Non-state actors for electricity Demand-Side Management

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In Demand-Side Management (DSM) with household appliances climate mitigation and sustainable development overlap completely. Efficient lighting has allowed large scale DSM in the South, with and without carbon crediting. The Kyoto Protocol CDM so far issued worldwide 3.1 mio CERs to lighting DSM. Refrigerators and Airconditioners are the next important household appliances after lighting but only minor experiments in Brazil occurred while such DSM is widespread in developed countries. What roles will non-state actors in developing countries have to expand DSM to refrigerators and Airconditioners ?

Few developing countries created policy for appliances, notably Ghana, and most have no instruments to deal with their manufacturers, their importers and their wholesalers of appliances. Where in the supply chain can businesses or utilities shape DSM and which NSA bring this to households. With a dominant national manufacturer, DSM is more upstream, in only importing countries more downstream. The discussion paper summarizes past DSM in the South and identifies differences. All appliance DSM use either labelling, MEPS or rebate schemes. What are roles in labelling, in MEPS or in rebate schemes? The track record of CDM projects with these appliances suggest that crediting can expand the effectiveness of DSM. So far carbon crediting has intensified the competition in the offgrid area, but the right monitoring might allow a similar impact for grid connected household appliances.

What lighting DSM with CFL lightbulbs has been implemented

Lighting DSM is the most profitable type of DSM and projects exchanging incandescent lightbulbs with CFL have been implemented in most countries. World Bank evaluations show Internal Rate of Return around 120% for such DSM. It addresses the classic problem of “split incentives”, the benefits do not accrue to those who pay the additional costs. In most Southern countries, these lighting DSM programmes remain far from the potential in scope and effectiveness. The only cause for this limited success is the management of the CFL distribution so that the split incentives are effectively aligned. A CFL instead of an incandescent lightbulb saves 2.87 – 9.77 US$/year with costs of 1.5 – 2.5 US$ per bulb. To redistribute the split incentives, it is necessary to vary the contribution from households so to reflect their benefit. There is large scope of lighting DSM for NSA if there are better solutions for CFL distribution.

All lighting DSM projects so far have only one uniform offer for the all households, a certain low price of the CFL lightbulb in exchange of an incandescent lightbulb. Furthermore, almost all lighting DSM projects are implemented with door-to-door exchanges. Many lighting DSM programmes are financed by the World Bank and the Bank is aware that door-to-door managed by utilities is an ineffective distribution but wherever they tried alternatives, they failed and reverted to door-to-door distribution. Perhaps the World Bank’s usual clients, the utilities are blocking other solutions but this is not addressed here.

Carbon funds from CDM have been used for lighting DSM with CFL in Bangladesh, China, Ecuador, Ghana, India, Kenya, Lebanon, Mexico, Nigeria, Pakistan, Ruanda, Senegal, Singapore, South Africa, Togo and in Vietnam. Among those 16 countries, only two pursue CFL distribution other than the utility managed door-to-door format – Mexico and Nigeria. Most of these CFL CDM projects are so-called Programmes of Activity (PoA), which allow to gradually expand the CFL exchanges with simplified documents for the UNFCCC registration and issuance. Both in Mexico and in Nigeria these PoA are run by private companies using different distribution formats with different NGOs and commercial retailers.

The CFL DSM programme in Mexico "Cuidemos Mexico" is designed and operated by coolNRG from Australia. It is undoubtedly the most flexible and adaptable CFL programme in operation. It has reached 5.7 mio households and the carbon credits (CERs) obtained are available on the carbon markets. It operates in 530 municipalities across Mexico and with a variety of distribution partners in retail outlets and in mobile distribution units. The most important distribution partners, Soriana, Chedraui and Coppel are present across the country. The programme has encountered one obstacle, it did not manage to use its monitoring system with hourmeters, so that the carbon credits obtained are far below its potential. Nonetheless, "Cuidemos Mexico" proves that a flexible distribution operation is possible based on two monitoring tools, an Internet-based data management system for various distributors to use and as identifier for households a unique identification code from the national utility.

