SUSTAINABLE ENERGY FOR EQUITABLE DEVELOPMENT

Contribution to the World Bank Group's Energy Strategy Review and Development

Bank Information Center

April 2010

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Acknowledgements:

The Bank Information Center would like to thank the ClimateWorks Foundation and the Rockefeller Brothers Fund for providing financial support for this effort.

The author and key contributors would also like to express their gratitude to the following individuals for their insightful discussions and useful feedback:

Shannon Lawrence, Heike Mainhardt-Gibbs, Andrew Scott, Teo Sanchez, Alison Doig, Hal Wackman, Chris Herman, Joe Athialy, Erin Carey, Alvin Carlos, Nadia Daar, Amy Ekdawi, Jelson Garcia, Nadia Hadad, Joshua Klemm, Josh Lichtenstein, Vince McElhinny, Norly Mercado, Christian Velasquez-Donaldson, Ashley Warriner, Said Yakhyoev and Aynabat Yaylymova.

Many thanks are also extended to Rebecca Harris for her excellent editing and input.

ABBREVIATIONS

CSOs	Civil Society Organizations
DSM	Demand-Side Management
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IEA	International Energy Agency
IEG	Independent Evaluation Group
IFC	International Finance Cooperation
IPCC	Intergovernmental Panel on Climate Change
IRP	Integrated Resources Planning
LPGs	Liquefied Petroleum Gases
MAGICC	Model for the Assessment of Greenhouse-gas Induced Climate Change
MDGs	Millennium Development Goals
OECD	Organization for Economic Cooperation and Development
PVs	Photovoltaics
R&D	Research & Development
RES	Renewable Energy Source
SFDCC	Strategic Framework for Development and Climate Change
SG	Strategic Goal
SNV	Netherlands Development Organization
SSA	sub-Saharan Africa
UNDP	United Nations Development Program
WBG	World Bank Group
WCD	World Commission on Dams
WHO	World Health Organization
SHS	Solar Home System

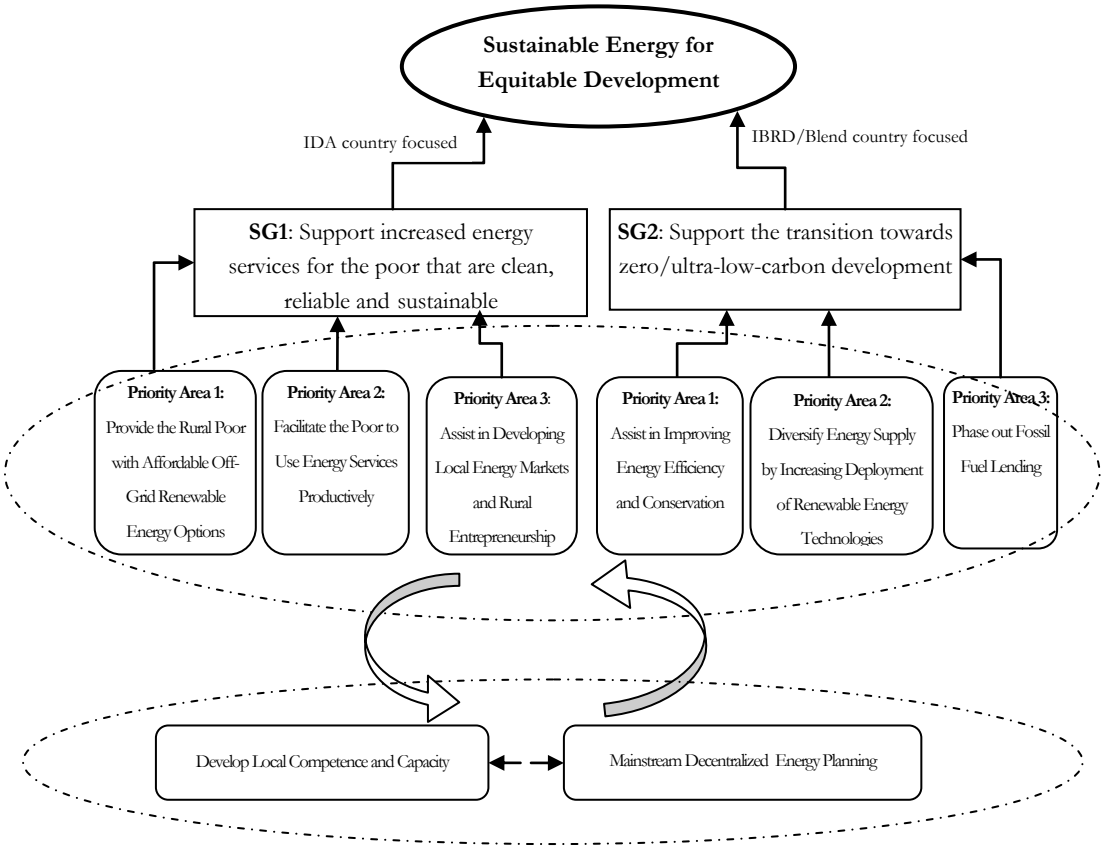
Executive Summary

The World Bank Group (WBG) faces the unprecedented challenge of assisting client nations in addressing the interrelated problems of persistent energy poverty and global climate change. More specifically, what types of energy services should the WBG support from a perspective of sustainable as well as equitable development?

The WBG envisions a sustainable energy future for client nations with access to energy for all people based on a diverse portfolio of energy sources generated from reliable, affordable and environmentally sound zero/ultra-low-carbon energy technologies. To achieve this vision, two strategic goals are proposed in the new strategy: 1) support increased energy services for the poor that are clean, reliable and sustainable; and 2) support the transition towards zero/ultra-low-carbon development. Under each strategic goal, specific priority areas are identified. Each priority area is intended to serve as a guiding principle for the WBG's energy operations, including loans, credits, technical assistance, advisory support and other derivative financing instruments. As a guiding principle of its energy-related operations, the World Bank Group will help its clients in the coming decade to leapfrog the carbon-intensive development path that most industrialized countries followed. The WBG will prioritize energy poverty given the WBG's core mandate of poverty reduction.

In addition to the priority areas, two synergic areas will be given priority when appropriate: 1) developing local competence and capacity; as well as 2) mainstreaming development of decentralized energy systems. See Figure A.

Figure A. Architecture of the WBG's new Energy Strategy



A number of specific targets are set under each strategic goal. The success of the strategy will be measured against these targets:

- Increase financing for renewable-based distributed energy systems by 40% annually starting from FY 2011;
- Provide 700 million poor with clean, reliable, and sustainable energy services by 2021;
- Increase average annual income by 30% per household or small business and decrease by 30% social costs associated with lack of education, health care and drinking water supply as a result of improved energy services;
- Increase by 30% the annual revenue for local energy supply/maintenance companies.
- Increase financing for energy efficiency by 40% annually starting in FY 2011;
- Double the share of clean, reliable and sustainable renewable energy sources in the energy mix of client nations by 2021;
- Phase out fossil fuel lending in all middle-income client countries by 2012, and in all its client countries by 2015 and implement full life-cycle risk adjusted cost accounting by 2012

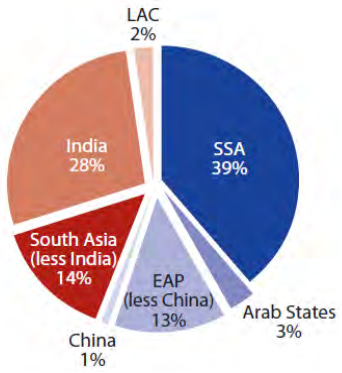
THE CHALLENGES

Energy Services and Poverty

Access to modern energy services is a prerequisite for poverty eradication and economic development. Modern energy services are vital to directly improving the quality of life of the poor, providing income generating opportunities and increasing productivity in all sectors, thereby contributing to overall social and economic development.

