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Energy and Water Supply Services: Improving Efficiency through Policy and Regulation

Energy efficiency and water conservation are each important for the delivery of electricity and drinking water. Energy efficiency can increase affordability by reducing consumers' electricity demand, expand access by reinvesting efficiency gains to increase network access, and improve sustainability by contributing to energy security and reducing harmful environmental impacts. Water conservation can help control expenses, improve service delivery, and increase the amount of available drinking water without incurring prohibitive costs.

The supply of energy and water services is also interlinked. Energy is essential to the supply of drinking water and irrigation because electricity is needed to extract, treat, and transport water to end users. Water utilities use significant amounts of energy; it is one of their largest cost items, if not the largest. For example, in the Philippines the energy cost is 0.3 to 1.0 kilowatt-hours (kWh) for every cubic meter of water supplied,[1] while in the United States the energy cost for ground water is 0.4 to 0.5 kWh per cubic meter.[2] In seven Southeast Asian countries, the typical electricity expense for the water supply is 18% of final water cost.[3] Figure 1 shows the cost of power and fuel as a component of operation and maintenance costs for water utilities in India.

Water is also needed to generate and supply electricity. Conventional energy suppliers use enormous amounts of water to help remove pollutants from power plant exhausts, generate steam that turns turbines, flush away residue after fossil fuels are burned, and lower the temperature of power plants through the cooling stations.[4] Renewable energy producers harness the energy conveyed by water to generate electricity from hydropower, geothermal, or tidal energy plants.


ADB PHOTO LIBRARY

A man exchanges his incandescent lightbulbs with energy efficient compact fluorescent lamps

Thus, energy and water efficiency measures can reduce costs for both energy and water utilities, hence improving the viability of utility operations and increasing the available revenues for expanding access. Increased water and energy efficiency can also reduce depletion of primary energy resources needed for new generation and ensure better use of available water resources; overall, it reduces the carbon footprint of energy and water services. Box 1 sets out examples of how electricity and water use interact.

Box 1: Electricity and Water Use

Water and Electricity in the Kathmandu Valley, Nepal
Communities in the Kathmandu Valley have very high electricity bills—up to 20 times the size of their water bills. This is unusual in South Asia, which has an average ratio of 4:1.[a] It was found that these communities use extra electricity to pump and store water because local suppliers provide unreliable and intermittent service. Reduced demand and improved delivery of water would reduce electricity use and increase the disposable income of this community.

Water and Electricity in Andhra Pradesh, India
In 2004, the Government of Andhra Pradesh introduced a policy that supplied free power to farmers who use water pumps for agricultural irrigation.[b] The policy requires that the water pumps be made more efficient by changing to more efficient motors, installing capacitors, using plastic pipes, and using frictionless foot valves.

Water and Energy Use in Samoa
In Samoa, 40% of the country's energy is generated from hydropower. Hence, low rainfall leads to low water levels in dams, significantly affecting the provision of electricity. Samoa is constantly looking to increase energy efficiency and diversify its sources of renewable energy to improve this situation because drinking water uses will be prioritized above electricity use in times of scarcity under 2010 regulations. Any action that improves the efficiency of water and electricity supply will increase the amount of resources available for use.

a A. McIntosh. 2003. *Asian Water Supplies: Reaching the Urban Poor.* Manila: ADB.
b Prayas Energy Group. 2008. *Awareness and Action for Better Electricity Service: An Agenda for the Community.* Pune: Prayas.

1 Subic Bay Water Regulatory Board's e-mail to A. de Vera, an Asian Development Bank (ADB) Water Consultant.
2 Center for Sustainable Systems. 2009. U.S. *Water Supply and Distribution Fact Sheet*. Pub No. CSS05-17. Ann Arbor: University of Michigan. http://css.snre.umich.edu/css_doc/CSS05-17.pdf
3 Asian Development Bank (ADB) and Southeast Asian Water Utilities Network (SEAWUN). 2007. *Databook of Southeast Asian Water Utilities 2005*. Manila and Hanoi: ADB and SEAWUN. The energy cost for water supply is 23% of water operating expense. The final water cost is equal to 76% water operating expenses plus 24% overhead costs. This makes electricity expense 18% of the final water cost.
4 B. Sovacool. 2009. Running on Empty: The Electricity-Water Nexus and the U.S. Electric Utility Sector. *Energy Law Journal*. 30 (11). p. 16.

