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RURAL ELECTRIFICATION FUND (REF)

REF MANUAL VOLUME 3

RURAL ELECTRIFICATION SUBSIDY PRINCIPLES
A REFERENCE MANUAL

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Abbreviations, Acronyms, and Definitions

Abbreviations

GHG	Green House Gas
LV	Low Voltage below 1 kV)
MV	Medium Voltage (1 kV to 33 kV)
PV	Photovoltaic (solar power technology)
NRE	New and Renewable Energy
RE	Rural Electrification
REF	Rural Electrification Fund
SHS	Solar Home System

Definitions

Concepts related to electrification

Community electrification rate	The percentage of national communities that are electrified
Developer	Entity (utility, private entrepreneur or CBO) that invests in infrastructure- projects and companies
Direct access to electricity	Households connected to the LV-system
Household electrification rate	Percentage of national households that are provided with an electricity service
Indirect access to electricity	Non-connected households living in electrified service areas that enjoy the benefits of public lighting and of improved public services.
National connection rate	percentage of national households that are provided with an electricity service
National electrification coverage	Percentage of national households with or without electricity service that live in electrified communities (service areas)

Concepts related to financing

Balance Sheet Financing	Granting of a loan to a project with reference to the financial strength of the parent company, to which recourse is made in case of default.
Developer	Entity (utility, private entrepreneur or CBO) that invests in infrastructure projects and companies
Financial Closing	The point in time when full agreement has been reached between equity investors and lenders; all conditions of lenders and investors have been met to finance the total financial package for the project, the loan agreements and shareholder agreements have been signed and financing disbursements can take place.

Limited Recourse Financing	A lending arrangement under which repayment of a loan and recourse in the event of a default relies mainly on the project's cash flow.
Non-Recourse Financing	Recourse fo debt repayment, default, or both belongs exclusively to the project company.

Concepts related to subsidies

Cross-subsidization policy	Pricing policy, which charges "low cost" consumers (e.g. urban electricity consumers) tariffs that are above the cost of supply to these, whereas "high cost" consumers (e.g. rural electricity consumers) pay tariffs that do not cover the full cost of supply to them. The "surplus revenue" captured from the former covers the financial losses on the latter.
Free rider	Recipient of a subsidy who would have acquired the product also in the absence of a subsidy
Inputs (in an OBA scheme)	Resources consumed in the production and delivery of an output
Investment subsidy	Subsidy, the size of which is determined by the cost of upfront investment; the subsidy can be paid (i) upfront in a number of installments until commissioning linked to progress in construction or (ii) as an annuity payment during operation for a fixed number of years.
Market deepening subsidy	Support to increase service coverage in serviced areas to include poorer households as well.
Market expanding subsidy	Subsidy to increase the national service rate.
Market pump priming subsidy	A temporary, time limited subsidy to lift market demand to a size that is sufficiently large to permit commercial delivery structures to be developed.
Market widening subsidy	Subsidy to increase electrification coverage,, bringing electricity to unserved communities.
Operating subsidy	A subsidy, the size of which is determined either (i) by specific operating cost items (e.g., the consumption of diesel fuel) or (ii) by the difference between annual operating costs and revenues.
Outcomes (of OBA scheme)	Ultimate impacts on the community of the services being provided.
Outputs (of OBA scheme)	Immediate results of the service provider's activities.
Output-based Aid (OBA)	Subsidy scheme that links payment of subsidy to the achievement of specified well-defined outputs.
Public-Private-Partnership	The opening up of new market opportunities for private entrepreneurs through the implementation of a time-bound specific public

	support program defined by a public agency in close consultation with private stakeholders; where for new and untested markets the costs and risks of initial market entry are shared between the public and the private sector.
Ramsey pricing	To focus taxation on products with the lowest demand elasticity in order to reduce the welfare distorting impact from product taxation (loss of consumer surplus)
Reverse Ramsey pricing principle	To focus subsidies on products and services with the highest elasticity of demand in order to achieve maximum market expansion per invested subsidy amount.
Smart subsidy	Subsidy scheme that targets payment of subsidy at the achievement of specified output goals.
Upfront subsidy payment	Payment of subsidy before start of operation; part of which may be *on award*, the rest *during construction according to milestones for progress in investment and in number of service connections*.

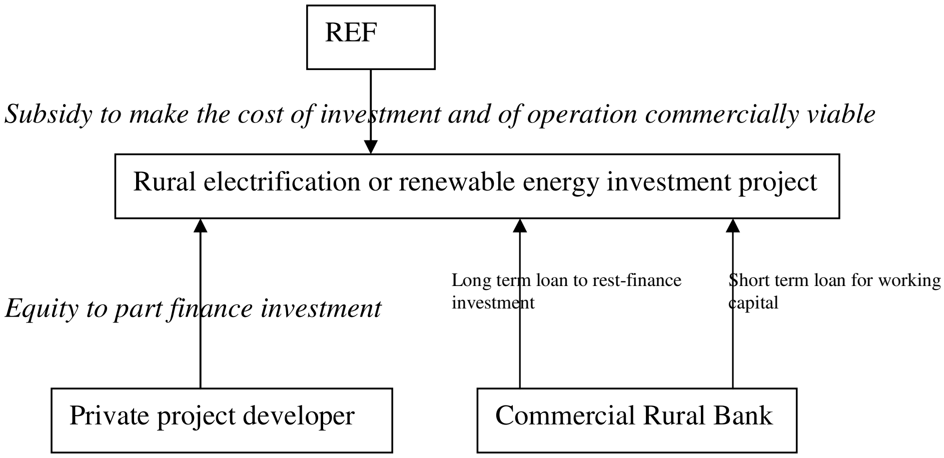
Instruments for linking payment with performance:

Bounty scheme:	Pre-specified payment given to service provider on evidence of meeting scheme's requirements.
Least-subsidy bidding scheme:	Franchise awarded through competitive process to service provider requiring least subsidy; failure of service provider to meet performance standards results in fine or other sanction.
Voucher scheme:	Voucher given to eligible beneficiary; the beneficiary exchanges voucher for service; and service provider redeems voucher for payment.

1 Rural Electrification Subsidies: Roles and Instruments

1.1 Why are Subsidies needed in Rural Electrification

RE is more expensive than urban electrification and rural households are poorer. The consumer affordability problem makes it difficult for potential investors to get rural electrification projects organized and financed. Without subsidies, RE-rates and the quality of supply will remain low for decades.[1]



The REF-subsidy enables project sponsors to attract *equity capital* and *commercial bank loans* to rest finance the cost of upfront investment and of needed working capital. The REF framework allows a maximum of players to engage in RE and simultaneously assists the development of the national capital market.

A well-designed subsidy scheme makes RE-projects attractive to private investors for two reasons.

- *One is the impact of the subsidy on the expansion of the market*. The lower cost of electricity supply increases the demand for electricity in the service area, inter alia, due to an increase in the connection rate: more households can afford to pay. The *"market deepening impact"* of the subsidy (getting more households and other consumers connected to the distribution grid in a community) makes more projects viable. Due to higher viability, more projects get implemented. That's the *"market expansion function"* of the subsidy.

- *The other is the impact on financial intermediation*. A subsidy paid during construction reduces the amount of finance, which a developer must raise in

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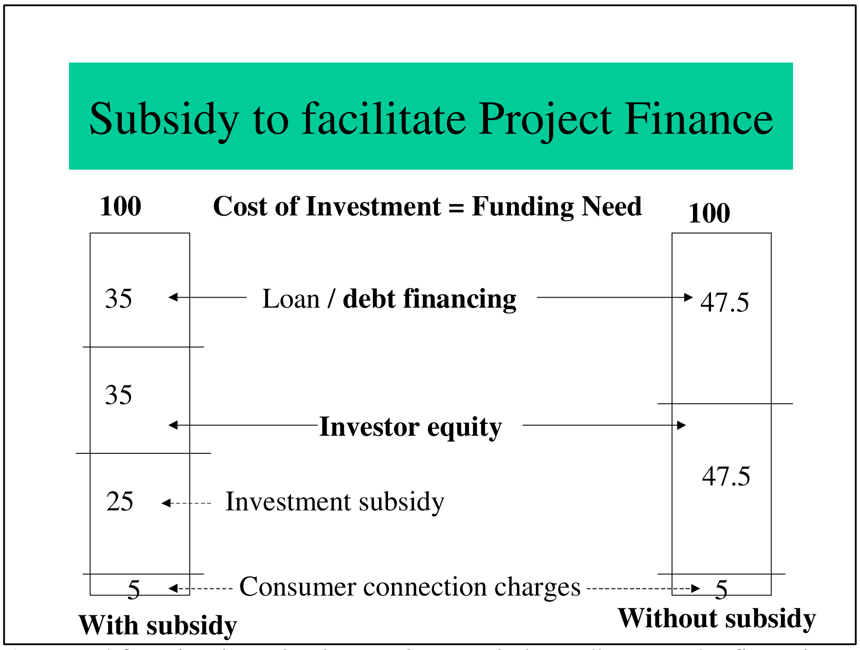
[1] Except for maybe a handful of European countries, there are no examples in the world of countries that managed to complete rural electrification without use of subsidies. Electricity consumers in the USA even today have a tiny rural electrification charge added to their bill that finances the cost of subsidized loans to rural electricity cooperatives.

the form of equity and loans. The investment risk and the lender's risk are reduced in parallel. This gives project developers and financial institutions the confidence to enter the market.

1.2 The Triple Role of Subsidies in promoting Rural Electrification

All RE-subsidies have one target in common: market expansion. But depending on the stage of electrification in the country, expansion of service can take place either through *market deepening* (increasing connection rates in projects) or through *market widening* (increasing national electrification coverage). With reference to this, *investment subsidies* to rural electrification projects have three roles in RE-strategies.

One is *market deepening*, to *increase the connection rate in the service area*. By reducing the financial cost, which the utility must recover through its tariff revenue, the average tariff is reduced. This improves affordability. The impact of the subsidy on the connection rate is maximized if - as a condition for receiving the subsidy - investors are required to use the subsidy revenue to reduce the fixed monthly tariffs and connection charges for lifeline consumers. Inserting this obligation in the subsidy contract links the subsidy for an "input" to the achievement of a specific "output".



A second function is to *facilitate "financial closure*": to get the financing package (equity + loans + subsidies + consumer contributions) for a project in place. An upfront investment subsidy[2] reduces the required equity contribution and the size of the investment loan. This makes it easier to get projects funded in countries with weak capital markets, where it is difficult to raise equity as well as long-term loans.

[2] The subsidy is paid according to registered progress in construction, with the last payment falling shortly after commissioning.

Because more rural electrification projects are implemented, the upfront investment subsidy promotes the *market widening* objective.

The “upfront investment subsidy” is important for small local project developers and communities. They face difficulties in raising equity and in being considered credit worthy by the banks. Thus, if the objective is to facilitate locally-based initiatives, the upfront investment subsidy is an important tool.

A side effect of the subsidy is that it should reduce the rate of interest on the investment loan: it lowers the risk of the project. The upfront investment subsidy limits the financial exposure of the lender and lowers the average tariff thereby reducing the risk that low affordability leads to arrears in consumer payments.

The commercial financing of RE projects can be facilitated by alternative instruments, which can supplement the RE-subsidy. REF funds can be used to finance the following support measures:

- *Partial risk guaranty facility* for RE-loans for construction companies, utilities, PV-vendors, fee-for-service companies and consumers.
- *Refinancing facility* for banks providing long-term loans to RE-projects
- *Training banks in appraising RE projects.*
- *Soft loans* provided through banks, where the REF pays the bank the NPV of foregone interest payments (difference between market rates and the interest rate charged to the developer).[3]

A third function of the subsidy is *to provide a means for imposing service quality standards and tariff regulation on rural electricity supply companies (RESCOs)*, making compliance with standards a condition for access to the subsidy. Solar home system vendors, for example, can be required to fulfill specified quality standards for their PV-systems and for their maintenance service as an eligibility condition for receiving subsidies to the sales of their systems. Standards can be introduced in small isolated grid projects, which increase the upfront cost of investment but reduce the life-cycle cost of supply due to savings on O&M costs.

How many REF funds can and should be allocated to the development of standards and to the strengthening of local capacity for quality control is a matter of judgment. Differing schools of expert opinion exist on how cost-effective the measure is.

1.3 RE-Subsidies: Financing Sources and Subsidy Targets

There are two potential financing *sources* for raising subsidies for rural electrification: the “tax payer pays” and the “urban electricity consumer pays” sources of finance.

There are two potential *targets for subsidization* –the *cost of investment* and the *price of the output* (subsidy to the cost of operation).

[3] This instrument is not recommended: it distorts rural credit markets and is per subsidy dollar less effective in attracting investments than an upfront investment subsidy.

The potential *instruments* for raising revenues and for channeling subsidies to rural electrification projects can be presented in a 2x2 matrix, as shown in table 1.1.

Table1.1 Subsidy Instruments for Market Penetration

Financing Sources	**Subsidy Targets**	
	Cost of investment	Price of output
Tax payer pays (includes donor funds and REF charges on transmission or power consumption[1])	• Direct capital subsidies • Soft loans • VAT exemption • Import duty exemption • Accelerated depreciation • Subsidies to R&D&D	• Top-up premium to the distribution company per sold kWh • Top-up premium to distribution company per (sold kWh to) lifeline consumers • VAT/excise duty exemptions on rural power tariffs • Vouchers for low income households
Power consumer pays	• Connection costs are subsidised by utilities • Support to loan finance the cost of consumer internal wiring	• National unified power transmission tariff • National or regional unified retail (distribution) tariffs • Lifeline rates

1) The power consumer pays the charge. But technically, it is a tax, which, if it had not been earmarked for the REF could have been used for other budget items. It is a matter of interpretation.

The ***tax payer pays*** financing mechanism to subsidize rural electrification uses the following instruments to channel financial resources to target recipients:

- *Capital subsidies*. Direct subsidies paid by the REF to purchases of SHS and to investments in grid electrification are a means to make rural electrification affordable to a larger number of consumers in the target area. They disadvantaged service areas commercially viable for utilities by simultaneously expanding MWh sales and reducing the cost of investment for the utility. They facilitate financial closure of RE-investments.

- *Soft loans* to investors in grid electrification or to dealers in solar home systems are another means to reduce the cost of investment.

- *Tax exemptions / tax rebates*. Tax breaks can be used either to reduce the cost of the investment (the first three below) or to increase the net revenue after taxes from the sales of the output (the last item below). Examples are:
  - exemption from payment of VAT on SHS and conventional power equipment
  - exemption from import duties for SHS and conventional power equipment
  - accelerated tax deductions for investments in collective renewable energy systems and in conventional grid based electrification
  - tax breaks on returns from investments in collective renewable energy systems and in conventional grid based electrification.

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- *Top-up premium payments to the rural power distribution company per sold kWh.* Argentina pays top-up premiums to lifeline rates for off-grid, dispersed population concessions.

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- *Lower VAT on power sold by rural distribution companies.*

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- *A rural electrification charge* is imposed on the transmission tariff and/or on retail tariffs in urban areas. Being a tax on electricity consumption, it is a matter of interpretation whether this represents an "electricity consumer pays" or a "tax payer pays" source of finance. The problem with such a charge is that energy intensive industries must be exempted. Otherwise, distorting price signals are given leading to investments in non-electricity using technologies, although the production cost of electricity using equipment may be lower without the tax. Another reason is to avoid unequal competition for energy intensive industries with producers from countries that do not impose a rural electrification charge on their manufacturers.

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Examples of the ***electricity consumer pays*** financing mechanism are:

- The c*ost of connecting a consumer* is born mainly by the rural power distribution company; the individual household consumer pays only part of the cost through the up-front connection charge. The utility recovers the financial loss on connections either through higher kWh tariffs, or through the fixed monthly charges on its invoices. When it is done through the kWh-tariffs, consumers with higher than average levels of kWh consumption finance most of the connection subsidy. When a power company has urban and rural consumers, the former subsidize the latter due to the higher levels of consumption in urban areas.

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- Some utilities assist households with arranging loans to finance the cost of internal wiring and the initial connection charge. Often, the transaction costs to the utility of the financial intermediation service are not fully reflected in the interest rates and other financial charges to the borrower.

- The application of a *national retail tariffs* pricing policy by state owned power utilities is the "classical" approach to cross-subsidize rural electrification.

- The policy of *unified national transmission tariffs* by a private or state owned national transmission company uses the same method, albeit on a more limited scale, in liberalized, vertically unbundled power regimes [4].

In practice, countries use a package of instruments to promote the objective of rural electrification. The composition of the package of incentive measures is defined by various factors:

- *The stage of rural electrification*. Over time, there is s shift in the relative importance of the four quadrants. During the early national power company stage, quadrant 4 instruments dominate. When power sector reform shifts the execution

[4] See Section for a short introduction to the implications of national transmission tariffs.

of RE-projects to the private sector, quadrant 1 instruments are used. During the later, market deepening stages of RE, quadrant 2 instruments gain in importance.

