UNEP

Lifting the Darkness on the Price of Light:

Assessing the Effect of Fuel Subsidies in the Off-Grid Lighting Market

United Nations Environment Programme

BMZ Federal Ministry for Economic Cooperation and Development

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Contents

1. Summary

Global subsidies to the energy sector are US$2 trillion per year. This study explores how subsidies can impede the entry of efficient lighting technologies into off-grid markets. The issue of fuel subsidies is key to understanding the dynamics of the off-grid lighting market. This study synthesizes and analyses existing information on energy subsidies and off-grid lighting in Economic Community of West African States (ECOWAS) countries[1]. It explores unintended consequences, the prospects for subsidy reform and associated policy strategies for reducing the need for fuel subsidies.

The study estimates that current subsidies for kerosene are US$4 billion per year in ECOWAS. Lighting fuel subsidies vary widely in the region; they can impede entry of efficient lighting technologies that were not available when subsidies were originally introduced. Promoting a transition to efficient off-grid lighting is one of the most effective ways of reducing dependence on lighting-fuel subsidies.

The study found a consensus that the most effective approach to mitigating the economic impact of subsidy reform would be to redirect those funds to well-targeted social programs. Additional policy options to facilitate the market for energy efficient lighting include: removing market barriers to efficient alternatives; improved financing; and, relaxing import duties and other taxes on more efficient lighting systems that meet minimum energy and quality standards. Lowering duties can be a very powerful instrument. For example, for every one million dollars of kerosene subsidy reduction, tariffs for 250,000 solar lanterns could be off-set. Combining these two policy actions would be revenue-neutral for the respective government.

[1] The ECOWAS countries include: Benin, Burkina Faso, Cape Verde, Ivory Coast, The Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo.

2. Overview

Energy is a basic need and an economic burden for all people—rich and poor alike—and nowhere more so than in developing countries. Energy costs become a particular hardship when the cost of fuel rises, often abruptly, with the vagaries of both world oil and currency markets. Indeed, the cost of energy helps lock people into poverty; there is broad agreement that this inequity should be addressed.

Subsidies are one of the widely used instruments of social and economic policy. They are employed in almost all sectors, from food to healthcare to energy. The rationale for subsidies in the energy sector are typically to bolster given fuels or energy-supply technologies, protect consumers from short-term spikes in energy prices, or serve as an ongoing safety net for the poorest populations. Subsidies are typically financed by redistributing these costs to others (through taxation).

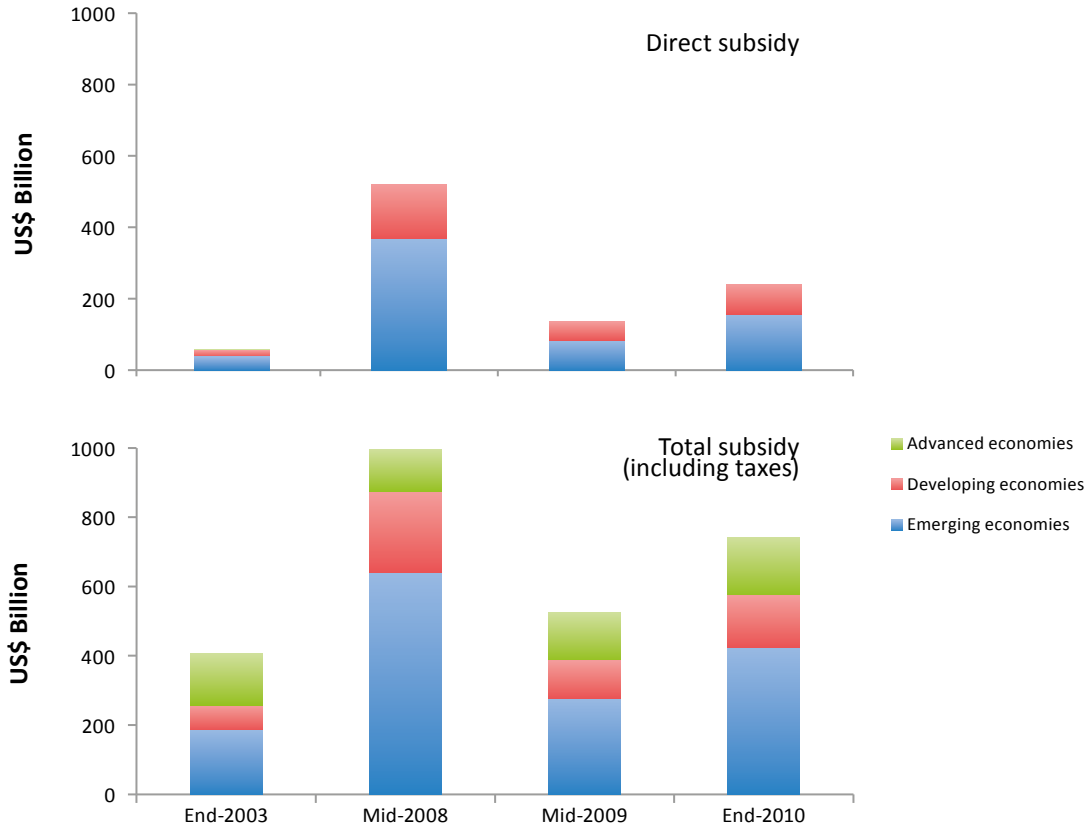
Subsidies for kerosene, the chief lighting fuel (Mills 2005), are arguably the most entrenched and difficult to reform. This stems from the particularly high degree of poverty among the intended beneficiaries, and related goals in some countries to induce households to switch from bio fuels to "modern" and "cleaner" kerosene for cooking[2].

While the aspirational benefits of subsidies are evident, they are also routinely criticized for failing to achieve intended goals, or otherwise inadvertently distorting markets. According to the International Monetary Fund, only 19% of all fuel subsidies in Africa are received by the poorest 40% of households, with some (particularly transportation fuels) being the most regressive ownership and use of vehicles is generally proportional to income. The poorest 40% receive 33% of the benefits in the case of kerosene, the chief lighting fuel (Coady *et al.* 2010; del Granado *et al.* 2010). Within ECOWAS, values just under 40% have been documented in Ghana, 35% in Mali (Coady *et al.* 2006), and 28% in Burkina Faso (del Granado and Adenauer 2011). These outcomes have the perverse effect of amplifying the very inequalities that subsidies are intended to reduce.

The annual global cost of subsidies across the entire energy sector (coal, natural gas, petroleum fuels, and electricity) reached US$2 trillion in 2011, 2.5% of GDP, and 8% of total government expenditures (IMF 2013a). Total fuel subsidies—defined as the difference between prices paid by consumers and the world market price plus transportation, distribution and retailing costs, as well as energy taxes that optimally value a host of externalities--amounted to US$740 billion in 2010 (and about US$1 trillion when world oil prices spiked in 2008 (Figure 1). For oil exporters, the subsidy is the difference between the domestic retail prices and the foregone value on the international market. Official statistics on total kerosene subsidy are not available for most countries. Thus, analysis requires the use of "price-gap" estimation techniques that compare actual local prices to free-market prices plus optimal taxes (IMF 2013a).

[2] While kerosene is relatively cleaner than fuel-wood, its combustion in stoves is vastly more efficient than in lanterns, while the alternative fuels and technologies available for lighting make kerosene the inferior strategy.

Figure 1. **Global fuel subsidies: 2003-2010**



Total "tax-inclusive" fuel subsidies are with reference to an optimal tax of US$0.30 per litre that includes environmental externalities. Advanced economies tend not to directly subsidize fuels, but to tend to under-tax them, although the inadequacy of taxation is greatest in developing and emerging economies. Note that substantial electricity subsidies are not included (Coady et al. 2010), nor are subsidies to energy producers.

Subsidies are awarded disproportionately to polluting forms of energy. In 2012, the total global investment in renewable energy was US$244 billion (Frankfurt School-UNEP Centre/BNEF 2013). Preferential public-sector subsidies for fossil-fuel energy sources routinely exceed what the private sector invests, in total, into alternatives.

Thus, direct subsidies (and equivalent, but indirect, tax policies) can work at cross purposes with other policy objectives such as rural electrification, mitigating greenhouse gas emissions, promoting fuel efficiency in vehicles, decongesting roadways, reducing energy import dependence, and maintaining competitive free-market conditions for emerging technologies. Energy subsidies also represent a cost (often substantial) to governments, and reforms are particularly vulnerable to public outcry during spikes in world oil prices—precisely when they are most needed. In the developing world, energy subsidy outlays often exceed those devoted to key social functions such as education.

There is a broad consensus about frequently adverse impacts of energy subsidies. In light of climate change considerations alone, the International Monetary Fund has called on governments to reconsider and reform subsidy practices. The Kyoto Protocol also calls for global subsidy reform[3]. The G-20 leaders have called for subsidy reforms (G-20 Leaders 2009). Many church and non-governmental organizations have called on the World Bank and other international financial institutions to curb fossil-fuel subsidies. European Union Climate Commissioner Connie Hedegaard, stated: "Instead of offering unsustainable and environmentally damaging subsidies for fossil fuels, public finance should encourage the development of new industries and

[3] Article 2(1)(a): "Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention."

businesses that are emerging in the course of the low-carbon transition" (Maclellan 2013). The World Bank also questions subsidies, deeming them an inefficient means of alleviating poverty given that wealthier consumers—the most intensive users of energy—enjoy most of the benefit (World Bank 2012). The United Nations Development Program has found in its experience with and study of energy markets around the world, that no effective means of subsidizing kerosene exists (UNDP and ESMAP 2003).