Lack of access to modern energy services exposes the poor to health burdens and deprives them of a myriad of opportunities for human development. A 2002 World Health Organization (WHO) study assessed the health impacts of indoor air pollution caused primarily by the burning of solid fuels such as dung, wood and agricultural residues. It estimated that indoor smoke from solid fuels was responsible for about 36% of lower respiratory infections[1] worldwide, caused almost 2 million premature deaths per year, and killed more people than malaria (1.2 million) or tuberculosis (1.6 million).

Figure 1: Share of population without access to electricity by region (2008)



Source: UNDP & WHO, 2008

A significant share of the global population does not have access to reliable electricity services. Although the linkages between access to energy and development have long been understood, the facts are that:

- some 1.5 billion people are currently without access to electricity, four out of five of whom live in sub-Saharan Africa (SSA) and South Asia (including India) (Figure 1), mainly in rural areas;

- nearly 2.4 billion people still use traditional biomass[2] fuels for cooking and heating, causing health problems from indoor pollution, ecologic damages from unsustainable resource use

[1] Lower respiratory infections was identified as the top leading cause of death in low-income countries and the third worldwide, according to the WHO (2004) http://www.who.int/whr/2002/en/whr02_en.pdf; http://www.who.int/mediacentre/factsheets/fs310_2008.pdf

[2] Traditional biomass, mostly referring to energy extracted by direct combustion in conventional devices such as mud stoves, is usually characterized by low energy efficiency and is associated with air pollution, especially indoor pollution which causes human health damage, such as various respiratory diseases, particularly to women, small children and the elderly.

and limited development opportunities due to time-consuming firewood collection, trapping poor and vulnerable communities in poverty (UNDP & WHO, 2008);

- a quarter of the world's population remains below the poverty line, i.e. living on less than $1.25/day (measured in 2005 dollar terms) (IBRD/WB, 2009).

The prospects for wide-scale poverty reduction do not look optimistic, particularly for SSA. The *Global Economic Prospect 2009* report projects that the number of people living on less than $1.25/day in SSA in 2015 will be 356 million, a 20% increase from the 1990 level, and a distinct move away from the MDGs for poverty reduction. This projection does not take into account the impact of the recent surge in energy and food prices, coupled with the economic downturn following the financial crisis which is expected to further exacerbate poverty levels. (IBRD/WB, 2009; United Nations, 2009)

Globally, the energy poverty situation will likely remain unchanged in the decades to come. As estimated by the International Energy Agency, there will be slightly less than 1.6 billion people in 2015 and 1.4 billion people in 2030 who lack access to electricity, and 2.6 billion people in both 2015 and 2030 who rely on burning solid fuels for heating and cooking (IEA, 2004; IEA, 2006).

Addressing the energy poverty issue is a daunting task that requires constant reassessment of preferred approaches. For example, traditional grid extension was once perceived to be the best way to increase a country's electrification rate. However, it is now understood to be vulnerable to significant fuel price fluctuations leading to fuel constrained power supply shortages. Even with adequate fuel supply, the traditional grid in some developing countries is generally exposed to greater risks than more decentralized energy systems such as localised grids.

An even more challenging task is how to facilitate income generation opportunities related to available energy services. The ability to productively use energy services helps to determine whether the poor can sustainably afford such services. Equally important is whether or not energy access can provide an escape from the poverty trap and the creation of sustainable livelihoods. This is applicable at the household level and is particularly relevant to women who typically dedicate more time and labour to basic subsistence activities than men, such as gathering fuel-wood, carrying water, and cooking. For example, according to Gabraal, et al. (2005), South Indian villagers spent approximately 2 to 6 hours each day collecting fuelwood. A similar UNDP study indicated 2-3 hours per day in Nepal (UNDP, 2006). Access to modern energy services could therefore significantly increase the amount of time available for other productive uses. In this regard, as pointed out in the report entitled "*The International Financial Institutions: A Call for Change*" from the US Committee on Foreign Relations, international financial institutions and donors have failed in delivering concrete development results because the focus has been mainly on issuing loans, providing grants and technical support towards making energy services available, without assisting the poor in making productive use of the energy access in order to create stable and self-sustaining economic livelihoods (Committee on Foreign Relations, 2010).

A related challenge is how to foster rural energy entrepreneurship and nurture local energy markets. All types of energy systems require maintenance and repair. Experience has shown that it is essential to establish local capacity during project implementation in order to keep projects running after cooperation with international partners ends. Even with domestic rural energy programs, it is crucial to build local energy markets and technical capacity. For example, the failure of the first two waves of massive biogas programs during 1960s and 1970s-1980s in China was attributed to a lack of local knowledge of biogas technology, resulting in several million biogas digesters becoming dangerous pits in rural China (He, 1988; Zhang et al., 2009).

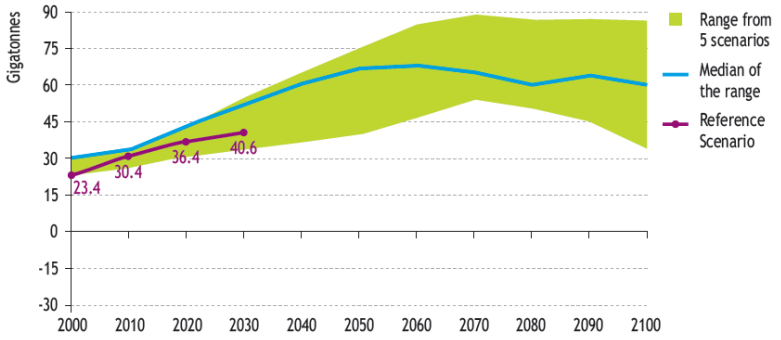
Energy Choices and Climate Risks

Rapidly increasing energy demand. According to the reference scenario in the IEA's *World Energy Outlook 2008*, the world's primary energy demand will increase by 45% between 2006 and 2030, and non-OECD countries will account for 87% of that increase due to rapid economic development.

CO_2 emissions from non-OECD countries. The rapid increase in energy demand in non-OECD countries is expected to contribute some 97% of additional CO_2 emissions in the same scenario. Given that our global climate system is changing at an unexpected pace, this is cause for serious alarm. While the developed countries that are primarily responsible for today's climate risks must lead global efforts to stabilize the levels of atmospheric CO_2 concentration by significantly cutting emissions, they cannot solve the climate crisis alone. Since 2005, the share of CO_2 emissions from non-OECD countries has been greater than those of OECD countries and is expected to continue to rise to 66% in 2030. This is due mainly to projected increases in energy demand in middle-income countries such as China, India and the Middle East supplied by carbon-intensive energy fuels (IEA, 2008). If no measures are taken, emissions are likely to keep rising, as illustrated in Figure 2, with potentially disastrous climate impacts (IPCC, 2007).

Figure 2. Energy-related CO2 emissions scenarios

IEA's Reference Scenario to 2030 compared with other published scenarios to 2100



Note: Shaded area gives the ranges taken from five scenarios published since 2001. Some of these included emissions of non-energy CO2 and other greenhouse gases.

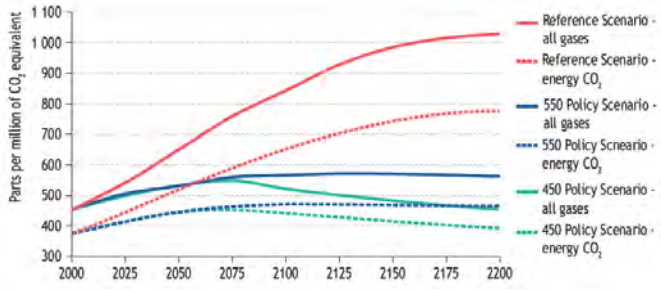
Sources: IPCC (2007); Nakicenovic (2007) and IEA analysis.

