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Justice and politics in energy access for education, livelihoods and health: How socio-cultural processes mediate the winners and losers

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ABSTRACT

The rhetoric on development benefits of energy access often focuses on education, livelihoods and health. Using case studies of two energy access projects in India, this paper demonstrates that these claims, while true in part, are neither simple nor straightforward. It argues that pre-existing socio-cultural processes mediate the development outcomes of energy access projects. In particular, the roles of gender, socio-economic positions and the local economy are vital in understanding the links between education, livelihoods, health and energy.

This paper is important for two reasons. First, working with culture as a mediator, it provides nuanced insights into relationships between energy access and three key development goals. Second, by presenting this analysis, the paper identifies a need for further research on the relationships between socio-cultural processes, development and energy access and, how by keeping these processes in mind, the benefits of energy access could be extended to less privileged social groups. This paper is based on a nine-month long ethnographic research in five villages in India's Bihar state. Home tours, interviews, participant observations and group discussions were used to collect the data.

1. Introduction

A substantial body of literature argues that "access to modern energy services is fundamental to human development" ([1]:7). Energy access extends working hours, reduces wastage of time and bodily energy, fosters livelihoods, improves education and raises human development indicators [2–6]. Modern energy also supports information flows, entertainment, better health services and indoor air quality [7,8]. Much of the academic and policy literature on energy access gives importance to three specific development outcomes: education, livelihoods and health [6,9,10].

Kanagawa and Nakata [5] find a positive correlation between per capita electricity consumption and education. Electric lighting creates conditions conducive to studying by reducing indoor pollution and health hazards caused by kerosene lamps [11]. Modern energy saves time spent on fuel collection thereby freeing time to study and enabling people, especially women, who work during the day to study in the evenings [3,12]. Reddy and Nathan [13] explain that access to clean energy could positively impact women's education, health and livelihoods. Thus, access to modern energy contributes to improved education and gender equality [14].

The positive impact on education has long-term implications for livelihoods and poverty alleviation [4]. Electricity improves livelihoods by powering irrigation pumps for farmers and rural industries [15,16]. Electric lights extend working hours and raise incomes [2,17]. By reducing indoor pollution, modern energy also improves health [18]. It reduces vulnerability to wood and kerosene fires, hazards which affect women more [19]. Health services also improve through the use of modern equipment and sterilisation techniques [20].

This rhetoric on education, livelihoods and health is the starting point for this paper. Using insights from two energy access projects, it demonstrates that, while true up to an extent, these development benefits of energy access do not materialise in a straightforward and uncomplicated way. Many of the claims discussed in the earlier paragraphs are simplistic. For example, "socio-political conditions" like political clout, community collaborations, social norms and access to schools mediate the uptake of solar home systems and therefore the benefits of modern energy in Sri Lanka ([21]:2587–88). Energy experiences are also gendered [22,23]. These social, cultural, political and economic conditions have received less attention in the

literature; instead, studies focus disproportionately on technical and financial aspects of energy access projects ([24]:2). Watson et al. ([24]:62) call for further work on understanding the "interaction between technical and cultural" aspects of energy access.

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By studying the socio-cultural processes in particular contexts, we can understand the ways in which the benefits of energy access materialise in people's everyday lives [25,26]. A focus on socio-cultural process provides a more nuanced understanding of the positive and negative impacts of energy access projects. Keeping this in mind, this paper investigates the socio-cultural processes that tailor the impacts of these projects in particular contexts. It argues that these processes mediate the development outcomes of energy projects. In particular, the roles of gender, socio-economic positions (caste) and the local economy are vital in understanding the links between education, livelihoods, health and energy. The paper makes three arguments related to these links. First, providing electric lights for studying helps mainly those who place a high value on education. Second, providing electric lights benefits boys and men more than girls and women. Third, providing lights allows businesses to save money, but does not result in business expansion, due to other market limitations.

Section 2 clarifies why the paper focuses on particular aspects and geographies. Section 3 explains the methodology for this research. Sections 4–6 provide empirical evidence for the arguments made in the paper. Finally, Section 7 presents concluding remarks and recommendations for future research.

2. Focusing on education, health and livelihoods through electric lights in rural areas

This section explains why this paper focuses on three particular development outcomes, electric lights and rural areas.

2.1. Three development outcomes

As explained, much of the rhetoric around energy and development focuses on education, livelihoods and health [1,27]. The two case studies for this paper also emphasise these outcomes. One case study, Husk Power Systems (HPS) provides "reliable and affordable electricity to improve" people's "health, education and livelihoods" (HPS Brochure). The other case study, Lighting a Billion Lives (LaBL) "provides illumination that advances education, health, and livelihood activities" (LaBL Brochure). Therefore, this paper tracks how these development outcomes are made practical and operationalised into everyday contexts, and in doing so are reworked, disrupted and contested.

