj-Pathlaiya had the highest rate of combined load shedding and power outages at 9.3%, along with 3.7% experiencing only load shedding, indicating the highest overall disruption in the region. Kathmandu and Bhairahawa-Butwal also reported significant power outages, with 99.0% of establishments affected, though no load shedding was reported in these areas. Pokhara had 97.1% of establishments reporting outages, and Nepalgunj-Kohalpur saw a similar trend, with 96.0% affected by outages and 2.0% by load shedding. A small percentage of establishments in Pokhara (2.9%), Nepalgunj-Kohalpur (2.0%) Kathmandu (1.0%) and, Bhairahawa-Butwal (1.0%), reported no power issues at all. This data suggests that power outages are a widespread issue across clusters.

Table 6.3: *Over fiscal year [2080/2081], did this establishment experience load shedding or any kind of power outages? [N = 614]*

		Over fiscal year [2080/2081], did this establishment experience load shedding or any kind of power outages?			
		Yes, experienced load shedding	Yes, experienced power outages	Yes, experienced both load shedding and power outages	No
Overall		1.0%	95.3%	1.6%	2.1%
Sector	Agriculture, forestry, and fishing	2.2%	93.3%	4.4%	0.0%
	Manufacturing	1.0%	95.2%	1.6%	2.3%
	Accommodation & food service activities	1.5%	94.8%	1.5%	2.2%
	Information and communication	0.0%	100.0%	0.0%	0.0%
	Human health and social work activities	0.0%	97.6%	2.4%	0.0%
	Financial and insurance activities	0.0%	96.4%	0.0%	3.6%
	Wholesale and retail trade activities	0.0%	90.0%	0.0%	10.0%
	Other service activities	0.0%	100.0%	0.0%	0.0%
Size	Large industry	2.4%	92.8%	3.2%	1.6%
	Medium industry	0.0%	95.5%	1.8%	2.7%
	Small industry	1.0%	95.7%	0.5%	2.9%
	Cottage industry	0.0%	98.6%	0.0%	1.4%
	Micro industry	1.0%	94.9%	3.0%	1.0%
Cluster	Biratnagar-Itahari	0.0%	100.0%	0.0%	0.0%
	Birgunj-Pathlaiya	3.7%	81.3%	9.3%	5.6%
	Kathmandu	0.0%	99.0%	0.0%	1.0%
	Pokhara	0.0%	97.1%	0.0%	2.9%
	Bhairahawa-Butwal	0.0%	99.0%	0.0%	1.0%
	Nepalgunj-Kohalpur	2.0%	96.0%	0.0%	2.0%

When examining energy usage more closely through the Key Informant Interviews (KIIs), it became clear that electricity supply remains a critical challenge across all industrial sectors, with frequent outages and voltage fluctuations severely disrupting operations. Industry Key Informants consistently reported power cuts ranging from three to twelve times per day, with durations spanning 10 minutes to as long as 4 to 6 hours, depending on the area. In some locations, outages occurred two to three times daily on average.

One respondent from a medium-scale industry emphasized the difficulties posed by the unpredictability of current outages. While scheduled load shedding in the past at least allowed businesses to plan ahead—ensuring voltage stability when power resumed—the current situation, in which load shedding has been officially declared "over," has ironically introduced even greater uncertainty and disruption. As the respondent noted, "Unscheduled outages are unpredictable and more challenging to manage."

6.4. Frequency of Power Outages Experienced by Establishments in a Typical Week

Establishments that experienced power outages were asked additional questions regarding their frequency, average duration, annual losses incurred, and the specific times of day and months affected by these interruptions. The following table reveals the frequency of power outages experienced by establishments across various sectors, industry sizes, and clusters. On average, establishments reported experiencing 21 power outages per week. In terms of power outages, the other service activities sector faced 26 power outages per week, while the information and communication sector reported significantly fewer, with just 10.

Both large medium industries generally experienced higher frequencies of power outages (22 incidents), whereas cottage industries had lower rates, with only 17 power outages. Geographically, Nepalgunj-Kohalpur experienced the highest frequency of power outages (35 incidents) in a typical week, contrasting sharply with Kathmandu, which reported the fewest, with only 6 power outage incidents per week.

Table 6.4: *Frequency of Load Shedding and Power Outages Experienced by Establishments in a Typical Week by Sector, Industry Size, and Cluster*

		In a typical week, how many power outages did this establishment experience?
	Overall	21
Sector	Agriculture, forestry, and fishing	20
	Manufacturing	22
	Accommodation & food service activities	22
	Information and communication	10
	Human health and social work activities	23
	Financial and insurance activities	16
	Wholesale and retail trade activities	20
	Other service activities	26
Size	Large industry	22
	Medium industry	22
	Small industry	21
	Cottage industry	17
	Micro industry	21
Cluster	Biratnagar-Itahari	28
	Birgunj-Pathlaiya	27
	Kathmandu	6
	Pokhara	12
	Bhairahawa-Butwal	18
	Nepalgunj-Kohalpur	35

Interviews with NEA representative in Nepalgunj revealed that a reason behind a higher power outage is the region's electricity supply. The industrial area receives power from a 33-kV transmission line originating from the Kohalpur substation. However, following the standard rule of thumb that the ratio of kilovolts to kilometers should be 1:1, a 33-kV line should not extend beyond 30 kilometers. In Nepalgunj's case, the extended transmission distance results in significant voltage drops, as the existing 33 kV line alone is insufficient to support the energy *demands of such a large city. Additionally, the absence of local electricity generation exacerbates the problem. If power generation facilities were situated closer, they could help stabilize the voltage by reinforcing the supply. Hence, during peak summer months, when demand surges, the limitations of this setup become evident, leading to frequent power trips and an increased number of outages.*

6.5. Average Duration of Power Outages

Overall, the minimum duration of a power outage was 10 minutes, while the maximum duration reached 147 minutes.

Among sectors, the shortest average minimum duration is observed in human health and social work activities (7 minutes), whereas financial and insurance activities report the shortest maximum duration at 95 minutes. Conversely, the longest average maximum duration is found in manufacturing (171 minutes), followed closely by information and communication (168 minutes) and wholesale and retail trade activities (167 minutes). Agriculture, forestry, and fishing experience an average minimum duration of 8 minutes but a notably high maximum of 159 minutes.

Among different industry sizes, medium industries faced the highest maximum duration of 243 minutes, while cottage industries had a minimum of 5 minutes and a maximum of 99 minutes. Regional analysis shows that Bhairahawa-Butwal had the longest reported outage at 277 minutes, while Nepalgunj-Kohalpur experienced relatively shorter outages, from a minimum of 5 minutes to a maximum of 91 minutes.

Table 6.5: *Average Duration of Power Outages by Sector, Industry Size, and Region*

		Average minimum duration of power outage	Average maximum duration of power outage
Overall		10	147
Sector	Agriculture, forestry, and fishing	8	159
	Manufacturing	11	171
	Accommodation & food service activities	8	104
	Information and communication	9	168
	Human health and social work activities	7	157
	Financial and insurance activities	11	95
	Wholesale and retail trade activities	11	167
	Other service activities	11	150
Size	Large industry	10	143
	Medium industry	15	243
	Small industry	10	141
	Cottage industry	5	99
	Micro industry	7	93
Cluster	Biratnagar-Itahari	7	105
	Birgunj-Pathlaiya	10	117
	Kathmandu	10	139
	Pokhara	15	153
	Bhairahawa-Butwal	12	277
	Nepalgunj-Kohalpur	5	91

6.6. Types of Losses Incurred by Establishments Due to Power Outages and Low-Quality Electricity Supply in the Past Fiscal Year

Establishments that experienced power outages were further asked about the types of losses they faced due to power outages and/or poor electricity supply over the past year. They were allowed to provide multiple responses. In the past fiscal year, power outages and low-quality electricity supply led to significant losses for establishments, primarily in the form of damage to machinery or equipment (52.6%) and increased maintenance or repair costs (51.3%). Additionally, higher fuel costs for operating backup generators were incurred by 40.5% of establishments, while spoilage or damage to raw materials or finished goods affected 33.4% of them. Some establishments also reported a decrease in product quality (23.0%) and a loss in sales revenue (19.6%) as a result of these issues. However, a minority (20.6%) reported that they did not experience any significant losses due to power outages or poor electricity quality.

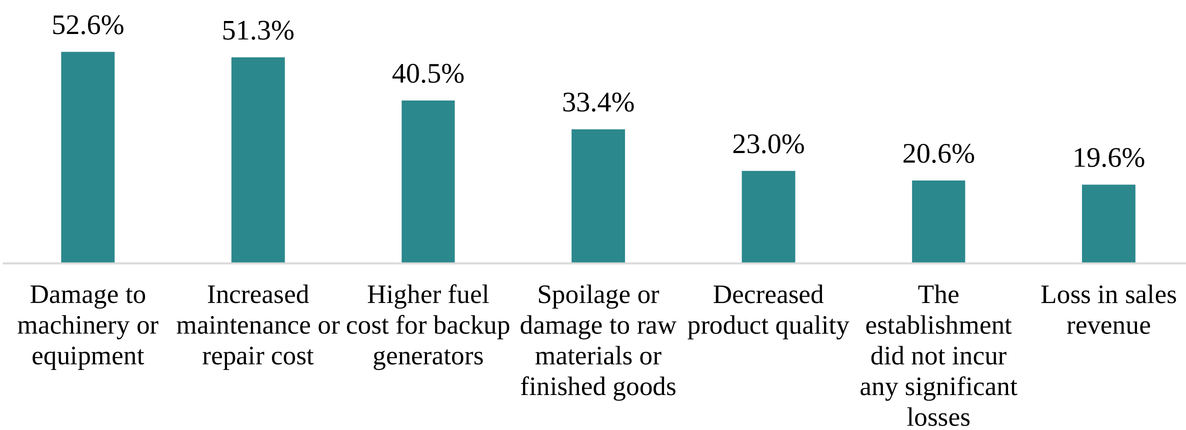


Figure 6.6: *What types of losses did this establishment incur due to power outage and/or low quality of electricity supply in the past fiscal year? [N = 587]*

The data highlights various types of losses establishments incurred due to power outages or poor electricity quality in the past fiscal year. Sectors such as human health and social work activities are particularly affected, with 61.0% reporting machinery damage and 63.4% experiencing increased repair costs. Accommodation and food service activities (52.3%) and information and communication (53.8%) report higher fuel costs for backup generators, while spoilage of raw materials or finished goods is a major issue in manufacturing (47.5%). Interestingly, decreased product quality is significant in manufacturing (36.9%) and other service activities (50.0%). Meanwhile, 20.6% of establishments overall reported no significant losses, though this varies across sectors, with 44.4% of wholesale and retail trade activities unaffected. Loss in sales revenue is most prevalent in other service activities (50.0%), contrasting sharply with sectors like health and communication, where it is notably lower.

In the past fiscal year, establishments across different industry sizes reported various losses due to power outages and/or low-quality electricity supply. Large industries were most impacted by damage to machinery or equipment (66.4%) and increased maintenance or repair costs (63.0%). Medium industries experienced similar challenges, with 58.5% reporting machinery damage and

59.4% facing higher maintenance costs. Small industries reported somewhat lower levels of these losses, with 59.2% incurring machinery damage and 56.1% seeing increased repair costs. Cottage industries experienced less damage overall, with 48.6% reporting no significant losses, but still faced higher fuel costs for backup generators (36.7%) and spoilage of raw materials (37.2%). Micro industries saw the least impact across most loss categories, particularly in machinery damage (20.0%) and higher fuel costs (4.3%). Interestingly, 48.6% of micro industries reported no significant losses, highlighting the relative resilience of smaller establishments to power supply issues.

Establishments in different clusters experienced various types of losses due to power outages or low-quality electricity supply during the past fiscal year. Damage to machinery or equipment was reported as a significant loss, particularly in Biratnagar-Itahari (69.3%) and Birgunj-Pathlaiya (65.6%), while Kathmandu recorded the lowest percentage (26.0%). Increased maintenance or repair costs followed a similar pattern, with the highest percentages in Biratnagar-Itahari (68.3%) and Birgunj-Pathlaiya (60.4%). Higher fuel costs for backup generators were most prominent in Birgunj-Pathlaiya (51.0%) and Pokhara (50.5%), while spoilage or damage to raw materials or finished goods was more frequently reported in Birgunj-Pathlaiya (50.0%) and Biratnagar-Itahari (39.6%).

Decreased product quality was relatively low across clusters, with the highest percentage in Biratnagar-Itahari (37.6%). A significant proportion of establishments in Kathmandu (42.0%) and Bhairahawa-Butwal (32.7%) reported not incurring any major losses. Loss in sales revenue was most prominent in Nepalgunj-Kohalpur (29.9%) and Birgunj-Pathlaiya (24.0%), while Bhairahawa-Butwal had the lowest percentage (7.1%). Overall, the impacts of power issues varied widely across the clusters, with some regions reporting significantly higher losses than others.

These results from the quantitative data strongly align with responses from key informant interviews (KII). Across interviewed industries, power outages and voltage fluctuations were reported to have severe consequences, ranging from machinery damage, part breakdowns, increased operational costs, production downtime, and man-hour losses, to broader operational setbacks that compromise efficiency and sustainability.

For industries reliant on continuous production, even brief power disruptions can result in substantial losses. The effects are particularly severe in manufacturing, agriculture, and service sectors, where process interruption leads not only to direct financial damage but also to reduced productivity and reputational risks.

In the agriculture sector, particularly in large-scale dairy farms, electricity is essential for automated milking systems. A power outage during milking can abruptly stop machines attached to cows' udders, causing distress to the animals and disrupting their natural milk production cycle. In some cases, cows later refused to produce milk, reducing the milk yield by up to 50% from a single interrupted session.

Similarly, manufacturing industries highlighted that voltage fluctuations and unscheduled outages frequently damage electronic components and raw materials, leading to significant repair and replacement costs. These costs are further exacerbated for businesses located in remote or peri-

urban areas, where specialist technicians charge premium rates and longer wait times lead to extended downtime.

Even relatively short outages can result in 30 minutes or more of lost production, as machinery needs time to cool down, reset, and restart, leading to further operational inefficiencies. In plastic molding and PVC pipe industries, for example, an outage during the molding process can cause the entire batch of products to be discarded, adding to financial strain.

The hospitality sector also suffers due to the inability to ensure uninterrupted service quality, especially in hotels catering to international tourists who are less tolerant of service disruptions. These outages affect everything from guest comfort to food preparation and digital service provision.

Beyond these immediate operational challenges, interviewees also stressed t the hidden costs of outages, such as man-hour losses and the need to reprocess partially completed work. Man-hour losses often go unnoticed but impose a considerable financial strain on businesses. For instance, if a power outage occurs and production halts, wage-based workers in sectors like packaging and assembling, lose income because their earnings are tied to output. Meanwhile, employers must still compensate salaried staff despite halted production, adding a financial burden without productive return.

As per the KIIs, the economic cost of unreliable electricity extends far beyond the price of backup power. They reveal a web of operational disruptions, productivity losses, and human resource inefficiencies that directly affect business resilience and growth potential.

Box Item 3: Impact of Voltage Fluctuations on Industries

'Our machinery is primarily affected in its electronic components by voltage fluctuations, particularly the synchronized systems we use for producing noodles, powdered milk, chocolate, and biscuits. These systems rely on precise weight balance during processing and packaging. Voltage fluctuations across the three phases often result in serious issues. For example, if two phases have 420 volts and one phase is at neutral voltage, the imbalance causes the motor to overheat. While the automatic machines may not trip, the excessive heat damages raw materials and forces us to halt production. This leads to significant losses, including labor man-days, machinery damage, and raw material wastage. In some cases, when production is in the baking phase, power tripping results in an entire batch being discarded.

Using generators to cope with power issues also presents its own set of challenges. If the voltage supply drops below 5%, the power trips, and an auto-mode generator delivers excessive power. This high-power output can cause machines to overheat and, in extreme cases, even explode. Such overheating damages both the raw materials and critical electronic components. To mitigate these risks, we avoid using the auto-generator technique. Instead, we wait for about 30 minutes, manually switch off the power, and only then start the generator. This process, however, requires a dedicated person to manage it, adding to our operational burdens.'

Source: KII with a medium-sized food processing industry in Pokhara.

6.7. Average Percentage Losses Resulting from Load Shedding and Power Outages

The data on average percentage losses due to power outages reveals that, overall, establishments experienced an 8% loss in sales. The impact of power outages was relatively consistent across most sectors, with agriculture, forestry, and fishing, manufacturing, accommodation and food services, and whole sale and retail trade activities each reporting losses of around 8-9%. The information and communication sector experienced a higher loss at 14%, suggesting a greater dependence on reliable power supply for operations. The financial and insurance sector faced the least impact, with a 6% loss in sales. In terms of industry size, large, small, and micro industries each reported losses around 8-9%, while medium industries experienced slightly lower losses at 7%. Geographically, Nepalgunj-Kohalpur and Birgunj-Pathlaiya reported the highest losses at 10%, while Kathmandu experienced the least disruption with only a 2% sales loss. These variations highlight the widespread, but uneven, impact of power outages across sectors and regions.

Table 6.7: *Average Percentage Losses Resulting from Load Shedding and Power Outages by Sector, Industry Size, and Geographic Cluster*

		Average Percentage losses that resulted from power outages (%)
	Overall	8%
Sector	Agriculture, forestry, and fishing	8%
	Manufacturing	8%
	Accommodation & food service activities	8%
	Information and communication	14%
	Human health and social work activities	10%
	Financial and insurance activities	6%
	Wholesale and retail trade activities	8%
	Other service activities	12%
Size	Large industry	9%
	Medium industry	7%
	Small industry	9%
	Cottage industry	8%
	Micro industry	8%
Cluster	Biratnagar-Itahari	9%
	Birgunj-Pathlaiya	10%
	Kathmandu	2%
	Pokhara	8%
	Bhairahawa-Butwal	7%
	Nepalgunj-Kohalpur	10%

6.8. Patterns of Power Outages Experienced by Establishments

The survey reveals that establishments experience power outages in different patterns. Power outages are mostly perceived as random events, with a dominant 86.7% of establishments reporting that power outages do not follow a regular schedule. Only a small proportion of establishments (7.6%) experience power outages at specific times of day, and even fewer (4.5%) report month-specific outages. This suggests that while load shedding tends to follow more predictable patterns, power outages are largely sporadic and unpredictable for most establishments.

Table 6.8: *Patterns of Load Shedding and Power Outages Experienced by Establishments*

		Overall
Is it that the establishment experiences power outages during certain times of a day, or during certain months of a year, or both, or is it just a random event?	Yes, power outages are time specific within a day	7.6%
	Yes, power outages are month specific	4.5%
	Yes, power outages are both time and month specific	1.2%
	No, power outages are random events	86.7%

6.9. Timing of Power Outages Experienced by Establishments Throughout the Day

Power outages are most frequently experienced by establishments around midday, with the highest frequency occurring at 12:00 noon, where 71.2% of establishments report power disruptions. This is followed closely by 11:00 AM and 1:00 PM, where 48.1% of establishments are affected. In the afternoon, the frequency of power outages decreases slightly, with around 30% to 35% of establishments affected between 2:00 PM and 4:00 PM. As the evening progresses, the occurrence of power outages continues to decline, with only 17.3% of establishments affected at 8:00 PM, and a further drop to 3.8% at 9:00 PM and 10:00 PM. By midnight, power outages are minimal, with only 1.9% of establishments affected from 11:00 PM to 3:00 AM. The early morning hours (4:00 AM to 5:00 AM) report no outages at all.

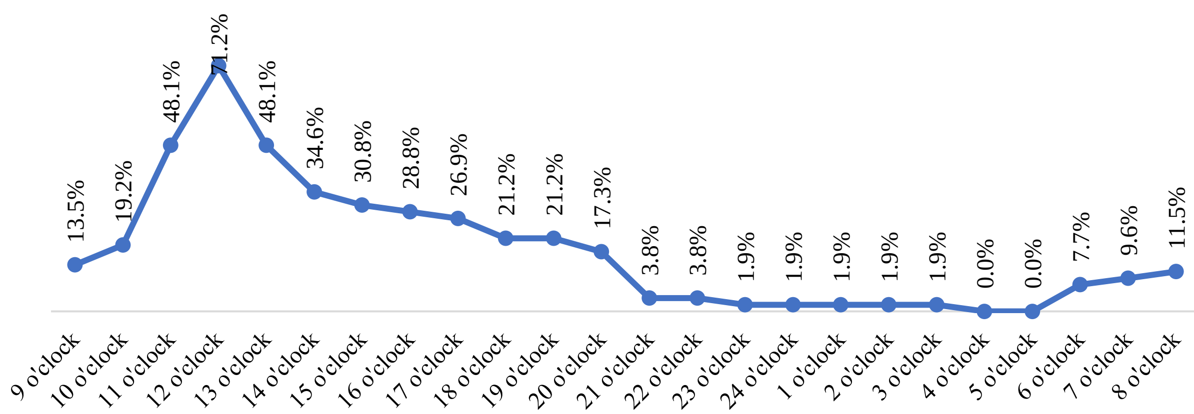


Figure 6.9: *Generally, at what time of the day does this establishment experience power outages? [N = 52]*

The data on power outages across different clusters shows significant variation in the timing and frequency of power cuts. In the Nepalgunj-Kohalpur cluster, power outages are reported consistently throughout the day, with the highest frequency occurring at 11:00 AM, 12:00 PM, and 1:00 PM, where 100% of establishments experience outages. Similarly, other clusters such as Birgunj-Pathlaiya, Bhairahawa-Butwal, and Kathmandu also face substantial outages, particularly during midday hours. For instance, in Birgunj-Pathlaiya, outages peak at 12:00 PM and 1:00 PM with 62.5% to 87.5% of establishments affected. Kathmandu reports a notable frequency of outages at 12:00 PM and 1:00 PM, with 100% of establishments affected at noon. In contrast, Biratnagar-Itahari and Pokhara experience fewer outages, with Biratnagar-Itahari showing a minimal presence of outages across most hours. Interestingly, while the evening hours see a drop in outages, clusters like Nepalgunj-Kohalpur continue to experience outages late into the night. Overall, the data suggests that power outages are most prevalent between 12:00 PM and 3:00 PM across most clusters, with some areas like Nepalgunj-Kohalpur facing more extended outages throughout the day and night.

6.10. Power Outages Experienced by Establishments Throughout the Year

The data on power outages or load shedding across different months of the year indicates that power cuts are most frequent during the months of Ashad and Shrawan, with 73.5% and 67.6% of establishments reporting outages, respectively. Baisakh, Jestha, and Falgun also show relatively high instances of load shedding, with 50% of establishments affected during these months. The frequency of outages decreases in the latter half of the year, with months like Kartik and Mangsir reporting lower percentages (8.8% and 11.8%, respectively). Other months, including Poush, Magh, and Chaitra, see moderate occurrences of power cuts, with around 23.5% to 38.2% of establishments reporting outages. This suggests that power outages are most prevalent in the mid-year months, with a gradual decline as the year progresses.

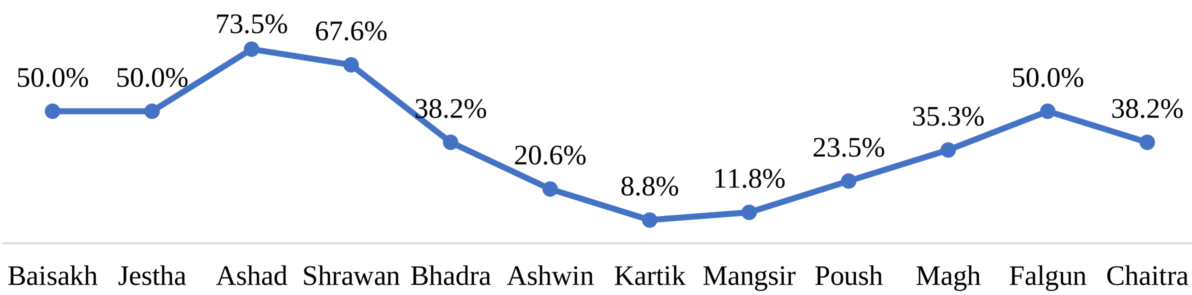


Figure 6.10: *During which months of a year does this establishment experience power outages? [N = 34]*

The data reveals significant variation in the frequency of power outages across different clusters in Nepal during various months. For instance, establishments in Biratnagar-Itahari and Birgunj-Pathlaiya experience frequent power outages, especially during the months of Baisakh, Jestha, and Shrawan, with Biratnagar-Itahari reporting 50-100% outages during these months. In contrast, Kathmandu experiences much lower outage rates, with disruptions primarily occurring in Baisakh, Jestha, and Shrawan, where 12.5%-75% of establishments report power cuts. Meanwhile, Pokhara, Bhairahawa-Butwal, and Nepalgunj-Kohalpur generally experience minimal or no outages throughout the year. The pattern indicates that power outages are more common in certain regions, particularly during the summer months (Baisakh, Jestha, and Shrawan), while the winter months (Mangsir, Poush, Magh) see fewer disruptions.

6.11 Loadshedding, power outages, and losses incurred by Establishments

The table highlights economic impact of loadshedding and power outages on industries and enterprises, quantified through average annual losses and their effect on forfeited profits. Overall, the combined annual losses due to power disruptions amount to 13,678 thousand NPR, resulting in 5,471 thousand NPR in forfeited profits (assuming that, in absence of power outages, these losses would translate into revenue and establishments would make 40% profit margin).

Additionally, this results in 1,368 thousand NPR in forfeited taxes (calculated based on a 25% tax rates on the lost profits).

he human health and social work sector experiences substantial losses, with a staggering combined loss of 44,036 thousand NPR—almost entirely due to power outages (43,983 thousand NPR). This results in 17,614 thousand NPR in lost profits and 4,404 thousand NPR in uncollected taxes, highlighting the critical need for reliable energy in healthcare.

The manufacturing sector follows, incurring 16,737 thousand NPR in combined losses, leading to 6,695 thousand NPR in forfeited profits and 1,674 thousand NPR in lost tax revenue, underscoring its vulnerability to operational disruptions.

Other sectors, such as agriculture, forestry, and fishing (4,918 thousand NPR in combined losses) and accommodation & food services (3,380 thousand NPR), also face significant challenges, though on a smaller scale. In contrast, sectors like wholesale and retail trade, information and communication, and other service activities report comparatively minimal losses.

Table 6.11.1: *Average annual loss incurred by establishment – across sectors, equivalent forfeited profits and taxes*

	Average annual loss incurred by establishments (In Thousand NPR)			**Forfeited Profits (rate = 40%)**	**Forfeited Taxes (rate = 25%)**
Sector	Due to Loadshedding	Due to Power outage	Combined		
Human health and social work activities	1,360	43,983	44,036	17,614	4,404
Manufacturing	12,563	16,619	16,737	6,695	1,674
Agriculture, forestry, and fishing	815	5,192	4,918	1,967	492
Accommodation & food service activities	11,471	2,981	3,380	1,352	338
Wholesale and retail trade activities	.	2,280	2,280	912	228
Information and communication	.	1,071	1,071	428	107
Other service activities	.	57	57	23	6
Overall	**8,933**	**13,600**	**13,678**	**5,471**	**1368**

Similarly, the following table highlights the impact of loadshedding and power outages on industries and enterprises, quantified through average annual losses across major industrial clusters. Establishments in Bhairahawa-Butwal experienced the highest loss at 20,296 thousand NPR per establishment, indicating it is the most severely affected cluster. Biratnagar-Itahari and Nepalgunj-Kohalpur followed with substantial losses of 17,610 and 15,913 thousand NPR of losses per establishment, respectively. Establishments of Birgunj-Pathlaiya and Pokhara reported moderate losses of 15,654 thousand NPR and 9,714 thousand NPR per establishment respectively. In contrast, industries and enterprises in Kathmandu recorded the lowest loss at 7,615 thousand NPR.

Table 6.11.2: Average annual loss incurred by establishment – across clusters

	Average annual loss incurred by establishments In Thousand NPR		
Cluster	**Due to Loadshedding**	**Due to Power outage**	**Combined**
Biratnagar-Itahari	.	17,610	17,610
Birgunj-Pathlaiya	5,261	15,880	15,654
Kathmandu	.	7,615	7,615
Pokhara	.	9,714	9,714
Bhairahawa-Butwal	.	20,296	20,296
Nepalgunj-Kohalpur	30,966	15,550	15,913
Overall	**8,933**	**13,600**	**13,678**

6.12. Usage of Alternative Electricity Sources by Establishments in Fiscal Year 2080/2081

The survey data illustrates the usage of alternative electricity sources, such as generators, battery backups, and solar PV, across various sectors, industry sizes, and regional clusters over the fiscal year 2080/2081. Overall, 61.7% of establishments reported using alternative sources of electricity, while 37.5% did not, and a small portion (0.8%) were unsure.

Sector-wise, the highest adoption rate was seen in Information and Communication, with 100% of establishments using alternative electricity. This was followed by the Human Health and Social Work activities (92.7%) and Financial and Insurance (85.5%). The Manufacturing sector had the lowest rate, with only 48.7% using alternative sources. In terms of industry size, Large Industries had the highest adoption at 92.8%, whereas Cottage and Micro Industries showed significantly lower adoption rates at 20.8% and 27.3%, respectively. Regionally, the Birgunj-Pathlaiya cluster had the highest adoption rate (71.0%), while Bhairahawa-Butwal had the lowest (47.0%). These findings indicate varying levels of dependency on alternative electricity sources, influenced by sector type, industry size, and regional location.

Table 6.12: Usage of Alternative Electricity Sources by Establishments in Fiscal Year 2080/2081, Disaggregated by Sector, Size, and Cluster [N = 614]

		Over the course of fiscal year [2080/2081], did this establishment own or share an alternative source of electricity besides the main electrical connection systems, for instance generators, battery backups, solar PV, etc.?		
		Yes	No	DON'T KNOW
Overall		61.7%	37.5%	0.8%
Sector	Agriculture, forestry, and fishing	55.6%	42.2%	2.2%
	Manufacturing	48.7%	50.0%	1.3%
	Accommodation & food service activities	73.3%	26.7%	0.0%
	Information and communication	100.0%	0.0%	0.0%
	Human health and social work activities	92.7%	7.3%	0.0%
	Financial and insurance activities	85.7%	14.3%	0.0%
	Wholesale and retail trade activities	50.0%	50.0%	0.0%
	Other service activities	0.0%	100.0%	0.0%
Size	Large industry	92.8%	7.2%	0.0%
	Medium industry	84.5%	15.5%	0.0%
	Small industry	61.5%	38.0%	0.5%
	Cottage industry	20.8%	75.0%	4.2%
	Micro industry	27.3%	71.7%	1.0%
Cluster	Biratnagar-Itahari	56.4%	41.6%	2.0%
	Birgunj-Pathlaiya	71.0%	29.0%	0.0%
	Kathmandu	69.3%	30.7%	0.0%
	Pokhara	65.4%	33.7%	1.0%
	Bhairahawa-Butwal	47.0%	53.0%	0.0%
	Nepalgunj-Kohalpur	60.4%	37.6%	2.0%

6.13. Types of Alternative Electricity Sources Used by Establishments

Establishments that own or share alternative sources of electricity, in addition to their main electrical connection, were asked to provide a list of all the alternative sources they use for electricity. The survey data highlights the types of alternative electricity sources used by establishments. Generators and backup generators were the most commonly used, with 70.7% of establishments relying on them. Battery backup systems, such as inverters, were also widely utilized, being chosen by 67.3% of establishments. In contrast, solar power options were less popular: only 6.9% of establishments used solar PV, and an even smaller proportion (0.3%) utilized a solar grid. This suggests that while traditional backup systems like generators and batteries are prevalent, renewable sources like solar power are not yet widely adopted among establishments.

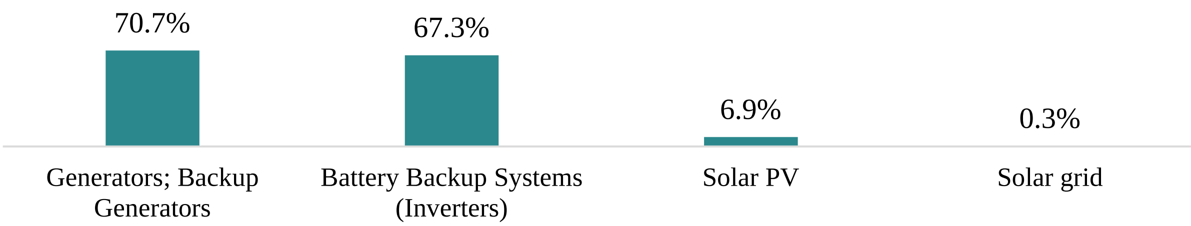


Figure 6.13: *Kindly list out all the alternative sources that the establishment used for electricity. [N = 379]*

The establishments reported utilizing various alternative electricity sources across sectors. Generators and backup generators were predominantly used in manufacturing (80.8%), human health and social work activities (76.3%), and accommodation and food service activities (71.7%). Battery backup systems (inverters) were the most relied upon alternative in sectors like information and communication (92.3%), human health and social work activities (86.8%), and financial and insurance activities (87.5%). Solar PV usage was comparatively lower, with the wholesale and retail trade sector showing the highest adoption at 20.0%, followed by agriculture, forestry, and fishing (12.0%). Solar grid systems were rarely used, with negligible adoption across all sectors.