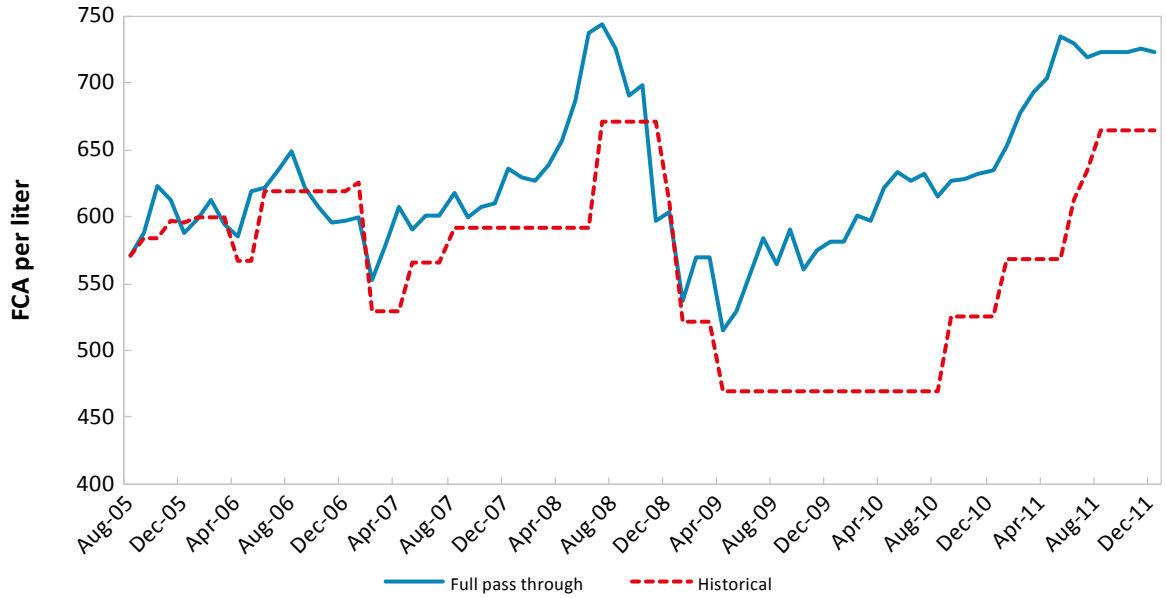
As of 2010-2011, half of all African countries subsidized the price of fuel, spending an average of 1.4% of GDP in the process (World Bank 2012). Subsidy costs have been growing.

The question of fuel subsidies is key to understanding dynamics in the off-grid lighting marketplace, and for formulating policy. Subsidies of lighting fuels also shape consumers' valuation of connecting to the grid. From a policy-analysis perspective, estimates of global outlays for fuel-based lighting are significantly understated if subsidies are not included, for example by over 50% in the case of India. From a consumer vantage point, near-term "savings" in the cost of lighting come at the cost of blocking technology changes that would eliminate lighting operating costs altogether (International Finance Corporation 2012).

3. The Situation in ECOWAS countries

Kerosene appears to be subsidized in some fashion in most, if not all, ECOWAS countries (N'Guessan 2011), with a total outlay of approximately US$4 billion each year. The 15 ECOWAS countries exhibit the full spectrum of policy and practice regarding lighting fuel subsidies, which can be readily observed through a comparison of highly variant retail kerosene prices. Pricing practices are highly fluid, with subsidies being introduced, adjusted, and even removed for periods of time, as illustrated in the case of Niger (Figure 2).

Figure 2. **Fuel prices in Niger**



"Full pass through" series (blue) represents the international oil prices and the "Historical" series (red) reflects retail prices actually presented to consumers. Note that taxes representing part of the full (unsubsidized) cost are not shown on the chart. Prices are in FCA per litre. IMF 2013. < http://www.eenews.net/assets/2013/03/27/document_pm_04.pdf>

3.1 Lighting Fuel Subsidies in ECOWAS Countries

The relevant lighting fuel is kerosene, as no evidence has been identified to indicate that subsidies are applied in the case of candles, which is the other popular regional off-grid light source in the region. Similarly, no information has been identified on the application of subsidies to batteries. Figure 3a illustrates the three – to four-fold variation in kerosene pricing across ECOWAS countries, and shows that member countries maintain kerosene prices that tend to be below, sometimes dramatically, – the maximum national average kerosene prices elsewhere in Africa (a rough proxy for zero subsidy).

While widespread subsidy is evident in ECOWAS, most countries have made considerable efforts to maintain proportionality with world oil price increases, and indeed many have closed the gap considerably in recent years. Historically, almost all ECOWAS countries have maintained kerosene prices at levels below that of transportation fuels (by as much as 65% in the case of Nigeria and Gambia), which fosters adulteration (Figure 3b). Many have clearly made an effort to close this gap, and as of 2011, six ECOWAS countries had attained price ratios that were not favourable to the adulteration of kerosene with diesel fuels. This is the highest value in the past decade.

Nigeria is the only country that consistently had a pricing policy that did not sufficiently discourage kerosene adulteration however, Nigeria's government has taken steps to conduct subsidy reforms. In mid-2011, the government decided to radically curtail gasoline subsidies, and waged a public campaign the rest of the year to convince the population. The Subsidy Reinvestment and Empowerment Program (SURE) outlined a combination of programs to stimulate the economy and alleviate poverty and raise evidence on the gain from subsidy removal. The program also announced a variety of social safety net programs to mitigate the impact of removing the subsidy on the poor segment of the population (IMF 2013b). Although the program met widespread protests across the population the government maintained the program, scaling back on several actions. The ultimate efficacy of the program is not yet known.

Figure 3a **Historical kerosene prices in ECOWAS countries**

Source: IMF price database

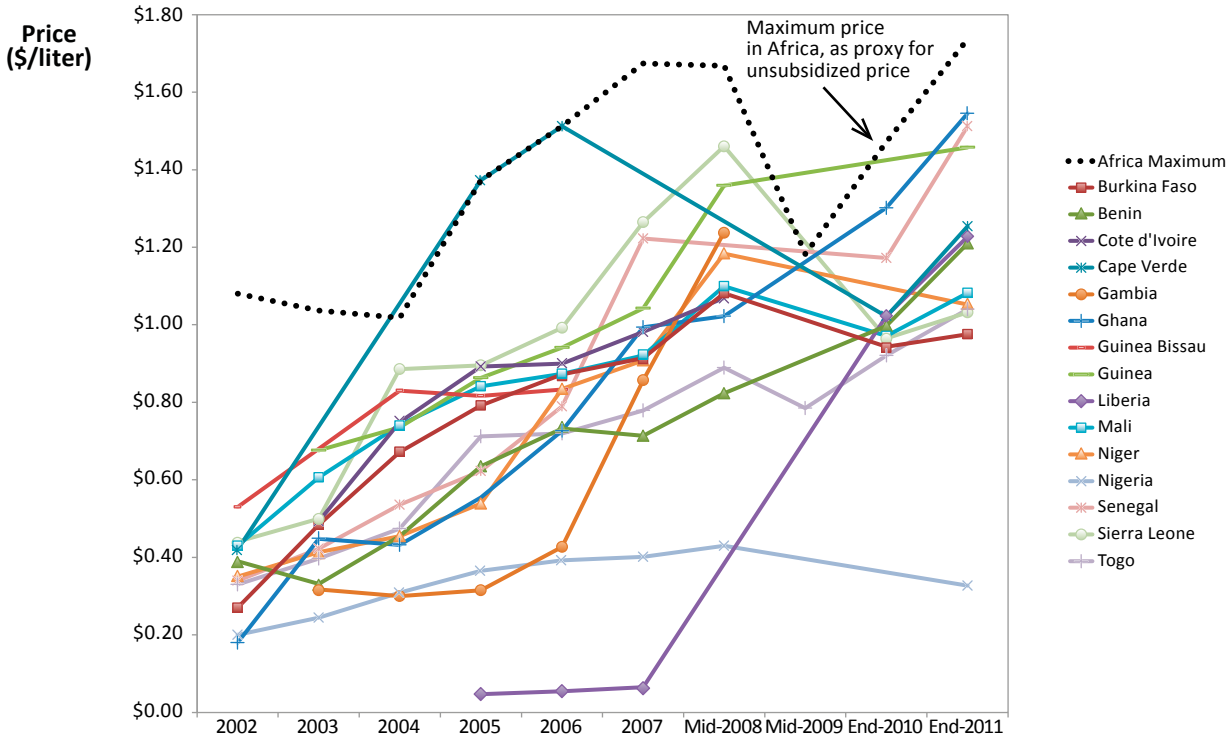
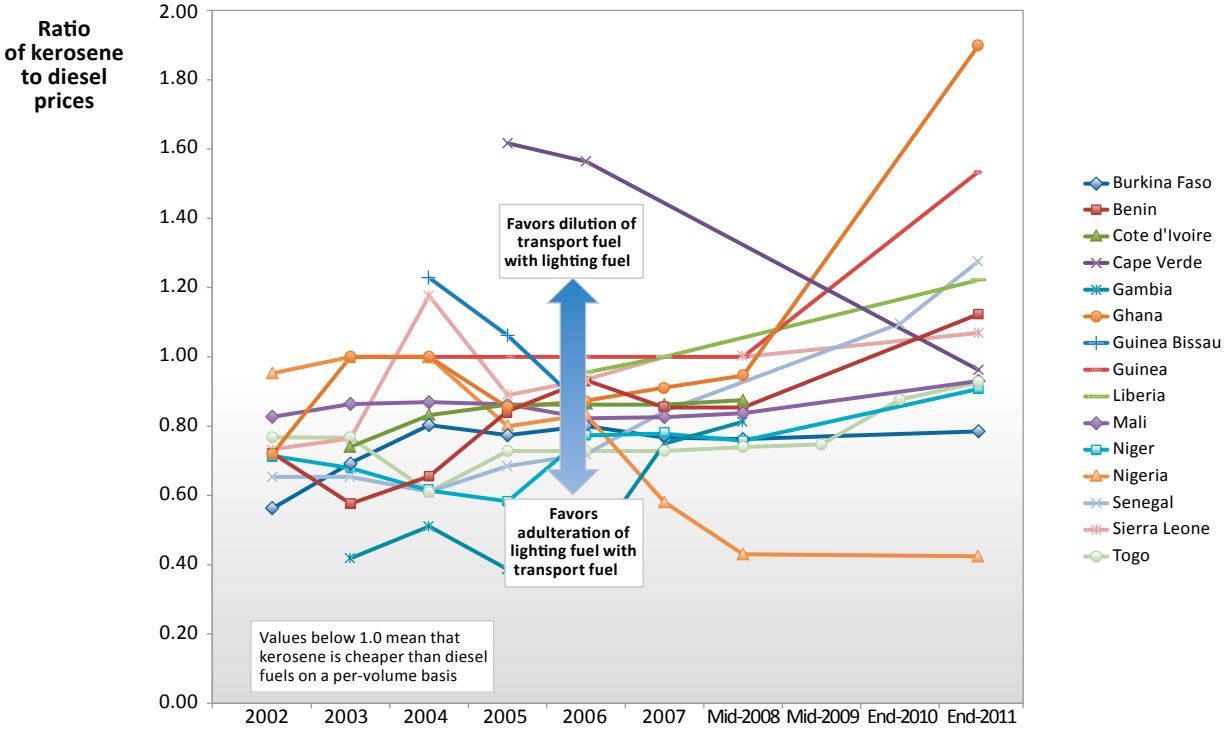