- *The quality of rural financial institutions*. When financial intermediation is weak, direct investment subsidies are a precondition for securing financial closure. In that case, the direct investment subsidy is the logical instrument. Depending on the level of the investment subsidy – the higher it is in percent of total investment - it will be given in combination with an output based subsidy.

- *The quality of the national taxation system*. As long as the national taxation system is weak and arbitrary, a situation in many low-income countries, tax rebates are an inefficient instrument.

- *The strength of the incentive impact*. When it comes to investment subsidies, experience shows that a *direct capital subsidy* has a stronger incentive effect on purchases than *tax rebates* having the same subsidy value [5]. The monetary value of direct capital subsidies is more transparent for investors and for voters - the impact of tax rebates on the state budget is more hidden. The lack of transparency can under some circumstances be attractive for politicians. Another advantage of tax rebates is the avoidance of a separate bureaucracy for the administration of subsidy payments.

- *Maintaining the momentum* is another: when the rate of expansion slows down, or more ambitious targets are set, new, supplementary instruments are introduced.

The point of the above survey of subsidy instruments is that a variety of alternative and supplementary measures exist to subsidize rural electrification. What the best combination is depends on the specific situation in each country.

[5] Also this rule has its exceptions. The tax rebates given in India to investors in wind farms had during the early stages on the program a strong incentive impact. Indian firms were faced with a general tight financial situation.

1.4 Why not set-up REF as a Revolving Fund giving subsidized Loans?

An alternative concept for the REF is to establish it as a *revolving fund*, *which gives interest rate free loans to investors*. The idea is based on two arguments.

1. By setting up a revolving fund, *funds put into the REF do not disappear.* They can be reused later for other RE- and RET investment projects.
2. By not giving REF funds as a free gift, *it is justified to place more funds into the REF, enabling the REF to loan-finance the total non-equity part of an investment*. This makes it easier for an investor to secure financial closure for his project.

The "fund conservation" argument is correct as far as the availability of *tied funds for RE-projects* is concerned; it is incorrect, if it refers to the *overall availability of loan funds*. An *upfront investment grant* and a *subsidized loan* are both capital subsidies, which reduce the amortization burden of debt finance, and thereby the annual fund outflow, which must be covered by annual tariff revenue. For the investor's annual payment it makes no difference, whether he gets (i) an *interest rate free loan* with a maturity of ten years or (ii) a *38.5% upfront investment subsidy and a 10 year loan at a 10% rate of interest* for the rest-financing need. The availability of funds for later project finance is also the same: the amount of money each year, which flows back to the bank and can be used for new lending, is identical! The point is illustrated in the table below, which shows the ten year cash flows for the "REF investment subsidy" and the "REF Revolving Fund" cases.

Comparison of 38.5% Investment Subsidy with 10 Year Interest Rate Free Loan

Year:	0	1	2	3	4	5	6	7	8	9	10
Investment	**100,000**										
REF Subsidy	38,500										
Bank Loan	61,500										
Rate of interest	10%										
Interest payment		-6,150	-5,764	-5,340	-4,873	-4,359	-3,794	-3,173	-2,489	-1,737	-910
Repayment		-3,859	-4,245	-4,669	-5,136	-5,650	-6,215	-6,836	-7,520	-8,272	-9,099
Annual payment		-10,009	-10,009	-10,009	-10,009	-10,009	-10,009	-10,009	-10,009	-10,009	-10,009
REF Subsidy	0										
REF Loan	100,000										
Rate of interest	0%										
Interest payment		0	0	0	0	0	0	0	0	0	0
Repayment		-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000
Annual payment		-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000

The argument for the investment subsidy procedure is that it strengthens the development of a national commercial structure for rural finance; whereas the revolving fund procedure weakens it:

- In the *REF investment subsidy case*, loan finance is provided on normal commercial terms by commercial banks, which can re-lend the annual inflow of money to any project purpose.

- Loans from a *revolving fund* are provided at non-market interest rates, and repayments can be used for lending to RE-investments only, making it administratively more complicated.

The "*100% debt finance" argument* in favor of a revolving fund is equally unfounded. An upfront investment subsidy makes a RE-project commercially viable and, thereby "bankable": the operating cash-flow can cover the repayment obligations on loans and provide a return on equity. Financial closure is secured in both cases! If participating banks lack funds, a credit line can be established to refinance RE-loans.

2 Subsidy Policy Objectives and Electrification Targets

2.1 Development Objectives guiding the Design of REF-Subsidies

The *development objective of REF-subsidy support* is to *assist rural transformation*. It establishes the ranking order for the development objectives of rural electrification:

1. Satisfy the productive demand for energy (economic development objective: to reduce poverty)
2. Satisfy the public institutional demand for electrification (social development impact: poverty alleviation and poverty reduction)
3. Satisfy the need for household lighting (household welfare: poverty alleviation)

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Based on the development objectives, the *key design criteria for REF subsidy policy* are to reach the following *outcomes*:

1. To maximise the productive potential of electricity infrastructure
2. To maximise the social benefits from indirect access to electricity, spreading the indirect benefits of electrification to poorer households that cannot afford direct connection to the grid
3. To get maximum new household access from available subsidy funds
4. To take regional equity into account on an objective basis

When these criteria are translated into *operational guidelines*, additional, *subsidiary design criteria* emerge. Subsidy policies and schemes must be judged by their ability to fulfill five *quality criteria*, which are:

1. Ability to promote the establishment of commercial service delivery systems, which requires to attract (a) private service providers and (b) private sources of debt and equity finance
2. Cost-effectiveness
3. Equity impact
4. Administrative ease
5. Transparent use of funds and good governance

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The first three criteria target the maximisation of the *socio-economic benefits* of subsidy schemes, the last two are general *administrative principles* with considerable economic implications.

Finally, further down *at the level of details*, relevant design issues are:

1. finding the right balance between the amount of available funding, which is used to fund the subsidies that are given directly to investments in individual RE-projects and the amount, which is allocated to general RE-support;
2. determining the cost-effective size of subsidy, which is offered to RE-projects;
3. defining "results" for RE-projects and payment criteria for offered subsidies;
4. linking results with subsidy payment in contracts;
5. designing implementation structures.

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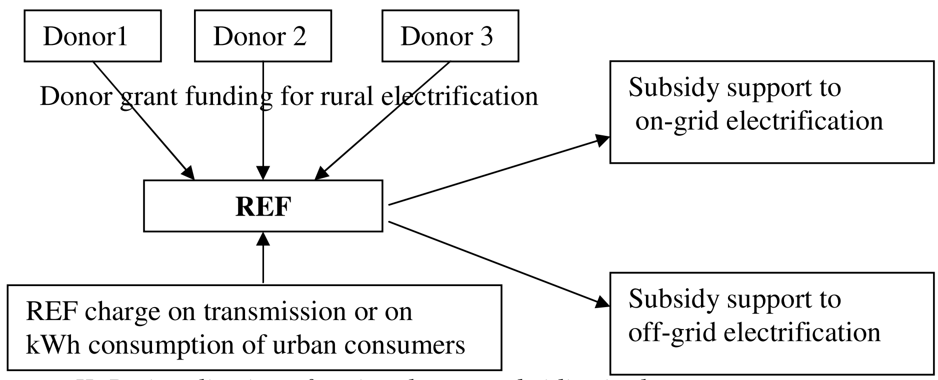
2.2 Institutional Objectives for the Creation of the REF

The function of the *REF is to provide subsidies – not loan financing to project promoters*. There are a number of reasons for this:

- Ample experience from Rural Development Banks and foreign Rural Electrification Boards proves that mixing subsidies and direct loans in one rural finance institution confuses consumers (who get conflicting signals about the cost of finance from the same institution) and the staff in the institution (split personality profile: one day "Santa Claus", the next day hard nosed bankers).
- Leaving debt financing to established financial intermediaries promotes the objective of rural electrification reform to attract private sources of capital (debt / bank lending and equity funds) to invest in rural electrification.
- It is generally acknowledged that *soft loans* are less effective per net present value of a subsidy to expand the level of investments than direct investment subsidies, and that they have distorting effects on the credit market.
- If a *refinancing facility* is needed due to the shortage of funds for long-term loans, it more efficient to created this by the Ministry of Finance and national banks in direct negotiations with international development banks and donors.
- Development of a *partial risk guarantee scheme* for loans given in support of RE-investments is a specialized discipline, which can be entrusted to the Ministry of Finance and the national banking sector.

A sub-objective for the creation of the REF is *to improve the coordination of donor assistance to RE-projects and the medium to long-term stability to the flow of donor RE-funding*.

I. Instrument for coordination and long- term commitment of donor assistance



II. Rationalization of regional cross-subsidies in the power sector

Another sub-objective is to rationalize the provision of regional cross-subsidies to rural electrification. When a national integrated power utility exists, cross-subsidies from urban to rural consumers are hidden in the schedule of national tariffs. Under a de-concentrated industry structure, cross-subsidies, such as a specific REF-charge on the transmission of electricity, are made transparent. The REF provides on-grid and off-grid RE.projects with equal access to subsidy funds, which improves the efficiency of allocating and using subsidy funds.

2.3 Definition of Electrification Access

What is meant by access to electricity?

Countries have different definitions of rural/national electrification rates. It can be[6]:

1. The *percentage of connected households*, the *household electrification rate*. If this is the primary success criterion by which progress is to be measured, the REF must support projects that enable a maximum number of new household connections to be added each year.

2. The *percentage of electrified communities*, the *community electrification rate*. It is a broad indicator of territorial electrification coverage. If it is the success criterion, the REF must support projects that get a maximum number of new communities electrified each year.

3. The *percentage of national households living in electrified service areas*, the *national electrification coverage*. It requires the REF to support projects that permit a maximum number of new households to live in electrified areas.

A subsidy policy that targets the achievement of maximum connection rates in projects requires a different design than a subsidy policy that aims at getting a maximum number of new projects implemented each year.

- It is less costly in terms of investment expenditure to target a 100% connection rate in one town, than to achieve a 25% connection rate in four towns of similar size.
- But in order to reach a "100%" rather than 25% connection rate in a supported RE-project, the average tariff needs to be lowered via the introduction of low lifeline tariffs to accommodate the affordability of the poorest households. The level of the subsidy per project must be increased.
- Since subsidies are a scarce good, the number of projects that can be supported by the available REF-funds is reduced.

The *maximization of the connection rate*, therefore, should not be the primary quantitative RE-target in countries with low electrification coverage:

- Progress in *regional coverage* is slowed down, which creates political tension.
- Targeting electrification coverage as the primary quantitative objective maximizes the satisfaction of the demand for power with the highest economic and social benefits: the *commercial productive demand for power* and the *social productive demand* from clinics, schools, public lighting and public administration.

Countries in the early RE-stage should promote *maximum electrification coverage*. This maximizes the percentage of the rural population that enjoys "indirect access to the benefits of electrification". For countries close to national coverage, the logical policy target is *electrification deepening*: the maximization of connection rates in the rural and urban service areas.

[6] In addition, there are differences of opinion about whether household ownership of a solar home systems, or at a even lower level, of a battery for lighting and radio/TV counts as electrification or as pre-electrification.

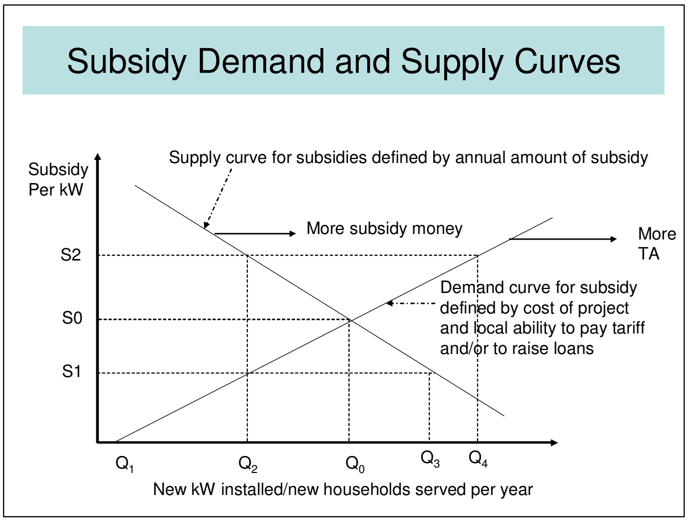
The subsidy scheme recommended in this study is based on the assumption that electrification coverage is the primary objective for the REF.

3 Subsidy Rates for Maximum Access

3.1 Demand and Supply Curves for RE-Subsidies

What subsidy rate is most likely to promote access – interpreted as the number of either new annual connections or new annual projects? The optimal mix of subsidies can be identified with reference to the demand and supply curves for RE-subsidies. The concept is shown in the "Subsidy Rates for Maximum Access" chart below.

The chart shows on the *y-axis* the *subsidy rate* expressed in terms of US$ per new connected household during the financial year. The *x-axis* shows the number of un-served households that can be connected during the financial year.[7]



The model shows that the optimal subsidy rate is defined by the position of the supply and demand curves, at the point of intersection.

The *demand curve, D*, expresses household ability / willingness to pay for electricity. If a household cannot pay the full cost of supply, a subsidized tariff is needed to get it connected! Increasingly higher subsidy rates are required if electrification through either grid connection or the provision of a SHS is to be affordable for larger numbers of households.

The *slope* of the demand curve is determined by the distribution of income. The *position* depends on (i) the population's ability to pay, which increases over time with per capita income; (ii) the cost ex-subsidy of the product (lower costs shift the demand curve for subsidies to the right); (iii) quality of service (poor service decreases demand); (iv) the marketing skills of project developers and other suppliers (turning latent wants into effective demand); (v) the local availability of the product ("keeping up with the Jones' effect"); and (vi) on the availability of credit. Thus,

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[7] An alternative way of presenting the concept is to show subsidies per project (per km of transmission line, distribution line, etc.) on the y-axis and the number of projects (or km of transmission lines, etc.) that can be implemented during the year. But since, in the end, the affordability of consumers is the limiting factor in RE, it is best to express the concept with reference to household consumers.

innovations in financial instruments that make better financing terms available to consumers or the provision of *indirect subsidies* to household electrification in the form of public promotion campaigns to increase consumer demand or in the form of technical assistance to manufacturers, etc. can shift the demand curve to the right.

The *supply curve, S,* shows, for a given annual REF subsidy budget, the relationship between the size of the subsidy rate and the number of consumers that can be given a subsidy. It's simple mathematics: the subsidy amount divided by the subsidy rate gives the number of beneficiaries. The *position of the supply curve* is determined by the annual budget for (direct) investment subsidies. The curve's intersection with the y-axis shows the size of the annual subsidy budget; the intersection with the x-axis, the total number of non-electrified rural households.

The *optimal subsidy rate is* S_1. It allows a maximum number of new consumers to get access to electricity. If the subsidy rate is set higher, for example at S_0, the limit on funding reduces the number of households that can be reached to H_0. At this level of subsidy, H_2 households ask to be electrified resulting in an unsatisfied demand of H_2-H_0. If the subsidy rate is fixed at S_2, then the subsidy budget can supply subsidies to H_2 households. But due to insufficient ability to pay of the H_2-H_0 households, only H_0 households will ask to be connected (or purchase a SHS). Some funds on the public budget line for the subsidy remain unused, less consumers are connected.

The **optimal balance** between direct and indirect investment subsidies is achieved when *the incremental cost for expanding access by one additional consumer* is the same across the technology options and supporting interventions.

Politicians define the subsidy budget with reference to inter-sectoral policy priorities. By modelling the demand and supply curves, the RE planners can support the political decision taking process providing information on the marginal costs of reaching various levels of annual connections. The politicians can compare this with their perceptions of the benefits of marginal expansions in the annual connection rate. In practice, politicians start by fixing medium to long term rural electrification targets. Planners then inform about the subsidy cost of meeting the targets, which politicians compare with budget requests from other sectors and their priorities in order to decide whether the targets are realistic, or should be adjusted.[8]

Once the overall subsidy budget has been decided politically, the *optimization process is a technical task for RE planners involving two steps*:

Step 1 is to propose the *optimal balance between direct and indirect subsidies* within the REF budget - access can be expanded through a shift of either the demand curve or the supply curve. The optimal allocation of funding is achieved, when a marginal change in the two budgets results in same horizontal shift in the two curves. Thus, when not enough projects are implemented with the annual investment subsidies, RE planners may check whether project sponsoring capabilities are too weak (increase in the budget allocation for indirect investment subsidies to TA), or, whether the ability to pay is too low (calling for an increase in direct investment subsidy).

[8] This is a slightly idealized description of the process. In most countries unrealistic targets are not adjusted. Therefore, progress in rural electrification usually lags behind the targets.

Step 2 is to identify the *optimal allocation of funds to alternative activities and products within the budgets for direct and indirect subsidies.*

- Within the budget for indirect subsidies, the division of funds between:
- – support for promotion campaigns,
- – technical assistance to reduce equipment costs
- – measures to reduce the transactions costs in financing, project planning, regulatory approval and other project implementation activities,
- – support to the preparation of local rural electrification plans and feasibility studies for national priority rural electrification projects (typically, larger regional projects identified in the indicative national rural electrification master plan).

- Within the budget for direct subsidies, between funds for:
- – support for feasibility studies and other project preparatory support versus subsidies for equipment investments.
- – Or between subsidy funds for SHS and for grid electrification investments respectively.