The survey data shows the utilization of alternative electricity sources by establishments of varying sizes. Large industries have the highest reliance on generators and backup generators, with 84.5% of them using these sources, followed closely by medium industries at 80.6%. Smaller establishments, like cottage and micro industries, have lower generator usage rates at 46.7% and 44.4%, respectively. Battery backup systems are popular across all sizes, with small industries leading at 71.9%, while micro industries follow closely at 70.4%. Solar PV systems are less commonly used, though cottage industries have the highest adoption rate at 13.3%. The solar grid system sees minimal adoption, with only 1.1% of medium industries using it. This data suggests that larger industries depend more on traditional backup sources, while smaller establishments are moderately inclined towards battery systems, with minimal interest in solar solutions.

The survey data also provides insight into the use of alternative electricity sources across various regional clusters. Generators and backup generators are widely used, with the highest adoption rates in Birgunj-Pathlaiya (81.6%) and Biratnagar-Itahari (78.9%). In contrast, Pokhara and Bhairahawa-Butwal have lower reliance on generators at 57.4% and 53.2%, respectively. Battery backup systems are most popular in Bhairahawa-Butwal (93.6%) and Pokhara (83.8%), indicating a preference for battery-based solutions in these clusters. Solar PV adoption remains low overall, though Pokhara stands out with a relatively higher usage rate of 17.6%, while Nepalgunj-Kohalpur reports no use of solar PV. The solar grid system is nearly absent, with only 1.8% of establishments in Biratnagar-Itahari using it. This suggests a regional variation in backup electricity preferences, with some clusters favoring generators while others rely more on battery systems. Solar solutions are minimally adopted across.

Findings from KIIs are consistent with the survey results. To address energy-related challenges, majority businesses rely heavily on backup generators as a primary solution. Even though generators come with their own set of issues, including high fuel costs, synchronization problems, *and the risk of overloading machinery, industries mentioned that this was the only easier, useful and popular alternative source.*

Likewise, Battery backup systems, including inverters and UPS, are also widely used—especially in sectors where power reliability is critical. For example, a representative from a medium-sized hospital mentioned that it has installed stabilizers and UPS on nearly every critical device, including X-ray machines, OPD computers, and ICU equipment. These investments reportedly cost between 15 to 30 lakh per stabilizer, depending on size and capacity. Similarly, transformer upgrades were undertaken by some small businesses to manage voltage drops—though even this did not fully resolve their energy reliability issues.

In contrast, the adoption of solar energy remains limited, aligning with the low uptake reported in the survey. KIIs revealed multiple reasons behind this:

- *Limited awareness about solar technology and available government support*
- *Perceived high costs, particularly the upfront investment and battery replacement expenses*
- *Technical uncertainty regarding whether solar PV systems can meet industrial energy demands*
- *Institutional restrictions, especially within industrial zones, where bodies like IZML reportedly restrict rooftop installations.*

As one manufacturing industry representative operating within an industrial zone explained, "IZML has no provision for net metering of solar rooftop systems."

Even industries that might benefit significantly from solar adoption are often unaware of financing models such as the "Energy as a Service" approach, which allows them to install solar without upfront capital or maintenance burdens. Most informants also lacked awareness of the Alternative Energy Promotion Centre (AEPC) and its relevant initiatives.

Nonetheless, some successful examples of solar integration were reported. A small industry in Pokhara replaced 10–12 LPG cylinders with just 2 after installing a solar water heating system. Another manufacturing firm installed a 500-kVA rooftop solar system synchronized with the NEA grid, and a hospitality business is currently exploring solar PV for cost-saving purposes.

6.14: Percentage of Electricity Sourced from Alternative Sources

Establishments that own or share alternative sources of electricity, in addition to the main electrical connection, were further asked to specify the percentage of their electricity derived from those alternative sources. The table below presents the percentage of electricity sourced from alternative sources across different sectors, industry sizes, and geographical clusters. On average, 12% of electricity in establishments came from alternative sources. Sector-wise, the highest percentage was observed in the human health and social work activities sector (15%), followed by manufacturing (13%), and accommodation and food service activities (12%). In terms of industry size, large industries had the highest share at 14%, while cottage industries had the lowest at 7%. Geographically, establishments in the Biratnagar-Itahari and Birgunj-Pathlaiya clusters led with 14% each, while Kathmandu, Pokhara, Bhairahawa-Butwal, and Nepalgunj-Kohalpur recorded a consistent 11%.

Table 6.14: *What percentage of this establishment's electricity came from those alternative sources? [N = 379]*

		Average percentage of establishment's electricity came from those alternative sources.
Overall		12%
Sector	Agriculture, forestry, and fishing	8%
	Manufacturing	13%
	Accommodation & food service activities	12%
	Information and communication	10%
	Human health and social work activities	15%
	Financial and insurance activities	9%
	Wholesale and retail trade activities	11%
	Other service activities	-
Size	Large industry	14%
	Medium industry	11%
	Small industry	12%
	Cottage industry	7%
	Micro industry	8%
Cluster	Biratnagar-Itahari	14%
	Birgunj-Pathlaiya	14%
	Kathmandu	11%
	Pokhara	11%
	Bhairahawa-Butwal	11%
	Nepalgunj-Kohalpur	11%

6.15: Intentions to Add or Increase Alternative Energy Sources

The survey data reveals that a relatively small proportion of establishments across various sectors and regions have intentions to add or increase alternative energy sources, with 22.1% overall expressing such intentions. The highest percentages were found in the other service activities sector (50.0%) and the wholesale and retail trade sector (40.0%), indicating a greater interest in alternative energy in these areas. Conversely, sectors like Manufacturing (16.1%), and Financial and Insurance Activities (16.1%) showed lower levels of interest in increasing alternative energy use. Industry size also played a role, with larger industries showing more interest (32.8%) compared to smaller ones. Geographically, establishments in the Biratnagar-Itahari cluster had the lowest intention (13.9%), while clusters like Pokhara (31.7%) and Nepalgunj-Kohalpur (30.7%) were more inclined to consider increasing their use of alternative energy. The overall trend indicates a need for further incentives or awareness to encourage the adoption of alternative energy across industries.

Table 6.15: *Do you have any intentions on adding/increasing alternative energy sources? [N = 614]*

		Do you have any intentions on adding/increasing alternative energy sources?	
		Yes	No
Overall		22.1%	77.9%
Sector	Agriculture, forestry, and fishing	35.6%	64.4%
	Manufacturing	16.1%	83.9%
	Accommodation & food service activities	27.4%	72.6%
	Information and communication	30.8%	69.2%
	Human health and social work activities	34.1%	65.9%
	Financial and insurance activities	16.1%	83.9%
	Wholesale and retail trade activities	40.0%	60.0%
	Other service activities	50.0%	50.0%
Size	Large industry	32.8%	67.2%
	Medium industry	23.6%	76.4%
	Small industry	18.3%	81.7%
	Cottage industry	19.4%	80.6%
	Micro industry	17.2%	82.8%
Cluster	Biratnagar-Itahari	13.9%	86.1%
	Birgunj-Pathlaiya	28.0%	72.0%
	Kathmandu	14.9%	85.1%
	Pokhara	31.7%	68.3%
	Bhairahawa-Butwal	13.0%	87.0%
	Nepalgunj-Kohalpur	30.7%	69.3%

6.16: Considerations for Adding or Increasing Alternative Energy Sources

Establishments intending to add or expand their alternative energy sources were further asked about the factors they consider for doing so. They were allowed to provide multiple responses. The survey data highlights the key factors driving the consideration of adding or increasing alternative energy sources among establishments. The primary motivation, cited by 46.3% of respondents, is to increase the security of supply during periods of uncertain access. Expanding energy usage was the second most common reason, with 43.4% of establishments expressing interest in using more energy. Additionally, 37.5% of respondents are looking to replace existing energy or electricity needs with alternative sources. Concerns over volatile energy prices also play a role, with 25.0% indicating that increasing energy security in such situations is a key consideration. Lastly, 17.6% of respondents view alternative energy as a potential income-generating activity, through selling energy to the grid or to other industries or enterprises. This suggests that both security and economic opportunities are strong drivers in the decision to adopt alternative energy sources.

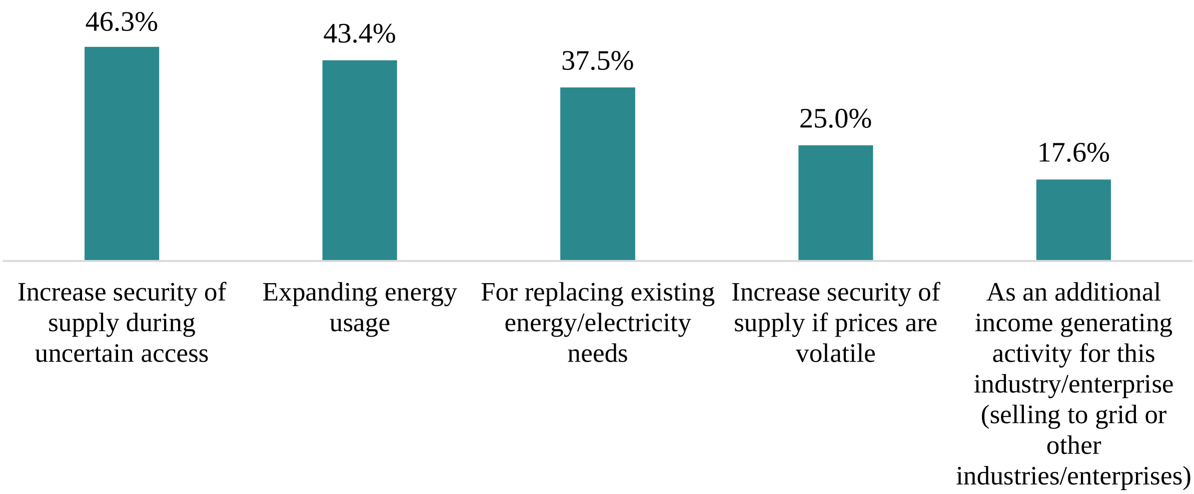


Figure 6.16: *What are your considerations for adding/increasing alternative energy sources? [N = 136]*

The considerations for adding or increasing alternative energy sources vary across sectors. The primary concern for most establishments is increasing the security of supply during uncertain access, with the information and communication sector leading at 75.0%, followed by financial and insurance activities at 66.7%. Expanding energy usage is a significant consideration in agriculture, forestry, and fishing (56.3%), and wholesale and retail trade activities (55.6%). Replacing existing energy needs is most critical in other service activities (100.0%) and less prioritized in accommodation and food service activities (32.4%). Concerns about price volatility drive decisions in agriculture, forestry, and fishing (43.8%), while generating additional income through alternative energy is least considered overall, except for notable mentions in other service activities (50.0%) and manufacturing (22.0%).

The survey data reveals varying considerations for adding or increasing alternative energy sources based on industry size. Increasing security of supply during uncertain access is a primary concern for small industries (60.5%) and micro industries (58.8%). In contrast, medium industries focus most on expanding energy usage (65.4%), followed by large industries (48.8%). Replacing existing energy needs is relatively important across large (46.3%) and cottage industries (42.9%). Concerns about securing supply amidst price volatility are notable among large industries (34.1%) and small industries (28.9%), though these considerations are less significant for micro industries (17.6%), and cottage (14.3%). Using alternative energy as an additional income source is least prioritized, especially in micro industries (5.9%), while large industries show the highest interest (24.4%) in this aspect.

The survey data reveals regional differences in considerations for adding or increasing alternative energy sources across various clusters. The need to increase security of supply during uncertain access is most prominent in Pokhara (72.7%) and Birgunj-Pathlaiya (50.0%), with lower interest in Nepalgunj-Kohalpur (22.6%). Expanding energy usage is a significant consideration in Kathmandu (66.7%), Nepalgunj-Kohalpur (51.6%) and, Pokhara (51.5%), while Biratnagar-Itahari (7.1%) shows much less interest in this factor. Replacing existing energy needs is most critical in Biratnagar-Itahari (57.1%) and Nepalgunj-Kohalpur (48.4%), while Pokhara (18.2%) is less focused on this aspect. Concerns over volatile energy prices are most evident in Bhairahawa-Butwal (38.5%) and Pokhara (36.4%), while other clusters like Nepalgunj-Kohalpur (12.9%) show minimal concern. Lastly, the potential for additional income from alternative energy generation is more significant in Nepalgunj-Kohalpur (29.0%) and Kathmandu (26.7%), while clusters like Biratnagar-Itahari (7.1%) show little interest in this opportunity.

6.17: Factors Contributing to Load Shedding and Power Outages in Industries and Enterprises

All respondents were asked to identify the reasons behind power outages and load shedding. They were allowed to provide multiple reasons on the issue. The persistent issue of load shedding and power outages among industries and enterprises can be attributed to several factors. A significant proportion of respondents, 50.5%, believe it is due to inadequate supply-related infrastructures, including grids and transmission lines. Additionally, 49.2% cite the use of older, energy-inefficient machines, technology, and appliances as a major contributor. Political and regulatory issues are also seen as a key factor, with 39.1% of respondents highlighting this concern. Furthermore, 29.0% believe the export of electricity to India and other countries exacerbates the situation, while 24.8% point to insufficient power generation from the utility sector. Lastly, 10.4% attribute the problem to the diversion of electricity to the residential sector. These multiple factors together contribute to the ongoing challenges faced by industries and enterprises.

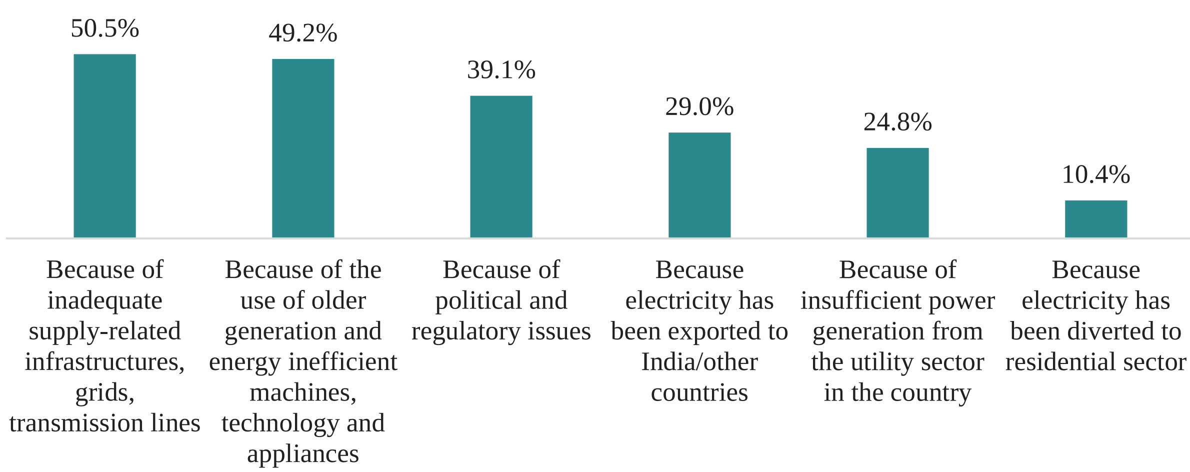


Figure 6.17: *In your opinion why does load shedding/ power outages still exist among industries and enterprises? [N = 614]*

The reasons behind the ongoing load shedding and power outages across various industries and sectors are multifaceted, with notable differences between sectors.

Load shedding and power outages among industries and enterprises are attributed to several factors. Inadequate supply-related infrastructure, including grids and transmission lines, is the most common issue, particularly in the wholesale and retail trade sector (70.0%) and other service activities (75.0%). The use of older generation and energy-inefficient machines is also a significant factor, with information and communication (69.2%) and human health and social work activities (58.5%) sectors being the most affected. Political and regulatory issues contribute notably in agriculture, forestry, and fishing (46.7%) and human health activities (48.8%), while electricity exports to other countries are a key concern in other service activities (75.0%). Insufficient power generation is moderately impactful, with wholesale and retail trade (30.0%) being the most affected. Lastly, diversion of electricity to the residential sector has the least impact across all sectors, with negligible concern in information and communication (7.7%).

The persistence of load shedding and power outages across industries varies by size, with some common trends and sector-specific issues. Larger industries (52.8%) and medium-sized industries (55.5%) cite inadequate supply-related infrastructures such as grids and transmission lines as a major factor contributing to power shortages. This issue is also significant for small industries (52.4%), though less so for cottage (45.8%) and micro industries (41.4%). The use of older, energy-inefficient machinery is another common concern, particularly for larger industries (55.2%) and medium-sized industries (50.9%), while smaller industries report this issue to a lesser extent. Political and regulatory challenges affect industries of all sizes, with larger industries (48.0%) expressing more concern compared to micro industries (30.3%). The export of electricity to neighboring countries is a significant concern for medium-sized (31.8%) and micro industries (30.3%), while it is less impactful for cottage and small industries. Insufficient power generation from the utility sector is seen as a larger issue for micro industries (31.3%) compared to larger industries. Finally, the diversion of electricity to residential sectors appears to be a minor issue across all sizes, with the least concern in cottage industries (8.3%).

The reasons behind load shedding and power outages across various industrial clusters in Nepal show notable regional differences. In the Biratnagar-Itahari and Bhairahawa-Butwal regions, inadequate supply-related infrastructures, such as grids and transmission lines, are the leading causes, cited by 60.4% and 60.0% of respondents, respectively. In contrast, Kathmandu (44.6%) and Pokhara (46.2%) report fewer concerns about infrastructure, with the former region also seeing high concerns about outdated, energy-inefficient machinery (72.3%) compared to other clusters. Political and regulatory issues are prominent in Bhairahawa-Butwal (46.0%) and, Kathmandu (45.5%) while electricity exports to neighboring countries are a significant concern in Nepalgunj-Kohalpur (44.6%), and Birgunj-Pathlaiya (41.1%). Insufficient power generation from the utility sector is most strongly felt in Nepalgunj-Kohalpur (60.4%), while the diversion of electricity to the residential sector is a minor issue across all regions, except in Biratnagar-Itahari and Nepalgunj-Kohalpur, where it is mentioned by 15.8% of respondents. These findings reflect a mix of infrastructure, technological, and policy-related challenges that vary by geographic region.

Across all industries, nearly all key informants consistently emphasized that power outages remain widespread, despite improvements in national generation capacity. The unreliability was attributed primarily to aging infrastructure, inefficient grid management, and instability in utility supply.

A recurring concern highlighted during the KIIs was that outdated and overloaded transformers and distribution systems—originally designed for much lower demand—have become inadequate *in the face of rapidly growing industrial consumption. These systems frequently fail or suffer voltage instability, disrupting operations and damaging equipment.*

Informants also pointed to frequent repair work, damaged cables, poor maintenance, and ineffective coordination within the utility as major contributors to prolonged and unscheduled outages. Even industrial zones, which are expected to have more robust service, experience issues such as low voltage and feeder-related disruptions, often pushing businesses to rely on expensive backup generators to maintain continuity.

Further compounding the issue is Nepal's dependence on electricity imports from India, which interviewees described as inconsistent and unreliable, particularly during periods of high domestic demand or geopolitical tension.

While natural hazards such as storms occasionally damage transmission lines, interviewees agreed that these are less frequent and less damaging than the persistent systemic and operational challenges that define the current state of Nepal's electricity infrastructure.

6.18: Satisfaction with Electricity Usage

Satisfaction with electricity usage across various sectors, industries, and regions reflects a wide range of experiences. On a scale of 0 to 10, with 0 being highly dissatisfied and 10 being highly satisfied, the overall satisfaction scores for the availability and regularity of electricity (5.95) and the technical quality of the supply (5.55) are moderate. However, satisfaction with affordability is notably lower (4.94), indicating concerns about pricing, while satisfaction with support services is also relatively low (5.09).

Among sectors, Information and Communication stood out with the highest rating for availability (7.54) and technical quality (6.00), but showed lower satisfaction with affordability (4.31). On the other hand, Other Service Activities consistently rated satisfaction lowest across all dimensions, particularly for support services (1.50). By industry size, large and cottage industries expressed relatively higher satisfaction with availability and technical quality, whereas micro industries rated affordability (5.20) higher than other dimensions. Geographically, Kathmandu emerged as the most satisfied cluster, especially for availability (7.67) and technical quality (7.41), while Nepalgunj-Kohalpur expressed significant dissatisfaction, with all dimensions rated below 4.

Table 6.18: *Satisfaction with Electricity Usage Across Sectors, Industries, and Regions [N = 614]*

		Satisfaction with the Availability and Regularity of Electricity	**Satisfaction with the Technical Quality of Electricity Supply**	**Satisfaction with the Affordability of Electricity**	**Satisfaction with Electricity Support Services**
	Overall	5.95	5.55	4.94	5.09
Sector	Agriculture, forestry, and fishing	6.16	5.36	5.49	5.27
	Manufacturing	5.95	5.82	5.06	5.17
	Accommodation & food service activities	5.51	4.80	4.51	5.26
	Information and communication	7.54	6.00	4.31	5.46
	Human health and social work activities	5.66	5.98	4.80	4.46
	Financial and insurance activities	6.89	5.93	5.32	4.93
	Wholesale and retail trade activities	5.80	4.90	4.33	3.67
	Other service activities	3.50	3.00	3.50	1.50
Size	Large industry	6.18	5.58	4.83	5.08
	Medium industry	5.91	5.70	4.87	5.42
	Small industry	5.91	5.44	4.98	4.89
	Cottage industry	6.23	5.96	4.77	4.79
	Micro industry	5.60	5.27	5.20	5.34
Cluster	Biratnagar-Itahari	6.60	6.35	4.96	5.36
	Birgunj-Pathlaiya	6.04	5.92	5.02	4.25
	Kathmandu	7.67	7.41	5.37	6.77
	Pokhara	6.20	5.34	5.14	5.78
	Bhairahawa-Butwal	5.98	5.31	5.08	5.40
	Nepalgunj-Kohalpur	3.20	2.96	4.08	3.00

CHAPTER 7: ENERGY PRICING AND WILLINGNESS TO PAY

7.1. Prevalence of Time-of-Day (ToD) Differential Tariff Mechanisms for Electricity Usage

The survey findings illustrate the differential tariff mechanism for electricity across various sectors, industry sizes, and geographic clusters. Overall, 23.3% of establishments report paying different tariffs for electricity usage during different times of the day (ToD), while 74.9% do not have such a mechanism in place. Among sectors, manufacturing industries (35.5%) report the highest prevalence of differential tariffs, followed by human health and social work activities (22.0%). In contrast, the information and communication sector (7.7%) and financial and insurance activities (3.6%) exhibit very low adoption of ToD-based tariffs. Large industries are most likely to pay differential tariffs (48.0%), whereas cottage industries (1.4%) and micro-industries (1.0%) rarely do so. Regionally, the Biratnagar-Itahari cluster leads in adopting ToD-based tariffs (41.6%), whereas Bhairahawa-Butwal and Kathmandu show much lower adoption rates, with adoption by 18.0% and 13.9% of establishments, respectively. Across all categories, a small fraction of respondents are either unaware of the tariff system or rely on third parties to handle billing.

Table 7.1: *What is the pricing mechanism of the electricity used by this establishment? Does this establishment pay a differential tariff rate for the electricity used at different time of the day (ToD)? [N = 614]*

		Yes, tariff rates are different for different ToD	No, it doesn't have a differential tariff rate	DON'T KNOW (BILLS PAID BY OWNERS OR FACILITY PROVIDERS)	DON'T KNOW (SPON-TANEOUS)
	Overall	23.3%	74.9%	0.5%	1.3%
Sector	Agriculture, forestry, and fishing	11.1%	86.7%	0.0%	2.2%
	Manufacturing	35.5%	63.5%	0.3%	0.6%
	Accommodation & food service activities	10.4%	88.1%	0.0%	1.5%
	Information and communication	7.7%	92.3%	0.0%	0.0%
	Human health and social work activities	22.0%	73.2%	0.0%	4.9%
	Financial and insurance activities	3.6%	91.1%	3.6%	1.8%
	Wholesale and retail trade activities	20.0%	80.0%	0.0%	0.0%
	Other service activities	0.0%	100.0%	0.0%	0.0%
Size	Large industry	48.0%	49.6%	0.0%	2.4%
	Medium industry	35.5%	63.6%	0.9%	0.0%
	Small industry	20.2%	77.4%	0.5%	1.9%
	Cottage industry	1.4%	97.2%	1.4%	0.0%
	Micro-industry	1.0%	98.0%	0.0%	1.0%

Cluster	Biratnagar-Itahari	41.6%	55.4%	0.0%	3.0%
	Birgunj-Pathlaiya	27.1%	71.0%	0.9%	0.9%
	Kathmandu	13.9%	85.1%	0.0%	1.0%
	Pokhara	18.3%	78.8%	1.0%	1.9%
	Bhairahawa-Butwal	18.0%	80.0%	1.0%	1.0%
	Nepalgunj-Kohalpur	20.8%	79.2%	0.0%	0.0%

7.2. Electricity Tariff Rates per Unit (NPR) by Time of Use

The table illustrates the electricity rates per unit in Nepal, categorized by time (peak, off-peak, and normal hours) and average rates across various sectors, industry sizes, and geographic clusters. The overall rate during peak time is NPR 11, off-peak time NPR 8, normal hours NPR 7, with an average rate of NPR 11. Among sectors, accommodation and food service activities, financial and insurance activities, and human health and social work activities report the highest average rate of NPR 12. Wholesale and retail trade activities exhibit the highest rate of NPR 13. By size, large, medium, and small industries have a consistent average rate of NPR 11, whereas micro-industries show a slightly higher average of NPR 12, and cottage industries maintain an average of NPR 11. Regarding clusters, most areas like Kathmandu, Pokhara, and Nepalgunj-Kohalpur align with the overall average of NPR 11, with Biratnagar-Itahari being slightly lower at NPR 10.

Table 7.2: *Electricity Tariff Rates per Unit (NPR) by Time of Use Across Sectors, Industry Sizes, and Regional Clusters*

		Rate of per unit of electricity during ……… (NPR)			
		Peak time	Off-peak time	Normal hours	Average rate
Overall		11	8	7	11
Sector	Agriculture, forestry, and fishing	11	8	7	10
	Manufacturing	11	8	7	10
	Accommodation & food service activities	11	10	8	12
	Information and communication	11	9	6	11
	Human health and social work activities	11	9	7	12
	Financial and insurance activities	12	10	8	12
	Wholesale and retail trade activities	11	9	6	13
	Other service activities				13
Size	Large industry	11	8	7	11
	Medium industry	11	8	8	11
	Small industry	11	8	7	11
	Cottage industry	10	5	9	11
	Micro-industry	10	8	9	12
Cluster	Biratnagar-Itahari	11	9	6	10
	Birgunj-Pathlaiya	10	6	8	11
	Kathmandu	11	8	9	11
	Pokhara	10	8	8	11
	Bhairahawa-Butwal	11	7	7	11
	Nepalgunj-Kohalpur	11	9	7	11

7.3. Anticipated Increase in Electricity Consumption with Reliable Supply

All establishments were posed a hypothetical question: If this establishment were to gain access to additional reliable electricity, would you, the management, or the technical team expect an increase in electricity consumption as a result. The survey data reveals that 59% of establishments overall anticipate consuming more electricity if reliable and uninterrupted supply becomes available, while 41% do not expect increased consumption.

Among sectors, other service activities (75.0%) and manufacturing (62.3%) have the highest proportion of establishments projecting increased usage, whereas information and communication (46.2%) and wholesale and retail trade activities (30.0%) show lower demand for additional consumption. By size, large industries (67.2%) are the most likely to consume more electricity, followed by medium (62.7%) and small industries (62.5%), while cottage (45.8%) and micro-industries (46.5%) are less inclined. Regionally, Nepalgunj-Kohalpur (82.2%) and Birgunj-Pathlaiya (73.8%) show the strongest potential for increased consumption, while Bhairahawa-Butwal (32.0%) and Kathmandu (37.6%) exhibit the least interest in additional electricity usage, even if it is reliable.

Table 7.3: *If this establishment has access to additional electricity that is reliable, would you or the management or the technical team anticipate the establishment consuming more electricity as a result? [N =614]*

		Yes, it will consume more electricity if reliable	No, it will not consume more electricity even if reliable
Overall		59.0%	41.0%
Sector	Agriculture, forestry, and fishing	62.2%	37.8%
	Manufacturing	62.3%	37.7%
	Accommodation & food service activities	57.8%	42.2%
	Information and communication	46.2%	53.8%
	Human health and social work activities	58.5%	41.5%
	Financial and insurance activities	48.2%	51.8%
	Wholesale and retail trade activities	30.0%	70.0%
	Other service activities	75.0%	25.0%
Size	Large industry	67.2%	32.8%
	Medium industry	62.7%	37.3%
	Small industry	62.5%	37.5%
	Cottage industry	45.8%	54.2%
	Micro-industry	46.5%	53.5%
Cluster	Biratnagar-Itahari	72.3%	27.7%
	Birgunj-Pathlaiya	73.8%	26.2%
	Kathmandu	37.6%	62.4%
	Pokhara	54.8%	45.2%
	Bhairahawa-Butwal	32.0%	68.0%
	Nepalgunj-Kohalpur	82.2%	17.8%

KIIs have provided further insights into the underlying reasons for these responses. Willingness to consume more electricity depends not only on the availability and reliability of the supply but also on contextual factors such as: affordability, necessity for core operations, overall financial condition and market demand for the product or service.

The KIIs highlighted that given the current economic downturn, many industries face limited or declining market demand, which significantly affects their production planning. As one large-scale industry representative stated: "The main factor is the economy. Our demand has dropped by 50–60%, and I'm even considering reducing labor. If demand returns to previous levels, I'd definitely use more electricity. But for now, I'm not planning to invest in anything new."

This perspective was echoed by several other industries, which emphasized that reliable and affordable electricity would be beneficial—particularly to minimize losses from downtime and production inefficiencies—but noted that without sufficient demand, investing in increased consumption does not make sense business sense.

Additionally, combination of economic uncertainty, financial stress, and institutional inertia are often the cited reasons behind the establishments not willing to increase electricity use, even it became reliable.

Some industries have become so accustomed to operate under constrained condition that they are resistant to change. One medium-sized enterprise explained: "During load shedding, despite facing significant hardships, we managed with what we had. This situation is much better compared to that time." underscoring the inclination not to change.

Furthermore, knowledge gaps and perceptions of reliability play a role. Some informants indicated a lack of awareness or understanding of how improved electricity services could enhance operations. In these cases, the perceived value of additional reliable electricity is low, especially when set against tight operational margins.

7.4. Utilization of reliable electricity

In addition to quantitative data, an open-ended question was asked to establishments that anticipated increased electricity consumption if supply became reliable. inquiring how they would utilize the additional electricity. When asked how they would use the additional electricity, the majority reported plans to add or upgrade machinery, aiming to enhance production, boost productivity, and improve customer service.

Reliable electricity was seen as a key driver for operational modernization, cost reduction, and efficiency gains. Interestingly, these responses were consistent across regions and scales.

Many businesses, regardless of their scale, indicated plans to utilize reliable electricity either for production increase or business expansion. Large and medium-sized industries, in particular, emphasized that they would invest in advanced machinery and expand product lines to boost their production capacity. A few businesses also saw reliable electricity as an opportunity to transition toward more energy-efficient and electric alternatives, such as replacing diesel-powered equipment with electric machinery.

In the accommodation and food services sector, the majority of businesses—large, medium and small—expressed interest in transitioning from LPG gas to electric stoves and other electric appliances. Remarkably, a majority of businesses in warmer regions such as Nepalgunj and Bhairahawa, along with those in tourist hubs like Pokhara, mentioned plans to install air conditioning and heating/cooling systems to enhance customer service. They also highlighted intentions to expand storage for perishable items by installing refrigerators.

Similarly, industries in the agriculture, forestry, and fishing sectors across all regions mentioned that reliable electricity would enable them to adopt more advanced equipment such as milk processing machines, grass cutters, water pumps, and cow dung drying machines. The majority of large and medium industries also expressed interest in business growth and expansion. In contrast, small, micro, and cottage industries emphasized plans to improve facilities in areas such as dairy production, irrigation, vegetable farming, and animal husbandry, including chick production, fish farming, and feed storage systems.

In the construction and manufacturing sectors, larger industries indicated that they would invest in technology-driven plants and expand business facilities, factories, or production areas to boost production capacity and streamline operations. Some also noted that they would replace diesel-powered systems with energy-efficient alternatives. The finance and insurance sectors**,** indicated plans to upgrade office infrastructure with better computers, lighting, air conditioning systems and other electric equipment.