Increasing the efficiency of water and electricity supply and use reduces consumers' need for the utility service. It also leads to more reliable electricity and water supplies and more efficiently run utilities, which can lead to lower prices for consumers or additional revenue to invest in expanding access.

The Importance of Energy Efficiency Services

Energy efficiency involves all changes leading to lower energy use for a given energy service (such as home appliances, lighting, heating, or cooling) or for a given level of activity.[5] It can result from technical changes, better organization and management, or improved sector economic efficiency.[6]

Energy efficiency services help consumers directly by reducing the demand for energy.[7] They can also help consumers indirectly, because efficiency gains can be reinvested to expand network access to unconnected consumers or be transferred to consumers, making energy services more affordable. Many different programs with different funding sources have been developed to assist in reducing energy consumption in low-income households.

Low-income consumers lack access to capital for investments in energy efficiency. Well-off consumers may be willing to invest in measures such as energy efficient appliances because they are cost effective over the full life of the appliance. However, often low-income consumers cannot even afford efficiency measures that would pay for themselves within a year. Thus, in most markets, the investment cost for energy efficiency technologies is a barrier that prevents low-income households from replacing their energy-inefficient equipment.

KALA MULQUEENY

Solar-wind powered street lighting in Palawan, Philippines

Establishing energy efficiency standards sets a targeted level for energy savings. It requires either a state or province or a utility to achieve targeted levels of energy savings (which in some jurisdictions has been framed as a reduction in greenhouse gas emissions). Energy savings are usually achieved by demand-side, end-use efficiency programs. For example, in the United States, 19 states have adopted an Energy Efficiency Resource Standard that requires achievement of specified energy savings targets by implementing energy efficiency programs.[8] These energy savings are tracked through a scheme certifying energy reductions as white certificates. In the United Kingdom, energy efficiency standards of performance require electricity retailers to spend money on residential consumers for energy savings targets. In 2000, the program was extended to all electricity and gas suppliers for residential consumers. Similar targets have been imposed in New South Wales, Victoria, and South Australia.

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Role of Policy Makers and Regulators

Policy makers and regulators can establish policy and regulatory incentives to promote energy efficiency. Policy makers can improve electricity supply services by integrated resource planning (IRP) or requiring electricity utility service providers to engage in IRP. IRP seeks to consider both demand-side (energy efficiency) and supply-side (efficiency and new generation) options for meeting energy needs that address new technological developments and environmental constraints in the most cost-effective way.[9] It also factors in environmental and social costs of different energy generation options. In addition, IRP seeks more rational planning for new generation projects and could potentially limit opportunities for corruption and sweetheart deals for large projects, the excessive costs of which are paid by the poor or require subsidized tariff increases.[10] Regulators can encourage efficiency by approving tariffs that set forth the terms under which the utility will provide grants and loans to pay for energy efficiency measures. A key way for regulators to promote energy efficiency programs is by allowing utilities to claim the costs of the energy efficiency program as allowable costs in rate cases or tariff determinations. Regulators can compel regulated entities to require consumer compliance with minimum efficiency standards for buildings and appliances before obtaining electricity services (hookup standards). Policy makers and regulators can also require

5 United Nations Environment Programme. 2006. *Energy Efficiency Guide for Industry in Asia*. www.energyefficiencyasia.org/aboutee.html (hereinafter "Energy Efficiency Guide, 2006").

6 Energy Efficiency Guide, 2006.

7 While energy efficiency measures or DSM generally reduce energy consumption, from the tariff side they can actually increase rates through their ability to defer CAPEX requirements for supply-side system upgrading. Examples include DSM cost recovery across an entire customer class or slow tariff increases over the long term. Lifeline customers paying fixed minimum rates may also not experience a reduction in energy expenditures. In these cases, other tariff subsidies or lifelines may still be required.

8 L. Schwartz. 2009.

9 J. Swisher, et al. 1997. *Tools and Methods for Integrated Resource Planning*. Denmark: UNEP Collaborating Centre on Energy and Environment.