There are other options. The ways in which countries decide to meet growing demand for energy services will have significant implications for future emission trajectories (see Figure 3). In order to avoid the worst scenarios, global greenhouse gas emissions must be radically curtailed.

Avoiding a carbon lock-in in developing countries. In this context, developing countries may be better off if they are able to leapfrog the carbon-intensive development path followed by most industrialized countries. This should be supported through the joint efforts of the international donor community and national governments. Capturing win-win opportunities through improved end-use energy efficiency, as well as adopting renewable energy-based distributed energy supply options should be prioritized. Choosing these options could help developing countries escape carbon lock-in[3] from a strategic perspective, continuing economic development without contributing to future climatic catastrophes and also hedging the emerging energy security risks associated with the recent high and volatile energy commodity prices in the global energy market (See Box 1).

[3] See, Unrush, 2000 & 2002; Unrush & Carrillo-Hermosilla, 2006.

Figure 3. Greenhouse-gas concentration trajectories by scenario[4]



Note: IEA used MAGICC (Version 5.3) to confirm that the projected emissions for all greenhouse gases to 2030 would result in concentration trajectories consistent with achieving stabilisation at around 700 ppm CO2 (equivalent to around 1 000 ppm CO2-eq) in the Reference Scenario, at 450 ppm CO2 (550 CO2-eq) in the 550 Policy Scenario and 380 ppm CO2 (450 ppm CO2-eq) in the 450 Policy Scenario.

Source: IEA, 2008

Box 1: Risk Adjusted Portfolio

Fossil fuel prices are risky in the finance theory sense that they fluctuate. This risk should be accounted for in energy planning processes. Because of the variability of fossil fuel prices, the risk adjusted cost estimates of conventional fossil-fired technologies tend to be considerably higher than estimates produced by traditional engineering models, which do not take these risks into account. Capital-intensive efficiency and renewable (solar and wind) technologies on the other hand, exhibit little systematic risk to because their cost streams are largely sunk and therefore riskless. As a consequence, their risk-adjusted cost-estimates are generally slightly lower than the estimates produced by traditional models.

The effect of taxes and market risk combine to make energy efficiency, solar and wind power considerably more attractive. Capital-intensive efficiency, solar and wind power technologies exhibit financial and economic characteristics that resemble the attributes of new manufacturing technologies: high capital and low operating costs and systems that are flexible, modular and rapidly deployed. The experience in manufacturing has demonstrated that singular focus on engineering unit cost measures such as cost per KWh is often an incorrect basis for comparing alternatives; "least cost" energy choices made on this basis may not be the most efficient, effective, sustainable nor equitable for our economies.

Cost estimates should be reflective of risks. Energy efficiency, solar, biogas, micro-hydropower and wind by virtue of their price certainty provide powerful benefits beyond their environmental contribution. A more prominent role for these utility service technologies can be justified on the basis of the valuable contribution their price certainty makes to the economies of fossil consuming and hydro-dependent countries by enhancing energy security and diversification objectives. Accordingly, proper cost estimation that reflects the market risk of fossil fuel and other cost streams is crucial for effective energy policymaking.

In addition, the traditional analysis of stand-alone technology costs is often not meaningful. But the portfolio effect is always meaningful for technology valuation, by creating a portfolio of strategies with uncorrelated cost, risk and outcome streams. Moreover, some mitigation schemes may be properly valued as public projects (per Lind-Arrow) – their contribution to the risk of the public portfolio will be minimal and their benefits widely dispersed. Financial economist Shimon Awerbuch has pointed out that efficiency and renewable (i.e., solar and wind power) utility service options, many with "near-zero operating costs and virtually no moving parts, offer a unique cost-risk menu along with other valuable attributes that traditional valuation models, conceived long before such attributes became technologically feasible, cannot 'see' because they are steeped in the vocabulary and measurement concepts of a different technological era. Properly understood and exploited, the attributes of distributed fuel-less technologies, including renewables, could undoubtedly form the basis for re-conceptualizing the electricity production and delivery process to create a vast new set of cost reductions."(Awerbuch, 2005)

Source: Michael Totten of Conservation International

[4] There is growing scientific evidence that climate sensitivity to increased CO_2 concentrations is greater than previously believed, and that atmospheric concentrations must be stabilized below 350 ppm to avoid catastrophic, irreversible climate disasters. Hansen J, Sato M, Kharecha P, Russell G, Lea DW, Siddall M. 2007. Climate change and trace gases. Philosophical Transactions of the Royal Society A, 365: 1925-54. Matthews, H. D., and K. Caldeira. 2008. Stabilizing Climate Requires Near-zero Emissions, Geophysical Research Letters, Vol. 35, February 27, 2008.

WBG'S ENERGY STRATEGIC VISION

The World Bank Group (WBG) faces the unprecedented challenge of assisting client nations in addressing the interrelated issues of persistent energy poverty and global climate change. As a multi-lateral developmental bank, the WBG's role is clearly defined as not only leveraging private investment but, more profoundly, directing the financing into the development of sustainable energy systems that could provide equitable development opportunities for all.

Against this backdrop, and in line with the WBG's ultimate mission of poverty reduction and economic development, the WBG envisions a sustainable energy[5] future for its clients by ***delivering universal access to high quality, reliable energy based on highly efficient, end use oriented service delivery and a portfolio of reliable, affordable and environmentally sound zero/ultra-low-carbon[6] supply technologies.*** Towards this end, the WBG will promote a paradigm shift away from the traditional approach of prioritizing the expansion of centralized, largely fossil fuel based supply infrastructure to renewable[7]-based distributed energy system, and create an enabling environment for investments in sustainable energy in client nations by following the policy framework proposed by World Resources Institute and International Institute for Sustainable Development, see Annex 1.

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[5] Tester et al. (2005) defines the notion of sustainable energy as "…*a dynamic harmony between the equitable availability of energy services for all people and the preservation of the earth for future generations*…," which covers not only technical and environmental but social dimensions as well. The WBG adopts this definition in determining what "sustainable energy" means in the Strategy.

[6] In the Strategy, "zero/ultra-low-carbon energy technologies" refers to the generation of GHG emissions per unit of energy output in lifecycle of production is at the level of near-zero or at the order of one magnitude less as compared with what the emissions would be otherwise. Although nuclear power is often seen as a low-carbon energy source, the WBG should continue its policy of not financing nuclear power generation, due to the costs, risks and complexity associated with it. Less carbon-intensive energy technologies, particularly coal-fired power generation without carbon capture and storage *cannot* be qualified as a low-carbon option. Nor can hydropower generation, which particularly in tropical regions can release enormous amounts of GHGs due to the decay of underwater vegetation. See St. Louis VL, Kelly CA, Duchemin E, et al., 2000. Reservoir surfaces as sources of greenhouse gases to the atmosphere: a global estimate. BioScience 50: 766–75. Fearnside PM. 2002. Greenhouse gas emissions from a hydroelectric reservoir (Brazil's Tucuruí Dam) and the energy policy implication. Water Air Soil Poll 133: 69–96. See also, Patrick McCully, Tropical Hydropower is a Significant Source of Greenhouse Gas Emissions: Interim response to the International Hydropower Association, International Rivers Network, June 2004, www.irn.org/.

[7] In the Strategy, renewable energy sources do not cover large-scale hydropower. Although there is no specific general definition of large scale hydropower that is accepted worldwide, the definition for this Strategy is made in contrast to the more commonly accepted upper limit of 10 MW for small-scale hydropower.