In the health and social services sector, larger businesses expressed that they would utilize reliable electricity to operate essential medical equipment, such as X-ray units, and blood-testing systems, to improve healthcare services. Meanwhile, small, medium, and micro enterprises stated that they would use reliable electricity to add or upgrade vital equipment, technology and infrastructure, such as refrigerators for vaccine storage, air conditioning, and enhanced lighting to improve service delivery.

Lastly, the information and communication sector mentioned plans to utilize reliable electricity to expand their service areas while reducing reliance on diesel and petrol, thereby optimizing operational costs and efficiency.

7.5. Willingness to Pay Additional Amount for Reliable Electricity (Percentage of Current Average Rate)

Industries expressing willingness (59.0%) to use additional reliable electricity, if available, were further asked how much the management would be willing to pay per unit for this additional electricity. The willingness of establishments to pay an additional amount for more reliable electricity, expressed as a percentage of the current average rate, varies across sectors, sizes, and clusters. Overall, establishments are willing to pay 4% more for reliable electricity. Among sectors, other service activities show the highest willingness (9%) followed by the Information and Communication sector (6%), Manufacturing (5%), and accommodation and food service activities, human health and social work activities (4%) while Financial and Insurance activities are the least willing at 2%. By size, Small and Cottage industries exhibit the highest willingness at 5%, whereas Micro-industries are at 3%. Across clusters, Birgunj-Pathlaiya demonstrates the greatest willingness at 8%, followed by Kathmandu at 6% and Pokhara at 5%, while Bhairahawa-Butwal shows the least interest at just 1%. These findings highlight variations in the perceived value of electricity reliability among different economic segments.

Table 7.5: *If electricity were to become more reliable (i.e., with no power outages/load shedding and with desired voltage), how much additional amount would the management be willing to pay for per unit of electricity? [N = 362]*

		Average percentage more compared to current prices
Overall		4
Sector	Agriculture, forestry, and fishing	3
	Manufacturing	5
	Accommodation & food service activities	4
	Information and communication	6
	Human health and social work activities	4
	Financial and insurance activities	2
	Wholesale and retail trade activities	3
	Other service activities	9
Size	Large industry	4
	Medium industry	4
	Small industry	5
	Cottage industry	5
	Micro-industry	3
Cluster	Biratnagar-Itahari	4
	Birgunj-Pathlaiya	8
	Kathmandu	6
	Pokhara	5
	Bhairahawa-Butwal	1
	Nepalgunj-Kohalpur	3

For articulating the conditions behind this willingness to pay (59.0%), key informant interviews provided valuable context. According to the interviews, industries are more likely to invest in reliable electricity only if it is critical to their operations and contributes significantly to production efficiency.

For instance, industries such as plastic molding, which depend on temperature-sensitive processes, reported suffering substantial losses during power outages. These industries indicated a strong interest in adopting reliable and cost-effective electricity supplied by the Nepal Electricity Authority (NEA), as it would help enhance productivity and reduce financial losses from unscheduled outages.

Similarly, a manufacturing firm stated that with a guarantee of uninterrupted electricity, they would willingly pay more. As one industry representative remarked: "The amount we lose could be offset by paying just 5–10% more."

Industry informants that expressed willingness to increase usage were also asked how much extra per unit they would be willing to pay. Many responses fell within the additional 5–10% range, suggesting a clear trade-off between reliability and affordability.

However, it is important to note that some small-scale industries remained hesitant, either directly or implicitly, to commit to paying higher rates—even for guaranteed reliable supply—due to ongoing financial constraints and uncertainty in their operating environment.

While reliability is highly valued, capacity and willingness to pay vary depending on industry size, production sensitivity, and current economic conditions.

7.6. Reasons for Not Increasing Electricity Consumption Despite Reliable Supply

Among establishments (41.0%) that would not consume additional electricity even if the supply were reliable, the primary reason cited was that their current energy consumption meets all operational needs, accounting for 86.0% of responses. Budget constraints were the second most common factor, preventing increased electricity usage for 15.2% of establishments. Environmental or sustainability goals and concerns about potential future price increases were each mentioned by 4.8% of respondents, while 4.4% expressed concerns about future unreliability of supply. Additionally, 3.6% of establishments noted that their current equipment and infrastructure setup restricts any additional electricity usage. These findings highlight operational adequacy and financial or infrastructural limitations as key reasons for stable energy consumption.

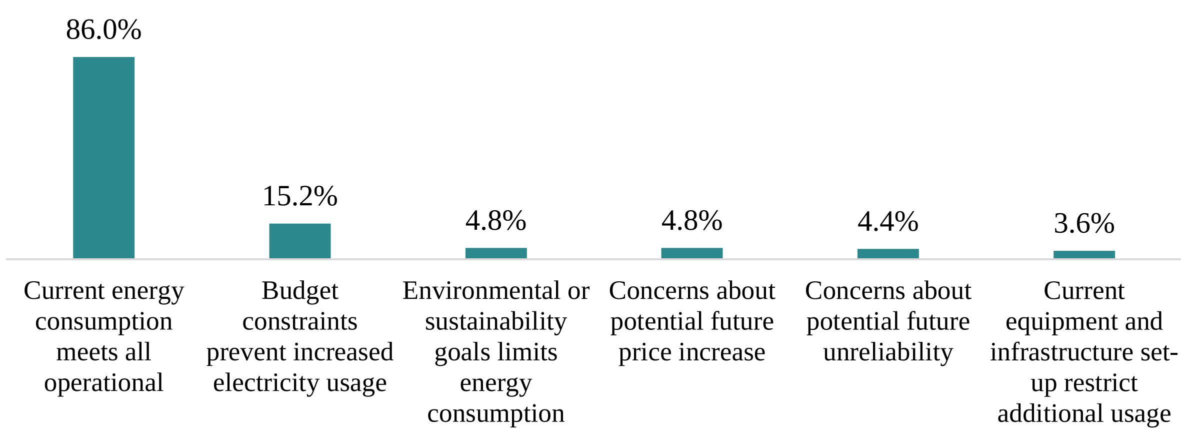


Figure 7.6: *Why would this establishment not consume additional electricity even if the supply were reliable? [N = 252]*

The data highlights reasons why establishments across various sectors may not consume additional electricity, even if the supply were reliable. For most sectors, a high percentage of respondents indicated that their current energy consumption meets all operational needs, with wholesale and retail trade activities, as well as other service activities, showing a perfect 100%. Budget constraints also emerged as a limiting factor, notably impacting 23.5% of establishments in agriculture, forestry, and fishing, but much less so in financial and insurance activities (6.9%) and not at all in other service activities. Environmental or sustainability goals were cited in some sectors, with information and communication (14.3%) and human health and social work activities (11.8%) reporting notable influence. Concerns about potential future price increases and unreliability were relatively minor, while limitations related to current equipment and infrastructure were significant in agriculture, forestry, and fishing (11.8%) but minimal in other sectors. Finally, energy-efficient practices had been implemented by certain establishments, particularly in wholesale and retail trade activities (14.3%) and manufacturing (7.1%), indicating a proactive approach to energy management in some areas.

The survey data reveals various reasons why establishments across different sizes would not consume additional electricity, even if the supply were reliable. For most industries, the main reason is that current energy consumption is sufficient for their operational needs, with large industries reporting 79.5% and medium industries at 90.2%. Budget constraints are more significant in smaller establishments, particularly cottage industries (25.6%) and micro-industries (20.8%), where financial limitations prevent increased electricity usage. Environmental or sustainability goals play a minor role, with large industries showing the highest percentage (10.3%) of establishments limiting energy consumption for these reasons. Concerns about potential future price increases are most pronounced in large industries (12.8%), while smaller industries such as micro-industries (1.9%) show less concern. Similarly, concerns about the future unreliability of the supply are a factor for large industries (7.7%) but are less significant for micro-industries (1.9%). Lastly, infrastructure limitations are a minor issue overall, with medium industries reporting no restrictions, while small and micro-industries show small percentages of establishments (3.8% and 5.7%, respectively) impacted by infrastructure constraints.

The survey data reveals a variety of reasons why establishments in different clusters would not consume additional electricity, even if the supply were reliable. In most clusters, the primary reason is that current energy consumption meets all operational needs, with Nepalgunj-Kohalpur (100%) and Birgunj-Pathlaiya (96.3%) having the highest percentage of establishments reporting this. Budget constraints are a common barrier across all clusters, with Biratnagar-Itahari (17.9%) and Pokhara (19.1%) showing relatively higher concerns about financial limitations. Environmental or sustainability goals limiting energy consumption are more significant in Kathmandu (9.7%) and Birgunj-Pathlaiya (7.4%). Concerns about potential future price increases are most notable in Kathmandu (14.5%), while concerns about unreliability of the electricity supply are more prevalent in Biratnagar-Itahari (10.7%). Lastly, current equipment and infrastructure limitations restrict additional electricity consumption, especially in Nepalgunj-Kohalpur (16.7%) and Biratnagar-Itahari (7.1%).

The survey revealed that 41% of industries indicated unwillingness to consume additional electricity, even if a reliable supply were guaranteed. While this may initially appear counterintuitive in a context where uninterrupted electricity is critical for industrial operations, qualitative findings from Key Informant Interviews (KIIs) help understand this unwillingness.

Interviews with industry representatives revealed that cost remains a major barrier to increased electricity use. For instance, one industry mentioned that they would only consider increasing their consumption if the government introduced Time-of-Day (TOD) tariffs, particularly those offering lower nighttime rates. This reflects a broader concern about price sensitivity and marginal profitability, especially among small and medium enterprises.

Moreover, broader economic challenges were commonly cited. Many industries described a stagnant or shrinking market, marked by reduced domestic demand, shifting consumer preferences toward imported products, and financial instability in the aftermath of the COVID-19 pandemic. According to one large-scale industry, domestic demand has declined by an estimated 40–45%, due to both the outmigration of working-age populations and changes in consumption behavior favoring imported goods over locally produced products. For example, a large food processing industry reported a significant drop in demand for local Jeera Masino rice as consumers increasingly opt for long-grain rice imported from India.

These demand-side constraints have caused many industries to adopt a cautious approach to operational investment, with several informants noting that "the current electricity supply is already sufficient for existing production levels." In this context, expanding electricity use offers limited or no financial return.

Additionally, government policy priorities—particularly those focused on revenue collection and import facilitation rather than supporting local industries—were perceived as further barriers to industrial growth. A medium-scale enterprise explicitly noted that "investing in reliable electricity does not justify operational costs or lead to revenue growth under the current business climate."

Despite this hesitancy, some industries acknowledged that reliable electricity does hold value, with a few willing to pay 5–10% more if it meant avoiding financial losses caused by power outages—highlighting a cost-risk trade-off between reliability and affordability.

CHAPTER 8: ENERGY EFFICIENCY

8.1. Adoption of Energy Efficiency Measures Across Establishments

The survey data highlights the adoption of energy efficiency measures across various sectors, sizes, and clusters in Nepal. Overall, 43.5% of establishments reported implementing energy efficiency measures, while an equal percentage (43.5%) reported not adopting such practices. Interestingly, 13.0% of establishments believed energy efficiency measures were unnecessary.

Among sectors, human health and social work activities had the highest adoption rate (53.7%), followed closely by other service activities (50.0%), while information and communication and agriculture showed the lowest rates at 23.1% and 31.1%, respectively. In terms of size, large industries were the most proactive, with 61.6% adopting measures, compared to only 15.3% among cottage industries. Cluster-wise, Pokhara stood out with 78.8% adoption, significantly surpassing other clusters like Kathmandu (27.7%) and Biratnagar-Itahari (31.7%). The findings indicate a variation in energy efficiency adoption influenced by sectoral focus, scale of operation, and geographic location.

Table 8.1: *Has this establishment adopted energy efficiency measures to reduce energy consumption while maintaining or improving productivity? [N = 614]*

		Yes	No	Energy efficiency measures are not really required for this establishment (Spontaneous)
	Overall	43.5%	43.5%	13.0%
Sector	Agriculture, forestry, and fishing	31.1%	55.6%	13.3%
	Manufacturing	44.2%	43.5%	12.3%
	Accommodation & food service activities	45.9%	39.3%	14.8%
	Information and communication	23.1%	61.5%	15.4%
	Human health and social work activities	53.7%	41.5%	4.9%
	Financial and insurance activities	42.9%	41.1%	16.1%
	Wholesale and retail trade activities	30.0%	50.0%	20.0%
	Other service activities	50.0%	25.0%	25.0%
Size	Large industry	61.6%	33.6%	4.8%
	Medium industry	50.0%	40.9%	9.1%
	Small industry	46.2%	40.4%	13.5%
	Cottage industry	15.3%	55.6%	29.2%
	Micro-industry	28.3%	56.6%	15.2%
Cluster	Biratnagar-Itahari	31.7%	45.5%	22.8%
	Birgunj-Pathlaiya	38.3%	53.3%	8.4%
	Kathmandu	27.7%	57.4%	14.9%
	Pokhara	78.8%	14.4%	6.7%
	Bhairahawa-Butwal	35.0%	46.0%	19.0%
	Nepalgunj-Kohalpur	48.5%	44.6%	6.9%

8.2. Specific Energy Efficiency Measures Implemented by Establishments

Of the establishments that reported implementing energy efficiency measures (43.5%), further inquiries were made to determine the specific energy efficiency measures currently in place at these establishments. Regular maintenance of machinery and appliances is the most widely adopted measure, with 78.3% of establishments reporting its use. Behavioral and operational changes to increase awareness follow at 64.4%, demonstrating the importance of cultivating energy-conscious practices. Upgraded equipment and machinery are utilized by 59.6% of establishments, reflecting investment in modern and efficient technologies. However, less focus is observed on measures like energy-efficient lighting systems (25.5%), the use of renewable energy sources (16.5%), and periodic energy audits (15.0%). These findings indicate that while maintenance and awareness are prioritized, there is potential for greater adoption of advanced and renewable energy solutions.

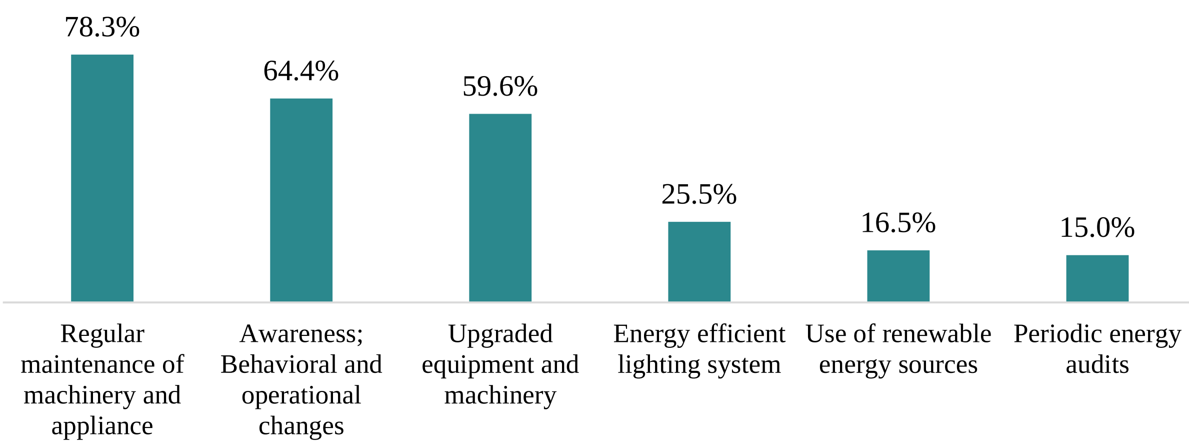


Figure 8.2: *Which specific energy efficiency measures are currently at place in this establishment? [N = 267]*

The data provides the insight into the adoption of energy efficiency measures across different sectors. Regular maintenance of machinery and appliances is the most commonly implemented measure, with near-universal adoption in the Information and Communication (100%), Wholesale and Retail Trade (100%), and Human Health and Social Work Activities (95.5%). Awareness initiatives, such as behavioral and operational changes, are also prevalent, with adoption rates ranging from 58.4% in Manufacturing to 100% in Information and Communication, and Other Service Activities. Upgraded equipment and machinery show varied adoption, with high implementation in Human Health and Social Work Activities (86.4%) but low rates in Accommodation and Food Service Activities (40.3%) and zero in Other Service Activities. The use of energy-efficient lighting systems is highest in Information and Communication (100%) but significantly lower in other sectors, such as Manufacturing (23.4%). Renewable energy sources and periodic energy audits are the least implemented measures, with minimal adoption across all sectors, particularly Wholesale and Retail Trade, and Other Service Activities, where both measures are absent. This indicates a sectoral disparity in the prioritization of energy efficiency measures.

The data highlights the implementation of energy efficiency measures across industries of different sizes. Regular maintenance of machinery and appliances is the most widely adopted practice, with micro-industries leading at 89.3%, followed by medium (80.0%) and small industries (80.2%). Awareness through behavioral and operational changes is fully implemented in cottage industries (100%), though micro-industries lag at 42.9%. Upgraded equipment and machinery is a key focus for large industries (77.9%) but is less common in micro-industries (25.0%) and cottage industries (27.3%). Adoption of energy-efficient lighting systems is limited across all sizes, with large industries at the forefront (32.5%). Similarly, the use of renewable energy sources is relatively low, ranging from 24.7% in large industries to just 7.1% in micro-industries. Periodic energy audits are the least adopted measure, with small uptake in large (20.8%) and medium industries (21.8%) but nearly absent in cottage (0.0%) and micro-industries (3.6%). These trends indicate that larger industries prioritize diverse energy efficiency measures, while smaller-scale industries focus more on cost-effective practices like maintenance and awareness.

The data illustrates the adoption of energy efficiency measures across different industrial clusters. Regular maintenance of machinery and appliances is highly practiced in clusters like Pokhara (87.8%), Biratnagar-Itahari (87.5%), and Bhairahawa-Butwal (80.0%), while Kathmandu lags behind at 53.6%. Upgraded equipment and machinery is widely implemented in Birgunj-Pathlaiya (95.1%) and Biratnagar-Itahari (87.5%), but adoption drops significantly in Nepalgunj-Kohalpur (38.8%) and Kathmandu (50.0%). Awareness through behavioral and operational changes is highest in Pokhara (87.8%), demonstrating a strong focus on behavioral adaptation in this region. Energy-efficient lighting systems show moderate adoption in Birgunj-Pathlaiya (56.1%) and Pokhara (25.6%) but are minimally used in other clusters, particularly Kathmandu (7.1%). The use of renewable energy sources remains limited overall, with the highest adoption seen in Pokhara (35.4%) and Kathmandu (25.0%). Periodic energy audits are inconsistently applied, with Birgunj-Pathlaiya leading at 34.1% and other clusters, like Kathmandu (3.6%), showing minimal usage. These findings reveal significant variations in energy efficiency practices across clusters, with some prioritizing equipment upgrades and behavioral changes, while others focus less on advanced or renewable solutions.

8.3. Adoption of Periodic Energy Monitoring and Audits

The data highlights the limited adoption of periodic energy monitoring and audits among establishments, with only 25.4% conducting these practices overall, while a significant majority (73.8%) do not.

This quantitative trend was also reflected during the industrial visits, where it was observed that only few industries had conducted regular energy audits, and some of them had even maintained detailed reports to support optimal energy efficiency. However, majority industries appeared unfamiliar with the concept and benefits of energy audits. Even among those that were aware, there was often hesitation to implement them due to concerns about additional costs. As a result, these industries tended to overlook the issue rather than take proactive measures to improve energy efficiency.

Sector-wise, financial and insurance activities (32.1%) and information and communication activities (30.8%) report the highest adoption rates, whereas agriculture, forestry, and fishing (11.1%) and wholesale and retail trade activities (20.0%) lag behind significantly. Across industry sizes, large industries demonstrate the highest engagement (49.6%), followed by medium industries (33.6%), while cottage (8.3%) and micro-industries (11.1%) show minimal involvement. Regional disparities are also evident, with Pokhara leading (53.8%) in conducting energy audits, contrasting starkly with Bhairahawa-Butwal (10.0%) and Nepalgunj-Kohalpur (10.9%). This indicates that smaller industries and certain sectors and clusters face barriers to adopting energy monitoring and auditing practices, suggesting the need for targeted interventions to promote energy efficiency.

Table 8.3: *Does this establishment conduct periodic energy monitoring and energy audits? [N = 614]*

		Yes	No	DON'T KNOW
	Overall	25.4%	73.8%	0.8%
Sector	Agriculture, forestry, and fishing	11.1%	88.9%	0.0%
	Manufacturing	24.8%	74.2%	1.0%
	Accommodation & food service activities	28.9%	70.4%	0.7%
	Information and communication	30.8%	61.5%	7.7%
	Human health and social work activities	26.8%	73.2%	0.0%
	Financial and insurance activities	32.1%	67.9%	0.0%
	Wholesale and retail trade activities	20.0%	80.0%	0.0%
	Other service activities	0.0%	100.0%	0.0%
Size	Large industry	49.6%	49.6%	0.8%
	Medium industry	33.6%	65.5%	0.9%
	Small industry	19.2%	80.8%	0.0%
	Cottage industry	8.3%	88.9%	2.8%
	Micro-industry	11.1%	87.9%	1.0%
Cluster	Biratnagar-Itahari	25.7%	74.3%	0.0%
	Birgunj-Pathlaiya	24.3%	73.8%	1.9%
	Kathmandu	26.7%	72.3%	1.0%
	Pokhara	53.8%	44.2%	1.9%
	Bhairahawa-Butwal	10.0%	90.0%	0.0%
	Nepalgunj-Kohalpur	10.9%	89.1%	0.0%

8.4. Investment in Energy Efficiency Improvements: Past and Planned Expenditures by Establishment Sector

The data on investments in energy efficiency improvements reveals a significant increase in planned investments over the next five years compared to the past five years. Overall, the total investment is expected to grow from NPR 2,568,611 to NPR 10,112,957. Among different sectors, human health and social work activities recorded the highest past investment of NPR 6,424,118, with a planned investment of NPR 18,882,273. The information and communication sector also shows a sharp rise, from NPR 475,000 to NPR 25,000,000. In terms of industry size, large industries have historically invested the most (NPR 6,052,244) and are expected to increase their spending to NPR 16,768,867. Medium and small industries also show significant growth in planned investments. Regionally, the Biratnagar-Itahari cluster has had the highest past investments (NPR 5,773,333) and plans to increase it to NPR 24,308,300. Other regions, such as Birgunj-Pathlaiya and Pokhara, also anticipate notable growth in energy efficiency investments. This trend highlights a growing emphasis on sustainability and efficiency improvements across various sectors and regions.

Table 8.4: *Investment in Energy Efficiency Improvements: Past and Planned Expenditures by Establishment Sector, Size, and Cluster [N = 614]*

		Investments made over the past five years [AMOUNT IN NPR]	Planned investments in coming five years [AMOUNT IN NPR]
	Overall	2,568,611	10,112,957
Sector	Agriculture, forestry, and fishing	681,667	2,568,889
	Manufacturing	3,350,537	15,169,595
	Accommodation & food service activities	1,048,545	2,154,800
	Information and communication	475,000	25,000,000
	Human health and social work activities	6,424,118	18,882,273
	Financial and insurance activities	308,423	260,000
	Wholesale and retail trade activities	869,333	
	Other service activities	525,000	2,500,000
Size	Large industry	6,052,244	16,768,867
	Medium industry	2,278,727	17,296,190
	Small industry	2,522,635	8,254,872
	Cottage industry	180,658	1,538,571
	Micro-industry	425,788	262,917
Cluster	Biratnagar-Itahari	5,773,333	24,308,300
	Birgunj-Pathlaiya	4,502,852	16,580,000
	Kathmandu	2,480,217	1,607,500
	Pokhara	1,760,001	8,475,152
	Bhairahawa-Butwal	2,173,860	4,350,000
	Nepalgunj-Kohalpur	721,875	2,400,000

8.5. Area of Investment on Energy Efficiency by Industries

An open-ended question was posed to establishments that had invested in improving energy efficiency, asking them to identify the areas where these investments were made and how they compared to previous conditions. Investment areas varied across sectors, with cottage, small, and micro industries often reporting little to no investment, mainly due to financial constraints or limited awareness. In contrast, most large and medium industries cited significant investments in new machinery and equipment upgrades aimed at reducing energy use and improving productivity.

However, a small portion of larger industries also indicated they had not made any such investments yet.

In the accommodation and food services sector, maximum number of larger industries focused on business expansion and diversification, investing in amenities like spas, casinos, and swimming pools, water park, and laundry. Other large and medium-sized industries focused on investing in essential equipment, such as air conditioning units, refrigerators, washing machines, inverters, voltage stabilizers, and energy solutions, with some also expanding its business by opening new hotel branches. Micro, small, and cottage industries mainly invested in hotel renovations, upgrading air conditioning systems, installing inverter batteries, Fan, new refrigerators and improving kitchen services. Notably, a hotel in Kathmandu highlighted its investment in solar energy.

In the agriculture, forestry, and fishing industries, investment in new machinery and equipment was a common trend across all regions. Large and medium industries invested in equipment such as fans, heaters, grass-cutting machines, and meter boxes. While, micro, small, and cottage industries focused on acquiring new machinery and making upgrades, including grass cutting machines, feed production machines, fans, heaters, inverter batteries, lighting, and wiring. Additionally, some small and cottage industries reported investments in business expansion and diversification, including vegetable and fruit production, buffalo farming, and fish farming.

In the construction sector, most small, cottage, and micro-industries concentrated on investing in new machinery, as well as repairs, upgrades, and maintenance activities. This included machinery upgrades in the concrete industry, generator repairs, and maintenance of electrical equipment. However, one medium-sized industry reported channeling its investment into expanding its housing construction business.

In the manufacturing sector, nearly half of the large and medium industries either did not responded or reported no investments. Among the rest, most invested in new and upgraded machinery, such as animal feed elevators, drying machines, automatic systems, steamers, and grinders, along with repairs to existing machinery/equipment. Some also invested in electrical and energy-related items like generators, batteries, transformers, microwaves, and meters. Whereas, majority of micro and small industries focused on upgrading machinery, including electric sewing machines and weighing machines, while repairing existing equipment like generators. Additionally, a small industry in Birgunj invested in stabilizers and preventers to prevent damage caused by voltage fluctuation. A few small and cottage industries also reported investments in expanding and diversifying their businesses.

In the financial and insurance sector, investments across all types of industries appeared similar, with a focus on office equipment and technology such as printers, computers, inverter batteries, fans, lights, AC units, and other electronic devices. Notably, a small industry also reported purchasing a new bike for official use.

In the human health and service sector, small, micro, and cottage industries reported investments in medical equipment such as pressure monitors, weight scales, blood testing equipment, and voltage stabilizers. Larger and medium industries, on the other hand, invested in advanced equipment like autoclaves and operation theaters, along with office essentials such as lighting, inverter batteries, transmitters, cables, and computers. One medium scale hospital reported expanding its services into cardiology, dental, and skin care.

Large and medium industries in the information and communication sector reported investments in office equipment, including improved lighting for TV stations, additional laptops, and other office technology and equipment, while other reported negligible or no investment.

8.6. Economic and Financial barriers

Establishments were also surveyed regarding economic, informational, technical, and institutional barriers that could hinder their adoption of energy efficiency measures and practices. Their perceptions were assessed on a scale from 0 to 4, where 0 indicated no barrier and 4 represented the highest level of barrier.

Economic and financial barriers to the introduction of energy efficiency measures vary across sectors, industry sizes, and geographical locations.

Energy efficiency improvements in industries face several barriers, including high upfront investment requirements, higher costs of capital, and lower returns compared to other investment areas. These challenges are further exacerbated by the perception that energy savings are not a priority since energy costs constitute only a small fraction of total production costs. Overall, the survey indicates moderate concerns across sectors, with average ratings of 2.42 for high investment requirements, 2.63 for capital cost, 2.17 for lower returns, and 2.16 for energy prioritization. Among sectors, manufacturing, accommodation and food services, and information and communication expressed relatively higher concerns about these barriers compared to wholesale and retail trade, which reported the lowest ratings across the board. Industry size also influences perceptions, with smaller industries, including cottage and micro-industries, reporting higher barriers, particularly regarding investment costs and returns. Geographically, clusters like Kathmandu and Biratnagar-Itahari exhibited the highest levels of concern, while Birgunj-Pathlaiya and Pokhara reported significantly lower ratings. This variation underscores the diverse challenges faced across sectors, sizes, and regions in addressing energy efficiency improvements.

Table 8.6: *Barriers to Energy Efficiency Implementation Across Sectors, Industry Sizes, and Regions [N = 614]*

		High upfront investment requirement for energy efficiency improvement.	Higher cost of capital and higher interest rate	Lower returns on investment because investments made on other areas generate higher returns than that made on energy efficiency	Energy savings is not a priority because energy cost is only a small fraction of total production costs.
Overall		2.42	2.63	2.17	2.16
Sector	Agriculture, forestry, and fishing	2.13	2.53	2.11	2.34
	Manufacturing	2.52	2.69	2.18	2.26
	Accommodation & food service activities	2.43	2.70	2.26	2.04
	Information and communication	2.46	2.62	2.62	1.92
	Human health and social work activities	2.39	2.73	2.20	2.24
	Financial and insurance activities	2.20	2.23	1.88	1.88
	Wholesale and retail trade activities	1.80	2.00	1.50	1.80
	Other service activities	2.25	3.50	2.25	2.25
Size	Large industry	2.03	2.34	1.85	2.04
	Medium industry	2.15	2.52	2.10	2.08
	Small industry	2.61	2.68	2.15	2.11
	Cottage industry	2.66	3.07	2.41	2.30
	Micro-industry	2.64	2.70	2.51	2.43
Cluster	Biratnagar-Itahari	2.87	2.87	3.03	3.21
	Birgunj-Pathlaiya	1.75	2.27	1.31	1.58
	Kathmandu	3.03	3.15	2.57	2.47
	Pokhara	2.18	2.33	1.83	1.70
	Bhairahawa-Butwal	2.31	2.51	1.90	1.79
	Nepalgunj-Kohalpur	2.40	2.68	2.40	2.27

8.7. Information barriers

The information-related barriers to implementing energy efficiency measures primarily revolve around a lack of awareness, difficulties in obtaining necessary information, and insufficient experience or confidence in energy efficiency practices.

The data highlights various barriers related to energy efficiency adoption, including lack of awareness, difficulty obtaining information, and lack of experience or confidence in implementing energy-efficient measures. On average, these challenges scored 2.18, 2.20, and 2.07, respectively, on a scale indicating moderate concern. Sector-wise, agriculture, forestry, and fishing report higher levels of difficulty and lack of awareness compared to financial and insurance activities, which showed the lowest concern. Cottage and micro-industries face significant challenges due to limited awareness and confidence, scoring 2.56 and 2.30 in these categories. Geographically, Biratnagar-Itahari reported the highest concern across all categories, while Pokhara consistently recorded the lowest ratings, reflecting regional disparities in energy efficiency awareness and experience. Overall, the data underscores the need for targeted interventions to enhance awareness and build capacity, particularly in high-need regions and smaller industries.

Table 8.7: *Information Barriers to Energy Efficiency Implementation Across Sectors, Industry Sizes, and Regions [N = 614]*

		Lack of awareness of the availability and benefits of using energy efficient technologies and devices.	Difficulties in obtaining necessary information on energy efficient technologies and devices.	Lack of experience and/or confidence in energy efficiency measures.
Overall		2.18	2.20	2.07
Sector	Agriculture, forestry, and fishing	2.42	2.47	2.33
	Manufacturing	2.32	2.31	2.20
	Accommodation & food service activities	1.99	1.93	1.79
	Information and communication	2.00	2.15	2.08
	Human health and social work activities	2.12	2.20	1.95
	Financial and insurance activities	1.80	2.04	1.88
	Wholesale and retail trade activities	1.90	1.90	2.30
	Other service activities	2.50	2.50	2.50
Size	Large industry	1.98	2.01	1.84
	Medium industry	2.16	2.18	2.04
	Small industry	2.18	2.19	2.00
	Cottage industry	2.56	2.38	2.43
	Micro-industry	2.20	2.32	2.30
Cluster	Biratnagar-Itahari	3.26	3.27	3.09
	Birgunj-Pathlaiya	1.55	1.56	1.61
	Kathmandu	2.22	2.18	2.30
	Pokhara	1.47	1.40	1.35
	Bhairahawa-Butwal	1.91	1.99	1.71
	Nepalgunj-Kohalpur	2.74	2.83	2.44

8.8. Technical barriers

Technical barriers to implementing energy efficiency measures focus on the lack of skilled personnel, limited local supplies for equipment parts, the need for reconfiguration of production processes, and the risk of malfunction or poor performance disrupting operations.