Figure 3b **Shifting incentives to divert or adulterate fuels**



Kerosene prices are frequently set lower than those of transport fuels, reflecting the particular interest in providing subsidies for forms of energy used by poorer consumers. Diesel is chosen here because it can be more heavily diluted with kerosene, although the ratios are even lower than for transportation fuels in most cases. Prices for 2008 and 2009 are as of mid-year; all others are as of year-end. Source: IMF price database.

Some ECOWAS countries provide direct subsidies in the form of fuel price reductions, but Burkina Faso (del Granado and Adenauer 2011) did so indirectly through reduced fuel taxation[4].

3.2 Estimating Subsidy Levels in ECOWAS

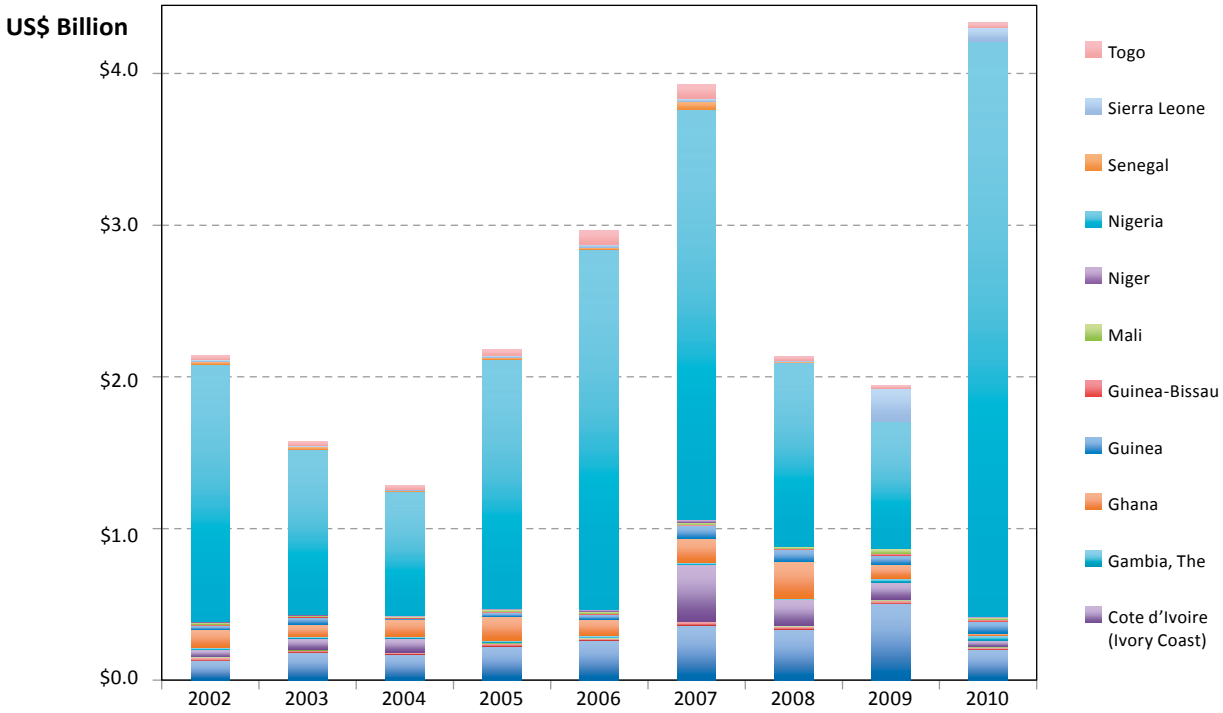
The magnitude of national subsidies is not generally reported in official statistics or budgets. Official statements and policies do not always align with reports from the marketplace. In Nigeria, for example, the official subsidized price of 50N/litre is often eclipsed by unauthorized prices of N150-N200 per litre even at official filling stations in urban areas (Associated Press 2013). This market failure is attributed to a wide variety of factors, ranging from hoarding of the product by resellers, to centrally directed diversion of the fuel to other purposes, to smuggling out of the country for sale in markets with higher prices. In such cases, the elimination of the subsidy would have negligible effect on prices experienced by end-users but would save millions of dollars from government budgets.

By applying a proxy of the "price-gap" approach noted above, a rough estimate of kerosene subsidies in ECOWAS can be arrived at by applying the difference between the highest national-average price seen in Africa and the in-country retail prices to the official consumption statistics. The price-gap method indicates that total subsidies have risen from about US$2 billion to US$4 billion per year across ECOWAS countries over the past decade (Figure 4a and Table 1), corresponding to per-capital expenditures up to approximately US$25 per year (Figure 4b). This could well be an under-estimate, as it assumes that the highest observed price is devoid of any subsidy and incorporates optimal taxation. A key, but unavoidable, uncertainty in this method is that differences in transportation costs among African countries are not explicitly adjusted for. Another caveat is that official consumption statistics are not always reliable, as they do not reflect actual import/export realities, including illegal diversion of fuels across borders.

Kerosene is only one of many fuels that are subsidized. In 2011, pre-tax fossil-fuel subsidies in Nigeria and Ghana cost US$7.5 billion, and US$276 million, respectively (ADB 2012). Ghana's combined fuel subsidies rose to about US$500M in 2012 and were projected to approach US$1.5 billion in 2013 (Kpodo 2013). When full (post-tax) subsidies are considered for the year 2011, petroleum subsidies account for 6.9% of government expenditures in Nigeria and 9.5% in Ghana (IMF 2013a). No official statistics on lighting fuel subsidies were identified in this study.

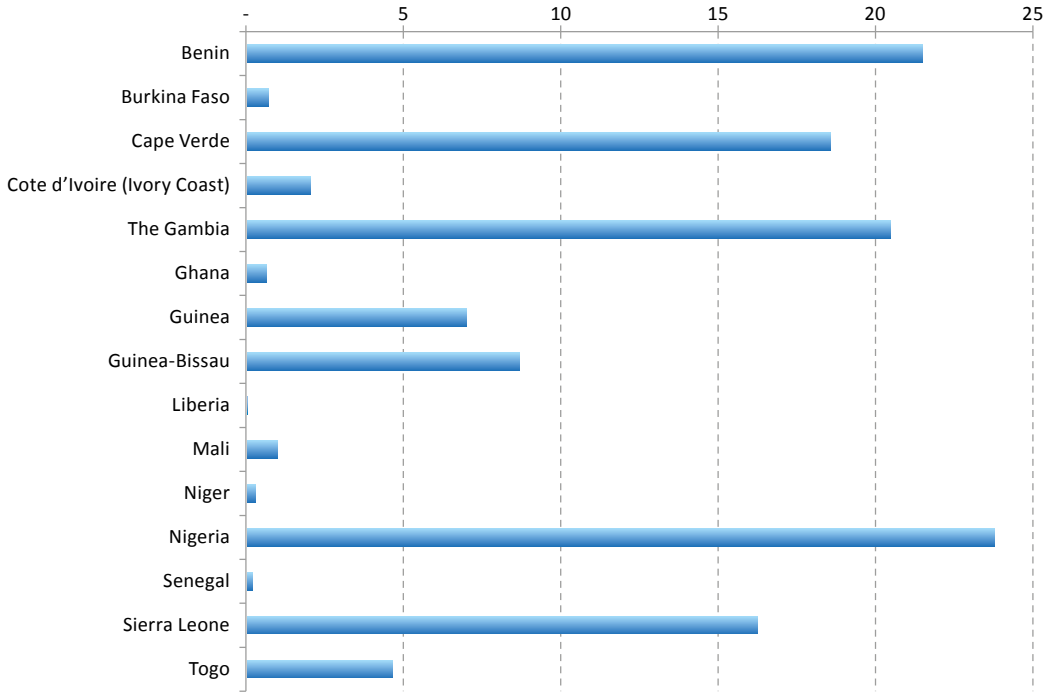
[4] The separate category of subsidies to energy producers or refiners that cannot make a profit even at free-market prices is not treated here, as they are not typically passed through to consumers.

Figure 4a **Approximate kerosene subsidy levels in ECOWAS countries**
Source: Author analysis



Approximate national kerosene subsidy expenditures are estimated by multiplying the official consumption statistics (USEIA 2013) by the difference between in-country kerosene prices and the highest observed across Africa (Coady et al. 2010). Potential differences in fuel transportation costs among the countries are not captured. Significant energy price increases in 2008 were overshadowed by a significant drop in reported fuel consumption in Nigeria. Prices for 2008 and 2009 are as of mid-year; all others are as of year-end. Potential subsidies to energy producers are not included.