THE STRATEGY

The aims of the WBG's new Energy Strategy are three-fold:

- to present an architecture with all the components, including strategic goals, priority areas, concrete targets and areas where synergy can be created, necessary for achieving the WBG energy vision;

- to serve as a Bank-wide guiding document to articulate the development of specific policies, guidelines or operational protocols across the WBG;

- to provide clear guidance for the allocation of the WBG's limited resources towards a series of priority areas whose effectiveness can be measured against a set of concrete targets set for the period of 2011-2021.

In this way, the strategic goals will be harmonized towards one energy vision, while individual targets can be reached at an operational or a programmatic level. The structure is presented in Figure 4.

Strategic Goals

To achieve the WBG's energy vision, the Bank will focus on two strategic goals:

1) support increased energy services for the poor that are clean, reliable and sustainable;
2) assist the transition towards zero/ultra-low-carbon development.

The first Strategic Goal focuses on IDA (International Development Association) countries[8], and the poor areas of middle income countries. An increasing share of the WBG's resources will be allocated in support of the development of clean, reliable and sustainable energy systems in these countries or geographical areas.

The second Strategic Goal will be particularly focused on IBRD and blend countries, given that:

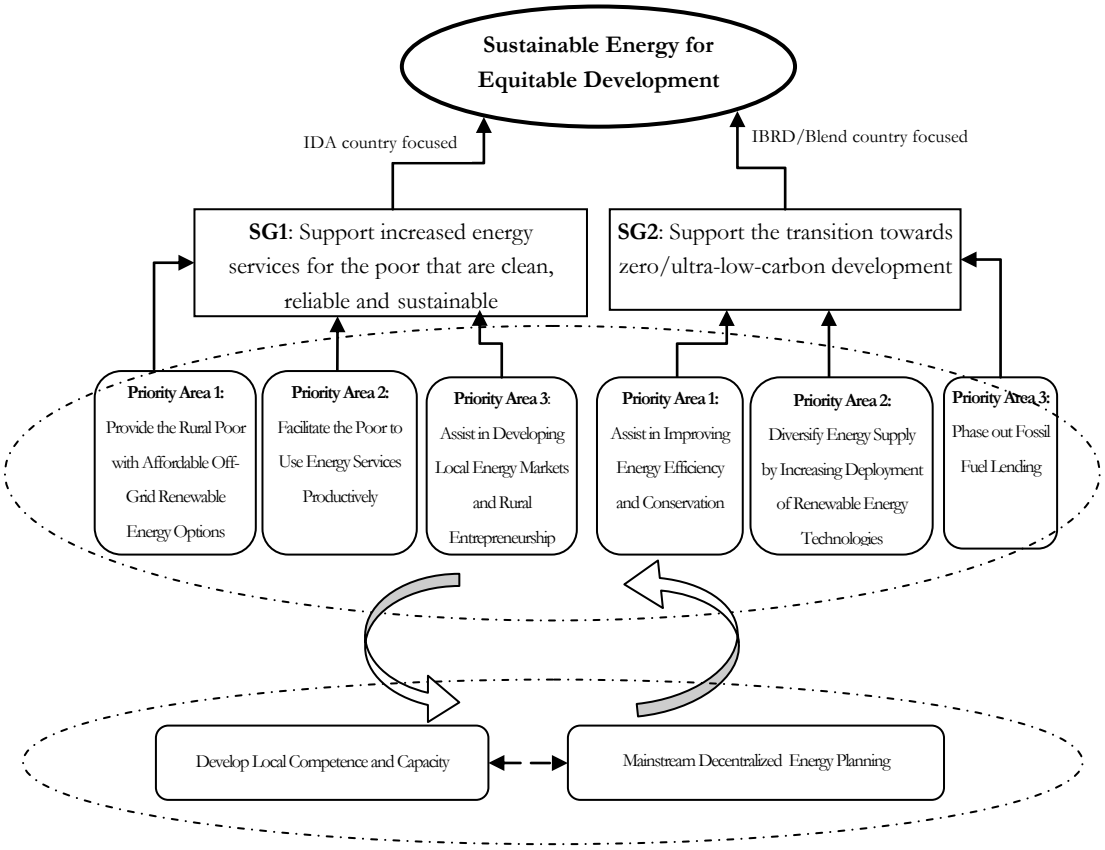
- their demand for energy services is projected to rapidly increase;

- greater opportunities to apply zero/ultra-low-carbon technologies exist in these countries, including improved end-use energy efficiency technologies and ecologically sustainable renewable energy systems;

In both IDA and IBRD countries, the WBG will prioritize projects and policy innovations that can capture synergies between these goals and produce the win-win benefits of expanding and improving energy service delivery for the poor while facilitating the transition to sustainable, zero/ultra-low-carbon energy systems. In particular, the WBG will prioritize an end-use oriented approach to the delivery of energy services in all of its activities, and will employ Integrated Resource Planning (IRP) methodologies to ensure that the full range of cost and risks for all service delivery options are appropriately evaluated in the planning process.

[8] The world's 79 poorest countries which are greatly in need of direct support from the international development community.

Figure 4: Architecture of the WBG's new Energy Strategy



Under the auspices of the United Nations Framework Convention on Climate Change, many client countries may develop comprehensive low-carbon development plans and specific mitigation actions that are appropriate to their specific national circumstances. The WBG will support elements of such plans that are consistent with its strategic priorities and end use oriented approach.

Strategic Goal 1 (SG1): Support Increased Energy Services for the Poor that are Clean, Reliable and Sustainable

The first Strategic Goal aims to help client nations with increased accessibility to clean, reliable and sustainable energy services for the poor and low-income groups to improve their living standards and help them escape the economic and environmental traps of poverty. Towards this end, the WBG will work its partners to overcome barriers to the provision of affordable, reliable and environmentally sound energy for the poor in its client nations.

Key targets:

- Increase financing for renewable-based distributed energy systems by 40% annually starting from FY 2011
- Provide 700 million poor with clean, reliable, and sustainable energy services by 2021;
- Increase average annual income by 30% per household or small business and decrease by 30% social costs associated with lack of education, health care and drinking water supply as a result of improved energy services;
- Increase by 30% the annual revenue for local energy supply/maintenance companies.

Priority Area 1: Provide the Rural Poor with Affordable Off-Grid Renewable Energy Options

The WBG has recognized that the adoption of traditional centralized energy systems such as grid expansion is often not the most efficient, effective, or sustainable means by which to expand the poor's access to clean, reliable, and sustainable energy services. For end-users in rural areas, such grid connected energy is often more expensive, due primarily to the high costs of long distance transmission and low density of electricity consumption. The transportation costs of non-electric energy commodities such as diesel, LPG or coal are often also cost prohibitive, preventing the rural poor from taking full advantage of these alternatives. For the utilities and fuel distributors, these factors reduce the incentives to extend the grid or the distribution stations to the unconnected and under-served rural poor.

Distributed energy options have often been overlooked as a means to deliver energy services to the poor in remote areas. Growing evidence has shown that for people who are not currently served by the grid, distributed solutions are generally much faster and appreciably cheaper than the classical centralised supply model. Moreover, even for grid-provided electricity, an increasing amount of new supply now comes from decentralized sources, because their lower cost and lower financial risk make them far more attractive to investors than central thermal plants.[9]

Decentralized renewable electricity is a promising way to meet the demand for basic energy needs. Results from the recent WBG-wide survey on energy priorities in the six World Bank regional and IFC departments show that almost all of the regions[10] not only identified making further improvements in access to electricity as a high priority but, more significantly, viewed the use of decentralized renewable electricity as a promising way to meet the demand for basic energy needs.[11] Such systems – which include, for example, solar home systems, small wind and mini-hydro, and portable solar lanterns – do not require installation of costly transmission lines and are becoming increasingly affordable thanks to improved economies of scale as a result of the growing number of users and technical improvements. In addition, decentralized systems are more likely to be manufactured and/or repaired locally and are hence, less dependent on foreign technical assistance, strengthening the sustainability of rural livelihoods. This will also empower people and communities in creating self-sustained business models and employment opportunities.