The data highlights key challenges associated with adopting energy efficiency measures, including the lack of skilled personnel, delays due to limited local supply chains for equipment parts, substantial reconfiguration of production processes, and potential risks of malfunction or disruption in production. On average, these concerns scored 2.18, 2.39, 2.40, and 2.39, respectively, indicating moderate overall concern. Sector-wise, manufacturing and human health and social work activities reported higher challenges related to reconfiguration and equipment delays, while wholesale and retail trade activities highlighted significant concerns about skilled personnel (3.00). Cottage industries faced the highest barriers among size categories, particularly regarding reconfiguration (2.66) and equipment delays (2.64). Geographically, Biratnagar-Itahari reported the most severe challenges across all factors, scoring over 3.0 in all categories, whereas Birgunj-Pathlaiya consistently reported the lowest concerns. The findings underscore the need for capacity-building programs, robust local supply chains, and technical support to mitigate these barriers, especially in high-risk regions and smaller-scale industries.

Table 8.8: *Technical Barriers to Energy Efficiency Across Sectors, Industry Sizes, and Regions. [N = 614]*

		Lack of skilled personnel to handle the efficient devices and processes.	Lack of local supplies for equipment parts and long wait times to get equipment parts from abroad.	Installing energy efficiency measures requires substantial reconfiguration of production processes.	There are higher probability of malfunction or poor perfo-rmance. Production process could be disrupted.
Overall		2.18	2.39	2.40	2.39
Sector	Agriculture, forestry, and fishing	2.56	2.27	2.20	2.41
	Manufacturing	2.22	2.54	2.53	2.49
	Accommodation & food service activities	2.03	2.22	2.22	2.34
	Information and communication	1.85	2.33	2.08	2.15
	Human health and social work activities	2.34	2.46	2.51	2.41
	Financial and insurance activities	1.78	1.98	2.25	2.02
	Wholesale and retail trade activities	3.00	2.22	2.10	2.10
	Other service activities	2.00	2.75	2.75	2.75

Size	Large industry	1.88	2.26	2.36	2.24
	Medium industry	1.97	2.39	2.33	2.26
	Small industry	2.32	2.45	2.35	2.44
	Cottage industry	2.38	2.64	2.66	2.49
	Micro-industry	2.33	2.26	2.44	2.53
Cluster	Biratnagar-Itahari	3.12	3.22	3.24	3.19
	Birgunj-Pathlaiya	1.38	1.55	1.63	1.75
	Kathmandu	2.28	2.66	2.81	2.68
	Pokhara	1.84	2.07	1.60	2.17
	Bhairahawa-Butwal	1.92	2.28	1.95	1.87
	Nepalgunj-Kohalpur	2.56	2.59	3.21	2.72

8.9. Institutional barriers

Institutional barriers to adopting energy efficiency measures are primarily related to compliance complexities, government policies, and uncertainty about the future of industries.

The data reveals significant challenges in adopting energy efficiency measures, particularly due to high compliance requirements, complex permitting processes, lack of effective government policies, informal payment demands for permits, insufficient legal protection of property rights, and uncertainty about the industry's future. On average, these issues scored 2.32, 2.73, 2.51, 2.47, and 2.75, respectively, with government policy and industry uncertainty being the most critical concerns. Among sectors, "other service activities" reported the highest challenges, especially regarding government policy (3.50) and informal payments (3.00). Cottage industries faced pronounced issues, particularly in compliance (2.54) and informal payments (2.96), while large industries reported comparatively lower concerns. Geographically, Biratnagar-Itahari stood out as the most affected cluster, scoring above 3.0 across all parameters, while Birgunj-Pathlaiya reported the least challenges. Kathmandu also showed high uncertainty about the future of its industries (3.30). These findings highlight the need for streamlined permitting processes, robust policy frameworks, and measures to address corruption and property rights concerns to encourage energy efficiency adoption across sectors and regions.

Table 8.9: *Institutional Barriers to Energy Efficiency Implementation: Sectoral and Regional Perspectives. [N = 614]*

		High compliance and complex permitting process to employ energy efficient devices and process.	Lack of effective government policies to facilitate energy efficiency programs.	Unofficial/ Informal payments demanded to receive government permits.	The country lacks legal protection of property rights.	Uncertainty about the future of the overall industry/ sector.
Overall		2.32	2.73	2.51	2.47	2.75
Sector	Agriculture, forestry, and fishing	2.29	2.73	2.42	1.95	2.51
	Manufacturing	2.41	2.80	2.58	2.53	2.82
	Accommodation & food service activities	2.20	2.59	2.44	2.53	2.91
	Information and communication	1.62	2.92	2.42	2.38	2.54
	Human health and social work activities	2.51	2.90	2.54	2.54	2.66
	Financial and insurance activities	2.14	2.64	2.41	2.38	2.29
	Wholesale and retail trade activities	2.10	2.10	2.10	2.30	2.50
	Other service activities	2.75	3.50	3.00	2.67	2.50
Size	Large industry	2.14	2.69	2.42	2.24	2.32
	Medium industry	2.20	2.67	2.37	2.43	2.75
	Small industry	2.44	2.78	2.51	2.57	2.95
	Cottage industry	2.54	2.89	2.96	2.65	2.80
	Micro-industry	2.26	2.65	2.46	2.46	2.81
Cluster	Biratnagar-Itahari	3.19	3.41	3.29	3.16	3.18
	Birgunj-Pathlaiya	1.53	2.17	1.88	1.62	2.05
	Kathmandu	2.76	2.88	2.80	3.21	3.30
	Pokhara	1.88	2.50	2.24	2.09	2.63
	Bhairahawa-Butwal	1.97	2.22	1.92	2.65	2.71
	Nepalgunj-Kohalpur	2.62	3.26	2.96	2.13	2.66

CHAPTER 9: SHOCKS AND RESILIENCE

9.1. Impact of Shocks on Energy Needs and Usage of Establishments

The data indicates that 51.3% of establishments reported their energy needs and usage were affected by shocks – whether it be the 2015 earthquake, the 2015-2016 economic blockade by India, the COVID-19 pandemic, and the global price escalation due to the Ukraine-Russia war. Sector-wise, the highest percentage of affected establishments was in Information and Communication activities (61.5%), followed by Accommodation and Food Services (59.3%), and Manufacturing (54.2%). Conversely, sectors like Financial and Insurance activities (26.8%) and Wholesale and Retail Trade (30.0%) reported lower impacts, with Other Service activities reporting no impact at all. In terms of size, large industries (63.2%) and medium industries (61.8%) were more affected compared to cottage industries (22.2%) and micro-industries (35.4%). Geographically, Pokhara (65.4%) reported the highest impact, while Bhairahawa-Butwal (40.0%) and Nepalgunj-Kohalpur (43.6%) experienced less impact. This highlights variations in the degree of impact across sectors, sizes, and locations.

Table 9.1: *Does your establishment' energy needs and usage have affected from any kinds of shocks such as earthquake (2015), Economic Blockade by India in 2015 and 2016, COVID and the related shutdown in 2020-2021 and the escalation of global price due to Ukraine Russia war (2022-2023). [N = 614]*

		Yes	No
	Overall	51.3%	48.7%
Sector	Agriculture, forestry, and fishing	46.7%	53.3%
	Manufacturing	54.2%	45.8%
	Accommodation & food service activities	59.3%	40.7%
	Information and communication	61.5%	38.5%
	Human health and social work activities	48.8%	51.2%
	Financial and insurance activities	26.8%	73.2%
	Wholesale and retail trade activities	30.0%	70.0%
	Other service activities	0.0%	100.0%
Size	Large industry	63.2%	36.8%
	Medium industry	61.8%	38.2%
	Small industry	56.3%	43.8%
	Cottage industry	22.2%	77.8%
	Micro-industry	35.4%	64.6%
Cluster	Biratnagar-Itahari	54.5%	45.5%
	Birgunj-Pathlaiya	58.9%	41.1%
	Kathmandu	44.6%	55.4%
	Pokhara	65.4%	34.6%
	Bhairahawa-Butwal	40.0%	60.0%
	Nepalgunj-Kohalpur	43.6%	56.4%

9.2. Impact of Major Shocks on Establishments' Energy Needs and Usage

Approximately 51.3% of establishments that reported being affected were further asked about the types of shocks that affected their energy needs and usage.

The data reveals varying impacts of shocks on establishments' energy needs and usage. Overall, the 2015/2016 economic blockade by India had the highest impact, affecting 55.6% of establishments, followed by the COVID-19 pandemic (47.0%) and the escalation of global prices due to the Ukraine-Russia war (37.5%). The 2015 earthquake had the least impact at 22.2%. Sector-wise, the financial and insurance activities sector was most affected by the economic blockade (66.7%), while Information and Communication experienced the highest impact from global price escalation (62.5%). Agriculture, forestry, and fishing were heavily affected by the pandemic (57.1%) but less so by other shocks. By size, medium industries reported the highest impact from the economic blockade (60.3%) and pandemic (54.4%), while micro-industries faced significant challenges during the pandemic (62.9%). Regionally, Nepalgunj-Kohalpur was most impacted by the economic blockade (79.5%), whereas Kathmandu (35.6%) and Biratnagar-Itahari (38.2%) felt the effects of the earthquake more strongly. These findings underline the differing vulnerabilities across sectors, sizes, and regions to various shocks.

Table 9.2: *Which of the above-mentioned shocks have affected your establishment's energy needs and usages? [N = 315]*

		2015 Earth-quake	2015/2016 Economic blockade by India	Covid -19 pandemic and related shutdowns	Escalation of global prices due to Ukraine-Russia war
Overall		22.2%	55.6%	47.0%	37.5%
Sector	Agriculture, forestry, and fishing	4.8%	47.6%	57.1%	23.8%
	Manufacturing	28.0%	57.1%	44.0%	40.5%
	Accommodation & food service activities	10.0%	50.0%	55.0%	35.0%
	Information and communication	37.5%	37.5%	37.5%	62.5%
	Human health and social work activities	35.0%	70.0%	35.0%	40.0%
	Financial and insurance activities	26.7%	66.7%	46.7%	26.7%
	Wholesale and retail trade activities	0.0%	66.7%	33.3%	0.0%
	Other service activities	0.0%	0.0%	0.0%	0.0%
Size	Large industry	26.6%	59.5%	31.6%	36.7%
	Medium industry	19.1%	60.3%	54.4%	44.1%
	Small industry	25.6%	55.6%	48.7%	34.2%
	Cottage industry	12.5%	31.3%	43.8%	50.0%
	Micro-industry	11.4%	48.6%	62.9%	31.4%
Cluster	Biratnagar-Itahari	38.2%	16.4%	40.0%	47.3%
	Birgunj-Pathlaiya	25.4%	50.8%	54.0%	52.4%
	Kathmandu	35.6%	73.3%	42.2%	26.7%
	Pokhara	14.7%	67.6%	54.4%	41.2%
	Bhairahawa-Butwal	12.5%	50.0%	30.0%	42.5%
	Nepalgunj-Kohalpur	4.5%	79.5%	54.5%	4.5%

9.3. Impacts of Shocks on Establishments' Energy Supply and Usage

The survey also highlights the impact of various shocks on establishments' energy supply and usage. The data reveals that the most significant impact of various shocks on establishments' energy supply and usage was the increased price of fuel, affecting 67.9% of respondents. Energy shortages were also a major concern, reported by 51.2% of establishments. These disruptions contributed to broader operational challenges, including decreased production (37.0%), increased cost of goods and services (29.3%), and reduced or halted operations (28.9%). Additionally, 24.2% of establishments experienced disruptions in energy supply and overall operations. These findings highlight the pervasive and multifaceted effects of external shocks on energy-related aspects of business operations.

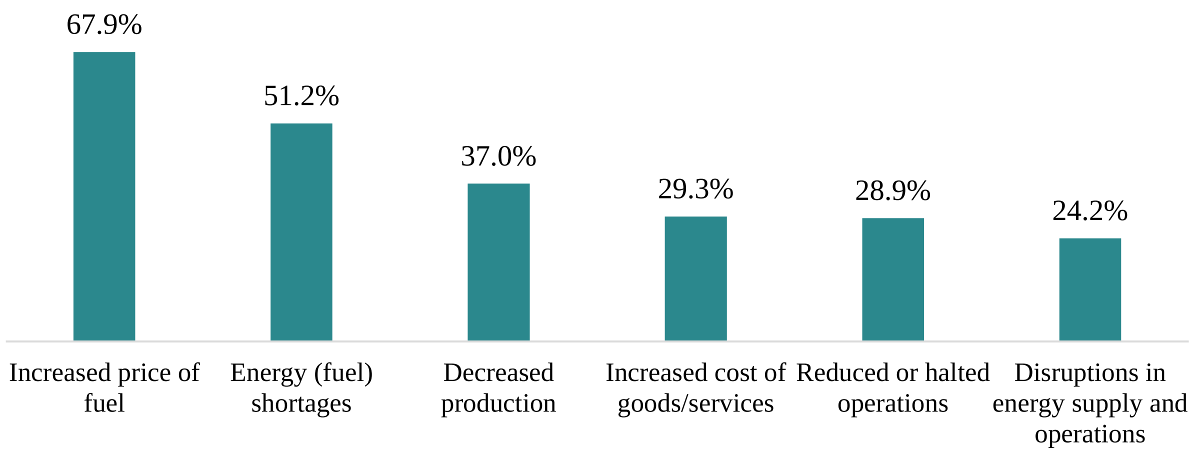


Figure 9.3: *How did these [shocks] impact your establishment's energy supply and usage? [N = 315]*

The impacts of shocks on energy supply and usage varied across sectors, with increased fuel prices being the most universally reported challenge, affecting over 65% of establishments in all sectors and reaching 100% in the Information and Communication sector. Energy shortages were also significant, particularly in Information and Communication (83.3%) and Wholesale and Retail Trade (60.0%). Decreased production was noted by 25% to 60% of establishments, with Wholesale and Retail Trade experiencing the highest impact (60.0%). The increased cost of goods/services was most prominent in the Information and Communication (83.3%) and Human Health and Social Work sectors (55.2%). Meanwhile, reduced or halted operations were notably reported in Information and Communication (50.0%) and Wholesale and Retail Trade (50.0%). Disruptions in energy supply and operations were less severe overall, with the highest impact in Wholesale and Retail Trade (31.1%) and relatively low impacts in other sectors such as Information and Communication (16.7%). These findings highlight sector-specific vulnerabilities to energy-related shocks.

The impacts of shocks on energy supply and usage varied across industries of different sizes. Large industries experienced the highest percentage of establishments reporting an increased price of fuel (74.6%), followed by medium industries (66.9%) and small industries (66.3%). Energy shortages were most reported in large industries (56.6%) and small industries (53.2%), indicating their vulnerability to fuel supply disruptions. Interestingly, decreased production was particularly significant in cottage industries (59.1%) and micro-industries (50.9%), suggesting that smaller-scale enterprises were more affected in terms of operational efficiency. Increased cost of goods/services was similar across all sizes, with the highest in medium industries (32.2%) and micro-industries (32.1%). Reduced or halted operations were most prevalent in micro-industries (34.0%) and medium industries (33.9%), highlighting their susceptibility to operational disruptions. However, disruptions in energy supply and operations were least reported in micro-industries (13.2%), suggesting a degree of resilience in this area. Overall, larger industries faced higher costs, while smaller industries struggled more with production and operational stability.

The impact of shocks on energy supply and usage varied significantly across different regional clusters. Nepalgunj-Kohalpur reported the highest percentage of establishments affected by the increased price of fuel (81.0%), closely followed by Birgunj-Pathlaiya (79.1%) and Pokhara (76.9%). Energy shortages were most acute in Birgunj-Pathlaiya (67.8%) and Pokhara (65.3%), while Biratnagar-Itahari experienced the lowest rate of fuel shortages (14.5%). In terms of decreased production, Biratnagar-Itahari had the highest percentage (57.9%), suggesting severe operational challenges, whereas Nepalgunj-Kohalpur (17.5%) and Kathmandu (20.3%) were least affected. The increased cost of goods/services was most pronounced in Birgunj-Pathlaiya (42.6%) and Pokhara (35.5%), indicating significant economic strain. Reduced or halted operations were highest in Kathmandu (49.4%), reflecting its vulnerability, while Nepalgunj-Kohalpur experienced the least disruption (3.2%). Similarly, disruptions in energy supply and operations were most prevalent in Birgunj-Pathlaiya (35.7%) and Pokhara (29.8%), with Bhairahawa-Butwal (9.3%) and Nepalgunj-Kohalpur (11.1%) reporting the lowest disruptions. Overall, Birgunj-Pathlaiya and Pokhara faced the most widespread energy challenges, while Nepalgunj-Kohalpur demonstrated greater resilience in several areas.

The insights from key informant interviews (KII) reinforce these findings by providing a better understanding of how industries have been affected by such shocks. During the economic blockade imposed by India in 2015-16, industries relying on diesel as an alternative energy source, faced severe hardships due to the shortage of fuel. While some industries connected to the border had easier access to diesel, other industries had to source diesel illegally, paying double the normal price to maintain operations. In contrast, industries that primarily used local raw materials or relied exclusively on electricity faced fewer disruptions.

The COVID-19 pandemic also created a unique set of challenges for industries. The pandemic led to decreased market demand, driven by out-migration and reduced consumer spending. In this scenario, SMEs and cottage industries whose focus market was within the country suffered the most due to the ripple effect caused by COVID-19.

Additionally, changes in purchasing power also forced the entry of new market model/ approaches (increased imports). This enforced existing industries to change their production and marketing strategies to compete with imports. As a result, industries that had invested enough adapted to the market, while those with less investment stayed stuck and found it hard to survive.

9.4. Strategies Adopted by Establishments to Cope with Energy-Related Challenges During Shocks

The survey also included a follow-up question about the strategies establishments adopted to address energy-related challenges during various shocks. In response to energy-related challenges during shocks, most establishments adopted the strategy of absorbing increased energy costs internally, with 65.7% bearing the financial burden themselves. A smaller but significant portion of establishments, 28.2%, shifted to non-renewable energy sources such as coal and fossil fuels like petrol and diesel to maintain operations. Some businesses opted to pass on the increased energy costs to customers, with 22.7% adopting this approach. Efforts to address energy challenges also included a transition to alternative and renewable energy sources (20.8%) and the implementation of energy efficiency measures (20.4%) aimed at reducing overall consumption. These strategies highlight a mix of adaptive and mitigative responses, with a preference for immediate cost absorption and resource shifts over long-term energy solutions.

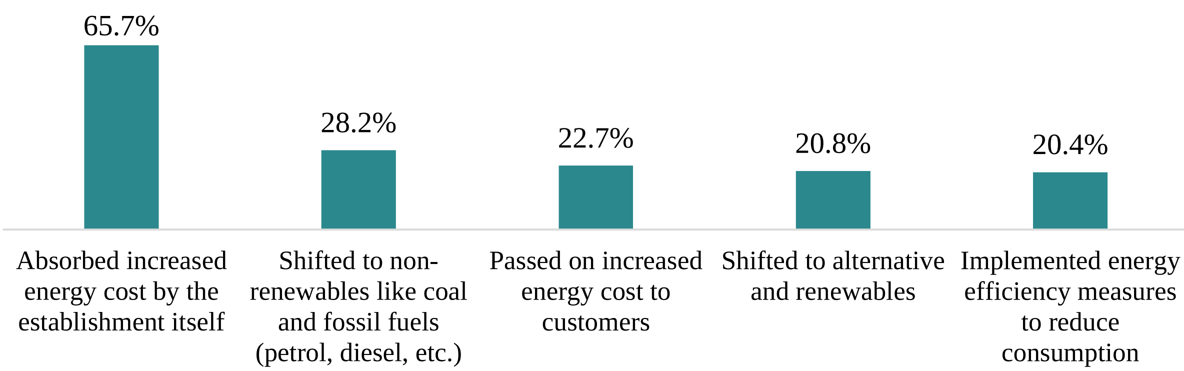


***Figure 9.4**: What strategies did your establishment adopt to cope with energy-related challenges during shocks? [N = 315]*

Establishments across sectors adopted various strategies to cope with energy-related challenges during shocks, with significant variations. The most common strategy was absorbing the increased energy cost internally, reported by over 65% of establishments in most sectors and reaching 100% in Other Service Activities and 76.7% in Financial and Insurance Activities. Shifting to non-renewables like coal and fossil fuels was also notable, particularly in Information and Communication (50.0%) and Financial and Insurance Activities (34.9%). Passing on increased energy costs to customers was less frequent, with the highest proportion in Other Service Activities (50.0%) and Human Health and Social Work Activities (34.6%). Shifting to alternative and renewable energy sources was embraced by Information and Communication and Other Service Activities (50.0% each), but less so in sectors like Agriculture, Forestry, and Fishing (12.5%). Implementing energy efficiency measures was relatively uncommon overall but was significant in Information and Communication (50.0%) and Agriculture, Forestry, and Fishing (40.6%), highlighting sector-specific adaptations to mitigate energy challenges.

Establishments across different industry sizes adopted various strategies to cope with energy-related challenges during shocks. The majority of large industries (69.2%), medium industries (68.1%), and micro-industries (72.9%) absorbed the increased energy costs themselves, reflecting a common approach to managing the financial impact. Cottage industries were more likely to absorb costs as well (72.2%), possibly due to their smaller operational scale. Shifting to non-renewable energy sources like coal and fossil fuels was common in large industries (35.0%) and medium industries (32.7%), while cottage industries (5.6%) and micro-industries (10.4%) were less reliant on this strategy. Passing on the increased energy costs to customers was more frequent in cottage industries (38.9%) compared to other industry sizes. Additionally, shifting to alternative and renewable energy sources was particularly noted in medium industries (25.7%) and large industries (22.5%), while smaller industries like cottage and micro-industries focused less on this shift. Finally, the implementation of energy efficiency measures was seen across all industry sizes, with large and medium industries leading the way at 21.7% and 22.1%, respectively.

Across different clusters, establishments employed a range of strategies to cope with energy-related challenges during shocks. In Biratnagar-Itahari (80.3%) and Nepalgunj-Kohalpur (85.7%), a significant majority of establishments absorbed the increased energy costs themselves, indicating a strong reliance on internal resources. In contrast, Kathmandu (39.0%) and Bhairahawa-Butwal (50.0%) had fewer establishments absorbing the cost, with more opting for alternative strategies. The shift to non-renewable energy sources, such as coal and fossil fuels, was most prevalent in Kathmandu (42.9%) and Birgunj-Pathlaiya (28.7%), while other clusters like Bhairahawa-Butwal (12.5%) and Nepalgunj-Kohalpur (9.5%) were less reliant on this approach. Passing on the increased energy costs to customers was more common in Bhairahawa-Butwal (37.5%) and Nepalgunj-Kohalpur (42.9%), while Kathmandu (28.6%) also saw a notable proportion adopting this strategy. Shifting to renewable energy sources was a prominent strategy in Pokhara (44.2%), while other clusters like Bhairahawa-Butwal (12.5%) and Nepalgunj-Kohalpur (4.8%) were less inclined to make this transition. Finally, implementing energy efficiency measures was most notable in Birgunj-Pathlaiya (27.0%) and Pokhara (34.2%), where establishments took proactive steps to reduce consumption.

9.5. Resilience of Establishments in Coping with Future Energy-Related Shocks

Data on the resilience of establishments in facing future energy-related shocks reveals significant variation across sectors, industry sizes, and geographic regions.

The data reveals significant variability in establishments' resilience to future energy-related shocks. Overall, only 4.9% of establishments consider themselves well-prepared, while a staggering 65.0% report being unprepared. By sector, Manufacturing (71.3%) and Other Service Activities (75.0%) exhibit the highest proportions of establishments being unprepared. Cottage and micro-industries report the greatest unpreparedness, at 79.2% and 82.8%, respectively, compared to 44.0% for large industries. Geographically, resilience varies across clusters, with Bhairahawa-Butwal (87.0%) and Nepalgunj-Kohalpur (83.2%) showing the highest levels of unpreparedness, while Kathmandu and Pokhara report higher proportions of partial preparations (24.8% and 13.5%, respectively). These findings highlight widespread vulnerabilities across sectors, regions, and sizes, underscoring the need for targeted interventions to improve preparedness for future energy-related shocks.

Table 9.5: *G4. How resilient do you consider your establishment to be in facing and effectively coping future energy-related shocks? [N = 614]*

		Well-prepared for any potential shocks	Some preparations in place, but could improve	Limited preparations in place	Unprepared for future shocks
Overall		4.9%	12.2%	17.9%	65.0%
Sector	Agriculture, forestry, and fishing	8.9%	13.3%	22.2%	55.6%
	Manufacturing	4.8%	8.7%	15.2%	71.3%
	Accommodation & food service activities	3.0%	20.0%	15.6%	61.5%
	Information and communication	7.7%	23.1%	7.7%	61.5%
	Human health and social work activities	2.4%	17.1%	34.1%	46.3%
	Financial and insurance activities	7.1%	5.4%	25.0%	62.5%
	Wholesale and retail trade activities	10.0%	10.0%	30.0%	50.0%
	Other service activities	0.0%	25.0%	0.0%	75.0%
Size	Large industry	11.2%	18.4%	26.4%	44.0%
	Medium industry	2.7%	17.3%	22.7%	57.3%
	Small industry	3.8%	11.1%	16.8%	68.3%
	Cottage industry	2.8%	6.9%	11.1%	79.2%
	Micro-industry	3.0%	5.1%	9.1%	82.8%
Cluster	Biratnagar-Itahari	1.0%	5.9%	28.7%	64.4%
	Birgunj-Pathlaiya	11.2%	22.4%	10.3%	56.1%
	Kathmandu	2.0%	24.8%	19.8%	53.5%
	Pokhara	9.6%	13.5%	29.8%	47.1%
	Bhairahawa-Butwal	4.0%	1.0%	8.0%	87.0%
	Nepalgunj-Kohalpur	1.0%	5.0%	10.9%	83.2%

CHAPTER 10: CLOSURE

10.1 Anticipated Areas of Government Support to Improve Energy Usage and Efficiency in Industries

According to the survey data, the industries expect the government to provide various forms of support to improve energy usage and efficiency. The most anticipated support is tax incentives for energy-efficient investments, with 59.6% of respondents highlighting this as a priority. (Energy efficient machinery is expensive to install thus the request for tax incentives). Policy and regulatory support also rank highly, with 54.4% in favor, while financial support or subsidies for adopting energy-efficient technologies and renewable energy are expected by 39.7% and 36.8% of respondents, respectively. Additionally, 20.2% of respondents call for education, training, and capacity building, and 18.9% seek research and development support to further enhance energy efficiency efforts.

Expected government initiatives to enhance energy usage and efficiency in the industry

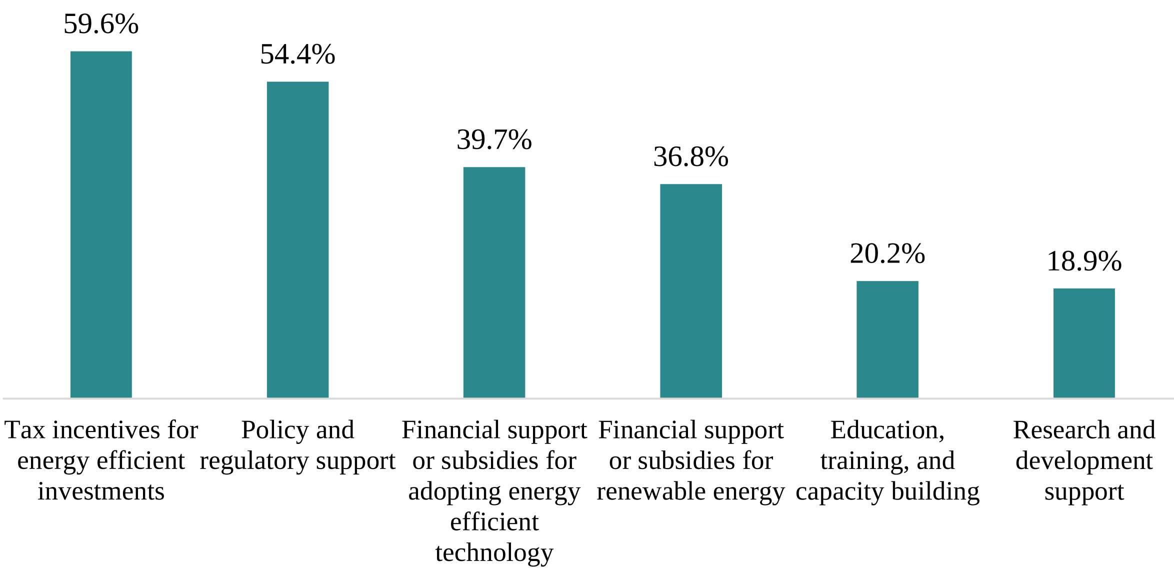


Figure 10.1: *What are the areas where this industry or the establishment itself anticipate government support to improve the energy usage and energy efficiency?*

The data reveals varying levels of anticipated government support across different sectors to enhance energy usage and efficiency. Tax incentives for energy-efficient investments are prioritized, especially in accommodation and food service activities (63.7%), manufacturing (61.3%), and human health and social work activities (61.0%). Policy and regulatory support is another key expectation, with human health and social work activities leading (68.3%), followed by wholesale and retail trade activities (60.0%) and financial and insurance activities (57.1%). Financial subsidies for adopting energy-efficient technology are most sought after by establishments in "other service activities" (75.0%), while support for renewable energy is moderately expected across all sectors, peaking at 46.7% in agriculture, forestry, and fishing. Interestingly, education, training, and capacity-building support are less demanded overall, with higher demand in "other service activities" (50.0%). Research and development support remains a niche requirement, with its highest anticipation in the information and communication sector (30.8%). These trends underline sector-specific priorities for advancing energy efficiency and sustainable practices.

The data highlights the varying expectations across industries of different sizes regarding government support for improving energy usage and efficiency. Tax incentives for energy-efficient investments are anticipated across all sizes, with cottage industries (69.4%) expressing the greatest need, followed closely by medium industries (61.8%) and large industries (58.4%). Policy and regulatory support is important for large industries (59.2%), while smaller industries show slightly lower demand. Financial support for adopting energy-efficient technology is most sought after by cottage industries (47.2%), whereas micro industries show the least demand (31.3%). Financial support for renewable energy is expected by medium, cottage and small industries at similar levels, around 38%, while education, training, and capacity building are most needed by micro industries (25.3%). Research and development support sees the highest demand from large industries (33.6%), with smaller industries expressing less interest in this area.

The data reveals varying expectations across different regions of Nepal regarding government support to improve energy usage and efficiency. Tax incentives for energy-efficient investments are most anticipated in the Birgunj-Pathlaiya cluster (73.8%), followed by Kathmandu (69.3%) and Biratnagar-Itahari/Nepalgunj-Kohalpur (57.4%). Policy and regulatory support are also highly sought after in Birgunj-Pathlaiya (72.0%) and Nepalgunj-Kohalpur (60.4%), while Kathmandu shows the lowest demand at 40.6%. Financial support for adopting energy-efficient technologies is expected by a greater number of industries and enterprises in Kathmandu (51.5%) and Birgunj-Pathlaiya (46.7%), while clusters like Pokhara (26.9%) and Bhairahawa-Butwal (26.0%) show less need. Support for renewable energy is most expected in Birgunj-Pathlaiya (46.7%), while Nepalgunj-Kohalpur shows the least demand at 19.8%. Education, training, and capacity building are particularly emphasized in Nepalgunj-Kohalpur (32.7%) and Pokhara (29.8%), while other regions show much lower levels of interest. Lastly, research and development support is most anticipated in Nepalgunj-Kohalpur (27.7%) and Kathmandu (20.8%), with other clusters showing less need in this area.

Expected government initiatives to enhance energy usage and efficiency in the industry across different clusters

Table 10.1: *What are the areas where this industry or the establishment itself anticipate government support to improve the energy usage and energy efficiency? [By Clusters]*

	Cluster					
	Biratnagar-Itahari	**Birgunj-Pathlaiya**	**Kath-mandu**	**Pokhara**	**Bhairahawa-Butwal**	**Nepalgunj-Kohalpur**
Tax incentives for energy efficient investments	57.4%	73.8%	69.3%	49.0%	50.0%	57.4%
Policy and regulatory support	55.4%	72.0%	40.6%	51.0%	46.0%	60.4%
Financial support or subsidies for adopting energy efficient technology	44.6%	46.7%	51.5%	26.9%	26.0%	42.6%
Financial support or subsidies for renewable energy	40.6%	46.7%	39.6%	36.5%	37.0%	19.8%
Education, training, and capacity building	3.0%	23.4%	22.8%	29.8%	9.0%	32.7%
Research and development support	10.9%	16.8%	20.8%	17.3%	20.0%	27.7%

10.2 Major energy-related challenges faced by the industries and establishments

In addition to quantitative responses, open-ended feedback collected from industries and establishments provide insights into the specific energy-related challenges experienced across different sectors and geographic clusters. These helps contextualize the statistical results and highlight the nuanced ways in which energy issues affect daily operations, productivity, and business sustainability.

In the Manufacturing Sector, industries reported that unscheduled power outages were the most critical challenge, particularly in clusters such as Birgunj-Pathlaiya, Nepalgunj, and Pokhara. In Biratnagar, high energy costs dominated concerns, while in Kathmandu, respondents highlighted heavy taxation and inefficient power distribution. Manufacturers also cited intense market competition, complex import procedures, high interest rates, and inconsistent tariffs as issues contributing to an unfavorable business environment.