2.2. Electric lights

Energy access efforts weigh disproportionately in favour of electricity. The World Bank's Global Tracking Frameworks reports that globally 85.3% of people have access to electricity but only 57.4% have access to clean cooking ([28]:2). Clean cooking and heating have been widely overlooked by energy access policies ([28]:50). International Energy Agency's projections show that electricity access will stay ahead of clean cooking in the future [28]. Within electricity access efforts, lighting initiatives take the lead. A survey by Energy Access Practitioner Network found that at least 102 of their 120 respondents were involved in lighting initiatives [29]. Only 69 were involved in clean cookstoves. This is further evidenced by the large number of initiatives focused on lighting – Lighting Africa, Lighting Asia, Solar Electric Light Fund, Global Off Grid Lighting Association, d.light Solar, to name a few. The two case studies for this paper also prioritise lighting. In addition, ESMAP's ([30]:7) multi-tier matrix considers "lighting and mobile phone charging" as first essential services. Consequently, this paper focuses on electric lights and what gets left out when there is an unequal focus on lights.

2.3. Rural areas

Energy access is a bigger problem in rural areas [31,32]. There is a 20 percentage point gap in electricity access and 60 percentage points gap in clean cooking between urban and rural areas [28]. In India, about 45% rural households lack electricity access compared to only about 7% urban households [33]. This has resulted in an increased focus on rural electrification [34] with a subsequent expansion of the number of projects aiming to improve energy access in rural areas. Thus, this paper focuses on rural areas.

3. Methods

Research for this paper was conducted in five villages in India's Bihar state, the state with the smallest percentage of people with electricity access [33]. For a comparative and "cross-technology investigation", two sustainable energy case studies and two baseline energy systems are considered ([35]:2).

The first case study, Lighting a Billion Lives (LaBL),[1] aims to provide lighting to a billion people. LaBL has projects in 2222 villages impacting more than 100,000 households [36]. As part of its business model, LaBL selects and works with a local entrepreneur in the target village and sets up a solar lantern charging station with 50 or 60 lanterns in their house.[2] Villagers rent solar lanterns on a daily or monthly basis. LaBL was present in two research villages.

The second case study, Husk Power Systems (HPS),[3] sets up biomass gasification-based micro-grids in villages and supplies electricity for a monthly rental. Its 84 plants impact 200,000 people in more than 300 villages [37]. The company's own team manages and maintains the micro-grids. HPS was working in one research village and had previously worked in another. Both projects assess lighting needs and kerosene expenditures to identify target villages.

The baselines include one village connected to India's central grid and a second village that is neither part of the case study projects nor connected to the central grid. In the second village, kerosene oil and a diesel generator micro-grid are sources of light. Kerosene does not directly produce electricity but provides lighting, a key electricity service. It competes with other electricity systems.

A nine-month long ethnographic study was conducted during 2012–13 during which three to six weeks were spent in each of the five villages. During this time accommodation was found in or near the villages. Since light was a key theme, most fieldwork was conducted after sunset. The villages had various combinations of energy systems and light sources, adding diesel generators, solar home systems, solar street lights and candle lights to the baseline and case studies. These were used in different combinations depending on the space, time and context. Socially, the village populations mostly consisted of Hindus with a sizable Muslim population in one. Within the Hindu villages several combinations of castes were present. Table 1 outlines the social makeup and light sources in the villages.

Mythology and history have created a hierarchy of castes in India. *Dalits* have the lowest position among the Hindu caste groups. *Dalits* are not only socially distinguished but are also spatially separated from the other castes. Their habitations are generally on the fringes, often separated from the village. Mostly landless, *dalits* are also the poorest of the poor.

A multi-methods approach was chosen to ensure the research was as comprehensive as possible [38]. In total 60 home tours and family interviews, 10 group discussions and 24 elite interviews were conducted. Participant observations data was recorded in 580 diary pages and more than 1200 photographs and videos. Family interviews were conducted with male and female members together. In some cases only male or female members were present. In total 34 higher caste and 26 lower caste families were interviewed and homes visited. Two higher

[1] http://labl.teriin.org/.

[2] LaBL also uses micro-grids and solar home systems. This paper is limited to its solar lantern programme.

[3] http://www.huskpowersystems.com/.

Table 1
Social makeup and light sources in research villages.

Village	Social makeup	Lights
Rangpur	Hindus, equal proportion of higher and lower castes	Central grid, kerosene
Berangpur	Hindus and Muslims, predominantly lower castes	Kerosene, diesel generator micro-grid
Bijuriya	Hindus, larger population of lower castes	Central grid, kerosene, LaBL, HPS (HPS shut down)
Sahariya	Hindus, predominantly higher castes	Central grid, kerosene, LaBL
Hardiya	Hindus, predominantly lower castes	Central grid, kerosene, HPS

caste, seven lower caste and one mixed caste group discussions were conducted. Out of these one was a mixed gender group and one female-only group. Elite interviews included project managers in the village who could provide a history of the projects and give insights into the functioning of the projects; village elders who could provide historical context of the village; and village council leaders. One LaBL NGO, one LaBL manager, one HPS deputy director and several electrification experts were also interviewed. NVivo was used to analyse the field notes, photographs and interviews. The present analysis and writing aims to produce a close representation of village life and dynamics. Present tense is used in writing as things narrated are still unravelling. References to events during fieldwork are in past tense. To avoid dehumanising the people whose stories are presented, pseudonyms are used for research participants and villages, rather than interview numbers.

