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Results-Based Financing for Off-grid Energy Access in India

Prospective case studies for the Energy Sector Management Assistance Program, World Bank

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A study on Economic Opportunities for Results-Based Financing.

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The views expressed in this report are those of the authors and do not necessarily reflect the views and policies of the Council on Energy, Environment and Water.

The Council on Energy, Environment and Water (CEEW) is an independent, not-for-profit, policy research institution. CEEW works to promote dialogue and common understanding on energy, environment and water issues in India, its region and the wider world, through high quality research, partnerships with public and private institutions, engagement with and outreach to the wider public. For more information, visit http://www.ceew.in.

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EDITOR'S NOTE

This paper was prepared by the Council on Energy, Environment and Water for the World Bank-administered Energy Sector Management Assistance Program (ESMAP). ESMAP is a global, multi-donor trust fund, which aims to assist low- and middle-income countries to increase know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth.

Results-Based Financing (RBF) approaches are becoming an increasingly popular way to support development objectives and wider public policy goals. The fundamental idea of RBF approaches is that payments that would otherwise be made automatically are made contingent on delivery of (a) pre-agreed result(s), with achievement of the results being subject to independent verification. RBF approaches have been pioneered in the health sector[1] but there has been increasing interest in whether and how they could be used within the energy sector or for climate mitigation activities,[2] and especially on how they may promote private sector investment in low-carbon energy sector opportunities.[3]

This paper will be published as part of a longer report (hereinafter referred to as the "main report") on Results-Based Financing (RBF) prepared by Vivid Economics, titled "An analytical guide to support Results Based Financing approaches". Case studies for the main report, which use the analytical framework for real world applications towards energy access solutions were written by the Council on Energy, Environment and Water (for South Asia) and GVEP International, and Climate and Energy Solutions (for Africa).

More of CEEW's research and publications on sustainability finance are available at: http://ceew.in/susfinance.

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1 See, for instance, http://www.rbfhealth.org/rbfhealth/

2 Ghosh, Arunabha, Benito Müller, William Pizer, and Gernot Wagner (2012) "Mobilizing the Private Sector: Quantity-Performance Instruments for Public Climate Funds," *Oxford Energy and Environment Brief* (August), accessible at http://www.oxfordenergy.org/wpcms/wp-content/uploads/2012/08/Mobilizing-the-Private-Sector.pdf .

3 ESMAP (2012) *Results-based approach in the Energy Sector: learning event*.

ABOUT CEEW

The Council on Energy, Environment and Water is an independent, not-for-profit policy research institution. CEEW addresses pressing global challenges through an integrated and internationally focused approach. It does so through high quality research, partnerships with public and private institutions, and engagement with and outreach to the wider public. In June 2013, the International Centre for Climate Governance **ranked CEEW 15th globally** in its first ranking of climate-related think-tanks and **number 1 in India**.

In under three years of operation, CEEW has: published the 584-page National Water Resources Framework Study for India's 12th Five Year Plan; written India's first report on global governance, submitted to the National Security Adviser; undertaken the first independent assessment of India's 22 gigawatt solar mission; developed an innovation ecosystem framework for India; facilitated the $125 million India-U.S. Joint Clean Energy R&D Centre; worked on geoengineering governance (with UK's Royal Society and the IPCC); created the Maharashtra-Guangdong partnership on sustainability; published research on energy-trade-climate linkages (including on governing clean energy subsidies for Rio+20); produced comprehensive reports and briefed negotiators on climate finance; designed financial instruments for energy access for the World Bank; supported Bihar (one of India's poorest states) with minor irrigation reform and for water-climate adaptation frameworks; and published a business case for phasing down HFCs in Indian industry.

Among other initiatives, CEEW's **current projects include**: developing a countrywide network of renewable energy stakeholders for energy access; modelling India's long-term energy scenarios; supporting the Ministry of Water Resources with India's National Water Mission; advising India's national security establishment on the food-energy-water-climate nexus; developing a framework for strategic industries and technologies for India; developing the business case for greater energy efficiency and emissions reductions in the cement industry; and a multi-stakeholder initiative to target challenges of urban water management.

CEEW's **work covers all levels of governance**: at the global/regional level, these include sustainability finance, energy-trade-climate linkages, technology horizons, and bilateral collaborations with China, Israel, Pakistan, and the United States; at the national level, it covers resource efficiency and security, water resources management, and renewable energy policies; and at the state/local level, CEEW develops integrated energy, environment and water plans, and facilitates industry action to reduce emissions or increase R&D investments in clean technologies. More information about CEEW is available at: http://ceew.in/.

ABOUT THE AUTHORS & THE PROJECT COORDINATOR

Vyoma Jha

Vyoma has been a Junior Research Associate at the Council on Energy, Environment and Water (CEEW). Her role involves providing research and legal analysis for CEEW's ongoing projects on: governance of geoengineering, governance of climate finance, integrated energy-environment-water policies, and climate change and business leadership. Her areas of interest include climate change law and policy, trade-investment-climate linkages and sustainable global governance.

Previously, she was selected as the NYU International Finance and Development Fellow and worked at the International Institute for Sustainable Development (IISD) in Geneva. At IISD, she worked with the Investment and Sustainable Development Program on recent developments in international investment law and policy. She also contributed arbitration analyses and journalistic reports for Investment Treaty News, a quarterly journal published by IISD. In addition, she was involved in the management of the Fifth Annual Forum of Developing Country Investment Negotiators held in Kampala, Uganda from October 17-19, 2011.

In India, Vyoma has done a judicial clerkship at the Supreme Court of India with the Honorable Justice V.S. Sirpurkar, where she worked extensively on matters of constitutional law, environmental law, human rights, arbitration and judicial reforms. She has a varied work background with internships at The Energy and Resources Institute (TERI), an environmental policy and research organisation; Economic Laws Practice, an international trade law firm; and the Competition Commission of India.

Vyoma holds an LL.M. in Environmental Law from New York University's School of Law. She graduated with a B.A. LL.B. (Hons.) degree from National Law University, Jodhpur (India) with a concentration in International Trade and Investment Laws. She is admitted to the Bar Council of Delhi, India. She is fluent in English and Hindi, and speaks French at an intermediate level. She is an avid photographer and film enthusiast.

Rishabh Jain

Rishabh Jain is a Research Analyst at the Council on Energy, Environment and Water (CEEW). At CEEW Rishabh focuses on renewable energy policy, technology and applications, with a keen interest in developing solutions that deliver improved energy services to the poor. He is a graduate in Mechanical engineering from Birla Institute of Technology, Mesra, Ranchi. Shortly after his internship in 2010 at the Indian Institute of Science, Bangalore, he published an international research paper on the variation of solar insolation in India. The research provides assistance to analyse and find the best locations in India for harnessing this renewable energy. During the summer of 2011 he worked as a fellow at a start-up ONergy. He visited various villages in West Bengal to undertake surveys and assess the local dynamics. In 2010-2011 he was selected for the Tata Jagriti Yatra where he, along with 400 youths, travelled for 18 days in a train across India to meet change makers of society. He is a recipient of the "Swami Vivekananda Pratibha Samman 2012" awarded by Vikas Bharti, Bisnupur as recognition for his work in the social sector.

Arunabha Ghosh

Arunabha Ghosh is CEO of the Council on Energy, Environment and Water (CEEW), an independent, policy research institution in India. He conceptualised and established CEEW (http://ceew.in) with a mandate to address pressing global challenges through an integrated approach. With experience in thirty countries, Arunabha's work intersects international relations, global governance and human development, including climate, energy, water, trade and conflict. He advises governments, industry and civil society around the world on: climate governance (financing, R&D, geoengineering); energy-trade-climate linkages; energy and resources security; renewable energy policy; water governance and institutions; and international regime design.

Dr Ghosh is also associated with Oxford's Global Economic Governance Programme and its Smith School of Enterprise and the Environment. Previously Global Leaders Fellow at Princeton's Woodrow Wilson School and at Oxford's Department of Politics and International Relations, he was also Policy Specialist at the United Nations Development Programme (New York) and worked at the World Trade Organization (Geneva).

His publications include: *Understanding Complexity, Anticipating Change* (India's first ever report on global governance, submitted to the National Security Adviser); *National Water Resources Framework Study* (for India's Planning Commission); *Governing Clean Energy Subsidies* (for Rio+20); *Laying the Foundation of a Bright Future* (on India's national solar mission); *Institutional Reforms for Improved Service Delivery in Bihar* (on irrigation reform); *Harnessing the Power Shift* (on climate finance); *International Cooperation and the Governance of Geoengineering* (for the Intergovernmental Panel on Climate Change); and three UNDP *Human Development Reports*. Arunabha has worked on trade governance for many years and led research on intellectual property, financial crises, development assistance, indigenous people, extremism and violent conflict.

Arunabha has presented to heads of state, India's Parliament, the European Parliament, Brazil's Senate, the Andhra Pradesh Legislative Assembly and other legislatures; hosted a documentary on water set out of Africa, honoured at the Webby Awards; written columns in many newspapers; and commented on radio and television across the world. He co-chaired work on geoengineering governance for the UK Royal Society; is a member of three track II initiatives with Israel, Pakistan, and the United States; and sits on the Governing Board of the International Centre for Trade and Sustainable Development, Geneva. In 2011, Asia Society named him an *Asia 21 Young Leader*.

Arunabha holds a doctorate and M.Phil. in international relations from Oxford (Clarendon Scholar and Marvin Bower Scholar); an M.A. (First Class) in Philosophy, Politics and Economics (Balliol College, Oxford; Radhakrishnan Scholar); and topped Economics from St. Stephen's College, Delhi University. He lives in New Delhi, India and speaks English, Hindi, Bengali and basic Spanish.

EXECUTIVE SUMMARY

Case study 1

Despite high solar radiation, the deployment of solar hot water (SHW) systems is well below potential in India. To the extent that SHW systems have been deployed, they mostly remain limited to areas where regulation demands it. Even though various central and state-level government subsidy schemes have rendered the capital costs of SHW systems affordable, the uptake of SHW systems among urban residential users remains low. The policy objective at the heart of this case study is therefore to increase deployment of SHW systems in urban residential buildings.

There are four key challenges that currently hold back the deployment of SHW systems: first, declining product quality due to cost pressures; second, high transaction costs in securing subsidies; third, and partly underpinning the second factor, multiple actors and unclear governance with regard to subsidy schemes; fourth, the absence of an incentive to expand markets due to insufficient regulation and a lack of awareness among customers.

An RBF mechanism could be used to incentivise vendors of SHW systems to potentially reach a wider customer base in urban residential areas, while overcoming some of the challenges currently facing their deployment. It would serve as an added motivation to move away from a business-as-usual scenario.

The RBF could target both SHW deployment in greater numbers *and* among new categories of customers in urban residential buildings. It could offer performance bonuses for reaching poor customers, low-income neighbourhoods, or retrofitting older buildings, with a pay-out structure based on exponentially rising bonuses for reaching higher shares of the target market. While it does not seem necessary for the principal to procure systems, it has to ensure that credible monitoring and verification arrangements are in place. Finally, an exit strategy could be based on a fixed time schedule, on reaching a stipulated number of customers, or on a combination of both. Penalty clauses could be introduced for less than satisfactory outcomes to reduce risk for the principal.

Case study 2

This case study considers the extent to which RBFs could support innovation across the energy access supply chain. On the one hand, research into new business models (the ‘software’ of the energy access supply chain) may offer the opportunity to roll out existing renewable energy technologies for uses beyond home lighting and into more productive uses; on the other hand, research and development into energy access technologies (the ‘hardware’ of the energy access supply chain) might yield new or more efficient energy access technologies. There is, however, little work in developing and scaling up new business models that might allow for the wider application of existing technologies. In addition, there are few incentives to encourage sustained investment into energy access technology R&D. The policy objective for this case study is therefore to incentivise technological R&D and/or to support business model innovation to increase energy access via off-grid renewable energy.

There are three key problems that are holding back R&D and business model innovation: first, even though there are some opportunities for technological improvements in energy storage and energy efficient appliances, there is little research capacity, investment, or indeed interest among large firms to capitalise on these opportunities. Second, existing customers are unhappy with poor quality systems; consequently few are willing to take the risk of taking a loan or spending their savings to cover the capital costs of solar home systems (SHS). Third, while business models based on variable usage payment schemes are trying to overcome the twin challenges of poor servicing and maintenance and high upfront costs, they are facing limitations in how rapidly they can be scaled.

As indicated above, this case study investigates the use of RBFs for the following three purposes:
Increase R&D and innovation in energy storage technologies
Increase R&D and innovation in energy efficient appliances
Support innovation in business models

The conclusion of this case study is that, while RBFs do not seem like a good option for the first two, there is an opportunity to use an RBF to encourage innovation in business models that offer better servicing and maintenance and variable usage payment options to the customer.

Such an RBF could support variable usage payment business models, defined as those that offer pay-per-use options to the customer, supplemented by better servicing. Such business models stand a good chance of widening the total customer base for, and expand the scope of, innovative energy access technologies. The RBF would work as an interest-free loan that is disbursed to the system vendor upon sale of the system to a customer. If the cost of the system is split into a down-payment that the customer pays upon sale, and a remainder that the customer agrees to pay as he or she uses the system (effectively the remaining investment of the vendor, which he or she hopes to recoup as the customer uses the system), then the RBF interest-free loan could be set as half of the remaining vendor investment. This would reduce the risk that the vendor carries, allowing him or her to scale up volume and sales.

