Energy and Poverty: the Efficacy of Electricity Subsidy in Alleviating Poverty in Zimbabwe

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ABSTRACT

The study set out to investigate the effectiveness of electricity subsidies in poverty alleviation in Zimbabwe through addressing the questions around the quantum and distribution of the subsidies between the poor and non-poor. The study also addresses the questions around the influence of the subsidy design and access features on the targeting performance of the subsidy. In order to understand the targeting performance of electricity subsidies in Zimbabwe, the Poverty, Income, Expenditure and Consumption Survey (PICES) household data was used in undertaking a benefit incidence analysis of the electricity subsidies. Benefit incidence analysis assesses the extent to which subsidies benefit the poor vis-à-vis the non-poor, hence showing the extent to which the subsidy is effective in reducing poverty. It also shows the key drivers of targeting performance in terms of access factors and design factors of the subsidy, hence providing information about potential areas of policy intervention. Empirical evidence carried here-in shows limited connectivity and usage of electricity by the poor and high level of exclusion of the poor in subsidy benefit, not helping in poverty reduction. The article established that current electricity consumption subsidy scheme in Zimbabwe has low target performance, implying that it is not pro-poor. The high level of exclusion due to low access, uptake and connection rates for poor households against the non-poor contribute to the lack of pro-poorness in the subsidy scheme. Policy simulations of possible subsidy options reveals that electricity connection subsides have a potential for a high impact in alleviating poverty in Zimbabwe and that consumption subsidies alone are not effective in trying to improve the lives of the poor.

KEYWORDS： Electricity, PICES, Poverty, Power-tariff, Subsidies, ZESA, Zimbabwe

1. Introduction and Context

Electricity in Zimbabwe is heavily subsidized. In 2017 the Zimbabwe Electricity Distribution and Transmission Company sold electricity to households at an average of US 9.96 cents per kWh, which was lower than the estimated efficient cost of supply of US12.4 cents per kWh[1]. This implied a subsidy of 24.5% per kWh consumed by households. The high proportion of subsidies in Zimbabwe could be indicative of a subsidy design that may be too generous, with low target performance and heavy burden on the fiscus.

Electricity is subsidised in many forms, including R&D, investment, generation, decommissioning and consumption (Kitson et al., 2011). In Zimbabwe consumption-linked subsidies include reduced rate of import duty for solar components, quantity-based increasing block tariff (IBT) schedule subsidy and VAT exemption. However, this study focuses on household electricity consumption subsidies and grid electricity which is generally considered of high quality and potential for enhancing productive activity. Until June 2020, Zimbabwe has been applying an IBT structure with three consumption blocks heavily subsidized. Such a structure is less self-sufficient, less redistributive, and lacks direct supply-side linkage[2]. This results in government subsidizing electricity utility companies through capital injection to cover losses from subsidies, despite government fiscal constraints. It also results in underinvestment in electricity generation and grid expansion by utility companies, which further limits opportunities for electricity access and connection among the poor and marginalised.

Improving the targeting performance of the subsidies is imperative as it focuses subsidy benefit on the poor who genuinely need the subsidy. It also reduces the cost of providing subsidies and creates fiscal space for government by limiting subsidies to the non-poor.

1.1 Electricity Access, Uptake and Consumption in Zimba we – Insights from PICES Data

The 2017 PICES data, indicate that 74% (2.4 million) of households have access to the national grid, of which, actual household connections are low, at 32% (1.1 million) – see Figure 1. Among the poor, the uptake rate of connections given access is 8%, while it is

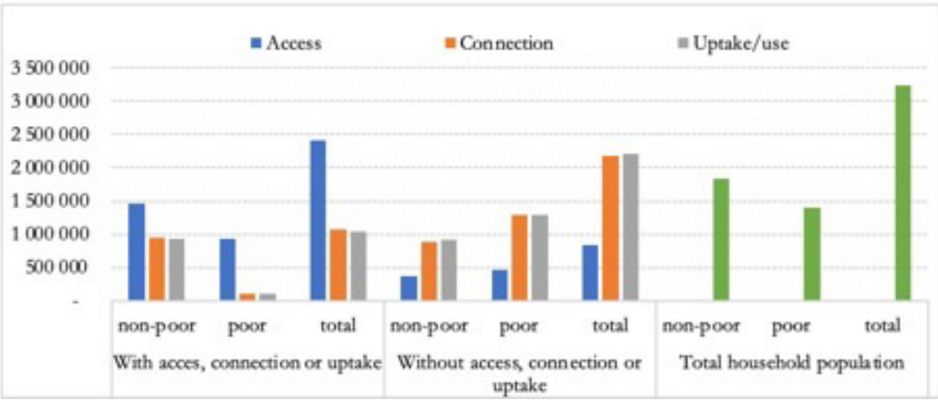
1 Based on data from the World Bank (2020).

2 In June 2020, Government announced a new tariff schedule with four blocks, with a new block of 201-300kWh that has a relatively lower tariff rate compared to the then existing tariff for consumption to that level, whilst maintaining tariff levels for the next band as before. The third block of the new tariff schedule, however, has a subsidy redistributive effect, allowing ZESA to charge above efficient cost reflective tariff. Notwithstanding the negative subsidy benefit on the fourth block, which is a result of the fixed exchange rate, the subsidy benefit on new tariff schedule remains similar to the old schedule, which is biased toward increased consumption, and does not discourage inefficient consumption.

relatively higher for the non-poor at 52%. Uptake or use of electricity among those with connections is relatively high (97% for the poor and 98% for the non-poor), suggesting that once a household is connected it has a higher propensity to consume electricity.

In rural areas, most households do not have any form of electric energy. About 56% of the poor are without electricity versus only 38% of the non-poor. Grid electricity usage is largely for the non-poor in rural areas (14%) than for the poor (3%). Solar home systems are the predominant source of electric energy in rural areas for both the non-poor and the poor, followed by solar lanterns. The main reasons for not having a connection to the grid differ across location and poverty status, but they mainly include initial costs, distance to national grid (mostly in rural areas) and non-ownership of land and property. Average monthly total expenditure on electricity of US$12.09 for the poor, remains low compared to US$22.73 for the non-poor. Low connection, usage of electricity and limited quantity consumed combine to suppress total value of the subsidy received by the poor households per month, leading to uneven subsidy distribution between the poor (9%) and non-poor (91%).

Figure 1: Electricity access, connection and uptake, 2017 (Number of households)



Source: Authors' construction from Zimstat 2017 PICES data

2. Literature Review: electricity subsidies and poverty: the broader context

There are several reasons why subsidies are important in the context of poverty reduction. Subsidies redistributes resources and make utility services affordable to the poor, thereby facilitating access to and use of electricity and improving their social welfare (Komives et al., 2005; Sovacool and Hess, 2017). They reduce the burden of electricity costs on the poorest 40% of households in Central America, thus contributing to poverty reduction

(Urdinola and Wodon 2012).

The efficiency and effectiveness with which subsidies reduce poverty and redistribute income to the poor is, however, predicated on the assumption that subsidies are pro-poor, reach and disproportionately benefits the poor more than the non-poor. However, subsidies may be ineffective in reaching and distributing resources to the poor (Vega et al., 2019). In Central America, subsidies reduced poverty with high levels of inefficiency because a large proportion of subsidies (more than 60c per dollar) benefited high-income households (60% of the households). Arze del Granado et al. (2012) found that electricity subsidies were regressive in 20 developing countries because the poor were consuming disproportionately less electricity than the rich. In Argentina, even though subsidies were found to protect the poor, they were not effective because they benefited the rich and non-residential consumers more than the poor households (Lakner et al. 2016).

Kitson et al. (2011) pointed three common approaches to measuring subsidies. The price gap approach, which measures the difference in observed price for electricity versus a free market reference price. This study applies this approach. However, this approach captures producer subsidies only to the extent that they are reflected in the consumers price. The transfer measurement approach, quantifies subsidy associated with a given programme, regardless of whether or not there is effect on end price. The integrated approach, combines direct financial transfers (including those benefiting producers through government assumption of risk) as well as transfers generated between producers and consumers and vice versa as a result of government policies. The main example of which is the Producer Support Estimate and Consumer Support Estimate (PSE-CSE) framework applied in particular by the OECD.

The design of a subsidy matters in determining the efficiency of a subsidy in reducing poverty and redistributing income. The threshold to determine household eligibility to a subsidy and the depth of a subsidy (i.e. the subsidy amount per unit of electricity consumed) are the main drivers of the efficiency of a subsidy scheme in Central America. The targeting strategy that relies on the amount of electricity consumed as an indicator of rich/poor households results in higher errors of inclusion and exclusion because the relationship between electricity consumption and income is not perfect.

Most studies on benefit incidence explain targeting performance of subsidies but do not explain factors behind performance of subsidies. Angel-Urdinola and Wodon (2007) found that electricity consumption subsidies in Cape Verde, Rwanda, and Sao Tome and Principe were regressive mainly due to access factors that prevent the poor from using electricity. The study established that shifting from IBT structure to VDT structure and from consumption to connection subsidies, though may not make the subsidy pro-poor, improves targeting performance of electricity subsidies. They also noted that the increase in targeting performance was mainly due to higher quantities consumed by poor and well-designed connection subsidies which were relatively more pro-poor than consumption subsidies as they raised benefit incidence above one (Angel-Urdinola and Wodon, 2007).