The CFL PoA in Nigeria allows different proofs of identity for a household, utility bill folio number or voter registration, and different distribution methods, door-to-door, direct installation as well as retail outlets, schools, other distribution points. It offers a broader range of CFL bulbs and allows each distributor to determine the price charged for the CFL. The PoA in Nigeria is run by a commercial energy company evidently attempting to adapt the CFL exchange activity to the context in Nigeria. The PoA is designed to allow all flexibility to define each PoA component for various distsributors. No new components (called CPA) have been submitted since 2012 and this indicates the difficulty to find suitable NSA that can serve as distributors in Nigeria.

The considerable expansion of CDM PoAs to 100s mio CFLs, notably in China, India and Pakistan, adding carbon credit income to the funding for DSM has not encouraged experimentation with different distribution formats. The CDM methodologies AMS-II.J and AMS-II.C have slowly become more adaptable but this has not allowed to differentiate for households and find better solutions to the split incentives. To the contrary, PoAs increasingly use micro-managed utility implementation, with inhouse software to record the exchanges door-to-door and control that the CFLs are used in the most frequently used rooms (policing will not succeed). These PoA do lessen the split incentives but instead of offering more CFLs or higher/lower prices so that households decide how to participate, keep one only exchange for all households, thereby reducing the overall volume of CFL exchanges.

What roles have NSA played in lighting DSM

The only two countries where lighting DSM with CFL is not implemented by governments, Mexico and Nigeria are opposites regarding climate policy. Mexico as a strong government and a forerunner in climate policy versus Nigeria as a weak state with only rudimentary climate policy capacity. In Mexico, the utility CFE ran a CFL exchange programme "Ilumex" distributing 45 mio CFL free of any conditions until 1997. The government then supported coolNRG in a variety of ways and has progressively banned incandescent lamps when coolNRG implemented the CFL PoA. Thus it is a case of a private company extending the early effort by the government and easing the subsequent regulatory tool of a ban on old incandescent technology. Whereas in Nigeria no government activity in lighting technology appeared.

In all other countries, NSA have only been involved as service providers, getting paid per number of lightbulbs distributed and for providing data to the utility companies.

What new lighting DSM experiments are possible for NSA

To redistribute the split incentive, the CFL price to the household can reflect the level of benefit to the household. Households with higher incomes are larger, use more lightbulbs and use them longer than poorer households that tend to be smaller and have less lightbulbs. Instead of offering every household the same number of CFLs for the same price and demand incandescent lightbulbs as exchange, a higher price for a CFL itself selects among the households those that benefit more from the CFL. The offer of the CFL at a specific price can be supported by a calculation of the benefit from the reduced electricity bill, using the actual tariff and actual hour of usage, if the calculation is credible and transparent.

Another related aspect is whether a flexible offer dependent on household types would also lead to higher carbon credits. In other words whether the carbon crediting can strengthen the redistribution of split incentives. The CDM methodology AMS-II.C allows this because of the monitoring with a sample of lightbulbs with hourmeters. The extend of the redistribution of the split incentives depends first of all on the subsidies in electricity supply. Households with the lowest tariff can get a CFL price offer comprising a subsidy element corresponding to the subsidy in that tariff. Countries with higher costs and higher subsidies allow more redistribution of split incentives.

In the Mexican CFL exchange PoA, the monitoring by coolNRG revealed the share of distributed CFLs not in use after four years at 85.6%, 83.1%, 76.7% and 87.2% in four sample batches among the 5.9 mio households that received CFLs (CoolNRG 2016). The price for the households was so low that not much care appeared in their usage. By comparison in the Ruanda CFL exchange project, operated door-to-door by the utility company, 36% of CFL were not operating five years after the installation. And in India failure rates vary between 20 and 26% after four years (the Indian CFL programme is similar to the Pakistan one more designed so different levels of governments cooperate in "tripartite contracts" irrespective of households needs). Many studies of CFL retention rates across the USA show 34 – 50% not in use after three years. CoolNRG has achieved as low as 20% unused CFL in

Australia even without payment and without exchange of old lightbulbs. The World Bank's Mexico CFL programme in the 1990s "Ilumex" showed lower participation rates by low-income households compared to medium and high-income ones (World Bank 2001). Undoubtedly the free exchange of the lightbulbs was seen in a particular Mexican context. CoolNRG failed to adapt their CFL exchange setup, successful in Australia, to the Mexican household behaviour. The following table shows all results of lighting DSM with climate finance so far (the number of CERs are only indicative of commercial need to get them on the market).