1. Solar Water Heating in South Asia

An RBF incentive for rolling out solar water heating in India

PROBLEM STATEMENT

- **Despite high solar radiation, deployment of solar hot water (SHW) systems is well below potential.**
- **To the extent SHW systems have been deployed, they remain limited to areas where regulation demands it.**
- **Even though the presence of central and state-level government subsidy schemes has made capital costs of SHW systems affordable, the uptake of SHW systems among urban residential users remains low.**
- **The policy objective is to increase deployment of SHW systems in urban residential buildings.**

KEY CHALLENGES

- **Declining quality due to cost pressures**
- **High transaction costs in securing subsidies**
- **Multiple actors and unclear governance with regard to subsidy schemes**
- **Little incentive to expand market thanks to insufficient regulation as well as lack of awareness among customers**

WHY THERE IS A CASE FOR RESULTS-BASED FINANCING (RBF)

An RBF mechanism could be used to incentivise vendors of SHW systems to potentially reach a wider customer base of urban residential areas, while overcoming some of the challenges currently facing their deployment. It would serve as an added motivation to move away from a business-as-usual scenario.

WHAT TO TARGET USING THE RBF MECHANISM

- **SHW deployment in greater numbers *and* among new categories of customers in urban residential buildings.**
- **Performance bonuses offered for reaching poor customers, low-income neighbourhoods, or retrofitting older buildings.**
- **Pay-out structure based on exponentially rising bonuses for reaching higher shares of the target market.**
- **Principal does not need to procure systems but has to ensure credible monitoring and verification.**
- **Exit strategy could be based on fixed time period or reaching a stipulated number of customers. Penalty clauses could be introduced for less than satisfactory outcomes to reduce risk for the principal.**

This case study is aimed at increasing the deployment of solar hot water (SHW) systems in urban residential buildings. It begins by analysing the problems present in the market for SHW systems in India and, proposes the most appropriate RBF design to achieve the desired policy objective.

Photo 1.1: Installed SHW system in a rural home in Udupi district, Karnataka

Photo courtesy: Arunabha Ghosh

1.1 Introducing the challenge

Multiple factors adversely affect the deployment of solar hot water systems in India

1.1.1 Overview of the current market situation

Before proceeding to analyse the problems that exist in the market for SHW systems in India, it is important to highlight some preliminary observations. The potential for deployment of SHW systems is believed to be high, as water heating comprises a significant share of the total energy consumption of a residential building. Currently, India has about 5.83 million square metres (m^2) of collectors installed, 80 per cent of which are installed in residential buildings.[1] China, on the other hand, had 168 million square metres of rooftop solar thermal collectors installed by the end of 2010[2] – approximately 29 times India's installed capacity. China's goal is to reach 300 million square metres of rooftop solar water heating capacity by 2020,[3] while India's aim stands at 20 million square metres of solar water heating capacity by 2022.[4] Interestingly, large parts of Eastern and Southern China have solar radiation of 2.5 kWh/m^2 per day compared to India's 4 kWh/m^2 of radiation per day.[5] In

[1] Ministry of New and Renewable Energy (2012) *Achievements – as of 31/08/2012*, accessed at http://goo.gl/nyyX1

[2] Earth Policy Institute (2011) *Harnessing the Sun's Energy for Water and Space Heating*, accessed at http://goo.gl/BrIq2

[3] ibid.

[4] Ministry of New and Renewable Energy (undated) *Jawaharlal Nehru National Solar Mission – Mission Document*, available at: http://goo.gl/jm6iy

[5] KPMG (2011) *The Rising Sun - A Point of View on the Solar Energy Sector in India*, at p.65; available at: http://goo.gl/MG9Ue

comparison with China, India's existing deployment and available radiation suggest that there is significant market potential for additional SHW systems.

1.1.2 Existing price support for SHW systems

The comparatively high capital cost of deploying a SHW system can be a disincentive for customers. To address this issue, there is an extensive subsidy scheme in place to incentivise the adoption of SHW systems. Presently a customer is eligible for two kinds of subsidies: central government subsidy, and state subsidy.

Central government subsidy

The average price of buying a solar water heater (SHW) ranges between Rs.18,000 to Rs.25,000 (approximately $330 to $460) for systems with 100 litres per day (lpd) capacities.[6] For flat plate collector (FPC) based systems each 100 lpd of capacity needs 2 m^2 of collector area, whereas for evacuated tubular collector (ETC) based systems each 100 lpd of capacity requires 1.5 m^2 of collector area. For General Category States,[7] the Ministry of New and Renewable Energy (MNRE) calculates the subsidy on FPC systems at 30% of the benchmark cost or Rs.3,300 per m^2 of collector area, whichever is less. In Special Category States,[8] the subsidy on FPC systems is calculated on 60% of the benchmark cost or Rs.6,600 per m^2 of collector area, whichever is less. For ETC based systems, the subsidies are slightly lower. For General Category States they are either 30% of the benchmark cost or Rs.3,000 per m^2 of collector area, whichever is less. In Special Category States it is 60% of the benchmark cost or Rs.6,000 per m^2 of collector area, whichever is less.[9]

In effect, the eligible subsidy for FPC systems ranges from Rs.6,600 in General Category States to Rs.13,200 in Special Category States. For ETC systems the range is from Rs.4,500 in General Category States to Rs.9,000 in Special Category States.[10] Another option for both kinds of systems and both categories of states is a soft loan (at an interest rate of 5%) for 80% of the benchmark costs. The loans are provided through all Scheduled Commercial Banks or Regional Rural Banks.[11]

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[6] The benchmark costs for a 100 lpd capacity FPC based systems ranges from Rs.22,000 to Rs.31,000, while for a 100 lpd capacity ETC based systems ranges from Rs.18,000 to Rs.20,000. However, based on multiple stakeholder discussions, the average cost of an FPC based system was pegged at approximately Rs.25,000 and of an ETC based system was Rs.18,000 (both with 100 lpd capacity).

[7] All states other than Jammu & Kashmir, Himachal Pradesh, Uttarakhand, and North Eastern states including Sikkim; Ministry of New and Renewable Energy (undated) *Financial Assistance*, accessible at http://goo.gl/JX8x0

[8] MNRE classifies Himachal Pradesh, Jammu & Kashmir, Uttarakhand, and the North Eastern states including Sikkim as Special Category States; MNRE (undated) *Guidelines to Domestic Users of Solar Water Heaters on Cost, Selection and Availability of systems,* accessible at http://goo.gl/Suc4A

[9] National Bank for Agriculture and Rural Development (2011) *Circular No. 245/ ICD – 45/2011,* accessible at http://goo.gl/bEQp3

[10] Ibid.

[11] See Ministry of New and Renewable Energy (undated) *Financial Assistance*; National Bank for Agriculture and Rural Development (2011) *Circular No. 245/ ICD – 45/2011*

Box 1.1: Subsidy for Solar Water Heating Systems versus Subsidy for Solar Home Systems

It is worth comparing the subsidy schemes for SHW systems with those for Solar Home Systems (SHS). Until February 2012, a consumer of a SHS was eligible for 30 per cent capital subsidy plus a soft loan (with an interest rate of 5 per cent) for half of the system cost (20 per cent of the system cost was needed as a down payment). From March 2012 onwards, however, a consumer is only eligible for a 40 per cent capital subsidy.

Photo 1.2: Solar powered house of a disabled person in shanty town in Udupi city, Karnataka

Photo 1.3: Solar powered house in a forest dwelling in Shishila village, Karnataka

Photos courtesy: Arunabha Ghosh

Different banks have tended to follow different norms in implementing the SHS subsidy schemes. In one case, the consumer had to pay interest on the capital subsidy amount as well until the funds had been received from NABARD. In another case the bank would not approve loans until the capital subsidy had been disbursed to them from NABARD.[12]

Both SHS and SHW have cumbersome processes. The difference, though, is that for SHS it often takes about six months for the capital subsidy to be disbursed, whereas in the case of SHW systems banks have not received the capital subsidy for nearly two years. This means that while consumers are paying interest on the subsidy amount for roughly six months in case of SHS, that burden extends to well over two years in the case of SHW systems. Table 13 illustrates that a customer has to pay an extra interest of Rs.1,271 due to delays in disbursement of the capital subsidy for SHW systems.

Table 1.5: Pricing of Solar Water Heaters (Prices in Indian Rupees)

Price of a 1.5 m^2 ETC system	18,000
Down payment (20%)	3,600
Capital subsidy (30% or Rs.4,500, whichever is lower)	4,500
Interest for 2 years at 12.5% rate on a loan of Rs.14,400	4066
Interest for 2 years at 12.5% rate on a loan of Rs.9,900	2795
Difference in interest	1271

Source: CEEW calculations based on data collected through discussions with stakeholders

[12] CEEW discussion with a Regional Rural Bank's Manager, Karnataka state, 1 October 2012

The capital and interest subsidies bring down the cost of the SHW systems considerably, as shown in the three tables below. Table 1.1 shows the impact on the capital cost faced by the consumer; table 1.2 converts this to the change in average payback periods across India; and table 1.3 illustrates the potential geographic variation in this impact.

Table 1.1: Impact of subsidy on the capital cost faced by the consumer

	2 m^2 FLAT PLATE COLLECTOR (FPC) (in Indian Rupees)	1.5 m^2 EVACUATED TUBE COLLECTOR (ETC) (In Indian Rupees)
100 litres per day capacity	25,000	18,000
Installation charge	2000	2000
Total cost without subsidy	27,000	20,000
MNRE subsidy	6,600	4,500
Final cost to the customer	**20,400**	**15,500**

Source: CEEW calculations based on data collected through discussions with stakeholders

The tables below contrast how the average payback period varies for SHW systems with and without the MNRE subsidy (Table 1.2), and for locations with more or fewer sunny days (Table 1.3).

Table 1.2: Average payback period of SHW systems in General Category States

	With MNRE Subsidy	Without MNRE Subsidy
Sunny days per year on an average	240	240
Units saved per year (1 Unit = 1 kWh)*	1200	1200
Rs. saved per year (Rs.5 per unit)	6000	6000
CO_2 emission prevented per year**	1.17 tonne	1.17 tonne
Price of system (in Indian Rupees)	FPC: 20,400 ETC: 15,500	FPC: 27,000 ETC: 20,000
Payback period	FPC: 3.4 years ETC: 2.58 years	FPC: 4.5 years ETC: 3.3 years

* It has been is suggested that when operational, a 100 lpd system would replace a 2kW electric geyser for 2.5 hours, hence saving 5 units of electricity. See, http://mnre.gov.in/file-manager/UserFiles/potential_electricitysSavings_swhs.pdf

** 1 unit of electricity = 0.975 kg of CO2 (when the source of electricity is coal); 1 tonne = 1000 kg

Source: CEEW calculations based on data collected through discussions with stakeholders

Table 1.3: Average payback period for SHW systems in General Category States for three scenarios based on the number of sunny days in the area

	Location 1	Location 2	Location 3
Sunny days per year on an average	100	200	300
Units saved per year (1 Unit = 1 kWh) *	500	1000	1800
Rs. saved per year (Rs.5 per unit)	2500	5000	9000
CO_2 emission prevented per year**	0.5 tonne	1 tonne	1.5 tonne
Payback period (without any subsidy)	FPC: 10.8 years ETC: 8 years	FPC: 5.4 years ETC: 4 years	FPC: 3 years ETC: 2.22 years
Payback period (with MNRE capital subsidy)	FPC: 8.16 years ETC: 6.2 years	FPC: 4.08 years ETC: 3.1 years	FPC: 2.27 years ETC: 1.72 years

* It has been is suggested that when operational, a 100 lpd system would replace a 2kW electric geyser for 2.5 hours, hence saving 5 units of electricity. See, http://mnre.gov.in/file-manager/UserFiles/potential_electricitysSavings_swhs.pdf

** 1 unit of electricity = 0.975 kg of CO2 (when the source of electricity is coal); 1 tonne = 1000kg

Source: CEEW calculations based on data collected through discussions with stakeholders

State subsidy

In addition to the MNRE subsidy, various states have introduced additional state-level subsidies to provide greater price support for SHW systems.

For instance, in New Delhi a customer is eligible for both the state as well as the central subsidy. The Delhi Government provides a subsidy of Rs.6,000 to each domestic consumer for installation of a SHW system of 100 lpd capacity from the approved and authorised manufacturers or dealers.[13] The subsidy reduces the payback period to approximately two and a half to four years in Delhi. In Bangalore, the Karnataka Government provides a rebate of Rs.0.50 per unit on the electricity bill up to a maximum of Rs.50 per month to consumers that have installed a system.[14] As a result, the payback period in Bangalore is approximately two to two and a half years.

Table 1.4 compares the costs of SHW systems and their respective payback periods between New Delhi and Bangalore. Despite the additional state capital subsidy in Delhi, the payback

[13] Presentation by Dr. Anil Kumar (undated) *Solar Water Heating System – Delhi Experience*, accessible at http://goo.gl/R2CE6

[14] Karnataka Renewable Energy Development Ltd. (undated) *Solar Energy Thermal*, accessible at http://goo.gl/SWgHq

period in Karnataka is shorter. This is primarily due to the fact that Karnataka experiences an assumed 300 clear sky days as compared to Delhi's 150 clear days.[15]

Table 1.4: Comparison of price of system and payback period between New Delhi and Bangalore

	New Delhi	Bangalore
Sunny days per year	150	300
Units saved per year (1 Unit = 1 kWh)	750	1500
Amount saved per year (Rs. 5 per unit)	3750	7500
CO_2 emission prevented*	0.73 tonne	1.5 tonne
State subsidy	Rs.6000	Rebate of Rs.0.50 per unit of electricity up to maximum of Rs.50, which translates to a maximum of Rs.600 per year
Price of system (in Indian Rupees)	FPC: 14,400 ETC: 9,500	FPC: 20,400 ETC: 15,500
Payback period	FPC: 3.84 years ETC: 2.53 years	FPC: 2.51 years ETC: 1.91 years

* 1 unit of electricity = 0.975 kg of CO2 (when the source of electricity is coal); 1 tonne = 1000 kg

Source: CEEW calculations based on data collected through discussions with stakeholders

The average payback period for SHW systems in India now ranges from three to four years. This is encouraging because the systems come with a minimum five-year warranty and a life span of 20 years with little maintenance required (as long as the original system is durable and adheres to technical standards).