Reforming subsidies has potential to generate substantial fiscal savings. In Central America it is estimated that reducing subsidy leakages to high-income households reduces fiscal costs by 30% to 50% without increasing poverty. However, it is noted that even though subsidy reform may increase subsidy pro-poorness, some households, especially middle-income households, would be negatively impacted and therefore government should address such costs. Progressive taxation and targeted fiscal transfers are found to be more efficient than residential electricity subsidies in achieving poverty reduction, distributional equity and macroeconomic stability. Araar and Verme (2012) showed that restructuring of utilities' tariffs has great potential of improving equity and efficiency of government spending. Komives et al. (2005) revealed that targeting mechanisms (e.g. IBT, VDT, geographic) do not address the utility services access gap between the poor and the non-poor, hence implying that subsidy reforms that seek to improve targeting mechanisms can only reduce poverty up to a limited extent and that connection subsidies are very important in reducing poverty when the access gap between poor and non-poor is very high.

Subsidy reform can be gradual or big bang. The latter gives rise to sharp increase in prices of electricity if subsidies are generally significant, thus resulting in higher welfare losses which the poor can fail to absorb. Some have suggested reforming electricity subsidies by integrating them into social assistance programmes[3] which have better mechanisms for identifying beneficiaries and distributing the subsidies with greater accuracy, addressing errors of exclusion (i.e. excluding the poor from subsidy benefits) or inclusion (i.e. including the rich in subsidy benefits).

Countries have looked at different ways of reforming their subsidy schemes. In El Salvador, the government eliminated electricity subsidy targeted at middle- and high-income groups of the population that consumed 100kWh to 300kWh of electricity in order to reduce subsidy fiscal costs. Honduras introduced geographic targeting whereby high-income neighbourhoods were excluded from the more generous subsidy scheme in order to improve the targeting performance of the electricity subsidy.

Lessons from international experience suggest that it is important to consider the following when reforming subsidies: (a) Identifying the population groups that will be negatively affected by the electricity subsidy reforms and consulting them in advance and providing compensatory policy measures to reduce adverse impact on their welfare and secure their buy-in; (b) Making public the benefits of electricity subsidy reform and ensuring that the reform efforts are credible; (c) Recognising and addressing political economy challenges to increase chances of success in reforming the subsidies; (d)

3 The integration of electricity subsidies into social assistance programmemes, however, works wellwhen the country has a high quality social assistance roster which identifies low-income households at national scale.

Ensuring that the reform agenda enjoys sufficient support from the government; and (e) Replacing subsidies with more accurately targeted forms of social assistance can often advance the same policy objectives at a lower fiscal cost (UNEP, 2003).

2.2 The downside of electricity subsidies

Good as they are intended and perceived, subsides have their own downside:

- Subsidies for electricity may aggravate the level and intensity of poverty if the tax system used to finance the electricity subsidies is regressive, while subsidy benefits to the poor are small (UNEP, 2008).
- In the midst of low revenue-to-GDP ratio and high fiscal constraints, subsidies constitute high opportunity cost in the form of public investment and social services such as health and education (Sovacool and Hess, 2017).
- Subsidies under-price products and artificially increase demand, hence creating shortages and funding pressure to provide the necessary infrastructure to meet higher demand. In Myanmar, subsidised domestic electricity created domestic shortages as suppliers preferred exporting electricity to China and Thailand at relatively higher prices (Sovacool, 2012; UNEP, 2008).
- The subsidization of fossil fuels significantly contribute to high carbon footprint (about 36% of carbon emission between 1980 and 2010, Stefanski, 2014), leading to global warming and climate change which disproportionately affect the poor who lack the means to adapt their livelihoods.

2.3 The distributional aspects of subsidies

The efficacy of a subsidy in helping to alleviate poverty and reduce inequality can be assessed through investigating its targeting performance. If a subsidy is properly targeted it benefits the poor and the vulnerable who most need the subsidy than the non-poor who can afford without any assistance. In that way, the resource envelop required by the government to assist the poor is reduced, creating fiscal space to finance other poverty reducing programmes. In addition, proper targeting subsidy discourages inefficient use/ consumption by the non-poor which could arise if they are included in the subsidy.

The targeting performance of an electricity subsidy is evaluated by considering three dimensions of performance suggested by Komives et al. (2005). These dimensions are: (i) benefit incidence, (ii) beneficiary incidence and (iii) subsidy material value (or subsidy depth). The benefit incidence shows how well a subsidy instrument targets the poor vis-à-vis the other households (i.e. pro-poorness of the subsidy). It is the average share of subsidy benefits received by the poor divided by the average share of subsidy benefits accruing to the entire population of households. Alternatively, it is the share of subsidy benefit to the poor divided by the share of the poor in the total population. A value of 1 means the subsidy is neutral because it delivers a subsidy benefit to the poor that is equal to the share of the poor in the population. A value greater than 1 means the subsidy is progressive (benefits the poor more than the non-poor); and a value of zero means none of the poor benefits from the subsidy.

The beneficiary incidence shows the extent of subsidy miss-targeting, measured by the error of exclusion (i.e. the proportion of the poor who do not receive a subsidy) or error of inclusion (i.e. the proportion of non-poor household who benefit from the subsidies. The material value of the subsidy shows the significance of the value of the subsidy received by the poor, thus informing about the generosity and impact of the subsidy on the poor. It is measured by the average subsidy value received by poor households as a percentage of their average income.

3. Methodology

3.1 Incidence analysis of electricity subsidies

The process of subsidy analysis typically begins with static incidence analysis (Araar and Verme, 2012). This will be used to examine the current distributional status of subsidies across households without considering any reform to the subsidy. It will give insights on whether subsidies are pro-poor or pro-rich and whether subsidies affect the level of poverty and inequality or not. Through static incidence analysis the study will give insights on the total cost of the subsidy to the government, who benefits from the existing subsidies and to what extent they benefit. The analysis will also give insights on the targeting performance of the subsidy, hence its effectiveness in income redistribution and poverty reduction . Static incidence analysis provides the baseline upon which to evaluate simulated subsidy reforms. The approach developed by Komives et al. (2005), Angel-Urdinola and Wodon (2005) will be used in conducting incidence analysis.

3.2 Identifying households getting the subsidy and how much they get

In order to identify the households who receive a subsidy and those that do not receive it, as well as to measure the level of subsidy received, the following steps are followed:

a. Ancillary charges and fees such as the 6% rural electrification levy are deducted from electricity expenditure to get actual electricity consumed and avoid over-estimation of electricity consumption. A simplifying assumption is made that all households did not have debts that they were paying for in their current bills so as to avoid over-estimation of current consumption.[4]

4 This assumption is reasonable because most of the electricity in Zimbabwe is prepaid and there has been about 7 years since pre-paid meters were installed. During these 7 years we expect that all

b. To calculate the quantity of electricity consumed by each household, the tariff schedule that existed during the time of the reported expenditure by the household is applied to the expenditure obtained from step (a). Residential electricity pricing in Zimbabwe is based on the IBT scheme, therefore when household total expenditure on electricity falls within the first block, the quantity consumed is estimated easily by dividing its electricity expenditure which falls within the first block by the tariff applicable to the first block as follows:

c. $$kWh_{h,1} = \frac{e_{h,1}}{p_1} \qquad (1)$$

However, if household total electricity expenditure falls in any other consumption block outside the first consumption block, then the quantity consumed will be obtained by deducting the maximum possible expenditure in the previous consumption block from the households total electricity expenditure and dividing the outcome by the tariff which is applicable to the consumption block that the household belongs. Then add all the maximum quantities of the consumption blocks , , which precede the consumption block where the household's total consumption belongs. The formula is as follows:

d. $$kWh_{h,b} = \frac{e_{h,b} - \bar{e}_{b-1}}{p_b} + \sum_{j=1}^{b-1} Q_j \qquad (2)$$

The same reasoning behind the formula is applied in any other tariff schedule such as VDT. As an example, consider an IBT schedule with three blocks and a household who spends US$40 on electricity per month as depicted in Table 1 below.

Table 1: Example tariff structure

Block number	**Consumptio block (min-max) kWh**	**Max. consumptio per block**	**Applicable Tari (US$/kWh)**	**Max. possible exp. per block ()**
1	0-50	50	0.10	5
2	51-200	200	0.16	24
3	201 and more	>200	0.20	>24

e. Clearly, the household's expenditure is greater than US$24 and therefore

households should have cleared their arrears.

its consumption block should be where it consumes more than 200kWh. Therefore the household's total quantity consumed for the month given an expenditure of US$40 will be calculated as follows:

f. [(US$40-US$24)/US$0.20] kWh + 200kWh + 50kWh = 330kWh
The unit average price of electricity faced by each household is obtained by dividing electricity expenditure obtained in step (a) by the quantity of electricity consumed obtained in step (c).

g. The average cost of generating, transmitting and distributing electricity to residential consumers, assuming efficient operations, was obtained from the cost of supply study commissioned by Zimbabwe Electricity Regulatory Authority (ZERA).

h. The financial value of the subsidy for each household is calculated by subtracting from the average cost of generating, transmitting and distributing electricity obtained from step (d) the unit price of electricity paid by the household obtained in step (c) and multiplying that by the total quantity of electricity consumed obtained from step (a). This approach of calculating the financial value of a subsidy received by the households is called the price-gap approach. The financial value of the subsidy is important in understanding how subsidies affect the use of public funds and the financial health of the utilities provider and is an appropriate measure of the cost to the government or the utility of providing the subsidy (Komives et al., 2005).

i. If the subsidy obtained from step (e) is positive, then that particular household received a subsidy and if on the other hand it is negative then that particular household did not receive a subsidy but rather cross-subsidized other households.