"Power cuts have really messed up our production and even damaged our raw materials. We now rely on costly diesel backup which further reduces our profit margins." — Small Manufacturer, Birgunj.

In the Accommodation and Food Services sector, industries faced acute challenges due to frequent power outages and voltage instability, especially in Biratnagar, Birgunj, and Nepalgunj. In Pokhara, high electricity costs added to the burden. However, in Kathmandu, the concern was more of a technical issue that causes outages.

"The entire wiring was connected incorrectly, causing a fire that led to substantial damage to our electrical equipment. This issue occurred due to NEA's negligence."— Medium Industry, Kathmandu

In Agriculture, Forestry, and Fishing, respondents in Biratnagar, Nepalgunj, and Birgunj-Pathlaiya reported production and storage losses due to unreliable electricity. Issues ranged from increase in poultry deaths to reduced fish survival rates and irrigation failures. In Bhairahawa and Kathmandu, high taxes and regulatory barriers were key concerns, particularly for small and cottage enterprises.

Similarly, in the Construction Sector, small and micro enterprises in Nepalgunj, Biratnagar, and Birgunj struggled with project delays and machinery damage due to frequent outages. In Bhairahawa, penalties for late bill payments and high electricity costs were additional reported burdens.

Meanwhile, in the Health Sector, power outages had a direct impact on service delivery and patient safety. Hospitals in Birgunj had to refer patients elsewhere due to malfunctioning medical equipment caused by unstable electricity supply.

"We can't use the X-ray and blood test machines due to power outages and unstable electricity supply. Patients end up waiting for hours or have to go somewhere else."— Small Clinic, Pokhara

In the Information and Communication Sector, businesses across Kathmandu, Pokhara, and Biratnagar cited high electricity costs and dependency on generators as major challenges, severely affecting operational continuity and cost-efficiency.

Across all clusters and sectors, the most consistently reported challenges were unreliable electricity supply, high energy costs, and regulatory complexities.

10.3 Solutions Proposed by Respondents

In addressing the energy-related challenges encountered across different sectors, respondents offered several key recommendations to reduce disruptions and promote the sustainability of industries and businesses. These suggestions, derived from open-ended questions, emphasize the following main areas:

1. **Reliable supply of electricity and stable voltage**: Unscheduled power outages and voltage fluctuations have significantly impacted industrial operations across Nepal. These disruptions have damaged machinery, spoiled raw materials, hampered operation and reduced overall productivity and service delivery. Like other sectors, the food and agriculture industries are also significantly impacted, with perishable items such as milk, dairy products, fish, vegetables, and fruits often going to waste. Additionally, frequent equipment malfunctions caused by voltage instability and power cuts have further compromised the quality of products and services. To cope with these challenges, businesses have relied on costly alternatives like gas, diesel generators, and inverters, increasing operational expenses.

   To address these issues, respondents strongly urged the Government and the Nepal Electricity Authority (NEA) to ensure a consistent and reliable electricity supply. They also emphasized the need for prior notification of power cuts, allowing businesses to plan operations and protect assets. Similarly, to address voltage issues, voltage stabilizers should be installed at various locations. Sectors like healthcare, which are especially vulnerable, called for dedicated and stable power lines to maintain uninterrupted services and ensure patient safety.

2. **Energy cost reduction, tax relief and incentives:** Industrialists across sectors and clusters perceived the current electricity prices for industries as excessively high. In addition to regular charges, many businesses face demand charges and penalties for late bill payments, which further strain their finances. Thus, to ease these pressures, respondent proposed several measures. These included providing affordable electricity, offering subsidies, or reducing tariff rates. Additionally, they proposed introducing the concept of tax havens for industries, particularly for small and micro enterprises.

   Large manufacturing firms, in particular, called for a more favorable business environment through sector-specific tax incentives aimed at enhancing competitiveness and supporting industrial growth.

3. **Improved Infrastructure and market access**: Respondents from sectors, such as manufacturing and health service emphasized the importance of routine testing and maintenance of electricity infrastructure—poles, wires, and transformers, to minimize power leakage and electricity theft. Some also advocated for underground electricity cabling to improve supply quality and reduce external damages.

   Beyond the electricity system, respondents stressed the need for upgraded physical infrastructure, particularly in transportation. Improved infrastructure would strengthen market connectivity, reduce logistical challenges, and support the efficient movement of goods and materials. Improved infrastructure would enhance the flow of goods, reduce costs, and support efficient market access.

4. **Government Support and Sectoral Policies**: Many respondents highlighted the need for targeted government support programs, such as agricultural subsidies or sector-specific incentives for industries. Respondents from financial, insurance, and manufacturing sectors emphasized the urgency of economic stabilization and regulatory clarity, arguing that unpredictability in policy and market systems undermines business growth. Manufacturing and construction industries recommended the enforcement of better regulations related to trunk lines and the abolition of monopolistic practices to ensure fair competition.

   Accommodation and food sector emphasized the benefits of investing in and promoting solar energy to reduce energy costs while enhancing tourism, culture, and environmental sustainability.

5. **Simplified import and export regulations**: Streamlining import restrictions and export processes was another key recommendation. Complex and time-consuming customs procedures often limited access to essential raw materials and imposed high costs on businesses. Industries in general advocated for lowering import duties to reduce costs and boost competitiveness. They also urged for streamlined customs processes to facilitate cross-border trade and improve the overall ease of doing business.

Key Informant Interviews (KIIs) provide valuable context behind these sectoral preferences. Many respondents emphasized that tax incentives and government subsidies would be critical enablers for the adoption of energy-efficient and renewable technologies, especially in light of the high upfront investment costs and the absence of immediate financial returns associated with such technologies.

Some industries strongly emphasized the need to prioritize domestic energy demands over electricity exports to India, arguing that ensuring a stable and sufficient power supply would not only enhance industrial growth but also contribute to increased government revenue in the long term. A recurring recommendation from key informants was the upgrading of transformers, substations, and distribution lines—infrastructure improvements deemed essential for addressing persistent voltage fluctuations and minimizing unplanned outages.

Large-scale industries informants, in particular, underscored the importance of having dedicated infrastructure, such as separate industrial feeders, to reduce disruptions caused by shared usage with residential consumers. Furthermore, stakeholders raised concerns about the monopoly structure of Nepal's electricity distribution system, which leaves them without alternatives when facing service inefficiencies. In response, many advocated for a decentralized electricity distribution model, empowering local authorities or industrial bodies to manage supply and address issues more responsively.

Additionally, industries also called for greater transparency and improved communication from electricity providers. Suggestions included public awareness campaigns on electricity distribution practices and real-time notifications about planned outages to help businesses plan operations more effectively. Finally, interviewees emphasized the value of energy audits and capacity-building programs focused on energy efficiency, which could help optimize energy use and enhance productivity across sectors.

Industries operating within industrial zones (IZML) appear to be adversely affected. Industries are required to pay additional demand fees, but without assurance of stable electricity. Some businesses are reportedly billed under ToD tariffs that do not align with NEA rates, and several lack ToD meters entirely. This has led to confusion, financial losses, and dissatisfaction with the service delivery.

To address these challenges, industries urge IZML to provide awareness on TOD meter installation as well to either eliminate demand charges or ensure an uninterrupted power supply that matches their energy needs. They also stress the need for greater transparency in electricity pricing, calling on industrial area management to remove unjustified additional charges and establish a more responsive mechanism for addressing consumer grievances[22].

[22] In the interaction held at IDA on June 9, 2025, IZML representatives mentioned that IZML no longer includes "demand charge" in their bills to the industries.

11. CONCLUSION AND RECOMMENDATION

Chapter 2: Institutions relevant for industries and energy transitions

Conclusion

- Alternative Energy Promotion Centre (AEPC) and Industrial Zone Management Limited (IZML) play crucial role in Nepal's energy transition and industrial development. AEPC has led variable renewable energy initiatives—ranging from rural electrification and clean cooking to expansive rooftop solar programs—establishing a foundation for sustainable energy adoption across the country. With programs on rooftop solar installations in commercial and industrial sectors through RESCO and Capex models, AEPC has begun supporting the industries and commercial sectors in transitioning towards renewable alternatives. However limited awareness among industries and inconsistent NEA policies has hindered broader uptake[23].

- Similarly, IZML provides vital infrastructure and utility services within industrial zones, and more importantly, has potential for integrating and managing Solar PV systems for renewables for the industries affiliated to it. Industries outside industrial areas (out of IZML jurisdiction) have autonomy to implement energy-efficient measures such as Time-of-Day (TOD) metering and leverage feed-in tariff benefits when installing solar PV, whereas industries within IZML-managed zones are constrained by centralized decision-making and a reluctance on the part of IZML to embrace renewable energy initiatives due to concerns over potential revenue loss.

Recommendations:

- AEPC needs to provide outreach to commercial and industrial sector. An aggressive dissemination campaign to industries needs to be launched. Private sectors (especially SMEs) should be made aware of the existing services provided by AEPC including various options such as RESCO and Capex models.

- For industries within IZML-managed areas, IZML has the mandate to promote centralized solar PV projects. Centralized solar projects across IZML industrial zones could be started by partnering with service providers. Feed In Tarif agreements with NEA would enable industries in IZML zones to monetize excess solar energy and reduce revenue loss fears. IZML should negotiate with the Nepal Electricity Authority (NEA) to create favorable arrangements. The current policy provision that limits solar PV in industries to just 1 MW should be revised.

[23] Though staff at NEA headquarters are aware of these provisions, NEA district offices – the entities that industries (which are not within the IZML areas) normally have to deal with – are generally not aware of these provisions.

Chapter 5: Operations and energy use

Conclusion

- Establishments within the sectors that require continuous service provisions such as accommodation and food service activities (128 hours per week) and human health and social work (127 hours per week), operate nearly round-the-clock. Establishments within the financial and insurance sectors (47 hours per week) have lower operational intensity – aligning with standard office hours. Similarly, large industries operate longer whereas regionally, industries in Pokhara, Nepalgunj-Kohalpur and Biratnagar-Itahari cluster shows longer operational hours.

- While the adoption of electricity is ubiquitous in establishments across all sectors, sizes, and regions, the survey findings reveal high dependence of industries and establishments on carbon-intensive and traditional fuel sources across key sectors. Diesel (49.01%) and fuelwood and traditional biomass (27.07%) dominates overall energy consumption. Sectors such as agriculture and manufacturing depend heavily on diesel pointing the need for machinery and power-backup operations. Similar case for establishments in accommodation and food service activities indicating heavy use of generators for power supplies.

  In contrast, service-oriented sectors like information and communication, finance, and healthcare show higher dependence on electricity. Still, renewable energy adoption, particularly solar PV, remains minimal despite some progress in health and wholesale and retail trade.

  Industrial activities, especially manufacturing, continue to rely on diesel, fuelwood and biomass including other carbon emitting fuels like furnace-oil and coal underscoring challenges in decarbonizing energy-intensive processes.

  Overall, the energy usage portfolio of industries and enterprises across various sectors reveals only less than 17 % of electricity usage (combined of solar PV and self generated wind-energy) while a major portfolio comprise of diesel (49.0%) and fuel wood (27.1%)

- While manufacturing sector is the most energy intensive – (an average of 0.000138 PJ per million NPR of sales/turnover) – this reflects inefficient energy use relative to its GDP contribution. Despite contributing the highest GDP, agriculture, forestry, and fishing sector exhibits moderate energy intensity (0.000048 PJ per million NPR) which implies the sector reliance on labor and natural resources over mechanized energy. Human health (0.000014 PJ per million NPR) and information and communication (0.000029 PJ per million NPR of sales/turnover) reveal low energy intensity despite substantial GDP contribution pointing service sectors energy efficiency while translating economic outputs.

- Daily load demand peaks between 10 AM – 5 PM, needless to say, are the core operational hours of the industries and enterprises. Sector-specific peak loads include agriculture (morning) and accommodation (7 PM – late evening). Similarly, some peak load variations are also noticed across industrial clusters/regions. On the other hand, highest demand occurs during Baisakh – Ashad Nepali months whereas demand dips during Kartik indicating reduced industrial activity during Dashai Tihar festival holidays.

Recommendations

- Electricity along with its cleaner alternatives like solar PV needs to be incentivized particularly in energy-intensive sectors – manufacturing, human health, agriculture and food and accommodation sectors. Industries may require structural changes in their operational process to adopt electricity and cleaner sources. Energy utility should prioritize grid resilience during specific Time of the Day depending upon the sectors and establishments using the electricity through TOD pricing and decentralized renewable systems. Micro and cottage industries need subsidies for cleaner energy adoption. These facts should guide Nepal’s energy polices.

Chapter 6: Energy and Electricity Supply

Conclusion:

- Industries and enterprises tend to face delays in obtaining electrical connections from the utility provider. When the establishments applied for electrical connections in recent years (two years back)- delays in obtaining connections averaged 33 days, rising to 85 days among the establishments in Bhairahawa-Butwal region.

- Power outages affect almost all industries and enterprises (95.3%). An establishment has to witness up to 21 incidents of power outages in a week in average that may range from a few minutes to few hours. Outages generally peaked at midday – affecting production or operation – and rendering losses.

- Adding to this, establishments has to rely on alternative source of electricity as a backup for regular metered connection. These carbon-intensive backup systems and other renewable alternative backups increase operational and production losses. While 61.7% of establishments have to use these backups – which comes from traditional generators (70.7%) and batteries /inverters (67.3%) whereas PV adoption remains minimal (6.9%).

- Power disruptions lead to several losses – cause machinery damage (52.6%), increased maintenance costs (51.3%), higher fuel costs (40.5%), spoilage and damage of goods (33.4%) resulting to losses equivalent to 8% of annual sales or turnover. These losses could be even higher for specific sectors (equivalent to 14% of annual sales/turnover in enterprises within IT sector).

- Power outages inflict significant economic damage, with estimated annual losses of 13,678 thousand NPR per establishment that translate into 5,471 thousand NPR in forfeited profits and 1,368 thousand NPR in lost taxes. The human health, social work, and manufacturing sectors are notably impacted, and regional clusters such as Bhairahawa-Butwal experience the highest per-establishment losses, highlighting the broader fiscal implications for both industries and government revenue.

- Industry representatives are of the opinion that barriers like inadequate infrastructure (cited by 50.5%) and political and regulatory hurdles (cited by 39.1%) are the major reason that the load shedding and power outages still exist in industries and enterprises.
- Regional inequality regarding irregular supply of electricity and affordability are equally concerning. Industries in Kathmandu area reported higher satisfaction with availability (7.67 out of 10) and shorter outages (6 outages per week) while industries in Nepalgunj-Kohalpur area reported minimum satisfaction level (3.2 out of 10) and faced severe disruptions (35 outages per week)

Recommendations:

- To expedite the approval process and reduce lengthy waiting times for getting electrical connections, utility providers and government agencies should implement digital application tracking systems and provide dedicated support services.
- Investments in modernizing grid infrastructure are critical. Regions that are affected most by outages should be immediately prioritized. Upgrading transmission lines, and coordinating load shedding schedules (pre informed power outages rather than uninformed outages), can help stabilize supply and reduce production losses.
- The government should support industries by ensuring a reliable electricity supply through increased power generation and by prioritizing the allocation of nationally generated electricity to domestic industries rather than exporting it. This approach will mitigate economic losses, preserve industrial profits, boost tax revenues, and ultimately strengthen the overall economy.
- Financial incentives and technical support are needed to encourage a shift towards renewable backup solutions. This transition will not only reduce operational costs and environmental impact but also enhance overall energy security.

Chapter 7: Energy Pricing and Willingness to Pay

Conclusions:

- Adoption of ToD tariffs is low among industries and enterprises. Only 23.3% of establishments have ToD tariffs for their electrical connection from the utility. While 48% of large industries adopt TOD tariffs only a miniscule of cottage and micro industries adopt them. Manufacturing (33.5%) and health and social work (22%) lead adoption whereas financial and IT sectors lag. Regional gaps also seen with establishments in Biratnagar-Itahari cluster (41.6%) outnumbering industries' in other locations. This might suggest uneven policy implementation or awareness among entrepreneurs or both.
- There is a high demand for reliable electricity. A majority 59% of establishments would increase consumption with reliable supply led by manufacturing sector (62.3%). Industries in Nepalgunj-Kohalpur (82.2%) and Birgunj-Pathlaiya (73.8%) show strong latent demand for reliable electricity.

- Across sectors, reliable electricity would help in facilitating machinery upgrades, diesel-to-electric transitions, and energy-efficient appliances (e.g., electric stoves in food and accommodation services).
- Willing to pay for reliable electricity is 4 % above current rates. Cottage industry and small industry are willing to pay even higher (5% above current rates) suggesting challenges for small scale industries to scale further due to the current irregular supply of electricity.

Recommendations:

- ToD tariff expansion is beneficial both to the industries and utility providers. ToD facility should also expand with awareness and simplified billing.
- Introduce subsidized tariff or ToD tariffs for micro and cottage industries to help them expand and scale.
- Grid upgrades at specific industrial regions would attract industries if reliable electricity are guaranteed.
- For sectors and industries that are willing to pay more, introduce premium prices with advanced grid resilience and continuous electricity supply and support services.

Chapter 8: Energy Efficiency

- Implementation of energy efficient measures by establishments is not so promising. Only 43.5% of establishments report adopting energy efficiency measures. Adoption of energy efficiency measures among establishments across sectors is uneven with larger rate of adoption among establishments in Human health (53.7%), accommodation (45.9) and manufacturing (44.2%). Large industries are also more likely to adopt energy efficiency measures (61.6%).
- Moreover, the adopted energy efficient measures are more focused on maintenance of machinery and awareness or behavioral change rather than the use of renewable energy sources and conducting period energy audits. Adoption of energy audits and monitoring as energy efficient measures is limited. Uptake of periodic energy audits and monitoring is low (25.4 % of overall establishments) – which also more common among large industries (49.6%).
- Multiple-fold investments in energy efficiency measures are planned by establishments of certain sectors like human health and social work and Biratnagar-Ithahari clusters. However, investment trends are primarily directed towards equipment upgrade and new machinery with limited focus on renewable energy and advanced technology. SMEs on the other hand are focusing on basic equipment like inverters and stabilizers.
- Barriers to energy efficiency adoption are mostly institutional (2.54/ on a scale of 0 to 4) followed by financial 2.35, technical 2.33 and lastly information 2.13. Also, lack of awareness and confidence in implementing energy efficiency measures are prevalent,

especially in agriculture and cottage industries. Complex compliance processes, ineffective government policies, and uncertainty about the future of industries are major obstacles, especially in clusters like Biratnagar-Itahari.

Recommendations:

- Encourage energy audits for large industries and provide technical support /grants for SMEs to offset energy audit cost.
- Simplify policy frameworks like permits, strengthen supply chain and eliminate other hurdles for those who want to introduce energy efficiency technology.
- Expand access to finance (on lower or subsidized rates) to invest in energy-efficient machines and technologies.
- Launch awareness to demonstrate increased return on investment from energy efficiency. Immediate focus should be on converting planned investments into actionable projects while addressing systemic barriers in high-need sectors and clusters.

Chapter 9: Shocks and Resilience

Conclusion

- Vulnerabilities related to energy-shocks are sector specific. Different shocks like 2015 earthquake, the 2015-2016 economic blockade by India, the Covid-19 pandemic, and global price escalation due to the Ukraine-Russia war over the period of time affected more than half (51.3%) of the establishments across the country. Accommodation and food services (59.3%) and manufacturing (54.2%) were among the hard-hit sectors whereas impacts on financial and insurance (26.8%) and wholesale and retail business (30.0%) sectors were low.
- Majority of the industries tend to absorb costs of fuel price surge during adverse shock events. Other ways to cope with energy-related challenges during shocks like shifting to alternative energy source (from renewables to non-renewable and vice-versa) and implement energy efficiency measures are generally low.
- Industries in Nepal are not so well prepared for future energy-related shocks. The majority 65% of establishments report being unprepared for future energy-related shocks. Cottage (79.2%) and micro (82.8%) industries are the most vulnerable.

Recommendations:

- High risk sector and vulnerable industries should be encouraged to develop energy contingency plans. Incentivize renewable transitions, promote low-interest loans for renewable transition. Train industries in energy resilience planning for example: integrating energy efficiency with shock mitigation strategy.

Chapter 10: Closure

- The survey results clearly indicate that industries expect government support in the form of tax incentives, policy reforms, and financial subsidies to promote energy efficiency. Tax incentives for energy-efficient investments emerges as the highest priority across sectors. Unreliable electricity supply, marked by unscheduled power outages and voltage fluctuations, stands out as the major challenge affecting productivity and operational costs. These power disruptions not only damage machinery and spoil raw materials but also force industries to rely on costly backup solutions, further straining their finances and competitiveness.

- Industries are of the opinion that there is an urgent need for infrastructure improvements. Regular maintenance and modernization of electrical systems—including the replacement of outdated transformers, improved wiring, and the installation of underground cabling—are critical to ensuring a stable power supply. Enhanced transportation networks are equally important for improving market connectivity and reducing logistical challenges for industries.

- Respondents have highlighted the importance of sector-specific policies that address unique challenges in areas such as agriculture, manufacturing, hotel and tourism, and healthcare. Simplifying import and export regulations and establishing targeted fiscal incentives for both large and small enterprises can help create a more favorable business environment, ultimately driving sustainable growth across different sectors.

- Finally, industries call for increased capacity building and collaborative initiatives in research and development to foster innovation in energy management. By investing in training programs and establishing partnerships between academia, government, and the private sector, Nepal can develop a more resilient and efficient energy landscape that meets the evolving needs of its diverse industrial base.

REFERENCES

Central Bureau of Statistics (CBS). (2024). *Nepal Standard Industrial Classification (NSIC)*. Government of Nepal.

Ministry of Finance (MoF). (2024). *Economic Survey (2022/2023)*. Government of Nepal. Retrieved from https://mof.gov.np

Ministry of Industry, Commerce and Supplies. (2024). *Industrial statistics (2022/2023)*. Government of Nepal. Retrieved from https://www.doind.gov.np/uploads/notices/Notices-202104241733286.pdf

NEA discontent over inquiry committee's report on clearance of dues of dedicated feeders and trunk lines. (2024, May 22). https://myrepublica.nagariknetwork.com/news/nea-discontent-over-inquiry-committee-s-report-on-clearance-of-dues-of-dedicated-feeders-and-trunk-lines/

बराल. (2023, December 14). *अदालतलाई प्राधिकरणको जवाफ : टीओडी मिटरको तथ्यांक मेटिइसक्यो*. Online Khabar. https://www.onlinekhabar.com/2023/12/1411283

Nepal Electricity Authority (NEA). (2024). *Annual report 2023/24*. Nepal Electricity Authority. Retrieved from https://www.nea.org.np/annual_report

Sharma, S., K.C., C., & Shrestha, D. (2024, January). *Household energy consumption and energy transition in Nepal 2023: A survey report*. Inter Disciplinary Analysts, Kathmandu

Baral, J. (2023, December 26). NEA v Industries: Dedicated feeders and trunk lines controversy explained-Online Khabar English News. *OnlineKhabarEnglishNews*. https://english.onlinekhabar.com/dedicated-feeders-and-trunk-lines-nep.html

Timilsina, G., & Steinbuks, J. (2021). Economic costs of electricity load shedding in Nepal. *Renewable and Sustainable Energy Reviews*, *146*, 111112. https://doi.org/10.1016/j.rser.2021.111112

Water and Energy Commission Secretariat. (2024). *Energy sector synopsis report (2024)*. Government of Nepal. ESR_2024.pdf\

Water and Energy Commission Secretariat. (2022). *Energy Sector Synopsis Report, (2022)*. Kathmandu, Nepal. Nepal Energy Sector Synopsis Report - 2022

World Bank. (2023). *Industrial sector employment and activity overview, FY 2022/23*. World Bank Group.

Gyawali, D. (2002). Yam between Bhot and Mughlan: Nepal's search for Security in Development. Chapter in K. Dixit and S. Ramchandran (eds) State of Nepal. Kathmandu: Himal Books.

Gyawali, D. (1994). A Fate Other than Marginality. Kathmandu: Himal May/June.

Kibria, G. (1998). Technology Acquisition in Pakistan: Story of a Failed Privileged Class and a Successful Working Class. Karachi: City Press.

Polanyi, K. (1944). The Great Transformation: the political and economic origins of our times. Boston: Beacon Press.

Sharma, S., Koponen, J., Gyawali, D., and Dixit, A. (2004). Aid under Stress: Water, Forests and Finnish Support in Nepal. Kathmandu: Himal Books for Institute of Development Studies, University of Helsinki and Inter Disciplinary Analysts, Nepal.

Shrestha, S.S. (2004). A Pioneer Falters: The Status of Nepal Ropeways. Chapter in Gyawali, D., Dixit, A. and Upadhya, M. (eds) Ropeways in Nepal: Context, Constraints and Coevolution. Kathmandu: Nepal Water Conservation Foundation and Kathmandu Electric Vehicles Alliance.

Stavrianos, L.S. (1981). Global Rift: The Third World Comes of Age. New York: William Morrow and Co.

ANNEX 1

Overview of Nepal Renewable Energy Program (NREP)

Nepal Renewable Energy Program (NREP), introduced by the Government of Nepal in February 2019, is a collaborative initiative between the UK Government and the Government of Nepal (GoN). It is implemented by the Alternative Energy Promotion Centre (AEPC), with technical support from a consortium contracted by the British Embassy. DAI Global UK leads this consortium, with Winrock International as a key partner. Initially, other organizations such as PEI and Samriddha Pahad were supporting partners, but due to various challenges, they are no longer involved. NREP is built on three core assumptions:

1. Developing Distributed Sustainable Energy: While large hydropower plants are central to Nepal's energy strategy, the country's unique topography and decentralized management structure make distributed sustainable energy, which traditionally served areas without grid access, equally critical. With 97% of the households now having access to electricity, the focus of NEA and AEPC has shifted to the remaining households without access. However, distributed sustainable energy is not just about filling gaps; it is fundamental to Nepal's energy transition, especially in cooking and other end-uses. At NREP, we avoid limiting the term to "distributed renewable energy" because the approach goes beyond production. It encompasses equitable consumption and efficient use. For example:

- Electric cooking solutions should extend beyond urban centers like Kathmandu.
- EV charging infrastructure must be distributed across Nepal, not just in major cities.

The program basically focuses on distributed sustainable development of energy that aims to improve energy security, access, and transition, with an emphasis on private investment in alternative energy. Energy security is also very important because, in areas such as Karnali where the distribution lines are very long, having the generation plant near consumption point helps with voltage, energy quality, and reliable access. This focus on distributed production, consumption, and efficiency defines the program's vision for sustainable energy development. The program advocates for energy democracy, encouraging innovation and efficiency in energy generation that is more distributed.

2. Promoting Private Sector Participation: Private sector involvement is essential for scaling sustainable energy development as it brings efficiency, innovation, investments, and long-term sustainability, as seen in other sectors.

3. Bridging Viability Gaps with Strategic Support: While private sector involvement in sustainable energy development is highly desirable, they do not readily come in because they see risk more than the return. To bridge this big viability gap, we provide a viability gap fund to attract them through the Sustainable Energy Challenge Fund (SECF) which is managed by the Central Renewable Energy Fund (CREF) under AEPC initially from the UK Government but a year ago, GIZ have also brought some German and EU funding. This Fund supports distributed energy systems through the following windows:

Solar Rooftops

SECF specifically target rooftop solar projects under 1 MW, addressing jurisdictional conflicts between NEA and AEPC. For such projects, a minimum of 51% of the annual PV energy generated must be self-consumed (as per net metering guidelines) and is offered through two mechanisms, which applicant industries and enterprises must choose when applying:

1. **Interest Rate Buy-Down:** Industries taking loans for solar investments receive a 5% interest subsidy for five years.
2. **Generation-Based Incentive Model:** Industries investing with their own equity receive a subsidy of NPR 1.50 per unit for the electricity generated.

Till now, 8 MW of solar rooftop are in operation with another 6-7 MW being implemented. NREP primarily focuses on larger industries, many of these located in industrial hubs such as the Hetauda-Birgunj and Butwal-Bhairhawa corridors. We also have other windows catering to small projects.

Bio-pellets

Bio-pellets are particularly effective as a sustainable alternative in replacing diesel and other fossil fuels, especially at the enterprise and industrial levels. While they are occasionally used in households, their practicality is limited by architectural constraints—such as the need for a terrace—making them less common in residential settings where electric cookstoves tend to be more popular. However, bio-pellets have gained notable traction in restaurants due to their efficiency and cost-effectiveness.

Currently, NREP is supporting three key projects related to bio-pellets:

1. **Husk Power:** This project aims at leveraging bio-pellets for energy transition in enterprises.

2. **Janda Devi/Bakas Energy:** This company is producing bio-pellets at scale, operating factories to meet growing demand. One of the significant challenges in Nepal's bio-pellet sector is the supply chain, but progress is being made. Large industries, such as Galaxy Packaging, have already replaced their diesel burners with pellet burners. Similarly, Dabur has begun using bio-pellets. In Kathmandu, several dalmot (snack) factories have transitioned to pellets due to neighborhood complaints about the smoke from burning mobile fuels. Economically, the cost of burning mobile fuels and pellets is comparable, but pellets are far more environmentally friendly, reducing smoke and neighborhood pollution.

3. **Innovation Window (Khumbu Agro):** A unique project in Solukhumbu led by Khumbu Agro is setting up a bio-pellet factory in the region. This initiative aims to replace LPG usage for 50 households and 50 hotels, which currently face exorbitant costs of LPG cylinders (ranging from NPR 10,000–12,000) due to transport and other logistical challenges. These cylinders are transported either by porters or helicopters. The bio-pellet factory will use raw materials sourced from nearby forests, providing a cost-effective and sustainable solution for the area.

Electric Cookstove

NREP promotes electric cookstoves, primarily through partnerships with microfinance institutions. Rather than providing direct subsidies, its approach focuses on developing a sustainable market for these cookstoves. Microfinance institutions already have an established client base, making them ideal partners for scaling the adoption of electric cookstoves. Currently, seven microfinance institutions are actively involved in promoting electric cookstoves, enabling their clients to transition to cleaner and more efficient cooking solutions. This market-driven approach ensures the long-term sustainability of electric cookstove adoption while addressing energy transition goals at the household level. We have been able to provide 40 thousand cookstove on commercial terms. Either people buy it through cash or take credit from microfinance institutions. Our other support includes developing informational materials such as posters, training programs for end-users, and as well as resources to create awareness and encourage usage.

Solar Pump

Under the same project, some microfinance institutions are also promoting solar water pumps in Madhesh Province. These pumps, with a capacity of 1–2 horsepower, are being introduced through a market development approach. So far, 28 solar water pumps have been successfully supported, that is being used for agricultural as well as fisheries.

EV Charging Station

A few initiatives under NREP's innovative window that is gaining significant momentum is the EV charging station where outfits like Estop and Jiva are setting up charging stations powered by the grid. At present, we're seeing an overwhelming number of applications for EV charging stations; however, with our project ending in March, we have to be very selective about who we choose to support.

Bio-gas plant

In Surkhet and Karnali region, NREP initiated work on a biogas plant with financing from the World Bank under AEPC. However, the project didn't work out as expected, not due to issues with the technology, but for other reasons that prevented it from gaining traction. There also was a cold storage-related project that didn't take off as planned for reasons unclear, but perhaps due to challenges involving local political leadership.

PPP model

The public-private partnership (PPP) model aims to support large projects, specifically under 1 MW of grid-connected solar or hydropower, through collaboration between the private sector and local government. This initiative not only provides energy to rural municipalities but also involves shared risks and returns between the government and private sector. If successfully implemented, local governments could generate revenue, thereby enhancing the benefits of federalism. NREP received around 600 to 700 substantial number of applications. However, NEA has been dragging its feet regarding power purchase agreements (PPAs), at one point even remarking, "We have a surplus in hydro, so why consider solar?" Fortunately, the situation is starting to shift with many municipalities in the Terai region expressing interest, but NREP insists that they secure a PPA from the NEA before proceeding, which ultimately has hindered progress. On a positive note, NREP has successfully implemented a mini-hydro project in the Solukhumbu area using the PPP model with funding by the World Bank.

NREP operates through two models of generation-based incentives: the **Self-Investment (Capex) Model** and the **RESCO Model** for rooftop solar. Under the **RESCO Model**, companies like Gham Power operate where industries do not need to make any investment upfront. The company puts in the application, installs and maintains the system, and the industry simply purchases the energy generated. The Self-Investment Model, on the other hand, encourages industries to invest in their own rooftop solar installations. Industries with the capacity to do so are the primary clients who take the lead in making these investments. As a result, many industries are now generating solar energy through this model.

Companies like Gham Power operate via both the model as per the interest of the industries. Initially, industries were not very confident and RESCO model was preferable due to mostly due decreased risk. Today as the cost is going down, and industries are getting more confident, they have realized that it is be more profitable to invest themselves and are veering towards the Capex Model as companies under RESCO model are reaching their limits. We, however, have RESCO model in pallets that are working well.