10 Prayas Energy Group. 2008. *Awareness and Action for Better Electricity Service: An Agenda for the Community*. Pune: Prayas.

regulated entities to implement demand-side management (DSM), supply-side efficiency programs, and other measures such as those described below.

Demand-Side Energy Efficiency Programs

Opportunities for significantly increasing energy efficiency have been identified in several areas. Traditional buildings and housing are known to have inefficient insulation for both hot and cold weather. In Asia, buildings consume significant electricity for air conditioning (in the hot tropical countries) and for heating (in the cooler winters of eastern and central Asia). Inefficient lighting, followed by inefficient appliances such as ceiling fans, air conditioners, and refrigerators, also waste significant electricity. With these known areas of inefficiency, opportunities exist for improving energy efficiency in building and housing insulation, lighting, appliances, and the other areas described below.

Retrofitted Buildings and Housing. Retrofitting buildings and housing with more energy efficient structures, equipment, or appliances includes investment in windows, insulation, caulking, weather stripping, and other building shell improvements. The most successful programs combine funds from the utility service provider, government, and grants, with little or no contribution from the recipient low-income households. In Australia, the Green Start initiative, a national program directed at low-income households, seeks to improve the energy and water efficiency of low-income and disadvantaged households by providing free home energy and water assessments; free supply and installation of energy and water efficiency products such as pipe insulation, efficient light bulbs, low-flow showerheads, draft-proofing, and seals for refrigerators, doors, and windows; and personalized help with accessing rebates and programs, and dealing with landlords and trades people in implementing the measures.[11] Home and building retrofitting may offer somewhat less potential for energy efficiency savings for consumers in developing countries than in developed countries, but energy efficiency is critical in the design of new housing for urban and rural households.

Opportunities for significantly increasing energy efficiency have been identified in… building and housing insulation, lighting, appliances, and other areas.

Efficient Lighting. These are programs aimed to help realize energy savings through improved efficiency of existing lighting systems and accelerate the deployment of new clean lighting technologies.[12] The European Commission adopted an Eco-Design Regulation in March 2009 that seeks to improve the energy efficiency of household lamps and provides for the progressive phasing out of incandescent bulbs beginning in 2009 until the end of 2012. The Asian Development Bank (ADB) has partnered with Nepal, Pakistan, and the Philippines to collect incandescent light bulbs and replace them with compact fluorescent lamps for little or no charge to the consumer.[13] Also in Nepal, street lights powered by wind and solar sources have been installed in lieu of standard electric street lighting.[14]

Efficient Appliances. Efficient appliances are those that meet the minimum government standard for energy efficiency. Establishing standards for appliances can be among the most cost-effective options available to governments and utilities for controlling demand, satisfying energy demand projections,[15] and allowing a limited supply of electricity to better serve a larger portion of the population. The Energy

IAN GILL

A woman proudly showing her improvised kerosene lamps, empty bottles are filled with kerosene and topped with a wick, and used as lighting in the evenings. Switching from kerosene to electricity improves safety and health

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11 Australian Government Department of Environment, Water, Heritage, and the Arts. Green Start. www.environment.gov.au/sustainability/greenstart/index.html (hereinafter "Green Start"). Similar state measures are also in place to provide low-income energy efficiency housing retrofit support. For example, the State of Victoria has had the Energy and Water Task force in operation since 2003 to assist low-income residents. The program offers free energy and water home improvements to low-income households in Victoria's most disadvantaged communities. Home improvements may include ceiling insulation, efficient lights, and fixing drafts and other sources of air leakage. New South Wales has the Low-Income Household Refit program; the pilot began in May 2009, with the full program to be rolled out later. The pilot offers free energy assessments and power saver kits that include some measures, though the free measures available to do not appear to include larger home efforts such as insulation. See Sustainability Victoria. www.sustainability.vic.gov.au/www/html/1464-energy-task-force.asp

12 The European Union phaseout on incandescent bulbs could be mentioned; quote follows. "In March 2009 the European Commission adopted an Eco-Design Regulation to improve the energy efficiency of household lamps, which stipulates the progressive phasing out of incandescent bulbs starting in 2009 and finishing at the end of 2012 [COM2008b]. The Regulation applies to non-directional lamps. Directional (reflector) lamps, such as spots, will be covered by a dedicated measure at the end of 2009 or in 2010."