3.3 Calculating subsidy targeting performance indicators

After getting the financial value of the subsidy for each household, the lower poverty line obtained from 2017 PICES data was used to distinguish the poor from non-poor using a binary indicator. Three dimensions of subsidy targeting performance (i.e. benefit incidence, beneficiary incidence and subsidy material value) were then measured.

3.4 Decomposing subsidy targeting performance

In order to inform policy reforms, there is need to go beyond merely indicating how the subsidy performed in targeting the poor, to analysing the drivers of performance of the subsidy. The three dimensions of subsidy targeting performance described above do not show the drivers of the performance of the subsidy. Therefore, the study followed the approach by Angel-Urdinola and Wodon (2005) to decompose the benefit incidence into access and subsidy design factors that influence the overall performance of the subsidy. This will inform the policy makers about the potential areas of reform in the short- and long-term to enhance subsidy impact on poverty reduction. The approach decomposes benefit incidence into five factors: (i) access to the grid (i.e. the grid is in the neighbourhood of the household), (ii) uptake or rate of connections to the grid by households that have access to the grid, (iii) targeting, (iv) rate of subsidization, and (v) quantity consumed. Factors (i) and (ii) are access factor while factors (iii) to (v) are subsidy design factors. Mathematically, the benefit incidence is decomposed as follows:

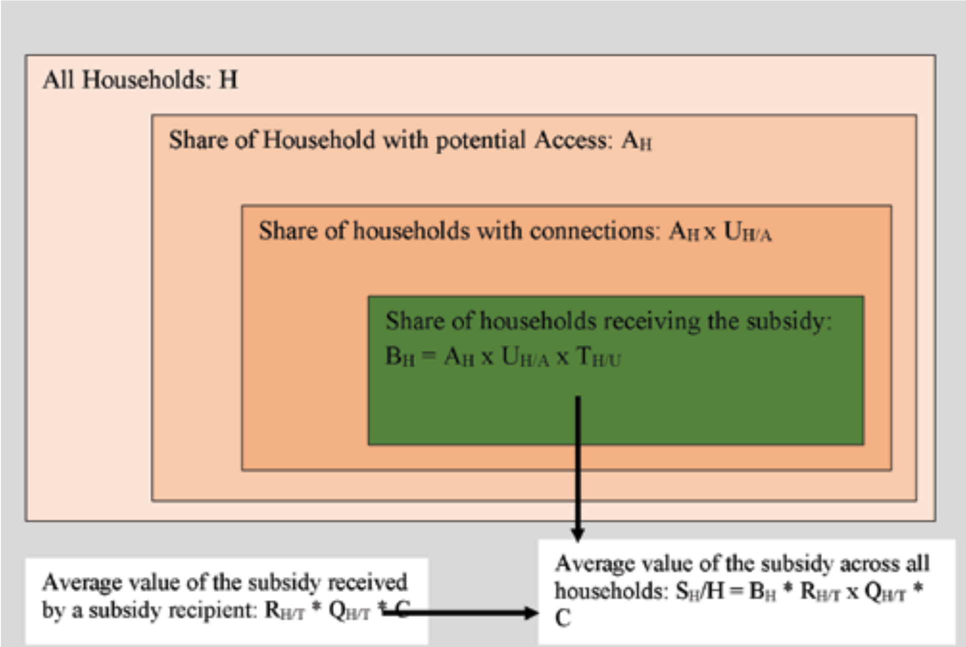
$$Benefit\ incidence = \frac{A_P}{A_H} * \frac{U_{P/A}}{U_{H/A}} * \frac{T_{P/U}}{T_{H/U}} * \frac{R_{P/T}}{R_{H/T}} * \frac{Q_{P/T}}{Q_{H/T}} \qquad (3)$$

where $\frac{A_P}{A_H}$ is the ratio of the share of poor households that have potential access to electricity to the share of all households with potential access to electricity; $\frac{U_{P/A}}{U_{H/A}}$ is the ratio of the uptake rate among the poor to the uptake rate among all the household (i.e. the ratio of the shares of poor to all households that actually use electricity because the decide to connect to the grid); $\frac{A_P}{A_H} * \frac{U_{P/A}}{U_{H/A}}$ is the ratio of the actual connection rate among the poor to the actual connection rate among all households (i.e. the ratio of the share of poor households that are connected and use electricity to the share of all households that are connected and use electricity); $\frac{T_{P/U}}{T_{H/U}}$ is the ratio of the share of poor households with access and connection who are targeted and actually receive a subsidy to the share of all households with access and connection who are targeted and actually receive a subsidy; $\frac{R_{P/T}}{R_{H/T}}$ is the ratio of the average rate of subsidization for the poor to the average rate of subsidization of all households; and $\frac{Q_{P/T}}{Q_{H/T}}$ is the ratio of average quantity of electricity consumed by the poor subsidy recipients to the average quantity of electricity consumed by all households who are subsidy recipients. The framework for decomposition of the subsidy performance is shown in Figure 2.

Table 2: Scenarios for modifying the subsidy design

	BASELINE		**SCENARIO 1**		**SCENARIO 2**		**SCENARIO 3**		**SCENARIO 4**	
BLOCKS	kWh	price	price	kWh	kWh	price	kWh	price	kWh	price
1	1-50	0.02	1-50	0.02	1-50	0.02	0-190	0.062	1-50	0.0199
2	51-300	0.11	51-190	0.11	51-190	0.11	>191	0.124	51-100	0.0399
3	>300	0.15	>191	0.124	191-300	0.124			101-200	0.0699
4					>300	0.13			201-300	0.0998
5									301-400	0.1025
6									>400	0.1197

Figure 2: Framework for decomposing subsidy performance.



Source: Komives et al. (2005)

3.5 Subsidy reform simulation

The simulation of electricity subsidy reforms in the study is based on the standard economic consumer's choice model suggested by Araar and Verme (2012). They show that electricity subsidy reform simulations can be done using less information such as a household budget survey showing household total expenditure/income, expenditure on electricity, a poverty line, own-price elasticity of electricity, and tariff schedules for electricity. The following scenarios were considered in the simulations :

The study simulate modification of IBT schedule and assessing the impact of these modifications on the targeting performance of the resulting modified IBT. The study does not, however, focus on simulating the impact of changing access because as noted by Komives et al. (2005), access is difficult for policy makers to influence in the short-run and that it changes over time due to investments made in the grid expansion. In addition, the simulation of expanding the grid would require detailed information from a supply-side survey which would enable the modelling of the investment behaviour of electricity supply firms. Therefore, the focus of the simulations is on the subsidy design features which are within easy reach of the policy makers to influence and on the connection subsidies as an alternative to consumption subsidies. Four scenarios that modify the subsidy design are considered (Table 2).

a. Scenario 1: the IBT schedule for 2017 is modified in two ways. The size of the second block is reduced from 51-300kWh to 51-190kWh. The 190kWh threshold is a conservative consumption level guided by the average monthly electricity consumption by the poor using lower bound poverty level, which the study set to accommodate all poverty levels.[5] This will likely help to reduce errors of inclusion, although there are also chances of households revising their consumption due to price effects, which may even worsen errors of inclusion. The second modification involves changing the price for the last block to reflect the efficient cost recovery price, currently at US$0.124 per kWh, for consumption above the new threshold of 190kWh.

b. Scenario 2: the modified IBT schedule in Scenario 1 is further modified by introducing a limit of 300kWh on the third block and adding a forth block with consumption of 301kWh and more. Furthermore, a volume differentiated tariff (VDT), pegged at US$0.1600 per kWh is introduced for consumption above 300 kWh. The intuition for this simulation is that the current IBT scheme subsidizes all levels of consumption, thus lacking a threshold beyond which a punitive tariff is effected to discourage potentially inefficient household consumption of electricity. Therefore, for consumption above 300 kWh a household has to pay a tariff of US$0.1600/ kWh for all units consumed. Thus, this will discourage potentially in efficient consumption of electricity. Since the price of US$0.1600 for the final block is greater than the efficient cost recovery price of US$0.124, this scenario is expected to generate some cross subsidies to the extent that households consume way more than the 300 kWh threshold.
c. The third scenario considers a shift from IBT schedule to VDT schedule which gives a subsidy on consumption up to 190 kWh at a price of US$0.062/kWh. For consumption which is above 190 kWh, that is, beyond the conservative upper bound average household electricity consumption by poor households, an efficient cost recovery price of US$0.124 per kWh is effected.
d. Scenario 4 represents the reconfiguration of the IBT schedule in November 2020 wherein ZEDTC introduced a six-consumption-block tariff schedule and changed the marginal prices of the consumption blocks as shown in Table 9. It is expected that increasing the number of blocks reduces consumer surplus and hence increases the revenue accruing to the electricity utility companies. However, one of the setbacks on the tariff schedule modification is that all the consumption remains subsidized regardless of the income

5 The 190kWh is an average based on poor households' electricity consumption calculated using the ZIMSTAT PICES dataset. The average is not basic consumption as defined by ZETDC's basic or subsistence consumption.

level of consumers. Thus, the tariff schedule potentially poses significant subsidy burden on the government and encourages inefficient consumption. Ideally, the threshold beyond which potentially inefficient consumption is penalised by charging at least a cost reflective tariff, should be introduced.