Table: Registered CFL PoA and single CFL projects

CFL PoA countries in the order of programme approval from UNFCCC	Number CERs issued so far from UNFCCC	
Ruanda	23,491	
Mexico	223,989	
India	2,000,120	
Bangladesh	not yet issued	
Vietnam	"	
China	"	
Senegal	"	
Kenya	"	
South Africa	"	
Pakistan	"	
Nigeria	"	

CoolNRG decided it could afford only hourmeters from a Mexican supplier which, after installation in the sample households, had "problems with data transmission" (ERM 2014). Again comparing to Ruanda, hourmeters in the sample households used over two years across the country allowed elaborate statistical precision (and an average daily usage of 4.4 hrs, Electrogaz 2012). The carbon crediting achieved in Ruanda, estimated to amount to 2.25 mio.US$ over the CFLs' lifetime, represents a significant profit over all costs of the project.

The dominant manufacturers of CFLs, Philips and Osram have been quite active in developing the CFL programmes in several countries but strikingly decided not to invest in developing low-cost hourmeters for that particular purpose. Osram outsourced that and then used a very clumsy hourmeter only to then realise that the meter itself influences user behaviour because users worry about electronic contents. Nonetheless, the Ruanda case and the Indian CFL PoA results prove that monitoring is not too costly, but so far no experiments with different CFL conditions as a function of likely usage have been realised.

The ideal experiment is to offer CFLs to those households using them most and charge them a price that achieves a payback within the households' financial ability. An obvious help to achieve this is the correct interpretation of these households' monthly electricity bills of the past and the usage of other appliances. Households where 50% of the electricity consumption is for lighting will certainly show a higher retention rate of CFLs than those consuming more electricity for more appliances. Similarly where 50% of the bill is lighting, these households have a lower propensity to pay the normal CFL price. To find an effective solution to the split incentive

requires experimentation of the CFL price charged related the electricity bills, in a manner to explore unknown sociocultural influences and factors.

Such experimentation is somewhat hidden in the World Bank Institute's CFL Design Toolkit. The regulators approving the CDM methodologies AMS-II.C and AMS-II.J contributed to discourage experiments with other CFL distribution by insisting on the exchange of CFLs with incandescent bulbs, an effort to increase environmental integrity in an unrealistic manner.

To assess further if NSA can create better CFL distribution solutions, other lighting DSM with LED lightbulbs and PV provides evidence for this potential. When NSA solutions to distribution of LED lights succeed they should be able to do so for CFL as well.

Organisational roles in Offgrid appliances

Everything said above for DSM with CFL lightbulbs applies equally to DSM with LED lightbulbs because of the much higher efficiency, the higher prices and the higher lifetime of the LED technology, the split incentives for LED are stronger than for CFL lightbulbs. The management problems of CFL PoA will continue to affect the forthcoming LED PoA. So far only in Singapore, in South Africa and in India DSM programmes with LED have been implemented and with similar PoA formats as before the CFL PoAs. Reflecting the higher prices of LED lighting, these three PoA target particular industries or public buildings with higher time of use, so by applying the methodology AMS-II.C, they achieve higher carbon credit volumes. No lighting DSM with LED in households using the public grid have appeared so far.