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[9] Lovins et al., Small is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size 2002, 428pp, Rocky Mountain Institute, www.rmi.org/;

[10] Except for ECA and MENA (apart from Yemen) where access is nearly 100 percent

[11] Except for ECA where increased use of renewables was not seen as a high regional priority, although judged important in some countries.

Evaluations show that off-grid renewable energy systems are more economically competitive than conventional energy alternatives. In the 2006's "*New Renewable Energy: A Review of the World Bank's Assistance,*" the Independent Evaluation Group (IEG) found that the off-grid renewable energy systems such as solar PV, small wind and pico-hydro technologies were more economically competitive than conventional energy alternatives such as diesel generators (less than 300 W).[12] They become even more attractive when linked with improvements in efficiency of end-use devices. Recent high and volatile fuel prices have left the users of conventional energy sources facing greater uncertainty and vulnerability.

There are sufficient renewable energy resources in many of the countries supported by the WBG. A recent WBG study entitled "*The Economics of Renewable Energy Expansion in Rural sub-Saharan Africa*" found that decentralized renewable energy could play an important role in expanding rural energy access in sub-Saharan Africa (SSA) where 77% of the population and nearly 90% of the rural people do not have access to electricity. The potential output[13] of renewable energy sources (including solar, wind, small hydro, geothermal, and biofuels) in many of these countries are multi-fold their current energy consumption, as shown in Annex 2.

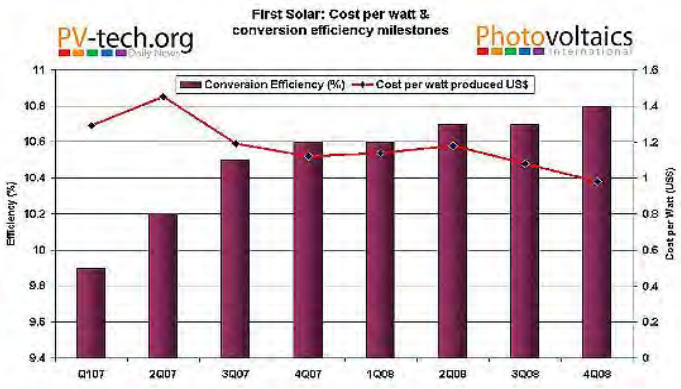
How do we bring renewable energy options to the rural poor in an affordable way? The real question is how to bring renewable energy options to the rural poor in an affordable way, rather than whether there are sufficient renewable energy resources for powering the economic development in these countries. The WBG will support the phase out of current subsidies to fossil fuel projects and make more resources available for incentivizing client nations in adopting energy efficient technologies and deploying renewable energy technologies. Wherever these options are less financially attractive compared to least-cost options, the WBG should provide financing in order to buy down the costs and make these options more affordable to the end users.

Costs and affordability of renewable electricity varies with region and type of electric power generation system. In general, with the growing market penetration of renewable energy technologies, economies of scale, and technology improvements, significant cost reductions have been observed, particularly with solar photovoltaics (PVs). For example, the world's largest manufacturer of thin film solar modules, First Solar has brought the manufacturing cost down below US$ 1.00/kWp in 2008, and is expecting a further reduction in the cost per watt below US$0.65 by 2012 or earlier. (Figure 5) Equally significant, First Solar has reached the highest stable conversion efficiencies. In comparison, the IEA reference case scenario estimated the average grid connection fee at a range of US$425 per household (IEA, 2008).

Figure 5: Cost of Solar PV and Conversion Efficiency by First Solar

[12] The comparison done by Chubu Electric Power Co., Inc. and others in 2005 was based on the assumption of US$38-40 per barrel (2005). See details in Chapter 2 of the IEG's report. The renewable energy technologies refer to off-grid systems.

[13] Technical potential was assessed under realistic assumptions for feasible expansion (Deichmann et al., 2010)



Source: http://www.pv-tech.org/news/_a/first_solar_first_to_us1_per_watt_manufacturing_cost/

To meet diverse demands such as cooking, heating and productive and process uses, a portfolio of energy sources other than just electric power is needed. Cooking and heating represent a major source of demand for energy services, especially in the rural areas of developing countries. At present, the predominant option for cooking and heating fuels are traditional fuels such as wood and charcoal. Biogas technologies can provide rural areas cleaner energy services while solving local environmental pollution and improving hygienic conditions. Moreover, these technologies can improve the economics of the farm by using otherwise wasted resources and/or improving the quality of the fertiliser through the composting process.

By 2007, about 25 million (about 10%) of Chinese rural households had installed biogas digesters (Wang, 2007), producing nearly 9 billion cubic meters of biogas annually, and benefiting a rural population of more than 75 million (Chinese Agriculture Ministry data)[14]. In Nepal, more than 200,000 households have installed domestic biogas plants with about 95% of the digesters in daily use and 12,000 people employed in the biogas industry sector. In Vietnam, more than 50,000 installations have been built under the SNV[15] supported programme alone, of which 99% are reportedly operational[16]. The success of biogas technology applications can be easily demonstrated to rural communities.

Important contributors to the successful deployment of biogas are the adoption of a market-based approaches and the involvement of multiple stakeholders in the development of the framework for the national programme, including a strong focus on quality control. The immediate benefits generated by the digesters could contribute to enhanced gender equality as research has demonstrated that typically, traditional modern energy services, such as electricity, benefit men first and to the greatest degree due to the often unequal social status of men and women in many rural areas, typically known as gender bias/implications.

Priority Area 2: Facilitate the Poor to Use Energy Services Productively

Helping the poor gain access to modern forms of energy services is merely a starting point on the journey towards poverty reduction. Arguably, modern energy services are pivotal to the creation of sustainable livelihoods through the economically and socially productive use of such energy services, such as the replacement of manual power with electric power in crop grinding and irrigation, development of new businesses and new streams of income, enhanced education and

[14] See: Ministry of Agriculture website [online] available http://www.agri.gov.cn

[15] Dutch Aid Implementing Agency.

[16] SNV and Hivos are now introducing the biogas system in several countries in Africa. http://www.hivos.nl/english/Hivos-news/Hivos-news/Africa-Biogas-Partnership-Programme

improved health care systems. Such types of productive use of energy services are essential for the poor to lift themselves above the poverty line.

In order to enable the productive use of energy services, the quality of energy services has to be ensured. Unreliable energy services can result in various economic losses. Unplanned interruption of power supply, including the fluctuation of voltage or frequency of electric current, can increase the risks of production losses, equipment damage and/or malfunctioning performance, which could spell disaster for the poor given their low resilience to such economic shocks. In this context, one of the WBG's foci will be to assist national/local governments to enhance the reliability of energy services provided to the poor, no matter how such energy services are produced and delivered. By doing so, the WBG would encourage the poor to take full advantage of modern energy services in an attempt to generate additional household incomes.

Women have a special interest in energy access programs as they are, in most cases, the primary beneficiary group of such programs, both directly and indirectly. The WBG will allocate additional resources to facilitate the establishment and organization of women's groups at the local level to encourage information sharing and the creation of business opportunities. Such efforts could result in increased income generation through the implementation of new business ideas or the improvement of traditional economic activities. This will not only help poor households escape poverty, but may also enhance women's social status in rural areas.