4. Discussion of Research Findings

4.1 *Overall subsidy structure implicit in households' tariff schedule*

In Zimbabwe, the IBT schedule is used in the pricing of household electricity and delivering of the subsidy to households. Alternative subsidy targeting methods such as means-testing, or geographic targeting have never been used. Table 3 shows evolution of IBT schedules for 2011-2020. The tariffs for Zimbabwe were almost stagnant from 2013 until revisions made in March 2020 to account for inflation through inflation indexing [6].

Table 3: 2013-2020 (Mar) IBT Tariff Schedule

Metering	**Tariff Block**	**Charge per kWh in US dollars (2011-2017) and ZWL (2019-2020)**			
		2011	**2014-18**	**2019 (Oct)**	**2020 (Mar)**
Conventional Meter	1-50kWh	0.02	0.02	0.41	0.49
	51-200kWh	0.02	0.02	0.91	1.08
	51-300kWh	0.11	0.11	3.87	4.61
	Balance	0.15	0.15	3.87	4.61
Prepaid Meter	1-50kWh	0.01	0.02	0.41	0.49
	51-200kWh			0.91	
	51-300kWh	0.06	0.11	-	1.08
	Balance	0.15	0.15	3.87	4.61

Source: ZETDC

The first 50 kWh units consumed by households are considered to be the lifeline, charged a tariff of US$0.02/kWh to ensure that the vulnerable and poor households can afford to purchase electricity. The second block of consumption has 51-300 kWh, but this block was revised to 51-200 kWh in October 2019 in an effort to reduce subsidies as

6 Electricity charges for domestic customers or households are zero rated for VAT in terms of Statutory Instrument 168 of 2012, whilst fi ed charges on commercial and domestic electricity are Zero rated for VAT in terms Statutory Instrument 245 of 2005. Implicitly, from 2009 to 2019 electricity sales, Government has forgone a total of about US$430,158,414.79 ($430 million) in value added tax (VAT) exemptions.

envisaged in the tariff determination code. This block was charged a tariff of US$0.11/kWh until 2019 when revisions were made to reflect inflation and exchange rate dynamics. The final block, which has consumption beyond 300kWh is charged a tariff of US$0.15/kWh.

In June 2020, Government announced a new tariff schedule with four blocks (Table 4). The new tariff schedule introduced a new block of 201-300kWh with a relatively lower tariff rate compared to the then existing tariff for consumption to that level, whilst maintaining tariff levels for the next band as before.

Table 4: The Current IBT Tariff Schedule-June 2020

Metering	**Tariff Bloc**	**Charge per kWh in ZWL (US dollars*)**	**Quantity eighted Subsidy depth**
Conventional/Prepaid Meter	<50kWh	0.49 (0.0196)	15%
	51-200kWh	1.08 (0.0432)	36%
	201-300kWh	2.94 (0.1176)	8%
	301+	4.61 (0.1844)**	-17%

*the conversion was at the official rate of 1USD to 25$ZWL

**at the time of completion of the study, the exchange rate had moved to 1USD to 57.3$ZWL, giving a subsidy depth of 49% for the block.

The new IBT schedule has some important implications for poverty. Holding other things constant and assuming a cost of supply of US$0.124/kWh, this tariff schedule implies a quantity weighted cumulative subsidy depth for the four consumption blocks of 42%[7] below the cost of supply which compares with 44% of the three consumption blocks applied in 2017. The fourth block of the new tariff schedule, however, has a subsidy redistributive effect, allowing ZESA to charge above efficient cost reflective tariff[8].

Notwithstanding the negative subsidy benefit on the fourth block, which is a result of the fixed exchange rate at the point of this analysis, the subsidy benefit on new tariff schedule remains similar to the old schedule, which is biased toward increased consumption. This significantly increases affordability and access to electricity by the higher consumers of electricity, often the non-poor. It also implies that the subsidy

7 This figu e jumped to 131% immediately upon movement of exchange rate from 1USD to 25ZWL to 57.3ZWL

8 This negative subsidy depth is only available for a given/fi ed exchange rate between USD and ZWL. If the exchange rate moves, the implied subsidy also changes and the net effect is dependent on whether tariffs responds to movement in the exchange rate.

is significantly reducing the burden of electricity expenditure among the non-poor, as compared to the poor. In addition, the new tariff schedule lacks an effective threshold beyond subsidized consumption level. Thus, even if households increases consumption, say to beyond 1000kWh, they will still receive a subsidy for the subsided portion, with no tariff penalties for over consumption regardless of whether or not such consumption is inefficient for a household. As a result, the current IBT subsidy model does not discourages inefficient consumption. Ideally, there should be a threshold beyond which the price overshoots the cost of supply of electricity. That thresholds should exempt most of the poor and ensure that the non-poor who can afford are subsidising the poor.

4.2 The Distributional Effects of Current Electricity Subsidies

Benefit Incidence: The targeting performance of the subsidy scheme embedded in the 2017 IBT schedule depicted by a benefit incidence indicator of 23%, implying that the electricity subsidy in Zimbabwe is regressive (Figure 3). This means that the poor households are getting only 23% of what they would have received under a universal targeting programme that distributes subsidies equally across all households. Implicitly, the poor households are receiving a share of the subsidy that is lower than the share of the poor households in the population. Thus, the findings suggest that a universal targeting approach that distributes electricity subsidies equally across all households would have been better than the self-targeting mechanism that is used by the IBT scheme.

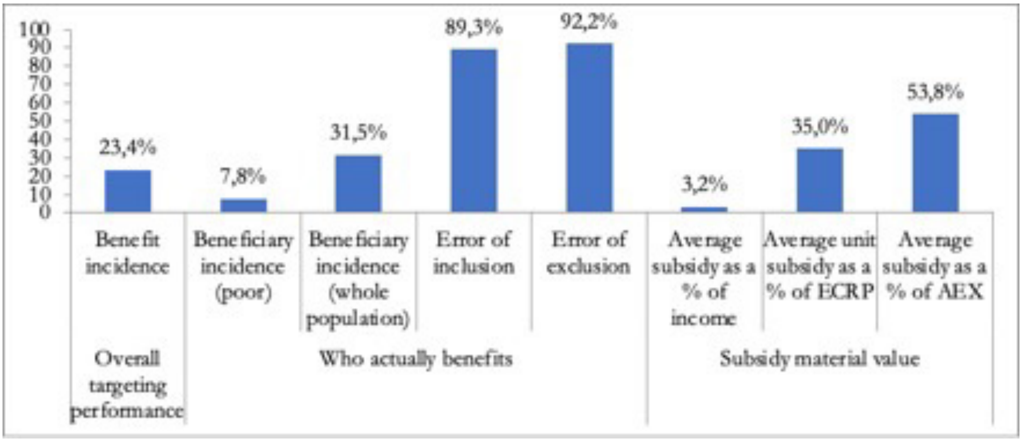
The challenge with the IBT schedule is that its targeting performance is predicated on the assumption that electricity consumption is a good indicator of household level of income. Therefore, it assumes that poor households consume less electricity and get deeper discounts through the lifeline block and other subsidized lower consumption blocks. On the other hand, the non-poor are assumed to consume more and therefore pay at least the cost recovery price for a greater part of their consumption. However, in Zimbabwe electricity consumption and income have a relatively lower correlation coefficient of 0.44.[9]

Also, the targeting in the IBT scheme is not purposive in the sense that everyone who consumes electricity receives a subsidy for part of their consumption (i.e. lifeline block consumption). By subsidizing up to 300 kWh, the IBT subsidy scheme is too generous and perpetuates high errors of inclusion, whereby rich people benefit from the subsidy, and limits cross subsidization among the households, thus potentially reducing the

9 The Pearson's correlation coefficient was used to determine the correlation between household weighted income and expenditure on electricity. Household total expenditure was used as a proxy for household income. There are several reasons why the correlation value is low in Zimbabwe and these include the following. The data used relates to the period when load shedding was high, hence consumption was constrained by supply and therefore it did not matter how much income one has. The use of alternative sources of energy such as gas and solar especially given the unreliable electricity supply also potentially weaken the correlation between electricity consumption and income.

pro-poorness of the subsidy. In addition, subsidizing a large part of consumption limits the scope for self-sufficiency of the subsidy model which ensures that the non-poor households cross subsidize the poor household without needing the government to make subsidies. In Costa Rica and Nicaragua the IBT systems are almost self-sufficient.