1.1.3 Challenges in expanding the market

Despite the price incentives and the shorter payback periods, there are different problems that continue to plague the SHW market and hinder the growth of SHW deployment in urban residential areas. These challenges are explored below.

Declining Quality

Capital subsidies are currently available only on benchmark costs. Even if a good quality system exceeded the benchmark cost, it would receive the same amount of subsidy as a lower quality system priced under the benchmark cost. Suppliers, in turn, cut costs and compromise on quality in a bid to respond to consumer desire to maximise the subsidy as a proportion of the system cost.[16] As Box 1.2 indicates, this is a problem which is by no means limited to India. Also, with the cost of SHW systems highly dependent on the prices of aluminium,

[15] MNRE (undated) *Solar Water Heating System (Potential and Savings)*, accessible at http://goo.gl/KgoHS

[16] CEEW stakeholder discussion with Delhi-based SWH manufacturer on 5 September 2012.

copper and glass, suppliers are reluctant to make significant investments in building inventories thanks to uncertain demand and volatile costs. The recent rupee devaluation has increased overall costs largely due to the rising prices of tubes imported from China. According to CEEW discussions with stakeholders and manufacturers, it appears that these price impacts are largely absorbed by the manufacturers or vendors of SHW systems and not passed on to the customers (India is considered a highly price sensitive market). Instead, many vendors begin to substitute lower quality components, resulting in a fall in the quality and efficiency of the systems.[17]

Box 1.2: China's experience: More aggressive policies, but similar problems as India

The solar water heating industry in China has attracted attention on account of its high job-creation and revenue raising potential. For deploying SHW systems, China prioritised rural areas by making them eligible for a 13% capital subsidy. Provincial governments, in addition, introduced their own regulations for deploying SHW systems. The urgency to develop the local SHW industry meant that individual municipalities promoted favourable policies. (In one city, 3 out of 10 jobs were found to be solar related.[18])

For example, Dezhou city in Shandong province incentivised customers by providing additional subsidy and made it mandatory for new and renovated houses to install the systems. Additionally, the Dezhou government provided local manufacturers a stable customer base in its capacity as a major procurer of public infrastructure in the city. This, for example, led to the construction of public bath houses in 200 surrounding villages powered by centralised SHW systems.[19] Following the Renewable Energy Law of 2006, most local governments made it mandatory to install SHW systems for civic buildings that were higher than twelve floors.[20]

Despite such favourable policies, doubts are being raised about the sustainability of state government subsidies, monitoring and inspection of sites, and lack of trained technicians.[21] These challenges are very similar to those being faced in India. In addition, a recent report highlights manufacturers' scepticism towards the boom of SHW systems in China: unsafe equipment because of lack of mandatory safety regulations; shift of focus from R&D investments to price wars in order to attract more consumers; and bad reputation of the industry due to poor quality systems.[22]

The Chinese examples do indicate better numbers of installed SHW systems in the country, but there are increasing concerns over the poor quality of these systems. Even if India were to make its subsidy policies or regulations for solar water heating more aggressive, it could lead to a situation where the quality of the systems suffer a great deal due to over capacity, or unscrupulous vendors, or both. In turn, this could lead to a serious trust deficit among the customers and further drive them away from deploying SHW systems in their homes.

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[17] CEEW stakeholder discussion with Delhi-based SWH manufacturer on 5 September 2012.

[18] Li, Rubin and Onyina (2012) *Comparing Solar Water Heater Popularization Policies in China, Israel and Australia - The Roles of Governments in Adopting Green Innovations*, Sustainable Development, August 2012

[19] Ibid.

[20] thinkprogress (2012) *Solar Thermal Scales New Heights in China*, 3rd July 2012, accessible at http://goo.gl/Hc6A9

[21] MNRE – Solar Water Heating Solutions for India (undated) *List of State Nodal Agencies*, accessible at http://goo.gl/AhNNC

[22] CaixinOnline (2012) *Solar Heaters Have Safety Flaws, Firm's Chairman Says*, 15th August 2012, accessible at http://goo.gl/q7p1m

High Transaction Costs

Moreover, the subsidy schemes suffer from very high transaction costs because the documentation required to process the subsidy is riddled with bureaucratic hurdles and is extremely time consuming. After the customer buys a subsidised system, it takes about 6-18 months on average for the subsidy application to be processed, verified and for the funds to be disbursed to the vendor.[23]

In the case of the interest rate subsidy, unlike the capital subsidy, there is no variation in the amount of subsidy offered across different states. Consumers in areas with fewer clear sky days have little or no incentive to opt for interest rate subsidies. At one level, this would be efficient, as more loans would be taken in areas with the highest solar potential. But since the capital subsidies do vary across states, consumers end up choosing them instead of interest rate subsidies. Moreover, the process for acquiring loans is also cumbersome (though not everywhere). In cases where the consumer expects to pay only the subsidised cost of the system, the capital subsidy would be preferred since the risk lies with the vendor who also bears the transaction cost of recovering the subsidy amount. In case the consumer has to apply for the subsidy (rather than the vendor) the choice between capital and interest subsidy would depend on which one is perceived to have a lower transaction cost.

In addition, banks claim that the transaction costs are very high for small loan sizes (between Rs.15,000 and Rs.20,000) and complicated procedures for crediting the subsidy amount against the interest payment obligations of the customer. CEEW also discovered that bank managers were at times unclear about changes in subsidy schemes and were often unable to disburse loans to customers due to the shortage of manpower and the lengthy documentation process.

Nevertheless, some reforms in response to the challenges of processing payments and disbursing subsidies are underway. The National Bank for Agriculture and Rural Development (NABARD), the agency responsible for administering the subsidy for solar water heating schemes, has started advancing funds to banks to ease the subsidy disbursement process.[24]

[23] CEEW stakeholder discussion with Bangalore-based SWH manufacturer on 6 September 2012.

[24] MNRE (2011) *Capital subsidy Scheme to be implemented by NABARD through Regional Rural Banks and other commercial Banks for Solar Lighting Systems and Small Capacity PV Systems*, accessible at http://goo.gl/Lp2Wt

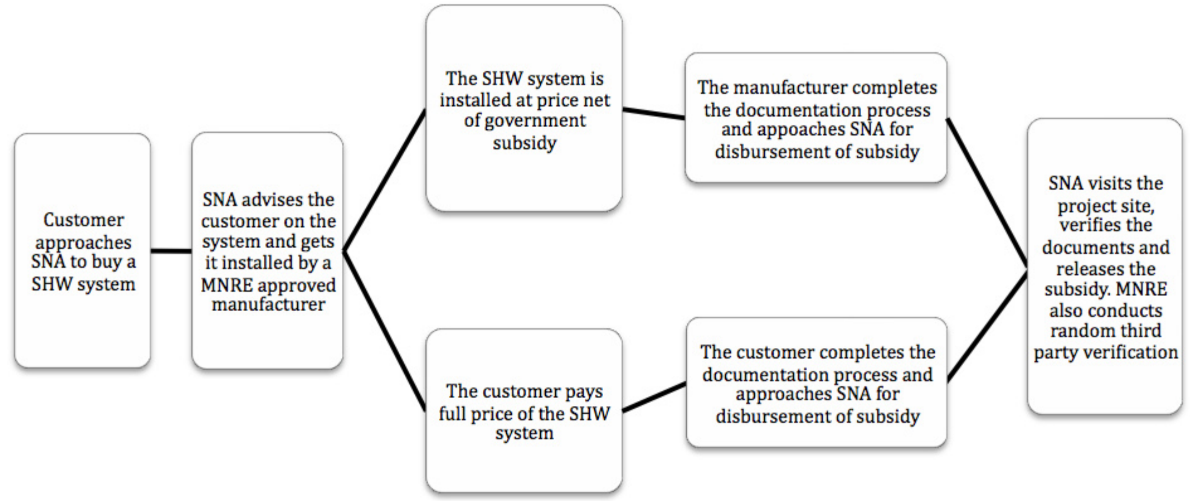
Multiple Actors, Unclear Governance

One reason why the transaction costs are high is the number of actors involved in the disbursement of subsidies and loans. A customer can purchase a government subsidised system in one of three ways.

– **Case 1: Customer approaches State Nodal Agency (SNA) for installation of the system**

The State Nodal Agency is an administrative department of the state government for implementation of the new and renewable energy programme. At present there are 35 state nodal agencies responsible for the same.25 The SNA is responsible for verifying installed projects and disbursing funds, which could accrue to the vendor or the final customer (Figure 1.1).

Figure 1.1: Step by step process of buying a subsidised system through a State Nodal Agency

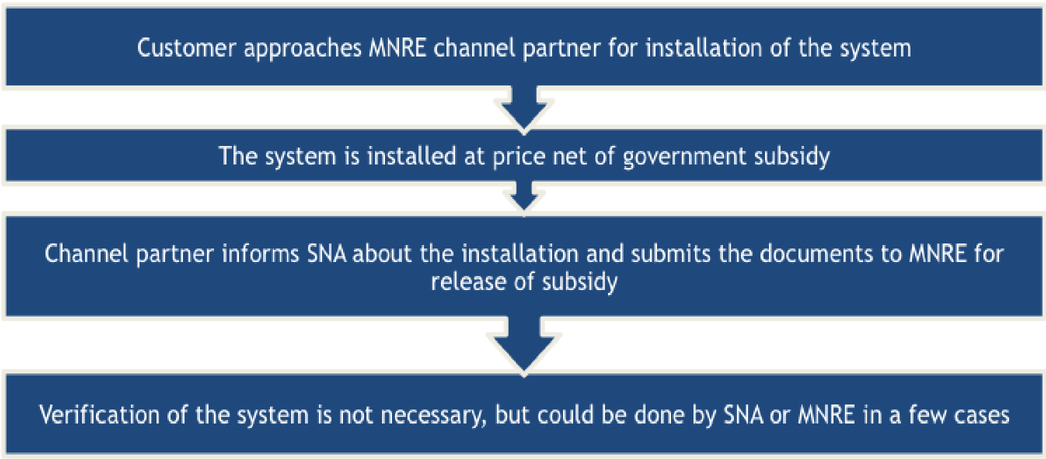


Source: CEEW analysis

[25] MNRE – Solar Water Heating Solutions for India (undated) *List of State Nodal Agencies*, accessible at http://goo.gl/AhNNC

– **Case 2: Customer approaches Channel Partners**
Channel partners are solar water heater manufacturers that have been accredited by MNRE and have received a grading from a credit rating agency of MNRE's choosing. Here, the customer approaches a channel partner to install the system. Channel partners, since they have been vetted on a prior basis, can seek subsidies from the SNA without each project being verified (Figure 1.2). They are also eligible to submit proposals to MNRE for directly receiving central financial assistance. At present there are 41 channel partners accredited by MNRE.[26]

Figure 1.2: Step by step process of buying a subsidised system through a Channel Partner



Source: CEEW analysis

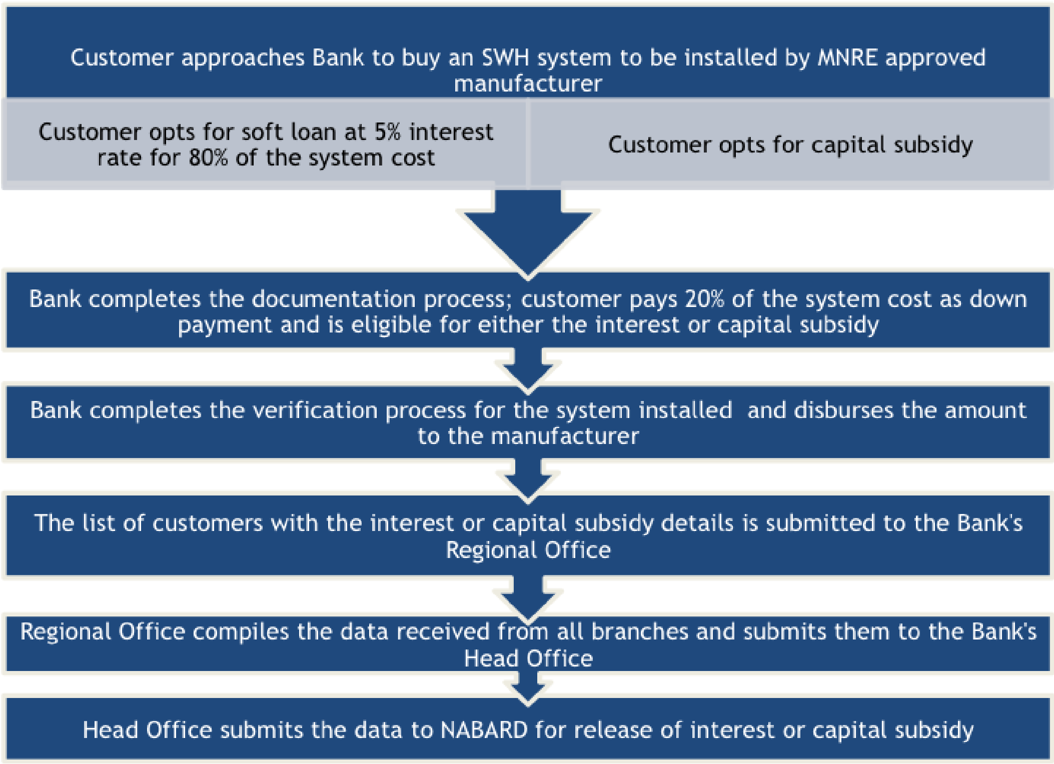
– **Case 3: Customer approaches a bank for either interest or capital subsidy to buy a SHW system**

A third approach is for the customer to approach Scheduled Commercial Banks or Regional Rural Banks.[27] In this case, the bank takes the lead in preparing all the paperwork and disburses funds to the vendor. Once the project has been verified and details submitted to the regional head office, the bank approaches central government agencies to secure the subsidy amount (Figure 1.3).