4. Electricity and education

Agriculture is becoming an increasingly unsustainable livelihood option in India (see also [39]). A lack of electricity and high diesel prices have resulted in an "energy squeeze" for many farmers ([40]:1). Farmers are forced to use less water resulting in low crop yields [40,41]. In addition, as families grow the division of land leaves subsequent generations with smaller land parcels. In this context, most people want to leave farming, or want future generations to find work in urban areas [39]. However, this search for alternate livelihoods applies mainly to men. Families have different priorities for women (Section 4.2).

Most young men encountered during the fieldwork and their families do not want to continue with agriculture. Higher caste farming families see their future mainly dependent on jobs and businesses (see also [42,43]). People in the research villages explain that these can only be gained through education. Many young men from these communities prepare for exams to access government jobs which are considered stable livelihood sources ([44]:967). Driven by a search for new livelihoods, education has become very important for landowning castes. The result is an increase in the value of lighting services.

A: so you need only one [solar lantern]….

Yes, only one …

[…]

Only for studying.

The main motive [for renting the solar lantern] is studying.

A: So, this has no other use [for you]?

No, no other use.

(Ranjeet Singh, higher caste, farmer, Sahariya)

This quote illustrates a wider trend in Sahariya, Bijuriya and Hardiya. Here many people rent solar lanterns or connect to micro-grids to facilitate education through access to better lighting facilities. Like many others in Sahariya and Bijuriya, Mr. Singh's family rents only one solar lantern, exclusively for children to study in the evenings. The villagers explain that electric lights are superior to the usual alternative, kerosene lights. They improve visibility because they are brighter and light a wider area [45]. This reduces the negative impacts of low lights on eyesight and makes studying easier. Electric lights are also seen as healthier and safer compared to kerosene lamps. In villages, people report that due to the low lights from kerosene lamps children need to bend down to study (Fig. 1). This results in direct inhalation of kerosene lamp fumes. After studying for a few hours, children's noses and nostrils turn black with soot deposits [46,47]. While studying children often doze off and fall on kerosene lamps. This causes burns or fires due to toppling of kerosene lamps [48,49]. It is also difficult and dangerous for younger children to fill kerosene in lamps and light them, an activity carried out daily before studying (see [50]). This impedes their studies in absence of older siblings or adults and makes them vulnerable to the dangerous kerosene oil. With solar lanterns and micro-grids children can turn the light on with the flick of a switch. Some villagers say that this makes children more independent. They do not need to depend on older siblings or parents to turn the lamp on. Even in their absence children can begin studying on time.

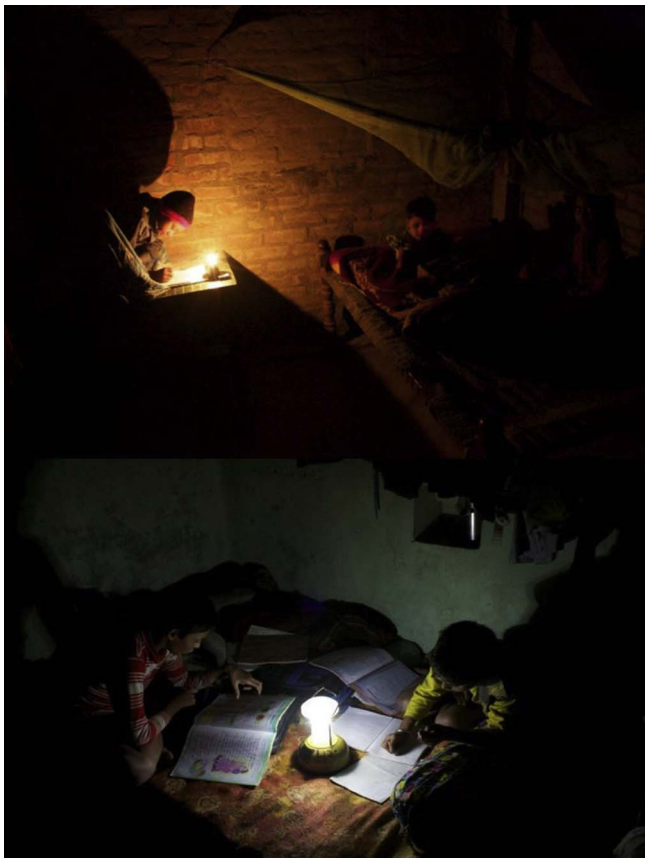

Fig. 1. A child in Berangpur studying under a kerosene lamp (top). Children in Sahariya studying under a LaBL lantern (bottom).