Figure 3: Indicators of subsidy performance for the 2017 IBT schedule



Source: Authors' own calculations from 2017 PICES data set

Notes: ECRP=efficient cost recovery price of electricity per kWh. AEX=average expenditure on electricity

The IBT scheme does not explicitly differentiate between the poor and non-poor, and with most of the consumption subsidized (78% of the kWh consumed pay less than cost recovery price), the cumulative benefits of subsides increase with consumption, disproportionately benefiting the non-poor whose consumption is high.[10] The share of subsidised kWh for the poor was only 8% of the total number of subsidised kWh. This was by far less than the 92% share of subsidised kWh for the non-poor. Furthermore, the target performance based on consumption level assumed in the IBT schedule does not factor low usage by the non-poor due to limited supply/availability of electricity and use of alternative sources of energy by the non-poor. Given supply side constraints in Zimbabwe, consumption of electricity could also be limited by supply of electricity. The non-poor are able to afford alternative sources of energy while consuming within subsidized range when tariffs go up. The poor would exhaust their income on alternative sources in the absence of electricity and are, therefore, crowded out by the non-poor who have resources to afford electricity and alternative sources.

Beneficiary incidence: The beneficiary incidence captures the probability that a household would benefit from the electricity subsidy. It is estimated at 8% for the poor

10 The new tariff schedule, with four blocks attempted to address the perpetual subsidy for all consumption levels by having a tariff that was above cost of supply tariff at the time (assuming the then exchange rate of USD1:ZWL$25). The tariff immediately went below cost of supply (to the moment the RBZ introduced a auction system on foreign exchange with rates

and 32% for the whole population. It means the chance or probability that the poor will benefit from the consumption subsidy delivered through the 2017 IBT scheme is 8%. The low beneficiary incidence is explained by the high number of poor households who are not consuming electricity because they either do not have access or they have access but not connected or they have access, are connected but did not consume electricity for other reasons.

Error of exclusion and inclusion: The error of exclusion in the subsidy scheme is very high at 92%. Thus, the subsidy is to a greater extent not helping much to reduce poverty since the bulk of the poor are not included by the current subsidy scheme. This is mainly attributed to household access-to-electricity factors explained in the decomposition of subsidy targeting performance into access and design features of the subsidy (see the next section).

The error of inclusion is estimated at 89%, suggesting that almost nine in ten non-poor households benefit from the subsidy. If subsidies are given to the non-poor who could actually afford non-subsidized electricity, it means that the subsidy could actually encourage inefficient consumption of electricity among the subsidized non-poor, resulting in the crowding out of the poor. A high error of inclusion implies that the subsidy is increasing inequality among households instead of reducing it. In this case, the 8% of the poor are included in the subsidy against 89% of the non-poor, hence explaining the low targeting performance and regressive nature of the subsidy scheme.

The error of inclusion is exacerbated by lower rates of electrification in Zimbabwe which is skewed against rural areas (National Renewable Energy Policy, 2020), and therefore majority of the population, mostly rural poor populace, is without access to electricity and thus automatically excluded from subsidy benefit.

Access to electricity subsidies enhances quality of life and enables generation of income through other subsistence productive activities. High errors of inclusion suggest that the government has scope to create fiscal space by reducing the subsidies for the non-poor and redeploy the resulting savings into poverty reducing expenditures. Given the monthly subsidy of US$6,312,411 to the non-poor, the government would save up to US$67,838,367 by reducing the errors of inclusion.

This amount was equivalent to 18% of the 2017 national budget allocation to the Ministry of Health and Child Care, 8% of the allocation to the Ministry of Primary and Secondary Education, 25% of the allocation to the Ministry of Higher and Tertiary Education, and 9% of the total sales revenue for ZETDC. For ZETDC the savings from reducing errors of inclusion could be used to expand the grid to increase accessibility to the poor, or enhance efficiency of the electricity utilities, and reduce the cost recovery price and hence burden of subsidies whilst increasing affordability.

Subsidy material value: The materiality of the subsidy was estimated at 3% of the average poor household's total income.[11] However, with this measure of materiality of the subsidy it is difficult to assess, without additional information, the significance the subsidy. This is the price gap between the efficient cost recovery price of electricity per kWh and the average price of electricity per kWh paid by the poor who benefited from the subsidy. The greater the price gap, the greater the depth of the subsidy and the extent to which the subsidy enhances affordability for the poor. It also shows the extent to which the subsidy creates savings on electricity expenditure for the poor, which savings can be used to increase expenditure on other items.

The unit subsidy can be expressed as a percentage of the efficient cost recovery price of electricity (ECRP). The study estimated the unit subsidy for the poor at US$0.0434 per unit of electricity consumed or 35% of the efficient cost recovery price. Thus, the subsidy was generous as the poor households saved more than a third of their expenditure per unit of electricity they consumed.

The depth of the subsidy can also be captured by the average subsidy for the poor expressed as a percentage of the poor households' average electricity expenditure (AEX). This shows how much of the poor households' expenditure on electricity is reduced as a result of the subsidy. This indicator is estimated at 54%, showing that the subsidy is very generous as the average expenditure on electricity for the poor is reduced by more than half of what they would have paid without a subsidy.

These indicators show that for the poor who are using electricity, the current subsidy is significant and enhances affordability while creating savings that can be used on other expenditures. However, the challenge is that low access and high errors of exclusion by the poor, reduces the total subsidy benefits they enjoy, resulting in more benefits accruing to the non-poor. Thus, the low benefit incidence of the subsidy, coupled with its generosity, creates scope for significantly reducing subsidies without significantly affecting the poor.

4.3 Decomposition of electricity subsidy performance

Using the values in Table 5 the determinants of subsidy targeting performance were computed with comparative analysis between the poor and total households (Table 6). The poor have a lower share in most determinants of subsidy performance, indicative of poor performance of subsidies towards poverty alleviation among the poor. For example

11 The material value of the subsidy as a percentage of income is calculated using the formula $[R_{P/T}*Q_{P/T}*C]/Y_{P/T}$ where the variables are as defined in Table 7.

, Table 5: Description and values of the components of the benefit incidence indicator

Symbol	Descriptio	Value
Ω	Benefit incidence	0.234
SH/H	Average subsidy benefit in the entire population	2.164
SP/P	Average subsidy benefit among the poor (US$)	0.507
C	Average cost-recovery price of electricity (US$)	0.12
B_H	Probability of receiving a subsidy in the whole population (i.e. beneficiary incidence)	0.31
B_P	Probability of receiving a subsidy among the poor (i.e. beneficiary incidence)	0.08
A_H	Share of households with access in total household population	0.74
A_P	Share of the poor households with access in total poor households	0.66
$U_{H/A}$	Share of households using/up-taking electricity among those with access	0.43
$U_{P/A}$	Share of poor households using electricity among the poor with access	0.12
$T_{H/U}$	Share of households subsidized among those with access, connection and targeted	0.98
$T_{P/U}$	Share of poor subsidized among the poor with access, connection and targeted	1.00
$R_{P/T}$	Rate of subsidization for the subsidized poor	0.35
$R_{H/T}$	Rate of subsidization for the subsidized population	0.26
$Q_{P/T}$	Average quantity of electricity consumed by the poor	149.87
$Q_{H/T}$	Average quantity of electricity consumed by the households using electricity	214.03
$E_{H/T}$	Average expenditure on electricity in the population using electricity	19.66
$E_{P/T}$	Average expenditure on electricity among the poor	12.09
$A_H * U_{H/A}$	Actual connection rate to the electricity grid for all households	0.32
$A_p * U_{P/A}$	Actual connection rate to the electricity grid for the poor	0.08

Source: Authors' computations from the PICES household survey data sets, 2017

the poor have a lower expenditure rate, quantity consumed, share of access, connections and receipt of subsidy compared to the entire population. The rate of subsidisation, among the poor with access, however, remains higher than the average for the country. This is partly because the poor consume relatively less electricity and therefore enjoy the deeper discounts at lower levels of consumption. As consumption increases, the subsidy depth reduces, resulting in lower rate of subsidisation associated with the non-poor who consume relatively more.