Table 4.1 Type of Subsidy Support that can be provided through REF-Funds

	Subsidize Investments (input)	*Subsidize Annual Cost of Operation (output)*
Direct Subsidies:	• Feasibility studies of project promoters • Rural transmission grids • Rural distribution grids • Generators in isolated grid systems • Consumer connections • Loan guarantee schemes • Solar home PV or institutional PV systems	• Cost of diesel fuel • Monthly losses on lifeline tariffs • Annual lump sum to operation based on "objective" cost parameters such as produced kWh
Indirect Subsidies	• Indicative rural electrification plans • Preparation of detailed local rural electrification plans and feasibility studies for new concession areas that are put up for bidding • Community awareness campaigns • TA to create competitive supply in rural power construction and consulting • TA to community and NGO schemes	• (Coupons for purchase of electricity provided to low income consumers)[1)] • (Payment of public lighting by state budget)[1)]

1) Countries giving such subsidies provide these through social state or local government budgets.

3.2 Combining Regional Equity with Maximum Access Policies

If the "maximum access model" is the sole guideline for subsidy policy, then only the most economic projects with the highest financial rates of return are implemented each year. The other projects are postponed to later years.

The *financial rate of return of electrification projects* is determined (i) by the cost of investment per consumer (beneficiary household) and (ii) by the level of the average demand per consumer. Since regional poverty incidence is linked to relative geographic isolation, electrification projects in poor regions are squeezed both by higher than average costs of investments and by lower than average levels of consumer demand for power. In addition, fuel costs are higher due to costs of transport. Thus, under the maximum access model, they would be the latest in line.

The issue of regional equity is inevitable and the responsible ministry/agency must define a policy for how to deal with it. Politically, the accelerated electrification of isolated rural areas may be justified on grounds of regional balance or social equity objectives, even when the economic rate of return is negative and lower than the average of proposed projects. The incidence of poverty is higher in some regions than in others, and since one ethnic group may be largest group in the disadvantaged area, lack of financial support to local electrification could easily be interpreted as ethnic discrimination.

Regional equity policy leads to the implementation of projects with widely *fluctuating levels of investment per connected consumer*. Since the benefits per consumer are more or less identical due to similar socio-economic conditions, the implemented projects have *widely fluctuating economic and financial rates of return*. Project promoters adjust for the high costs and low ability to pay of the local population by *providing extra-high subsidies* to projects located in low-income / high cost regions. This shifts the supply curve S in the "Subsidy Rates for Maximum Access" chart to the left and makes it more steep (less elastic). Less overall access is achieved.

From the point of view of *economic allocative efficiency*, the regional equity policy is undesirable. Providing the highest subsidies to the projects with the lowest rates of return results in a drain of resources away from more productive investments. But, firstly, national cohesion would suffer if concessional funding were concentrated on the faster growing regions only. Secondly, since some of the poorest regions benefit, the *social impact of regional equity policy* is positive provided that two conditions are fulfilled:

- There must be an *upper bound on the level of subsidies per beneficiary household*; otherwise the opportunity cost lost social benefits in project alternatives is higher than the social benefit from implementing the project.

- The granting of higher subsidy levels must *be based on transparent and objective criteria*; otherwise, there is an obvious risk of arbitrary intervention in the project selection process [9].

The adoption of objective quantitative criteria for handling the regional equity issue permits the REF to operate on near-commercial banking procedures in the evaluation of subsidy requests.

3.3 Targeting Subsidies: The Minimization of Free-Rider Effects

The "subsidies for maximum access chart" assumes for simplification that consumers (or projects) are paid identical subsidy rates: the rate S_1 established by the intersection of the demand and supply curves. In that case, consumers (projects) located in the lower end of the steep subsidy demand curve reap a “consumer surplus” because they get higher subsidies than needed for making access affordable to them. A subsidy rate of S_0, for example, is sufficient to get H_0 households connected. Paying the S_1 subsidy rate to their project promoters results in a "consumer surplus" equal to $(S_1-S_0)xH_0$. This is a "deadweight loss" for the REF: the “additional subsidy payment” does not expand access with one single household! The “deadweight loss” of reaching higher connection rates leads to high marginal subsidy expenditures per added household: the additional subsidy revenue needed to expand the number of annual connections from H_0 to H_1 is $((H_1 - H_0)xS_1 + (S_1- S_0)xH_0)$.[10]

In order to focus subsidy expenditures on the expansion of access, the number of "free riders" must be reduced. The deadweight loss of the REF subsidy can be minimized if a discriminatory subsidy policy is implemented, paying lower subsidy rates to projects (households) located in the lower end of the subsidy demand curve than to those in the upper end. Saved “deadweight expenditure” can finance projects located beyond the S_1/H_1 cut-off point. This is OBA.

Various approaches for targeting subsidy payments to the desired output are possible. Chapter 5 takes a look at the instruments that can be used to reduce the free rider problem in the promotion of solar home systems, SHS. Chapter 6 analyzes the options for grid based electrification.

3.4 Instruments for maximizing Connection Rates in a Service Area

At the *micro-level*, the OBA-challenge is to design tariff policies that effectively transfer project subsidies to the needy: to consumers that have an objective affordability problem.

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[9] Project promoters can always find a justification for implementing non-economic projects: strategic considerations (nearness to border), regional equity (district has low electrification rate), political (combating threat of ethnic unrest, or promoting the re-election of a local politician).
[10] See the “Incremental Subsidy Cost Curve” for solar home systems in section 5.2, page 30.

To provide electricity service to a maximum number of consumers is a major objective for any RE-program. The tools for maximizing connection rates within the service territory of a utility, often referred to as *electricity intensification,* can be divided into two major categories, listed below by declining target effectiveness.

3.4.1 Individual means-tested subsidies

Individual means-tested subsidies cover the gap between the recipient's ability to pay and the cost of supply for the service provider. The subsidy payments are linked directly to the provision of the subsidized service to the target group. In the 1990s, Russia introduced a means tested subsidy scheme to enable low-income households to pay their district heating bills, Chile for urban water supply.[11] The local municipality identifies the low-income households and their individual ability to pay[12], and pays the difference between the cost of service and the ability to pay directly to the district heating or water supply companies.

The means tested subsidy is an effective tool for raising or maintaining connection rates in established service areas, targeting a 100 percent connection rate in these. Due to its "social policy aspects", means tested subsidies are normally financed by the public budget rather than by earmarked consumer levies. A drawback of the scheme is its openness in terms of duration: it continues to be needed as long as household poverty persists unchanged.

3.4.2 The lifeline tariff

The lifeline rate is an *instrument of income redistribution*, transferring revenue from relatively rich to relative poor consumers, and an *instrument for increasing connection rates in service areas.*

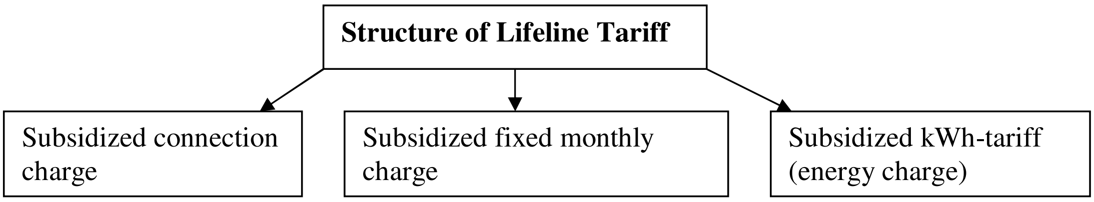
Lifeline tariffs are loss making tariffs on low-consuming customers. A lifeline tariff is composed of:

(a) a low upfront connection charge for low residential loads[13]
(b) a fixed charge (for metering, billing and other services) which, often, is set at zero;
(c) a low kWh lifeline tariff for initial levels of monthly/bimonthly kWh-consumption;
(d) a threshold level for the monthly/bimonthly kWh-consumption for which the lifeline kWh-tariff is paid;
(e) a mandatory minimum monthly consumption level, which must be paid for, whether or not the minimum quantity is consumed;

[11] The replacement of highly subsidized tariff by full economic cost tariffs led in both countries to large tariff hikes making it necessary to introduce a new mechanism to protect vulnerable households. Since connection was universal in Russia's and Chile's urban areas, the affordability of consumption – not of connection – was the issue.

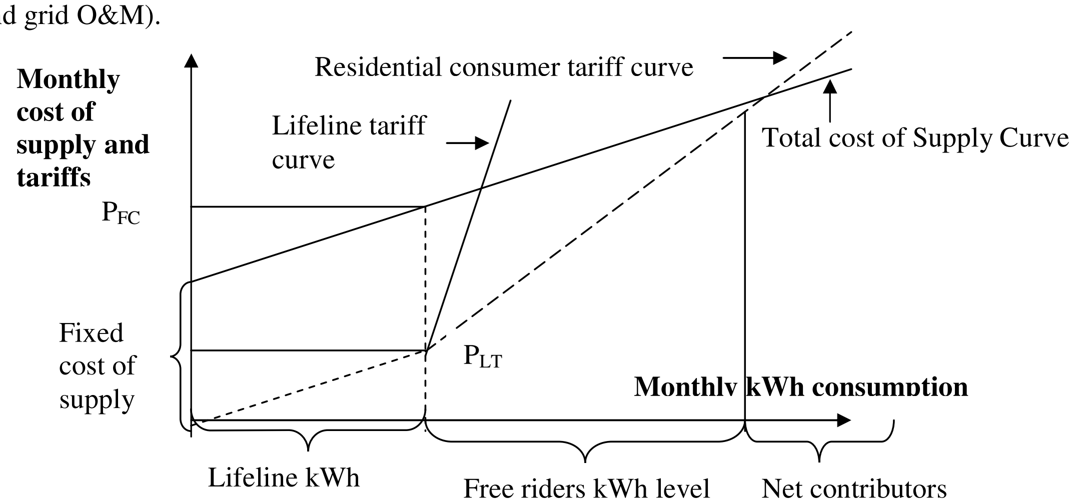
[12] In Russia, the ability to pay level for district heating was fixed at 15 percent of household income. Chile adopted the recommendation by the Pan American Health Organization that no household should pay more than 5% of its monthly income in water and sewerage charges.

[13] The effect on connection rates can be reinforced by assisting low-income households with a loan scheme for paying for the cost of their upfront internal wiring expenses.



The concept of the lifeline kWh tariff is associated often with "a low lifeline tariff for initial levels of monthly/bimonthly kWh-consumption". A low kWh-tariff, however, is not a necessary element of a lifeline tariff policy. A scheme, which subsidizes the upfront cost of household connection (line-drop plus meter) and/or the monthly fixed costs of residential supply (invoicing, meter reading, basic maintenance of line drops) through the average kWh-tariff, is a lifeline tariff scheme, even though the kWh tariff is the same for all monthly levels of residential consumption.

The chart below illustrates a monthly lifeline tariff, where only the *fixed cost* per residential consumer (for billing and invoicing, maintenance of line drop and meter) is subsidized. The *monthly fixed charge* for lifeline consumers is zero. The *kWh-tariff* for the lifeline level of consumption *equals the cost of supply of a residential kWh* (bulk energy + distribution charge for line losses, amortization of grid investments and grid O&M).



The utility charges its lifeline consumers for a minimum level of monthly kWh consumption, in this case equal to the "lifeline rate consumption range", even if consumption is less. As long as a lifeline consumer does not overstep his lifeline consumption of say, 15 kWh, he is charged P_{LT} while the full cost of supply for the utility, shown by the "total cost of supply curve", is P_{FC}.

Absolute and relative poverty criteria for fixing the lifeline rate

The *notion of the lifeline rate*, that is, the guiding principle for how the lifeline rate and the applicable consumption level are arrived at, needs to be clarified by policy makers:

The tariff can be fixed with reference to an *absolute poverty criterion* - making a “survival” level of electricity consumption affordable for the poorest sections of the population. In rural electrification the survival level of consumption would be a 15 kWh of monthly consumption corresponding to the use of three light bulbs and a small radio. The tariff would not be generous but stretch the ability and willingness to pay of the poorest households to the limit.

The alternative is to apply a *relative poverty* concept, allowing a “basic comfort” level of electricity consumption to be easily affordable for poorer households. It is judged not be socially acceptable that the share of household income to pay for electricity is higher than X%. The lifeline kWh-tariff rate can be lowered, and the upper limit for the eligible lifeline consumption level for the low tariff can be increased, to say 50 kWh per month, covering also the power consumption of a small TV, a fan and a smaller electric cooker. [14]

In both cases, the *targeted connection rate* must be defined. A 100% connection rate calls for a lower lifeline tariff level than a 60% connection rate.

The “general lifeline tariff” and “specific lifeline tariff” pricing approaches

In the *“general lifeline tariff” approach*, all residential consumers pay the same tariff for the first monthly lifeline levels of consumption. Three general versions and combinations of these exist:

1. The *connection charge* for all residential households is below the cost of connection. An alternative, non-subsidized, option is to split the connection charge into a low upfront payment and a number of monthly installments that are added to the bill until the total cost has been paid.

2. The *monthly fixed charge* for all residential consumers is zero; the total cost of supply to the utility is recuperated through the kWh-tariff.

3. The *residential kWh-tariff* increases stepwise with increasing levels of consumption.

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The “residential consumer tariff curve” shown in the chart above, is an example. The fixed monthly charge is zero and the residential kWh-tariff has two-steps: a low kWh-tariff for the first lifeline levels of kWh-consumption and a higher tariff for kWhs above the lifeline limit. Residential consumers with “high” levels of consumption are charged more than the cost of their supply (the “net contributors” in the chart). All other consumers pay a price, which is less than the full cost of their supply, meaning that also some consumers outside the lifeline consumption category are subsidized (in the chart, those with a monthly consumption in the “free riders kWh level” range).

The “*exclusive lifeline rate” approach* attempts to reduce the number of “free riders” by subsidizing only technologies that are used primarily by low-income households

[14] In some countries, the relative poverty concept has been misused, leading to grossly inflated minimum thresholds.

and/or by subsidizing only the low volumes of electricity consumption that are typical for low-income households. Examples are:

- The utility *offers its residential consumers the option of choosing to be charged either the "lifeline tariff" or the "residential consumer tariff"*. The *"lifeline tariff",* as shown in the above "lifeline tariff curve", is composed of (i) a zero fixed charge, (ii) a fixed minimum level of consumption for which the full kWh tariff is paid and (iii) a penalty kWh-price for any monthly consumption above the lifeline level. [15]. The *"residential consumer tariff"* is composed of (i) a fixed charge and (ii) an energy charge. In the lifeline tariff chart shown above, the residential tariff follows the *"cost of supply curve"*. This pricing policy is possible when the fixed monthly charge for lifeline consumers is subsidized 100% from "external" subsidies paid by the REF. Otherwise, the residential tariff is higher and cross-subsidizes losses on lifeline consumers.

- Solar home system subsidies that are given only to the small 22 Wp and 35 Wp systems (see chapter 4).

- In some countries and projects -particularly in small isolated grids fed by micro- or mini-hydro run-of-river generators, where capacity rather than energy use is the limiting factor - load limiters are used to save the cost of metering the low levels of household consumption. The consumption of the household is limited by the use of load limiters to 50W, 75W, 100W or so. Household pays a low fixed charge depending on the level of load, which increases to full cost coverage and above as the installed load increases.

    - Very basic internal wiring systems priced below-cost are installed by the utility as part of the line drop and the installment of a meter.

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3.4.3 For which circumstances are the specific instruments relevant?

The usefulness of each instrument depends on the stage of electrification.

When the *national electrification rate is low*, e.g. the case of Uganda, where only 6 percent of the national population has access to electricity, the appropriate policy is an "extensification-policy", which focuses on getting as many RE-projects implemented as possible. The policy aims to reach the "higher income" rural households that can afford to pay "full-cost-coverage" tariffs and to cover the productive and social demand for electricity. In countries at this stage of electrification, planners should be hesitant to introduce a lifeline tariff. Exceptions to this rule are energy-resource rich countries, such as Mozambique, which can attract export-oriented energy-intensive industries, due to their low-cost generation advantage.

At increasing electrification rates

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[15] The penalty reduces the incentive for consumers slightly above the lifeline tariff level of consumption to contract their supply on lifeline tariff terms.

If the objective is to reach the *poorest 40% of rural households* at least subsidy cost, the *absolute lifeline concept* would be applied in an OBA-scheme:

- The *upfront connection charge* and the *mandatory monthly minimum payment* would be set at low levels to make supply affordable for the target group.
- Assistance would be provided to finance *basic internal wiring*, for example through a loan, which is repaid to the utility by a monthly charge added to the monthly bill until the loan has been repaid.
- The *lifeline consumption limit* would be fixed at the basic survival consumption level of 15 kWh per month.

A lifeline tariff policy should be implemented through *low connection charges*, through *low or zero fixed monthly charges* and by *providing assistance in loan financing the initial cost of consumer installations*.[16] The use of *stepwise increasing kWh tariffs* is less advisable. It encourages multiple family households to install multiple meters (one for each family in the household) in order to benefit from the lower kWh rate, rather than one.