In Bijuriya, HPS[4] supplied electricity at fixed times, i.e. 6pm–11pm. Some villagers claim that this automatically set study timings for children. Earlier, parents needed to chase children to fill kerosene in lanterns for studying. This gave children an excuse to be reluctant and resulted in delays. In contrast, the fixed time of HPS supply (6pm) made an implicit rule for children to begin studying. As Mr Shankar Singh (higher caste farmer) of Bijuriya puts it, the start of the electricity supply by HPS and the automatic turning on of lights emerged as a

[4] When it functioned in the past.

"signal for children" to begin their evening studies.

LaBL lantern users in Sahariya and Bijuriya also support this argument. LaBL has created a new daily practice. People visit the entrepreneur every evening to collect recharged solar lanterns. Although the collection timings are not fixed, it was observed that most collections happen in an hour's window before sunset. Children collect most lanterns. This implicitly sets a fixed time for children to begin studying. The fixed battery backup of LaBL – 3–4 h – and the fixed timings of HPS – 6pm–11pm – fix study durations. Some people report that earlier children often half-filled the kerosene lanterns. The lamps quickly ran out of kerosene, thereby limiting the study time. This is no longer possible with electric lights.

Electric lights reduce children's dependence on others and eliminate any excuses linked to the difficulty of handling kerosene lanterns. In addition, HPS and LaBL trigger and structure study times and durations. Therefore, electrification projects are 'better' for education for two reasons. First, they provide 'better' or superior light sources that make studying easier and help avoid health and safety hazards of kerosene lamps. Second, they help control and manage the activity of studying by making children independent in handling the light source, fixing study times and modifying studying habits.

The importance of light for education is visible in the research villages. However, 'better' light sources primarily help those who have historically had more access to education. The remainder of this section explains this using the examples of caste and gender differences. In these villages *dalits* do not find 'better' lights and *lights only* projects useful because they do not attribute the same value to education as the land owning higher castes do. Girls do not get access to 'better' lights because in comparison to the boys, families attribute less importance to girls' education.

4.1. Electricity, education and caste

This section argues that most *dalits* do not find *lights only* projects useful. Most *dalits* in Bijuriya and Sahariya do not rent LaBL lanterns. This is because, unlike the higher caste farmers, they do not see education as a pathway to alternate livelihoods. They already pay for a source of light, kerosene and do not see value in spending on another energy source that provides *only lights*. However, they do see value in connections from micro-grids or the central grid. With these they get additional services like mobile phone charging which kerosene cannot provide.

In the research villages, most *dalits* do not see education as a means of accessing alternate livelihood opportunities like government jobs due to three reasons. First, a lack of access to good quality education. Second, an inability to pay for higher education due to a lack of material and financial capacity. Third, an inability to pay bribes largely seen as necessary to gain employment. The first two reasons emerged during this research. The third has been added from literature.

> It came up that the education level in the village school was dismal. Some people of the *harijan [dalit] tola* [colony] also added that they did not have enough money to send their kids to private schools in town and were forced to send them to the village school or not send them at all.
>
> **(Field notes after group discussion with *Dalits*, Sahariya, 08/12/2012)**

This excerpt from the field notes discusses two factors behind lack of access to good quality education. First, the standard of education in government schools in the villages is dismal [43]. In all research villages, people from all castes consistently argued this. Because of this, higher caste farmers send their children to private schools and tuition classes in nearby towns [44]. The second factor is lack of sufficient financial means. Being the most economically disadvantaged group, most *dalits* cannot afford private schools or tuitions (see also [51]). Again, this argument was cited consistently across all villages. Most *dalits* have accepted the available options, either to send their children to government schools, or to not send them to schools at all.

Without good quality primary and secondary education, access to higher education institutions is very difficult. In addition, higher education involves considerable expense. Farmer families often either mortgage or sell their material possessions – primarily land – to pay for their children's higher education ([52]; [40]:45). Most *dalits* are landless. They continue to work in the fields of higher caste farmers or gain other employment from them (see also [53]). *Dalits* explain that this makes higher education inaccessible for them. They explain that due to a lack of material possessions, they are unable to pay donations[5] and exorbitant fees for private colleges. In the absence of higher education, gaining white-collar government or private jobs is a distant possibility. Jeffrey et al. ([53]:968) emphasise that a lack of capacity to pay bribes for jobs also excludes *dalits* "from secure white collar employment".

These factors break the link between education and alternate livelihood opportunities for most *dalits*. During the research an overwhelming commitment to and belief in the promise of education was mostly seen among higher caste, land-owning groups. Most *dalits*, especially in Sahariya, find education useful but unlike the higher castes, they do not see alternate livelihood opportunities emerging from education.