[26] MNRE – Solar Water Heating Solutions for India (2011) *List of Channel partners of Solar Thermal Systems – As on 31.10.2011*, accessible at http://goo.gl/mrtCj

[27] See generally, MNRE (undated) *Financial Assistance*, accessible at http://goo.gl/JX8x0; MNRE (2011) *Capital subsidy Scheme to be implemented by NABARD through Regional Rural Banks and other commercial Banks for Solar Lighting Systems and Small Capacity PV Systems*, accessible at http://goo.gl/Lp2Wt

Figure 1.3: Step by step process of buying a subsidised system through a bank



Source: CEEW analysis

The three different ways highlighted above offer several avenues for the customer to purchase a government subsidised SHW system. In reality, however, the customer is left to navigate through a maze of different steps and multiple agencies, reducing the incentives to apply for subsidies in the first place.

In addition to the multiple actors, such as state nodal agencies, channel partners, and different banks, multilateral actors have also entered into the fray of SHW systems. The UNDP-GEF Project on Global Solar Water Heating was launched in 2008 in association with MNRE to 'accelerate & sustain SHW market growth by building up market demand, strengthening supply chain, adopting qualitative measures and establishing supportive regulatory environment'.[28] This project is due to end in December 2012. Another project was launched by UNDP-GEF and MNRE in August 2012,[29] but it is not clear whether it will fully replace the existing scheme, or whether it would be tied together with central or state government subsidy schemes. Conversations with the project consultants based at MNRE suggested that the process and modalities were as yet undefined.

[28] Dr. A.K. Singhal (2012) *National Programme and UNPD-GEF Project on Global Solar Water Heating*, Presentation at the National Workshop on Solar Water Heaters (23 August 2012), accessible at http://goo.gl/mNBj4

[29] Global Environmental Facility (2012) *New GEF-UNPD Project on Solar Technology starts in India*, accessible at http://goo.gl/g4wwb

Insufficient and weak regulation

The market for SHW systems in India is primarily driven by regulation, with vendors mostly servicing large clients through large tenders based on where installation of the systems has become mandatory.[30]

Regulation of SHW systems varies across Indian states. The Delhi Government, for example, has made the use of solar water heating systems mandatory in buildings such as industrial units, hospitals, nursing homes, hotels, canteen, government buildings and residential buildings having an area of 500 m^2 or more. By contrast, the Haryana Government's regulation for residential buildings is for areas larger than 500 square yards (418 m^2) and the Karnataka Government's regulation makes it mandatory for residential buildings having 200 m^2 of floor area or 400 m^2 of site area.

At present, regulation alone is proving to be insufficient to stimulate investment and greater deployment of SHWs. Even if the regulations exist, there is little compliance due to the lack of strict monitoring and enforcement procedures. Further, even though SHW systems are mandatorily installed in some residential buildings, they suffer from quality degradation or breakdown.[31] There is a weak monitoring mechanism to check if the systems, against which subsidies are provided, are operating at the stated efficiency without any regular problems. In relation to these larger buildings, there is need for stricter enforcement of existing regulations.

1.2 Considering and choosing an RBF approach

1.2.1 RBF objective

It could be argued that there might be a case for strengthening the existing system of capital and interest rate subsidies. However, the complex subsidy structure, its impacts on payback periods in different cities, and the challenges with multiple actors and agencies, we believe that an RBF mechanism added to the existing subsidy structure would not be the best approach. Furthermore, the existing regulations are weak in providing incentives to expand to new sets of customers, and there is a lack of strict enforcement. In fact, even with stronger regulations, weak enforcement could result in poorer quality products (see Box 1.2). Introducing an RBF mechanism to bolster the existing system would only add additional layers of bureaucracy and complicate the process further.

However, despite all the schemes in place, there is still limited awareness among smaller clients and individual households regarding the availability of SHW systems and the subsidies attached to them. The need is to educate households about the available choices in water heating in order to drive an attitudinal shift in favour of SHW systems. The Indian urban residential landscape across different cities is a mix of high-rise buildings, large private bungalows, lower income housing developments, and unauthorised urban slums. Thus,

[30] CEEW stakeholder discussion with Ahmedabad-based SWH manufacturer on 5 September 2012

[31] CEEW stakeholder discussion with Delhi-based SWH manufacturer on 5 September 2012

homeowners in different parts of a city will need different types of SHW systems. Since there is limited awareness about the systems, the suppliers of SHW systems are also the ones best placed to offer alternative SHW designs to customers at different costs. They must be given incentives to inform consumers about these systems, their efficiencies and standards, financial implications and payback periods, and the choices available to the customer depending on their living conditions and needs. The key consideration for suppliers must not be merely the installation of SHW systems in buildings as prescribed by regulation. Rather, the sector has to mature to a level where vendors find it profitable to sell SHW systems across a much larger and more diversified set of residential users.

Currently, no incentive exists where new markets or new SHW needs are addressed. The proposed RBF scheme would potentially be used only to reach out to a wider customer base of urban residents, while overcoming the challenges posed by insufficient regulatory incentives and lack of awareness.

The main outcome we hope to target is higher sales among new and diverse sections of urban residential users. An RBF approach is employed when the aim is to increase output in a market or to create a new market. In the present case study, the ultimate objective would be to increase the number of SHW systems installed *and* cater to a new and diverse customer base of urban residential users. The added incentives, provided to the vendors through result-based payments, would be aimed at reaching out to customers with varying income levels and different system requirements. The basic idea is to use the RBF mechanism to stimulate competition in the market for SHW systems and incentivise the process of selling these products to new customers. It is important to reiterate that this proposed RBF scheme will not be about solving all the problems in the SHW market in India.

1.2.2 The case for choosing RBF – (i) necessary pre-conditions

In order to proceed with the design of the RBF, it is important to determine if the three necessary preconditions for using RBF instruments are fulfilled:

1. Sufficient access to upfront finance
2. Sufficient institutional capacity
3. Measurable and controllable outputs

Upfront finance: There are many subsidies and regulations in place to incentivise the installations of SHW systems in residential buildings. However, there is still a glaring gap in the adoption of these systems across residential users. The main issue for consideration, then, is to determine whether the suppliers/vendors have access to any upfront finance to drive the necessary behavioural change among customers to adopt SHW systems in residential areas. Being small or medium enterprises, most of the suppliers/vendors have limited financial capabilities to carry out extensive awareness drives or marketing strategies to attract customers. Bank loans are available at usual rates and the vendors do not receive any special rebates for operating in the solar sector. Thus, there is little incentive for them to reach out to a wider customer base. They continue to operate on a business-as-usual model and restrict themselves within the existing subsidy framework and the limited mandatory installations.

With major information gaps and potential market failures, financial markets are not likely to warm up to the SHW systems sector without strategic interventions to create a robust financing ecosystem. A range of funding channels, financial institutions, and other stakeholders exist in the financial ecosystem that could be relevant for the SHW systems market. These financial stakeholders include multilateral funding channels, Indian public and private sector banks, public sector (non-bank) financial intermediaries (for example, Indian Renewable Energy Development Agency), bilateral funding channels, venture capital and private equity firms, new market mechanisms, and government fiscal support. But these institutions lack cohesion and information sharing. However, in order to increase bankability and overall solar market development, the different types of institutions need to be strategically coordinated at the programmatic level, at the project level, and in terms of ancillary support measures. Many of the following current and contemplated regulatory programmes need improvement or expansion to build confidence and awareness among financial groups and thereby increase bankability.[32]

Public sector non-banking financial institutions such as Reserve Bank of India (RBI) or the Indian Renewable Energy Development Agency (IREDA) can play an important role when setting policy directions whereas non-financial supporting institutions such as the Solar Energy Corporation of India, the Bureau of Energy Efficiency (BEE), the Solar Energy Centre, and the India Banks' association could help to channel funds, provide necessary skills and help in component certification.

The suggested RBF mechanism could provide vendors with the additional finance needed as an incentive to tap new customers and sell more SHW systems. The design of the RBF mechanism, however, must also try to ensure that it assists the market players in overcoming some of the challenges they face in accessing upfront finance. If the pay-outs are linked to early stage results, then the result-based payments could help create an enabling environment for the market players to continue their operations by providing them with additional financial support to ease their initial working capital requirements.

Institutional capacity: The institutional capacities of the agents (suppliers/vendors) are seemingly in place.

However, in terms of the principal, there are multiple agencies that could be tasked with the implementation of the new RBF scheme. Any one of the government ministries such as Ministry of Finance, Ministry of Science and Technology, Ministry of Micro, Small and Medium Enterprises, Ministry of Housing and Urban Poverty Alleviation, or Ministry of Urban Development could play a pivotal role in channelling the necessary funds and providing the required assistance for the RBF scheme.

However, none of them has a specific mandate to work on clean energy related projects. If one proceeds to narrow down the institution based on technology, then the implementing

[32] Council on Energy, Environment and Water, and Natural Resources Defense Council (April 2012) *Laying the Foundation for a Bright Future: Assessing Progress under Phase 1 of India's National Solar Mission*, accessible at http://goo.gl/JkgIA

ministry could be the Ministry of New and Renewable Energy (MNRE). This selection could have the merit of being able to test the viability of the RBF scheme, as compared to other ongoing MNRE programmes on solar water heating. However, this could also prove to be a demerit as an MNRE-managed RBF scheme could end up confusing vendors who already have to navigate the existing MNRE channels for various kinds of subsidy measures.

There is a new institution in the making which has not yet fully matured but could potentially also have a role. The National Clean Energy Fund (NCEF) has been created for 'funding research and innovative projects in clean energy technology'. The corpus of the NCEF is created through the levy of a clean energy excess on coal produced in and imported to India at a rate of Rs.50 per tonne.[33] Presently, if a new agency, such as the NCEF, is tasked with the RBF instrument then it may have insufficient institutional capacity to achieve the desired results. This is because the NCEF's mandate has not been finalised and, to the extent some guidelines exist, they are not being followed. The Operational Guidelines of the NCEF are inconsistent with the NCEF's stated objectives to further research and projects in clean energy technologies. Moreover, the projects being funded do not adhere to the stated objective of the NCEF; rather funds are being spent to cover budgetary shortfalls of some ministries.[34] If the NCEF becomes one of the new agencies through which RBF funds are channelled, then its capacity would have to be strengthened.

The main consideration in this regard is not whether there is any upfront finance or institutional capacity. There are various sources of potential funding and there are enough institutions that could be tasked with implementing an RBF scheme. The question, then, would be one of choosing one or two partner institutions from the given set of options.

Measurable and controllable outputs: Here, the output would not be merely the number of SHW systems installed overall but rather the number of systems installed in areas outside the purview of mandatory regulations. So long as there is independent monitoring of the installations, the outputs could be measurable. Another key factor for success would be how well the monitoring and verification systems are designed within the final RBF. Monitoring and verification should not be considered to be the final output on which the payment will be contingent. It should be looked upon as one part of the entire RBF scheme, so that there is a legitimate process of monitoring and verification before any disbursement of payments.

1.2.3 The case for choosing RBF – (ii) the risk-incentive trade off

In order for the RBF to be preferred over conventional instruments such as an upfront grant, the gains from stronger incentives should outweigh the increase in costs thanks to transferring a portion of the risk to the vendors.

[33] Press Information Bureau of the Government of India (2010) *Proactive Steps in Budget 2010-11 for the Environment*, 26th February 2010, accessible at http://goo.gl/bn01w

[34] CBGA (2012) *Framework and Performance of National Clean Energy Fund* , accessible at: http://goo.gl/OaYyC

a. Is the result under the control of the agent?

The results are likely to be largely in the hands of the vendor, since they are the ones who would be selling the SHW systems to different categories of customers. Whether they use an awareness strategy or other marketing tools to increase their customer base is immaterial, as long as the final outcome is increased sale of SHW systems to different consumer segments outside of the purview of existing regulations. There is a risk that, a vendor's best efforts notwithstanding, the demand to buy SHW systems is insufficient.

b. Is there a clear line of sight for the principal to the result against which the result-based payment is being made?

Yes. There could be predefined segments of urban residential users based on:

– Income bracket (lower income households installing the systems would yield a higher premium);
– Locality (large number of installations in a low income locality in relation to a high income area would receive a higher premium);
– Kind of building (retrofitting in older buildings would receive a higher premium compared to installations in new buildings).

It should, thus, be relatively easy to assess the number of SHW systems sold by the vendor among each segment as long as a credible system of monitoring and verification is in place.

c. Does the RBF stretch the balance sheet of the agent?

Yes, the balance sheet of the agent would be stretched as the vendor would have to increase spending on advertising, better marketing tools and other costs that might be incurred while tapping into a potentially new customer base. However, these tasks would not be much different from what the agent has to otherwise undertake with existing customers. To the extent that the costs would be recovered in the normal course of business, an RBF intervention targeting new customers or new types of dwellings and buildings is unlikely to prove prohibitive.

d. Is the cost base largely variable?

The cost base of vendors is relatively variable: if they sell fewer SHW systems then their revenues are lower, but so are their costs. The main cost-related risk would arise if there is a significant investment in building up the inventory of solar hot water systems targeted at new sets of customers and associated marketing and advertising costs. However, even these can be adjusted according to levels of throughput relatively easily. This implies that should the vendor choose to continue its earlier business model of selling only to large enterprises rather than service smaller or poorer households, it would not suffer any substantive losses from sunk costs.

e. What is the time horizon of the RBF?

The time horizon of the RBF is unclear. It should ideally be in place until it manages to create an enabling environment for the market players to thrive within the expanded customer base. However, the pay-out periods should be shorter than the time it currently takes to secure the subsidies. Otherwise, the RBF programme would not be any different from existing schemes with long drawn out payment schedules. The payments could be made based on clear targets for increasing sales of SHW systems within a given quarter, half-year or at most a year. The result-based payments would also assist the vendors in reducing their upfront capital costs for deployments in subsequent time periods.