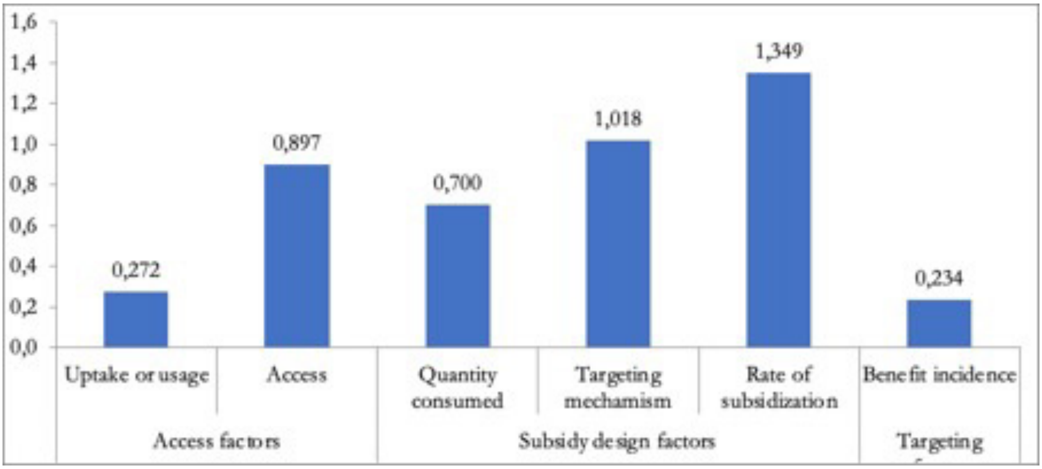
Table 6: Decomposition of Determinants of Subsidy Performance

	share of households with access (A)	share of households with uptake or usage (U)	share of households subsidized (T)	rate of subsidization (R)	average quantity consumed kWh/month (Q)
poor households	0.66	0.12	1.00	0.35	149.87
all households	0.74	0.43	0.98	0.26	214.03
ratio (poor to all)	0.90	0.27	1.02	1.35	0.70

Source: Authors' calculations from PICES 2017 data sets based on framework by Angel-Urdinola and Wodon 2005a.

The relative comparative ratios between the share of the poor and all households then gives decomposition of drivers of subsidy targeting performance (Figure 4). The key driver for poor targeting performance revealed by the benefit incidence indicator of 23%, computed from the given data, is low uptake or usage of electricity.

Figure 4: Determinants/drivers of subsidy targeting performance



Source: Authors' calculations from PICES 2017 data sets

While access for the poor households is almost at par with that of all households, their uptake rate of electricity is relatively lower compared to that of the non-poor. This suggests that the gap between access and usage of electricity is mainly underpinned by low actual connections to the grid among the poor.[12] As noted in Table 5, the access rate for the poor (66%) is relatively closer to that of all the households (74%). However, the usage rate is very low for the poor at 12% compared to 43% for all the households[13]for those with access. Thus, the actual connection rate to the grid for the poor is very low at 8% (i.e. A*U=66%*12%) compared to 24% for all the households with access. As a result, the targeting performance of the subsidy is very low (about 23%) mainly because of lower usage of electricity which is mainly driven by lower rate of connections among the poor. This implies that in order to improve the subsidy targeting performance to the advantage of the poor, priority has to be given in addressing connections to the grid by the poor. A significant share of the poor has access but not connected (58%) hence it is automatically excluded from the electricity consumption subsidy, making the subsidy very regressive. By simply helping the poor households to connect, the targeting performance of the consumption subsidy will improve. Thus, intervention measures by government should be towards facilitating connections to the grid by the poor households while reviewing the consumption subsidy to optimize the benefits to the poor.

The second factor that is mainly driving the poor targeting performance of the subsidy is quantity of electricity consumed. Consumption subsidies benefit those who consume the subsidized product. Without consumption there will be no benefit. Thus, all the households without access or connection or usage of electricity are excluded from the subsidy benefit. The proportion among poor households without either access, or connection, or usage is very high at 92% which means a significant proportion of the poor households are automatically excluded from the subsidy benefit. Thus, in such cases of higher exclusion of the poor due to lack of access, connection and usage, a consumption subsidy is not a good policy instrument of trying to help the poor.

With consumption subsidies, the higher the level of consumption the more the subsidy amount accrues to the benefit of the consumer (i.e. if there are no thresholds for the amount subsidized and no over-pricing of the product for additional units consumed). In the case of the 2017 IBT schedule most of the electricity consumed (up to 300 kWh) was subsidized and therefore more total cumulative subsidy benefits accrue for higher consumption up to the 300 kWh threshold. On average the non-poor consume relatively more than the poor and this could partially be explained by relatively lower burden of electricity expenditure among the non-poor compared to the poor.

Although the rate of subsidization is progressive, there is more room for improvement. The analyses of the IBT schedule across different tariff blocks support this finding in that the schedule subsidizes the non-poor at the same rate as poor households at lower levels of consumption. As consumption increases to the mid-tier block, consumption is

12 It might also be indicative of the broadness of the definition of access used in the survey, which seem to be highly inclusive, accommodating households who are in the vicinity of the national grid as mentioned in Part II.

13 These ratios might have been affected by the broader definition of ccess.

still subsidized despite possibility that a relatively lower share of the poor might not be consuming in the block. However, additional consumption above 300 kWh is priced more than the cost recovery price. This discourages potentially excessive inefficient consumption of electricity, promotes self-financing in the subsidy scheme, reduces the burden of subsidy on the government and promotes income redistribution between the poor and non-poor. The PICES Data shows that some households consume in excess of 3700 kWh, a level which is beyond expected household consumption. Thus, charging a tariff which is at least cost reflective discourages such potentially inefficient consumption (for example commercial use of electric power meant for domestic). Geographical targeting of subsidies should also be considered.

Access to the grid, at a rate of 66%, among the poor against 74% of the entire population leading to an access ratio of 0.9, on paper fairly contributes in improvement of targeting performance of the subsidy. However, with access alone and without connection the poor neither uptake nor use the electricity from the grid and, therefore, the errors of exclusion from the consumption subsidy are magnified. Thus, with limited connection despite high access to the grid by the poor, the consumption subsidies will tend to be regressive. Attention has to be paid to supply-side interventions that increase connection to the grid among the poor.

The results of the decomposition of the benefit incidence indicator generally show that the main factor undermining the performance of the subsidy targeting is low rate of electricity usage among the poor households relative to the total population, leading to higher rates of exclusion. A relatively large share of the poor with access need to be assisted in connecting to the grid in order to enhance targeting performance of the consumption subsidy. Thus, improving the rate of connections among the poor may increase the pro-poorness of the subsidy. This implies that the government may need to explore connection subsidies instead of consumption subsidies or even exploring a combination of both subsidies. Currently, the government is not subsidizing connections to the grid.

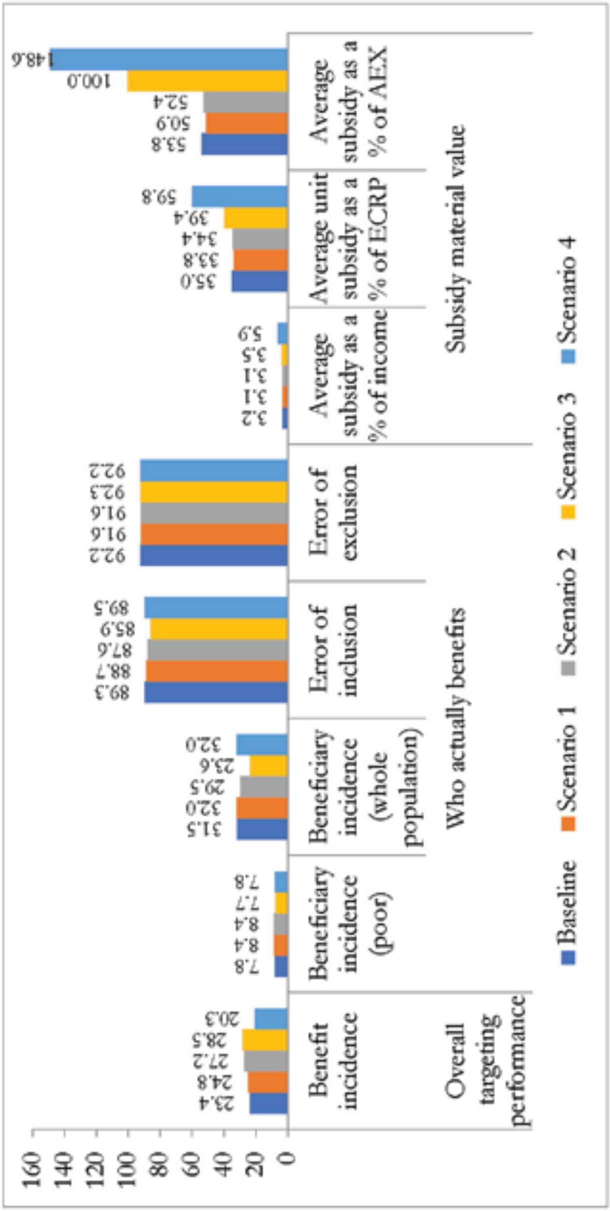
The results also show that subsidizing consumption is not a good priority when connection and usage rates of electricity by the poor are relatively lower, as this makes the subsidy regressive and less beneficial to the poor. However, since quantity consumed is the second main factor influencing the targeting performance, consumption among the poor needs to be encouraged through improving the subsidy design scheme. For instance, higher and potentially inefficient consumption may be penalized by paying above cost recovery price. The rate of subsidization and targeting mechanism have room for improvement, but they are relatively not the main drivers of poor subsidy targeting performance. The targeting mechanism embedded in the IBT scheme does not discriminate between the poor and non-poor and therefore tends to be neutral on its influence on the targeting performance. Purposive targeting needs to be considered to improve the pro-poorness of the subsidy. The subsidy needs to be given to the poor households only or to ensure that the non-poor are subsidized to a very lesser extent.