> We think that if our children get a bit educated then they won't have to rely on anyone if they go somewhere. If there would be some work at home, then they would be able to take care of it. That's it!
>
> […]
>
> Sir, we do not have the capability to educate [our children] much. But at least they [the children] would succeed in calculating…
>
> **(Groups discussion, *dalits*, daily wagers, Sahariya)**

Here *dalits* explain that the primary outcome and benefit that they attribute to basic education is self-reliance in basic functional tasks such as calculating wages or reading documents[6] (see also [51]:99). They do not talk about jobs or other alternate livelihood opportunities. As a result most *dalits* in these villages do not value education as much as their higher caste counterparts.

Given the relative lesser value of education for *dalits*, the drive to access 'better' lights for the purpose of improving educational outcomes is also lesser. Among *dalits* in Bijuriya and Sahariya the solar lanterns are not popular. This is because they are already paying for a light source, kerosene. While they acknowledge that lights from the solar lanterns are 'better', they cannot justify paying for an additional energy source that provides *only lights*, irrespective of qualitative concerns.

Dalits do recognize added value and are ready to pay for electricity connections from micro-grids. Micro-grids bring additional services like mobile phone charging that are critical and that *only electricity can provide*. The importance of mobile phones for communication and connectivity has been widely discussed [54–57]. People in these villages spend INR100-150 every month to charge mobile phones at shops in nearby towns. Opportunities for monetary savings gives them incentives to connect to micro-grids.

4.2. Electricity, education and gender

This section argues that the access to lighting services is gendered due to two reasons. First, due to socio-cultural notions around safety and honour that dictate a gendered separation of spaces, many girls cannot access electric lights in spaces where men and boys are present. Second, providing 'better' lights to girls is given less importance

[5] Bribe paid to get admission in higher education institutions.

[6] In Berangpur, Bindeshwari Sao, an illiterate *dalit,* explained that his brother duped his land away by getting his sign on a paper he could not read. Mr. Sao did not want this to happen to his children. This was his main reason to educate his children.

because families attribute less importance to girls' education.

> S: See, now there is no [electric] light. The children do not study at home. There, you see the light [pointing at a solar street light] at the *bangla,* all of them go there to study.
>
> [….]
>
> W: No, my children do not go to study there. I mean boys go. But how would girls go? *After cooking,* they would study here a little bit.
>
> [….]
>
> A: Girls would not go to study there?
>
> W: No! It's all men there.
>
> [….]
>
> Boys are there….The girls will study here, under the kerosene lamp. *They would cook and then* light a lamp to study. [Emphasis added]
>
> **(Wife (W) and Son (S) of Devendra Manjhi household, *dalits*, Bijuriya)**

This *dalit* colony in Bijuriya has a community meeting place (*bangla)* where men socialise. This space 'outside' the home is dictated by strict social and cultural norms that give men privileged access [58,57]. The social and cultural norms dictate a gendered separation of spaces [57–59]. Such norms deter girls from going to 'others' homes or 'outside' their own homes to study, especially in tuition classes which mostly happen after school hours. In addition, due to safety concerns most parents prefer that girls avoid venturing out after dark (see also [42]:2089). The predominance of boys in tuition classes also serves as a deterrent for the girls' parents.

The *dalit* community place is lit by a government-funded solar streetlight (SSL). The boys use it as a study space. Due to the large presence of boys Manjhis do not allow their girls to study under this community light. As a result, boys get access to 'better' lights from the SSL while girls have to compromise with kerosene lamps. Scholarly and policy literature on energy access have long argued for a focus on community services [60,30]. Government of India's rural electrification policy also focuses on electrifying community places [61]. Community services like lighting in streets and community centres should indeed be an integral part of the energy access agenda. However, as the evidence here suggests, the distribution of benefits from community services depends on socio-cultural norms (see [62,63]).

Many families prioritise lights or 'better' lights in front of the house rather than inside, as a symbol of esteem [58]. Lighting arrangements depict their material capacities and social status [58,64]. Boys, young men and very young girls can inhabit these spaces and study under these lights. However, girls (young and old) cannot inhabit these spaces, and instead must stay indoors. They compromise, either by discontinuing their studies or studying under the inferior, polluting and hazardous kerosene lamps. During the fieldwork, many children (both male and female) and young men were observed and recorded (through a camera) studying under the LaBL lanterns (Fig. 2). However, no post-pubescent young woman was found studying under these lights. Micro-grids lessen the disparities in access to lighting due to this inside–outside concern as people may simultaneously light multiple spaces, giving young women access to 'better' lights inside.