The *means tested subsidy* is an urban phenomenon, which requires a sophisticated municipal administration for evaluating individual household ability to pay and for administering the payments. It can be relevant for RE in the final "market deepening" stage when universal electricity access is expanded to include the poorest rural households in serviced areas, that are not connected to the grid, which is established in their neighborhood.

3.4.4 The basic elements of REF-subsidy strategy

The REF strategy for use of funds rests on five pillars.

1) The REF will in constant dialogue with the financial sector encourage and facilitate the introduction *new debt instruments* on the market, which can replace or reduce the need for *investment subsidies*.

2) Measures on the *supply side* (*to reduce the economic and financial cost of electricity)* and measures on the *demand side* (to *strengthen the demand for electricity)* are used in a mutually reinforcing, complementary manner.

3) The division of the annual REF-budget between funds for *investment subsidies* and funds for *general RE-support activities* is determined by the cost-effectiveness of the latter.

4) *Subsidy rates for investments in RE-projects* are set at the level, which balances the *annual demand* for investment subsidies with the *annual supply* of funds for investment subsidies.

5) Payment of *investment subsidies is performance based*.

[16] A utility can assist household consumers by onlending a loan taken from a bank to individual households.

Pillars 1 and 2 refer to measures that shift the *demand curve for investment subsidies* to the right. Pillars 4 and 5 attempt to find the optimal position on the *supply curve for investment subsidies*. Pillar 3 established the practical principle for finding the right balance between the use of REF-funds for general support activities (pillars 1&2) and for investment subsidies (pillars 4&5).

Re 3: finding the right balance between investment subsidies and support activities

An *investment subsidy* reduces the financial cost of RE for the investor, has zero – or very modest - impact on the economic cost of RE[17], and no impact on the level of future investment in RE.

RE-support activities financed by the REF improve the quality and lower the cost of financial intermediation and of construction.[18] This reduces both the economic and the financial cost of investments in RE, meaning, that a given volume of investment subsidies can finance a larger volume of RE-projects. The impact of a successful RE-support activity is long-term: the demand curve for investment subsidies is shifted permanently to the right.

The long-term benefit explains the spending priority for RE-support projects, which is established by pillar 3: the REF funds each year the economic scope for RE-support projects – all projects having a benefit-cost ratio larger than 1 are financed. What is left on the annual REF budget (after deducting the budget for the operating cost of the REF) is used to fund investment subsidies. [19]

Pillars 1 and 2: shifting the demand curve for investment subsidies to the right

The *weakness of the national capital market* is the most important "structural cost factor". Banks give 1-4 year loans only, demand a high self-financing share (50% equity) and strong collateral to accept a project. These loan conditions are not due to the specific risk of lending to RE-projects; they are enforced by the weak state of the national credit market. The outcome is an upward push on rural tariffs:

- Smaller operators use the more expensive informal loan market because they cannot comply with the eligibility conditions for accessing commercial loans.
- Limited access to loans forces RE-operators to invest in technologies with low investment and high operating costs that are not least-cost over the lifecycle.
- The mismatch between the short maturity of RE-loans and the long economic lifetime of RE investments drives up the level of RE-tariffs, because the annual cash-inflow must cover the debt-coverage requirement.

[17] The investment-subsidy makes it easier to finance least-cost technologies which are investment intensive. This reduces the economic cost of RE.

[18] Due to deficiencies in the technical and financial infrastructure for RE-projects the cost of RE is higher than it could and should be. The REF-investment grant, therefore, is partly a compensation for the cost of these inefficiencies, and partly a subsidy to overcome the barrier of low household income and the "inevitable" high cost of electricity supply in rural areas.

[19] Thus, the budget for investment subsidies = annual REF-budget minus funds for support measures minus funds for REF operating costs.

The *inadequacy of the technical infrastructure* is the second important structural bottleneck. There is a scarcity of well-trained RE-consultants, construction firms, service companies, and dealerships. The situation leads to:

- less-than-optimal choices of technology and modes of operation and
- due to lack of competition for goods and services to high input prices.

"Suppressed demand" for power is a third structural problem. Because productive, institutional and household users face financing and know-how barriers which prevent them from investing in electricity using equipment, the demand for power in RE-projects is lower than the economically rational level. The non-exploitation of potential demand for power in a service area causes the average tariff to be higher than necessary, due to the fixed costs in power distribution, consumer metering and invoicing.

Pillars 4 and 5: finding the right points on the subsidy supply curve

The last two pillars define the specific REF approach to "performance based / output-based-aid" (OBA). The objective is to design a scheme for subsidy entitlements and for disbursement of payments, which achieves the RE-target at least subsidy cost to the REF, inter alia, by reducing the free-rider-problem to a minimum.[20]

Pillar 4 lets the *demand from projects define the annual schedule of investment subsidies*. Since the level of the subsidy rates is determined by market demand and not by political preferences and beliefs about consumer affordability, no alternative approach can generate a higher level of RE-investment. Rate setting under the subsidy demand-supply approach is a technical discipline:

- At the end of a year, the REFS looks at the size of the next year's budget for investment subsidies, and estimates what average subsidy rate would reduce project demand for RE-investment subsidies to the size of that budget.
- Based on this, it sets the schedule of subsidy rates for the next fiscal year.
- The first time this is done, much guesswork is involved in rate setting as the market demand for subsidies (ability of project promoters to generate projects with the subsidy level) is not well known. During the first and the following years of operation, the REF will get to know the market through the number of project applications it receives for funding. It can, based on that information, adjust any off-market-rate to a realistic level the following fiscal year.

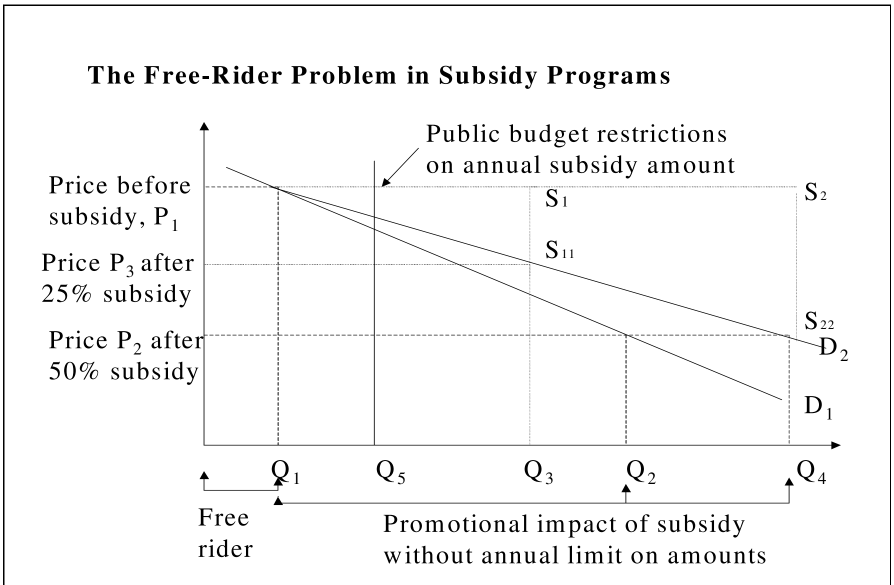
Pillar 5 establishes the principle that *payment of a subsidy should be linked to the achievement of specified goals.*

[20] Meaning that the REF pays the investor-operators no more than is needed in order to induce them to provide electricity service to the targeted number of communities and consumers. Please refer to Volume 3: "RE-Subsidy Principles. A Reference Manual, Sections 4.3 Targeting Subsidies: The Minimization of Free-Rider Effects and 5.1 The Free Rider Chart".

4 Minimization of Free-rider Effects in Subsidies to SHS

4.1 The Free Rider Chart

The objective of providing subsidies to investments in SHS is to increase sales (serviced households) in the target area, not subsidize purchases of SHSs that would be bought anyway. A *market expanding subsidy* is efficient when the percentage of "free riders" that benefit from the subsidy is low. The principle is illustrated in the chart below.



At the unsubsidised selling price P_1 of the technology, consumer demand is limited to the amount Q_1[21]. The provision of a subsidy equal to P_1 minus P_2 increases consumer demand to either Q_2 or to Q_4, depending on the reaction of consumer demand to changes in the price of the product, the so-called "*price elasticity of demand*". If demand is elastic, as shown by the demand curve D_2, product sales increase to Q_4. If demand is relatively inelastic, as shown by demand curve D_1, sales increase to Q_2.

In both cases, the number of "*free riders*" equals Q_1, the number of consumers who would invest in the product also without a subsidy. For them, the subsidy is a "free gift". When demand elasticity is high, the *promotional impact,* Q_4–Q_1, is large compared with the free rider impact, Q_1. When the elasticity of demand is low, the promotional impact Q_2–Q_1 is relatively small [22].

A further complication arises, when the subsidy amount set aside in the annual state budget is insufficient to cover total annual demand for the subsidy. In the figure

[21] Quantities on the x-axis could express annual system sales (number of units) or annual Wp sales.
[22] The policy recommendation from this is that "market pump priming subsidies" should not be used in the case of products or services having a low price elasticity of demand.

above, the budget made available for the subsidy, limits the number of benefiting customers to Q_5, which reduces the *"market expansion/free rider ratio"* to Q_5-Q_1/Q_1.

4.2 The Incremental Subsidy Cost Curve

The **incremental subsidy cost curve** is calculated by dividing the increase in annual subsidy expenditures with the number of added SHS sales (including new fee-for-service customers). The increase in the subsidy rate benefits all purchases of SHS-systems and not just the extra sales; the incremental subsidy cost curve, therefore, rises steeply. In the chart, an expansion of annual SHS-sales from Q_1 to Q_3, requires a subsidy per SHS of S_3 and a total subsidy expenditure equal to $P_1P_3S_1S_{11}$. If politicians want to expanded annual sales to Q_4 (doubling the expansionary effect), the subsidy rate must be raised to S_2, leading to additional annual subsidy payments of $P_3P_4S_{11}S_2S_{22}$. As seen in the chart, whereas the *increment in annual sales* is roughly the same for the two stepwise increases, the *incremental expenditure* of raising the subsidy rate from S_3 to S_2 is much larger than the rate increase from zero to S_3.

Sooner or later, the economic-financial cost of higher subsidy rates becomes larger than the socio-economic benefits of extra sales. When that happens, the increase in subsidy expenditure is too high to reflect national priorities.

The practical problem with calculating the incremental subsidy cost curve is that the demand schedules, in particular, the price elasticity of demand are not known at the start of the support program. Planners make assumptions about the level of annual sales and the price elasticity of demand with reference to the results of market (ability and willingness-to-pay) studies and to international experience in countries with similar characteristics. Results during implementation show whether the assumptions and policy recommendations need to be reviewed.

A numerical example from Senegal illustrates the issue[23].

The **elasticity of demand** for a product is defined (i) by the affordability of its price to consumers (*"income effect" of price changes*) and (ii) by the availability of a close substitute for the product (*"cross-price elasticity of demand effect" of price changes*). Consumers capable of paying the high upfront cost of SHS are located in the upper three income deciles. They can adjust their consumption pattern, which means that *affordability (the income effect)* is not an insurmountable problem. *Substitutes* exist in the form of small household gensets and car batteries. Gensets provide better electricity supply, but are more expensive and, therefore, an option for the very richest rural households only, who would not be interested in a SHS. Batteries provide lower service and are costly to charge. The alternatives are not close substitutes, meaning, that the substitution effect will be limited. Under these circumstances, it is not likely that the price elasticity of demand is larger (numerically) than –1 [24]. Judging from the

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[23] Example from "Senegal Energy Sector Investment Operation: Eligibility Criteria and Subsidy Levels for Financing Rural Electrification" World Bank Consultant Report, January 2001

[24] IEA/OECD estimates of the demand reaction to the 1973 and 1979 oil prices hikes were a short-term price elasticity of -0.3 and a long term price elasticity of -0.7.

experience in Kenya (more than 100,000 SHS installed within less than 10 years) and in Zimbabwe (annual sales of 6-7,000 SHS), it is reasonable to assume that a well designed promotion campaign could increase sales in Senegal to 6,000 SHS per year without subsidies, being split 70/20/10 between the 22W, 35W and 55W systems. For ease of calculation, we assume that only 35 W systems are marketed. The installed market price of a 35W system is FCFA340,000 (US$550). Let us further assume that politicians contemplate four subsidy options, ranging from 40,000 to 100,000 FCFA per installed system, see table below.

Table 5.1: Marginal Subsidy Cost Curve for 35 Wp SHS

Assumed elasticity of demand = minus 1					
Sales price of SHS, FCFA	340,000	300,000	280,000	260,000	240,000
Subsidy per SHS in FCFA:	0	40,000	60,000	80,000	100,000
Subsidy in percent of installed cost:		12%	18%	24%	29%
SHS units sold per year	6,000	6,706	7,059	7,412	7,765
Increase in sold SHS compared with zero subsidy	0	706	1,059	1,412	1,765
Stepwise marginal increase in number of sold SHS		706	353	353	353
Total annual subsidy expenditures Mill. FCFA	0	268 mill.	424 mill.	593 mill.	776 mill.
Annual subsidies divided by added customers, FCFA		380,000	400,000	420,000	440,000
Cost of subsidy per marginal customer, FCFA		380,000	440,000	480,000	520,000

Source: Model calculations

Under these assumptions, the introduction of a subsidy of 40,000 FCFA (US$65) per SHS would expand sales by 706 units and lead to annual subsidy payments of 268 million FCFA. The cost of these subsidy payments divided by the number of additionally sold units – the marginal subsidy cost of expanding the market - is 380,000 FCFA per unit, which is more than the market price without subsidies of 340,000 FCFA. That is, if it were possible to discriminate between customers, it would be cheaper for the state budget to provide the 706 units free of charge to the final users! Expanding the annual market *by 1,765 SHS* requires 776 million FCFA in subsidy payments or 440,000 FCFA (US$733) per beneficiary household! Compared with a subsidy of 80,000 FCFA per unit, the 100,000 FCFA subsidy increases sales by 353 units at a subsidy cost of 520,000 FCFA per unit!

The expansionary impact is more favorable if the elasticity of demand turns out to be numerically higher. An *elasticity of demand of –2*, leads to subsidy cost of 210,000 FCFA per added customer for the 40,000 FCFA per SHS subsidy and of 350,000 FCFA for the 100,000 FCFA per SHS subsidy.

4.3 Market pump-priming Subsidies

The above calculations of the marginal subsidy cost curve take as point of departure that sales in Senegal have reached an initial plateau of 6,000 units. This is the estimated size of the commercial market without subsidies after an intensive market campaign has been undertaken. The marginal subsidy cost curve look at the impact of increasing sales beyond this level, which can be called the "natural commercial market", that is, the demand without subsidies. The fact is that annual demand in 1999/2000, when these calculations were made, was between 1500 and 2000 units. Developers lacked the confidence in the market and the financial means – because sales volumes were low - to undertake effective promotion campaigns. This "deadlock" situation justifies the introduction of "*market pump priming subsidies*".

A market pump priming subsidy is a temporary, time limited subsidy to lift market demand to a size that is sufficiently large to permit commercial delivery structures to be developed.

The *objective* is to get the development of this "natural commercial market" jump started to a level that makes investments by the private sector in a nation-wide SHS marketing and service infrastructure commercially viable. The nation-wide presence of this marketing structure and the demonstration effect of sold SHSs ("keeping up with the Jones") will maintain a high level of annual sales also after the phasing out of the pump priming subsidy.

A *market pump-priming subsidy* for solar home systems should:
1. Have a maximum lifetime of two to five years
2. Be launched with either pre-announced *time-limits* for its duration or with pre-announced *sales targets*, after which the subsidy scheme will stop.
3. Have pre-announced *declining subsidy rates* during the subsidy period.

Making consumers aware of that the subsidy rate decreases from a specific date onwards creates psychological pressure to advance purchase decisions. This increases the price elasticity of demand. The subsidy provides a sense of urgency also on the side of SHS distributors and gives them confidence in the commercial size of the SHS market. This triggers co-financing investments by SHS distributors in marketing campaigns that reinforce the demand impact of the subsidy. The "marginal market expanding impact" of a market pump priming subsidy should be higher than the -2 assumption for the elasticity of demand, which was used in the last numeric example above.

During the *market pump priming subsidy period*, it is inevitable that the richer households pocket the subsidy, as they are the first to acquire a SHS.

4.4 Market deepening Subsidies

The “natural, without subsidies” market for solar home systems amounts to 10-20 percent of households in the off-grid areas. The objective of a **“***market deepening subsidy***”** is to expand sales to reach the poorer households also.

The existence of a “natural commercial market” for SHS requires careful targeting of the subsidy in order to get maximum expansionary impact. Three major instruments can be used to reduce the free rider problem.

1. One is *timing for the introduction of the market deepening subsidy*. Once the pump-priming subsidy has achieved the goal of creating a commercially viable level of demand for SHS, it should be abolished. After some years, when the annual demand for SHS starts to decrease due to the saturation of the “natural 15-20% market”, a “*market deepening subsidy”* can be introduced to expand access to include lower income groups. As most of the 15-20 percent of richest households have purchased a SHS by then, the free rider problem is limited.