Figure 4b **Kerosene subsidy expenditure: US$/capita, 2010**
Source: Author analysis



National expenditures normalized to expenditures per capita (entire national population, electrified and non-electrified combined).

Table 1. **Estimated kerosene subsidies for ECOWAS countries (US$ million/year)**
Source: Author analysis

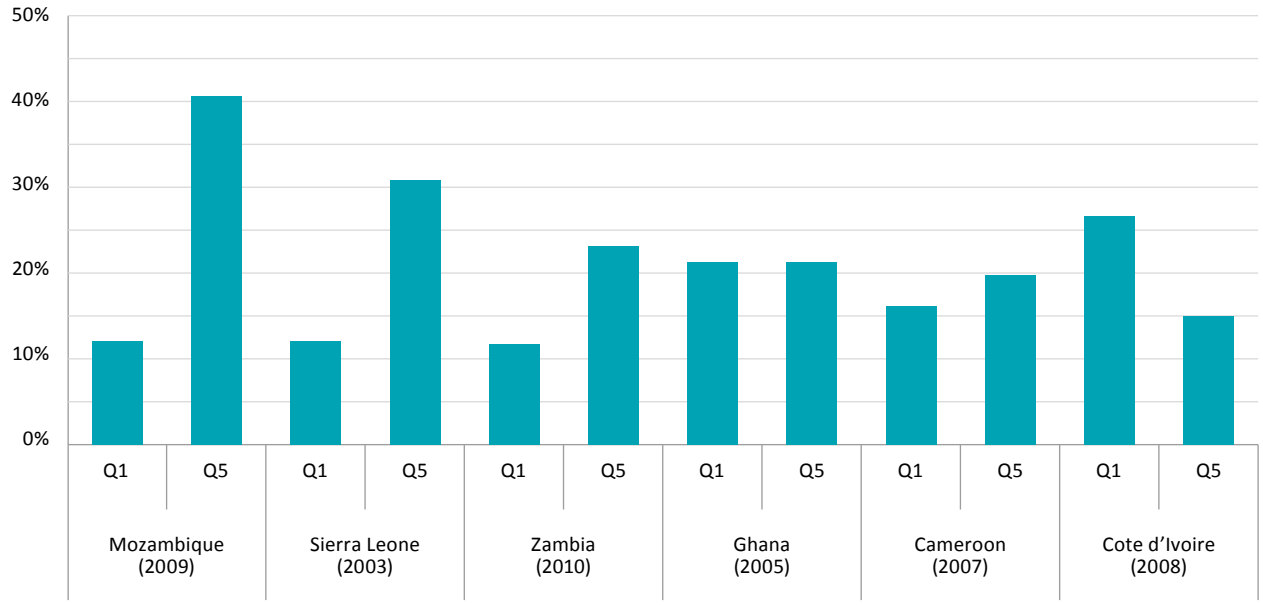
	2002	2003	2004	2005	2006	2007	2008	2009	2010	Trend: 2002-2010
Benin	109	184	173	224	265	362	336	503	204	
Burkina Faso	22	16	10	19	10	22	18	22	11	
Cape Verde	7	3	2	6	4	4	4	7	9	
Cote d'Ivoire (Ivory Coast)	48	75	94	-	-	372	172	113	38	
The Gambia	12	8	8	13	13	14	7	28	34	
Ghana	122	84	115	158	110	158	242	90	15	
Guinea	25	47	9	27	33	84	84	61	76	
Guinea-Bissa	9	3	2	5	5	6	3	11	14	
Liberia	13	13	12	15	6	6	0	-	-	
Mali	14	10	6	13	15	19	15	32	14	
Niger	6	6	6	8	13	16	-	4	4	
Nigeria	1,695	1,087	820	1,644	2,374	2,703	1,211	833	3,790	
Senegal	18	17	9	12	12	55	8	4	2	
Sierra Leone	10	9	5	11	22	18	10	218	93	
Togo	29	28	28	43	89	92	26	20	29	
Total	2,139	1,589	1,300	2,197	2,970	3,933	2,136	1,946	4,333	

3.3 Indirect Costs of Subsidies

Subsidies can have a significant indirect cost in cases where they result in kerosene being diverted to mix into transportation fuels (unsubsidized and thus more costly), with the result that tax revenues are lost due to the reduced volume of vehicle fuel sales, while at the same time enriching vehicle owners as well as fuel vendors who capture the associated illicit profits. One estimate for 2005 found that nearly half of the kerosene in Senegal was consumed by diesel vehicles, with a tax loss of approximately US$25 million annually (Kane 2005).

While kerosene subsidies are less regressive (beneficial to wealthier consumers) than other types of fuel subsidies, they may deliver more benefits to wealthier households than to poor ones (Figure 5).

Figure 5. **Potential distribution of kerosene subsidy to households by income group, % of kerosene subsidy**



Distribution of kerosene subsidy to households, by income group (percent of total national kerosene subsidy) (World Bank 2012). "Q1" refers to the lowest quintile (lowest 20% of households, by income) and "Q5" refers to the upper quintile (top 20% of households, by income).

4. Adverse Effects of Subsidies in the Off-grid Lighting Arena

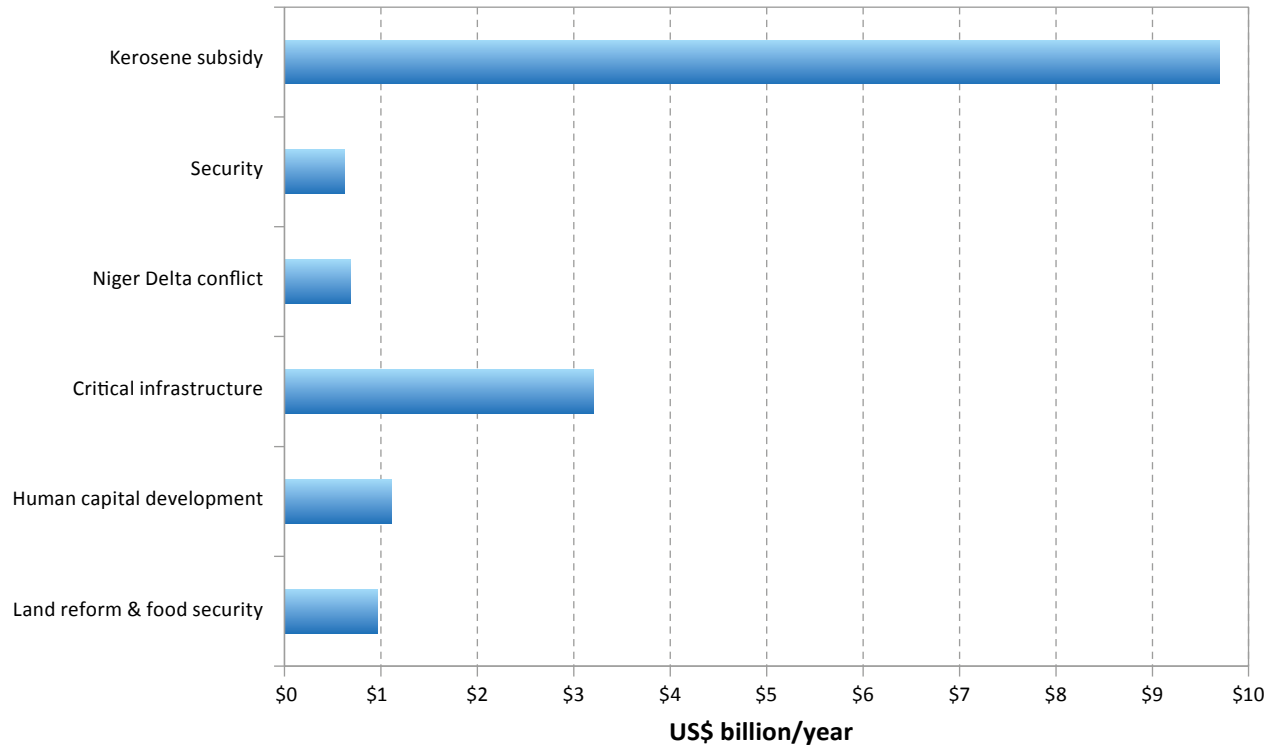
Lighting fuel subsidies have a myriad of adverse effects. Some are at the macroeconomic level, as seen in the case of Ghana where subsidy reform was a component of a strategy to address a severe national deficit (Kpodo 2013). Others are at a very individual level, where severe fuel shortages can be caused by illegal diversion of subsidized fuels to be mixed with more costly transport fuels. Ironically, the resulting scarcity—and inflated black-market prices—lead to lighting fuels being adulterated with highly dangerous (i.e. more volatile and thus explosive) motor fuels).

4.1 Macro-economic Impacts

Subsidies are costs to governments and even more so to the broader society. Even oil-producing countries forego export revenue earnings when they sell subsidized fuels domestically. The budgetary demands associated with fuel subsidies are also significant contributors to national deficits. Differences in subsidy levels among neighbouring (or trading) countries also change the relative competitiveness of industries, and can cause undesirable or even illegal movement of consumers across borders to purchase less expensive fuels. On the other hand, near-term competitiveness benefits of subsidies are, in the long run, negated by the inefficiencies they engender (IMF 2013a). Subsidies dilute the energy price signals that help moderate demand and thereby, the volatility of world energy prices.

Subsidies also mask environmental costs ("externalities"), which is why the definition of subsidies includes the difference between true market prices plus taxes that represent environmental and other external costs and ultimate retail prices.

Figure 6. **Kerosene subsidies vs social programs: Nigeria (2009)**
(Adenikinju n.d.)