1.2.4 The case for choosing RBF – (iii) positive spill-over effects

Bank managers in India continue to remain sceptical about solar technology, repayment of loans and delayed subsidy disbursement. A clear policy and line of sight with decrease in bureaucracy and time could mitigate some of their concerns and result in more lines of credit for SHW entrepreneurs. With wider deployment, confidence in the systems among customers and financiers could increase.

Moreover, anticipating an opportunity to enter new markets, several new companies could start manufacturing systems. This could lead to more jobs across the value chain. The growth of small and medium sized entrepreneurs may, however, be partially constrained, leading to consolidation of the industry since large corporations have an advantage of economies of scale.

More importantly, the process would require initial investments, which may be procured as bank loans. But since the payment is linked to results, there is a possibility that a few could miss a threshold minimum target before the RBF is paid out. For these vendors the risk would be the sunk investment in procuring the systems but without the price support that would allow them to start repaying bank loans. To be sure, such an outcome would not be a failure of the RBF mechanism *per se*. It is part of normal business risk where loans are taken and investments made based on certain expectations of potential market size. The failure to fulfil that potential is a risk that the vendor (and its financiers) would have to bear.

1.3 Designing the RBF for solar water heating

In designing the RBF based on the analytical framework, we will detail the following: eligibility, conditionality or trigger for paying out the RBF, structure of the pay-out, size of the payment, and the role of the principal.

1.3.1 Eligibility

Although eligibility could be open to incumbent and new vendors, the vendor selection should be based on certain minimum operational guidelines and minimum quality standards, to ensure that there is no adverse selection of poor quality vendors. At the same time, the technical eligibility criteria should not be so tedious that nascent firms are excluded by default. In a market that already has few firms, it is important to structure the the RBF mechanism to lower barriers to market entry for new firms.

1.3.2 Conditionality

The ideal trigger for releasing the payment would be the successful installation and consecutive use of an SHW system. However, it is infeasible to shift the risk of use of systems entirely on to the vendors. For the RBF programme to the successful we therefore recommend that the vendors be incentivised on achievement of partial results within certain stipulated timeframes; in particular we propose to pay out the incentive upon verification of installation and the installed SHW system being in operation. This would help the vendor by reducing her/his financial risk, while still placing the trigger reasonably close to the ultimately desired outcome.

It is also necessary to make the pay-out dependent on third party monitoring and verification. The risk of low-quality systems being installed is high and could undermine potential demand among prospective consumers. To reduce monitoring and verification costs, the pay-out could be bundled for a large number of projects, giving the vendor the option to opt for a one-time verification. This could reduce the average cost of verification per system.

1.3.3 Pay-out structure

The structure of the incentive payment could be a basic pay-out plus certain premium bonuses based on three pre-defined criteria (as discussed in the earlier section):

- Income bracket (lower income households installing the systems would yield a higher premium);
- Locality (installations in a low income locality would receive a higher premium than installations in a high-income locality);
- Kind of building (retrofitting in older buildings would receive a higher premium compared to installations in new buildings)

The differential rates of premium available to the vendors could serve as the added incentive for them to increase awareness of SHW systems and, in turn, increase sales through a new and diverse customer base. This way the RBF is designed both as a grant for deploying additional systems and a prize for reaching new types of customers.

Furthermore, we propose that the basic incentive should not vary linearly with the result as it may have the effect of discouraging vendors from exploring new markets and business plans once they are comfortable with a partial result. The incentive per unit could be increased as more results are achieved. One possible way to design this would be to make the incentive vary exponentially where the disbursed amount increases with the number of systems sold.

In addition, the vendor could receive an extra incentive per unit by servicing predefined segments of the urban population based on income bracket, locality and retrofitting in older buildings. This extra incentive may vary from segment to segment and would act as a top-up to the earlier mentioned incentive based on the number of systems installed (Box 1.3).

While the lump-sum basic payment would serve as an incentive to break into new markets, the per-unit additional payment would act at the margin.

Box 1.3: Hypothetical calculation of the result-based payment based on the conditionalities

A vendor would be eligible for an incentive (*I*) on completion of the threshold target. But, this incentive would be disbursed in phases. For example:

% of threshold target achieved	Portion of the incentive disbursed (%)	Cumulative incentive disbursed (%)
25	10%	10%
50	15%	25%
75	25%	50%
100	50%	100%

The top-up amount varies according to categories of customers served:

Category of customer	Incentive on per unit sold
C1	X
C2	Y
C3	Z

Let us assume the threshold target for receiving the total incentive ***I*** is 10,000 systems.

A vendor is able to sell 5,000 systems. He services three categories of customers C1, C2 and C3 by selling 1,000, 1,500 and 2,500 systems respectively.

Hence he would be eligible for **Rs.0.25 *I*** since he has sold 50% of the threshold target. In addition, he would be eligible for a top up of **Rs.(1000X + 1500Y + 2500Z).**

Hence the total incentive received would be ***0.25I + 1000X +1500Y + 2500Z***

1.3.4 Size of the payment

Lack of awareness and easy availability of a conventional electrical heater as a cheaper option is one of the major challenges to the upcoming solar water heating industry. It is assumed that the incentive provided to the vendor would be passed to the customer to reduce the difference in costs. Since electrical geysers consume power in the order of kilowatts it is suggested that while calculating the difference between the two systems the cost of electricity avoided is also included.

In terms of proposing an appropriate payment amount, a possible design of incentive could be the difference between the initial cost of a solar hot water system and the sum of a conventional electrical geyser with one year's consumption of electricity. Since the yearly bill of the conventional geyser may vary from location to location it is recommended that the RBF incentive also be site specific.

Thus, the size of the incentive could be calculated as follows:
Size of Incentive = Initial cost of SHW – (Initial cost of conventional geyser + one year of electrical bill)

1.3.5 Role of the principal

A crucial role of the principal in this case would be to provide a part of the finance to the vendors ex ante in order to assist them in raising awareness of SHW systems among customers and creating a competitive market for SHW systems. The principal would not be purchasing systems; rather it would be providing incentives to the vendors to reach out to a new customer base, disaggregated by type of customer. Additionally, the principal would also need to ensure that there is a credible and independent system of monitoring and verification in place. The final payments would hinge on the success of the vendors, thus making it crucial to have a third-party assessment of their systems. Ultimately, the aim of the principal would be to increase the number of SHW systems installed and to ensure that agents tap into a new and diverse customer base, by providing high quality systems customised to different needs in urban residential buildings.

1.3.6 Exit strategy

The main idea behind proposing this RBF mechanism is to create a self-sustaining market for SHW systems in urban residential areas. As per the main report, a phased exit strategy in such a case would be the best option. The principal should then look to reduce RBF payments after a stipulated minimum period by which time the market has reached the point of self-sufficiency.

The main report measures self-sufficiency as the gap between the price at which firms are willing to offer the good and the price at which consumers are willing to buy the good. In order to arrive at this point, the principal could either set a fixed time period for the RBF payments or a maximum total funding that the RBF scheme would undertake in totality.

We propose that the principal set a fixed time period by which a certain number of systems must be sold to a predetermined number of households in each category of urban residential buildings.

Also, in case of a situation where the RBF-induced market development does not work out as planned, the main report suggests that the principal should prepare itself and the agents for the next possible steps based on certain intermediate checkpoints. A likely situation could be that a vendor does not meet the set number of target households to be eligible for the RBF. In such cases, instead of not disbursing any results-based payments at all, the principal could consider including an intermediate checkpoint that stipulates that the payments would reduce in proportion to the extent by which the target is missed. For instance, even for grid-connected solar projects under India's National Solar Mission, the government signs contracts with project developers that allow it to encash bank guarantees should the developers fail to commission projects on time. Such partial penalty-based schemes could reduce the risks for the RBF principal, yet offer vendors incentives and compensation in proportion to their effort and success in deploying SHW systems among new customer segments.

1.4 Conclusions

This case study began by highlighting the potential for deployment of SHW systems in urban residential households. It then moved to a detailed analysis of the various problems plaguing the present market for SHW systems in India, which ranged from declining quality and high transaction costs to multiple actors and unclear governance.

However, it was then pointed out that, even if these problems were fixed, there is little incentive for vendors to expand their markets. This is due to insufficient regulatory incentives and a lack of awareness. An assessment of the three necessary conditions for an RBF to be viable led us to propose an RBF mechanism that is targeted at vendors to increase sales among new and diverse sections of urban residential users. In absence of external subsidies vendors may find it difficult to pitch solar systems against conventional geysers.

Hence, it seemed necessary to incentivise vendors through external grants in the form of an RBF. The main aim of the RBF scheme would be to increase the number of SHW systems installed *and* to ensure that vendors reach out to a new and diverse customer base of urban residential users. The proposed RBF scheme is designed using a basic incentive to stimulate outreach into new markets, and a per-unit additional incentive, in order encourage additional sales. The size of the payments is calculated so to make SHW systems competitive with traditional heating geysers, assuming that vendors pass on the subsidy via lower end-prices

2. Stimulating R&D in energy access technologies

Incentives for innovation in India

PROBLEM STATEMENT

- **Many new business models offer greater application of renewable energy technologies that go beyond home lighting and into more productive uses.**
- **There is, however, little work in scaling up the business models or facilitate R&D in the wider application of these technologies.**
- **There is very little incentive to encourage such business models to widen their customer base and expand the scope of the energy technologies.**
- **The policy objective would be to incentivise technological R&D or business model innovation to increase energy access via off-grid renewable energy.**

KEY CHALLENGES

- **R&D in energy storage or energy efficient appliances is possible by reasonably identifying targets for technological improvements. However, there is little research capacity or investment or interest among large firms to undertake these tasks.**
- **Existing customers are unhappy with poor quality systems. Very few are willing to take the risk of taking a loan or spending their savings to cover the capital costs of solar home systems (SHS).**
- **Business models based on variable usage payment schemes are trying to overcome the twin challenges of poor servicing and maintenance and high upfront costs; but they are facing limitations in how rapidly they can be scaled.**

WHY THERE IS A CASE FOR RESULTS-BASED FINANCING (RBF)

The conditions are not appropriate to drive R&D in energy storage or efficient appliances. But there is a possibility of encouraging innovation in business models that offer better servicing and maintenance and variable usage payment options to the customer, thereby providing quality assurance and easing their financial burden.

WHAT TO TARGET USING THE RBF MECHANISM

- **Support variable usage payment business models, defined as those that aim to widen the customer base and expand the scope of the energy technologies by offering better servicing and maintenance and pay-per-use options to the customer.**
- **Portion of upfront capital costs covered via an interest-free loan subject to customer willingness to adopt the system and pay for its use.**
- **Pay-out structure would depend on the size of the investment required for a particular business model (single system, micro-grid, etc.), customers' willingness to pay, availability of alternative sources of finance, and a minimum number of customers adopting the system.**
- **Principal does not need to procure systems but has to facilitate the availability of upfront finance for the vendors.**
- **Programme could be exited after one payback period; alternatively, recouped amount could be used to support other entrepreneurs or target new areas with similar variable usage payment options, thereby extending the scope of deployment of off-grid energy solutions.**

This case study prepared by CEEW considers innovation across the energy access value chain. This includes both innovation in business models (the 'software' of the value chain) and innovation in technologies (the 'hardware' of the value chain). While RBF interventions for the two most pressing technological innovation needs, better energy storage and more energy efficient off-grid (DC) compatible appliances, do not seem feasible, an RBF intervention supporting an innovative business model may be an effective way of increasing energy access.

2.1 An RBF for R&D in energy storage?

Pre-financing requirements and the absence of clear targets disfavour an RBF for R&D into energy storage technology in India

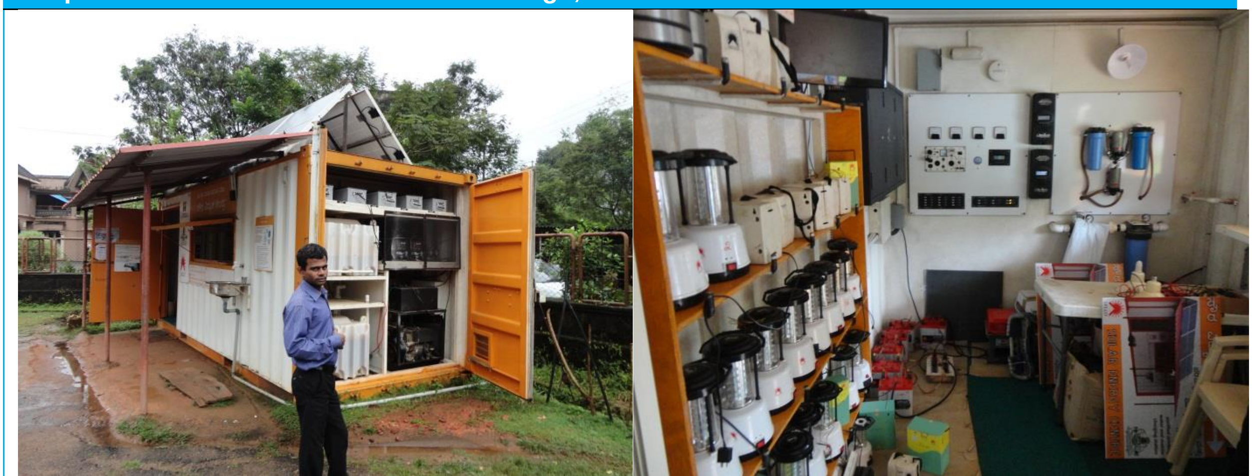
2.1.1 Introduction

Lead acid batteries have been commercially used for over a century with little technological improvement. A typical 40Ah (ampere-hour) battery that can be used to run four lights weighs 15-18 kg depending on the manufacturer. The battery weight comprises mostly lead (70 per cent) and sulphuric acid; and most of these batteries require maintenance once every six months.

