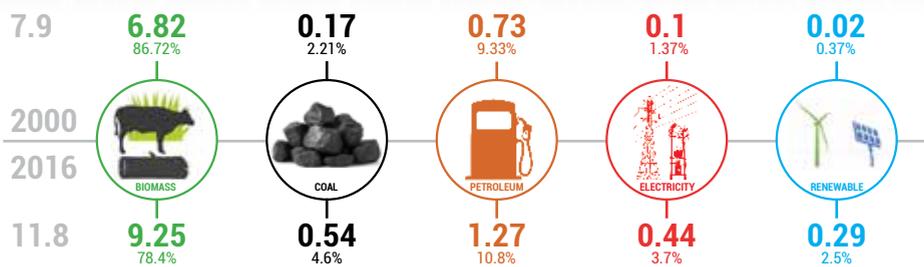


Challenges to increasing the productive use of HYDROELECTRICITY IN NEPAL

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Total energy consumption in tons of oil equivalent (x10⁶)

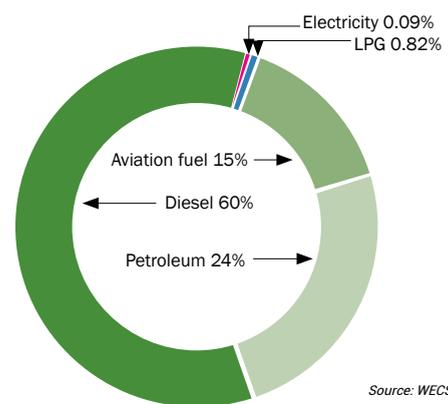


Nepal's energy system is dominated by biomass¹ and fossil fuel. In 2016, Nepal consumed 11.8 x 10⁶ tons of oil equivalent energy, of which 78.4% came from biomass, 10.8% from petroleum products and 4.6% from coal.² Electricity and renewable sources such as solar and micro hydro accounted for 3.7% and 2.5% respectively of the total energy.³ In 2000, biomass had accounted for 86.72% of the total energy mix while electricity's share was 1.37%. Petroleum products were 9.33% of the total while coal occupied 2.21% share of the total energy use of 7.9 x 10⁶ tons of oil equivalent.

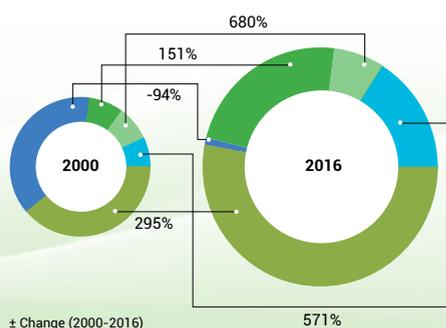
Petroleum products: Increasing dependence

In 2000, Nepal imported 857,847 kL of petroleum products from India and this dependence has increased considerably since.³ Sixteen years hence, in 2016 that quantity had almost tripled to 2,477,986 kL⁴ purchased at an estimated cost of Rs. 155 billion in equivalent currency.⁵ Over this period, the import of petrol has increased by 571% while that of diesel increased 295%. In the same period, import of Liquefied Petroleum Gas (LPG)⁶ and aviation turbine fuel (ATF) increased by almost 680% and 151% respectively. Kerosene import, in contrast, had declined by 94%. Currently 85% of the imported petrol and diesel is used in the transport sector.⁷

Energy consumption: transport sector by fuel type



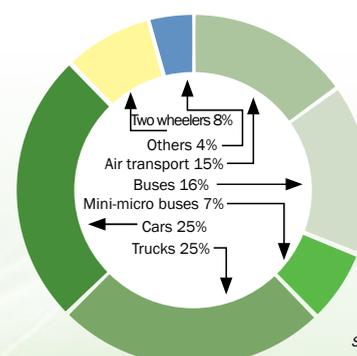
Increase in import of petroleum products



	2000	2016
Quantity (kL)		
Diesel	333,791	1,319,873
Kerosene	325,198	19,607
LPG	72,585	566,400
ATF	65,620	164,836
Petrol	60,653	407,270
Total	857,847	2,477,986
Per cent		
Diesel	39	53
Kerosene	38	1
LPG	8	23
ATF	8	7
Petrol	7	16