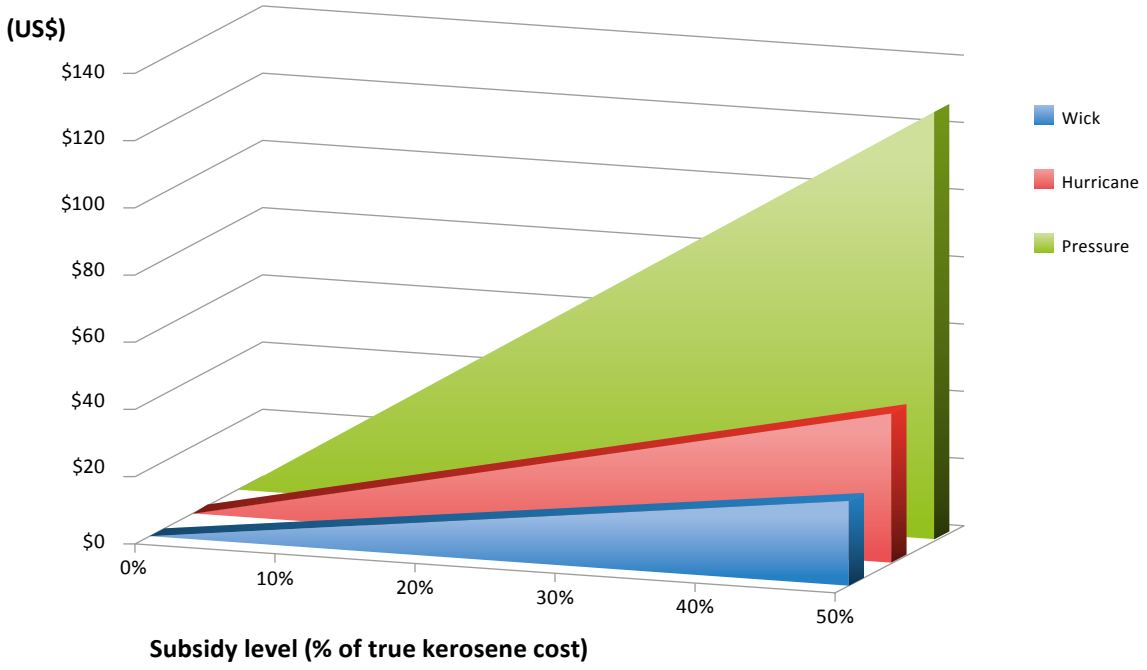
Energy subsidies compete with—and sometimes eclipse—public investment in other social programs such as healthcare and education (IMF 2013b). This is particularly pronounced in Nigeria, where kerosene subsidies alone amount to more than those for security, critical infrastructure, human capital development, and land and food security combined (Figure 6). In the 2004 timeframe, Ghana was spending more on fossil fuel subsidies (2.2% of GDP) than on public health (Laan *et al.* 2010). This situation is not unique to Africa; prior to subsidy reforms, fuel subsidies in Indonesia exceeded health spending by five fold, road and irrigation by two fold, and education spending by 25 percent (Yemtsov 2010). In Yemen, subsidies were at one point higher than public expenditures for health and education combined (Coady *et al.* 2006).

4.2 Hampering the Transition from Lighting with Fossil Fuels to Sustainable Alternatives

In recent years, grid-independent electric lighting systems (typically using LED technology) have emerged as alternatives to fuel-based lighting. They are so efficient and inexpensive compared to traditional solar-electric systems that their costs can often be recovered in a timeframe not longer than one year.

The market prospects of unsubsidized new technologies, such as solar lighting systems, are undercut if they are placed in competition with subsidized fossil-fuel-based lighting. Current levels of subsidies have a profound downward effect on the cost of light to consumers. While this may have near-term benefits for poverty alleviation, it can effectively halve the economic value of switching to technologies that would even further reduce lighting operating costs. For perspective, in a single year the level of subsidy awarded to the fuel burned by a single lamp can be on par with the price of purchasing a replacement solar lantern (Figure 7), which are available at costs of US$20 or less.

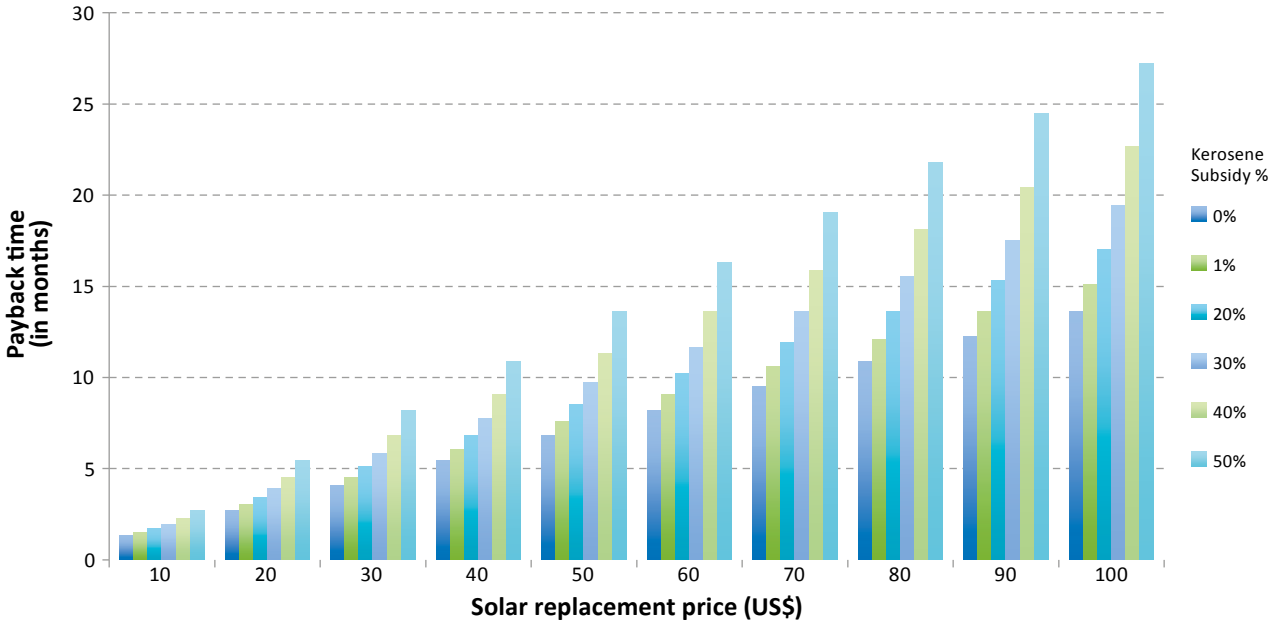
Figure 7. **Annual «hidden» cost of kerosene subsidies (US$ per lantern per year)**



Values computed for this study, assuming 4-hour per day operation and representative fuel-use rates (0.02 l/h for wick lamp, 0.035 for hurricane lantern, and 0.10 for pressure lantern). Unsubsidized kerosene price is taken as highest national-average prevailing in Africa as of 2011 (US$1.75/litre, per the IMF dataset used throughout this study). This is a proxy for a true price (excluding any form of subsidy, but attending to the transportation costs that apply in the case of Africa).

Viewed a different way, the effect of a 50% kerosene subsidy is to approximately double the payback time required for the user to recover their potential investment in a solar replacement system. As seen in Figure 8, this differentially discourages the purchase of more costly but higher quality systems with more features. For example, while a US$10 solar lantern takes only two months longer to pay back under a 50% subsidy, a US$100 solar illumination system takes 20 months longer.

Figure 8. **Extension of solar replacement system payback times with increased kerosene subsidy**
Source: Author analysis (using the same assumptions as in Figure 7)



4.3 Fuelling Illicit Activity

Subsidies readily spawn domestic black markets when formally combined with consumption quotas for end users or when shortages arise for some other reason. For example, in India, where subsidies are limited to a specific consumer segment, they can trigger diversion to sectors where the subsidy is not available (Rao 2012), as was the case in Ghana where official kerosene prices were effectively doubled as the fuel was used to adulterate transportation fuels or unsubsidized diesel fuels for vehicles (GhanaWeb 2006; Laan *et al.* 2010)[5]. Senegal has also had serious levels of transportation-fuel dilution with kerosene, which can be understood in the context of transport fuel prices more than twice that of kerosene (Kane 2005) (Figure 3b).

Many reports state that in Nigeria, highly subsidized kerosene is diverted to the (unsubsidized) aviation sector or mixed with diesel fuels (PPPRA 2013). Diversion for aviation became so widespread that for an entire year no aviation fuel was imported to Nigeria. Instead, subsidized domestic household kerosene (at N40/litre) was sold to airlines at N152/litre at very large "arbitrage" profits to intermediaries (Ekundayo and Agabi 2011). Perversely, this diverted and high-priced fuel can then reappear on the household black market at two to three times its official subsidized price, possibly inducing middle players in the supply chain to dangerously adulterate the kerosene with subsidized motor fuel and then sell it for lighting use. Meanwhile, even for fuels not so diverted, about 95% of the retail outlets in the country offer kerosene at three- to four-times the subsidized value (Bello and Olowa 2012), indicating that the subsidy payments often do not reach the intended end users but instead only increase profits accruing to the supply chain.

Subsidies and other pricing imbalances also encourage the formation of black markets and smuggling to neighbouring states where prices are unsubsidized. These unsanctioned activities sometimes involve local "malpractice" among vendors and other independent actors, while in other cases appear to involve corruption within the public sector.