Offgrid lighting with LED and PV cells has been expanding in Africa for several years. Carbon crediting from CDM with the PoA format has been established in Chad, Côte d'Ivoire, Ethiopia, Kenya, Madagascar, Malawi, Mali, Namibia, South Africa, Tanzania, Uganda and Zambia. Preparations for expanding to all other African countries have been made. Among the 19 PoA for LED lighting in offgrid areas, only one has multiple suppliers in its scope, the Ethiopian Development Bank one (CDM#10285). It lists six retail chains as distributors in the PoA and offers households the most popular lighting models from four manufacturers, d.light, Azuri, Greenlight, Omnivoltaic. Offgrid lighting seems to be more conducive for PoA designs comprising experiments with participation formats. On the other hand, there is a tendency emerging for manufacturers to create their own PoAs, especially in Kenya with four competing offgrid lighting PoA (#9071, #7489, #7470, #6110) already registered with UNFCCC. No monitoring results have been published so far for LED PoA.

The payback periods for offgrid LED with PV are similar to those of CFL versus incandescent lightbulbs but higher upfront costs and lower household incomes require pay-as-you-go solutions to finance offgrid LED systems. Mobile banking in Kenya is an enabling factor why the intense competition among offgrid LED providers produces a rapid suggestion of experiments and rapid expansion of the wining distribution solution. The absence of split incentives is another factor. More importantly, the offgrid LED expansion also shows that carbon crediting enhances

the competition and ideally will add competitive advantage to the higher quality systems. Efficient monitoring methods can increase this influence of the carbon crediting.

An example for operational roles for NSA and their importance is the Bangladesh Solar Home Systems PoA, initiated by Grameen Shakti in 1996 and expanded by the governmental IDCOL since 2002 (SHS CDM#2765). It is currently approaching 3 mio SHS systems installed. IDCOL aims for 100,000 systems installed per month. IDCOL provides loans for 80% of the SHS costs to around 50 NGOs implementing this PoA across the country. IDCOL loan conditions are the same for all 50 as well as extensive technical assistance, training, component testing and installed SHS inspections. Each NGO can choose their suppliers as long as the parts comply with technical specifications from IDCOL. The most successful NGO is Grameen Shakti in part because it operates through 46 village technology centres and around 1000 engineers providing design, installation advice, maintenance and warranty services. Strikingly all are female in a rather patriarchal society. The close advice to each household permits to offer many different SHS configuration while maintaining the same financial terms, a 15 % down payment and monthly instalments of 11 US$. High quality maintenance and warranty are certainly as important as the financial offer details. That Grameen Shakti experimented for 5 years with 20,000 SHS customers before foreign funding was introduced has been another important success factor. IDCOL has stated that it will withdraw more and more from the PoA because the 50 NGOs are performing all necessary functions with the exception of IDCOL being the conduit for the carbon credit sales.

IDCOL also implements the CFL exchange programme in Bangladesh (CFL CDM#4793), Efficient Lighting Initiative of Bangladesh (ELIB). Phase 1 of ELIB experimented with distribution of 10 mio CFLs via distribution centres. In phase 2 ELIB adopted the same door-to-door uniform distribution approach used in most CFL programmes offering only one CFL size of 23 W. Phase 1 was unsuccessful because some CFLs were not installed in the households. The Rural Electrification Board is operating all CFL PoA components in phase 2. Bangladeshi NGOs would be as successful in grid areas with CFLs as they are in offgrid areas with LED and PV. An extensive lighting survey preparing ELIB showed that awareness for savings from CFL is high and the price elasticity of lower-income households purchasing CFL is pronounced (ESMAP 2009). Differentiated distribution of CFLs in ELIB by NGOs would bring higher CFL usage, higher carbon credits and faster uptake.

DSM with Airconditioners and refrigerators

Airconditioners are the most important household appliance for DSM where they are the largest part of household electricity consumption because Airconditioners are the dominant contributor to peak load in many power grids. In India, 40-60% of summer peak demand is for room Airconditioners. Increasing the efficiency of Airconditioners creates therefore the highest savings in powerplant capacity. China and the USA are the countries with most Airconditioner DSM. The standard format is providing households with rebates or vouchers when buying a high efficient Airconditioner. Possible roles of NSA are to administer the rebates and vouchers. In Airconditioner DSM in Mexico, the rebates are directly given via the utility's monthly electricity bills

(SEAD 2015). Airconditioner DSM evaluations in the USA have shown that free-ridership is a problem, rebates are not specific enough. The Mexican Airconditioner DSM cost 600 mio US$ and had operational deficiencies that created an actual increase in electricity consumption (SEAD 2015). Very successful Airconditioner DSM in some states of the USA manage to raise the average efficiency to SEER 23 (twice market average), but such rebates (1,200US$ per Airconditioner) are prohibitive for larger states. Airconditioner DSM in the USA is also targeted at the distribution level in the supply chain (mid-stream approach). Shops and retailers are paid to stock more high efficient models. This has also been successful for lighting, both for CFLs and for LEDs.