Formateret: Indrykning: Før: 0.11 cm, Automatisk nummerering + Niveau: 1 + Nummereringstypografi: 1, 2, 3, … + Begynd med: 1 + Justering: Venstre + Justeret: 0 cm + Tabulator efter: 0.63 cm + Indrykning: 0.63 cm

2. *Maximum market expansion is achieved by focusing subsidies on the SHS that have the highest elasticity of demand* – this can be called the reverse Ramsey pricing principle for subsidy policy[25]. It is unlikely that the 55 Wp system fulfill this criterion. 55 Wp systems are purchased by higher-income consumers that that can afford TV, the small systems are purchased by poor households. Since the latter have the greatest affordability problems, their demand must be assumed to be more price-elastic. *The market deepening subsidy should, therefore, be given only to SHS that are purchased by low-income groups*. Judging from the experience of the market in Kenya, in poor countries, the free market demand, undistorted by subsidies, might result in a 70/20/10% split between the 22Wp, 35Wp and 55Wp systems[26]. Giving subsidies only to 22 Wp and 35Wp systems excludes the more well-to-do households that purchase 55 Wp systems because of their demand for TV-systems. If households need a 55 Wp system and can afford it, they will buy it, if not, they can buy a smaller, subsidized system and add an additional module at a later stage, when they do. The 35Wp and 22 Wp system should receive the same subsidy per system; if higher subsidies are given to 35 Wp systems, a strong rationale must be provided for this.

   Indirectly, the promotion of the mass market for the smaller systems has a positive effect also on the development of a service delivery chain for 55 Wp systems. The revenue from the sales of smaller systems makes the investment in setting up franchise dealerships more viable. It reduces the fixed cost of a dealer-service center per US$ of annual income.

3. Another, complementary, instrument for market deepening is to *promote the introduction of RESCO-services to off-grid areas*. Fee for service delivery makes

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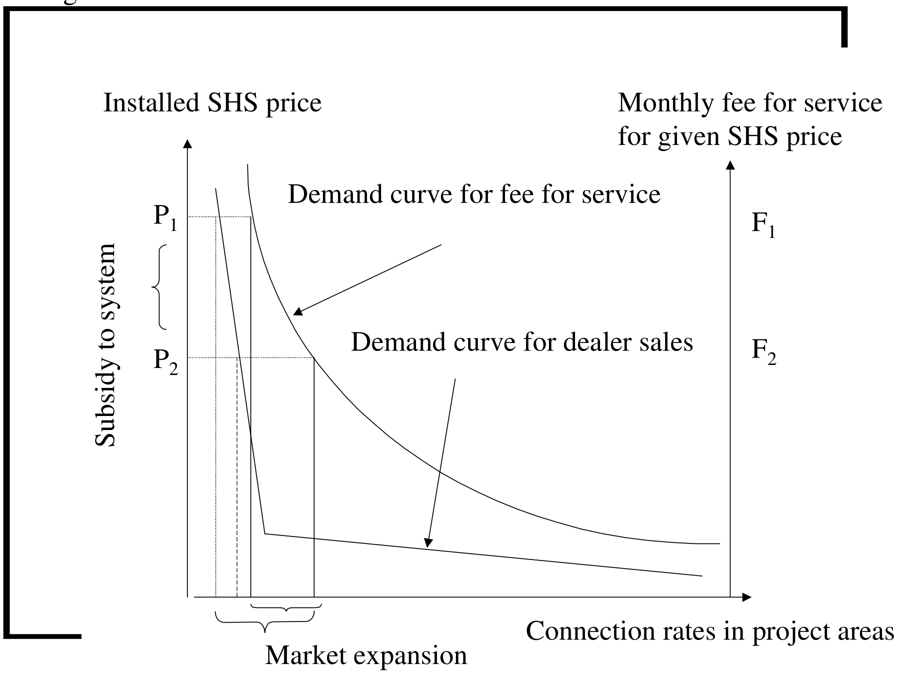
[25] The Ramsey pricing principle for taxation policy is to tax products with low demand elasticities in order to reduce the negative welfare effects of taxation (loss of consumer surplus).

[26] The precise system sizes vary. The term “22Wp system” is used generically, and can in practice refer to anything between 18Wp and 25 Wp.

PV-service accessible for a larger number of households by *(i) reducing the up-front payment of consumers* and *(ii) eliminating the need to search for a loan.* Even in the absence of a subsidy, a larger number of households can get access to electricity service. To the extent that the introduction of a RESCO service is dependent on sufficient local demand density – to justify the creation of the manpower intensive local service and billing systems, the subsidy and the RESCO service reinforce each other. The REF-subsidy could be given to 35 Wp and 22 Wp systems only.

In the figure below, the market expanding impact of the RESCO service is shown to come partly from the price effect of the subsidy on monthly payments and partly from the introduction of fee for service, which lowers the upfront cost of investment. This impact is shown in the chart by the higher market demand for fee for service for a given installed system cost, that is, by a horizontal shift to the right in the demand curve.



4.5 Subsidies to Institutional Solar-PV Systems

"Institutional PV-systems" are PV-systems used for clinics, schools, community centers, public lighting and water pumping for community supply.

Ideally, institutional systems are financed in their totality through the budgets of the Ministries of Education (school systems), Health (clinics and doctors/nurses living quarters) and Water (pumping of water for potable uses). The role of the REF and the Ministry of Energy would be to provide TA to the sector ministries for identifying least cost options and for preparing technical specifications and to keep the ministries informed about upcoming electrification projects.

Involving the REF in providing subsidy-finance for these systems is the second best option. What subsidy policy principles can be defined in this case? It can be argued that no free rider problems exist for institutional systems: it is a question of the convenience of that one public institution (the REF) rather than another (sector ministry or local government) provides (part of) the budget for the purchase. The division of institutional responsibility provides three upper limits to the subsidy rates that the REF can fix for institutional solar PV-systems:

- One is to avoid subsidy rates that distort investment decisions by final recipients, making solar PV-systems being the preferred option, when alternative technologies are the least cost option.[27].
- Another is to avoid upfront investment subsidies that tempt local communities to acquire a system, although they do not have the financial means to maintain it.
- The third is the impact on available REF-funds. The institutional PV-systems are expensive, and can swallow a heavy chunk of REF subsidies, leaving too little for supporting grid based electrification.

Otherwise, there are no deadweight losses. The savings on energy expenditure that clinics or schools make on their operating expenses can be channeled to good social-productive uses.[28] Clinics can improve their health care services, schools can purchase more educational material.

4.6 Policy Recommendations for the Design of SHS Subsidy Schemes

The first step to devise a subsidy policy for SHS is to ask politicians to define the ***politically accepted balance*** between *(a) the incremental increase in annual subsidy expenditure* and *(b) the incremental increase in market expansion.*

The next step is to *design subsidy schemes that maximize the "market expansion / free rider ratio"***.** One instrument for getting "maximum access per subsidy amount" is *appropriate timing,* using a three phased approach:

1. A first phase where a *market pump priming subsidy* is launched
2. A second phase when *no subsidies* are given
3. A third phase where a *market deepening subsidy* is introduced

At the present development of the PV-market, a *market pump priming scheme* is called for in most countries. This fits with the objectives for GEF support under "operation program 6: promotion of renewables by removing barriers and reducing implementation costs". Normal GEF-practice has been to link GEF-grant to the expansion of the solar PV-market. Typical levels of assistance by GEF have been US$2 per Wp, a subsidy rate that is time bound and declining over time.

What should not be done – but unfortunately has been done - is to encourage SHS-distributors to reduce the sales price of their SHS by US$2 per Wp. Such a policy

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[27] For example inducing purchases of solar refrigerators when kerosene powered refrigerators are cheaper to operate.

[28] The World Bank's Uganda ERT (Energy for Rural Transformation) program found that the energy bill could amount to 20-50% of operational expenses in clinics.

gives the highest subsidies to the 55 Wp system in absolute (US$-dollars) and relative (percentage of installed system cost) terms.

Table 5.2: Effect of US$2 per Wp Subsidy

	55 Wp	35 Wp	22 Wp
Installed cost, US$ per system	690	580	370
Subsidy in US$ per system	110	70	44
Subsidy in % of installed cost	16%	12%	12%

The policy is undesirable for two reasons:

- that SHS purchased by relatively richer households receive the highest subsidy is against the equity objective of the aid policy of international donors that finance the GEF;
- the US$ per Wp subsidy by not focusing its subsidy payments on the SHS with the highest elasticity of demand does not promote the maximum expansion of the SHS market[29]; this is against GEF's own mandate, which is to push maximum carbon replacement per invested subsidy amount.

GEF's interest is in the final output; market expansion, not how it is done. The REF must have the freedom to define which subsidy program can expand the domestic market most efficiently. The mass market for PV-systems in low-income countries is the 22-35 Wp market. It is the creation of this market, which GEF-funds should support. Thus, whereas GEF's annual payments to the national REF can be linked directly to annual SHS sales expressed in Wp, the REF should be given the freedom of choice to channel the annual GEF's resources to those PV-systems, where the greatest effect is achieved:

- no subsidies need to be given to 55 Wp SHS sizes and above, and
- 35 Wp systems and 22 Wp systems receive the same US$ per unit subsidy; a subsidy roughly equal to 20-25% of the system cost of a 22 Wp system is probably sufficient to make a perceptible impact on the market.

In Uganda, the recommendation was made to provide US$ 2.50 per Wp until 30 Wp and US$1.50 per Wp until 50Wp after which there is a ceiling.

[29] Neither when measured in terms of number of installed SHS nor in terms of installed Wp-capacity.

5 Design of OBA Schemes for Grid Electrification

5.1 The Concept of "Performance-based" or "Smart" Subsidies

5.1.1 Beware of slogans! [30]

The challenge for subsidy policy is *to design a scheme that uses aid in a cost-effective manner to achieve well-defined objectives*. This means to target subsidies carefully at the needy, such as:

(i) project developers trying to implement projects with high socio-economic rates of return that are not commercially viable without subsidies, or

(ii) low-income households that are unable without the subsidy to afford a service considered to be of high socio-economic value.

Subsidies that comply with this goal are in literature on the subject referred to as "performance based subsidies", "targeted subsidies" or "smart subsidies". Recently, a new annotation has come up: "Output-based Aid (OBA)". The words are different; the meaning - depending on the interpretation of "output"- is the same:

- The connotation "*smart subsidies*" refers to the need to use subsidies intelligently to support a multitude of specific goals: improvement of the supply base, reaching financial closure, reducing affordability problems, enhancing the development potential of electricity supply.
- The wordings "*performance based subsidies*" and *"targeted subsidies"* emphasize that the focus of intelligent subsidy design is on the goals that are promoted.
- As long as the term "*output-based aid"* is used to underline the "focus on targeted outcome" – defined as a subsidy scheme that links payment of subsidy to the achievement of specified well-defined outputs - the three notions are identical: a significant part of the service provider's compensation is linked to the achievement of a specified result. But, in some presentations, the impression is given that OBA as a concept refers narrowly to schemes under which subsidies are paid directly in support of "final outputs and not to inputs". We shall return to that in section 6.1.3.

[30] "Slogan-classifications" serve a useful function by flagging important issues - specific quality aspects - that must be kept in mind in the design of a scheme. Yet, when not used properly, they confuse. In this, the literature on "subsidy policies for service-provision" resembles the literature on the "practice of management", where new management gurus come and go. They present a new perspective for looking at things, which catches the attention and imagination of practitioners. Yet, while the guru has a point, he typically oversells it, presenting what is an aspect of reality as the totality of reality for the theme he is discussing. Managers who faithfully follow the instructions and implement the propose scheme, realize after implementation that they have lots of unsolved problems left, that require additional tools to be solved. That's why management fads appear, disappear and finally reappear under the guise of new names.

5.1.2 "No to operating subsidies"

For a long time, during the 1980s and 1990s, operating subsidies had fallen out of favor in the international expert community. The backbone reaction, when a subsidy scheme was being contemplated, was from the outset to reject any notion of subsidizing the cost of operation. One pointed out *three risks*:

1. *Distortion in allocation*. Badly designed schemes, for example subsidies to diesel fuel for power generation in isolated grids, lead to a deviation of subsidized fuel to uses other than power production. This increases the cost of the subsidy per generated kWh.

2. *Sustainability*. If the operating subsidy is essential for the financial survival of the project (=tariffs equal consumer ability to pay), then the sustainability of the project is at potential risk. Once the institution providing the subsidy can no longer afford it; the effect is similar to withdrawing the plug to a lifeline support in an operation room.

3. *Undetermined duration*. This is the opposite risk of the above. Subsidies are like drugs: users get addicted to it and very soon cannot imagine life without it; the public institution providing the subsidy often develops similar symptoms of addiction. Operating subsidies, therefore, tend to have a longer than necessary life, making the subsidy cost per sold kWh unnecessarily expensive.

Yet, pills exist against each of the three diseases:

- The pill against the first is to design a non-distorting subsidy scheme.
- The pill for the second is to place funds in an escrow account.
- The pill for the third is to design a scheme with a pull-out strategy, which is build-in from the start fixing the end of its duration (number of years) and letting annual subsidy rates decrease over time.

Thus, *one cannot argue rationally against operating subsidies in general*. One can argue against the implementation or continuation of a specific scheme if it has unwanted distorting side effects or is inefficient per spent subsidy-dollar in terms of desired goal achievement.

For clarity of discussion one should *define what is meant by the term "operating subsidy*":

- An *operating subsidy* is a subsidy, which is determined (i) by a specific operating cost item, such as the consumption of diesel fuel in a power generator or (ii) by the difference between annual operating costs and revenues from below-cost tariffs.

- An *investment subsidy* is a subsidy, which is determined by the size of the investment program. The subsidy can be paid (i) upfront in a number of installments until commissioning being linked to progress in construction, or (ii) as an annuity payment during operation. The fact that the annuity is paid during operation and not upfront, does not change the fact that it is an investment subsidy.

5.1.3 "No to investment subsidies, in with output-based aid"

At the end of the 1990s, the pendulum swung back: investment subsidies fell out of fashion. They were accused of being inefficient, providing support to *inputs – defined as "resources consumed in the production and delivery of an output"* - instead of supporting the output, the provision of the service, directly. The attacks brought operating subsidies back again, this time classified as "output-based aid".[31]

The case against *investment subsidies* relates to two potential weaknesses:

(i) *The lack of a direct link to service quality*. The classical example of an inefficient investment subsidy is the case, where the supported investment in construction takes place, but the intended service provision is not provided. E.g. the case of a national power company, which invests in new rural distribution lines although available power capacity in the system is insufficient to cover the demand of existing customers. Or, the telecom company, which in return for an attractive short-term monopoly position in commercial telecom agrees to invest in a rural telecom program, but provides poor service during operation.

(ii) *Clumsiness in terms of targeting*. The objective of the subsidy is to reduce the cost of service to the consumer, making access to the service affordable to a larger number of households in the service area. To do this via a general investment subsidy, which benefits "everybody" leads to high free rider effects.

Output-based-aid, as practiced in a number of countries, differs from earlier operating subsidies by not providing subsidies to the cost of operation. The subsidy is provided either directly to the targeted final recipient (e.g. by giving a purchase voucher to low-

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[31] On a discussion site at the World Bank's website, Warrick Smith & Penelope Brook summarized the concept as follows: " Traditional approaches to delivering subsidies for public services channel the subsidy—whether financed by domestic taxpayers or donors—to the inputs consumed by state-owned service providers, with at best an indirect relationship with the services actually delivered. And affordability concerns are often addressed through cross subsidies built into service prices. The results have often been disappointing. Public sector provision with soft financing frequently suffers from limited incentives for efficiency and innovation, weak accountability for performance, and limited opportunities for leveraging public resources through private sector financing. And cross-subsidies too often benefit the well-off more than the poor. Output-based aid seeks to address these weaknesses by delegating service delivery to a third party (such as a private company or non-governmental organization) under contracts that link the payment of subsidies to the outputs or results actually delivered to target beneficiaries. This approach is intended to provide a sharper focus on objectives, improve incentives for efficiency and innovation, enhance accountability for the use of public resources, and create opportunities for mobilizing private financing."

income households) or to a desired outcome, such as to the number of connected customers.[32]

It is highly useful for the designer of a subsidy scheme to understand the ideas behind the "OBA-slogan": the relevant criticism against specific features of earlier construction focused subsidy schemes. The critique provides a valuable checklist against which specific design proposals can be tested for "*result effectiveness*" (do you achieve what you want?) and for "*subsidy resource efficiency*" (do you achieve your targeted outcome with the minimum subsidy?).