4.4 Weakness/gaps in the existing electricity subsidy model

The above discussion of research findings reveal that the current subsidy scheme is not pro-poor, implying it has high level of exclusion of the poor and low target performance, mainly due to low uptake, connection rates and quantity consumed by poor households against the entire population. There are several other observable gaps in the existing model that explains this outcome, which could be the points of focus on the suggested subsidy reform programmeme:

- The country is using a passive targeting mechanism, which e targets subsidies through quantity consumed (e.g. as in IBT). Instead, active targeting is more accurate and reduces errors of inclusion, hence leading to higher targeting performance of subsidies. However, it may be considerably difficult to identify and deliver subsidies to people who qualify for it. Active targeting of subsidies requires administrative selection of the beneficiaries (Komives et al., 2005). However, such a targeting system for subsidies may be very costly to design and take many years to build and many more to refine, and once in operation their administrative costs may be very high (Scott and Pickard, 2018). Personal attributes (e.g. student, pensioners, veterans, refugees, etc.), geographic indicators (e.g. poor neighbourhoods, rural areas, high density areas, etc.) and proxy means test variables (e.g. electricity consumption below a threshold, quality of electricity connection, income threshold, electricity expenditure above a burden limit expressed as a percentage of total expenditure, etc.) may be used to administratively identify potential beneficiaries of the subsidy (ibid.).
- Despite the difficulties in active targeting of subsidies, the increase in digital solutions has increased the number of means tested (or administrative) targeting mechanisms in use recently (Scott and Pickard, 2018). Active targeting would be relatively cheaper to implement if the social assistance programme is very strong, with wide coverage. Then, active targeting would ride on the social assistance database of beneficiaries to identify and deliver the subsidy. In Zimbabwe, already the water utility – Zimbabwe National Water Authority (ZINWA) and municipal authorities – uses active targeting for its subsidies. Specifically, geographic targeting is being used by ZINWA in determining water tariffs, whereby subsidized tariffs are disbursed to neighbourhoods where the poor reside. The framework for geography-based electricity subsides may ride on the existing experience

Figure 5: Targeting performance of simulated scenarios



Source: Authors' computation using 2017 PICES household survey data and infrastructure to embark on active targeting of electricity subsidies.

- Related to that, the current subsidy model does not have connection subsidies and does not cover for compensation of electricity infrastructure development by consumers, particularly the poor. The existing arrangement is such that consumers can do connections and install electricity infrastructure at their own costs to expedite connection to electricity[14].
- The overall consumption subsidy model is not linked to the supply side, rather it is focused on the demand side and assumes supply as constant. The model does not factor the loss by the ZESA through cost of generation, lost margins, power theft and absence of penalties on non-payment of electricity (for households that are not on prepaid metering). Besides, the existing model has a negative trickle-down effect on to electricity generation and supply. For example, the power company simply reduces the tariff rate as recommended by the Government in lieu of tax relief. The electricity company does not receive the equivalent amount as a grant from government in compensation for the cost in generation of the subsidised electricity. ZESA is then forced to absorb the costs of the subsidy, which then threatens its operational and power generation substantiality.
- In addition, the current model does not promote distribution of electricity by IPPs. Whereas most IPPs can generate electricity to augment current generation by ZESA, they face the challenge of distribution as they rely on ZESA infrastructure. Also, the current model does not deliberately support development of green energy.

4.5 Simulated and Non-Simulated Electricity Subsidy Reforms

Simulation of possible subsidy options reveals that increasing connectivity to electricity by the poor is critical in ensuring high incidence of benefit on the poor. Possible simulated and non-simulated subsidy reforms for Zimbabwe include reconfiguration of the IBT tariff schedule, introducing connection subsidies, enhancing non-tariff-based subsidy reforms and integrating supply side subsides.

Reform Option 1: Reconfigure the tariff schedule

The current IBT subsidy scheme was deemed to have a low targeted performance with subsidy benefits accruing more to non-poor than the poor. The current electricity

14 For example, people can engage a private contractor to install an electricity line and do in-house installations. ZETDC will then inspect, authorize and energize the connections. ZESA does not pay for the infrastructure as they take it as a donation from customers through an agreement. The ownership and rights of control of the infrastructure will be transferred to ZESA as soon as the connection is done. During the first five years, households who intend to connect from the established infrastructure have to pay compensation to the other households who are the primary financiers of the infrastructure

subsidy is applicable to every consumption block, potentially resulting in lack of cross-subsidization, income redistribution and self-financing. It was also noted that the targeting performance of the subsidy was mainly driven by lack of usage among the poor.

The results of the simulations of the subsidy design under the four scenarios are shown in Figure 5. The results show that the VDT scheme (Scenario 3) outperforms the other schemes with a targeting performance indicator of 29%, a relatively generous subsidy to the poor and relatively lower errors of inclusion. However, this comes at the expense of a relatively slightly lower beneficiary incidence to the poor of 8% and high errors of exclusion of 92% (Figure 5).

A VDT combined with an IBT (Scenario 2) is the second highest performer in terms of targeting performance (27%), beneficiary incidence and errors of inclusion and exclusion followed by Scenario 1 at 25% and Scenario 4 (20%). Overall, the simulated subsidy scheme scenarios indicate that while changing the subsidy design may improve the targeting performance, this does not cause the consumption subsidy schemes to be pro-poor. All the subsidy designs simulated are regressive, thus emphasizing the importance of addressing the access factors, attempting other forms of subsidies which are not consumption subsidies and other targeting mechanisms which are not self-targeting.

Reform Option 2: Introduce connection subsidies

Connection subsidies rather than consumption subsidies may generate progressive distribution of subsidies since the main problem is limited usage among the poor due to poor connectivity to the national electricity grid. The average connection fee in Zimbabwe is US$100 whereas the average cost of a connection is US$250. The connection fee between the poor and non-poor is the same. However, the study simulates a scenario where a larger subsidy is given to the poor such that the connection fee for the poor is US$50. The results for the simulation of connection subsidies indicates that connection subsidies are better targeted than consumption subsidies with a benefit incidence ranging between 0.33 to 1.9 (Table 7).

Table 7: Benefit incidence Simulations for connection subsidies

	Benefit Incidence indi ator
Scenario A	0.325
Scenario B	1.859
Scenario C)	1.808

Source: Authors' calculations from 2017 PICES data and ZERA data

Thus the connection subsidies are potentially pro-poor and therefore may be more effective in ensuring that the poor benefit form subsidies. This is mainly attributed to the fact that the main problem why the poor are excluded in consumption subsidies is limited usage of electricity due to lower rates of connections among the poor. Therefore, improving connections by subsidizing the connection fees is a very effective way of ensuring that subsidies are pro-poor. However, literature notes that the uptake of connections may be low even if the cost of connections is subsidized (Lee, Miguel, and Wolfram, 2020). This suggests that more needs to be done apart from giving subsidies and that there are other barriers to establishing connections apart from costs of connection.

Reform Option 3: Non-tariff based subsidy reforms (non-simulated)

Simulated models based on tariff based subsides consumer have shown a weakness of not being optimal. The observed intuitive rationale for such an outcome is that there is need to compliment these reforms with other non-tariff based reforms for tariff based subsidy reforms to be effective. Non-tariff subsidy reforms are critical in addressing the targeted performance incidence of tariff subsidies. In Zimbabwe there are many incidences of power theft[15] and access to subsidies power by deemed strategic sector and big players with no accruing benefits. Also, the structure of transfer pricing on part of public institutions and entities accessing power is not clear. There is need for reforms on classification of large and strategic consumers of power as well as recasting of the existing subsidy model. For example, government could move entirely or in part from input based power subsidy to out based power subsidy for large consumers such as industry and agriculture. The government could then implement a targeted subsidy system on these critical sectors.