Black markets have been documented, for example, from Ghana (Genfi 2013), to Cote d'Ivoire (GhanaWeb 2002), from Volta to Togo (GhanaWeb 2009), and from Nigeria to various neighbours (Alike 2013 Up to 20 to 30% of total petroleum consumption in Niger is smuggled primarily from Nigeria (ESMAP 2009) and from Tanzania to Malawi (LuminaNET 2013). From India to Bangladesh, estimates range from 38 to 50% of all kerosene is smuggled out of the country, often garnering nearly four times the otherwise subsidized price (Saikia 2013; Indiresan 2011), the Philippines (Saikia 2013; Allvoices.com 2011), and from Venezuela to Guyana (LuminaNET 2013).

[5] According to Bacon (2001), kerosene can be blended with gasoline up to 5% and with diesel up to 20% without consumers noticing.

4.4 Health, Safety, and Environmental Impacts

Policies of fossil-fuel energy subsidization often run contrary to environmental policy and health policy. This occurs as a direct result of demand being artificially increased by subsidized prices, as well as due to fuel-switching that changes emissions in ways that compromise health. An IMF study estimated that if petroleum subsidies alone were reduced by 50%, then global greenhouse gas emissions could be trimmed by 14 to 17% by the year 2050 (Coady *et al.* 2010).

Vehicle emissions increase considerably when their fuels are diluted with kerosene, creating yet another problem: health impacts. In particular, emissions of benzene, hydrocarbons, carbon monoxide, and particulate matter increase when transport fuels are diluted with kerosene (Sinah 2012).

Fuel-based lighting, particularly with kerosene, can cause a host of adverse health outcomes (Mills 2014). The diverse morbidity and mortality risks reported in the literature include: burns; health risks from indoor air pollution; poisoning and chemical pneumonia from non-intentional ingestion (drinking) of kerosene by children; compromised visibility and visual health; and, adversities resulting from fuel-based lighting in off-grid health clinics. Disproportionate effects on women and children are illustrated by maternal and infant mortality outcomes, and reduced infant birth weights. Substantial mental and emotional injury accompanies these incidents, in addition to the costs of medical aid, lost work time, and replacing lost homes and property. All of these impacts are compounded to the degree that artificial price reductions increase demand.

Acute health and safety risks arise from subsidies when the resulting fuel price differentials or scarcities lead to the adulteration of kerosene with transport fuels. The mixture is explosive, and the mortality rate of those sustaining injuries and reaching hospitals is approximately 25%. In Nigeria, "kerosene epidemics" have claimed many lives (Table 2).

Table 2. **Illustrative "epidemics of kerosene disasters" caused by kerosene adulteration**

Year of occurrence	Location [individual events]	People injured/killed [female: male]
1984	Lagos, Nigeria	53/30 [1.9:1]*
1994	Rajasthan, India	303/37
2001	Lagos, Nigeria	116/18 [1.5:1]
2001	Lagos, Nigeria	59/35 [1.3:1]
2001	Madang, Papua New Guinea	38/5
2004	Edo State, Nigeria	2500/368
2011	Port Harcourt, Nigeria	1/5
2011	Edo State, Nigeria	1/8
2011	Duhbri, India	62/8
2012	Edo and Delta States, Nigeria	11/11

**Ratio in month of burn disaster (March); ratio was 1:1 in earlier periods. Source: Mills 2014.*

4.5 Political Risk

The adverse impacts of subsidies notwithstanding, consumers may become accustomed to subsidies and view the prevailing prices as a permanent entitlement, with any fluctuations blamed on local governments rather than conditions in global energy markets. This creates resistance to change and a risk of social unrest in the event of policy changes.

The media have documented numerous accounts of protests and violence when subsidies are eased or removed, including recent events in Ghana and Nigeria (Kpodo 2013). This state of dependency creates political risk for policymakers; it also raises a material concern about the effect of rising energy costs on household and business budgets.

5. Policy Strategies

5.1 More Effective Subsidy Implementation

At a minimum, care must be taken to design any lighting fuel subsidy implementation to ensure that benefits accrue to the intended lower-income audiences; mitigate any corruption in the system that would enrich non-intended audiences; improve transparency; implement pricing systems that respond dynamically to world oil price changes; and harmonize subsidy levels (if any) across national borders.

In most applications of subsidies, wealthier populations (not the intended target) also obtain benefits, rendering the programs less than ideally efficient at poverty alleviation. In many cases, energy subsidies are even regressive, i.e., benefitting the wealthier segments of the population more than the lower-income groups. This is less so for kerosene than other fuels (e.g., automobile fuels, where wealthier people tend to drive more), but the effect is still significant.

Relative kerosene and motor fuel prices are key triggers of problems such as smuggling and fuel adulteration. To reduce these problems, many ECOWAS countries have made efforts to rationalize relative prices, but the reforms are often reversed later. Within ECOWAS, Senegal and Cote d'Ivoire are particularly important in this regard, as they are upstream in the fuel distribution chain from other ECOWAS countries including Gambia, Guinea Bissau, Sierra Leone, Liberia, and Mali (Kane 2005). Sufficient consequences should apply when subsidy laws and regulations are violated, as in the case of fuel diversion and adulteration.

The aggregate levels of subsidy are rarely disclosed publicly. Increased budgetary transparency and accounting of the diverse sources and forms of subsidies are necessary to improve understanding of current subsidy practices and to evaluate their efficacy. An effort to poll 80 countries for consistent information on fossil-fuel subsidies resulted in full responses in only 27 cases (Global Subsidies Initiative 2011). Thirty-four countries declined to provide responses. Only one full respondent (Mali) was an ECOWAS member. In addition to information on subsidies, it is important to have an objective accounting of fossil-fuel flows. In the cases where there are no independent controls at the importation and refinery levels, transparency is also necessary to verify the quantities and destinations of various fuels (Kane 2005).

If subsidies cannot be fully eliminated, automatic pricing systems can be devised that restore some degree of moderated, real-world variability to prices. Using this technique, energy price changes are smoothed using moving averages and caps. This approach was briefly experimented with in Ghana, for only a few months in early 2003, along with a 90% overall price increase (49% for kerosene), but it was not sufficient to overcome the political pressures similar to those facing full price liberalization. Mali (from 1994 to 2003) and perhaps other ECOWAS countries have also experimented with automatic pricing (Coady *et al.* 2006).

Large inter-country price differences distort economic competitiveness, and create significant incentives for illicit cross-border trade of fuels. ECOWAS may contemplate harmonized regional practices to curb this activity, as has been proposed by the IMF (2011) for the trading subgroup (WAEMU).

5.2 Subsidy Reforms

Subsidy reform has been widely attempted, but has been effective in only a minority of cases. Reducing or eliminating subsidies clearly translates into a near-term increase in energy costs for consumers, and has a disproportionate effect on lower income groups who devote a higher proportion of their household expenditures to energy. Consumers can be impacted directly through higher energy costs and indirectly by the effect of higher prices on goods and services that require energy inputs.

Fortunately, policymakers have a variety of tools available for offsetting these impacts, which have in common the principal of redirecting funds previously dedicated to subsidies to other social programs. This can have an immediate intrinsic benefit in terms of improving the efficiency of government expenditures. The IMF concluded that in the case of direct transfers to the poorest segments of a population—conditional on use for social goals such as education—58 cents of each US dollar would reach the target group, as compared with only 22 cents for kerosene (Laan *et al.* 2010). Nonetheless, once established, subsidies have proven difficult to remove given a host of social, political and economic challenges.

Conditions and remedies vary depending on local circumstances. The box below summarizes seven general subsidy-reform recommendations from a UNEP review of reforms in France, Ghana, and Senegal. These are largely consistent with the findings of an extensive review of subsidy reform efforts and best practices conducted by the IMF (2013).

Elements of successful strategies for reforming fossil-fuel strategies (Adapted from Laan *et al.* 2010)

PROCESS

- Identify and consult in earnest with stakeholders
- Develop and implement continual communication strategies to ensure transparency

RESEARCH

- Assess the nature of the subsidy to be reformed, its original objectives, and its current role in the economy
- Assess
- Analyze the economic, political, social and environmental context and drivers for reform
- Identify political-economy issues, including equity considerations around beneficiaries and non-beneficiaries, as well as other stakeholders
- Make results of this research public to improve understanding of the rationale for reform

GOALS

- Articulate the objectives of the reform
- Assess the potential impacts
- Consider the limitations on reform, including funding available for interventions to ease the transition
- Assess external constraints, such as donor requirements or international obligations

STRATEGY

- Determine a realistic and pragmatic timeframe for reform
- Design *temporary* transitional measures to reduce impacts on energy users
- Develop a communication strategy that ensures transparency

IMPLEMENTATION

- Ensure that those responsible for implementing the reform are committed to its success
- Communicate to all affected groups and the general public the necessity of reform, the planned strategy, and the benefits that will result

VERIFICATION

- Monitor the impacts of the reforms, and identify unintended consequences early
- Adjust policies as necessary

PERSISTENCE

- Establish independent institutions and automated (objective) price-setting mechanisms to provide constructive separation between day-to-day political factors and the supply and pricing of energy
- Ensure that government's role is transparent and publicly documented
- Promote public input processes

A central recommendation is clear communication to the public about current subsidies and proposals for improvement. Materials prepared for Indonesia's government provide a good example (IISD/GSI 2012). In Ghana, efforts to disclose and widely publicize the scale of subsidies and the large extent of their receipt by more well-off populations was viewed as a key element of making subsidy reform politically palatable (Coady *et al.* 2010). Commercial interests benefitting from subsidies also tend to object to reforms, and may even attempt to organize popular dissent to maintain the status quo. The poorer segments of a population of course also benefit from subsidies.

A key strategy of socially acceptable subsidy reform is to redirect the resources saved in subsidy reform to other social functions that carry significant hidden costs to governments. Examples include healthcare, education, hunger, homelessness, under-employment, public transportation, and infrastructure needs. This is done through a combination of expanding existing programs, founding new ones, or directly compensating impacted individuals with cash or vouchers. The case of fuel-based lighting offers specific opportunities to address the underlying problem through reinvestment to directly reduce dependency on lighting fuels. Substantial and sustained political will is an essential ingredient of successful subsidy reform. Significant efforts in this regard have been made in Burkina Faso (del Granado and Adenauer 2011).