13 ADB. 2009. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Grants Nepal: Energy Access and Efficiency Improvement Project.* Manila (hereinafter "Nepal Energy Access and Efficiency Improvement Project"); ADB. 2009. *Report and Recommendation of the President to the Board of Directors: Proposed Multitranche Financing Facility and Administration of Cofinancing Islamic Republic of Pakistan: Energy Efficiency Investment Program.* Manila; and ADB. 2009. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Grant Republic of the Philippines: Philippine Energy Efficiency Project.* Manila.

14 Nepal Energy Access and Efficiency Improvement Project

15 Collaborative Labeling and Appliances Standards Program. General Information on Standards and Labeling. www.clasponline.org/clasp.online.resource.php?no=21&page=1

A woman uses a compact fluorescent lamp in her store

Star program in the United States rates appliances that are significantly more efficient than the required minimum government standard.[16] This rating system helps consumers save money and protects the environment through energy efficient products. The Indian Bureau of Energy Efficiency also has a standards and labeling program with similar purposes, as do many countries around the world. These can be applied in developing countries.

Fuel Conversion Programs. Low-income households often burn kerosene and other petroleum products for cooking and lighting, and may also burn traditional biomass fuels indoors, leading to health and safety problems and ultimately higher health care costs. In South Africa, a program shifting energy use from kerosene to electricity (i) reduced the total energy requirement (because electric lighting and cooking is more energy efficient than kerosene); (ii) reduced cost (because electricity, generated from a mix of coal, nuclear energy, and hydropower, is cheaper than kerosene, which is produced from petroleum); (iii) reduced environmental impact (because kerosene is toxic to aquatic life and is a possible groundwater contaminant); and (iv) increased safety (because kerosene-related burn injuries and cooking accidents are common).

Electricity Automation. Smart grids hold the potential for being an efficient way of delivering electricity to the consumer. A smart grid is an "intelligent electricity delivery system" that may be able to predict peaks in the demand for electricity, perceive system overload, detect electricity pilferage, and correct these conditions.[17] Smart grids can increase capacity, improve energy efficiency, and lower greenhouse gas emissions by managing loads, reducing system loss, and allowing interaction between the utility and consumers.[18] An integral part of the smart grid is the installation of smart meters, which measure electricity consumption and communicate with appliances and the electric utility through the smart grid.[19] Developed countries are in the early stages of utilizing smart grid technologies. Their use in developing countries may not occur in the near future and will face many challenges.

Supply-Side Energy Efficiency Programs

Energy efficiency is most commonly associated with managing demand, but it is also applicable to managing supply.[20] Tremendous amounts of energy are lost as heat when power is generated, transmitted, and distributed. Supply-side management seeks to limit and reduce energy loss in the process of producing electricity. Power utilities can do this through proper planning and adoption of efficient technology. Energy generating companies obtain direct benefits—more efficient systems translate to reduced wholesale power costs, improved voltage levels, more system capacity, and potentially reduced investment in system improvements. Consumers obtain indirect benefits, which include improved system reliability and lower retail prices. Several opportunities and options for supply-side management are described below.[21]

Supply-side management seeks to limit and reduce energy loss in the process of producing electricity…through proper planning and adoption of efficient technology.

Prohibiting Inefficient Coal-Fired Plants. In January 2007, the People's Republic of China (PRC), adopted a policy measure for increasing overall energy sector efficiency which sought to close down small, inefficient coal-fired power plants and prevent construction of new similar ones. Though not appropriate everywhere, this policy measure has been important in the PRC.

Resource Preparation and Use. These measures support more efficient management and use of resources by (i) improving inefficient energy resource generation, for example by using clean coal technologies; (ii) substituting one fuel source for another; and (iii) using renewable energy. From these measures, power output per unit of resource is increased and environmental impact reduced.

Electricity Generation and Energy Conversion. Energy efficiency enhancement in electricity generation and energy conversion involves (i) improving the operations of existing power plants to ensure that equipment and systems operate at the most energy efficient level, (ii) upgrading electricity generation units through the installation of equipment enhancements, and (iii) generating heat and electricity from a single source (cogeneration).