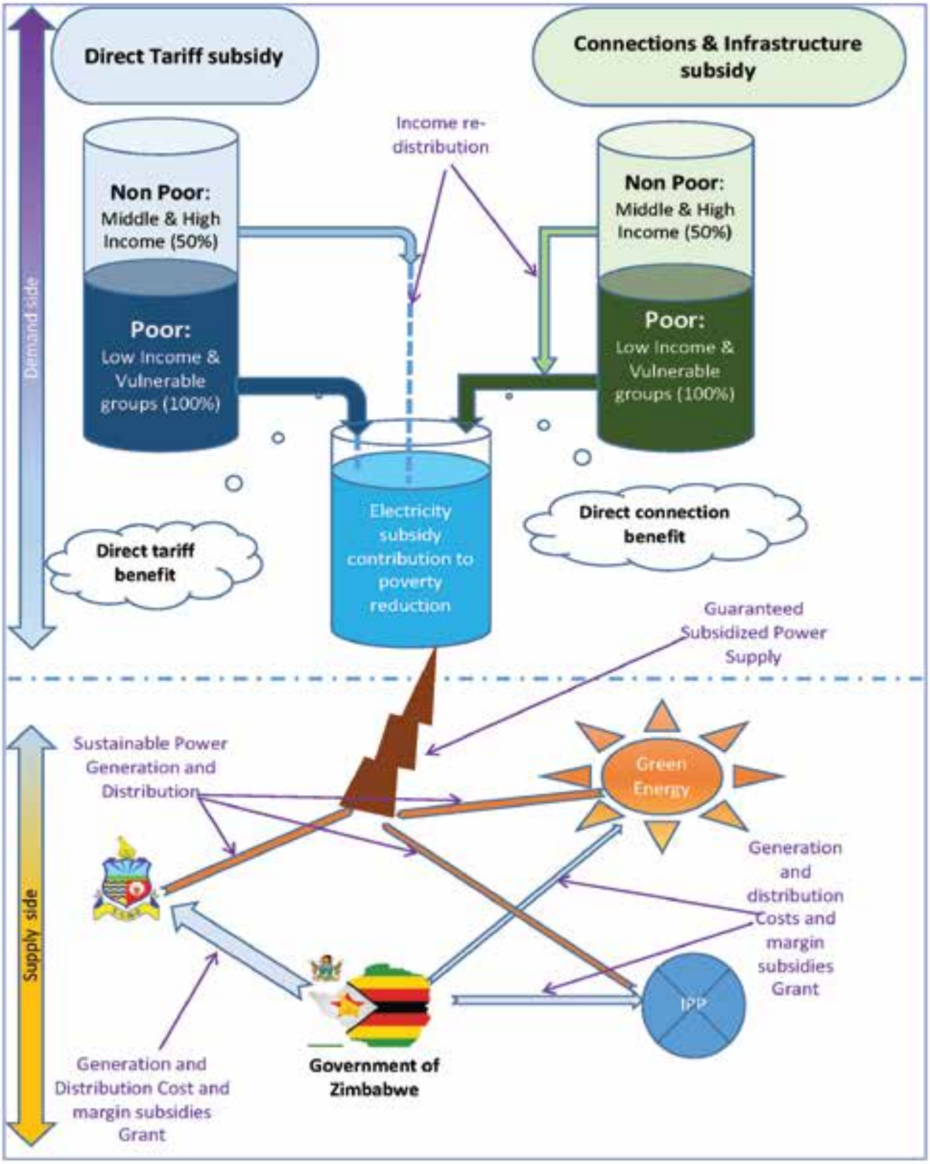
Reform Option 4: Integrating supply side subsides (Non-simulated)

Whilst the study focused on consumption subsidies, the optimality of the reform policy agenda is not complete without supply side reforms. Consumptions subsidies viewed in isolation are not the sole conduit for power subsidies for poverty alleviation. The burden of subsides to the part government cut across supply and consumption subsidies. These subsidies impair the financial health of the energy suppliers, deter investments in the energy sector, and impose large fiscal costs where they are provided by governments (Kitson et al., 2011). Subsidies can be reformed by reducing costs as well as increasing revenues and stakeholder analysis and distributional analysis are important for designing suitable reform programmes (ibid).

The power generating and distributing company is carrying the burden of consumption subsidies and this has affected their operational viability. The operational challenges faced by public power companies (ZPC and ZETDC) reflect elements of the companies carrying the burden on state power-subsides. ZESA is faced with serious revenue collection challenges as the majority of customers are failing to settle their bills on time. Attempts have been made in the past years review tariff structures to have pricing of

15 Although heft penalties were introduced to curb vandalism and theft of electricity infrastructure there is still room to consider other effective measures as well.

Figure 6: Household Income-Differentiated and Supply Enhanced Power subsidy model



Source: Authors' formulation

power that is towards full cost recovery, while at the same time preserving price subsidies for low income households. ZESA, has also instituted demand side management (DSM) programmes[16] with a view to reducing energy consumption and improving its operational performance. The effectiveness of these measures is, however, weighed down by the inefficient subsidy scheme the country is implementing.

With a quantity target approach used in current subsidy model, if supply is restricted or tariff increases, it would imply that majority of people will consume in the first block which is highly subsidized. The poor would then be excluded by crowding out given that they exhaust their resources on alternative sources of power and would not be able to afford electricity. Such a structure would the affect the power company, ZESA, in that most of its power ends up being consumed at below cost, not because consumers are not willing but supply is limiting consumption.

The inclusion of supply side subsides is on the notion that supply of power is a major determinant of the effectiveness and target performance of consumption subsidy matrix. ZESA's regular request for tariff review should be a trigger to also consider supply side subsidy reforms. Zimbabwe is currently facing power deficit and this impact on availability of power to household, and often ZESA resort to shedding power for extended periods. The effective generation and technical subsides that accrue to ZPC/ZETDC might not be adequate to cover the loss incurred through loss incurred through subsidies power generation costs and margin losses. Many Sub-Saharan African countries are characterized by weak institutions, poor quality of electricity service delivery typified by frequent outages, and weak social protection systems that pose serious challenges to the design and implementation of subsidy reform (Kojima, *et al,* 2014).

5. Conclusion and Policy Eecommendations

Deductions from the study are that, with proper reforms and structuring, electricity connection subsides have a potential for a high impact in alleviating poverty in Zimbabwe. Consumption subsidies alone are not effective in improving the lives of the poor and these need to be complemented by connection and supply side subsidies that support increased uptake of electricity by the poor. In other words, the low uptake and usage of electricity excludes the poor from benefits of electricity subsides, implying that with consumption subsidies, it is the poor who are technically subsidising the non-poor by exclusion due to limited connectivity and uptake of electricity. The policy decision, therefore, should not be about whether or not subsidies should continue to be used as tool of alleviating poverty, rather it should be on how to reform the subsidies in order to optimize their effectiveness in alleviating poverty.

The study recommends policy reforms premised on a reviewed electricity subsidy

16 ZESA managed to implement the pre-paid meter programme, upgrade of the existing billing system, and enforcement of the disconnection policy for seriously delinquent accounts.

model that combines reconfigured consumption (IBT tariff schedule) and connection subsidies, based on household income, differentiated using geography and supported by supply-side subsidies (Figure 6). The model depicted in Figure 4 says the central government should bear the cost of consumer subsidies such that investments into electricity generation, transmission and distribution as well as in maintenance of infrastructure are not compromised due to unfunded subsidies. This ensures that more electricity is generated with access and connectivity to electricity extended to the poor so that they benefit from the consumption subsidy.

The connection subsidy enables the poor to afford the cost of connecting to the electricity grid so that their uptake of electricity is increased, potentially enhancing their benefit from the consumption subsidies. The geographic zoning of households according to their locations which proxy their income status would be used as targeting mechanism for subsidy beneficiaries. The zoning could be based on local authority classification. Those in low income (high density) areas would be regarded as the poor targeted for a relatively higher level of subsidy, while those in medium income (medium density) areas would be targeted as medium income earners who benefit from a lesser subsidy level and those in high income (low density) areas would be regarded as non-poor and therefore may be considered as non-eligible for the subsidy.

The upside of the proposed model is that it optimises on electricity subsidies by incorporating a number of different types of electricity subsidies, for the benefits of the poor consumer, the electricity producer(s) and the government. To the poor household, there is income redistribution through higher charges for high income households and heavy users, whilst the power companies' income is enhanced through transfer of burden of subsidy to central government, as well as through charging efficient pricing without disadvantaging the poor. The model also assists the electricity supplier in containing excessive use of subsidised electricity, electricity theft and reduction of error of inclusion. To government, the model ensures efficient distribution of benefits of subsidy, without burdening the power producer.

Specific policy reforms that could be implemented include:

a. The reconfiguration of the IBT tariff schedule to include an efficient cost of supply tariff for consumption beyond an average consumption for the poor. An additional block, for consumption beyond a threshold, say 1000kWh, meant to enforce efficient consumption by penalizing consumption mostly for commercial use under household connections.

b. Introduction of connection and electricity infrastructure development subsidies in order enhance access, connection, and uptake of electricity. This can be achieved through introducing electricity credits for a portion of the value of the connection or infrastructure based on income levels.

c. Restructuring of supply-side subsidies and non-tariff subsidy reforms (including power theft and reconfiguration of electricity subsidies to large and strategic consumers) and incorporate them in the consumption subsidy model.

Areas for Further Study

The above findings, simulations, conclusions, and recommendations are based on a partial equilibrium analysis which considers individual consumption behaviors contained in PICES data. The analysis is, therefore, restricted to assessing direct financial subsides that accrue upon consumption of electricity, excluding the indirect subsidies and costs that the poor realistically incurs. For example, costs borne by ZESA are funded by the fiscus which in turn is financed in part through taxation. The subsidy burden might indirectly be transferred to the poor through high level of taxation. The study, therefore, recommends further research that focuses on a general equilibrium analysis of the effect electricity subsidies, which incorporates indirect costs such as taxation paid by the poor, as well as supply-side subsides.

In addition, the article assesses the efficacy of the existing subsidies in alleviating poverty. However, analysis should also consider the economic efficiency of subsidies in addition to making them pro-poor. Implicitly, the major objective for policy makers should be to have an electricity pricing policy that ensure economic efficiency of resource use and ensuring financial viability of the power producers. Consistent with this, further studies should, therefore, include subsidies to non-households, mostly on commercial. The data on cost of service for Zimbabwe by the World Bank shows that agricultural subsidies are extremely important and significant and that any sustainable programme of subsidy management needs to consider these. A comprehensive study on total subsidies for both household and non-household sectors in Zimbabwe could inform an economically efficient subsidy regime in the energy sector.

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