In all countries, Airconditioner DSM is dependent on energy efficiency labels. These labels don't reduce split incentives but weaken the effects. Colour coding and clear efficiency classes are designed to inform buyers of Airconditioners. In China the combination of DSM and labels has been well demonstrated with a subsidy for 34 mio Airconditioners of 2.4 bnUS$ that raised the market share of the top efficiency class models from 5% in 2009 to 70% in 2010. In the following year the Minimum Efficiency Performance Standard (MEPS) was raised so the lower efficiency models were prohibited. Designing Airconditioner DSM requires understanding how households react to efficiency labelling. The Chinese label administration CNIS tracks Airconditioner purchase decisions in 400 cities in real-time also to improve the design of DSM programmes.

The split incentives for Airconditioner DSM are large because the peak load reduction creates the benefits on the utility side. Even so 280 utilities in the US already run rebate schemes, Lawrence Berkeley Lab studies show that it would be economic under current electricity tariffs to double average Airconditioner efficiency in the USA (SEAD 2015). There has been only one attempt to use carbon crediting for Airconditioners, in 2007 with a CDM methodology designed for Ghana (methodology NM0159) by the Ghana Energy Foundation. It was rejected with the justification (EB29) that it contained policy measures, exactly of the kind the Paris Agreement Articles 6.2 and 6.8 are now intended for. Creating and enforcing efficiency labels is often done in Ministries of Energy or Environment which generally fall short without strong partners from industry. This is a for-profit company in Europe, Eurovent, and much more importantly, the China Household Electrical Appliances Association (CHEAA) whose members manufacture 70% of the world's Airconditioners.

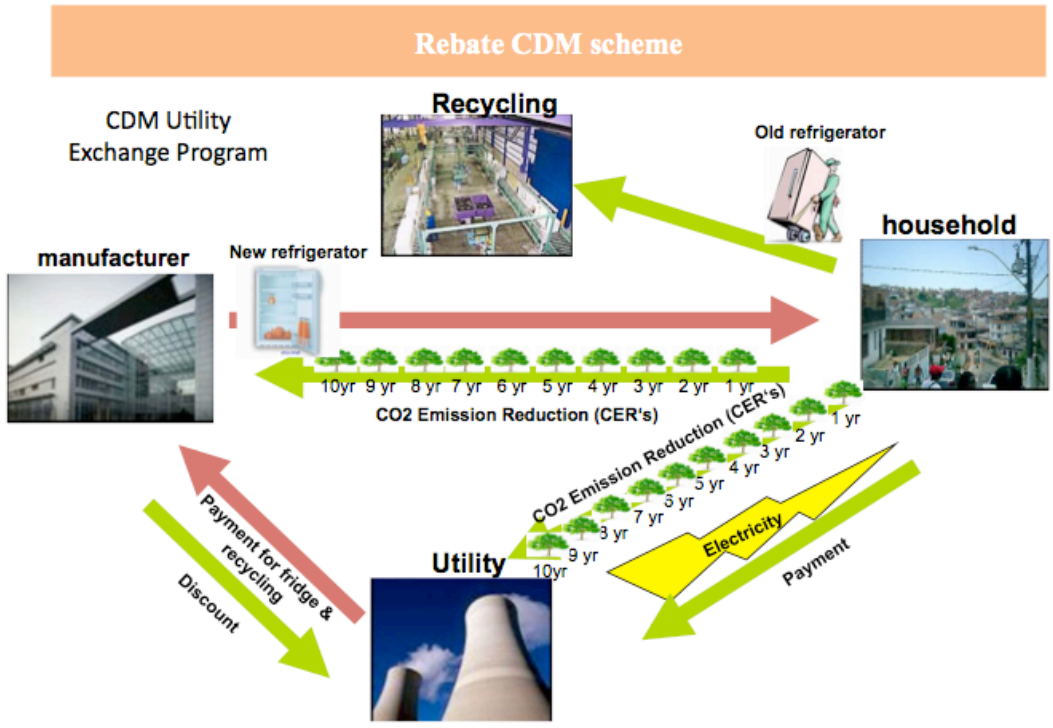
Potential roles for NSA in Airconditioner DSM:

- determine household decision making factors
- awareness of efficiency labels in industry and in households
- Airconditioner testing and certification for importers and wholesalers
- Certification of testing laboratories in industry and commerce
- quality control of maintenance of installed Airconditioners
- administer rebates taking into account household conditions
- monitor efficiency levels in market segments
- establish what levels of rebates are above utility self-interest as additionality benchmarks
- management of carbon crediting

- elaborate a Montreal Protocol HCFC Management Phaseout Plan and HFC Phasedown Plan input for the national manufacturing and servicing industries

There have been few DSM projects with refrigerators that include carbon credits, so far only in India and in Brazil. Almost all Brazilian utility companies are replacing lightbulbs and refrigerators in low-income households. In Salvador and in Sao Paulo, the utilities (Coelba and Eletropaulo) have produced CDM project documentation but have not received carbon credits so far. Exchanging old with high efficiency refrigerators can create around 2 tCO2e credits per refrigerator contributing to the higher price of the high efficiency model. In addition the Brazilian utilities reduce their losses as they have to supply electricity at highly subsidized tariffs to the low-income households. NGOs play an important role in these DSM projects because they distribute the efficient lightbulbs and refrigerators and advice households on managing their utility bill. They are indispensable service providers for the Brazilian utilities in low-income areas. The governmental appliance efficiency administration PROCEL controls the utilities' DSM programmes but has not embarked on harnessing carbon crediting although it would complement the Brazilian DSM regulation effectively. The following diagram shows the operation of such a refrigerator CDM set-up when it is managed by the refrigerator manufacturer (in CDM PoA terminology the "Coordinating and Managing Entity" CME) and this role can be played by any other NSA (for instance the Ghana Energy Foundation).

Figure: Integrating carbon crediting into rebates for high efficient refrigerators



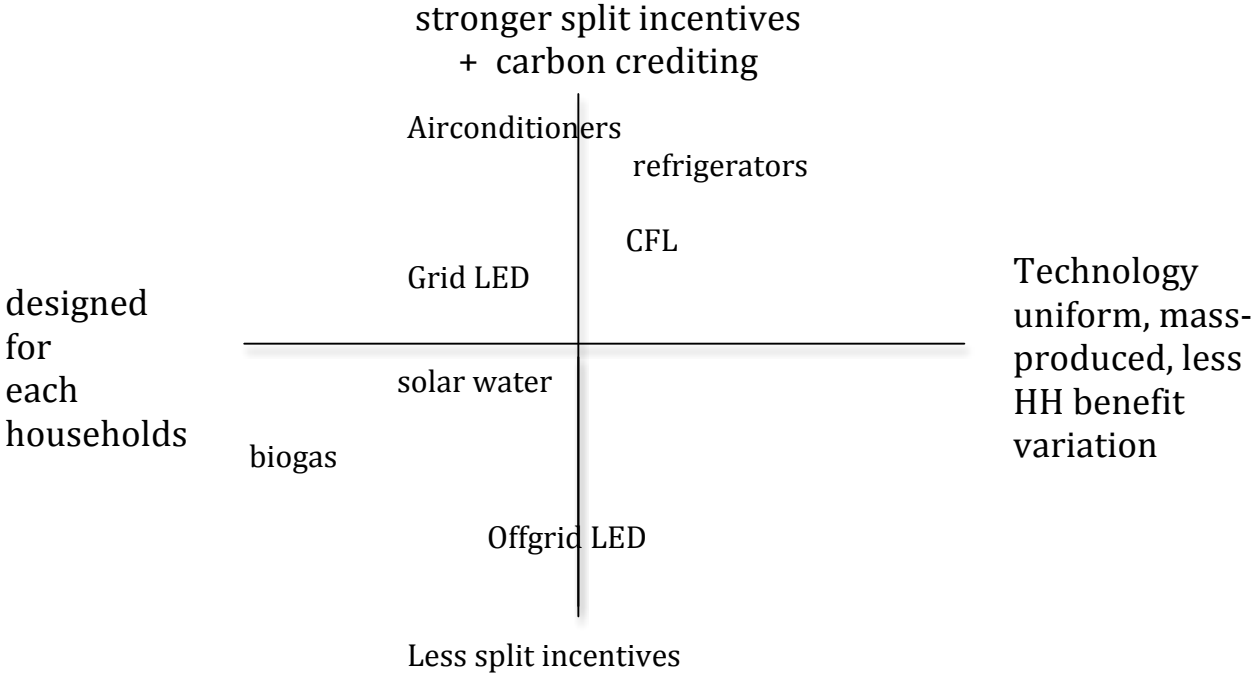
For refrigerators, the manufacturers have been more active albeit slow in harnessing carbon credits than the utilities. LG Electronics India Pvt is the only company that succeeded with a CDM project introducing high efficiency refrigerators (CDM#6916) and obtained 6,954 CERs from this CDM project. Samsung Electronics implemented a similar project (CDM#7345) but has not obtained carbon credits so far. Both cases were hampered in their monitoring because average efficiency data across the refrigerator market was not available or inconsistent. Bosch/Siemens Hausgeräte