Every time Mr. Devendra Manjhi's wife talks about the girls studying (in the quote at the beginning of this section), she precedes it with a mention of them cooking. This emphasises most household's priorities for girls, irrespective of caste. Both studying and cooking dinner take place at the same time, in the evenings. In most households girls cook while boys study. Fig. 3 from Berangpur clearly depicts the domestic politics of energy access: in a household with electric lights, a boy studies beside his father, while a girl (at the far end) prepares dinner. This discrimination between male and female children stems from the fact that, compared to boys, most families value girls'school education less. This is due to two reasons. First, scholarship on education and employment for women suggests that education for females – irrespective of caste – is not perceived as leading to future economic benefits like alternate livelihood opportunities ([65]:58–59; see [66]:1391). Jeffrey et al. [44] note that women are not expected to take up paid employment outside home. Jobs for girls are often irrelevant for most parents because girls leave the household in the long term and do not contribute financially to it. Finding a suitable groom and marrying young woman into a good family take precedence. Motivated by this, most families – from all castes – do not focus on girls' school education. Instead they are 'educated' differently, to carry out household tasks like cooking, cleaning and childcare. Electric lights are not required for such an education.

Second, it became clear during the fieldwork that in Bihari villages, financial resources that would otherwise fund girls' education instead are diverted into a future dowry. Gifts, voluntary or forced, in the form of dowry are an integral part of Bihari weddings, and the bride's parents are responsible for most wedding expenses. These customs spring from notions of honour [58]. Norris ([67]:16) explains that parents start saving soon after a girl's birth in order to gradually accumulate her wedding dowry. Money, which would have otherwise been invested in girl's education, is saved over long term to gift as dowry. Bersier ([68]:20) explains that in pure economic terms investing in education for boys is "seen as 'assets' and girls as 'liabilities'". Jeffrey et al. ([42]:2088) report that more recently girl's education has grown in importance for their "role as civilised home makers". Many grooms now demand educated girls who can teach their prospective children (child care) or to take up jobs like teaching and contribute to the household finances (see also [52]). However, neither role requires expensive private schooling, or higher education. By providing crucial certificates for parents' claims during marriage negotiations, lower quality government school education often suffices. As a consequence, after school studies are not considered important for most post-pubescent girls. Since girls' formal education is accorded lesser importance, parents do not feel the need to arrange 'better' lights for them.

Although scholars [13,69,12] argue that electricity is beneficial for female education, evidence here suggests that the situation is much more complicated. The claims of LaBL and HPS about mobilising education are true. However, mediated by the social, cultural, political and economic processes of the villages these projects support education primarily for those who already have better access to education. They end up exacerbating existing social inequalities rather than breaking them down. Electricity helps education, but mostly for the male members of higher caste families. Household priorities mean that on the one hand most females do not get access to clean lighting and on the other they have to spend more time carrying out household tasks like cooking which have grave health and safety impacts (Section 6).

5. Livelihoods and economies

Kerosene light has a marginal cost, where additional expense is incurred with every extra minute of kerosene use. After a period of time, if shopkeepers make no sales, they prefer to close the shop in the evenings to save their constantly depleting energy source and money. Instead, if they have access to an energy source with a fixed cost, they could keep the shops lit and open for longer (hoping for sale), even if there is no sale. Electric lights could help shopkeepers extend working hours and improve livelihood opportunities [70,30].

> It is 10 pm. Too late in the night by village standards. But the four benches around Mote Singh's tea stall are occupied. People are chatting while sipping tea. More than a year ago, the stall in Sahebganj village of Bihar's Muzaffarpur district used to be empty by 6 pm. Singh's fortune has been illuminated by a 15 Watt CFL.
>
> **(Paliwal [71], Down to Earth Magazine)**

This 15 W Compact Florescent Lamp (CFL) is powered by a HPS

Fig. 2. Children studying under LaBL lanterns. Young men and very young girls can be seen but no young women.

micro-grid. The quote is reflective of the 'extension of working hours' and increased income opportunities that scholars and practitioners often talk about [2,70,72]. Both HPS and LaBL have fixed monthly or daily rentals. Within standardised limits of time and wattage of HPS and battery capacity of LaBL, businesses can use electricity for as long or as brief a period as required. Such energy sources eliminate marginal costs associated with kerosene lanterns and support the 'extension of working hours'. However, while electrification projects help extend working hours, livelihood gains are derived not from increased sales and additional income but rather from cost savings from switching to less expensive sources ([73,62,74] for arguments on additional income generation).

5.1. Social networks matter more than electricity networks

Some people in Hardiya agree that HPS electricity supply is helping

Fig. 3. Gender politics of energy access: son studies under electric light while daughter (far end) cooks on an earthen hearth.

the market stay open for longer. However, most explain that electric lights and their comparative advantage over kerosene lights or the extension of working hours do not lead to any direct increase in incomes. The longer hours or brighter lights do not result in a rise in the number of customers or sales.