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16 Energy Star. www.energystar.gov
17 ESRI. 2009. Enterprise GIS and the Smart Electric Grid. New York: ESRI (hereinafter "ESRI. 2009").
18 ESRI. 2009.
19 ESRI. 2009.
20 Power System Engineering, Inc. Loss Reduction. www.powersystem.org/services/resourceplanning/ lossreduction/lossreduction.aspx
21 Africa Energy Efficiency Toolkit of REEEP. Renewable Energy & Energy Efficiency Partnership. 2009. *Energy Efficiency Module 13: Supply-side Management.* http://africatoolkit.reeep.org/Power%20Point%20Presentations/Energy%20Efficiency%20-%Module%2013%20Presentation.ppt#361,13.Transmission

Transmission and Distribution. The transmission and distribution of electricity from the power plant to utilities and end users may be made more efficient by (i) reducing technical losses with various measures such as increasing transmission voltage, installing higher efficiency transformers in electricity substations, and replacing overloaded lines with larger-sized conductors; (ii) planning to relocate transformer and substation sites closer to consumers using large loads; (iii) reducing non-technical losses with innovative metering (e.g. prepayment metering) and load monitoring schemes; (iv) instituting harsher penalties for electricity theft and pilferage; (v) instituting a steadily decreasing cap on system losses that transmission and distribution utilities can pass on to their consumers; (vi) aggregating the energy load of several users to allow them to take advantage of lower energy prices; (vii) giving incentives or imposing penalties to improve system power factor;[22] (viii) shifting load patterns through demand-side management and demand pricing schemes to even out the load on the electric system to avoid excessively high peaking periods;[23] and (ix) improving the monitoring of energy flow and sales across the system grid.

Transport of Fossil Fuels. Efficient transport measures include using high-efficiency motors and ensuring that pipelines used to transport fossil fuels are correctly sized. They can also be as simple as checking the tire pressures of vehicles transporting the fuel and planning transport routes.

Other Energy Efficiency Measures

Participation in energy efficiency programs can be encouraged by several measures that are not complete energy efficiency programs in themselves. They will limit the total cost (and probable subsidy) of energy efficiency programs associated with serving low-income households.

Revenue Cap Structures and Decoupling. Revenue cap structures are tariff structures that set the price of service that a utility provider can charge by providing a limit on the amount of revenue that a utility can earn. Revenue caps are calculated by subtracting expected efficiency savings (X) from the rate of inflation measured by the consumer price index (CPI) or CPI – X. Revenue caps can be used in the provision of electricity or water where the demand is beyond the control of the utility provider, and where the cost incurred by the utility provider in meeting the demand is not affected by short-term variations in quantity of supply demanded. They promote energy efficiency because they break the link between a utility provider's incentives to increase sales from the profits it receives. Decoupling works by breaking the link between the amount of electricity a utility sells to consumers and the revenue it collects from consumers to cover its fixed costs.[24] Utilities typically seek to increase electricity sales by increasing demand in order to increase revenues. Decoupling removes this incentive and in doing so also eliminates a utility's disincentive to promote energy efficiency.[25]

Load Limiters. An electric service load limiter limits the level of current a consumer receives from a power line.[26] It is established at the consumer's location or remotely with an automatic meter.[27] It works by interrupting the flow of current through the consumer's power circuit when the level exceeds a predetermined maximum.[28] Load-limited customers have a powerful incentive to choose high-efficiency lighting and appliances.

Box 2: Time of Day Tariffs

The People's Republic of China
Twenty provinces charge large consumers peak and off-peak tariffs, rendering more than 50% of the total electricity consumed subject to time-of-day tariffs.[a]

Mongolia
Industrial and commercial entities and residential customers under a time of day tariff are charged the same rate of MNT51 per kilowatt-hour (kWh) for daytime consumption; the rate for night consumption is about MNT8 per kWh less. Industrial and commercial consumers are charged a higher rate of MNT102 per kWh for consumption during peak hours.[a]

[a] ADB. 2005. *Electricity Sectors in CAREC Countries: A Diagnostic Review of Regulatory Approaches and Challenges*. Manila.