Another important aspect of the productive use of modern energy services in rural areas is the resulting improvement in social services. Modern energy services that are, in most cases, supplied by decentralized renewable energy solutions can significantly improve the delivery of primary social services such as education, health care, clean water and public street lighting. With electricity, for example, the local schools may be able to structure night educational programs. Improved social services not only allow people to work more productively, but also help prevent them from falling back into poverty. The WBG will work closely with local governments, communities and civil society groups (CSOs) to provide the poor communities with clean, reliable, and sustainable energy services that can create significant long-term social benefits, and to help local people to fully capture those benefits.

Knowledge sharing on productive energy uses is crucial. It is worth noting that some poor communities might be less knowledgeable in terms of how to make productive use of energy sources/technologies, even though they have affordable access to such sources/technologies. Knowledge sharing and experience dissemination among villages can be facilitated by energy project teams in various forms. This will provide the poor with energy services and the tools that can help them sustain such services. Rural energy projects to be funded by the WBG will incorporate components that focus on providing business development ideas, information and capacity building that can be helpful in job creation or identifying income generation opportunities[17].

Priority Area 3: Assist in Developing Local Energy Markets and Rural Entrepreneurship

From a sustainability perspective, it is essential to foster the rural energy industry rather than to merely provide a system that relies heavily upon foreign investment and technical assistance. Self-sustained local energy markets and rural entrepreneurship is essential for significant scale-up or replication of feasible energy solutions for the poor in developing countries. In promoting such approaches, the WBG is cognizant of the fact that it is increasingly recognized that

[17] New telecommunications technologies may be particularly useful in this regard. See, e.g. Muhammad Yunus on Tech, Profit and the Poor, Fortune Magazine, April 03, 2008; Nicholas P. Sullivan, You Can Hear Me Now, How Microloans and Cell Phones are connecting the World's Poor to the Global Economy, 2009

international development aid should be used as a catalyst to deliver sustainable, replicable outcomes based upon the development of local capacities.

Multi-benefits derived from local entrepreneurship and rural energy markets are obvious and profound. Building local capacity is particularly important and relevant when modern energy services are provided by the application of off-grid renewable energy technologies. The multi-benefits derived from local entrepreneurship and rural energy markets are obvious and profound in terms of natural resource management, increased local employment, income enhancement, and creating more secure and sustainable energy systems. This will not only provide energy to the poor but will also simultaneously enhance development outcomes.

At a local or community level, the markets for rural household energy services such as solar home systems (for lighting), biogas digesters (for cooking, heating and lighting), and mini or pico hydropower can be developed through rural entrepreneurship, innovative replicable business models, assistance from the international development community with a special focus on social benefits and income generation, technical know-how transfer and financing for private sectors (Martinot et al., 2002). In most cases, large-scale energy utilities show little interest or expertise in providing energy services to the poor communities in rural areas. When such services could be provided by locally developed or local market-oriented energy service companies with initial assistance from local governments and/or the international development community, evidence has shown that both energy suppliers and end-users benefit. Box 2 provides just one of many examples of such an arrangement.

Box 2. Development of local markets for solar home systems in rural Tanzania by SolarNow

The "SolarNow" program of Rural Energy Foundation in Africa aims at building a sustainable supply chain and creating demand for solar home systems in rural, off-grid Tanzania using custom-developed market-building strategies that are effective in the lower market densities and incomes characteristic of the country. The success of the program was attributed to three strategies that were implemented throughout the pilot period 2004-2005 and in the scale-up phase that followed.

1. Marketing and Sales: This involves providing support to dealers through development of promotional materials, new marketing ideas and awareness campaigns that enable them to get the word about solar to their target markets.

2. Business Development: This involves identification of potential new dealers, support to start-ups and established solar dealers and development of the market chain; it also involves linking up with microfinance institutions and other new actors such as hire purchase agencies and other non-traditional types of dealers.

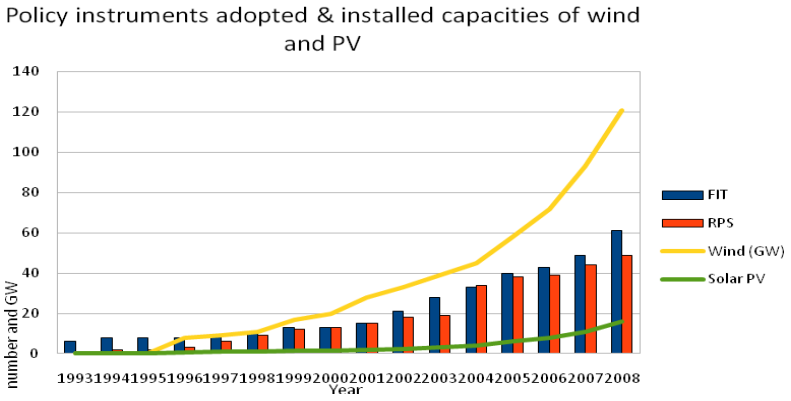
3. Technical Training: This involves building expertise in the installing, designing and post-sale service of PV household systems among dealers and technicians in rurally-targeted locations where dealers are active.

By actively engaging local companies and people at an early stage and running low-budget hands-on training and customer-oriented product dissemination programs, the local SHS market and expertise have been developed successfully. The program's cost of facilitating access to renewable energy is USD 5 per end-user. In 2010 the SolarNow program was awarded the EU sustainable Energy award and Rural Energy Foundation is a finalist of the 2010 International Ashden Awards.

Note: Texts were based on the EU Proven report entitled Case Study Report: Solar Now Program: Development of the PV Market through Practical and Commercial Approaches in Tanzania and more information can be provided through Rural Energy Foundation (http://www.ruralenergy.nl).

The market for renewable energy sources and technologies is expanding. The market for renewable energy sources and technologies has been expanding rapidly over the past several years, particularly where strong supportive policy instruments at national, state or provincial levels are in place (See Figure 6). Although much of the current expansion occurred in developed countries or middle income countries such as China, India and Brazil, the potential for other developing countries is substantial (as indicated in Annex 2).

Figure 6: Policy instruments adopted and installed capacities of wind and PV



Source: REN21, 2009

The WBG will 1) support and facilitate the development of local energy markets for renewable energy technologies that could be installed, maintained and potentially manufactured locally, and; 2) provide appropriate financing assistance to make the initial investment affordable and the application sustainable to the poor in rural areas, and; 3) integrate this component into other WBG-wide programs, such as IFC InfraVentures[18] and Lighting Africa[19].

Strategic Goal 2 (SG2): Support the Transition towards Zero/Ultra-Low-Carbon Development

The WBG will fight climate change by supporting the transition towards zero/ultra-low-carbon development in client countries. A well-articulated response to the challenge of the climate-development nexus can minimize the cost of dealing with climate issues, while at the same time, providing developing countries with leapfrogging opportunities for achievement of a level of socio-economic development that is on par with that of the industrialized world.

The WBG will phase out lending to fossil fuel projects by 2015, a crucial step in supporting the transition to a zero/ultra-low-carbon future. The WBG will move to reduce the proportion of fossil fuel project lending with the objective of phasing out such support in all middle-income countries by 2012, and in all countries by 2015.

[18] This program is intended to provide risk capital to fund the early stage of the development of infrastructure projects in IDA countries.

[19] This program aims to provide electricity to 250 million sub-Saharan Africans who are currently without such accessibility.

Key targets:

- Increase financing for energy efficiency by 40%annually starting in FY 2011;
- Double the share of clean, reliable and sustainable renewable energy sources in the energy mix of client nations by 2021;
- Phase out fossil fuel lending in all middle-income client countries by 2012, and in all its client countries by 2015 and implement full life-cycle risk adjusted cost accounting by 2012.