> A: Now that you have better lights in your shop, has the number of customers increased?
>
> No, nothing like that has happened.
>
> A: Or do you keep your shop open for longer?
>
> No, not even that. How much would we sell in a rural area? This is the main thing.
>
> A: All customers are from the village?
>
> Yes, people from outside the village won't come here!
>
> […]
>
> This is a village. Here, even if you light a [kerosene] lantern you would have the same sale. Whether you decorate the shop or you light 10 [electric] bulbs, you would have the same sale.
>
> **(Inder Shah, Shopkeeper, Hardiya)**

Mr. Shah informs that, due to their brightness and wider coverage area, electric lights make it easier to work ([10]:1411). However, they do not result in incremental income. He explains that the number of customers and income are limited by the customer pool of the village. They visit his shop for their daily needs independent of his lighting arrangements. People running commercial establishments in other research villages make the same argument. The villagers often depend on one or two shops and tea stalls. They generally do not travel outside the village for their everyday needs. Since these small village establishments differ substantially in their scale from urban establishments, they do not emerge as business centres and see very little commerce from people outside the village. The market in Hardiya gets business from nearby villages. However, this is very limited. These customers visit the market because of its proximity, not because it has electric lights. There are only isolated shops in other research villages. Their small commerce depends mostly on local customers.

While the people running commercial establishments rule out the possibility of additional customers due to better lighting, they explain that the current customers choose one shop over the other based on social behaviours and networks. Lights play very little role in this.

> [Slightly agitated] Do you think new customers would be born if I get new lights [referring to the solar lights]?!
>
> […]
>
> There is something called behaviour. The shop runs on our behaviour too. And if you give good quality product, then people would even drink [tea] in the dark, even if there is less light…
>
> **(Pyare Mandal, Tea Stall owner, Bijuriya)**

Electric lights do not result in more income. However, they lead to savings.

5.2. Saving money with electric lights

Electric lights promote cost savings rather than increase incomes. Like many other domestic and commercial users, Mr. Mandal uses LaBL lanterns in his shop as a cheap alternative to the standard, Liquefied Petroleum Gas (LPG) based petromax which gives more light. Table 2 shows the significant cost difference of the two main energy sources for the daily lighting of Mr. Mandal's shop. He compromises with less light but the solar lanterns make economic sense leading to a daily INR44 savings as compared to LPG. Low light is not an issue for Mr. Mandal nor the other commercial enterprises in the research villages, where the level or quality of light does not directly correlate with income.

Table 2
Daily expense calculation for lighting Mr. Mandal's shop (data collected during fieldwork).

LPG lighting (petromax/ gas light)	Amounts	Solar lighting	Amounts
Amount of LPG used per day	0.5 kg	No. of LaBL lanterns rented per day	2
Cost of LPG	INR 100/kg	Cost of each lantern per day	INR 3
Total cost per evening	INR 50	Total cost per evening	INR 6

LaBL and HPS help people save money previously spent on expensive fuels like kerosene or LPG [75]. While the Indian government subsidises kerosene, entry into the government's kerosene network is very difficult and contingent on social and political connections. In addition, each household is allotted a limited quota. Many people have to purchase kerosene on the black market where it is two to three times more expensive. Electrification projects help many people stay within their quota, and as such, they can avoid buying more expensive kerosene. Through this, the lights from LaBL and HPS create direct monetary benefits for their users. However, people do not use them if they do not link these lights with direct monetary benefits.

Poorer people with small incomes – like Mr. Mandal – try to manage at home within their kerosene quota. They generally do not spend money on additional kerosene. Therefore, saving money spent on more expensive black market kerosene by using LaBL lanterns does not apply to them. When lights do not connect to income or savings at all, Mr. Mandal finds 'better' lights a luxury. On being asked how those at home manage, he remarks (slightly agitated):

> "Of course they would live in dark….*this is not London*….they use kerosene lamps" [emphasis added].
>
> **(Pyare Mandal, Tea Stall owner, Bijuriya)**

By invoking London, Mr. Mandal refers to a place inhabited by wealthier people who can afford provisions – like better domestic lighting – that are costly and therefore a luxury rather than a necessity. For him costly domestic solar lanterns without any savings are luxuries. In addition, some people like *dalits* in Sahariya are not enthusiastic about LaBL due to the solar lantern's inability to light up multiple spaces at the same time. They explain that they can distribute kerosene oil in multiple lamps and use them to light multiple spaces (see also [76]). However, many poorer people join HPS. Micro-grids light multiple spaces, provide additional electricity services like mobile charging and offer a clear economic justification.

6. Health and well-being

By replacing kerosene lamps and gas lights, electrification projects create healthier and safer conditions for studying and commercial activities [77,48,10]. However, what about people not involved in these activities, and what about everyday activities other than studying and commerce? This section illustrates that the health and safety benefits of energy access projects are limited because of a greater focus on electric light, to the exclusion of other critical services like cooking and heating whose serious health impacts are felt disproportionately by women and children [22].

6.1. Health and safety without clean cooking

Health and safety concerns around energy sources are not limited to kerosene lamps. Cooking is mostly carried out on earthen hearths fuelled by wood, agricultural waste, coal and kerosene. Since it is hard to cook outside, most hearths are kept in closed spaces in winters. This causes serious indoor pollution with well-established health hazards.

Fig. 4. Children study in the kitchen under a LaBL lantern while their mother cooks in Sahariya.

Dictated by social and cultural norms, women do much of the cooking and are disproportionately impacted by these hazards.