Key challenges in promoting Solar PV in Nepal

- **Awareness:** Many industries and individuals are still unaware of solar energy and its benefits, preventing broader adoption.
- **Energy Storage Costs:** While the costs associated with energy storage (batteries) present a challenge, they are not as significant as are other barriers. The trend of distributed investment is making rooftop solar more attractive to individual investors.
- **Net Metering:** Although net metering policy exists, few applications are being submitted, which stems from a lack of information, even within the NEA, with staff are unfamiliar with the policy.
- **Lack of Information and Communication:** The NEA lacks comprehensive knowledge about alternative energy options, which hinders the adoption of solar solutions.
- **Hydropower Mindset:** The NEA's predominantly hydropower-centric mindset with hydropower dominating the energy landscape and limiting the exploration of alternatives further complicates the issue, making it more political than technical.
- **Vested Interests:** The government's preferential treatment of hydropower is rooted in the belief that Nepal has enough rivers to meet its energy needs, resulting in little incentive to explore other sources. They are also concerned about potential revenue loss from hydropower if solar is more widely adopted. For instance, the reluctance to embrace electric vehicles is tied to fears of reduced revenue income from petrol and diesel taxes.
- **Political and Economic Reasons:** Influential political figures and stakeholders are personally heavily invested in hydropower fostering resistance to promoting solar PV, which they often view as a cheap competition rather than a complementary energy source to hydropower.

Strategies to overcome constraints to Solar PV

With innovation advancing, there's ample opportunity for everyone in the energy sector, especially given that the cost of solar has significantly decreased. When NREP started, it was around NRs 130,000 per kW, but it has now dropped to about NRs 40,000 per kW. Major constraint remains in policy. For net metering, while the Ministry's guidelines allow for a capacity of 1 MW, NEA has capped it at 500 kW without a clear rationale, an inconsistency that makes people hesitant to invest in larger projects. Aside from energy storage and policy issues, challenges seem minimal, as interest in solar is growing and investment is becoming more like crowdfunding, with funds are distributed across various projects.

What can be recommended are the following:

- **Awareness**: Increased emphasis on public awareness campaigns and engagement with the industry.
- **Policy Constraints**: Policies related to buyback rates and incentives need to be revisited to make them more appealing to investors and industries, particularly through feasible net metering.
- **Private Sector Participation**: Encouraging greater private sector involvement is crucial, which can be achieved through improved policies that help reduce the viability.
- **Focusing on the "missing middle market"**: It refers to medium-sized industries in Nepal's energy sector that have been largely overlooked. While NEA has focused on large-scale projects and AEPC has concentrated on smaller household-level energy solutions, medium-sized industries have been left unsupported. This gap needs to be bridged by targeting these middle-tier industries and providing them with the necessary support to transition to alternative and sustainable energy sources.

Major players and the challenges in promoting solar rooftop systems in Nepal

Sustainable energy challenge fund being a government fund, even if NREP ends it is still going to be there. UK funding is no longer available, and Norwegian and Danish sources have withdrawn. So new development partners and funding opportunities are being sought to sustain the program beyond 2025. GIZ has secured funds from the EU and Germany, while KFW has launched the DKTI program that supports solar rooftops, solar mini-grids, and solar water pumps. For solar rooftops, they have implemented an interest subsidy buy-down policy, which is part of the projects under AEPC.

{*Based on discussions with Suman Basnet*}

ANNEX 2

Overview of Promotion of Solar Energy in Rural and Semi-Urban Regions of Nepal (DKTI)

Program Name: Promotion of Solar Energy in Rural and Semi-Urban Regions of Nepal (DKTI)
Funded By: German Federal Government
Grant Amount: €9.5 Million

Program Overview

The program aims to promote clean energy through nationwide rooftop solar installations targeting commercial and industrial entities. The tentative goal is to install a total capacity of 15 MW of rooftop solar systems.

The program operates under a subsidy modality, offering a 50% interest subsidy for a period of 5 years. The subsidy amount is directly deposited by DKTI into the bank where the industry has taken the loan. Recently, there has been growing interest among many industries in adopting rooftop solar systems, driven by the frequent unannounced power outages that have impacted their operations.

Objective: Promotion of clean energy and Reduction of CO_2 emissions.

Implementation Modality

I. Renewable Energy Service Companies (RESCO):
   Service is provided through companies such as Gham Power.
II. Assessed Own Modality (Capex):
   Industries apply directly, adhering to technical standards set by AEPC.
   Example: LABIM Mall.

In this model, the industry handles the application process, owns the subsidy, and retains ownership of the assets.

Additional Benefits for Industries:

- Custom duty and VAT subsidy of 28% on solar panels and inverters, facilitated through a letter from AEPC.

Rooftop Solar System Design

After installation, the system optimizes energy use based on the lowest per-unit price: Prioritizes solar energy and switches to electricity from NEA if solar is insufficient and uses diesel generators as a last resort.

Examples of Assessed Own Projects

- **Hotel Himalaya:** 300 kW (Under construction)
- **Hulas Steel:** 1 MW (Under construction)
- **NEPO Industries, Bhaktapur:** 500 kW (Under construction)

Challenges in the Solar PV

1. Lack of Awareness (Initial Years):
   - When the project began, there was limited information about solar energy benefits.
   - Businesses were largely unaware and uninterested, leading to a lack of demand for the first 1–2 years.

   To address this, AEPC collaborated with regional chambers of commerce and industries, conducting awareness programs within industrial corridors.

2. Net Metering Issues:
   - Initially, Nepal Electricity Authority (NEA) was rigid in processing net metering applications.
   - Currently, NEA has become more flexible, especially for systems below 500 kW, though the process remains tedious.
   - For systems above 1 MW, industries must secure prior permission from NEA.

   Example: Reliance Spinning Mills installed a 3 MW rooftop solar system.

Future Potential

- Rooftop solar systems have significant potential as the cost of solar energy continues to decrease.
- To unlock this potential, the government must:
  - Simplify and improve net metering services.
  - Prioritize an energy generation mix rather than relying solely on hydropower.

{*From discussions with Niraj Sapkota, Solar Rooftop Coordinator, AEPC*}

ANNEX 3

AEPC and Renewal Energy (Solar) Transition Scenario in Nepal

Overview

The key focus of this document is to identify the key support systems that facilitate the energy transitions, with a particular emphasis on the mechanisms supporting solar energy development. The Alternative Energy Promotion Centre (AEPC) plays a key role in providing electricity through off-grid solar systems, especially in rural areas. Nepal's solar energy initiatives include on-grid rooftop systems and off-grid solutions like solar mini-grids and irrigation pumps. Solar mini-grids are crucial for providing reliable energy to communities, though challenges such as infrastructure gaps, lack of local government support, and technical manpower shortages persist. AEPC's major programs, supported by international donors like GIZ and USAID, promote solar technologies in rural and semi-urban regions through various funding mechanisms, including subsidies and public-private partnerships. This document also discusses the decrease in Power Purchase Agreement (PPA) rates, influenced by regional benchmarks and declining solar technology costs, and NEA's ongoing efforts to expand renewable energy capacity. Additionally, it highlights the progress in rural electrification, solar water heating, solar irrigation, and the adoption of electric vehicles in Nepal.

AEPC Mandate and working procedure

The Alternative Energy Promotion Centre (AEPC) is responsible for providing electricity through alternative renewable energy sources in areas without access to electrification, with a strong emphasis on off-grid solutions. AEPC's ***subsidy derivative mechanism*** recommended providing a 1KW system for every three households. However, this approach has evolved, and AEPC now focuses on electrifying entire communities, supplying energy to the whole area, and supporting productive end uses.

In the subsidy derivative mechanism, AEPC provides 90% of the funding, while the Local Government contributes 10%. Once a project funded through this mechanism is completed, the company that built it is responsible for maintenance and operation. After the project's completion, the Local Government assumes responsibility for the project. During this transition, AEPC trains local resources to operate the grid. However, there is a challenge: the local government often does not take on this responsibility as expected.

Mostly, AEPC prioritizes off-grid areas, particularly those identified as **"Last Mile Electrification**."

Last mile electrification *refers to efforts aimed at extending electricity access to the most remote and underserved communities, typically at the "last mile" of the electricity distribution network. These are areas where conventional grid extension is challenging due to geographical, economic, or infrastructural barriers.*

Guidelines to establish Renewal project in Nepal

Renewable energy projects in Nepal must adhere to technical guidelines established by the Nepal Photovoltaic Quality Assurance (NEPQA), which are applicable to ministries, AEPC, and REDS. The most recent update to these guidelines is from 2015, with a new version currently being prepared and which is under review.

Solar Technology Overview

Nepal is embracing solar energy through both on-grid and off-grid systems.

- On-Grid Solar: Rooftop solar systems tied to the grid.
- Off-Grid Solar: Includes solar irrigation pumps, solar mini-grids, and home systems designed to meet the energy needs of remote and rural areas.
- Solar Home System: 20 watts peak to 100-watt peak system.

Understanding the Role of Solar Mini-Grids in Nepal

Solar mini-grids are transformative technologies designed to enhance energy reliability and suitability in specific areas by utilizing solar power. Unlike individual solar home systems that cater to single households, solar mini-grids provide energy to entire communities, ensuring a more reliable and sustainable energy supply.

Technological Aspect	**Social and Economic Aspect**
Solar mini-grids use solar energy as the primary resource, with batteries designed according to the system's requirements to meet the local energy demand during non-sunlit hours.	While the technology is sound and continues to function effectively in many regions, the long-term success of these systems relies on strong community participation, sustainable revenue generation, and adherence to established technical guidelines.
Under AEPC's subsidy delivery mechanism, a 1kW solar system is required to serve at least three households, thus promoting broader access to solar power.	The success of solar mini-grids in Nepal is deeply influenced by social and economic factors. It includes important but difficult issues from business knowhow to revenue generation.
	For example, a 170 kW mini-grid system in Jajarkot was commenced with the intention to connect 520 households. However, due to lower-than-expected number of households participated, resulting in insufficient revenue generation even to cover basic operational expenses (including operator cost), and ultimately the sustainability of the system.

Major Challenges regarding Off-grid Solar System in Nepal:

Infrastructure Gaps: The lack of essential infrastructure, such as roads, transmission lines, and substations, remains a major hurdle in enhancing solar system deployment in rural regions.

Ineffective Local Government Participation: Local government bodies often fail to provide adequate support and intervention, which hampers the success of solar initiatives.

Technical Manpower Shortage: Finding and retaining technically skilled personnel in the villages to operate the systems is a persistent challenge. Operators often leave after training, necessitating either the training of new local personnel or the hiring of external experts with sufficient technical knowledge.

Major Programs under AEPC

a. DKTI (Promotion of Solar Energy in Rural and Semi- Urban Regions)

Supported by German government, the focus is on Solar Mini grid, Solar Water Pump and Solar Rooftop

Systems Type	**Target**	**Delivery Mechanism**
Solar Mini Grid (Off-Grid system)	To build two large solar mini-grid systems (around 250 kW). Tender process already completed, and installation is ongoing.	90% AEPC subsidy and 10% local body contribution.
Rooftop Solar (On-Grid System)	To install a total of 15 MW of systems. 2 MW of installation has been completed so far.	50% interest subsidy for 5 years by DKTI + 50% developer's investment (equivalent to a 20% subsidy of the system).
Solar Water Pumping (Off-Grid system)	Provide irrigation facilities to small farmers and community-scale operations in the Terai region, specifically targeting those located 300 meters from grid access.	90% funding from AEPC, with 10% contributed by local bodies.

b. POSTED (Promotion of Solar Technologies for Economic Development)

Supported by German Federal Ministry for Economic Cooperation and Development, the focus is on Solar Mini-grids, Solar PV irrigation Pumps, Solar Rooftop systems. The funding mechanism is to provide full technical support, including capacity building, training, and studies. However, it does not directly engage in implementation models.

c. NREP (Nepal Renewable Energy Program)

Supported by the British Embassy, the focus includes a wide range of innovative renewable energy (RE) technologies such as solar rooftops, micro-hydro, solar cooking stoves, and solar cold storage systems. Although associated with AEPC, NREP operates independently in a consortium consisting of 8 partners. The funding mechanism is to provide funding up to 1 crore NPR or 50% of the total project cost for projects implemented under a Public-Private Partnership (PPP) model. It has the mandate to fund solar projects up to 1 MW capacity. For solar rooftop projects, it offers a subsidy of 1.5 NPR per kWh per unit.

Solar Implementation model in Nepal and their progress as of now:

Based on the programs under AEPC and other independent organizations like USAID, there are several solar projects being implemented through various models, as outlined below:

1. **Subsidy Delivery Mechanism:** The primary business model for solar mini-grid implementation under the Alternative Energy Promotion Centre (AEPC) programs in Nepal operates on a 90-10 subsidy mechanism. According to the Nepal Renewable Energy Guidelines of 2015 (currently under revision), AEPC provides 90% of the funding, while the remaining 10% is covered by local government bodies. Under this delivery Mechanism, based on ward-level studies, approximately 45 mini-grids have been successfully installed, though the official report is still pending. Before the testing and commissioning phase of off-grid solar technology projects, AEPC conducts essential training for users. This includes key components like revenue generation from solar energy and operator training. Operators receive intensive training to ensure the effective management and sustainability of the systems.

2. **Institutional Solar Power Systems (ISPS):** The off-grid solar technology landscape in Nepal includes a specific focus on Institutional Solar Power Systems (ISPS), which cater to essential public facilities such as health posts, ward offices, schools, and hospitals. These systems are designed to provide economical and reliable electricity to sectors that require an immediate and consistent power supply to meet unmet energy demands.

    - The ISPS systems typically have a capacity ranging from 1 to 2 kilowatts peak (kWp).
    - The financing model for ISPS under the AEPC includes a 60% subsidy from AEPC, with the remaining 40% cost to be borne by the institution benefiting from the system.

    However, the implementation process faces significant challenges, particularly in rural areas. In the previous year, the mandate to facilitate ISPS installations was not fully met due to budget limitations. This resulted in fewer installations than planned. Despite past challenges, the current year's target is to distribute and install 100 ISPS systems. These installations are based on criteria such as the specific needs of the institutions, existing demand, and a thorough selection process to ensure that the systems are deployed where they are most needed.

3. **50-50% Subsidy Model: The system is grid-tied and is implemented under the (IPP) model which is prevalent in solar rooftops. In this model,** a 50% interest subsidy is provided for five years and 50% of the cost covered by the institution’s own contribution. This model supports industries by reducing the financial burden of initial solar system installation through combined subsidies and self-investment.

4. **NREP’s innovative technology Model:** NREP focuses on a diverse range of innovative renewable energy technologies, including solar rooftops, micro-hydro, solar cooking stoves, and solar cold storage systems. Though associated with AEPC, NREP operates independently and provides funding of up to 1 crore NPR or 50% of the total project cost for projects implemented under a Public-Private Partnership (PPP) model for solar projects up to 1 MW capacity. For solar rooftop projects, NREP offers a subsidy of 1.5 NPR per kWh per unit. The company covers 50% of the installation costs and NREP covers the remaining 50% of the costs over the next 5 years. This encourages solar adoption by easing the initial cost burden and reducing the effective cost of solar energy.

5. **Solar energy as a Service Model:** A third-party investor (not the industry) finances the installation and maintenance of the solar system. The industry signs a Power Purchase Agreement (PPA) with the third party. The industry buys electricity at a pre-agreed rate, often lower than the grid rate. Sometime, the particular company receives subsidy and does all the required investment for the industry who want to employ the technology who purchase the electricity from that company. A case example is the company such as Ghampower. It installs the entire solar energy system, finances the installation and manages their operations. The industries buy solar-generated electricity from Ghampower at a specified, fixed Power Purchase Agreement (PPA) rate which typically is for a period of 10 to 15 years. After the payback period, ownership of the system is transferred to the industry.

   Benefits for the industry from this model:

   - No upfront costs or maintenance responsibilities for the industry.
   - Offers industries a cost-effective alternative to hydro-generated electricity, with an average cost reduction from NPR 9-10 per unit to PPA rate around NPR 6-7.5 per unit. From this model industries can benefit NPR 2-3 per KWh.
   - Provides reliable energy and financial savings over time.

Factors Contributing to the PPA Rate Decrease to Rs 5.94

The decrease in the Power Purchase Agreement (PPA) rate to 5.94 reflects a combination of regional influences and advancements in solar technology. Here's a breakdown of the key factors behind this reduction:

- **Reference to India's PPA Rate**: The reduction in the PPA rate seems to be influenced by India's lower PPA rates. Since Nepal often benchmarks its energy policies and pricing against regional standards, especially India's, the drop in the rate could be a reflection of this regional alignment.
- **Decrease in Solar Technology and Battery Costs**: Over the years, the cost of solar technology, including photovoltaic (PV) panels and batteries, has decreased significantly. This reduction in technology and installation costs allows for lower PPA rates, as the overall investment needed to set up solar projects has become more affordable.

The current PPA rate of Rs 5.94 is still feasible for the private sector, as evidenced by the participation of private companies in the bidding process. Initially, when solar technology was less developed, higher PPA rates and substantial government subsidies were necessary to encourage adoption. However, as the market has matured, lower PPA rates are now sufficient to attract investment. If it was not feasible, private companies wouldn't have participated in the bidding process.

Furthermore, in regions like the Terai, where land and road access are easier, large-scale solar projects (ranging from 500 to 800 MW) can be installed more cost-effectively. The economies of scale increase the feasibility of the rate in these areas, making projects more attractive to developers while remaining profitable. However, the PPA rate of Rs 5.94 may not be as effective in hilly and rural areas of Nepal. The costs associated with setting up solar projects, including transmission lines, can be significantly higher in these regions. For example, the cost of mini-grids in such areas can range from Rs 10 to 12 lakh per kW. Various factors, including terrain, accessibility, and infrastructure, contribute to these higher costs, making it challenging to achieve the same level of cost-effectiveness as in the Terai.

Work-in-progress of NEA in energy transition:

NEA has recently initiated the process to install 800 MW of new capacity by opening a Power Purchase Agreement (PPA) for bidding. This move is a critical step in expanding Nepal's renewable energy infrastructure and addressing the country's growing energy demands. The response to NEA's call for bids has been substantial, with 134 bidders participating and submitting approximately 3,000 bids. This high level of interest reflects the private sector's confidence in the feasibility and profitability of solar and other renewable energy projects under NEA's framework. Moving forward, NEA will select the projects that will contribute to the 800 MW capacity based on a set of criteria, including price, requirement, and capacity. The selection process is likely to prioritize projects based on the availability and flexibility of substations and their load capacity. NEA's strategy also involves a need-based selection process, where projects that address specific energy generation needs at certain substations may be prioritized. This means that NEA will consider where the energy is most needed and which substations have the capacity to handle the additional load.

Overview of Progress in Renewable Energy (RE) in Nepal:

Rural Electrification: There has been a remarkable improvement in electricity access in rural areas through the deployment of solar mini-grids. These systems have enhanced the availability of electricity for essential services, including schools, health posts, and community centers. Solar mini-grids are especially beneficial in remote areas where grid extension is challenging.

Solar Water Heating: Promoted by AEPC and Local Governments, these systems are being utilized for drinking water and sanitation purposes, significantly improving access to clean water in various regions. Adoption of solar water heating has also contributed to reducing reliance on conventional fuel sources.

Increasing use of Solar-pumping in the Terai Region: Solar energy is increasingly being used for irrigation purposes in the Terai region. This shift from diesel-powered pumps to solar-powered ones has brought about environmental benefits by reducing carbon emissions and lowering operational costs for farmers. The adoption of solar irrigation systems has also enhanced agricultural productivity by providing a more reliable water supply.

Growing Adoption of EVs: Nepal has witnessed a growing adoption of electric vehicles, which is a positive step towards reducing the country's reliance on fossil fuels. This progress is complemented by an increase in the number of EV charging stations across the country, making it more convenient for EV owners and encouraging further adoption.

Awareness and Adoption of Solar Energy in Industries and Communities: Industries and communities are increasingly adopting solar energy solutions. For instance, to support its manufacturing operations, Reliance Spinning Mills has implemented a solar panel system with a capacity of approximately 9 MW. This initiative aims to fulfill the company's year-round energy requirements. The installation of the solar panel system has led to a significant reduction in annual electricity costs, amounting to approximately NRs 6 crore.

Development of Solar RoadMap*:* The International Centre for Integrated Mountain Development (ICIMOD) has initiated the development of a solar roadmap for Nepal. This initiative, supported by various national and international entities, aims to harness Nepal's solar potential and further contribute to the country's energy transition. The roadmap will provide strategic direction for the expansion of solar energy projects, ensuring sustainable and efficient use of solar resources.

Update on Renewable Energy Projects (Floating Solar)

Rasuwagadhi Hydropower Company Limited, a subsidiary of Chilime Hydropower Company, has recently completed a study on the implementation of floating solar technology in their pondage. The company has successfully conducted a Power Purchase Agreement (PPA) rate for this initiative. This projects also holds an immense potential for future development of Pumped Storage Hydropower (PSH).

Information about Major donors in Solar technology in Nepal

Donor/Agency	Role/Contribution
GIZ	Focal agency in solar systems in Nepal.
British Embassy	Another focal agency, involved in solar technology programs, though specific details of contributions are not mentioned.
ADB	Major stake Project 1: To install distributed minigrid of capacity 3.2 MW in rural Nepal (Dolpa, Humla, Jumla)- Tender call- A Chinese company got this project- Work has not started yet. Projects 2: After earthquake, called tender for providing small solar system from 8 KW to 15 KW 130 schools in 12 districts. Tender has already been awarded. Provided major support in IPP projects: Provided funding of 10 Rs (for 1st 30 month), while 6.6 Rs was covered by NEA when the PPA rate was 16.6 Rs (2 project completed).
USAID	USAID has its own programs, supporting solar technology indirectly through another party such as Urja Nepal. USAID had envisioned installing solar rooftops (8 kW to 50 kW) in 130 schools across 12 districts. The tender has been already awarded but the project is currently halted due to some issues.

{*based on discussions with Prasis Poudel, Solar PV Monitoring and Evaluation Expert, Alternative Energy Promotion Centre (AEPC)*}

ANNEX 4

Nepal's Electricity: Assessing Domestic Industrial Consumption Versus Export

Background

Nepal's abundant hydropower potential has generated a long-standing policy debate. Amidst competing analyses and interpretations—shaped by the power dynamics, beliefs systems and vested interests of various stakeholders and institutions—the country faces a complex policy dilemma: whether to prioritize electricity exports to generate revenue earnings for the state, or to focus on expanding domestic consumption to support its own economic growth. To shed further light on this debate, as well as to present our own analysis about which path could be better, we draw on survey data from industry and enterprises, together with secondary sources and key assumptions to compare alternative allocation of energy between exports and domestic industrial use.

Exporting surplus power offers concrete macroeconomic gains. Seasonal hydropower surpluses, especially in the monsoon, can be sold to India, earning foreign exchange and improving Nepal's balance of payments. In fact, for the past 2-3 years, Nepal has begun selling electricity to India. In the first half of fiscal year 2024/25 (July–Dec 2024), NEA sold about 1.76 billion kWh electricity to India at an average of NPR 7.39 per unit, earning roughly NPR 13.4 billion[24]. In the last fiscal year Nepal was a net exporter: imports from India totaled NPR 16.929 billion while exports were NPR 17.066 billion, yielding a modest trade surplus of about NPR 0.137 billion[25]. These earnings boost Nepal's Indian Currency reserves and can contribute to critical imports (fuel, food, etc.). They also encourage infrastructure investment such as new cross-border transmission lines.

However, each megawatt-hour (MWh) of electricity exported (at a price lower than what domestic consumers pay) is one less available for domestic users and for growth. Nepal's industries and enterprises still faces widespread power shortages and have to cope with erratic outages.

Reliable, affordable electricity is widely recognized as critical for domestic economic growth. Several studies on industry and energy point that expanded access to clean, steady power will promote industrialization, agricultural productivity and value-added services. Nepal's Long-Term Development Vision (2018 – 2043) envisions a sustained annual GDP growth of 10.5%, with industrial sector expected to grow at 13% annually. This trajectory aims to increase the industry's share of GDP to 30% by 2043, up from below 15%, where it has remained for more than a decade. Achieving such growth requires much more energy to power industries: for developing economies, a 1% increase in electricity consumption leads to 1.31% GDP growth.[26] And it this growth in electricity consumption could be brought about in a cost-effective manner by hydropower and

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[24] Republica, *"Nepal exports electricity worth Rs 13.4 billion to India in first five months of current FY,"* December 21, 2024, https://myrepublica.nagariknetwork.com

[25] Nepal Electricity Authority (NEA), *A Year in Review: Fiscal Year 2023/2024.* Kathmandu: Nepal Electricity Authority, August 2024 (Bhadra 2081).

[26] See https://www.nepjol.info/index.php/HN/article/view/16484/13407

other renewable sources, the environmental benefits would be substantive. Economically, industries and enterprises experience lower losses, higher output and sales, and larger profits when they have steady electricity. These processes, in turn, generate jobs, higher wages, and increased tax revenues for the state. As a result, powering up factories and agribusiness domestically can multiply economic benefits beyond the nominal value of the electricity itself.

Those who oppose export stress that Nepal has been suffering from chronic domestic power shortages and must address this issue before considering power exports[27]. Selling power abroad when domestic residents and factories remain dark is seen by these critics as economically foolish, and unbecoming of a sovereign nation. Moreover, if electricity is seen as a critical input to production and hence an important raw material for industrialization, exporting it would condemn the exporting country to a resource-exporting, manufactured item importing, neo-colonized status, they maintain.

A strong counter argument from those advocating for export is that, due to licensing and take-or-pay arrangements that Nepal government has entered into over the last two decades, the private sector and Nepali banks have made massive investments that have made them a much bigger player in the power sector than the official entity NEA. These investments – and indeed the investing financial entities too – will be in serious jeopardy if power surplus to current Nepali demand cannot be sold to the Indian market; and it will call into question Nepal's reputation as a private investment friendly country.

A consensus view emerging in recent years is that a balanced approach maximizes national benefit: first meet domestic demand, including latent or suppressed demand from industries and consumers, then export the surplus. The Ministry of Energy, Water Resources, and Irrigation has also emphasized this dual focus. In a special message included in the NEA Annual Report for Fiscal Year 2023/24, the Minister of Energy described hydropower as the backbone of economic progress and emphasized that the country's top priority is to utilize clean energy within the country, aiming for universal access and greater use in industry and agriculture. Likewise, the Secretary of the Ministry highlighted the importance of expanding both domestic consumption and electricity exports, presenting them as complementary goals.

In spite of these statements and supposed good intentions, comparatively less attention has been given to addressing and stimulating domestic electricity demand—both latent and suppressed. The marginal economic return to Nepal is greater when increased electricity consumption supports increased industrial output and tax revenue locally, rather than being sold at discounted rates abroad. The first major study to point this out was the 2003 USAID report on the *Economic Impact of Poor Quality on Industry in* Nepa*l*, with its assertion that if Nepal exported electricity, it would earn 6 US¢ per kWh whereas if it used that within Nepal, it would earn 86 US¢.[28] The following sections expand on these arguments and counter arguments based on the research findings of this study.

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[27] Kaoru Ogino, Mikiyasu Nakayama, and Daisuke Sasaki. "Domestic Socioeconomic Barriers to Hydropower Trading: Evidence from Bhutan and Nepal." *Sustainability* 11, no. 7 (2019): 2062. https://doi.org/10.3390/su11072062.

[28] See https://synergyforenergy.files.wordpress.com/2011/06/economicimpact_poorpowerquality_nepal_complete.pdf

Current Trade Balance with India

In FY 2023/24 (July 2023–June 2024), NEA reported becoming a net electricity exporter. In that year, Nepal exported about NPR 17.066 billion worth of power to India, while importing about NPR 16.929 billion. This tiny surplus, equivalent to NPR 0.137 billion, marks Nepal's first net gain in cross-border electricity trade. However, in dry seasons Nepal still relies on Indian imports to meet peak demand. Exports occur mainly in the wet months. There is, however, a price asymmetry. While Nepal exports electricity to India at an average rate of NPR 7.39 per unit (with spot market prices sometimes being as low as a fourth of that!), it imports electricity at a higher average rate of NPR 9.17 per unit.

There is also another asymmetry at work: while Nepal sells surplus power at around NPR 7.39 per kWh to India, its domestic industrial tariff is roughly NPR 10.54 per kWh (survey data). Simply put, each unit exported forfeits about 30% of potential revenue compared to selling it domestically.

Given Nepal's low industrial electricity consumption – largely due to unreliable supply and frequent outages – targeted interventions are required to stabilize delivery, boost domestic usage, and unlock new revenue steam for the NEA and the government. Besides investing in new generation projects, this discussion proposes measures to capture value from Nepal's latent industrial demand along with industry's willingness to pay for reliable electricity. Drawing on industry enterprise survey, secondary data, key assumptions, we model several scenarios:

Scenario 1: Premium Pricing for Reliability

Survey results indicate that 59% of industries and enterprises are ready to consume more electricity – provided the supply is steady and reliable. Moreover, these firms have expressed a readiness to pay a premium for uninterrupted, high-quality supply. On average, these industries/enterprises would accept a tariff increase of around 4% above current rates in exchange for guaranteed reliability.

With 9,085 registered industrial establishments in Nepal[29], if 59 percent of them i.e., roughly 5,360 firms, each pay 4 percent more for reliable electricity, NEA's industrial-sales revenue would rise substantially. This added revenue could provide NEA and the government with funds for further grid upgrades and capacity expansions. In practice, this could be achieved via time-of-day (TOD) rates or quality surcharges that reflect the premium value of stable electricity.

Scenario 2: Activating Latent Demand

Many firms report that their current electricity use is constrained by reliability. The survey reported the average monthly electricity bill per establishment to be NPR 230,753 (or NPR 2,769,036 annually). About 59% of the 9,085 registered industrial/enterprise establishments said they would increase consumption if reliability improved. That is roughly 5,630 establishments. If each of these raised consumptions by just 20% under better supply, additional revenue would be: NPR 2,769,036 × 5,630 × 20% = NPR 3.1 billion per year. If consumption jumped by 30% (i.e., a more optimistic

[29] According to data published by the Ministry of Industry, Commerce, and Supplies, a total of 9,085 industries were registered as of Fiscal Year 2022/2023.

scenario), the extra revenue becomes about NPR 4.7 billion per year. In other words, simply by harnessing existing latent demand through reliability investments, NEA could earn billions of rupees annually.

Scenario 3: Reducing Industrial Losses and Capturing Tax

Power outages impose heavy costs on businesses. Survey data shows that an average firm has annual sales of around NPR 152 million but loses around NPR 13.68 million (an average of around 8 to 9 %) due to outages. Assuming a 40% profit margin and 25% tax on profit, a typical firm pays around NPR 15.2 million in taxes [= 25% of (40% of 152 million)]. The lost profits from outages for one firm (= 40 % of 13.68 million) represent around NPR 1.37million (25% of 5.47 million) in forgone tax. If outages were eliminated, government tax revenue would rise accordingly. In effect, the economy could gain roughly 8 to 9% more tax revenue from industry were the industries to get more reliable power. This scenario highlights that beyond NEA's own sales, Nepal's treasury foregoes significant receipts when firms operate below capacity due to unreliable electricity.

Scenario 4: Price Asymmetry (Export vs. Domestic)

Selling power abroad at below-domestic prices is essentially a lost margin. With the export price at NPR 7.39/kWh and domestic industrial price at around NPR 10.54/kWh, each exported unit costs Nepal NPR 3.15 in lost potential revenue (a 29.89% shortfall). In aggregate, exporting 1 TWh instead of selling domestically would mean roughly NPR 3.15 billion less revenue. Thus, even small shifts in the balance between exports and local sales have large revenue implications.

Scenario 5: Price Arbitrage via Domestic Diversion

Using recent NEA trade values (exports to India at NPR 17.066 billion, imports at NPR 16.929 billion), Nepal's net surplus is only NPR 0.137 billion. But consider diverting just 30% to domestic industries of what was exported (and selling that 30% at the higher domestic price). Under this hypothetical split, 70% of exports yields NPR 11.946 billion, and 30% of exports repurposed yields an extra NPR 6.650 billion (30% × 17.066 billion × 1.2989 price gain). The improved net balance (new exports + domestic sales – imports) would be NPR 1.667 billion i.e., about 12 times larger than the original NPR 0.137 billion surplus. In short, reallocating 30% of exports to local industry would dramatically boost Nepal's economic growth.

In conclusion, prioritizing domestic industrial consumption over export offers Nepal far greater economic dividends. By investing in grid reliability and adopting demand-based pricing, NEA can tap into substantial latent demand—boosting sales without additional generation capacity. More reliable power reduces firms' production losses, elevates their revenues and profits, and propels GDP growth. As industries expand, NEA's sales and the government's corporate-tax receipts rise in tandem. Narrowing the gap between domestic and export tariffs further captures value that would otherwise leak abroad. Ultimately, reserving a larger share of clean hydropower for Nepal's own factories and communities generates a virtuous cycle of stronger industry, higher employment, increased tax revenue, and an improved trade balance—outcomes that far outweigh the gains from exporting power at discounted rates.