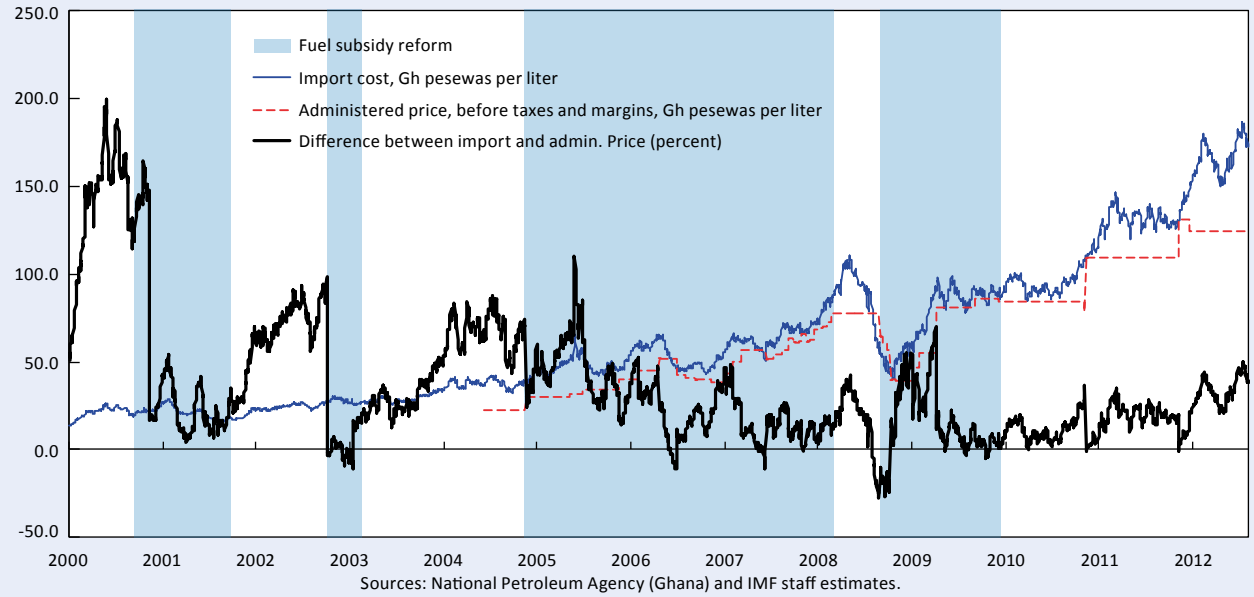
Efforts at subsidy reform are often opportunistic, sometimes being implemented during dips in world oil prices. Such well-intended efforts may not persist. For example, during the return to high prices from 2007 to 2008 when countries, including Ghana, reversed reforms that had been put in place only a few years earlier (Laan *et al.* 2010).

For socio-political reasons, efforts at reform may exclude the key lighting fuel, kerosene. Some have even recommended reforming subsidies on fuels such as those for transportation and redirecting those to subsidize kerosene (del Granado and Adenauer 2011). Ironically, this strategy would unintentionally increase the likelihood of fuel diversion of kerosene to transportation fuels.

Energy subsidy reform has been attempted, with very mixed success, in a number of ECOWAS countries: Burkina Faso (del Granado and Adenauer 2011), Ghana (Box 1), Guinea (World Bank 2012), Mali (34% increase in kerosene price in 2005 (Coady *et al.* 2006)), Niger and Nigeria (IMF 2013b). These reforms, however, often exempt kerosene as it is seen as the fuel most heavily affecting the poor.

Given that electricity is one of the largest areas of energy subsidy in sub-Saharan Africa (IMF 2013b)—and that subsidies are particularly concentrated in West Africa—ensuring that consumers move to off-grid alternatives to fuels can pre-empt dependency on future elect subsidies and the costs those will impose on governments[6]. Conversely, if fuel-based lighting users switch to the grid, then yet a new form of subsidy flows to the lighting arena.

Figure 9. Repeated efforts at fossil fuel subsidy reform in Ghana



Sources: National Petroleum Agency (Ghana) and IMF staff estimates.

Chart source: IMF 2013b.

Laan et al. (2010) provide a detailed history of the on-and-off subsidy reform efforts in Ghana. In 2001, many fossil-fuel subsidies were lifted, resulting in a near doubling of energy prices. However, cross subsidies (in which prices were increased to one customer segment so as to compensate for the cost of subsidizing another segment) were used to keep the prices of kerosene artificially low. In the face of rising world oil prices, the strategy lasted only about a year.

The same approach was tried yet again in 2003, and while the government attempted to protect the poor with cross subsidies, indirect effects of higher energy prices caused incomes to fall by about 9 percent. The policy was abandoned within just 6 months.

A third attempt was made in early 2005, with more emphasis on the types of strategies noted previously, including increased transparency about fossil fuel price build-ups and communicating to the public that funds formerly invested in subsidies would be refocused on other social programs, but still adhered to the cross-subsidies of kerosene (and LPG). Educational fees were eliminated, additional funds were made available to the Community Health Compound Scheme, and planned investment in mass urban transport was expanded and expedited along with increased efforts on rural electrification (Coady *et al.* 2006) and mass transit (del Granado et al. 2010). The National Petroleum Authority was created to insulate price setting from government and politics, but its independence is questioned. The program was abandoned again as world energy prices jumped in 2007-2008. Keeping fuel prices low became a core issue in the subsequent presidential campaign and so the practice of subsidization was continued. A fourth effort was made in 2009, and lasted only a year. Return to subsidization had the effect of stressing the economy and creating enormous debt within the state-owned oil company; even when this debt was refinanced, cross-subsidization of kerosene and LPG was being continued. The fifth and most recent reform occurred in February 2013, at which time kerosene prices were increased by 15% (Kpodo 2013)

[6] Electricity tariffs recover less than historical costs in Benin, Burkina Faso, Cape Verde, Ivory Coast, Ghana, Mali, Nigeria, Senegal, and tariffs have been higher than costs in Sierra Leone and Niger. In addition to retail subsidies, line losses average 25% in sub-Saharan Africa, more than twice that observed in the industrialized world, and bill-collection success averages about 85%. Thus, reducing dependence on grid electricity helps reduce the demand for inefficient government cash infusions. Just as kerosene subsidies merit reform, so too do those subsidies that apply to grid power.

5.3 Redirecting Resources Spent on Energy Subsidies to More Productive Ends Within the Lighting Services Realm

An ideal subsidy-reform strategy will address inequities, improve economic efficiency, and help address underlying energy issues while managing political risk. An example of this is the targeted kerosene-to-liquified petroleum gas (LPG) program for cooking in Indonesia (IISD/GSI 2013). To help alleviate the burden of an approximately US$4 billion annual subsidy of kerosene as a cooking fuel, in 2007 the Indonesian government began providing free "start-up" packages consisting of an LPG tank plus stove and accessories. The target was set at 46 million of these packages at a one-time cost of US$1.6 billion spread over 5 years. By 2012, kerosene use in the country had been reduced from 9.8 million litres to 1.7 million litres.

Analogously, subsidy resources can be reinvested in rural electrification. Where reduction of dependency on lighting fuels is the goal, an even more cost-effective approach (assuming an unsubsidized grid) is to support the introduction of good quality off-grid pico-solar systems. Such lighting systems are a particularly suitable technology application in a subsidy reform context. In other circumstances, such as applications for heating or transportation fuels, the cost of reducing energy demand is typically much higher. This approach has been taken in the case of India, where the Ministry of New and Renewable Energy Solar Lantern Program (ongoing) has significantly bought down the purchase prices for 800,000 lanterns and the Remote Village Solar Lighting Program has done so for 600,000 larger solar home systems since 2010.

These types of efforts are slated to be scaled up dramatically (International Finance Corporation 2012). Over 300,000 LED lanterns have been subsidized in Nepal, with smaller numbers in Pakistan and the Philippines. Uganda's Energy for Rural Transformation program includes a 45% subsidy on all solar equipment[7], and in its second phase encouraged equipment suppliers to invest in rural areas. Microfinance and non-governmental organizations provided cash or loans, minimizing the need for direct government engagement. In Ethiopia, solar products are exempt from inland duties and taxes. Partial subsidies for solar home systems have been utilized in Ghana (N'Guessan 2011).

Figure 7 illustrated how significant a redirection of subsidy funds could be. The costs associated with a 40% subsidy to operate one conventional hurricane lantern (burning kerosene) for three years (approximately US$100), would free up enough funds to purchase three basic solar lighting systems (which could produce far more light). Thus, hypothetically redirecting one year's kerosene subsidy to kerosene-free alternative lighting systems would eliminate the need for all subsequent subsidies for the service life of those new systems. In practice, such a process would need to be implemented gradually to allow time for technology deployment and other adjustments. More importantly, subsidizing incumbent solar technologies can have very adverse impacts on the fledgling off-grid lighting markets where entrepreneurs are otherwise making good inroads. More details on potential adverse effects of subsidizing solar lighting systems are summarized in the box on the following page.

[7] Uganda ERT includes a direct price subsidy for off-grid solar PV (US$5.5/Wp up to 50 Wp for SHS including lanterns; US$4/Wp up to 500 Wp for commercial and institutional systems) (Rammelt 2013).