Priority Area 1: Assist in Improving Energy Efficiency and Conservation

Improving energy efficiency is the cheapest, greenest, and fastest source of energy. The WBG will therefore prioritize efficiency in both its policy and project work. Currently, the WBG's initiatives for improving energy efficiency are driven by two forces, 1) increased energy prices; 2) power generation capacity constraints. The WBG has achieved success on energy efficiency improvements in transition countries by carrying out energy price reforms, such as in Romania and Ukraine. In Ghana and Indonesia, corresponding compensatory measures were taken as a means of coping with the adverse impacts of rising energy prices on the poor. In response to power shortages in Argentina and Vietnam, the WBG supported a nationwide replacement of incandescent light bulbs with energy efficient, compact fluorescent light bulbs.

Energy efficiency and conservation should be an integral and ongoing component of the medium- and long-term energy strategies in all countries. Energy efficiency and conservation can be better achieved if there is consistent support from client nation governments. This should be part of the medium- and long-term energy strategy in any client country. Long-term energy planning can save a substantial amount in retrofitting costs and/or investment in new generation capacity, even though some degree of upgrading and improvement may still be necessary. The WBG will support its clients in developing energy efficiency-oriented planning. Towards this end, Bank staff will screen the project pipeline for energy efficiency potential early in the project design phase, as proposed in the Strategic Framework for Development and Climate Change (SFDCC). This requires internal reform within the WBG to recalibrate staff incentive structures in order to tip the scale in favour of energy efficiency investments.

The WBG will also prioritize end use oriented utility services (see Box 3) and energy services that achieve win-win-win benefits of sustainable development, expanding and improving energy service delivery and zero/ultra-low-carbon development; focusing on areas where there are synergies, not tradeoffs, between the development agenda and the climate agenda.

Providing incentives for energy efficiency. To eliminate structural, institutional and regulatory barriers that impede the uptake of energy efficiency and distributed energy systems, the WBG will work with its partners to create new regulatory paradigms that incentivize businesses and households to improve efficiency and invest in distributed power systems. The WBG will also assist client nations to establish rigorous efficiency performance standards for buildings, vehicles, appliances, industrial motor systems, lights, and other energy and water consuming devices. In addition, the WBG will help implement better labelling and disclosure mechanisms to enable consumers to make better informed choices about life-cycle energy costs and environmental impacts of the products they purchase. This should be combined with monitoring oversight of manufacturers to ensure labelled products perform as claimed.

Box 3. End-use oriented utility services

End-use oriented utility services is one among several terms used by electric, natural gas and water utility experts to a) contrast a significantly different planning process from the conventional and traditional supply-side expansion model; and, b) to emphasize delivered services rather than supply generation. As one of the world's largest private utilities, PG&E in California, found out, they could deliver five times more utility services per unit of investment through end-use efficiency improvements than through traditional supply expansion. But the regulatory system thwarted this approach by only rewarding more sales of supply (whether kWh of electricity, litres of water or thermal of natural gas). If sales declined because of the efficiency gains, then the utility lost earnings. That is why the end-use-oriented method needs to be combined with decoupling utility revenues from earnings, which California successfully implemented several decades ago. Now, the utility is allowed to recoup their lost earnings from declining revenues as an incentive to help customers reduce their utility bills through efficiency gains.

The focus on end-use (and onsite) delivered services also ensures that all the costs are accounted for, not just generation costs at the busbar (and excluding transmission, distribution, externalities, price volatilities of fuel and water inputs, etc). The term has not vanished, and the concept is thriving in many localities.

Demand-side management (DSM) is another term, but it is typically interpreted rather narrowly by utility planners as a minor adjunct to supply expansion, and all too often is focused on load management and load shifting. The end-use-oriented services approach has been in use for several decades by the California Public Utility Commission and the California Energy Commission, although it is referred to as comprehensive integrated utility planning, and now being adopted by several dozen states and provinces.

Source: Michael Totten of Conservation International, see also, World Development Report 2010, Reducing Human Vulnerability: Helping People Help Themselves, Box 4.10, California's Energy Efficiency and Renewable Energy Programs. World Bank, December 2009.

Promoting Integrated Resources Planning (IRP) for efficiency and conservation is a key instrument that the WBG will use to achieve multi-benefits in energy programs. IRP is a decision support tool used by both regulators and utility operators to evaluate the full range of cost and risk factors for all options for delivery of local utility services, including all end-use efficiency approaches. IRP, including end-use efficiency (since traditional IRP may overlook end-use efficiency and focus on assessment of supply options), and regulatory decoupling to remove the perverse incentive of expanding supply even though it is many times more costly per kWh, is essential for fiscally prudent and financially responsible decision-making.

IRP is highly synergistic with other innovative policy initiatives, such as decoupling, in encouraging demand side efficiency. It facilitates transparency and stakeholder engagement around decisions that are otherwise constrained to supply options, enables fuller consideration of environmental and social costs, and reduces corruption and subsidies (California Energy Commission, 2005). Moreover, it allows for the use of the utility's lower cost of capital and earnings-on-capital requirements in comparing competitive end-use and distributed efficiency gains with supply options. The WBG will fund only those client countries that can transparently demonstrate they have gone through a thorough, comprehensive IRP.

In connection to the IRP approaches, a full life-cycle, risk adjusted cost accounting approach will be introduced and implemented within the WBG to ensure all externalities are taken into account when financing decisions are made. With such data available, a thorough option assessment for alternatives will be made that can take fuller account of externalized elements of development that may not be captured by traditional planning tools. These would include GHG emissions, water use, air, water and soil pollutants, land footprint, the extent to which a system is

prone to fail gracefully or catastrophically, and its vulnerability to various threats and risks[20] for comparison in terms of environmental impacts, both locally and globally. In addition, this will inform decision-makers from both the WBG and client nations, of climate-related business opportunities and risks. Equally important is the public disclosure of all the relevant data for the purpose of transparency.

The WBG will help countries develop zero/ultra-low-carbon policies and strategies under different energy scenarios. Lastly, it worth mentioning that in middle-income countries in particular, the WBG has a valuable role to play in supporting programmes and initiatives aimed at creating zero/ultra-low-carbon development pathways. By supporting groundbreaking initiatives, incorporating renewable energy and energy efficiency measures within rapidly growing economies, the WBG may play a catalytic role in promoting the transition to a zero/ultra-low-carbon future. To attain this goal, the WBG will help countries develop zero/ultra-low-carbon policies and strategies under different energy scenarios, and will identify win-win investment opportunities in energy infrastructure development in member countries, with a special focus on energy efficiency and renewable energy options. In order to assist client countries in implementing these zero/ultra-low-carbon strategies, the WBG will also help client countries in mobilizing financial resources, building markets for zero/ultra-low-carbon energy technologies and strengthening R&D competence through the facilitation of international/regional cooperation and collaboration.

Priority Area 2: Diversify Energy Supply by Increasing Deployment of Renewable Energy Technologies

Diversifying the energy supply portfolio is one way of enhancing energy security at a national level, while managing investment risks and maximizing portfolio performance under a variety of uncertainties at a corporate level. Given today's growing concerns of climate change and eventual depletion of coal resources, it is extremely difficult to predict what the cost of using fossil energy will be in the coming decades. The implications for developing countries would be that they could face energy/fuel shortages even if generation capacity is adequate, though based on coal.

The WBG will promote diversification of energy supply. The WBG will assist developing countries in enhancing energy security through the development of a portfolio of zero/ultra-low-carbon energy sources. Continuously improving energy storage technologies will eventually overcome intermittency issues related to renewable energy solutions. Before this occurs, a number of schemes such as portfolio-based renewable energy solutions or a mini-grid could serve as intermediate solutions to mitigate the intermittency effect. For countries where traditional renewables, such as biomass, already account for a large share of energy production, modernization efforts will be prioritized to improve efficiency, environmental performance and operational stability.