Addressing NEA's Reluctance on Industrial Rooftop Solar

While our analysis emphasizes maximizing domestic consumption, NEA has valid concerns about allowing widespread solar PV installations under net-metering for large industrial users. Industrial customers currently pay a premium tariff, and their revenues help cross-subsidize rural electrification, without which, rural electrification in Nepal would remain purely a loss-making service. If many firms generate their own power on-site, NEA fears a substantial loss of high-margin sales—and an even larger burden on the already subsidized rural electricity.

Rather than seeing rooftop PV as a threat, NEA can leverage it to strengthen overall grid performance. Industrial solar arrays help reduce daytime peaks, easing stress on transmission lines and cutting technical losses. In practice, integrating solar under a structured net-metering scheme can enhance reliability for all users and smooth out demand spikes. Importantly, the case for reallocating 20 to 30 percent of electricity to domestic industry remains compelling even as rooftop solar expands. Although on-site PV will shrink some daytime grid load, the net effect of more reliable supply and demand-responsive pricing will be a sustained rise in industrial consumption. By pairing thoughtful net-metering policies with strategic hydropower allocation, NEA can maintain its financial balance in the long run, speed the transition to clean energy, and fully capture the economic value of its hydropower resources.

ANNEX 5

Proceedings of the interaction with FNCCI, industrialists, hydropower and solar developers

Proceedings of Presentation and Interaction Program On:
Survey Findings of 'The State of Energy Use in Industries and Enterprises of Nepal'

Venue: IDA Office
Date: June 2, 2025
Time: 8:30 am to 12:00 noon

Objectives of the Session:

- Present key findings from the national survey on industrial energy use
- Discuss challenges, constraints, and opportunities for improving energy reliability and efficiency in industries
- Gather insights and feedback from stakeholders

Discussions:

It was agreed that frequent outages and high cost for energy hamper competitiveness in industries and enterprises thereby stalling industrial growth and overall economy.

"While industry drives Nepal's economy, contributing 13.6% to GDP and creating employment, its potential is undermined by persistent energy challenges. Beyond land and labor constraints, ***quality electricity*** *is essential for industrial competitiveness. Despite Nepal's inherent comparative advantage (i.e., the potential for affordable and reliable energy), the frequent power outages and high electricity costs make it hard for industries to grow and compete."*

A. Energy-related Issues, Challenges, and Opportunities in Industries and Enterprises

1. Fossil Fuel Dependency

There is widespread reliance on diesel due to unreliability of electricity: Across key sectors such as manufacturing, hospitality, services, banking, and even agriculture, there continues to be a heavy dependency on fossil fuels. From a technical perspective, when both megawatt capacity and overall energy supply are insufficient, the use of diesel becomes inevitable. It reflects a significant level of suppressed electricity demand within industries and enterprises. While many businesses express a strong willingness to shift toward cleaner and affordable energy sources, unreliable electricity supply remains the major obstacle which prevents from moving away from diesel to electricity.

One industrialist noted, *"Based on my analysis and experience, high-rise buildings and banks collectively operate an estimated 2,000 MW of backup generators to manage frequent power outages. In the banking sector alone, around 1,200 MW worth of generators are in place to ensure uninterrupted operations. These numbers show how much we still depend on diesel, but* *also point to a big opportunity in switching to electricity—if the power supply becomes more reliable, affordable, and of better quality."*

This persistent dependence on diesel is not due to a lack of interest in clean energy solutions, but rather a systemic failure to provide reliable and quality supply. Addressing this gap is crucial to enable industries to transition to sustainable energy and for reducing Nepal's reliance on costly and polluting imported fossil fuels.

A question was raised as to what would be the latent or suppressed demand for electricity in the industrial sector. It was agreed that the proportion of energy needs that comes from diesel, petrol, bio-fuel, LPG, etc., is indeed a proxy for the suppressed demand**.**

2. **Equipment Damages from Outages**

Machinery damage: Frequent power outages cause significant damage to electrical machinery in the industries. While electricity tripping is often cited as the primary reason, another major factor behind equipment failure is voltage fluctuation, which is equally harmful and often overlooked.

3. **Financial Burden of Backup Investment**

Costly backups: Due to ongoing power issues, industries are compelled to invest heavily in reliability technologies like On-Load Tap Changers (OLTCs'), diesel generators, online UPS systems, solar installations, and capacitor banks for backups. This leads to substantial unnecessary financial and operational burdens. But there is no protection through the government to the industrial consumers. A participant noted, "In my factory, only 20% of the equipment cost is on production machinery, while 80% is spent on backup systems."

4. **Infrastructure Gaps in Industrial Zones**

Infrastructure has not been adequately developed: Transmission lines and transformers in industrial zones are often outdated, under-capacity, or poorly maintained. In many cases, transformers are unable to withstand the industrial load, leading to frequent equipment failures and power interruptions. This makes it extremely difficult for industries to operate efficiently.

Additionally, while the Nepal Electricity Authority (NEA) has technical experts, there appears to be a gap in applying this expertise effectively. NEA should be able to assess and recommend appropriate infrastructure for each specific location. A recent example is the installation of low-quality poles and lines along the under-construction Asian Highway. These lines are designed to carry 11,000 volts, but the materials used are substandard that has weak weather resilience capacity. They are highly prone to tripping during adverse weather conditions—directly affecting industries with unexpected outages.

To prevent such issues, NEA and relevant authorities must conduct comprehensive technical studies before installing infrastructure. Each location should be assessed for its demand, risk factors (e.g., weather, load type), and assure strict supervision of suppliers and contractors during installation. Based on this analysis, suitable and durable infrastructure should be designed and implemented to ensure uninterrupted power supply—especially in industrial zones that are critical to economic growth.

B. Grid and NEA Related Issues and Challenges

5. Accountability of Service Provider (NEA)

For industrial consumers, faith in NEA is minimal, because there is a lack of accountability from NEA. The quality of electricity supplied tends to be poor. Despite ERC's claims of reciprocal treatment, NEA applies blanket approaches, which puts an unfair burden on industries. These chronic issues reflect systemic failures, not individual errors.

6. Transmission and Distribution System Flaws

Weak transmission and distribution design: The existing transmission and distribution systems suffer from structural flaws, such as infrastructure deficiency as well as a weakness in fundamental design, causing frequent outages, voltage fluctuation and poor-quality and unreliable electricity supply.

According to a few industrialists, frequent tripping particularly stems from substandard equipment (e.g., under-capacity transformers, poles, etc.)

Seasonal fluctuations in power generation: Power generation and supply varies severely by month and time of the day, disrupting industrial operations.

A participant remarked, " *I had intended to transition entirely to electricity in my factory, but the engineers cautioned against it due to Nepal's unreliable power supply. If I rely only on electricity, I might face big losses. So, I am compelled to continue using outdated machinery that runs on coal and biomass. Additionally, I incur substantial expenses on diesel generators and backup systems to keep things running smoothly.”*

The unstable power damages product quality and raises operational costs, eroding industry's comparative advantage.

7. High Tariffs & Cost Inefficiencies

NEA's administrative and overhead costs are unjustifiably high; these costs are often passed on to consumers, resulting in inflated industrial electricity tariffs. Moreover, Nepal's industrial electricity costs is much higher than that of neighboring countries like India, Bhutan, and Bangladesh.

8. NEA's Operational Efficiency

Evaluating NEA's loss: It is often claimed that the Nepal Electricity Authority (NEA) is operating at a loss. To assess this accurately, we must calculate the actual operating costs per unit and compare it with neighboring countries like India and China. This include staff/MW, construction/MW or per KM, transmission and distribution lines etc.

Operating costs include administrative expenses, transportation, staffing, and logistics. For example, NEA currently has approximately 700 vehicles (many operating in the service of the ministry, PM's office etc.) and around 12,000 employees. By improving efficiency in these areas—streamlining operations and optimizing employee use—significant cost reductions can be achieved. This would help reduce the overall operational burden and improve NEA's financial health.

9. Structural & political constraints

Financial mismanagement and political interference hinder sustainable power sector reform. This unresolved issue jeopardizes Nepal's industrial growth and export potential causing a loss of global competitiveness in the industrial sector and ultimately a threat to the nation's well-being.

10. Willingness to Pay and Industrial Feedback

Participants mentioned that industrialists have expressed a willingness to pay an additional 4% premium on electricity tariffs if they are assured of a reliable power supply. However, this willingness to pay could increase further if industries are guaranteed uninterrupted power and can eliminate their reliance on diesel generators. Diesel remains one of the most heavily used energy sources in the manufacturing sector, primarily due to the unreliability of grid electricity. Reducing this dependence by ensuring consistent electricity supply would not only improve operational efficiency but also support a cleaner and more cost-effective energy transition for the industrial sector.

However, other participants were of the opinion that charging industries an extra premium for electricity is unfair. Supplying electricity to industries isn't doing them a favor—it's an investment in building the nation. Instead of raising costs, the government should be offering subsidies. Individuals mainly use electricity for personal comfort, but industries use it for production, which drives economic growth, creates jobs, and supports countless families. Yet, instead of receiving support, industries are being burdened with higher charges.

The study shows that some industries are even willing to pay up to 4% more than their current rates. But this situation should not arise. Industries aren't paying more because they want to—they're doing so out of power outage, just to get reliable electricity. In reality, they should be getting electricity at a cheaper, subsidized rate. Industries are the backbone of the nation's economy, and they deserve dependable, affordable energy—not added financial pressure.

C. Recommendations Proposed

1. For NEA (Service Providers)

Address core institutional weaknesses

- Recognize the systemic nature of the issue: Reforms must go beyond individual efforts, because the per unit operation cost is really high in the power system.
- Unbundle NEA's monopoly: It is critical to provide a level playing field and to ensure check and balance between generation, transmission and distribution aspects of the overall grid to foster a competitive, accountable, and consumer-focused sector.

Modernize and Upgrade Infrastructures

- Replace under-capacity distribution and transmission system and invest in resilient and efficient system, for example, weather-proof poles/transformers; implement smart grid technologies such as real-time fault detection systems for proactive maintenance; Strengthen the distribution system design.

Manage Outage; Promote Transparency and Accountability

- Impose penalties for frequent outages and even for delayed outage responses. Additionally, improve operational efficiency by eliminating non-technical outage excuses, such as weather-related delays.
- Develop public dashboards for outage tracking and resolution timelines and formalize mechanisms for consumer feedback and complaints.

Address both demand and supply sides issues:

The survey offers a comprehensive view of energy use and highlights the need for reliable electricity. However, to make effective policy recommendations, it is crucial to analyze both the demand and supply sides of the energy sector. While we have sufficient data on current electricity demand, we also need updated insights on the supply side. This includes understanding:

- The current generation and transmission capacity
- Projected electricity demand over the next 10 years by taking policy parameters such as overtaking Bangladesh and India in per capita electricity consumption.
- Upcoming hydropower and renewable energy projects that can meet future demand of both power (MW) and energy (Mwh) during different times of the day and seasons.

2. For Regulatory & Oversight Bodies (NEA Regulatory Wing; ERC, DOED)

Tariff & pricing reforms

- Introduce targeted industrial tariff subsidies to increase competitiveness.
- Promote Time-of-Use (TOD) metering for demand management within the industries all over Nepal.
- Mandate cost-reflective tariffs, and comparisons with international standards, to prevent NEA from passing inefficiencies onto consumers.

Corporate governance & operational accountability

- Facilitate NEA unbundling of transmission and distribution operations.
- Enforce regulatory audits to cap administrative costs of service provider.
- Make mandatory reporting of losses due to voltage issues and power outages and impose penalties to the service provider for persistent grid instability affecting industries.

3. For Government

Policy initiatives & investment in strategic infrastructure

- Prioritize energy storage, by funding conventional seasonal as well as pumped storage hydro and battery storage projects to ensure daily peak and dry-season reliability. Recognize storage as essential for energy availability, supply stability, power quality, and affordability.
- Provide tax incentives for industries shifting from fossil fuel (diesel, coal) to grid and solar power, as well as to those investing in energy efficiency.
- Invest in grid modernization along the industrial corridors.
- The current approach to supply-side development appears to be misguided. Recently, a procurement notice was issued for a 5,000 MW Power Purchase Agreement (PPA), but it lacks a strategic focus on the appropriate technologies. At present, there are viable options available such as storage, pumped storage, and battery systems. Our efforts should be directed toward conventional seasonal storages and pump storage.
- Supply-side development should be built on four key pillars**:** availability, reliability, quality, and affordability**.** Unfortunately, the current trajectory does not align with these principles and represents the wrong type of development.
- The high consumption of coal, diesel, and LPG in industries is driven by various factors. However, survey findings suggest there is significant potential for industries to transition entirely to electricity—provided that a reliable supply is ensured.

  "*The primary barriers to this transition are not technical but financial and policy related. Shifting from fossil fuels to electricity requires upfront investments, and this raises concerns about cost. In this context, government incentives become crucial to support the transition.*

  Addressing these concerns will require more than just technical solutions—it calls for political dialogue. Therefore, such discussions should not be limited to bureaucrats; it must also involve political parties, academia, media and key decision-makers, so that meaningful and sustainable solutions can be developed and implemented."

List of participants at the state of Energy Use in Industries and Enterprises of Nepal, presentation and interaction program (June 2, 2025)

S. N	Name of the Participants	Name of the Organization	Designation
1	Mr. Anil Parajuli	Gham Power	Manager of the project that Gham Power is undertaking for UNIDO
2	Mr. Bharat Raj Acharya	FNCCI	Treasurer, FNCCI; Industrialist
3	Mr. Bholeshwor Dulal	Morang Chamber of Industry	Executive Member, MCI; Industrialist
4	Mr. Chandra K.C	IDA	Data Manager
5	Mr. Chudamani Bhattarai	Morang Chamber of Industry	Director General, CIM
6	Ms. Daya Laxmi Kilamik	Bhaktapur Chamber of Industry	Chair Person, BCCI
7	Mr. Dipak Gyawali	IDA	Chairman
8	Mr. Himal Khanal	IDA	Research Associate
9	Dr. Ram Prasad Dhital	Electricity Regulatory Commission (ERC)	Chairman, ERC
10	Mr. Ratna Sansar Shrestha	-	Chartered Accountant and Energy Expert
11	Dr. Sandip Shah	Pashupati Renewables	President, SOPPAN
12	Mr. Laxman Biyogi	Urja Khabar	Editor
13	Ms. Roshani Maiya Dhaubanja	FNCCI	President, BCCI
14	Mr. Pankaj Pokhrel	IDA	Research Manager
15	Mr. Prakash Gopali	All Three Media Ghar	Journalist
16	Mr. Prasis Poudel	POSTED GIZ AEPC	M&E Expert, Solar and Wind, AEPC
17	Ms. Prativa Rijal Oli	Morang Chamber of Industry	Executive Member, MCI; Industrialist
18	Ms. Rabina Thapa	IDA	Research Associate
19	Mr. Sandeep Thapa	IDA	IT Associate
20	Mr. Sanjeev Madhikarmi	Bhaktapur Chamber of Industry	Executive Member, BCI; Industrialist
21	Mr. Shiva Shrestha	All Three Media Ghar	Journalist
22	Mr. Som Nath Adhikari	Morang Chamber of Industry	Executive Member; Industrialist
23	Dr. Sudhindra Sharma	IDA	Executive Director
24	Mr. Suman Basnet	Nepal Renewable Energy Programme (NREP)	Team Leader
25	Mr. Suman M S Basnyat	IDC	Climate Finance Expert
26	Mr. Surya Prasad Adhikari	Barahi Hydropower Public Limited (BHPL)	IPP
27	Mr. Suyesh Pyakurel	Morang Chamber of Industry	Industrialist/ Immediate past president

ANNEX 6

Proceedings of the interaction with relevant Government Agencies i.e., MOEWRI, WECS, NEA, AEPC, IZML and ERC

Proceedings of Presentation and Interaction Program On:
Survey Findings of 'The State of Energy Use in Industries and Enterprises of Nepal'

Venue: IDA Office
Date: June 9, 2025 Monday
Time: 8:30 am to 12:00 noon

Objectives of the Session:

- Present key findings from the national survey on industrial energy use
- Discuss challenges, constraints, and opportunities for improving energy reliability and efficiency in industries
- Gather insights and feedback from stakeholders

Thematic Discussion of Core Issues

1. **Seasonal Outages During Peak Generation: A Paradox**

   Participants found it paradoxical that industries experience significant power outages during Jestha (May-June), Ashad (June-July) and Shrawan (July-August), a period when hydropower generation – most of which are run-of-the-river schemes, is at its peak. Other participants pointed out that there could be several contributing factors that lead to power outages during this season:

   - Grid instability and quality issues: Technical weaknesses in transmission and distribution lead to frequent outages, even when generation is sufficient.
   - Weather and environmental factors: June, July and August is the monsoon season. Monsoon-related weather events may cause disruptions to the transmission infrastructure.
   - Due to transmission and distribution repair-related work, the utility deliberately puts off the supply during this time of the year, which may appear to industries as power outage.
   - Fiscal year-end (Baishakh to Ashad) which is mid-July sees a surge in developmental activities across Nepal. There is a surge in development activities in the months prior to the end of the fiscal year – this may place additional loads on the grid. In the months prior to the end of the fiscal year, government and institutional bodies hurry to spend their remaining budgets, mainly on infrastructure projects such as road construction, electrification, and others.
   - This last-minute spending often results in poor-quality work, as projects are carried out hurriedly without proper planning or supervision. In the case of electrification, for

example, vendors sometimes build infrastructure without adequate preparation, leading to problems like low voltage, frequent tripping, and unreliable service. Participants pointed out that this issue is made worse by the fact that Ashad (June-July) falls during the monsoon season, when heavy rains disrupt construction and reduce work quality. As a solution, they suggested shifting the fiscal year-end from Ashad to Chaitra (March/April)—a drier and more stable period—so development projects can be implemented more effectively and sustainably.

- Increased industrial production: Cement, steel, and other infrastructure-related industries ramp up production during this period to meet fiscal deadlines, further stressing the grid.
- As per the findings, industrial electricity demand peaks during the dry season — exactly when NEA's generation capacity is lowest — creating severe supply gaps. This is further worsened by the fiscal year cycle (Falgun to Ashad), which compresses industrial production into a short window, triggering concentrated load spikes during low hydropower availability. As per some participants, restructuring the fiscal year cycle could help spread industrial production and energy demand more evenly across the year, reducing seasonal strain on the grid and allowing NEA to focus resources on improving grid stability and reliability rather than costly capacity expansion.

2. Grid Reliability, Outages, and Investment Needs

Industries continue to experience frequent power outages, even on dedicated feeders. For instance, Balaju Industrial Zone reported up to 37 hours of outages per month. Despite having separate feeders in 9 out of 10 industrial zones managed by IZML, such outages remain persistent, raising serious concerns about NEA's grid capacity and operational limitations. Concerns were also raised about the load management challenges that integrating large volumes of variable renewable energy, mainly solar, posed. It was pointed out that ensuring reliable (n-1 redundancy) supply demands significant investments in grid automation, redundancy, voltage control, and loss reduction - investments that may exceed NEA and government's current financial capacity. In order to do so, tariff may need to be hiked. However, higher tariffs risk industrial competitiveness and broader economic growth.

3. Institutional Coordination and Policy Harmonization

Significant coordination gaps exist among key institutions — NEA, AEPC, IZML, FNCCI, ERC, Ministry of Energy, and Ministry of Finance — resulting in fragmented and inefficient decision-making. Urgent legal reforms are required to harmonize policies related to solar development, net metering, feed-in tariffs (FIT), and industry participation to establish a coherent and effective energy transition framework. Moreover, the Electricity Regulatory Commission (ERC) should link tariff setting with NEA's performance through reliability-based penalties and incentives. While tariff revisions are inevitable to fund critical grid quality improvements, these must be balanced with mechanisms that ensure accountability and protect industrial competitiveness. As one participant emphasized: "*Tariff and penalties should go hand in hand*."

4. **Solar Rooftop Net Metering and Feed-In Tariff (FIT) Barriers**

   Though the concerned ministry, the Ministry of Energy, Water Resources and Irrigation (MOEWRI) has allowed for 1 MW of industrial solar production in its 2080 B.S. directive, NEA has set the metering cap at 500-kW. This has reduced the capacity for net metering and has created barriers to industrial solar uptake.

   One participant noted "*According to the current policy, net metering is allowed up to 1 MW and Feed-in Tariff is limited to 500 kW, even though many industries have rooftop capacity to generate 5–6 MW. There are no technical barriers; it's purely a policy constraint. This limitation should be addressed in the recommendations.*"

   Additionally, dual contracting process for FIT (between developer, NEA, and industries) is legally cumbersome.

5. **Industrial Transition to Clean Energy**

   Transitioning industries from fossil fuels to electricity presents significant financial challenges for both the utility and industries. NEA must invest heavily in grid upgrades, transmission infrastructure, and system reliability — costs that often translate into higher electricity tariffs. At the same time, industries face substantial capital requirements to replace fossil-fuel-based equipment (e.g., 51 husk boilers identified across 10 industrial zones) with modern electric alternatives. Higher tariffs could further strain industries' competitiveness.

   To enable this transition, targeted government interventions—such as subsidies, soft loans, and grants—are critical. However, concerns remain over the government's fiscal capacity to sustain large-scale financial support. Expanding policies like solar rooftop installations and Feed-in Tariffs (FIT) could help offset some of the financial pressures. A comprehensive cost-benefit analysis is urgently needed to design balanced, evidence-based policies that promote industrial electrification while protecting economic competitiveness.

- **Data and Survey Gaps**

  1. **Coal consumption**: Some participants mentioned that IDA' survey severely under-report the usage of coal by industries. As per the WECS data, coal consumption by the industries remains high, though compared to past years it is declining. Participants pointed out that the data from the Department of Customs also shows the import of coal into the country to be significant and that the industrial sector is the sector that uses the imported coal. The participants mentioned that this could be due to the under-representation of the types of industries that use coal and that this limitation in survey data needs to be acknowledged.

  2. **Diesel generator consumption data**: One of the participants having expertise in electrical engineering, mentioned that there is a system in Diesel generator where you can also record per unit consumption. Unfortunately, this question was not asked during the survey. According to this individual, this data would have been helpful to calculate the latent/suppressed demand i.e., the demand for electricity.

3. **Analyzing the diesel generator data for latent electricity demand:** The survey revealed that many industries use diesel generators as a backup power source. One participant suggested going a step further by identifying how many industries use these generators primarily for electricity generation versus other operational purposes. This distinction would help estimate the latent demand for electricity in the industrial sector—that is, the amount of power industries would likely consume from the grid if a reliable and consistent supply were available. Supporting this idea, a participant with expertise in electrical engineering pointed out that diesel generators often come equipped with systems that record per-unit electricity consumption. However, this detailed data is often available but not systematically collected or analyzed. He emphasized that collecting and using this unit-wise consumption data would be valuable for accurately assessing the hidden or unmet electricity demand across industries.
4. **Need for a more robust understanding of the willingness to pay**: The survey results show that on average the industries and enterprises are willing to pay 4% more than what they are currently paying if electricity is reliable. This figure may not match with the latent or suppressed demand in the sector. It was suggested to use more robust econometric / statistical methods to refine willingness to pay estimation. Additional scenario modeling (e.g. production loss under voltage fluctuation) could yield more realistic figure such as making feasible up to 20% tariff increase for industries and enterprises (taking into account the fact that they already pay more through diesel and other fossil fuels.
5. **Lack of Segregated Industrial Energy Consumption Data:** Currently, per capita energy consumption figures are heavily skewed towards the household sector, failing to accurately reflect industrial consumption patterns. There is a critical need to calculate industrial sector per capita electricity consumption separately. Existing data also significantly underestimates the industrial use of diesel, coal, and backup generators, resulting in an incomplete picture of total industrial energy demand and dependency.
6. **Alternative energy / generator backup – Fear or need?** An energy expert raised an important question: Is the use of alternative energy or generator backup driven by actual need or by fear of power outages? From this perspective, it is essential to analyze the data carefully. The survey found that even in some industrial clusters where power outages are relatively infrequent, industries still reported using generators as a backup source. This suggests that the decision to maintain backup systems may sometimes be influenced more by perceived risk than by actual supply issues. Understanding whether this reliance is from genuine necessity or precautionary behavior is crucial for designing better energy policies and improving grid reliability confidence among industries.

- **NEA Perspectives on Solar Scale-Up**

  Representatives from NEA clarified that industrial customers play a critical role in cross-subsidizing rural electrification. Given that the higher tariff that the industrial users have to pay helps fund and subsidies rural electrification, allowing unrestricted rooftop solar installations and generous Feed-in Tariffs (FIT) poses a serious threat to NEA's revenue stream. The representative from NEA mentioned that NEA is already under financial strain due to extensive Power Purchase Agreements (PPAs) signed with private hydropower producers to meet growing industrial demand. If industries — NEA's largest and most reliable customers — shift significantly to self-generation through rooftop solar, NEA could face major revenue losses.

  While solar costs continue to decline, surplus hydro-electricity generation during the wet season already creates system balancing challenges. Although the government introduced a work plan in 2080 to stimulate demand, actual demand growth has not materialized due to insufficient implementation support from the ministry. From NEA's perspective, the policy debate on large-scale rooftop solar expansion and unrestricted FIT must carefully balance renewable energy promotion with financial sustainability. Without proper policy safeguards, the electricity sector risks fragmentation, financial instability, and viability challenges.

  NEA participants highlighted critical concerns related to NEA's financial sustainability:

  - **Revenue Cross-Subsidization**: Industrial consumers remain key contributors to cross-subsidizing rural electrification. A significant shift to rooftop solar could reduce NEA's industrial revenue base, undermining this subsidy mechanism.

  - **Financial Strain from Existing PPAs**: NEA already carries heavy financial obligations from extensive PPAs signed with private hydropower producers to meet rising demand.

  - **Lack of Demand and Potential Impact of Solar Adoption**: Despite a significant increase in power generation during the wet season, the demand from the industrial sector has not correspondingly increased in proportion. In a scenario where demand remains static or does not grow, widespread adoption of unlimited solar energy could lead to a decline in current consumption levels. This potential reduction in demand may adversely affect NEA's revenue, leading to a financial imbalance within the system and weaken grid stability.

- **Updates on NEA's National Solar Development Plan**

  The participants from NEA mentioned that NEA has announced an ambitious plan to add 960 MW of solar capacity — primarily through private sector development under Power Purchase Agreements (PPAs) — within a one-year timeframe. To achieve this, NEA is adopting a scattered purchase model, aiming to enhance system flexibility and help address dry season supply gaps through diversified solar generation.

- **Consolidated Recommendations**

  Participants identified that Nepal's energy challenges, particularly for the industrial sector, are rooted not in inadequate generation but in policy fragmentation, weak grid infrastructure, and lack of coordinated institutional efforts. A multi-dimensional approach is required to address these systemic issues. Consolidated recommendations are provided below.

1. **Demand Optimization in Industries**
   - Shift industrial load toward wet season; incentivize off-peak industrial operations.
   - NEA should prioritize grid quality improvements over generation expansion.
2. **Tariff and Utility Performance Reform**
   - ERC's Action:
     a. Link tariff adjustments to NEA's reliability performance.
     b. Introduce penalties and incentives based on service quality.
   - Government and Fiscal Measures:
     a. Prioritize large-scale investment in grid quality, automation, and stability.
     b. Focus investments on storage solutions such as pumped storage hydropower and battery storage to manage dry season gaps, reduce reliance on imports, and ease environmental pressures.
     c. Re-structure NEA's revenue model to reduce its heavy reliance on the industrial consumers.
     d. Avoid blanket 20-unit electricity exemption (which supposedly targets poor households) since this distorts policy and strains NEA's finances.
3. **Renewable Integration and Policy Harmonization**
   - Develop balanced solar policies that:
     a. Carefully balances renewable energy promotion with NEA's long-term financial viability, ensuring both sector growth and grid reliability.
     b. Simplify legal and regulatory processes for solar installations, FIT, and net metering.
     c. Eliminate the current dual contract process for FIT and revise the 500 kW FIT cap to enable larger rooftop installations.
     d. Integrate energy transition planning with broader industrial and economic policies to attract investment and prevent long-term import dependency.
     e. Introduce reliability-based penalties and incentives to drive better utility performance.

4. Enabling and Cross-Cutting Measures

- Design demand creation strategies to absorb surplus generation during wet season.
- Promote energy efficiency, renewable energy adoption, and alternative energy sources to enhance industrial resilience.
- Revise the fiscal year cycle to decouple infrastructure spending from the monsoon season and smoothen industrial energy demand throughout the year.

- **Further Research and Data Improvements: Feedback Provided By Participants**

1. Incorporate Size-Based Loss and willingness to pay correlation: Assessing industrial energy losses based on industry size would help create stronger links between loss volumes and industries' willingness to pay. This could refine targeted policy interventions.
2. Comprehensive Industrial Energy Consumption Mapping: Collect and integrate detailed data on diesel, coal, and backup systems to provide a more accurate picture of industrial energy use. Current coal consumption appears to be understated compared to customs and WECS data — cross-verification with WECS provincial energy demand surveys is recommended.
3. Apply Advanced Econometric Modeling for WTP & Demand Elasticity: Utilize advanced statistical techniques to estimate willingness-to-pay (WTP) and demand elasticity under different reliability scenarios.
4. Thematic Areas for In-Depth Future studies:
    - Feasibility of industrial fuel switching from fossil fuels to electricity.
    - Potential for industrial transition from old to advance electric machineries.
    - Economic impacts of higher renewable energy penetration on NEA’s financial sustainability.
    - Grid stability and management under high variable renewable integration.