However, gel batteries have been developed where sulphuric acid is mixed with silica fume, which causes it to stiffen. This reduces the weight of the battery by 15 per cent - 20 per cent but increases the cost by 25 per cent - 30 per cent. Furthermore, these batteries do not require any maintenance.

Another recent technological improvement in lead acid batteries relies on replacing one of the electrodes with activated carbon. This, in turn, decreases the weight by 30 per cent, and increases the efficiency and life of the battery.[35]

Photos 2.1 & 2.2: The exterior and interior views of a solar energy kiosk renting solar-charged lamps and batteries in Dharmasthala village, Karnataka



Photos courtesy: Arunabha Ghosh

[35] Cnet (2012) *New lead-acid battery angles for micro hybrids*, 6/1/2012, accessible at http://goo.gl/1AaD8

In order to increase energy access to consumers who are unable to afford solar home systems, a few organisations have successfully implemented a rental model for solar lighting. An entrepreneur owns a kiosk where he/she charges the battery during the daytime. In the evening either the entrepreneur distributes the batteries to the consumer or the consumer visits the charging centre to rent it (photos 2.1, 2.2 and 2.3). Since lead acid batteries are heavy, transportation becomes a tiring process for both entrepreneur and consumer, making it unattractive especially for female entrepreneurs.[36] There is also an additional cost of operating a vehicle to transport the heavy batteries. These challenges can be overcome if the weight and volume of the battery were reduced.

Photo 2.3: Fruit vendor using rented solar-charged batteries for evening lighting in Kundapur town, Karnataka

Photo courtesy: Arunabha Ghosh

Other technologies that are being experimented for grid storage include flow batteries, lithium ion, and sodium sulphur technologies. Flow batteries and sodium sulphur are being tested for large energy storage systems. It is estimated that the global market for advanced batteries would double each year for the next five years, reaching $7.6 billion by 2017 and revenues in the sector would increase to $29.8 billion by 2022.[37] For off-grid applications, lithium ion (Li-ion) batteries seem to be the best option as they have high energy density and are light in weight.

Until recently, R&D for Li-ion was focused on electrical vehicles and one of the priority areas was to reduce the weight and volume. Since both electrical vehicles and solar home systems (SHS) require daily charging and discharging, reduction in cost and weight of Li-ion batteries can greatly benefit the off-grid renewable electricity sector as well. Some industry

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[36] Interviews with rural entrepreneurs in Dakshin Kannada District, Karnataka State, 2 October 2012.

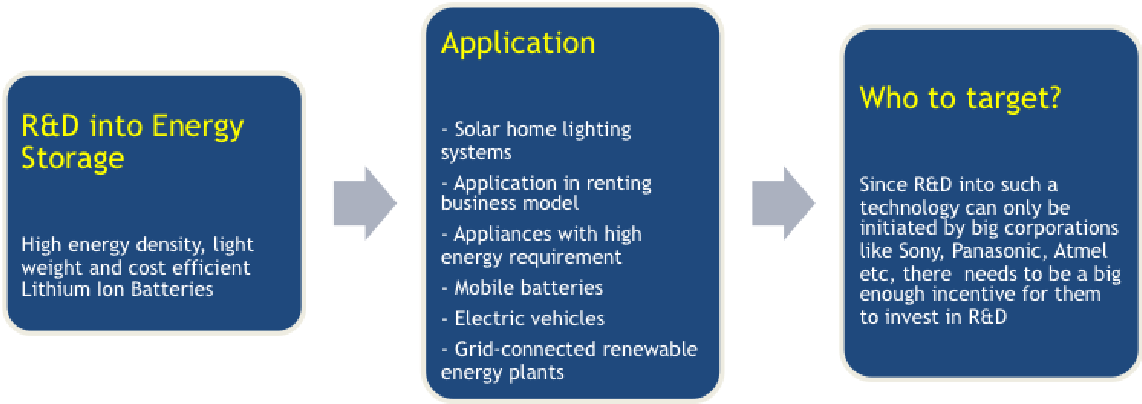
[37] Solar Thermal Magazine (2012) *Advanced Batteries for Energy Storage Will Represent a Market of Nearly $30 Billion by 2022*, August, accessible at http://goo.gl/mZ9It

predictions estimate that the prices of Li-ion batteries could fall from the present $500-$600/kWh to $200/kWh by 2020 and $160/kWh by 2025.[38]

In July 2012, Panasonic inaugurated a lithium-ion battery manufacturing unit in China, which would cater to the demand of renewable energy powered households in Europe. These cells would have a capacity of 1.35 kWh with a battery management system to control the charge and discharge of the batteries.[39] Panasonic aims to cut costs by increasing production ratio, procuring materials locally and reducing logistics cost.[40]

In India, R&D into Li-Ion batteries has been initiated by the National Centre for Photovoltaic Research and Education (NCPRE) at the Indian Institute of Technology, Bombay.[41] During the five-year project that started in 2009 NCPRE aims to increase the life cycles of the batteries and develop a prototype lithium-ion cell for high energy density applications. However, there has been no industry involvement in the project.[42]

Figure 2.1: How R&D in energy storage could be applied – and who would do it



Source: CEEW analysis

Could RBFs be used to incentivise research into low weight, high storage batteries in India? In principle, large prizes or other incentives could be used to drive innovation investment by large corporations (see Figure 2.1). But innovation depends on a number of factors, not just the amount of funding available. Unless an innovation ecosystem exists, along with the necessary funding, human capital, institutional support, regulatory environment, and commercial opportunities, it would be difficult to deliver results.[43]

[38] McKinsey Quarterly (2012) *Battery technology charges ahead*, July, accessible at http://goo.gl/XfXaj
[39] Environmental Expert (2012) *Panasonic to Begin Mass-production of Long-life Lithium-ion Battery System for Solar-powered Homes in Europe*, 4/6/2012, accessible at http://goo.gl/wJJVN
[40] Panasonic (2012) *Panasonic Inaugurates New Lithium-ion Battery Plant in China to Respond to Global Demand*, 17/7/2012, accessible at http://goo.gl/vLmji
[41] National Centre for Photovoltaic Research and Education (undated) *Solar PV Systems and Modules*, accessible at http://goo.gl/wCVDn
[42] Interview with researchers at NCPRE, October 2012.
[43] Ghosh, Arunabha (2012) *Innovation needs an ecosystem*, Sunday Business Standard, 26/2/2012.

2.1.2 Analysis of pre-conditions – (i) Upfront finance

For R&D in energy storage, the availability of upfront finance would be a major challenge. Although we could not find information on the amount of R&D investment in this area, our consultations with battery companies based in India revealed their reluctance to undertake what they felt would be very large investments. In fact, none had analysed whether there was a scope for devoting resources towards R&D. Large companies with established markets and high financial turnover have little incentive to invest in developing batteries targeted at small, rural consumers.[44] The amount of payment within an RBF scheme would need to be large enough (although unspecified) to incentivise the largest market players to enter the fray. Meanwhile, small social entrepreneurs do not have the technical base or innovation systems to develop improved batteries.[45]

2.1.3 Analysis of pre-conditions – (ii) Institutional capacity

In terms of institutional capacity, various government ministries could be tasked with implementing such a programme. For example, Ministry of Finance, Ministry of Science and Technology, Ministry of Micro Small and Medium Enterprises, or the Ministry of New and Renewable Energy (MNRE). However, none of them has a specific mandate or the budget to administer large investments into R&D in batteries.

2.1.4 Analysis of pre-conditions – (iii) Measurable and controllable outputs

Since batteries have wide applicability (lighting systems, rental models, mobile use, electric vehicles, and so on), it is likely that private consumers and entrepreneurs, including rural or urban poor, would come forward if batteries were efficient, light and durable. Thus, it might be relatively easier to structure an RBF with observable targets in the form of decrease in battery weight or increase in battery storage efficiency.

2.1.5 Conclusion

R&D in battery technologies is a promising area of innovation, which could yield concrete results. The challenge is that the institutional capacity (both public and private) as well as the large upfront investment needed towards this end are missing. Existing market conditions in India do not seem to be suited to an RBF approach, especially since the size of the investment itself is unclear. Nevertheless, if innovation could be triggered in other countries, the resulting products could be valuable for deploying in India as well.

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[44] Interviews with Exide, Luminous, Hyderabad Batteries Limited, and Amar Raja Batteries during October 2012.
[45] Interview with Selco Foundation Lab, 2 October 2012.

2.2 An RBF for R&D in energy efficient appliances?

2.2.1 Introduction

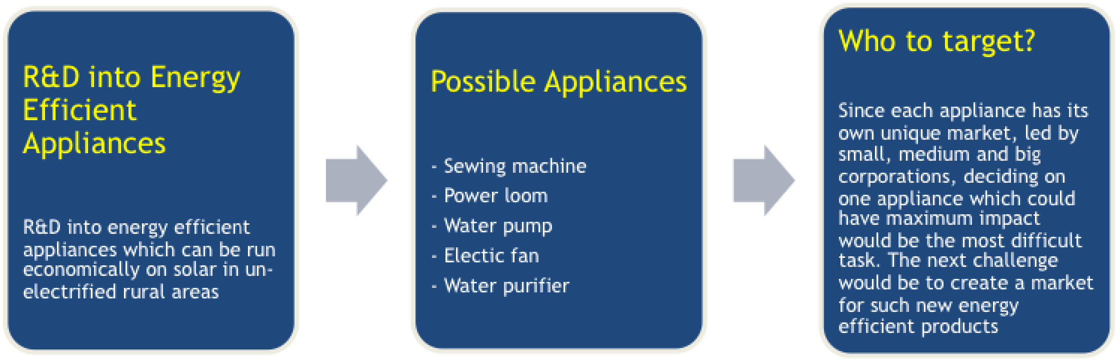
Innovation in the energy efficiency of appliances can be considered in a holistic way, integrating considerations about renewable energy, energy efficiency and livelihood generation. For instance, income generating appliances such as power looms, water pumps or sewing machines have high power requirements, which require a large amount of energy to operate and, in turn, a large amount of investment in the solar home system. But such appliances, by offering solutions beyond merely lighting, offer opportunities to raise incomes and broaden the economic and social impact in rural communities (say, by allowing women entrepreneurs to establish small home-based businesses).

A sewing machine may consume 150 W (watts) whereas the power consumption of power looms and water pumps may vary from 1 HP (746 W) to 3 HP (2238 W). A small enterprise running five sewing machines for 8 hours/day may require energy worth 6000 Watt-hours/day. The cost of powering such a system net of government subsidies with one-day battery backup would be Rs.290,000 (approx. USD 5,300). This cost, however, could be reduced significantly if the sewing machines were made more energy efficient. A sewing machine with a more efficient power consumption of 75 Watt may only require Rs.140,000 (approx. USD 2,600) worth of investment in a solar home system.

Based on the high capital cost of installing a solar system to run a small rural enterprise, this option is often not financially feasible for rural households. CEEW's discussions with sewing machine companies in India revealed that they did not have a specific R&D department to improve power efficiency. They already enjoy deep market penetration and have little incentive to expand into new areas, such as servicing small rural businesses. Moreover, most of the machines sold are currently imported rather than manufactured in India, so the R&D capacity is also limited.[46] Also, since the demand for such machines would be low as compared to existing alternating current (AC) machines, companies are unlikely to invest in developing a small, niche product. If R&D were incentivised *and* coupled with public procurement, then companies within or outside India might assume the task of manufacturing newer, energy efficient models of various appliances.

[46] The views expressed indicate the sentiments of one of two major market players that were interviewed by CEEW. Numerous attempts to get details from the other major company did not yield any results.

Figure 2.2: How R&D in energy efficient appliances could be applied – and who would do it



Source: CEEW analysis

2.2.2 Analysis of pre-conditions – Measurable and controllable outputs

An RBF focusing on R&D to redesign appliances to make them more energy efficient could lead to a reduction in the investment for solar systems for homes and small enterprises. It could also create new opportunities for livelihoods and employment for poor households unconnected to the electricity grid. However, the RBF would only work if specific appliances were targeted for increased R&D spending (Figure 2.2). Unlike batteries, which have wide application, the types of appliances demanded by different rural entrepreneurs would vary from place to place. There are multiple potential consumers for multiple appliances and the decision to choose one appliance to focus R&D efforts would be difficult. Alternatively, the target could be a consumer appliance, like efficient fans, which have wide demand but its income generation potential would be low. Moreover, as in the battery example, the RBF instrument would need to be large and attractive enough to incentivise the biggest market players (of the selected appliance) to increase R&D spending in developing products that would be both more efficient and run on direct current (DC) for sale to a niche market.

2.2.3 Analysis of pre-conditions – Upfront finance and institutional capacity

Given the difficulties in choosing one particular appliance to target incentives at, the questions of upfront finance and institutional capacity becomes even harder to deal with.

A large part of our field visits were associated with understanding the needs of entrepreneurs or local vendors who had a sense of the demand for lighter or more efficient products. As a result, we have been able to illustrate the nature of R&D requirements, the range of applications and the potential target beneficiaries for an incentive scheme. But small-scale operators or social entrepreneurs cannot perform the type of innovation required. There is a need to incentivise large companies to undertake such R&D operations. Having contacted large manufacturers, we neither found much enthusiasm about undertaking such operations, nor any idea whether they had the in-house financial ability or inclination to kick-start R&D in such areas.

2.2.4 Conclusion

Since the case fails to meet the three necessary preconditions for an RBF to be viable, we decided not proceed with designing an RBF mechanism for R&D in efficient appliances. Note that we have not dismissed the potential for R&D in these cases. But the nature of the challenges facing R&D in products, have kept us one step short of developing the RBF design for R&D in energy storage or energy efficient appliances in India. If the conditions were appropriate elsewhere (or at the global level), then perhaps innovation prizes could be used to stimulate research and product development.

It is also possible that there may be other hardware innovations worthy or an RBF-like incentive. The reason we focused on batteries and appliances is because in all our conversations with field-level NGOs, social entrepreneurs, or vendors, these two were the ones that were most frequently cited. The same stakeholders mentioned why it was difficult to stimulate innovation in these technologies under present circumstances.