Potential adverse effects of subsidizing solar lighting systems

Direct subsidies for LED lighting products for lanterns and/or their grid charging at this time are problematic and likely unnecessary in this particular case for a number of reasons (Mills and Jacobson 2007):

Need and Practical Considerations

- Some products that are now available have price points that are at or below the "willingness-to-pay" levels identified by target customer groups (Mills and Jacobson 2007; Gengnegal et al., 2013; Baker and Alstone 2011) This suggests that there may not be a need to apply subsidy in order to deliver solar lights at the targeted price levels. In fact, doing so could artificially mask the true price differences among products and thereby bias the program in favour of the more costly products.
- A meaningful way to define a subsidy level would be to have it indexed to the mature market prices of emerging technologies that might not be affordable initially. However, there is currently no body of research or analysis that defines the mature market prices of current white light emitting diode (LED) products.
- A targeted subsidy (for example, selected by income) could be implemented in locations where there are exceptionally rich socioeconomic data, but is not likely to be replicable in mass-market situations.

Lack of Scalability

- The use of subsidies (or other forms of financial incentives) limits scalability, considering the 1.3 billion people, plus many small enterprises, lacking electricity.
- A decade or more has been spent promoting US $100 solar lanterns in the developing world. Their sales are very slow, even among relatively wealthy end users. The manufacturers have unsuccessfully relied on a subsidy-like business model in which donors purchase these lanterns and give or otherwise make them available to end users. Subsidies have also been of very limited influence in promoting growth of the larger solar home systems in the developing world.

Unintended Outcomes or Side Effects

- If solar lantern prices are subsidized to certain groups and not others, some recipients would likely choose to resell the lanterns at the market price rather than using them.
- Resentments would likely be generated on the part of product retailers in the surrounding areas because they would be viewed as extracting unreasonable profits when trying to sell products at market prices with appropriate margins. There are field reports about deliveries of solar lighting systems under aid programs that are exempted from duties, an effective subsidy that results in those lanterns out-competing local companies.
- Similarly, where grid-charging is used rather than (or to augment) solar charging, and recharging-fee subsidies are instituted, charging enterprises in surrounding villages will likely lose business.
- Subsidies applied non-proportionally (for example, through an across-the-board credit or by eliminating VAT or import duties) to all products could negate the significant incentives for solar lighting currently embedded in the VAT structure in some countries.
- Subsidizing battery-charging services would reduce the true differential cost of ownership between solar (or other non-grid charging systems) and grid-based recharging.
- Subsidies (for example, those implemented in the form of vouchers) offered to end users would differentially benefit higher-income families, if it turned out that the poorest people in the target population could not afford higher-priced LED lights even at the subsidized price or lacked the financial literacy to understand the role of the vouchers.
- A subsidy on some products but not others would distort the purchasing behaviour and disadvantage products not awarded a subsidy. Such concerns have been expressed by industry (International Finance Corporation 2012). This practice may also lull low-income buyers into acquiring a system that has unaffordable maintenance costs (for example, where battery-replacement costs are high or frequent).
- Consumers can lose sight of the temporary nature of subsidies, and resent any restoration of prices to market levels. This can be coupled with a misperception of price gouging.
- Subsidy differentials near borders could disrupt local markets and induce transboundary smuggling.

Those opting to apply subsidies to solar lighting technologies should endeavour to minimize if not eliminate the adverse impacts noted above.

Removal of subsidies will not in and of itself ensure rapid penetration of new fuel-saving lighting technologies. Aside from direct financial incentives for solar-LED products, there are other ways that governments can work within markets to promote off-grid lighting solutions. Strategies to remove market barriers include:

- Establishing product quality assurance procedures;
- Educating distributors and consumers;
- Training for manufacturers and distributors;
- Encouraging supply chains that make alternative products available where needed, and:
- Communicating true cost of subsidies and who they benefit, fiscal framework for solar lanterns (positive) and for kerosene-using equipment (deterrent).

Innovative financing, such as micro-credit revolving funds or interest buy-downs, could have a strong impact. Reducing or eliminating import tariffs (which would translate to lower retail prices on products for consumers) is another approach[8]. For example, each one million dollars of kerosene subsidy reduction could offset tariffs on approximately 250,000 lanterns, because combining these two policy actions would be revenue-neutral for the respective government[9].

In some cases, reforming lighting fuels has implications for other energy end-uses. In particular, kerosene is seen as a more desirable cooking fuel than non-renewable and inefficiently combusted biomass, so special measures might need to be taken to ensure that users are able to continue using kerosene for cooking. In West Africa, with the exception of Nigeria, where 55% of urban households and 7% of rural households use kerosene for cooking, only Benin (3.2% and 0.9%) has levels exceeding 1%. However, in many countries kerosene is not used at all for cooking (Legros *et al.* 2009).

It is not realistic to propose that in a future scenario where global kerosene demand for lighting is reduced significantly, kerosene prices would decrease as the result of a supply-demand effect, in turn inducing more consumption for lighting. This would not likely occur because bulk kerosene is a valuable commodity fuel that is traded internationally, and the marginal effect of fuel-based lighting on price is not large enough to induce major price swings on an international level. Moreover, the fuel still has value in the aviation sector and refining practices could be changed to make other petroleum products out of the associated crude oil.

[8] In Africa, solar components face a variety of compounding taxes and fees (import duty, excise duty, VAT, surcharges), typically leading to a 5-30% increase in the price of the final product—10-17% for three ECOWAS countries analyzed (Lighting Africa 2013). For example, in Ghana, an imported solar lantern is assessed a 10% import duty, 12.5% VAT, and an additional levy of 3.5%.

[9] Hypothetically assumes landed cost of US$25 and tariff of 15%, or a tariff of about US$4 per lantern.

6. Conclusion

Present-day subsidies on lighting fuels slow the progress of market mechanisms that have already begun to introduce solar lighting systems that offer safer, more reliable, and more economical long-term solutions. A key frame of reference is that the consumer cost-of-lighting-service is distinct from the unit cost (price) of fuel. The costs to consumers of inefficient lighting strategies, even when subsidized, can be higher than those of more efficient and unsubsidized alternatives.

Although many ECOWAS countries have attempted subsidy reforms—or at least closed the gap somewhat between free-market prices and subsidized ones—there is more to be done. Were this to occur on a regional and harmonized basis, a number of confounding problems could be avoided.

While kerosene is the chief form of subsidized energy most used for lighting, policy analysis must consider a broader range of fuels and nuances. These include the relative pricing of transportation fuels that can either be mixed with diverted lighting fuels, or, conversely, used to dilute lighting fuels (in times of scarcity), creating serious health and safety risks. Similarly, any changes in kerosene subsidy will impact other end-uses, notably cooking, and measures must be taken to proactively minimize any unintended consequences. Electrification programs (connection to the grid) are a transformative strategy that will discourage the use of off-grid lighting, so long as the electricity supply is reliable and the price affordable.

Simply shifting subsidies from kerosene to solar lanterns has a certain intuitive appeal, but this strategy could be disruptive to pre-established, and especially to emerging, markets. Alternative strategies could focus on removing market barriers to innovation through the establishment of product quality assurance procedures including minimum quality performance specifications and supporting policies such as education and public awareness; training and other forms of capacity building; and helping supply chains become established to make alternative quality-assured products available where needed. Innovative financing, coupon and leasing schemes, or eliminating import tariffs, could all improve consumer access to kerosene alternatives, without the need to directly subsidize those alternatives.

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About the UNEP Division of Technology, Industry and Economics

Set up in 1975, three years after UNEP was created, the Division of Technology, Industry and Economics (DTIE) provides solutions to policy-makers and helps change the business environment by offering platforms for dialogue and co-operation, innovative policy options, pilot projects and creative market mechanisms.

DTIE plays a leading role in three of the six UNEP strategic priorities: climate change, harmful substances and hazardous waste, resource efficiency.

DTIE is also actively contributing to the Green Economy Initiative launched by UNEP in 2008. This aims to shift national and world economies on to a new path, in which jobs and output growth are driven by increased investment in green sectors, and by a switch of consumers' preferences towards environmentally friendly goods and services.

Moreover, DTIE is responsible for fulfilling UNEP's mandate as an implementing agency for the Montreal Protocol Multilateral Fund and plays an executing role for a number of UNEP projects financed by the Global Environment Facility.

The Office of the Director, located in Paris, coordinates activities through:

> The International Environmental Technology Centre – IETC (Osaka), which promotes the collection and dissemination of knowledge on Environmentally Sound Technologies with a focus on waste management. The broad objective is to enhance the understanding of converting waste into a resource and thus reduce impacts on human health and the environment.

> Sustainable Consumption and Production (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.

> Chemicals (Geneva), which catalyses global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.

> Energy (Paris and Nairobi), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.

> OzonAction (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.

> Economics and Trade (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies. This branch is also charged with producing green economy reports.

DTIE works with many partners (other UN agencies and programmes, international organizations, governments, non-governmental organizations, business, industry, the media and the public) to raise awareness, improve the transfer of knowledge and information, foster technological cooperation and implement international conventions and agreements.

For more information:

see www.unep.org/dtie

This study synthesizes and reviews existing information on the presence and interplay of energy subsidies and off-grid lighting in ECOWAS countries, explores unintended consequences, and assesses the prospect of subsidy reforms and associated policy strategies.

The en.lighten initiative also invites readers to consider two companion studies: *Light and Livelihood: A Bright Outlook for Employment in the Transition from Fuel-based Lighting Electrical Alternatives;* and, *Light for Life: Identifying and Reducing the Health and Safety Impacts of Fuel-Based Lighting.*

The United Nations Environment Programme (UNEP)-Global Environment Facility (GEF) en.lighten initiative was established in 2009 to accelerate a global market transformation to environmentally sustainable lighting technologies by developing a coordinated global strategy and providing technical support for the phase-out of inefficient lighting. The initiative is a public/private partnership between UNEP, OSRAM, Philips Lighting, National Lighting Test Centre (China) and the Australian government's Department of Industry with the support of the GEF.

For more information about the en.lighten initiative, please visit: www.enlighten-initiative.org

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