5.1.4 When rhetoric meets reality

The basic idea behind OBA is sound, yet, when applying it as a guideline for subsidy policy, one must be aware of the trade-offs:

- The rethoric about output cannot change the fact that investment – an input - comes first in RE and must be facilitated by the subsidy. Shifting the subsidy from the input side (cost of investment) to the output side (delivery of services) raises the size of required upfront equity and loan finance and increases the risk of the investment. Increased project risk leads investors to add a risk premium to the equity rate of return and lenders to impose a risk premium to the interest rate for project loans.
- There are costs of micro-management: for the REF the higher administrative cost of monitoring and supervision, for project developers the cost of more extensive reporting.[33]

The above two costs of OBA are real, the higher efficiency of OBA with regard to achieving the targeted output is theoretical. As with all design issues, it is a question of finding the right balance: the improved goal achievement of an "incentive payment scheme" must outweigh its costs. In this case, the issue boils down to how risk is appropriately allocated and shared.

[32] Some proponents of OBA get carried away by rhetoric. Instead of emphasizing the "final result" aspect of "OBA", they claim that OBA pays for "outputs", whereas old-fashioned "input-based subsidies" pay for investments. This can easily confuse, for example, leading to the misinterpretation that the rural electrification subsidy should be paid per kWh-sold by the operator. A "per kWh subsidy" cannot be classified as "smart": an operator can only to a limited extent influence the size of his kWh-output! An economic upturn in his area increases power demand; a downturn decreases it. If somebody puts up a small dairy, the operator enjoys an increase in sales; whereas he loses output if the cotton mill connected to his system closes due to low international cotton prices. A per kWh subsidy thus reinforces the profits of the investor, when events outside his control turn out well, and his losses when events turn out bad. It is precisely the opposite risk sharing, which is called for PPP (Public-Private-Partnership) exercise. In a "GHG-reduction project" RE-project the annual payment for achieved CO_2-reduction is calculated directly with reference to the annual kWh-output of the renewable energy plant. The CO_2 reduction payment is not a subsidy, but payment for a commercial product.

[33] The risk is that design of performance based subsidy schemes becomes a goal in itself, instead of a cost-effective instrument to achieve goals; that the designers get carried away. A warning example of the excesses the OBA-principle can lead to is the draft contract for the privatization of the operation of the London Underground: the section on performance parameters has 1400 pages.

5.2 Type of RE-project and tariff regulation

The REF subsidizes three types of grid electrification projects:

1. *Local project developers, including CBOs*, apply for REF-subsidy support to isolated grid projects and "smaller" grid connection projects. Light-handed tariff regulation allows developers to negotiate tariffs with the local community according to the local cost of supply after deduction of the REF-subsidy. The regulator and the REF are informed about the tariff and its calculation, general rules for which may have been included in the subsidy convention.

2. *RE-utilities apply for REF-subsidy support for the extension of the distribution grid from their license area into unserved rural territory*. In some countries, e.g. Panama, the regulator expands the utility's franchise to include the new service area, extending the approved tariff schedule of the franchise to include also the new customers. In other countries, the utility may apply for a separate franchise for the grid expansion project and ask the regulator to approve a specific tariff schedule based on the cost of supply in the new service area. A case, in between the two, is Chile, where the national territory is divided into six tariff zones based on demand-density per km and topography. The regulator fixes the average tariff for each zone through model-results for efficient utility operation.[34] The tariff for a new service area is, therefore, pre-fixed by the zonal characteristics of the area.

3. The *national power planning authority*, (which can be the REF), *organizes tenders for specific RE-projects*. The tender awards the distribution & sales license and the REF-subsidy. The project can be a "*national priority" project* identified by the authority, or a *grid extension project submitted by a utility to the regulator for licensing* and for which another utility then submitted a competing application to the regulator.[35]

[34] The utilities sub-divide their average tariff into an "urban" and a "rural" tariff zone.
[35] The Electricity Law usually requires regulators to publish license requests in the official gazette. If, after a specified time period, no other investor has expressed an interest in the license for the proposed project, the utility gets the go-ahead. Otherwise, the regulator must arrange a public bid for the project.

5.3 Use of Competition to drive down Subsidy Rates

Two basic competitive approaches – with various variations - are used by REFs to establish what subsidy rates RE-projects need, and to push these down to a minimum:[36]

- *Direct competition between projects*, using the requested level of subsidy as the parameter for ranking project proposals. The REF organizes periodic calls for tenders for RE-projects using a specified quantitative criterion for ranking projects and selecting these for funding until available funds are exhausted. In countries, where this approach has been applied, the criterion has been the *lowest subsidy per connected customer*. This criterion is relevant when electricity "intensification" (connecting a maximum of households to the grid) is the key objective. For countries, in the early stages of electrification, where electricity "extensification" (getting a maximum of new areas and communities electrified) the *lowest subsidy per km of distribution line* criterion would be a more appropriate choice.
- *Indirect competition between projects* relies on the aggregate demand for limited REF-funds to fix the subsidy rate that balances the total demand for funds with the supply of REF-funds. The REF publishes once per year its subsidy rates and eligibility conditions inviting developers to submit projects for funding. Projects that attain commercial viability based on the rates apply.

Direct competition *Indirect competition between projects*

Direct competition	Indirect competition	
Selection of projects through *call for tender* by comparing the impact per $ of subsidy requested by project sponsors	Selection of projects through the ability of project promoters to get commercially viable projects established on the basis of *published subsidy levels*. The balance between demand and supply drives down the subsidy rate.	
↑	↑	↑
Project sponsors submit project proposals to REF in response to periodic call for tenders that can be organized on a regional basis. Projects are selected based on least subsidy per connected customer. In addition, the REF may identify and develop specific national priority projects and organize tenders for their licenses. The winning criterion can be the lowest asked for subsidy for project investment or the lowest subsidy per connected customer	Project sponsors submit project proposals to REF throughout the year submitting feasibility study. All projects that fulfill general eligibility criteria are funded. If the annual funds are used up, payments for "late" project proposals are postponed to next year.	REF finances feasibility studies for specific national priority projects not having a project sponsor and organizes tenders for their licenses. The investment program and subsidy entitlement is listed in the tender document. The bidding utility offering the lowest average tariff wins.

[36] This contrasts with the approach practiced in the Philippines during the 1990s, where all rural electrification projects received a 100% investment subsidy.

5.3.1 Factors that influence the choice of competitive approach

RE-projects are located at different points on the upward slope of the subsidy demand curve. Yet, the *indirect competition* approach awards the same subsidy rate to all projects: the rate; which balances demand for the investment subsidy with its supply. The *direct competition* of a tender procedure results in individual subsidy rates, that, at least in principle, should correspond to the location of each project on the subsidy demand curve. In theory, therefore, the direct competition approach should be more efficient in eliminating "free riders".

In practice, the efficiency advantage of direct competition is negligible:

- The subsidy award curve of a pluri-annual RE-program slopes upwards as the program expands into increasingly more expensive areas. Yet, in a given year, the subsidy needs for reaching commercial viability of "competing" projects are homogeneous in an *indirect competition* regime. The REF policy of "stingy" annual subsidy rates limits the range of potential projects in a year to a narrow band along the slope of the long term curve. In a given year the subsidy needs of applying projects are "clustered", and there is little potential for reducing the average subsidy rate by getting individual subsidy rates through competitive bidding.

- Project promoters in a *direct competition* regime know from the award of REF subsidies to projects in the previous bidding round, what subsidy levels they can ask for without risking to fall outside the eligible range. This results in a "clustering" of subsidy applications close to the intersection point between the demand and the supply curves for subsidies.[37]

As the two approaches produce similar subsidy levels, the choice of competitive approach can be decided on grounds of administrative efficiency and convenience.[38]

5.3.2 Fixing the tariff or the subsidy in tenders for projects?

When RE-projects are tendered, the RE-contract comprising the distribution and sales license plus the REF-subsidy for the project is normally awarded on the basis of the

[37] Chile tries to get around this problem by using financial cost-revenue calculation to fix the subsidy rates for applying RE-projects at their point on the subsidy demand curve. Based on the information provided by the feasibility study for the project, a financial spreadsheet model calculates the subsidy that is required to cover the gap between the revenue from the fixed consumer tariffs and the cost of supply. The feasibility studies prepared by the utilities, therefore, try to overestimate costs and underestimate demand, forcing the REF to use benchmarks for checking the validity of the figures.

[38] For the first year of the introduction of a REF-subsidy, the outcome may be different. Fixing the subsidy rates for the first time involves substantial guessing about how much is needed to attract investor interest, and what tariff levels rural consumers are willing to pay in practice. Therefore, some over-or undershooting of the subsidy rate may take place.

least payment required to provide the specified service. Because "least payment" is the sum of (i) tariff revenue and (ii) subsidy revenue the organizers of the tender must chose whether the *lowest subsidy request* or the *lowest average tariff* is to be the winning criteria. In the "bidding for lowest subsidy" case, the tender document fixes the tariff schedule for the project, in the "bidding for lowest tariff" case, the subsidy terms.

Program affordability and the country's level of electrification dictate the choice of option:

- In Argentina's and Chile's RE-programs (i) the unserved rural population represented 6 percent of the national population, (ii) there was huge funding available through the transmission levy to provide subsidies (in Argentina), (iii) and the 6% lived in the poorest regions of the country. Thus, it made sense in both countries to fix a tariff, which – while being higher than urban tariffs in Chile – was affordable for a majority of the unserved population in the new concession areas. RE-support, therefore, is organized as a "market deepening" subsidy. The tariff levels are fixed independent of the local cost of supply to make service affordable to a targeted minimum percentage of the local population, with the RE-subsidy covering the difference between the local cost of supply and the consumer tariff. In the RSA, the unserved population is larger percentage wise and in absolute numbers than in Chile and Argentina. But, the Government knows that the underprivileged "black" population sees the provision of housing, of jobs and of electrification as the key parameters for judging its performance. The state owned power company ESKOM has the political mandate to get the RSA 100% electrified in a few years, and has roughly US$300 million a year in RE-subsidies to do the job. ESKOM, therefore, targets 100% electrification in all new distribution areas, using a zero connection charge to achieve it.[39] In pursuing this policy ESKOM hires those constructors- developers-consultants that can do the job for the lowest subsidy per connected customer[40] and selects the projects accordingly.

- In Uganda, the unserved rural population represents 80 percent of the national population. More than 90% of the Government's capital budget is donor financed, leaving little scope for introducing generous REF-subsidies. The REF-scheme, therefore, is organized to target maximum electrification coverage: subsidy rates are fixed each year at the lowest possible level to generate enough projects to "swallow" available REF-funds. Utilities fix consumer tariffs to cover the local cost of supply minus the subsidy in the concession area.

What a REF does not want is to *politicize the tariff-setting process*. This is bound to happen *when politicians fix tariffs*. Tariff setting will be seen as a political decision and cost-reflective inter-regional differences in the level of tariff can then easily be misinterpreted as representing examples of regional political discrimination. Because the "political willingness to charge" is lower than the "consumer willingness to pay",

[39] Whether it's a brick house, a mud house or a straw house does not matter to ESKOM (it matters in Côte d'Ivoire, where only solid houses located in areas with approved town plans are electrified). Everybody gets connected as ESKOM does not want to have to go back later to connect unserved customers applying for connection – it's too expensive.
[40] Or more precisely, the lowest investment per connected customer.

tariffs will be set too low and subsidy funds be swallowed up by too few projects.[41] When the *tariff is fixed by a competitive bidding process*, there is a greater likelihood that tariff levels are accepted as being determined by "objective" factors, making tariff differences between regions more acceptable.

5.4 Promoting Private Service Delivery and Finance

The *"fixed subsidy" model* makes it easier than the "*bidding for lowest subsidy" approach* to attract private service providers to RE. The subsidy award process is simple and transparent, providing project developers with the certainty that the applied for subsidy is approved as long as all published conditions for support are fulfilled. Developers can calculate their full-cost coverage tariffs during project preparation and present these to the local population.

Leveraging public RE-funds with private finance[42] is a strategic goal of RE-subsidy schemes.[43] A 100 percent investment subsidy, which is paid upfront[44] defies that goal: no private finance is leveraged, and the control of the financial sector's due diligence project review is eliminated. This is a handicap because project promoters have few incentives to prepare realistic project proposals, once the majority of the cost of investment is subsidized upfront, the risk of financial failure is born by the REF. Therefore, as soon as a "risk threshold" is reached for the REF-subsidy's share of the total cost of investment, the REF-subsidy must be split into an "upfront payment component" and a "payment during service delivery component".

A 60 percent investment subsidy, for example, could be divided into:

- a 50% upfront payment, linked to progress in the investment program;
- the other half of the subsidy could be paid in half-yearly installments during the first five year of operation, being linked to quantitative targets for new connections or monthly kWh-sales.

5.5 Optimizing the Use of Individual Subsidy Instruments

5.5.1 Use of up-front investment subsidies

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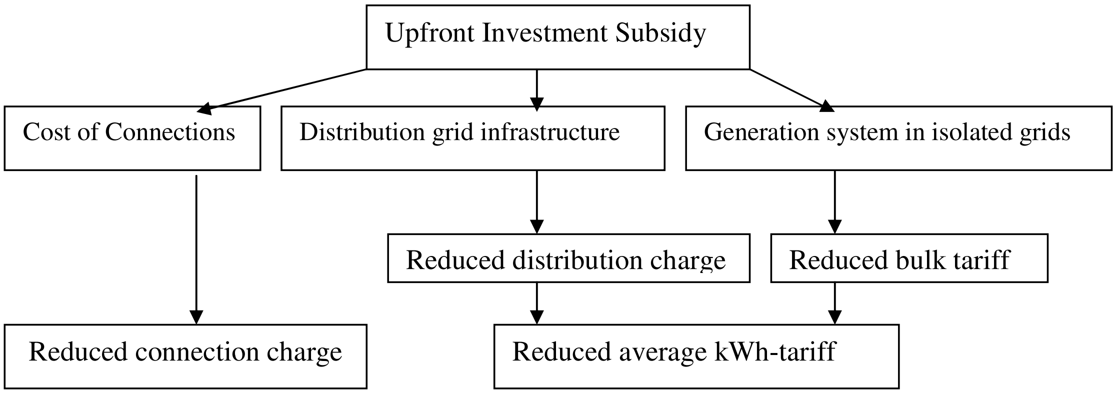
[41] The immediate instinct of politicians is to favor the "fixed tariff" option. The REF may be part of a power sector reform, which replaced the state-owned monopoly utility's national tariff system, by individual utility tariffs based on the local cost of supply of the private service provider. It is politically difficult as part of the reform process to accept differentiated tariffs that reflect the local cost of supply when these result in substantially higher tariffs being charged to the poorer rural population. There is, therefore, in the beginning, when the reform process is implemented, a strong urge to fix a tariff, which is close to the "urban" tariff, although this means that heavy subsidization is called for, making it possible to finance very few projects in a year. This position can also be influenced by the argument of planners that tariffs should be fixed based on the local population's ability to pay.

[42] Attracting additional capital to rural electrification from commercial lenders and private sources of equity.

[43] The role of subsidies as facilitator of project finance is explained in section 1.3.

[44] "Upfront" does not mean that everything is paid at "project start", but that payments are disbursed according to progress in construction during the investment implementation phase.

The upfront investment subsidy can be used to support three categories of physical investments.



The *subsidy contract* signed between the regulator/REF and the utility describes the *payment terms* and *conditions* for the award of the investment subsidy. Typically, the investment subsidy is paid in a number of installments according to progress in the investment program. The subsidy contract may include a description of the lifeline tariff policy, which the utility must implement. to ensure that a large percentage of the subsidy is used to improve the access of low-income households to electricity. Without the specific conditions in favor of lifeline consumers, a posible utility reaction, illustrated in the chart above, would be to use the subsidies "mechanically" to reduce the connection charge and the average tariff across the board. The regulator monitors that the prescribed lifeline policy is applied in practice; it will be included in the license conditions for the operator.

As an instrument for promoting rural electrification, the upfront investment subsidy has some strengths and some weaknesses.

The great comparative advantage of the *upfront investment subsidy* is its ability to *facilitate project finance and financial closure* in countries, where rural credit institutions are weak and project promoters have problems in raising equity and in offering collateral.[45]

One weakness is that once the national rural electrification program penetrates into the costly areas, the required *investment subsidy moves towards the 100% level* if reasonable connection rates are to be reached, and losses on lifeline consumers are to be financed. In off-grid projects, where diesel generation is used to supply a mini-grid, even a 100% investment subsidy, may not be enough to cover the losses on lifeline consumers. A 100% investment subsidy paid upfront destroys the objective of leveraging public subsidy funds with private investment finance. Therefore, if private finance is to participate in the co-financing of the investment and play a useful screening role in project appraisal, *a "high" missionary investment subsidy must be split into two portions*: One, which is paid *"upfront"* linked to the investment program and another *"future"* portion, which is amortized over three to five years

[45] See Volume 2, chapter 1.2:" The triple Role of RE-Subsidies"

linked to, for example, the projected number of lifeline consumers. If the connection rate grows faster than foreseen, the recipient utility receives its total subsidy amount earlier. This provides an incentive to push the connection of lifeline consumers.

The other weakness is that *the upfront investment subsidy provides no incentive for the operator to intensify the grid* by *connecting more "lifeline consumers", once the contracted numberconnections has been reached.* The lifeline revenue "per definition" is lower than the cost of supply. Regulation can provide some help – like giving consumers within X meters from the distribution line, the right to be connected; the "future portion" described above, also. But while alleviating the problem, they do not eliminate the conflict of interest.