2.3 An RBF to support innovation in energy access business models?

An RBF may be effective at supporting the roll-out of promising new energy access business models

2.3.1 Introduction

In India, although there is a case for improving battery or appliance technology, the highest urgency of innovation lies in filling prominent gaps in servicing, maintenance and financing of off-grid renewable energy systems. The evidence suggests that, in order to access reliable and affordable energy technologies, poorer households need innovations not just in products but also in the finance available to buy SHS. They also need better servicing and maintenance of the SHS component installed in their homes.[47] Currently, it is difficult to find innovations targeted at the needs of poor households for two main reasons:

1. *Financial Risk:* Large and small financial institutions are unable to visualise the long-term benefits in investments in off-grid solar. This results in fewer financial innovations that make such systems more accessible to rural and poor households.[48]
2. *Lack of Commitment:* Manufacturers try to sell products designed for the developed markets rather than to the 'Bottom of the Pyramid' (BOP). Most organisations do not consider innovations for the BOP market a main priority for the company's business. As a result, adequate management and technical resources are not allocated nor research budgets earmarked for low-cost innovations. Rural markets for off-grid electricity are challenging since profit expectations are low. Potential market participants are hesitant to invest resources to innovate products targeted at poor households. Moreover, they are

[47] See generally, Selco (undated) *Need for Innovations*, accessible at http://goo.gl/vN3jV
[48] *Ibid*

unable to judge the needs of the end-users in rural areas due to a lack of capacity to serve these regions. Ultimately, the number of service providers catering to the needs of the non-electrified households in rural areas remains low. [49]

CEEW has identified two specific innovation needs in service and finance that could potentially be targeted with an RBF.

Servicing and maintenance of off-grid energy access technologies

One of the main problems facing customers of solar home systems (SHS) is poor after-sales servicing and maintenance. Entrepreneurs hoping to serve off-grid energy solutions face a vicious cycle of bad history, lack of trust, and insufficient finance. In the past, the government has heavily subsidised or distributed free solar lights in non-electrified villages.[50] However, poor quality systems, lack of after service and poor maintenance have created a lack of trust among customers.[51] In turn, households have been unwilling to pay for the systems when there are few guarantees for the quality of the product or the efficiency of the after-sales service. A small customer base, small deal sizes and lack of information about renewable technologies are reasons why banks are averse to giving upfront finance to entrepreneurs. There is, then, a need to incentivise better service provision by vendors, such that customers are satisfied with the product and do not default on their loan repayments. Over time, this could revive confidence among financial institutions to consider financing off-grid renewable energy projects.

Payment processes for energy access technologies

The second issue concerns the ability of customers to pay for the SHS. With the off-grid sector mostly comprising poor households, there is a need for innovation in the financing options available to such households to adopt new energy access technologies.

An example of a company developing solutions to overcome shortcomings in servicing and finance is Simpa Networks.[52] It has developed a solar home system that runs on the 'pay as you go' prepaid model. The customer purchases credits in advance and the system automatically shuts down once the credits are exhausted. The battery powering the system is locked in a box on to which a 'smart meter' is installed. The meter is responsible for regulating electricity use. One major concern is that the system could be tampered with. Simpa is trying to mitigate this problem by selecting its customers carefully. This time-consuming process will become harder to sustain as soon as the company tries to scale up its operations and expand its customer base.[53]

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[49] *Ibid*

[50] The Times of India (2011) *HC order govt to arrest 233 mukhiyas*, 25/8/2012, accessible at http://goo.gl/ohuJ0

[51] CEEW discussions with rural and urban poor consumers in Karnataka, 1 and 2 October 2012; also see PV Magazine (2010) *I came, I installed…I left*, November 2010, accessible at http://goo.gl/72TiS

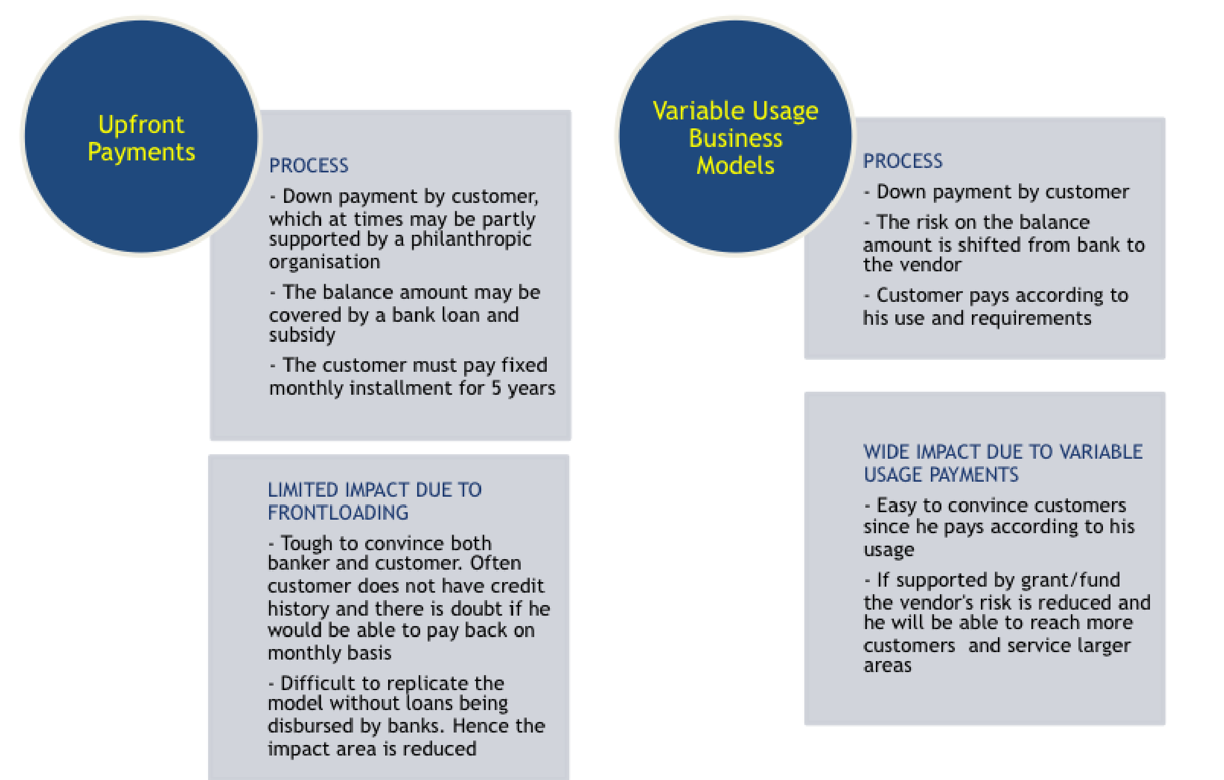
[52] See generally, http://simpanetworks.com/

[53] This example has been offered not to make it central to the case study or to support Simpa *per se* as a company. Instead, the aim is to illustrate how entrepreneurs offering off-grid energy solutions based on more reasonable payment structures for customers are encumbered by the need to restrict or slow down the scale of operations.

The above example highlights how some vendors are trying to ease financing hurdles by offering households a more flexible choice for making payments. The customer does not necessarily have to make monthly interest payments to banks or other financial institutions, nor be burdened by a loan for the capital cost of the system. In turn, the prepaid nature of the service allows the household to design expenditures on electricity according to expected and actual financial flows. Moreover, since the customers would purchase units in advance only if they are sure that the system would work, the servicing of the system is automatically part of the contract with the vendor.

The use of SHS is likely to become widespread only if both the system *and* after-sales service are of high quality, and if people are satisfied enough with the system to be willing to pay for the electricity generated. Thus, innovative business models based on 'flexible payments' could help to increase the uptake for SHS on two fronts: first, by lowering the upfront costs for customers by giving them flexible payment options, and secondly, by tying payment to better servicing, the risk of systems failing is borne by the vendor instead of the customer (see Figure 2.3 for a comparison of business models based on upfront and variable usage payments).

Figure 2.3: Upfront payments vs. variable usage business models payments



Source: CEEW analysis

At the same time, such businesses have a limited window with privately raised equity investments to continue their pilot-testing phase. Financial requirements may vary from company to company. A small company comprising 3 to 4 employees with sales of

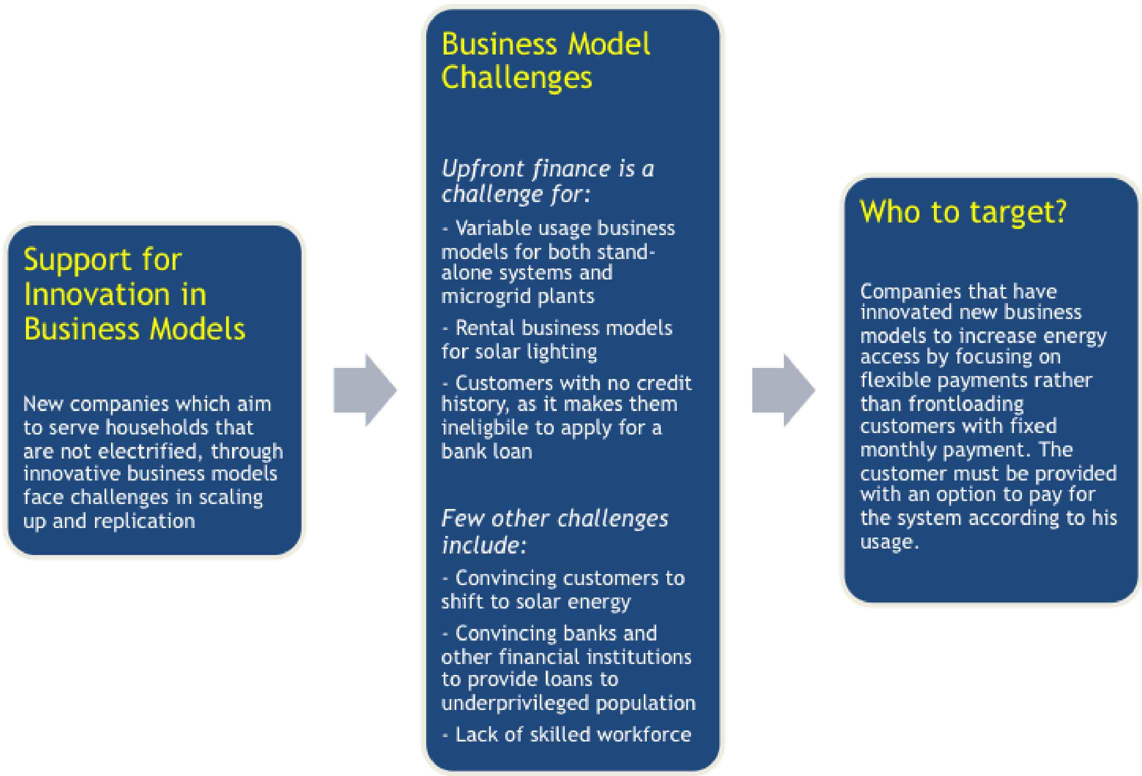
Rs.200,000 to Rs.300,000 ($3700 to $5555) per month, would require approximately Rs.2,000,000 to Rs.2,500,000 ($37,000 to $46,300) for operating a single branch within a radius of 50 km. CEEW's discussions with one vendor suggests a need for additional sources of finance to continue operations.[54]

2.3.2 The case for RBF to support business model innovation in energy access

Variable usage payment business models aim to widen the customer base and expand the scope of the energy technologies by offering better servicing and maintenance and pay-per-use options to the customer. Thus, they offer both quality assurance and ease a customer's upfront financial burden to take up off-grid energy applications.

An RBF could, thus, be used to promote innovation in financing options that creates new business models for existing off-grid products (figure 2.4). For instance, there are gains from innovation in variable usage business models as these have the potential to target two challenges: (a) aversion to take large loans for the capital cost; and (b) concerns about system quality and poor past experience with lack of after-sales service.

Figure 2.4: How innovation in business models could be applied – and who would do it



Source: CEEW analysis

[54] Stakeholder discussion with Bangalore based vendor on 26 September 2012

However, the RBF would also have to be structured in a manner that eases some of the risk for the vendor. Otherwise, the risk of upfront capital investment is shifted entirely on to the vendor, the main reason why these businesses are carefully selecting consumers and limiting their operations. This is the case not only with companies like Simpa, which are relatively better known, but also with smaller or potential entrepreneurs who are planning to set up businesses offering solar lighting on a rental basis.[55] An RBF that promotes variable usage business models (to benefit consumers) would also have to help potential entrepreneurs with support in the form of working capital.

2.3.3 The case for choosing RBF – (i) necessary pre-conditions

Here, we discuss the design of an RBF mechanism for encouraging variable payment business models. Similar to the approach followed in the previous case study, we first examine whether the three necessary preconditions for using RBF instruments are fulfilled:

1. Sufficient access to upfront finance
2. Sufficient institutional capacity
3. Measurable and controllable outputs

A major part of the discussion on upfront finance and institutional capacity mirrors the discussion in the previous case for an RBF for SHW systems in India. There are multiple agencies and government ministries that could be tasked with providing finance to and implementing a new RBF scheme. However, no one particular institution can be identified that has a mandate to advance the objectives proposed by the RBF scheme. We will, however, attempt to highlight some other factors that could help iron out issues of upfront finance and institutional capacity.

Upfront finance: In addition to the existing market capital of companies, different financial packages in the form of solar loans are available through banking or micro-finance institutions.