Inverted Block Rate Tariffs. Inverted block rate tariffs split consumer consumption into blocks. The tariff increases for each block per unit of energy consumed. The consumer is invoiced for the sum of energy consumed over each of the blocks. Inverted block rate tariffs, with or without load limiters, provide a strong incentive for using high-efficiency lighting and appliances instead of energy-inefficient lighting and appliances.

Time of Use Tariffs. Time of use tariff structures set electricity rates depending on the time of day or the season.

- Time of day tariffs. Off-peak tariffs are lower than those for peak times. This type of tariff promotes energy efficiency because electricity costs more to supply at peak hours; it can improve the reliability of energy supply by shifting demand from peak

[22] The power factor is the ratio of power actually being used in an electric circuit to the power that is apparently being drawn from the power source. A more efficient system will have a higher power factor. A low power factor means more apparent power beyond actual power—what the electric load actually requires. The difference is an electricity loss, which requires the utility to upsize its conductors and transformers. For this reason, customers with a low power factor can be penalized with additional charges. Customers with low power factor problems are typically industrial and commercial end users with several or large induction motors.

[23] Technically speaking, this is described as improving the system load factor: the load factor is the ratio of average demand to the peak demand, usually through a 24-hour period. An efficient system will have a high load factor (approaching 100%). A high load factor occurs when there is relatively no variation in the demand for electricity throughout the day. A low load factor is inefficient, as the utility will need to provide substantially more power supply through a limited peak demand period. A typical DMC has low to medium-low load factor as households switch on their lights (incandescent) and appliances through the peak hours of 6:00–10:00 pm, causing demand to rise to nearly double that of daytime demand.

[24] L. Schwartz. 2009. The Role of Decoupling Where Energy Efficiency is Required by Law. Issues Letter. Montpelier, Vermont: The Regulatory Assistance Project (hereinafter L. Schwartz. 2009).

[25] L. Schwartz. 2009.

[26] US Patent No. 6373150. Electric Service Load Limiter. www.patentstorm.us/patents/6373150.html (hereinafter "US Patent No. 6373150").

[27] US Patent No. 6373150.

[28] US Patent No. 6373150.

to off-peak periods.[29] Electricity costs more to supply at these peak periods. Using time-of-day tariffs to even out the peaks and troughs can improve the reliability of energy supply by shifting demand from peak to off-peak periods.[30] Moreover, if significant enough, it could avoid the need to build new power generation to serve peak load, and will have system efficiency and environmental benefits. However, it requires that metering be installed and that the provider use billing software able to distinguish between the blocks. Box 2 presents examples of where time-of-day tariffs are used.

- Seasonal tariffs. Seasonal tariffs should be higher during particular high-use times of the year. However, in some cases, they are applied to make prices lower than appropriate during low-use times of the year. For example, in Tajikistan, the tariff is based on the winter tariff rate, which is a season of high use. Discounts are provided in the summer. Thus, while a seasonal tariff applies, it doesn't work to constrain high winter use. The summer discount obviates the beneficial effect of the higher winter prices.[31]

Water Conservation and Efficiency Measures

As with energy, water conservation and efficiency involves managing both consumer demand and supply.[32] Water supply and wastewater treatment systems are both infrastructure-intensive, requiring expensive pumping, treatment, and conveyance systems.[33] An example of the operating and maintenance costs of a water utility provider is set out in box 3. The most cost-effective and sustainable way to meet burgeoning clean water needs, especially for those who do not have access to the same, is to maximize the capacity of existing water supply infrastructure by increasing efficiency rather than encouraging new construction. Making water supply systems more efficient can also help control costs, improve service delivery, and expand access without incurring prohibitive costs.

SOHAIL HASNIE

Enhancing the efficiency of the transmission and distribution of electricity increases supply

IAN GILL

Efficient use of water allows farmers to irrigate their land

Box 3. O&M Costs of a Water Utility

In Viet Nam, the Saigon Water Corporation's operating expenses for the supply of water are 35%–38% for bulk water, 23%–27% for electricity, 19%–21% for salaries, 8%–13% for other operations and maintenance, and 7%–9% for water treatment.[a]

[a] ADB. 2009. *HCM City Water Supply Project Energy Efficiency Audit*. Consultant's Report. Manila (TA 7091-VIE).