Based on NOC

Energy consumption: transport sector by vehicle type



Electricity. Sectoral uses

While the dependence on imported petroleum has grown, the performance of the electricity sector is far from satisfactory. In 2000, Nepal's Integrated Power Supply System (INPS) managed by the Nepal Electricity Authority (NEA) received 1,701.45 GWh of electricity and lost almost one fourth of the available supply because of technical and non-technical factors; it sold only 1,269.28 GWh of electricity. The amount sold can be disaggregated as follows: 508.36 GWh (40.05%) to industries, 467.05 GWh (36.8%) to domestic users, 145.41 GWh (11.46%) to commercial/non-commercial sector, 15.74 GWh (1.24%) to irrigation and drinking water supply, and 2.68 GWh (0.21%) to transportation. Supply to streetlights, temples and India accounted for the rest.⁸

In 2016, sixteen years later, the amount of electricity the NEA received in the INPS had more than doubled to 5,077.14 GWh: 65% supplied by in-country hydropower plants and other sources, and 35% (1,777.68 GWh) imported from India.⁹ The systemic losses (1,358.16 GWh) increased to 26.75% and NEA sold remaining two third (3,718.97 GWh) to various buyers. That year, NEA's largest buyer at 1,796.78 GWh (48.31%) was the domestic sector, followed by industries at 1,205.69 GWh (32.42%). The commercial and non-commercial sectors accounted for 11.32% (420.85 GWh), the irrigation and water supply bought 2.7% (100.42 GWh), and the transport sector was 0.16% (6.09 GWh) of the quantity sold. Streetlights, temporary supplies, temples, sales to community and India accounted for the remaining 5.08%.

Electricity budget of INPS in GWh¹⁰

Year	Available	Sold
2000	1,701.45	1,269.28
2016	5,077.14	3,718.97

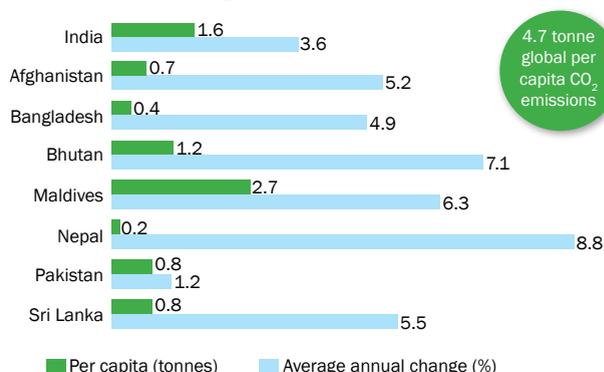
Based on NEA (2009) & (2017)

From 2000 till 2016 the INPS faced prolonged power cuts, which had reached up to 16 hours a day in the non-monsoon months in 2016.¹¹ Since mid October 2016, using added supplies from in-country hydropower plants, imports from India, and improving demand management, the NEA has minimized persistent daily power cuts in some sections of the INPS. This change has improved public's perception towards the NEA, as well as incremental improvement in performance of the industrial sector.¹² Yet, the achievement in productive use of electricity is not encouraging with Nepal's annual per capita electricity consumption only at 132 kWh in 2016, the lowest in South Asia. This low consumption is one indicator of the country's status as one of the least developed countries in the world.¹³ The 1.37% share of electricity in the overall energy mix in 2000, for example, increased to only 3.7% in 2016 while the share of petroleum products in the mix almost doubled.¹⁴

The industrial sector with highest share of the total electricity consumed in 2000 (40.05%) slipped to the second place in 2016, though in absolute terms, the amount increased by 137%.¹⁵ In the same period, the share of domestic and commercial/non-commercial sector reached 1,796.78 GWh from 467.05 GWh (284%); and 420.85 GWh from 145.41 GWh (189%) respectively. The transport sector, the potential bulk users, however, was further exposed to petroleum; electricity consumption in this sector only increased nominally to 6.09 GWh in 2016 from 2.68 GWh in 2000.