Recently, the World Bank Group's *infoDev* has proposed an India Climate Innovation Centre (CIC), which aims to be a holistic country-driven approach to accelerate the development, deployment and transfer of climate technologies. It is being piloted as a mechanism to support innovation by offering a full suite of services to address locally relevant barriers to climate technology commercialisation. In addition to supporting promising new technologies and ventures, CIC could also provide access to finance, equipment and facilities, market information, policy advocacy and technical assistance, as well as facilitate national and international collaboration.[56]

The mission of the CIC is to create, leverage and aggregate a holistic portfolio of programmes, services and financing in India that bridge local market gaps and support the

[55] CEEW discussions with potential entrepreneurs in Udupi city slum and Dharmasthala village, Karnataka, 1 and 2 October 2012.
[56] India Climate Innovation Centre (CIC) – Business Plan at p.11, available at: http://www.infodev.org/en/Project.127.html

accelerated growth of innovative climate technology ventures. Its core goals consist of filling market gaps by:

- Giving access to flexible finance at a number of strategic levels.
- Building capacity of new and existing enterprises and facilitating the interaction of innovative enterprises with large industry.
- Enabling collaboration and supporting an ecosystem that aggregates existing partners.
- Creating regional clusters of innovation to leverage existing resources and infrastructure.
- Providing a hub for building international partnerships that can facilitate technology transfer and collaborative R&D, as well as business-to-business linkages.[57]

An important consideration, then, would be whether the CIC could be relied upon to provide additional finance to spur innovation in the identified areas. That said, the CIC need not be the only funding source. The challenge is to create a financing ecosystem for renewable energy, in general, and for off-grid applications and business models, in particular. There are early-stage attempts underway to create networks of financiers, technology developers, government institutions and other stakeholders, which could potentially promote innovative business models and small-scale entrepreneurs.[58] It is too early to comment on the success of these efforts.

Institutional capacity: The institutional capacities of the agents and principal are seemingly in place. There are numerous schemes through which external donors and public agencies within India channel funds to non-governmental (for-profit or not-for-profit) organisations to deliver services.

However, if a new agency, such as CIC or NCEF, is tasked with the RBF instrument then there may be insufficient institutional capacity to achieve the desired results. This is because the CIC is at the pre-implementation stage, with only a business plan for the financing and implementation of CIC in India. However, the structure of CIC indicates that it would provide a range of services such as finance, capacity building, ecosystem development and innovation cells. Such an enterprise could help drive small innovators who offer new payment processes and better servicing by creating a new self-sustaining business model.

Similarly, as the case study on solar water heating illustrated, the NCEF's mandate has not been finalised and, to the extent some guidelines exist, they are not being followed. Moreover, if the NCEF becomes one of the new agencies through which funds are channelled, then its capacity would have to be strengthened.

Measurable and controllable outputs: The task of determining the measurable and controllable outputs would be challenging but manageable. For instance, the kind of payment processes that would qualify as "variable payment" would have to be determined upfront. In addition, the contracts would have to define the metrics for pay-outs: whether selling off-grid solutions to single households or small businesses, or entire communities, or even a larger scale of deployment.

[57] *Ibid* at p.7

[58] CEEW will be leading work in this area over the coming months, but at this stage there are no operational networks that could be referenced.

2.3.4 The case for choosing RBF – (ii) The risk-incentive trade off

In order for the RBF to be preferred over conventional instruments such as an upfront grant, the gains from stronger incentives should outweigh the cost increase from the risk transfer to the vendors.

a. Is the result under the control of the agent?

Yes, the result is mostly under the control of the agent as they are in charge of increasing the number of SHS by offering more flexible payment options to the customers. The more they ease the upfront cost burden of the customer, the greater the numbers they should manage to sell (so long as vendors have the working capital to cover the capital costs in advance).

b. Is there a clear line of sight for the principal to the result against which the result-based payment is being made?

Yes possibly. The principal would have to judge the result based on specific metrics against which the payment is being made. These metrics would largely depend on deciding what are counted as 'variable usage' business models and on the scale of deployment. As long as the principal is clear on these criteria, it should be easy to define whether the results have been achieved.

c. Does the RBF stretch the balance sheet of the agent?

It depends. RBF would stretch the balance sheet of the agent compared to a business model where the customer assumes the burden of upfront down payment and/or a bank loan. However, if the aim were to win more customers by offering 'variable usage payment' schemes, then the RBF mechanism would ease the balance sheet of the agent by giving it a portion of the working capital it would need to cover capital costs. In the absence of the RBF intervention, the agent could recover its costs over the payback period, but would have to bear the entire risk of capital investment in the interim.

Could the agent hedge some of the risks by relying on alternative revenue streams? Yes, if the agent were a large firm with a range of energy products and services in its portfolio. In that case, variable usage payment models would be only a new type of service offering and the agent could, in fact, draw on its trust and credibility in existing markets, as well as any working capital, to win new customers. But, as the problem has been described here, the challenge is faced mostly by small social entrepreneurs without other sources of revenue. To the extent such vendors break into new rather than existing markets, their scale of operations is limited by access to capital and concerns about whether customers will eventually pay or not. Such small vendors would rely on an RBF-type instrument to cover some of the risk of initial capital investment.

d. Is the cost base largely variable?

The cost base of the RBF is entirely variable. The payment would only come through if all relevant stakeholders had agreed to deploy a system based on variable usage payments. These stakeholders would include both the vendor and the customer (household) but also potentially the local bank (say, to guarantee the customer's contract with the agent).

Note that here the bank's role is not to offer a loan. Instead, the bank could simply vouch for the customer if, say, she/he had an account. In one city slum, CEEW researchers found that a local bank had agreed to lend to one SHS customer, only when all other households in the slum had opened bank accounts in the local branch.[59] This way of establishing and leveraging social capital could be even more effective for variable usage payment businesses, since the upfront investment would be low for the customers. In the case of variable usage business models, so long as a household opens a bank account, local banks could be willing to offer a statement in favour of the household. The costs for the agent would be directly linked to the number of systems so installed.

e. What is the time horizon of the RBF?
As with the SHW case study, the time horizon is unclear at the moment. It would depend on how long the entire scheme runs. However, a part of the pay-out must be given upfront as long as the household agrees to the installation and a local bank vouches for the customer. The RBF scheme should run at least for the length of the payback period for recovering costs via a 'variable usage payment' scheme. In this way, the vendor could use revenues earned during this period to support investments among new consumers.

2.3.5 The case for choosing RBF – (iii) Positive spill-over effects

Some of the positive spill-over effects of a successfully designed RBF for variable usage business models are highlighted below:

- Access to electricity for households not eligible for loans. Availability of electricity could potentially lead to an increase in productive activities and raise the income of a household. A few examples of such activities are: studying for longer hours, rolling *bidis* at night, and engaging in small trades such as selling fruits and vegetables after sunset, or stitching clothes at night to generate an extra income.[60]
- Reduction in burns and injuries due to use of kerosene lamps.
- Reduced indoor air pollution.
- Reduction in travel time to purchase fuel.

2.4 Designing RBF interventions relevant to the problem

In designing the RBF based on the analytical framework, we will detail the following: eligibility, conditionality or trigger for paying out the RBF, structure of the pay-out, and the role of the principal.

[59] Field visit to Udupi city slum, Karnataka, 1 October 2012.

[60] Observations during CEEW field visits, October 2012.

2.4.1 Designing RBF interventions relevant to the problem – (i) Eligibility

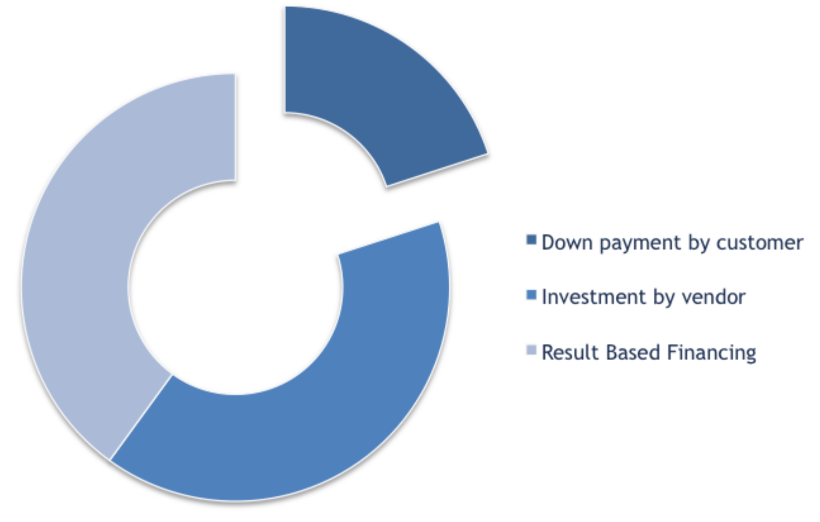
The RBF mechanism would be aimed at companies that create new business models by offering variable usage payment options to customers, thereby increasing the uptake of SHS. The eligibility could be based on certain additional criteria such as minimum numbers of households serviced or a threshold number of households that have agreed to have the SHS installed in a particular target area.

2.4.2 Designing RBF interventions relevant to the problem – (ii) Conditionality

The RBF intervention would be paid as an upfront amount as soon as the household agrees to install the system. The RBF, in essence, would supplement the investment made by the investor in order to dilute his risks. For example, as illustrated in Figure 2.5, if a portion of the cost is paid by the customer as down payment (a sum much smaller than if the customer had to cover upfront capital costs of the system), then the RBF could be set at half of the remaining cost of the system.

Our suggestion is that a part of the payment incentives should be linked to after-sales service, for example, half-yearly or annual maintenance visits. Is there a possible inconsistency between our stress on the need for after-sales support and the RBF, which is designed to ensure that the vendor does not have to bear the entire burden in terms of continued use of the system? Not really. This is because while the RBF reduces the vendor's payback period, she/he would still bear most of the cost for the system. The return on investment would continue to remain contingent on the continued use of the system, which would ensure a steady revenue stream. This would not happen unless the after-sales service is of high quality and the system retains its integrity in terms of power output.

Figure 2.5: Breaking down the total cost of SHS under the proposed RBF mechanism



Source: CEEW analysis

2.4.3 Designing RBF interventions relevant to the problem – (iii) Pay-out structure

The aim here is to incentivise entrepreneurs who, in turn, target customers through variable usage payment options. An entrepreneur may provide services either through standalone systems or through micro grids. Often potential customers are not eligible for bank loans due to absence of credit history or required documentation. To service these customers vendors have to bear the risk of non-payment. An RBF can assist the vendors by covering a part of the risk by providing assistance in form of an interest free loan. Once recovered it may be utilised for the next cycle of assistance on discretion of the lender.

Since the RBF payment would be made upfront to the vendor, it should not be mistaken as a subsidy. Rather, it could be considered as a result-based incentive through an interest-free loan. The costs recovered by the vendor from the customer over the stipulated time period should help him to pay back the RBF amount to the principal. This is a response to the absence of bank financing for such risky business models illustrated earlier. Alternatively, the principal could also allow the money to be reinvested into another cycle of system installation. This is why we recommend that the RBF programme should run for at least the length of one payback period. In turn, this could make the business model a self-sustaining success story.

Entrepreneurs operating micro grids often service areas where population density and electricity requirements are low to medium. Hence, large investments are required for setting up and operating micro grid plants. There may be a possibility that customers may not be willing to pay the amount desired by the developer. Hence, for micro grids the assistance may be in the form of the difference between the amount per unit desired by the developer (to generate a positive net present value with a discount rate greater than or equal to the cost of capital or the required internal rate of return) and the amount the customer is willing to pay.

2.4.4 Designing RBF interventions relevant to the problem – (iv) Role of the principal

The main role of the principal in this case would be to help facilitate the shift from frontloading investments on customers to creating a more sustainable ecosystem for the market players to branch out into newer areas with their innovative payment structures. The principal may also conduct monitoring and third party verification from time to time, in order to ensure that the installed systems are functioning well. In this case, however, the customers would be the best verifiers, as they are unlikely to pre-pay for electricity if the systems are not well maintained or serviced.

2.4.5 Designing RBF interventions relevant to the problem – (v) Exit strategy

The proposed RBF mechanism in this case study is designed to encourage innovation in business models. The ultimate objective would be to create a self-sustaining market for these new business models. According to the main report, this would benefit from a phased exit strategy.

The principal should ideally look to reduce RBF payments after a stipulated minimum period by which time the market has reached the point of self-sufficiency. In this case, the main challenge for variable usage payment models is not the cost of the system itself but the ability of vendors to assume the upfront costs *and* the risk of supplying electricity or other services to unknown customers. The RBF serves as a way to cover a portion of those upfront costs and reduces the payback period for the vendor, thereby allowing the vendor to reach out to a wider customer base.

If one round of funding were successful and it resulted in regular customer usage and per-use payments for the service delivered, the recovered funds could be reinvested in a second round of installations or could be returned to the RBF principal. The principal, in turn, could use the funds to stimulate similar business models in other areas or with new vendors. Or, if the funds were limited and available only for the duration of one payback period for a particular business model, the programme could be shut down subsequently. Either way, the risk for the RBF principal is low.

2.5 Conclusions

The main premise of this case study was to analyse the scope of facilitating R&D for the wider application of renewable energy technologies, which go beyond home lighting and into more productive uses. There was a case for R&D in energy storage by making batteries more efficient, light and durable. However, this case failed to meet the necessary preconditions for an RBF to be viable. A similar case was made for R&D into energy efficient productive (income-generating) appliances, but it too failed to meet the necessary criteria for the application of an RBF mechanism. There remained the case for innovation in business models, whereby an RBF was proposed to encourage new and innovative business models that offer variable usage payment options to customers.

The prices of solar lighting systems have decreased in recent years making it comparable to the conventional electricity generation systems. However, upfront finance remains a major challenge among rural households. Recently a small number of entrepreneurs and vendors have tried to overcome this barrier by providing the end user with the option of variable usage payments. A business model that customises the payment structure based on customer needs could potentially increase the demand for these systems. The risk of non-payment, however, still lies with the entrepreneur. The proposed RBF scheme is, thus, designed in the form of an interest free loan that could help the entrepreneur reduce the risks as well as offer high-quality service to a larger number of customers than would otherwise have been possible.

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