List of participants at the state of Energy Use in Industries and Enterprises of Nepal, presentation and interaction program (June 9, 2025)

S. N	Name	Affiliation	Designation
1	Mr. Anjal Niraula	Gham Power	CEO
2	Dr. Bivek Baral	Kathmandu University	Professor; Electrical Engineering
3	Dr. Bikram Acharya	Institute for Governance and Public Affairs (IGPA)	Researcher; Electrical Engineer
4	Mr. Chandra K.C	IDA	Data Manager
5	Mr. Dipak Gyawali	IDA	Chairman
6	Mr. Himal Khanal	IDA	Research Associate
7	Dr. Laxman Pd. Ghimire	AEPC	Deputy Director
8	Mr. Madhu Pd. Bhetuwal	Former Secretary	Water and Energy Comission Secretariat (WECS)
9	Mr. Nav Raj Ojha	Nepal Electricity Authority (NEA)	Energy Efficiency Department
10	Mr. Nimesh Adhikari	Industrial Zone Management Limited (IZML), Central office	Electrical Engineer
11	Mr. Pankaj Pokhrel	IDA	Research Manager
12	Dr. Ram Prasad Dhital	Chairman	Electricity Regulatory Commission
13	Ms. Rabina Thapa	IDA	Research Associate
14	Mr. Raju Maharjan	Ministry of Energy, Water Resources and Irrigation (MOEWRI)	Under Secretary
15	Mr. Sandeep Thapa	IDA	IT Associate
16	Mr. Sanjay Manandhar	Industrial Zone Management Limited (IZML), Central office	Electricity Department Head
17	Mr. Shanker Khagi	Former USAID	National Energy Expert
18	Mr. Shiva Shrestha	All three Media	Media Person
19	Dr. Sudhindra Sharma	IDA	Executive Director
20	Mr. Sushil Aryal	Nepal Electricity Authority (NEA)	Deputy Manager, Project Management Directorate

ANNEX 7

Participant List of Key Informant Interviews with Industries and Enterprises

Details of Key Informant Information Participant List- Energy Use in Industries and Enterprises Survey

S. N	Date	Name of the Informants	Name of Industry	Industry Type
1.	December 2, 2024	Pawan Jain and Govinda Solanki	Dhiraj Chamal Udhyog Pvt. Ltd, Morang	Medium
2.	December 2, 2024	Praful Das	Hulas Motors Pvt. Ltd, Morang	Medium
3.	December 2, 2024	Kiran Vyas	Kiran Cake, Morang	Small
4.	December 3, 2024	Giri Raj Basnet	Green Yard Agro Farm Pvt. Ltd, Morang	Large
5.	December 8, 2024	Umesh Dawadi and Arjun Dhungel	Phewa Pauroti Pvt. Ltd, Pokhara	Small
6.	December 8, 2024	Maniram Pandey	Pokhara Noodles, Pokhara	Medium
7.	December 9, 2024	Khem Bahadur Dhakal	Hotel Peninsula Pvt. Ltd, Pokhara	Small
8.	December 9, 2024	Birat Thapa and Bishwo Thapa	National Cable and Elite Pvt. Ltd, Pokhara	Small
9.	December 9, 2024	Madhu Acharya Gyawali & Sharmila Pandey	Fishtail Hospital Pvt. Ltd, Pokhara	Medium
10.	December 15, 2024	Dhan Bahadur Khadka	Tandon Plastic Udhyog Pvt. Ltd., Nepalgunj	Medium
11.	December 16, 2024	Shakar Prasad Tiwari	Aashirbad Paints Pvt. Ltd, Nepalgunj	Large
12.	December 16, 2024	Suryadaya Pratap Singh	Laxmi Plastic Pvt. Ltd, Nepalgunj	Medium
13.	December 16, 2024	Srijan Shrestha	Shakti Poly Pet Pvt. Ltd, Nepalgunj	Large
14.	January 12, 2025	Rajan Subedi and Rajendra Sharma	Lumbini Polymers, Bhairahawa	Medium
15.	January 12, 2025	Nikesh Shrestha	Nandani Agro Industries, Bhairahawa	Large
16.	January 12, 2025	Raj Kumar Singh	Siddhartha Oil, Bhairahawa	Large
17.	January 12, 2025	Debraj Rijal	Grand Kitchen, Bhairahawa	Small

ANNEX 8

Participant List of Key Informant Information with Energy Experts

S. N	Date	Name	Name of Organization	Designation
1.	August 29, 2024	Prasis Poudel	POSTED / GIZ	Solar PV Monitoring and Evaluation Expert
2.	December 12, 2024	Anjal Niraula	Gham Power; Service Provider	CEO
3.	December 15, 2024	Srijesh Prasad	Electricity Distribution Sector, NEA	Engineer
4.	December 22, 2024	Niraj Sapkota	Alternative energy Promotion Center (AEPC)	Solar Rooftop Coordinator, under DKTI
5.	December 27, 2024	Suman Basnet	NREP Donor Funded VRE Project	Team Leader, under NREP (Nepal renewable energy promotion) programme
6.	January 1, 2025	Dr. Laxman Prasad Ghimire	Alternative Energy Promotion Center (AEPC)	Deputy Director, Wind and Solar Energy
7.	January 5, 2025	Padam Oli and Sanjay Manandhar	Industrial Zone Management Limited (IZML)	General Manager and Electrical Engineer
8.	July 11, 2025	Nirmal K.C and Sabitri Dhamala	Water and Energy Commission Secretariate (WECS)	Engineers / Section Officers

ANNEX 9

List of participants in the interaction program in Biratnagar, Morang

Industry – Academia Dialogue
Energy Use in Industries and Enterprise Survey – Survey's Preliminary Findings and Interaction

List of participants

S. N.	Name	Organization/ Industries
1	Mr. Rakesh Surana	President, Chamber of Industries, Morang
2	Mr. Suyesh Pyakurel	IPP, Chamber of Industries, Morang
3	Mr. Nanda Kishor Rathi	Senior Vice-President, Chamber of Industries, Morang
4	Mr. Bholeshwor Dulal	Vice President (Agro/Hydro/Energy Sector), Chamber of Industries, Morang
5	Mr. Bipin Kabra	Vice President (Employer Sector), Chamber of Industries, Morang
6	Mr. Santosh Kumar Bhagat	Board Member, Chamber of Industries, Morang
7	Mr. Srijan Pyakurel	Board Member, Chamber of Industries, Morang
8	Mr. Dipak Gyawali	Chairman, IDA
9	Mr. Sudhindra Sharma	Executive Director, IDA
10	Mr. Rahul Gupta	Energy Cell member
11	Mr. Giri Raj Basnet	Green Yard Agro farm
12	Mr. Kiran Koirala	Fujima Oli Company Limited
13	Ms. Isha Guragain	Bikalpa on Alternative
14	Mr. Samir Chhetri	Bikalpa on Alternative
15	Mr. Anuj Sapkota	Journalist
16	Mr. Tilak Kumar Sah	Shree Pashupati Jute Mills
17	Mr. Saroj Koirala	Sanima GIC insurance
18	Mr. Arjun Subedi	Sanima GIC insurance
19	Dr. Kamal Parsad Dulal	Purbanchal University
20	Mr. Ramesh Babu Kafle	Purbanchal University
21	Mr. Sunil Kumar Chaudhary	Hulas Wire Industries

22	Mr. Vedanaand Yadav	Asian Thai Food
23	Mr. Himal Khanal	IDA
24	Mr. Ramesh Sigdel	Reliance Spinning Mills
25	Mr. Pawan Bothra	Hulas Khadyanna
26	Mr. Sanjeeb Kumar Mahato	Hulas food
27	Mr. Qaiser Alam	Rijal Tarhi Industries
28	Mr. Cheena Thapa	Reporter Daily Darshan
29	Mr. Binod Subedi	Nagarik Daily
30	Mr. Pashupati Nepal	Advocate
31	Mr. Binay Kumar Karna	Laminar Pvt. Ltd.
32	Mr. Hareram Singh	Baba Jute Mills
33	Mr. Pardeep Niraula	Pragati Textile
34	Mr. Vishwamitra Chaudhary	Reliance Spinning Mills
35	Mr. Prafulla Chandra Das	Hulas Motor
36	Mr. Som Nath Adhikari	
37	Ms. Kiran Byas	Kiran Cake Parlor
38	Mr. Pritesh Ghimire	NMB Bank
39	Mr. Antaraj Neupane	Bizmandu.com
40	Mr. Sandip Chaudhary	CIM
41	Mr. Binod Bhattarai	CIM
42	Ms. Rabina Thapa	IDA
43	Mr. Ramesh Dhungana	IDA

ANNEX 10

List of participants in the interaction program in Pokhara, Kaski

Industry – Academia Dialogue
Energy Use in Industries and Enterprise Survey – Survey's Preliminary Findings and Interaction

List of participants

S. N.	Name	Organization/Designation
1	Mr. Uttam Man Buddhacharya	Senior - Vice Chairman, PCCI
2	Mr. Pawan Kumar Prajapati	Former Chairman, PCCI
3	Mr. Dinesh Chandra Bastola	Vice Chairman (Industries), PCCI
4	Mr. Balaram Acharya	Vice Chairman (Commerce), PCCI
5	Mr. Shiva Gautam	Secretary General
6	Mr. Manoj Kumar Shrestha	Treasurer
7	Mr. Sudip Pradhananga	Joint Secretary General
8	Mr. Dipak Gyawali	IDA/NAST
9	Dr. Sudhindra Sharma	Executive Director, IDA
10	Professor Bishwo Kalyan Parajuli	Sociologist
11	Mr. Mohan Prasad Subedi	TAAN Gandaki
12	Mr. Rikhi Raj Giri	Chief Engineer, TTR
13	Mr. Rudra Lal Shrestha	Chairman, Pokhara industrial Sector
14	Ms. Sharmila Sharma Baral	Vice Chief Administration Officer
15	Mr. Lekhnath Poudel	Chairman, Readymade clothes Association
16	Mr. Thomnath Aryal	Chairman, Furniture Association
17	Mr. Himal Khanal	Researcher, IDA
18	Ms. Rabina Thapa	Researcher, IDA
19	Mr. Chinta Mani Bastola	Chairman, Money Exchage Association
20	Mr. Prem Pahari	Federation Of Contractors' Associations of Nepal (FCAN), Kaski
21	Mr. Pradip Rajbhandari	Pokhara Electronic and Mobile Business Association, Kaski
22	Mr. Maniram Pandey	Pokhara Noodles
23	Mr. Buddhi Bahadur Bhujel	Himshree Foods Pvt. Ltd.
24	Mr. Ek Narayan Gautam	Chamber of Commerce and Industries, Kaski
25	Ms. Durga Baral	Chamber of Commerce and Industries, Kaski
26	Mr. Hari Baral	
27	Mr. Tikaram Subedi	Chairman, Wholesale Businesses Association
28	Mr. Devendra Praju	Chamber of Commerce and Industries, Pokhara
29	Ms. Sita Gurung	PCCI
30	Mr. Sunil Chhetri	PCCI
31	Ms. Anita Acharya	PCCI
32	Mr. Radharam Ghimire	PCCI
33	Mr. Tikaram Subedi	PCCI
34	Ms. Sapana Subedi	PCCI

ANNEX 11

Questionnaire – State of Energy Use in Industries and Enterprises in Nepal

A. COVER [TO BE COMPLETED AS PER SAMPLE AND SAMPLING FRAME]

Sampling and Screening Information	
Name of the industry/enterprise	
Sector	
Size	
cluster	
District	
Name of City/town/village	
Name of the respondent	
Designation	
Contact number	Mobile number/ Land line number

sector		**size**		**cluster**	
Agriculture, forestry, and fishing	1	Large industry (Fixed capital exceeding five hundred million rupees)	1	Biratnagar-Itahari	1
Manufacturing	2	Medium industry (Fixed capital between one hundred fifty million and five hundred million rupees)	2	Birgunj-Pathlaiya	2
Construction	3	Small industry (Fixed capital less than one hundred fifty million rupees, other than a micro enterprise and cottage industry)	3	Kathmandu	3
Accommodation and food service activities	4	Cottage industry (Based on traditional skills and technology)	4	Pokhara	4
Information and communication	5	Micro-industry (Fixed capital not exceeding two million rupees, excluding house and land)	5	Bhairahawa-Butwal	5
Human health and social work activities	6			Nepalgunj-Kohalpur	6
Financial and insurance activities	7			Other specify	97
Education	8				
Other specify	97				

READ THE FOLLOWING TO THE RESPONDENT BEFORE PROCEEDING.

The goal of this survey is to gather information and opinions about the energy usage and problems in industries and enterprises in Nepal. The information gathered here will help to know the current status of energy usage among industrial and business sectors as well as recommend new policies and programs for improving energy efficiency and energy costs.

The information and opinions you provide will be anonymized. Neither your name nor the name of your business will be used in any document based on this survey.

con	Has the respondent provided informed consent to the data privacy protocols?

Yes	1
No	2

Number of attempts:	
First attempt	1
Second attempt	2
Third attempt	3

Reasons for Refusal:

Postponed time and date	1	Did not want to participate in the interview	3
Not available (no time)	2	**OTHER (SPECIFY)**	**97**

B. GENERAL INFORMATION

Id	Firm id	

Let's start the conversation with general information about this industry/business.

legal	What is this firm's current legal status**?**

Public limited companies	1	Limited partnership	5
Private limited companies	2	OTHER (SPECIFY)	97
Sole proprietorship	3	DON'T KNOW	-98
Partnership	4		

yearop	In what year did this establishment begin operations?

	Year
Year establishment began operations	
DON'T KNOW (SPONTANEOUS)	**-98**

INTERVIEWER: PROVIDE FOUR DIGITS FOR YEAR (BIKRAM SAMBAT)

labor	At the end of fiscal year **[FY 2080/81],** how many permanent, full-time individuals worked in this establishment? Please include all workers and managers. Permanent, full-time workers are defined as all workers that work for a term of one or more years and/or have a guaranteed renewal of their employment and that work a full shift.

activity	In fiscal year [2080/81], what was this establishment's main activity and product, that is, the activity and product that represented the largest proportion of annual sales? **INTERVIEWER: PLEASE RECORD THE DESCRIPTION OF THE ACTIVITY AND PRODUCT IN DETAIL, FOR EXAMPLE, "LEATHER SHOE MANUFACTURING' NOT JUST SHOE MANUFACTURING". FOR SERVICES, "RETAIL SALE OF WOMEN'S OUTDOOR CLOTHING" NOT JUST "CLOTHING". IF MANY GOODS ARE SOLD, SUCH AS IN A GROCERY STORE OR PHARMACY, INDICATE THE TYPE OF STORE.**

	activity	**DETAILED DESCRIPTION OF MAIN ACTIVITY AND PRODUCT**
Manufacturing or production of	**1**	**DESCRIPTION:** **EXAMPLE: Manufacturing of OPC and PPC cement, ready-mixed concrete, concrete pole and bricks**
Retail trade of	**2**	
Wholesale trade of	**3**	
Construction of	**4**	
Hotel	**51**	
Restaurant	**52**	
Provide services of	**6**	

labor_p	At the end of fiscal year **[FY 2080/81],** how many permanent, part-time individuals' workers worked in this establishment? Part-time workers are defined as all workers that work for a term of one or more fiscal years and/or have a renewal of their employment but work for less than a full shift.
labor_s	At the end of fiscal year **[FY 2080/81],** how many seasonal workers worked in this establishment? Please include all related workers and individuals who either worked full-shift for only certain seasons.

		Number of staff
labor	Permanent, full-time workers at the end of the last fiscal year	
labor_p	Part-time workers employed last fiscal year	
labor_s	Seasonal workers employed last fiscal year	

[NOTE: DON'T KNOW = -98; NO PART-TIME OR SEASONAL WORKERS = 0]

labor_plen	How many hours in a week were the permanent, part-time individuals employed on an average in fiscal year **[FY 2080/81]**?
labor_slen	What was the average length of employment of all full-time seasonal/temporary workers in fiscal year **[FY 2080/81]**?

	Hours/Months
Hours in a week a part-time individual was employed in the last fiscal year [In HOUR]	
Average length of a seasonal or temporary worker employed in the last fiscal year [In MONTH]	

C. OPERATIONS AND ENERGY USE

oper	What is the total number of operating hours for this establishment in a normal week?

		Constraint
Hours of operation in a normal week		>=1 and <=168

fuel	Think of the different types of fuel or energy sources that are used by this establishment to operate/run its major as well as other secondary activities. I am going to read aloud the list different types of fuel that are generally used. Kindly mention whether or not this establishment uses them.
fuel_prop	Considering the total energy usage portfolio of this establishment as 100 percent, what proportion of the total energy consumption is made up of [fuel]?
fuel_unit	In the fiscal year [2080/2081], what was the average unit/quantity of [fuel] used by this establishment in a month? **[Don't know = -98] [Energy bill paid by building or facility owners = -100]**
fuel_exp	What was the average expenditure on [fuel] used by this establishment in a month? [NPR] **[Don't know = -98] [Energy bill paid by building or facility owners = -100]**

[From fuel_prop to Fuel exp, repeat for each selected in fuel]

fuel		**fuel_unit**		**fuel_unit**	**fuel_prop**	**fuel_exp**
Electricity	1	Kilo- watt-hour (kWh)	1			
Solar PV (Self-generated)	2	Mega-watt-hour (mWh)	2			
Coal	3	Liters (l)	3			
Diesel	4	Kilo-liters(kl)	4			
Petrol	5	Kilograms(kg)	5			
Kerosene	6	Quintals(Q)	6			
Furnace-oil	7	Tonnes(T)	7			
Wood/Biomass	8	Cylinder (14.5 kg)	8			
Traditional biomass and agri-residue	9	Watt-hour (Wh)	**9**			
Wind energy (self-generated)	10	Others(specify)	97			
LPG	11					
Thermal energy from exo-thermic process (Self-generated)	12					
Others (specify)	97					

act	List out the major energy intensive activities of this establishment? What are the activities in which the majority of the fuel is consumed? **[SELECT UPTO FOUR]**

Activities			
Industrial equipment (other than for process heating)	1	Computers and administrative equipment	8
Lighting	2	Electric motors	9
Space heating	3	Electrical and electronic appliances	10
Water heating	4	Cooking	11
Chilling/refrigeration	5	Laundry	12
Air conditioning and ventilation	6	Other (specify)	97a, 97b, 97c
Process heating (for manufacturing industries)	7		

peak	Generally, at what time of the day does this establishment have peak load demand (electricity or other fuel sources)? **[SELECT ALL THAT APPLY]**

9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
17	**18**	**19**	**20**	**21**	**22**	**23**	**24**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**

peak_month	During which months of a year does this establishment have peak load demand (including electricity and all other fuel sources)? **[SELECT ALL THAT APPLY]**

Baisakh	**Jestha**	**Ashad**	**Shrawan**	**Bhadra**	**Ashwin**
Kartik	**Mangsir**	**Poush**	**Magh**	**Falgun**	**Chaitra**

D. ENERGY AND ELECTRICITY SUPPLY

apply	**Over the last two years, did this establishment apply to obtain an electrical connection?**

Yes	**1**	
No	**2**	*GO TO load*
DON'T KNOW (SPONTANEOUS)	**-98**	*GO TO load*

wait	In reference to that application, approximately how many days did it take to obtain it from the day of the application to the day the service was received?

	Days
Days waited for electrical connection	

[NOTE: LESS THAN ONE DAY = 1; STILL IN PROCESS = -96; APPLICATION DENIED = -97; DON'T KNOW = -98]

load	Over fiscal year [2080/2081], did this establishment experience load shedding or any kind of power outages? **Please note that load shedding refers to planned or pre-informed reductions in power supply whereas outage refer to irregular and unplanned interruptions in power supply.**

Yes, experienced load shedding	1	*GO TO load_len*
Yes, experienced power outages	2	*GO TO out_num*
Yes, experienced both load shedding and power outages	3	*GO TO load_len and out_num*
No	4	*GO TO alt_source*
DON'T KNOW (SPONTANEOUS)	**-98**	*GO TO alt_source*

load_num	In a typical week, how many load-shedding did this establishment experience?

	Number
Number of load shedding in a typical week	
DON'T KNOW (SPONTANEOUS)	**-98**

load_len	How long did these loadshedding last on average? What was the duration of one load shedding on an average?

	Hours	**Minutes**
Average duration of loadshedding		
DON'T KNOW (SPONTANEOUS)	**-98**	**-98**

load_loss	Could you estimate the losses that resulted from load shedding as a percentage of total annual sales?

	Percent of sales (%)
Annual losses due to loadshedding	
DON'T KNOW (SPONTANEOUS)	**-98**

load_trend	**Is it that the establishment experiences load shedding during certain times of a day, or during certain months of a year, or both. ?**

	out_trend	
Yes, load shedding is time specific within a day	**1**	
Yes, load shedding is month specific	**2**	***GO TO load_month***
Yes, load shedding is both time and month specific	**3**	
DON'T KNOW	**-98**	***GO TO out_num***

load_time	*[Ask if load_trend = 2 or load_trend = 3]* Generally, at what time of the day does this establishment experience load shedding? **[SELECT ALL THAT APPLY]**

9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
17	**18**	**19**	**20**	**21**	**22**	**23**	**24**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**

load_month	*[Ask if load_trend = 2 or load_trend = 3]* Generally, during which months of a year does this establishment experience load shedding? **[SELECT ALL THAT APPLY]**

Baisakh	**Jestha**	**Ashad**	**Shrawan**	**Bhadra**	**Ashwin**
Kartik	**Mangsir**	**Poush**	**Magh**	**Falgun**	**Chaitra**

out_num	In a typical week, how many power outages did this establishment experience?

	Number	
Number of power outages in a typical week		
DON'T KNOW (SPONTANEOUS)	**-98**	*GO TO out_loss*

out_len	How long did these power outages last on average? What was the minimum duration of power outage? What was the maximum duration of power outage?

	Hours	**Minutes**
Minimum duration of power outage		
Maximum duration of power outage		
DON'T KNOW (SPONTANEOUS)	**-98**	**-98**

loss_type	What types of losses did this establishment incur due to power outage and/or low quality of electricity supply in the past fiscal year?

losses			
Damage to machinery or equipment	1	Decreased product quality	5
Increased maintenance or repair cost	2	Loss in sales revenue	6
Higher fuel cost for backup generators	3	Other (specify)	97
Spoilage or damage to raw materials or finished goods	4	The establishment did not incur any significant losses	0

out_loss	Could you estimate the losses that resulted from power outages as a percentage of total annual sales in the past fiscal year? **[DO not ask if loss type = "0"]**

	Percent of sales (%)
Annual losses due to power outages	
DON'T KNOW (SPONTANEOUS)	**-98**

out_trend	**Is it that the establishment experiences power outages during certain times of a day, or during certain months of a year, or both, or is it just a random event?**

	out_trend	
Yes, power outages are time specific within a day	**1**	
Yes, power outages are month specific	**2**	**GO TO *out_month***
Yes, power outages are both time and month specific	**3**	
No, power outages are random events	**4**	**GO TO *alt_source***

out_time	***[Ask if out_trend = 2*** **or** ***out_trend = 3]*** Generally, at what time of the day does this establishment experience power outages? **[SELECT ALL THAT APPLY]**

9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
17	**18**	**19**	**20**	**21**	**22**	**23**	**24**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**

out_month	***[Ask if out_trend = 2*** **or** ***out_trend = 3]*** During which months of a year does this establishment experience power outages? **[SELECT ALL THAT APPLY]**

Baisakh	**Jestha**	**Ashad**	**Shrawan**	**Bhadra**	**Ashwin**
Kartik	**Mangsir**	**Poush**	**Magh**	**Falgun**	**Chaitra**

alt_source	**Over the course of fiscal year [2080/2081], did this establishment own or share an alternative source of electricity besides the main electrical connection systems, for instance generators, battery backups, solar PV, etc.?**

Yes	**1**	
No	**2**	**GO TO *alt_plan***
DON'T KNOW (SPONTANEOUS)	**-98**	**GO TO *alt_plan***

list_source	**Kindly list out all the alternative sources that the establishment used for electricity. [MULTIPLE LISTING ENCOURAGED]**

Sources			
Generators; Backup Generators	1	Electricity generated from within the industrial (exothermic) process	5
Battery Backup Systems (Inverters)	2	Negotiated alternative power supply arrangements	6
Solar PV	3	Solar grid	7
Electricity generated from bio-mass	4	Others (specify)	97

alt_share	What percentage of this establishment's electricity came from those alternative sources?

	Percent
Percentage electricity from generators	
DON'T KNOW (SPONTANEOUS)	**-98**

alt_plan	**Do you have any intentions on adding/increasing alternative energy sources?**

	Yes/No
Yes	**1 [Go to alt_cons]**
No	**2**

alt_cons	**What are your considerations for adding/increasing alternative energy sources?**

Considerations			
For replacing existing energy/electricity needs	1	Increase security of supply during uncertain access	4
Expanding energy usage	2	As an additional income generating activity for this industry/enterprise (selling to grid or other industries/enterprises)	5
Increase security of supply if prices are volatile	3	Other (specify)	97

out_cause	**[ASK ALL] In your opinion why does load shedding/ power outages still exist among industries and enterprises? [MULTIPLE OPINIONS POSSIBLE]**

Reasons for power outages/load shedding			
Because electricity has been diverted to residential sector	1	Because of political and regulatory issues	6
Because electricity has been diverted to agriculture sector	2	Because of the use of older generation and energy inefficient machines, technology, and appliances	7
Because electricity has been exported to India/other countries	3	There is no load shedding at present **[DON'T CHECK IF load == 4]**	8
Because of insufficient power generation from the utility sector in the country	4	Others (specify)	97
Because of inadequate supply-related infrastructures, grids, transmission lines	5		

sat	On a scale of 0 to 10, while 0 being highly dissatisfied and 10 being highly satisfied, please indicate to what extent are you or the management and staff of this establishment are satisfied with regards to the usage of the electricity from the electric connection provided by the national utility.

	RANK	(SPONTANEOUS) DOES NOT APPLY	DON'T KOW
sat_a. How satisfied are you or the management and staff of this establishment with the current availability and regularity of electricity?		**-96**	**-98**
sat_b. How satisfied are you or the management and staff of this establishment in terms of the technical quality of the electricity supply, including voltage stability and other important parameters?		**-96**	**-98**
sat_c. How satisfied are you or the management of this establishment regarding the affordability; i.e., price or per unit price that you have to pay for the electricity?		**-96**	**-98**
sat_d. How satisfied are you or the management and staff of this establishment regarding the support services – like customer support, provision of dedicaded feeder, notification of outages, etc – that are provided while using the electricity?		**-96**	**-98**

E. ENERGY PRICING AND WILLINGNESS TO PAY

price	What is the pricing mechanism of the electricity used by this establishment? Does this establishment pay a differential tariff rate for the electricity used at different time of the day (ToD)?

	price	
Yes, tariff rates are different for different ToD	**1**	**GO TO** *tar_peak*
No, it doesn't have a differential tariff rate	**2**	**GO TO** *tar_avg*
DON'T KNOW (BILLS PAID BY OWNERS OR FACILITY PROVIDERS)	**3**	**GO TO *rel***
DON'T KNOW (SPONTANEOUS)	**-98**	**GO TO** *tar_avg*

tar_peak	What is the rate of per unit of electricity during peak time?
tar_off	What is the rate of per unit of electricity during off-peak time?
tar_norm	What is the rate of per unit of electricity during normal hours?
tar_avg	What is the rate of per unit of electricity paid by this establishment?

[DON'T KNOW = -98; DOES NOT APPLY = -96]

rel	If this establishment has access to additional electricity that is reliable, would you or the management or the technical team anticipate the establishment consuming more electricity as a result? **Note: Reliable electricity refers to uninterrupted supply of electricity with desired technical qualities like optimal voltage.**

	rel	
Yes, it will consume more electricity if reliable	**1**	
No, it will not consume more electricity even if reliable	**2**	***GO TO not_consume***

If yes, for what would you use this electricity for? [OPEN ENDED ANSWER]

add_pay	If electricity were to become more reliable (i.e., with no power outages/load shedding and with desired voltage), how much additional amount would the management be willing to pay for per unit of electricity? Express this in percentage in terms of average per unit price of electricity the establishment have been paying.

	Percent
Additional per unit price	
DON'T KNOW (SPONTANEOUS)	**-98**

not_consume	**[Ask if *rel* = 2]** Why would this establishment not consume additional electricity even if the supply were reliable?

Reasons for not consuming additional electricity			
Current energy consumption meets all operational needs	1	Current equipment and infrastructure set-up restrict additional usage	5
Budget constraints prevent increased electricity usage	2	Concerns about potential future price increase	6
The establishment has already implemented energy-efficient practices	3	Concerns about potential future unreliability	7
Environmental or sustainability goals limits energy consumption	4	Other (specify)	97

F. ENERGY EFFICIENCY

eff	**Has this establishment adopted energy efficiency measures to reduce energy consumption while maintaining or improving productivity? Energy efficiency measures include upgrading energy efficiency equipment, regular maintenance, process optimization, lighting improvements, energy monitoring, employee training and awareness, and so on.**

	Yes/No
Yes	**1**
No	**2**
Energy efficiency measures are not really required for this establishment (Spontaneous)	**3**

behav	**[ASK IF eff = 1** Which specific energy efficiency measures are currently at place in this establishment? **[INTERVIEWER: DON'T READ ALOUD] [INTERVIEWER: PROBE FOR MULTIPLE ANSWERS]**

Energy efficiency measures adopted			
Upgraded equipment and machinery	1	Periodic energy audits	5
Improved insulation and building envelope	2	Use of renewable energy sources	6
Energy efficient lighting system	3	Awareness; Behavioral and operational changes (Use electricity only when required, switch of machines appliance when not in use, proper timing related to installation and operation of machinery and so on)	7
Regular maintenance of machinery and appliance	4	Other (specify)	97

audit	**[Ask all] Does this establishment conduct periodic energy monitoring and energy audits?**

	Yes/No
Yes	**1**
No	**2**
Don't know	**-98**

invest	Over the last five years, how much has the establishment invested in improving energy efficiency (i.e., introducing and upgrading energy-efficient technologies, conducting energy audits, and so on) ? **[AMOUNT IN NPR]**
invest_fig	**PLEASE WRITE IN FIGURES**
invest_word	**PLEASE WRITE IN WORDS**
future	In the coming five years, how much has the establishment planned to invest in improving energy efficiency (i.e., introducing and upgrading energy-efficient technologies, conducting energy audits, and so on) in the coming five years? **[AMOUNT IN NPR]**
future_fig	**PLEASE WRITE IN FIGURES**
future_word	**PLEASE WRITE IN WORDS**

	Amount in NPR	**In words**
Investments made over the past five years		
Planned investments in coming five years		

[DON'T KNOW = -98; NO PLANS FOR INVESTMENT = -99]

trans	**[ASK IF invest > 0]** Could you mention in a few words the areas in which the investments were made compared to how the things were before? **[OPEN ENDED]**
bar	Let us now discus about economic, information, technical and institutional barriers that might prevent this establishment from introducing energy efficiency measures and practices. On a scale of 0 to 4, while 0 being no barrier at all and 4 being the highest level of barrier, how do you rank the following barriers.

ECONOMIC AND FINANCIAL	RANK (0-4)	(SPONTANEOUS) DOES NOT APPLY	(SPONTANEOUS) DON'T KNOW
bar_f1. High upfront investment requirement for energy efficiency improvement.		**-96**	**-98**
bar_f2. Higher cost of capital and higher interest rate?		**-96**	**-98**
bar_f3. Lower returns on investment because investments made on other areas generate higher returns than that made on energy efficiency?		**-96**	**-98**
bar_f5. Energy savings is not a priority because energy cost is only a small fraction of total production costs.		**-96**	**-98**
INFORMATION			
bar_i1. Lack of awareness of the availability and benefits of using energy efficient technologies and devices.		**-96**	**-98**
bar_i2. Difficulties in obtaining necessary information on energy efficient technologies and devices		**-96**	**-98**
bar_i3. Lack of experience and/or confidence in energy efficiency measures.		**-96**	**-98**
TECHNICAL			
bar_t1. Lack of skilled personnel to handle the efficient devices and processes.		**-96**	**-98**
bar_t2. Lack of local supplies for equipment parts and long wait times to get equipment parts from abroad		**-96**	**-98**
bar_t3. Installing energy efficiency measures requires substantial reconfiguration of production processes.		**-96**	**-98**
bar_t4. There are higher probability of malfunction or poor performance. Production process could be disrupted		**-96**	**-98**
INSTITUTIONAL			
bar_g1. High compliance and complex permitting process to employ energy efficient devices and process.		**-96**	**-98**
bar_g2. Lack of effective government policies to facilitate energy efficiency programs?		**-96**	**-98**
bar_g3. Unofficial/Informal payments demanded to receive government permits.		**-96**	**-98**
bar_g4. The country lacks legal protection of property rights.		**-96**	**-98**
bar_g. Uncertainty about the future of the overall industry/sector.		**-96**	**-98**

G. SHOSCKS AND RESILIENCE

Looking at what has happened in the past 10 years, some event standout as SHOCKS. Some of these includes the earthquake (2015), Economic Blockade by India in 2015 and 2016, COVID and related shutdown in 2020-2021 and the escalation of global price due to Ukraine Russia war (2022-2023).

shocks	Which of the above-mentioned shocks have affected your establishment's energy needs and usages? [Select all that apply]

shocks			
2015 Earthquake	1	Escalation of global prices due to Ukraine-Russia war	4
2015/2016 Economic blockade by India	2	None of the above	-98
Covid -19 pandemic and related shutdowns	3		

impact	How did [shocks] impact your establishment's energy supply and usage?

impacts			
Disruptions in energy supply and operations	1	Increased cost of goods/services	5
Energy (fuel) shortages	2	Decreased production	6
Reduced or halted operations	3	Other (specify)	971
Increased price of fuel	4	Other (specify)	972

cope	What strategies did your establishment adopt to cope with energy-related challenges during [shocks]? Select all that apply

cope			
Implemented energy efficiency measures to reduce consumption	1	Passed on increased energy cost to customers	4
Shifted to non-renewables like coal and fossil fuels (petrol, diesel, etc.)	2	Absorbed increased energy cost by the establishment itself	5
Shifted to alternative and renewables	3	Other (specify)	97

resilient	How resilient do you consider your establishment to be in facing and effectively coping future energy-related shocks?

resilient			
Well-prepared for any potential shocks	1	Limited preparations in place	3
Some preparations in place, but could improve	2	Unprepared for future shocks	4

INTERVIEWER READ OUT:

I would like to ask you a few questions about revenue and sales of your products/services. These questions are important to understand how effectively and efficiently the industries/enterprises utilize energy.

For example: It would help us know about energy consumption per capita of employees or total sales generated per unit of energy utilized, and so on.

You could either choose to say amount or ratios

prodn	**[Ask if activity == 1]** In fiscal year **[2080/2081],** what were this establishment's total annual production for its main product? **[Unit: ……………………………………………………………………………….] [KG, Liter, Box, pieces, Quintals, Tones and other specify etc.]**
sales	In fiscal year **[2080/2081],** what were this establishment's total annual sales for **all** products and services? **[In NPR]**
sales_word	Write in Words: **EXAMPLE: FIVE MILLION AND THREE HUNDRED THOUSAND** RUPEES

	Sales (NPR)
Total annual sales for all product or services	

H. CLOSURE

support	What are the areas where this industry or the establishment itself anticipate government support to improve the energy usage and energy efficiency?

Areas of support and intervention			
Reduced electricity prices			
Financial support or subsidies for renewable energy	1	Policy and regulatory support	5
Financial support or subsidies for adopting energy efficient technology	2	Education, training, and capacity building	6
Research and development support	3	Public private partnership in the area of renewable energy	7
Tax incentives for energy efficient investments	4	Other (specify)	97

chal	**If you were to summarize in a few words, what are the main challenges faced by this industry or the establishment itself related to energy or other related issues? And what do you think could be done to minimize these challenges?** **[INTERVIEWER: PROBE FOR QUALITATIVE RESPONSE]**

[OPEN ENDED ANSWER]

THANK YOU

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