5.5.2 The Annual Lifeline Consumer Subsidy

A powerful means to eliminate the conflict of interest *is during a specified number of years to pay the project promoter an annual subsidy per lifeline consumer*, which covers the *total loss* per lifeline consumer. [46]

Annual Lifeline Consumer Subsidy paid to the Utility

↓

Payment covers the difference between the average annual cost of supply to a lifeline consumer and the annual revenue from the tariffs charged to a Lifeline Consumer

In missionary electrification, lifeline demand represents a high percentage of annual power demand. A lifeline tariff subsidy covering the gap between the cost of local supply and the local ability to pay, can, therefore, make rural electrification projects commercially viable even in the poorest regions and, in principle, bankable. In theory, a "national lifeline tariff schedule supported financially by long-term annual subsidies from the Universal Charge" eliminates the need for an upfront investment subsidy.

The "annual lifeline consumer subsidy" has some advantages and some disadvantages.

Provided that the lifeline tariff rate is correctly structured (see section 3.2) and not too low, *the external lifeline subsidy ranks high on an OBA-scale*: being linked to consumer affordability, it promotes the connection rate objective of the rural electrification program.

The *pay-as-you-go scheme of the lifeline subsidy* matches the *structure of revenue inflow and outflow requirements* of the Universal Charge:

- The *subsidy outflow* obligation of the Universal Charge is upfront-loaded since the annual compensation payments for stranded costs are likely to be highest in the early years. The *revenue inflow* from the Universal Charge, on the other hand, grows over time, unless the kWh-charge is reduced, due to the annual growth in power demand.

[46] This is the option used in the Argentinean off-grid RE-program, see Volume 2, chapter 2.

- If subsidy support to new rural electrification projects is spread over time with at least some of the payments being made during operation, the *subsidy outflow for missionary electrification can be relatively modest in the early years*. This allows in the early years to approve more projects for funding.[47] *Over time the obligatory subsidy payments increases* due to the cumulative demand from new annual projects that require subsequent annual payments and due the increase in investment costs of new projects as electrification reaches the final very expensive stage.

In countries with weak rural financial institutions and financially weak rural utilities and project promoters, the major *disadvantage* of the annual lifeline consumer subsidy is that the investment must be 100 percent financed by equity and loans.

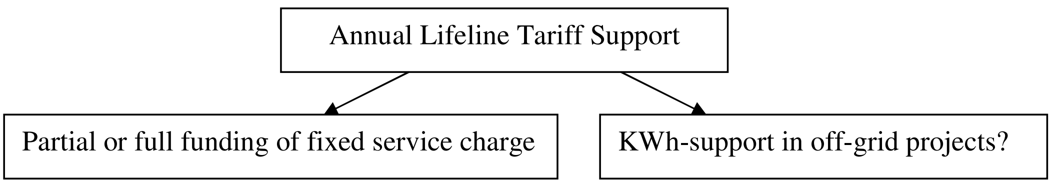
For an on-grid missionary electrification program, it is a weakness that the subsidy can not be targeted exclusively at new lifeline households, it is also *backward looking*, paying for lifeline tariffs in existing service areas. Another weakness is its *indeterminateness* in terms of *time scale* - when to end the subsidy - and in terms of *subsidy scale*: what level of lifeline tariff is appropriate and how do you avoid that the supplier overstates his cost of supply to get more subsidies? These weaknesses can generate a "generous" lifeline rate, making it an expensive means for expanding access in on-grid electrification projects.

5.5.3 Combining an "upfront investment subsidy" with "annual lifeline tariff support"

The "upfront investment subsidy" and the "annual lifeline tariff subsidy" are partly *substitutes* and partly *complementary instruments* for promoting missionary electrification.

The optimization task is to find the appropriate balance between the two subsidy instruments, exploiting the comparative advantage of each instrument and letting it play its appropriate role.

The combination of using the "upfront investment subsidy" to fund the cost of connections (line drops and meters) and an "annual lifeline tariff support subsidy" to fund the reduction in the fixed monthly charge of the lifeline tariff is a strong instrument for *maximizing the connection rates* in the service areas.



[47] Unless the NPV of the future lifeline payment support is deposited by the REF in an escrow account for the beneficiary. This security measure for the project promoter d not be necessary, where the ERC can adjust the rate of the Universal Charge upward if a revenue shortage is forecast.

The subsidy to investments in the grid infrastructure and in the generation system in off-grid projects will be paid partly upfront to enable the project to be financed and partly, to "stretch" the funding support, be paid as an annuity over a number of years.

5.6 REF-Tools giving utilities incentives to maximize connections

5.6.1 Utility disincentives for maximizing connection rates

A number of tools are available to maximize connection rates in service areas. Yet, RE-planners face the practical problem that *private utilities have little if any economic incentive to make efforts to maximize connection rates in their license areas*. Attracting lifeline consumers to the grid involves substantial administrative efforts and costs, which even though they are compensated for by higher average tariffs on full-paying consumers, may not be considered worthwhile by utility management. The "richer commercial" households and local businesses that are the driving force in developing small locally owned projects, have no economic interest in including an expansion of the planned grid to include the poorer households, if it leads to no reduction in their electricity bills.

5.6.2 Administrative and regulatory tools to maximize connections

One way of addressing the problem of insufficient utility incentives is *to take the responsibility for maximizing access and introducing access enhancing measures out of the hands of the utility*. Three examples of this are listed below:

1. In the *means-tested subsidy* approach, the utility charges all consumers, including low-income households tariffs that reflect the full cost of the service to the utility. The problem of covering the cost of providing electricity service to low-income households, who cannot afford to pay the full cost of the service, is taken care of by municipal administration is taken care of by the and the payment of subsidies to their consumption is done by.

2. The Argentinean off-grid concessions have a *dual tariff system for "lifeline consumers"*, *consisting of consumer tariffs and of utility tariffs.* The regulator *dictates "specific lifeline rates",* which the utility charges to consumers. The REF concession terms contain *annually regulated utility tariffs for its lifeline consumers that are paid to the utility for the service*.[48] The utility sends a monthly invoice to the regulator/REF to cover the difference between the two rates.

5.6.3 Use of License Conditions and the Terms of REF-Subsidy Contract to promote maximum Access

The Tender documents for the West Nile RE Project, the first project prepared under the new regime, comprise, amongst others, the draft Distribution and Sales License and the draft REF-subsidy Contract for the project, which stipulates what subsidies

[48] The original rate was established by competitive tender for the concession.

are available for the project. Rural electrification is seen as a difficult private-public-partnership task, and the package deal concept, therefore, permeates the philosophy of the License, which balances rights and obligations on a quid pro quo basis. Three safeguards ensure that Government subsidies result in higher connections.

(i) The tariff principles discussed above.

(ii) The License holder is required to present his strategy for maximizing access as one of the schedules of the license

(iii) The *five-yearly tariff revision procedure* coincides with the required *presentation by the Licensee of his five years expansion plan*. The approval process gives the regulator a potent instrument for promoting the objective of maximum access. The regulator can insist that a "lifeline" tariff structure is applied, which promotes the connection rate in a license area. The regulator can approve a higher average tariff if the licensee offers to expand his grid to connect unserved communities. The average tariff and the tariff structure looks different if the regulator is advised that investments will take place to connect an additional 20,000 low income households rather than 5,000 low income households.

5.6.4 Use of incentives to get utilities to maximize connections

The regulator/REF can abstain from dictating the terms and methods for maximizing access, but *through incentives encourage utilities to pass on most of their REF-subsidy revenue to low-income consumers and to social-education-health institutions through "below cost of supply tariffs" for these.* The utility identifies the means for maximizing access, which allows the terms to be tailor-made to prevailing local conditions. The policy does not violate the principle of cost-reflective tariffs, as the losses on lifeline tariffs are financed 100% by the "external" REF-subsidy, whereas the tariffs charged to other consumers equal the cost of their supply with no over-charging.

The REF can let the *number of connections per subsidy amount (US$) be the criteria for project selection* and tie the payment of the awarded subsidy to progress in the number of connections that are achieved.[49] The REF subsidy contract can specify the number of connections that must have been done in the project area, before the project receives the first installment of the approved subsidy amount. After this, the subsidy can be paid per additional connection and invoiced on a monthly or quarterly basis until the awarded subsidy has been fully paid. The subsidy per connection criteria for

[49] *Published subsidy rates expressed as a fixed percentage of project costs* should not be used in rural electrification. A percentage subsidy is difficult to administer because project promoters have an incentive to artificially inflate the cost budget submitted to the REF. Since this must be done in consultation with the contractors, who win the bids for the work, the REF would be required to do follow up cross checking of the submitted invoices. Either by having a data base on typical costs, by cross-checking the tax declarations of the contractors in cooperation with the tax authorities and by being represented on the bid evaluation committees. Thus, whereas the transparency of percentage subsidies is high for project promoters, the transparency of submitted invoices is low for the officers at the REF.

project selection motivates the utility to think creatively in order to qualify for subsidy support; while the payment procedure forces the utility to implemented its plans.

In *published fixed subsidy rate schemes*, *the REF* can *make the subsidy award conditional on the implementation of the plan to maximize connection rates in the service area, which is presented by the service provider in his subsidy application*. The application information material includes two other qualifying criteria: (i) a *checklist for a minimum of access-promoting terms* that must be fulfilled by the applicant, and (ii) a *minimum number of connections per US$10,000 in subsidies*, which a project must achieve to qualify for the subsidy.[50] Since countries want to promote "extensification", and not just intensification, the latter criterion can be sub-divided into two: one for project areas within 1 km of an existing distribution line, and one for those, that are located more than 1 km from a distribution line.

5.7 The Postage Stamp Rural Transmission Tariff

The "tax payer pays financing mechanism" of REF subsidies can be combined with the "consumer pays financing mechanism" of a "postage stamp" national power transmission tariff whereby urban consumers cross-subsidize rural consumption. Rural inhabitants in villages connected to the national grid are cross-subsidized directly. The other rural electrification projects benefit indirectly: the national transmission tariff eliminates the need for using REF funds to subsidize MV-lines in national grid electrification projects; therefore, more funding is available for isolated and regional grid projects.

The national transmission tariff facilitates the *establishment of small nationally owned power utilities* taking the burden of investing in subs-transmission assets off- the shoulder of these, and making the contracting of bulk supply easier. *Cost-effectiveness* should not be affected negatively by national transmission tariffs as long as grid connection projects and the transmission lines are identified by and decided on the basis of least cost expansion planning. The *equity impact* of national transmission tariffs is positive. It involves a transfer of funds from urban to rural consumers, and urban households are richer on average than rural households.

Theoretical purists may express doubts about the *economic development impact* of national transmission tariffs pointing out the risks of distorting price signals about the cost of power transport. In theory, this could lead to non-optimal location decisions for investments in energy intensive industries and in power plants. The risk is minimal. For non-energy intensive industries the price of power is not a location factor. Energy intensive industries would for other cost reasons - road transport and communication - still prefer to be located close to the major urban demand centers. The location of new power plants can be influenced by the Government through its decisions on the granting of construction permits.

[50] This measure eliminates "free riders": say a large agro-business, which electrifies residential homes of its own staff, but is not interested in expanding the electrification to include other villagers.

Lack of transparency about the size of the cross-subsidy is a potential problem, as the rural subsidies are hidden in the general transmission tariffs. The problem can be reduced by publishing estimates about the size of the implicit transfers in the annual report about the status quo of rural electrification.

6 International REF Models

	Organisation of REF	Subsidy Targets and setting of Subsidy levels	Level of local initiative	Tool to maximise Connection Rate	Regional Equity Tools	Coordination tools and priority setting	Technology neutrality
Argentina	RESCO-Concession for Dispersed Areas model Electrification program for rural dispersed population 8% of national population were unserved; the program targeted half of these (1.4 million population=300,000 private users + 6000 public services (schools, clinics, etc) Existing provincial concession areas were divided into "concentrated area market" (non-subsidised concession) and "dispersed area market" (subsidised concession). Regulatory agency organises the bidding round for the RESCO-concession and regulates it. Subsidies co-funded by provincial governments' electricity promotion funds (fee on transmission generates Electricity Promotion Fund of >US$300 M per year, of which ~$90 M is used for RE subsidy) and by national government, which assists provincial governments short of funds	The exclusive concession in the concession area is only for consumers in the lifeline rate category. Bidding won by candidate requiring lowest tariff per (lifeline) consumer (indirectly, since the rate schedules paid by consumers are fixed by the regulatory authority the bids are for the lowest subsidy per consumer). Operational (monthly) subsidy for each concession holder covering the difference between cost of supply and revenue from lifeline tariffs fixed by regulator Connection subsidy paid to concessionaire Subsidies amount to ~60% of cost of supply	Absent at village level. Subsidies are co-funded by provincial Governments funds and national Government funds Two concessions were issued to cover the need of unserved population	Subsidies are for lifeline rate (level depends on service quality) Fee for service; tariffs for minimum 4 kWh/month paid by consumers is US$10 per month Consumers must pay subsidised connection fee Connection target: >60%	National lifeline tariff The electrification program focused exclusively on the remaining underserved areas.	The Concession dictates the total coverage of communities in the area. The scope and scale of consumers to reach is defined in concession	The feasibility studies made to define concession conditions establish the least cost supply options Since concessions are for dispersed population only, grid extension is not feasible. Mini/micro-grids and stand alone systems such as solar PV-systems are the options used.

Chile	<u>Regional Infrastructure Fund with free competition model</u> Comision Nacional de Energia, CNE, main policy maker and regulatory body (giving non-exclusive concessions) ís in charge of the Rural Electrification Program (PER) RE-funds channelled through National Fund for Regional Development, which provides annual block funding to each region for a wide range of infrastructure activities. Source of RE-funds: state funds + WB/IDB loans + donor grants for renewable energy projects Project selection: Systematic application of evaluation methodology which prioritizes potential electrification investments based on (i) long-term benefit/cost analysis from both economic and financial perspectives + (ii) subsidy per consumer Distribution tariffs all over in Chile are fixed according to "objective" benchmark criteria - demand density, etc. – which divides utilities in six different tariff categories; each utility then divides its service area into two separate tariff zones	One time direct investment subsidy. No need for PER to set tariff rates as CNE has fixed tariff categories Evaluation model provided by Ministry of Planning and Coordination fixes maximum permitted subsidy level in a project = negative net present value of project for a 10% real rate of return on investment. Projects that provide the greatest number of new connections with the lowest FNDR subsidy per connection are funded in a progressive fashion until the subsidy funds for that year are exhausted. If competing utilities bid for the same project, the utility asking for the lowest subsidy gets it. Subsidy levels of 30-80%, averaging 60% of cost of investment. 1995 average subsidy per dwelling was US$1080, in 1999 US$1510. Only 6% of national population was unserved, which explains the high cost of investment (areas with difficult topography and low population density). All utilities that participated in the program had their own construction companies. Got a fiscal credit for 80% of their construction cost	Procedure for local involvement: (i) Community presents project to municipality; (ii) Municipality contracts preparation of technical proposal - normally done by local utility; (iii) Regional government selects local projects for approval by CNE and allocates additional own funds to projects as a means to qualify for additional FNDR subsidies the next year	Distribution company finances the initial user costs of in-house wiring, meter, and connection charge for line drop. The sum is repaid by users over time through a charge on their monthly bills For line extension projects tariffs for particular end-user groups are regulated, (tariffs of rural consumers about 60% higher than city dwellers). Tariffs for stand alone system not.	Central government allocates subsidy funds to regions based on (i) number of households without electricity (ii) progress achieved by region in rural electrification previous year National transmission bulk tariff	Coordination: none. The ad-hoc individual project approval – in 1999 a total of 200 projects were given subsidies gave some coordination problems in terms of sub-optimal investments	Solar home systems only supplied to 1000 consumers out of >100,000.