Role of Water Sector Policy Makers and Regulators

Policy makers and regulators can establish policy and regulatory incentives to promote water conservation and efficiency measures. They can introduce DSM by educating consumers on proper water use, repair of household leaks, and water conservation technologies. They can also require regulated entities to implement DSM and supply-side efficiency programs such as the measures described below.

Demand-Side Management Measures in the Water Sector

DSM in the water sector refers to managing consumers' end use rather than the water utility trying to meet consumers' supply requirements.[34] It needs the right combination of restrictions, pricing, and water

[29] Regulatory Assistance Project. 2008. *China's Power Sector: A Backgrounder for International Regulators and Policy Advisors*. Montpelier, Vermont and Gardiner, Maine. www.raponline.org/docs/RAP_ChinaPowerSectorBackground_2008_02.pdf1; S. Dixit, et al. 2008. Background Paper on the Clean Energy, Good Governance and Regulation Forum. Singapore. March; and S. Nakhooda, et al. 2007. *Empowering People—A Governance Analysis of Electricity in India, Indonesia, Thailand and the Philippines*. Washington, DC: The World Resources Institute.

[30] RAP. 2008. *China's Power Sector: A Backgrounder for International Regulators and Policy Advisors*. Montpetier, Vermont and Gardiner, Maine. www.raponline.org/docs/RAP_ChinaPowerSectorBackground_2008_02.pdf1; S. Dixit, et al. 2008. Background Paper on the Clean Energy, Good Governance and Regulation Forum. Singapore. March; and S. Nakhooda, et al. 2007. *Empowering People—A Governance Analysis of Electricity in India, Indonesia, Thailand and the Philippines*. Washington, DC: The World Resources Institute.

[31] ADB. 2005. Electricity Sectors in CAREC Countries: A Diagnostic Review of Regulatory Approaches and Challenges. Manila (hereinafter "Electricity Sectors in CAREC Countries. 2005").

[32] J. Barry. 2007. *Watergy: Energy and Water Efficiency in Municipal Water Supply and Wastewater Treatment*. Alliance to Save Energy. p. 2. www.rivernetwork.org/resource-library/watergy-energy-and-water-efficiency-municipal-water-supply-and-wastewater-treatment (hereinafter "J. Barry. 2007").

[33] J. Barry. 2007.

[34] G. Stiles. Demand-Side Management, Conservation, and Efficiency in the Use of Africa's Water Resources. International Development Research Centre. www.idrc.ca/en/ev-31090-201-1-DO_TOPIC.html (hereinafter "G. Stiles").

efficiency policies for ensuring healthy, safe, and reliable water supplies in times of scarcity.[35] Good water DSM ultimately means appropriate pricing of all water supply sources—not only water obtained from the main network, but water from alternative service providers and groundwater. In developing countries, the price of water rarely reflects the cost of service and hence is too low to promote efficient use. Once an appropriate balance of the price of water and cost of service is attained, key DSM activities include educating consumers on appropriate water use and managing household leaks.

Other DSM policies and water conservation technologies need more in-depth analysis in particular countries and contexts to determine whether they are more cost effective than supply-side options. Such policies and technologies include low-pressure pipes, sprinkler systems, and drip systems for irrigation; different types of water recycling; improved water canal lining materials to reduce seepage; automatic water flow restrictors for domestic or industrial ablution; low-flush toilets; low-flow showerheads; and seasonal variations in the water tariff.[36]

Good water demand-side management ultimately means appropriate pricing of all water supply sources—not only water obtained from the main network but also water from alternative service providers and groundwater.