The tripling of the use of petroleum products¹⁶ is one of the main reasons for the increase in the country's average annual carbon emission rate in 2016 at 8.8%. This rate is the highest in South Asia though Nepal produced 6,984.08 metric-kT of CO₂, or 0.2 mT per capita, which is the lowest in the world.¹⁷

Carbon dioxide (CO₂) emissions by country in South Asia

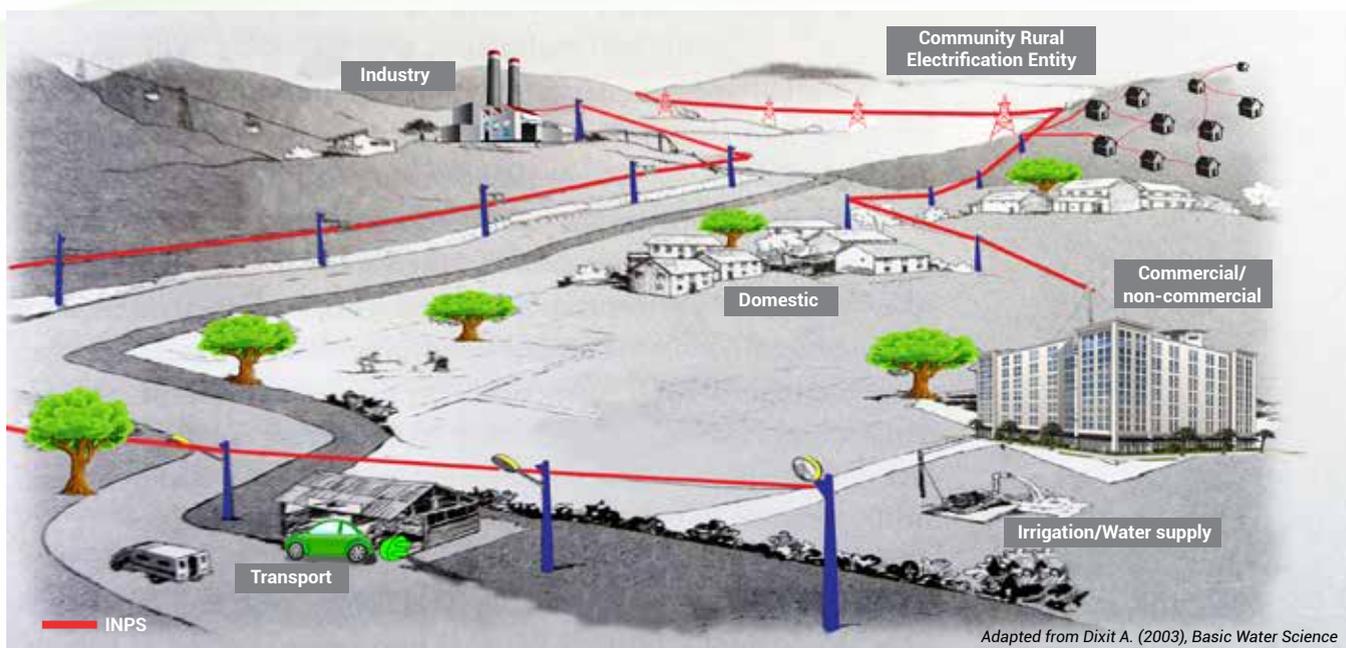


Source: CSE (2017)

Increasing use of electricity

Nepal must increase its total amount of productive electricity consumption to achieve higher socio-economic development. According to the ADB, if the country's human development index is to reach 0.81 from the current 0.5, annual per capita electricity consumption must approach 2,000 kWh.¹⁸ In the 2017 budget speech, the GoN estimated that in fiscal year ending July 2018, annual per capita use of electricity would reach 140 kWh. Much higher targets of productive use of electricity must be set and the challenges of the following sectors addressed:

Domestic: Appropriate policy can incentivize users to switch from Liquefied Petroleum Gas (LPG) to electricity-operated appliances for cooking and heating. NEA charges industries different tariff rates for peak and normal hours, but not yet for domestic consumers. While urban households may need additional incentives through Time of Day (ToD) tariff for switching to electricity even while it has become cheaper than LPG,¹⁹ rural households can be targeted to make the switch, particularly if they fall under the service areas of grid based and off-grid Community Rural Electrification Entities (CREEs). Making use of biomass more efficient will be vital. Restructuring tariffs, supply reliability and just regulation by Nepal Electricity Regulatory Commission are, nonetheless, critical factors.