Guatemala	*Fideicommissum* set up from proceeds of privatisation + loans from IDB and BCIE. US$151 million for rural transmission; US$ 183 for rural distribution. Banco Mercantil de Guatemala fiduciary. *Technical Committee* (1 from Ministry of Energy 1 from INDE, 1 from distribution) oversees correct execution of investments	*Energy Ministry defined PER* (Rural Electrification Program) for 1999-2004 period. The RE-investment program for distribution and investment subsidies were included as part of the information in the tender package for the sale of 80% of the shares in the two "rural" distribution companies. An average cost of investment of US$630 per new consumer was set in Fideicommission for PER.	No information available, but local involvement seems absent	No information available	INDE, the state owned national transmission company has postage stamp tariff	Contract for construction of transmission lines signed between INDE and the distribution companies and private purchaser of distribution companies	No information available. But seems mainly concerned with grid based electrification

Panama	<u>Mixed concessions – independent projects model</u> Privatization of generation and distribution assets of the national power company IRHE, some of the proceeds used for RE subsidies *RE-Office, REO,* with 16 professionals set up as subsidy agency with *Board* of three (deputy)ministers and placed either under the *Social Fund* or under the *Office of the President*. Functions: (i) promotion (data base on project opportunities, TA to project promoters), (ii) indicative planning, (iii) subsidy award. *Trust Agent* disburses awarded funds according to phased schedule Regulation by *ENTE* (multi-sector agency).	One-time investment subsidy Tariffs are not fixed by REO. Regulation of tariffs by ENTE for grid extension projects, by contract between project promoter and consumers for isolated systems. Three subsidy award mechanism: (i) Concession put up for bidding; (ii) biannual open call for tender for project proposals, (for both: selection criteria for projects is investment subsidy per connected consumer); (iii) targeted awards for social connections (rural health clinics and schools, poor rural communities) Estimated total of 150,000 households. Goal to fund an average of 15,000 new connections per year during ten years Expected subsidy levels are >65% of cost of investment	Biannual call for tender asking for submission of project proposals.	In case of grid extension projects (regulated by ENTE), the new customers are incorporated within existing rate class of the distribution company.	(i) Regional balance promoted by rule for subsidy allocation which establishes that no province is to receive more than X% of funds and not less than Y% of funds. (ii) Targeted awards for social connections (schools, clinics, poor communities)	(i) Indicative rural electrification plan (ii) REO aggregates identified projects that are regionally concentrated into a concession (mainly tool for economies of scale: average project size for isolated systems in data base is 30 connections)	

Senegal	Rural Electrification Super-Agency model *Ministry of Energy and Mines (MIME)* subdelegates to *ASER, (Senegalese rural electrification agency)* an autonomous body, the implementing authority for RE-Action program. ASER provides (i) TA and information to project developers, constructors and consultants, (ii) follow-up technical assistance during operation, (iii) investment subsidies, (iv) guarantees and (v) refinancing facility for banks lending to RE projects. RE-concessions are prepared by ASER, concession conditions are fixed by *CRSE, the regulator*, MIME issues the concessions.	Two options are still under discussion (1) Subsidies are fixed according to specific investment items, such as km of transmission line; whereas bidding is for average tariff (2) Annual call for proposals is organised; available funding awarded to projects according to least subsidy per connected consumer Subsidy levels: 25-45% up-front investment subsidy depending on technology (grid extension, isolated grid, stand alone PV) 75% subsidies to feasibility studies for locally planned projects (subject to repayment once a project has been approved for investment subsidy)	In addition to a number of annual national priority projects (top-down planned), the concessions for which are put up for tender by ASER, locally planned projects (bottom-up planned) can apply for subsidy funds in response to bi-annual call for tender for project proposals	Local lifeline rates (Planning hypothesis for connection rates: villages >1000 inhabitants = 30-60%, 500-1000 inhabitants = 20-40%; 250-500 = 10-30%).	National state owned tansmission company, *SENELEC,* invests in rural rural transmission network (33kV and above). Has postage stamp tariff.	National Rural Electrification Plan defined by Ministry of Energy (MEMI) Based on that, ASER prepares local RE project studies which are consolidated into an annual priority investment program, which is approved by MEMI in consultation with CRSE. Projects in the program are developed into concession areas put up for tendering.	Initial idea of PASER is to design area concessions that comprise both grid based electricity as well as targets for the development of electricity service based on stand alone SHS-systems for individual consumers

Uganda	Open ended Fund, fixed subsidy model Subsidy funds in support of rural electrification projects are provided by the *Rural Electrification Fund, REF*, funded by grants from donors and a rural electrification charge on transmission. The *Rural Electrification Agency, REA*, is in charge of the rural electrification program. Subsidy request for projects are processed by REA and approved by the *REF Board*, composed of senior government, private and donor representatives, which also sets the annual subsidy levels and criteria. A *Trust Agent* disburses awarded funds according to phased schedule RE-concessions are prepared by REA but issued by *ERA, the regulator*	Based on the availability in a given year of REF funds for investment subsidies (annual REF funds minus allocations for social and technical intermediation) and the anticipated demand from project promoters for investment subsidies, the REF Board fixes the subsidy levels that are expected to balance demand and supply. Subsidy levels are fixed as US$/UGShilling per physical category of investment, such a km of MV-line, LV.line, transformer etc. They are published at the beginning of the financial year together with eligibility criteria. Expected subsidy levels amount to 35-40% of the cost of investment in a project Project promoters can apply throughout the year to RA for funding; they are entitled provided they fulfil criteria	Locally planned projects can apply for subsidy funds throughout the year REA ensures that concessions for a number of national priority projects identified in the indiciative national rural electrification master plan are put up each year for tender. But any project promoter can take on these projects at any time before they are put up for tender and apply for subsidy funds like other bottom-up projects	Although tariffs, in principle are set at the discretion of the project promoter (subject to regulatory approval), the contract for the awarding of subsidies obliges the project promoter to pass on as much as possible of the value of the subsidy as losses on lifeline tariffs	Top-down planed national prioriy projects ensure minimum coverage by region, as great efforts will be undertaken to get project promoters to undertake these Higher subsidy rates for projects located in poor regions Intensive TA to local project developers in regions falling behind		

Relevance of Argentinean Model

The *Argentinean concession model* for off-grid rural electrification is:

1. the “ultimate Rolls Royce model” for equalizing the commercial opportunities for *off-grid electrification of dispersed rural populations* with the situation for on-grid, traditional utility operation;
2. the “ultimate OBA model”, scoring high in terms of *targeting its RE-subsidies to the needed* - the poor households and institutional applications.

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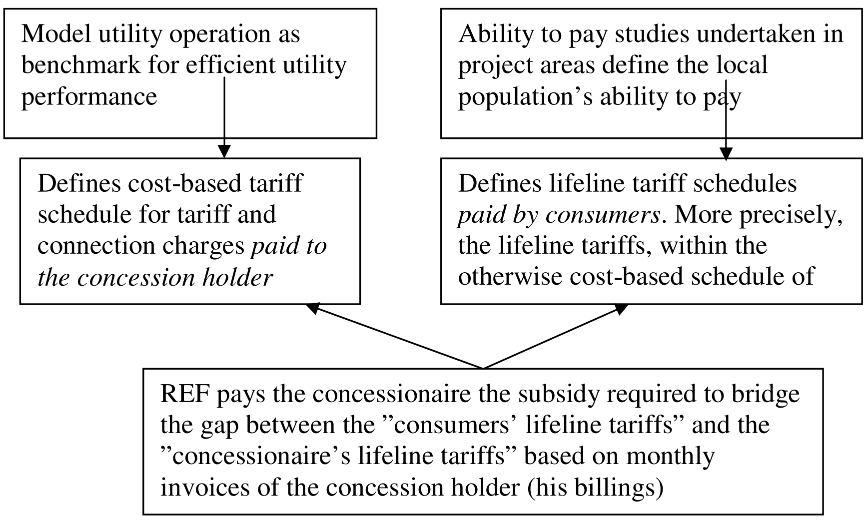
A dual mechanism is used to focus available subsidies on the target consumers:

(1) Electricity concessions in rural provinces are divided into “on-grid” areas (= commercial concession to which no subsidies are paid) and “off-grid areas” (= non-commercial concession entitled to subsidies). The size of each off-grid concession area is large enough to provide a consumer base of at least 1500 households plus public institutions and productive uses. The concession holder installs mini-grids and SHS on a fee-for service basis. Bidders can bid for both concessions areas. In Argentina, in each of the hitherto three off-grid tender cases, the utility that won the off-grid concession was identical with the one winning the on-grid concession. Due to the obvious economies of scope, this is not surprising.

(2) Subsidies are focused on reducing tariffs paid by low-income households. The Argentinean model is unique in providing not an up-front investment subsidy, but instead a current monthly subsidy for each lifeline consumer. The concession holder receives two payments for his service delivery to consumers: (i) the tariff charged to the consumer plus (ii) a monthly subsidy for each consumer in the subsidy receiving lifeline tariff category.

Argentinean Concession for Off-Grid Operations



The exclusive supply concession for the off-grid area is for supply to low-income consumers: no other service provider can ask for subsidy payments to electrification projects in the concession area. All other consumers pay full cost coverage tariffs fixed by the concession holder, and any service provider can, in principle, set up an operation in the "concession area" to supply commercial customers. The cut-off criteria for the subsidized lifeline consumer category is shown in the table below.

Exclusivity of Argentinian Rural Concessions (Subsidy Payments)

Mini-grid based electricity supply	Individual systems – SHS
• less than 24 hours service: subsidy cut-off of 50 kWh/month for household consumers and 80 kWh/month for commercial consumers.	• 8 different user tariffs depending on contracted monthly consumption, ranging from 3.75 kWh to 30 kWh. • For household consumers contracting more than 12 (30?) kWh/month and commercial consumptions higher than 25 kWh/month no subsidies are paid to the concessionaire

The difference between the "ability to pay" based tariffs paid by consumers of $10 per month (aiming at a minimum 60% connection rate) for a survival consumption of 4 kWh (in the case of SHS), and the "concessionaire's full cost lifeline tariffs" are substantial, as can be seen from one concessionaire's tariff schedule, shown in the table below.

"Concessionaire's full cost lifeline tariffs" 1999-2000

	$/month fixed charge	$/kWh variable tariff
SHS	22	1.14
Grid, 8 hours operation	38	0.27
Grid, 18 hours operation	36	0.21
Grid, 24 hours operation	41	0.21
Connection charge	$ 56	

In the Argentinean model, the "service territory" (expected number of lifeline consumers and institutional users) and the "lifeline tariffs" that the concession holder is allowed to charge consumers are fixed in the tender documents for the concession. The concession is awarded to the bidder asking for the lowest subsidy amount. Since the subsidy is the difference between the full-cost coverage tariffs (revenue) required by the service provider and the tariffs charged to lifeline consumers, the winning criterion is identical to the lowest full cost average tariff.

The Argentinean model is of interest to developing countries that (i) have well-developed financial markets capable of financing RE-investments 100% through equity and debt and (ii) are near the end of rural electrification having only the most difficult and expensive areas left to electrify. The idea of dividing concession areas into "commercial" and "non-commercial" is being attempted in other countries, e.g. in Ghana (the concept as yet still under-developed) and in the Philippines, where non-electrified "off-grid" areas are taken out of existing concessions and offered to private developers and to community initiatives.

Relevance of Chile's PER (Rural Electrification Program)

Chile's rural electrification program scores high in terms of local involvement in setting priorities for rural electrification and for using objective criteria to satisfy regional equity considerations. The program has six distinguishing characteristics.

(i) *Local authorities are deeply involved in the project identification and selection procedure*. Project selection is a staggered process. (a) It starts at the district level with the identification and selection of projects (where local authorities get the local utility or a consultant to prepare the feasibility study for a local electrification project). (b) Next, the provincial level authorities decide which district proposals are forwarded to national level for approval of financing. When the annual subsidy fund available for the Province is exhausted, the remaining project proposals are rejected, but can reapply the next year. (c) Finally, the national program administrators decide between the projects forwarded by the Provincial authorities – or rather check that conditions are fulfilled for the financing of each project by the Provincial authorities. At each level, the selection is done "objectively" based on the modelling of economic benefits.

(ii) *Subsidies for rural electrification are co-funded by the "pure" rural electrification funds and the general infrastructure funds* (the National Fund for Regional Development) that are allocated from the national budget to local authorities. Regional equity is promoted by using objective criteria such as under-electrification to distribute annual RE-funds to individual provinces. The willingness of a Province to co-fund rural electrification projects with general infrastructure funds is an additional criterion for determining the size of RE-funds.

(iii) *The selection of projects for subsidy support is done on the basis of the lowest subsidy per connected customer*. Projects that provide the greatest number of new connections with the lowest subsidy per connection are funded in a progressive fashion until the subsidy funds for that year are exhausted.

(iv) The planning authority uses *a standard financial analysis model to calculate the maximum subsidy entitlement* of the project. The model uses the estimates of the project feasibility study about the costs of supply and the expected levels of demand during a 15-20 years period. The cash-flow - including the revenue from the subsidy - is to give the investor a 10% rate of return on the investment. The maximum awarded subsidy, therefore, is equal to the negative NPV of the project (cash flow without subsidy). The avoids the potential problem of over-investment caused by the "subsidy per connected customer" criterion. The marginal cost of adding an additional customer in a grid based system is lower than the subsidy per customer, which the utility will receive. If there is no upper limit on the total subsidy a project can receive, it pays to connect 100% within the area of the distribution line even though the utility knows that many customers will be disconnected later, due to non-payment of bills.

(v) *The service areas of utilities are classified by the regulator in Chile into six different tariff zones based on objective criteria such as demand density per km of line.* The individual cost of supply of the utility does not determine its tariffs. A benchmark efficient utility model is used to calculate what the efficient cost of distribution ought to be for each of the six categories. The utilities themselves sub-divide their own tariff area into two tariff zones - such as "urban" and "rural"; the urban tariffs being below and the rural tariffs being above the average tariff for the zone. Thereby, Chile avoids the problem found in most countries that the "bidding for lowest subsidy per customer" method requires that the tariff schedule is fixed in the tender documents. The political willingness to charge being less than consumer willingness to pay risks leading to a serious problem of "politization" of tariff setting.

(vi) *The absence of any use of a national rural electrification master plan*. There was no great need for a master plan. 40% of the rural population was unserved at the start of the program. But since the rural population equaled only 15% of the national population, the unserved population was only 6% of the national population and, furthermore, was concentrated in a few provinces. Despite this fact, regional rural electrification plans may have made sense: the stepwise implementation of investments led to some loss of economies of scale and to some sup-optimal location of sub-transmission systems. This increased the cost of follow-up extension projects making them higher than necessary.

A further interesting aspect is the *role of competition* in the Chilean model:

1. *Direct competition between utilities for bidding on a project proposed by a local authority was rare*. In 1999, only 10 out of 200 projects attracted more than one bidder, and of these the incumbent - the utility having its distribution grid nearest to the project, which usually had prepared the feasibility study - won eight of the projects. If Beaumol's "contested monopoly theory" is to be believed (threat of entry preventing monopolists from going for full monopoly rent extraction), the potential threat of competition should have had a downward effect on the level of subsidies that the utilities demanded in the 190 non-contested projects. Yet, the Provincial authorities noted that the utilities in their feasibility studies were overstating the cost of investment and under-estimating demand in order to squeeze out as high a subsidy entitlement as possible (high negative NPV). The authorities, therefore, increasingly used standardized cost assumptions to check the cost of investment estimates made in the feasibility studies.
2. *The introduction of (i) investment subsidies for RE and of (ii) competition for RE subsidy funds had a strong impact on the willingness of utilities to undertake RE projects*. Utility managers indicated that the short and medium-term income from rural electrification projects is marginal; the expected returns from the projects were not the primary motivator. Utilities bid to gain service territory and to forestall potential competitors from gaining access.

Favorable *tax write-offs for investments* and the *revenue from construction* – the distribution utilities in Chile have their own construction departments – were additional strong motivators for the utilities.

The experience of Chile is relevant for countries with a well-developed federal structure – such as Nigeria. But it requires a very sophisticated local and regional planning structure. One should also note that the process for project selection takes time: two years from the time a feasibility study is contracted until a project isd approved for funding.

Relevance of Senegal's ASER (Rural Electrification Agency)

Rural electrification in Senegal will be orchestrated by a newly created, politically autonomous apex institution, ASER, that will provide technical and business development assistance, determine subsidies and RE tariffs. Projects will be proposed by beneficiary communities and by ASER. All RE assets will be owned and operated by the private sector. Financing will be managed entirely through local commercial banks. A Rural Electrification Fund managed by a local commercial bank will provide short-term commercial credit at prevailing interest rates, long-term loans at fixed nominal interest rate, and a subsidy, the exact mix of which is determined by ASER.

At the time of this writing, the final subsidy scheme has not been fully decided on. One option, based very much on the Chilean experience is for ASER to set tariffs for each project to cover costs and provide a reasonable return. Another is to fix the subsidy and to let bids for concessions be determined on the basis of the lowest tariff.

An interesting – and challenging – aspect with Senegal's PASER (national rural electrification program) is the intention to design area concessions that comprise grid based electricity as well as targets for the development of electricity service based on stand alone SHS-systems for individual consumers. This aspect of Argentina's "disbursed population concession" is unusual for a country at an early stage of rural electrification: only 4% of rural dwellers have a connection.[51]

Another interesting aspect is the role played by the state-owned national transmission company, SENELEC, in extending a 33 kV rural transmission grid. Normal practice in recent Electricity Laws seen elsewhere is to define anything below 132 kV (or 66 kV) as "distribution" (lines between 11 and 66kV are referred to as "sub-transmission grid" or "transport lines"). Whether the consequence is intentional or not - the national power sector and rural electrification strategy is silent on the motive - letting SENELEC invest in the 33 kV grid has the impact of encouraging entry of *national project promoters* and of discouraging entry of *international project promoters*. The lower overall investment requirement makes it easier for local investor to raise the necessary capital for distribution grid. For international investors, which need sufficient scale to recuperate their larger overhead costs and make entry into the market worthwhile, it preempts a revenue-generating investment opportunity.

[51] Bolivia, though has some demonstration experience with the involvement of the Sta. Cruz Electricity Cooperative (one of the three largest distribution utilities in Bolivia) in providing SHS on a fee-for-service basis to disbursed rural consumers within its concession area.