Supply-Side Management Measures in the Water Sector

The five supply-side interventions for water and wastewater efficiency improvements with the most potential are rainwater harvesting, efficient pumping, leak management, system automation, and metering and monitoring.[37]

Rainwater Harvesting. Rainwater harvesting involves collecting water on the roof of a home or office and storing it for later use. In Gansu Province in the PRC, a rainwater harvesting project assisted more than 200,000 families and provided water supply and irrigation to about 1 million people by providing each family with a clay-tiled roof catchments area, upgrading the traditional clay-lined water cellars by lining them with cement and attaching a small metal pump, and placing plastic sheeting over the rills in fields to concentrate the runoff rainwater to the crops.[38] Spare plastic sheeting was also used to build greenhouses and a trench was dug around each greenhouse to collect rainwater. In India, rainwater harvesting is practiced by the people of the Thar Desert in Rajasthan.[39] One traditional means of collecting rainwater is the construction of small underground tanks (*tankas)* in houses or courtyards. These are made by digging small circular holes in the ground, lining them with polished lime, and decorating them with tiles to keep the water cool. The water collected is used only for drinking. *Tankas* are still used in residential areas, temples, *dharamshalas,* and hotels. There are nine other traditional methods of rainwater collection in the Thar Desert.[40]

Efficient Pumping. Efficient pumping involves optimizing the energy used by the water pumping system. Pumping improvements range from lower-cost measures—such as motors with low startup electricity requirements (soft starters), smaller size pump rotors (trimming impellers used when pumps are oversized), and repairing motors to their original efficiency (rewinding motors)—to higher-cost measures such as replacing inefficient pumps and installing pump flow controls (variable-speed drives).[41]

Leak Management. Leak management generally covers two basic activities: detecting and repairing leaks in a water supply or wastewater treatment system, and reducing leakage by managing the water pressure in the pipes.[42] Automated controls that reduce pressure in the network can drastically lower leakage rates, especially at night.[43] Pressure management will cost less than repairs to numerous leaks in buried pipes.[44] Effective management of leaks can save enormous quantities of water and energy.

Water System Automation. Water system automation involves ways to computerize or automate some or all of the water supply system to promote efficiency and handle operations in response to changed situations. Stand-alone devices that act on information from a sensor to perform simple actions, such as an automatic shutoff valve responding

PHOTO CREDIT

Solar panels harness the sun's heat to generate electricity

[35] Green Start.
[36] Green Start.
[37] J. Barry. 2007.
[38] J. Gould. Rainwater Harvesting Project in Gansu Province, China. United Nations Environment Programme: Dams and Development Project. http://hqweb.unep.org/dams/documents/ell.asp?story_id=14
[39] J. Cochran and I. Ray. 2009. Equity Reexamined: A Study of Community-Based Rainwater Harvesting in Rajasthan, India. *World Development*. 37(2).
[40] Rainwater Harvesting. Thar Desert. www.rainwaterharvesting.org/Rural/thar-desert_tradi.htm
[41] J. Barry. 2007.
[42] J. Barry. 2007.
[43] J. Barry. 2007.
[44] J. Barry. 2007.

S. HASNIE

Distributed generation, such as this micro hydropower plant, can increase access to rural and remote areas

to a water-level indicator, are the most basic and inexpensive form of automation.[45] Other forms include equipment to optimize water pressure in the supply network; automatic alarms to reflect leaks, breakages, or other water supply system emergencies; and automatic shutdown of the water pumps.[46] Water system automation saves water, energy, and operational costs; improves service; and lengthens equipment life.

Metering and Regular Monitoring. Water supply system components and operations must be regularly monitored to evaluate performance against benchmarks and targets and ensure equipment is operating efficiently. Monitoring is an operations and maintenance protocol that serves as a no-cost or low-cost efficiency enhancement within reach of all utility budgets.[47] The basic steps for putting a successful monitoring and metering system in place are the following: (i) create a water metering and monitoring system, or expand and upgrade existing systems; (ii) develop baselines and metrics for regular monitoring; and (iii) create targets and measure these against set baselines and benchmarks, and obtain the proper measurement instrumentation.[48]

Policy makers and regulators have a significant role to play in enhancing the efficiency of water and energy supply services.

Next Steps: Enhancing the Efficiency of Water and Energy Supply Services

Improving efficiency in the supply of energy services has significant potential to contribute to energy security, reduce the need for increased energy generation, and reduce negative environmental impacts. Improving efficiency in the supply of water services would increase the available amount of water, better conserve the resource, and reduce the costs incurred. Because electricity is a significant operational cost of water supply services, and water is a significant component of generating and supplying electricity, improving the efficiency of the delivery of each utility service will contribute to more efficient and less expensive provision of the other. Policy makers and regulators have a significant role to play in doing both.

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For details, you may visit www.adb.org

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