Sectoral electricity use GWh (%)						
Year	Industry	Domestic	Commercial/ Non-commercial	Irrigation/water supply	Transport	Community Rural Electrification Entity
2000	508.36 (40.05)	467.05 (36.8)	145.41 (11.46)	15.74 (1.24)	2.68 (0.21)	0
2016	1,205.69 (32.42)	1,796.78 (48.31)	420.85 (11.32)	100.42 (2.7)	6.09 (0.16)	104.48 (2.81)
Change (%)	137.17	284.71	189.42	537.99	127.24	New user

Based on NEA (2009) & (2017)

*Figure in parentheses indicates "%" of total electricity sold. ** In 2000, street lights, temple, temporary supply and bulk supply to India accounted for 10.24% of the total electricity sold. These supplies accounted for only 2.99 % in 2016.

Industry/Enterprises: Increasing the quantity of electricity used in industries requires addressing structural supply side constraints afflicting the sector.²⁰ The share of manufacturing (secondary) in GDP at 6% is very low. Reliable, affordable electricity supply can become a catalyst for the sector if sustained efforts are made to invest in building technological and managerial capacity, improve other infrastructure in the economy, minimize political interference in corporate boardrooms and organized labor, reform international trading conditions, and promote small-scale manufacturing. Innovative and broad-based country-owned strategies that tap into financial and human resources are needed.²¹

Service sector. Over the last twenty years, the share of service sector in Nepal has continued to grow with share of agriculture declining and industry remaining stagnant. The sector contributed about 38.9% to GDP in 2000 and 53.3% in 2016.²² Remittances, amounting to less than 5% of gross domestic product (GDP) in 2000,²³ increased to 32% in 2016, while, capital investment has averaged less than 20%.²⁴ The expansion in the import-backed service sector is unlikely to continue²⁵ without serious policy interventions in improving productive capital expenditure. It is, however hard to

estimate how much incentivizing higher electricity consumption in service sector will add to the economy. Nonetheless such a policy in the hospitality industry, hospitals and educational institutes must be backed by simultaneous reforms for substituting imported items through in-country productions.

Irrigation and drinking water: Potential for increased use of electricity has to be sought in surface and groundwater pumping for irrigation. The policy must also enhance the contribution of conservation ponds, micro-irrigation and drip irrigation in a reinvigorated agriculture system of Nepal.

Transportation: Diesel and petroleum powered vehicles dominate Nepal's transport sector. The country's clean-energy transport segment includes about 714 *safa* (clean) electric tempos (that accommodates 10 persons) in Kathmandu, 300 electric cars, 2,000 electric scooters, more than 15,000 electric tricycles in the Tarai, and two cable car systems.²⁶ Increasing the share of electricity use in public transportation would require addressing investment costs for clean-fuel operated mass transit systems as key to resource-efficient, inclusive, people friendly and healthier cities.

Conclusions

The present energy mix and their uses in Nepal are result of a lack of coherent policy that has conceived electricity as an end in itself rather than a means of production. While use of traditional energy sources incur a plethora of environmental and public health consequences, continued reliance on imported petroleum based fuels increases exposure to more financial, environmental and political risks that can jeopardize Nepal's energy-security. The reliance on poorer forms of energy also means that Nepal will not be fulfilling commitments to reduce carbon emissions as stated in the Nationally Determined Contribution (NDC) submitted to the United Nation Framework Convention on Climate Change (UNFCCC).²⁷ This dependence correspondingly undermines benefits that Nepal can receive from the ongoing global renewable energy revolution.

Nepal's energy policy needs to be therefore guided by the objectives of a) providing universal access to modern and reliable clean energy at affordable prices, b) contributing to economic and social development while creating in-country jobs, and c) minimizing import of petroleum products by switching to electricity from sustainable hydropower development and other cleaner sources. Meeting these objectives needs creative, coherent and consistently forward-looking policies.