Indoor air pollution due to cooking with biomass causes depression, cardiovascular diseases and alterations in immune defence among women [78,79,18]. There is fairly strong risk of acute lower respiratory infection (ALRI) among children due to indoor air pollution from biomass fuels [80–82]. ALRI causes most deaths among children under the age of 5 years ([83]:3).

It was observed during the research that some younger children ended up sharing the kitchen space while studying because they could not be left unaccompanied. In addition, poorer people who can afford only a limited number of solar lights manage them in ways such that different members of the household can co-habit the lighted space and perform different activities. Even with access to LaBL lanterns, these children were exposed to indoor pollution (Fig. 4). In this case, the health and internal environment argument of the electrification projects becomes contentious. Children are safe from the harmful fumes of kerosene lamps, but they are still exposed to dangerous pollutants from cooking fuels.

Cooking on biomass in open hearths also causes fires. In India, female mortality is more than four times higher than males when burns are the cause of death [19]. Burns are the only unnatural cause in which female deaths outnumber males [19]. Most females in Bihari villages wear a *sari* – long pieces of cloth wrapped around the body, parts of which droop down. As women move around during cooking, these pieces sometimes fall into open flames. Women's vulnerability to fire came up during the research, even in villages that had electricity through the central grid, LaBL or HPS.

6.2. Health and safety without clean heating

Heating during winter months affects the indoor environment in village homes. It was observed that in Bihari villages space is heated by burning biomass or coal. Biomass is burned as open fires called *ghura* or as small, mobile ambers in earthen pots called *borsi* around which people sit to keep warm (Fig. 5). *Borsi* is used indoors and left in rooms all night to keep the space warm. This puts people at risk of carbon monoxide poisoning [84]. Half a million women and children die annually in India due to indoor air pollution [83].

Females and small children, spend most of their time inside homes, in closed environments (Section 4.2). This is reflected in their heating spaces. As a consequence, they are exposed to a higher concentration of pollution [85]. It was observed during the research that, keeping to the social norms, men used open spaces for their *ghuras* where other men could join them for socialisation. Women and children used closed spaces for their *ghuras* or *borsies*, when they were away from the hearths.

Since, neither electrification case study provides cooking or heating services, people who join them remain dependent on other energy sources. Thus, wood-fired hearths, *ghuras* and *borsies* share spaces with LaBL solar lanterns and HPS light bulbs (Fig. 5). The risks to health and life due to these energy sources, and the real and hidden costs that they result in, might reduce the benefits that the electrification projects claim [28]. Therefore, electricity from the sustainable energy projects does not result in improved health and safety for everyone, in all spaces and at all times.

7. Conclusions

Policy and academic discourses often take for granted that access to energy will lead to development benefits. While true to an extent, the education, livelihoods and health benefits of energy access do not manifest in a straightforward and un-complicated way. Energy access projects create benefits, but the extent to which these benefits are felt across the community is unequal.

This paper argues that socio-cultural processes mediate the impacts of energy access projects. It provides evidence that in particular, the roles of gender, socio-economic positions of certain groups (caste) and the local economy are vital in understanding the links between education, livelihoods, health and energy.

This paper illustrates that due to particular socio-cultural priorities, a focus on electric lights has unequal impacts for women and certain social groups. Males, particularly male members of the higher castes, who already enjoy a privileged position, reap most benefits of electric lights. Directed by existing socio-cultural norms, women spend more time indoors and in front of cookstoves. Therefore, a stronger focus on clean cooking and heating services may have greater impacts for them in the short to medium term. In addition, micro-grids providing electricity (rather than just lighting) might lead to better social outcomes, because they will be accessed by lower castes and by girls/women.

Electric lights help commercial establishments save money on more expensive fuels and extend their opening hours. However, due to the

Fig. 5. Women and children use *borsi* in Sahariya while a LaBL lantern lights the space.

limited pool of customers in villages an increase in sales or incomes does not systematically take place. Moreover, people are less interested in electric lights when they are not connected to clear cost savings.

Poorer people spend money on mobile phone charging and find paying for micro-grid connections more beneficial. They take electricity connections primarily for charging phones. Lights come along with it. Therefore, projects designed to bring services that people find more critical, and that *only electricity* can provide, rather than *only lights,* may have a wider reach, even for the provision of lighting services.

It is not an aim of this paper to dismiss the development impact of energy access projects. Instead, the paper argues for more nuanced thinking and assessment of the impacts of energy access projects by developing a more nuanced understanding of the relationships between development and energy. As explained in the paper, this relationship is often mediated by local socio-cultural processes. Energy access projects cannot be expected to completely transform the socio-cultural process of the spaces in which they operate. However, their design could be tailored and their focus modified to bring greater benefits to less privileged groups of society.

Finally, the paper argues for a need for further studies on how local socio-cultural processes mediate the impacts energy projects and how by keeping these processes in mind, the benefits of energy access could be extended to less privileged groups.

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