considered CDM projects in Brazil and Peru but then withdrew. A new standardized baseline framework for refrigerators just approved by UNFCCC (EB94) might overcome the monitoring problems of LG and Samsung.

Comparing DSM for different appliances and for opportunities to reduce split incentives

The extent of split incentives is the reason why DSM is attractive and avoids building new power capacity. DSM returns some of the benefits from the utility to the households. The more accurate this is done the higher the impact. NGOs have been particularly successful in doing so for lighting DSM, avoiding the rigidity and unresponsiveness of uniform utility managed lightbulb exchange programmes. Airconditioners and refrigerators are the two other appliances with large scale DSM activity in most countries. Technical potential in Brazil for Airconditioner is estimated 30 – 8 TWh, for refrigerators 24 – 17 TWh and lighting 12.4 – 7.7 TWh. In India, Airconditioner DSM potential is 87 – 25 TWh, lighting 46 – 41 TWh and refrigeration 19 – 11 TWh. The ranking of the efficiency potential among the three appliances varies between countries. For each of these three, the potential corresponds to several mid-sized powerplants in electricity load (500 MW) in larger countries. But in lighting as well as for Airconditioners and refrigerators, the majority of DSM programmes are very utility-centric. To compare DSM programmes and operational roles of NSA it is illustrative to situate them in the following diagramm

Figure: Opportunity space



When split incentives are strong, but the technology is uniform and not adaptable to household conditions, carbon crediting is an additional means to distribute split incentives. The carbon credits can be signed over from each household to the utility or to a third entity, an NGO or NSA. The CFL PoA in Mexico could further reduce the

split incentives with the carbon crediting, when it realises the monitoring, and develop PoA components for household classes that produce more carbon crediting. Airconditioners have more variation in the appliance's service to households and the variability of the service is where NSA can initiate improvements to the DSM programmes from utilities. Research on CDM project implementation has been quite rudimentary and especially on "co-benefits" little is studied in detail. Sociocultural variables are always present in split incentives and DSM preparations are dominated by engineering analysis and behavioural factors are not sufficiently integrated.

Adaptation to household conditions and quality maintenance is as important in Offgrid LED as it is for Airconditioners. This suggests the question whether such joint technical and financial service as from Grameen Shakti Bangladesh would not equally be success factors for an NSA that distributes Airconditioners with monthly payments, warranty, detailed monitoring of the Airconditioner performance so that carbon crediting is further reducing the split incentives.

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