End Notes

- 1 See MoF (2016/2017), Economic Survey of Nepal (GoN): Annexes, pp 77.
- 2 NEA supplies electricity to towns along India Nepal border, See NEA (2017) and (2009) Annual Report
- 3 Includes petroleum, diesel, kerosene, aviation turbine fuel and LPG, excluding furnace oil, light diesel oil and mineral turpentine oil.
- 4 <http://www.nepaloil.com.np/import-and-sales-22.html>.
- 5 See Nepal Oil Corporation, Annual Report 2014/2015.
- 6 We have used a factor of 1.81 as suggested by Atomic Energy Conference Vienna to convert LPG in Metric tons to Kiloliters.
- 7 See WECS (2014), Energy Data Sheet, June, Government of Nepal.
- 8 See NEA (2009) Annual Report.
- 9 See NEA (2017) Annual Report
- 10 A comparison of electricity available (GWh) in the INPS and that sold to various consumers in 2000 and 2016 shows losses of 25.4% and 26.75% respectively. NEA (2017) mentions that the loss in 2016 was 22.9%. The difference in these two numbers needs to be further examined and reconciled.
- 11 After 2000 Nepal faced heightened violence, political and constitutional crises with implications on performance of the hydropower sector.
- 12 According to Nepal Rastra Bank industries, on average, operated at 57.3% of their total capacity in the fiscal year 2016-17, as against 48.2% in 2015-16 because of,

among others, greater availability of grid electricity. See <http://epaper.ekantipur.com/epaper/the-kathmandu-post/2017-12-10/suppliments/money.pdf>

- 13 Though it hides the differences among users, per capita is a useful starting point of analysis. This figure is from MoF (2014/15). Ministry of Finance: Government of Nepal, Budget speech Annex 71. Also see NPC (2017). *Nepal's sustainable development goals: Baseline report-2017*. Kathmandu: Government of Nepal, National Planning Commission. World Energy Statistics (IEA, 2017) suggests that in 2015 Nepal's annual per capita electricity use was 138 kWh. The differences need to be reconciled.
- 14 This share of petroleum products in the energy mix does not match the three times increase in their import. In light of widespread use of LPG and anecdotal stories of reduction is the use of fuel wood in both rural and urban homes in Nepal, it would be prudent to reassess Nepal's total energy mix for policy targeting.
- 15 In last ten years, many industries have installed captive generating sets and these are not included in this analysis. Industries served by INPS continue to face power cuts.
- 16 The import of thermal based electricity from India also adds to the increased rate. India's energy mix in 2012 was as follows "coal 42%, oil 27%, natural gas 6 %, bio mass 22%, Hydro 1%, solar/wind 1%, and nuclear 1%. See, Banarjee Ranjan Key Note address to IIT Alumni September (2014) / IITBAA/alumni14-presentation-by-profrangan-banerjee-global-perspective-on-consumption-of-energy. CEED India quoting Central Electricity Authority in its Energy Status Report on Bihar, suggests that 89% electricity generated in Bihar is thermal based.
- 17 See Center for Science and Environment, New Delhi (2017) for change in average emission. For emission by countries see <http://edgar.jrc.ec.europa.eu>.
- 18 Adapted from Nakarmi, A. M. "Current Energy Consumption, Trends and Future Energy Scenario" (IPPAN), Seminar, 2016 Jan 4, Kathmandu.
- 19 See NEA (2017). Annual Report. For analysis of cost *ibid* Nakarmi (2016).
- 20 Growth Diagnostic May 2014 Nepal.
- 21 According to the International Finance Corporation (2013), on average, low income countries could expect 4 to 5% annual job growth if electricity supply were made more reliable, see Nepal Diagnostic (2014) for details.
- 22 See <https://www.adb.org/sites/default/files/publication/204091/nep.pdf>. The share in 2016 would be somewhat higher than this percentage in 2015.
- 23 See Shrestha, B. Contribution of Foreign Employment and Remittances to Nepalese Economy based on https://nrb.org.np/ecorev/pdf/files/vol20_art1.pdf
- 24 See Former Finance Minister Lohani P. C. "Sukulgunda Chintan" in Kantipur, 4th January 2018
- 25 See Pyakuryal, B. and Acharya, K. in <https://thehimalayantimes.com/business/service-sector-needs-sustainable-base-expansion/>
- 26 From Clean Energy Nepal (CEN) and Electric Vehicles Association of Nepal (EVAN).
- 27 Nepal's NDC has pledged, "By 2050, Nepal will achieve 80% electrification through renewable energy sources having appropriate energy mix. Nepal will also reduce its dependency on fossil fuel by 50%".

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