Given the extraordinary risks of large dams, the World Bank will only support large hydropower projects that are demonstrated to comply with the recommendations from the World Commission on Dams (WCD). For those countries where hydropower is an option, WBG support will be evaluated with particular care. Large hydropower projects devastate freshwater ecosystems, flood large areas and land for earthworks and construction activities. Additionally, they lead to the destruction of habitat for local flora and fauna, changes in the migratory pathways of fish, loss of livelihood, and even large-scale displacement of the population, in addition to the potential impacts on the climate due to GHG emissions. To what extent such disturbances occur is largely dependent upon the scale of the dam and technologies applied, as well as managerial and governing capacity.

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[20] See Mark Z. Jacobson, Review of Solutions to Global Warming, Air Pollution, and Energy Security, Atmosphere/Energy Program, Dept. of Civil & Environmental Engineering, Stanford University, presented at the Microsoft Research Faculty Summit 2009, July 13-14, 2009, www.stanford.edu/group/efmh/jacobson/revsolglobwarmairpol.htm.

WCD recommendations include: conducting comprehensive options assessments to identify the best, least-cost and least-risk energy service solutions; performing due diligence on risk of emitting greenhouse gases as a result of flooding vegetation; adoption of transparency international best practices for preventing and minimizing corrupt contracting and construction practices; respecting the rights of affected communities by negotiating legally binding agreements and ensuring the free prior and informed consent of indigenous peoples; providing for environmental flows to maintain downstream ecosystems and livelihoods; and developing a funded, enforceable compliance plan. See Annex 3.

Priority Area 3: Phase out Fossil Fuel Lending

To meet the need for sustainable development, energy that is generated by fossil fuels must take into account the release of greenhouse gases and their contribution to climate change, with its negative impact on agriculture and food production in developing countries. While recognizing that it is each country's right to set its own energy strategy, the WBG will help governments adopt sustainable energy strategies that address the energy needs of the poor and that minimize climate change, which will disproportionately affect the poor.[21]

In line with the G20 leaders' commitment to phase-out of inefficient fossil fuel subsidies over the medium term, and in recognition of the recommendations of the 2003 Extractive Industries Review, the WBG will phase out any form of support to fossil fuel, particularly coal and oil projects in all middle-income countries by 2012, and in all its client countries by 2015, while maintaining targeted safety net programs to ensure energy access for the poor.

These would be in alignment with the WBG strategic shift towards increasing support to the deployment and development of cleaner energy technologies in developing countries. A phase-out of the lending to fossil fuel projects will to contribute to level the playground for renewable energy and energy efficient technologies to be economically competitive in some countries.

Areas for Creating Synergies

In addition to the priority areas listed under each strategic goal, two synergic areas will be given priority when appropriate: developing local competence and capacity; as well as mainstreaming development of decentralized energy systems.

Developing local competence and capacity. Development of competence and capacity at all levels is not only critical to successful project implementation, but also and perhaps more importantly, sustainable project operation. Past experience suggests that projects lacking this component did not persist in the long term, though the impacts of such failures lingered. This is particularly true when it comes to some renewable energy projects. Development of local competence and capacity can, in return, help the international community, including the WBG, to better design, implement and monitor projects and programs at the local level. Institutional capacity building can also put the client countries onto a self-sustained development trajectory. Therefore, the strengthening of local competence and capacity plays a significant role in the achievement of the aforementioned strategic goals. Wherever appropriate, the WBG will prioritize this action and promote it as a synergic activity.

Mainstreaming Decentralized Energy Planning. Various studies show that the advantages of large-scale centralized energy supply systems can hardly materialize before all of the system components including the generator, transmitter and distributor and the grid operator optimize their

[21] Striking a Better Balance: The Final Report of the Extractive Industries Review (December, 2003).

performance from a systems perspective. The larger and more complex the system is, the more difficult it would be to achieve the optimal performance.

By contrast, distributed energy systems are closer to the energy demands, therefore not only reducing the transmission and distribution losses and hence costs as well, but also facilitating the deployment of renewable energy technologies. Against this backdrop, the WBG will encourage client nations to adopt decentralized energy planning on a local scale to take full advantage of distributed energy systems and to gain an optimal efficient utilization of a portfolio of energy resources, particularly renewable energy sources such as solar, wind, geothermal or small hydropower. In view of a potential lack of knowledge of or the skills required to perform, decentralized energy planning, the WBG will provide additional technical support on this front and will ensure that the advantages of such planning is fully understood. In the planning process, the WBG will assist client nations with effective public participation and consultation, ensuring the active engagement of local communities, particularly women's groups for achieving positive social outcomes in addition to the delivery of clean, reliable and sustainable energy services.

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Annex 1. Enabling Investment in Sustainable Energy[22]

POLICIES AND REGULATIONS

- Long-term integrated energy planning;
- Policies and regulations encouraging energy efficiency;
- Policies and regulations promoting renewable energy;
- Access to electricity for the poor;
- Pricing structures encouraging efficiency and reducing consumption;
- Subsidy reforms to reveal true costs of fossil fuels and promote the viability of sustainable energy options.

INSTITUTIONAL CAPACITY AND GOVERNANCE

- Executive agencies' capacity for sustainable electricity;
- Regulatory agencies' capacity to oversee implementation of sustainable electricity policy;
- Utilities' capacity to promote energy efficiency and renewables;
- Transparency of policy, planning, and regulatory processes for electricity;
- Stakeholders' engagement in policy, planning, and regulatory processes.

[22] Cited from Box 2 in the recent publication entitled "Investment in Sustainable Energy Futures – *Multilateral Development Banks' Investments in Energy Policy*" from World Resources Institute and International Institute for Sustainable Development.

Annex 2. Comparison of Electrification Rate & Annual Technical Potential of Renewable Energy Sources in SSA

Country	Rural Electrification Rate (%)	Potential Annual Production of Renewable Energy Relative to Current Annual Domestic Energy Consumption
Angola	10.7	27.9
Benin	8.5	12.5
Botswana	12.0	22.4
Burkina Faso	6.3	15.9
Cameroon	9.0	12.7
Congo	15.0	43.6
Cote d'Ivoire	18.0	9.6
DR Congo	4.0	24.7
Eritrea	5.0	9.5
Ethiopia	2.0	8.5
Gabon	18.0	20.3
Ghana	23.0	5.7
Kenya	5.0	6.5
Lesotho	6.0	1.4
Madagascar	5.0	14.6
Malawi	5.3	6.4
Mauritius	99.0	86.2
Mozambique	6.3	23.4
Namibia	13.0	100.5
Nigeria	26.0	50.4
Senegal	18.0	12.5
South Africa	55.0	1.3
Sudan	19.0	27.6
Tanzania	2.0	14.1
Togo	4.0	8.9
Uganda	4.0	3.1
Zambia	3.3	25.2
Zimbabwe	19.0	8
Other Africa	8.0	N/A
sub-Saharan Africa	**11.9**	N/A

Sources: Buys, et al. (2007), Table 10; IEA (2008b), Table 2.

Annex 3: Hydropower[23]

In 2000, the World Bank-supported World Commission on Dams (WCD) released its comprehensive assessment of large dams and issued recommendations for future water and energy projects. The WCD concluded that while "dams have made an important and significant contribution to human development," in "too many cases an unacceptable and often unnecessary price has been paid to secure those benefits, especially in social and environmental terms, by people displaced, by communities downstream, by taxpayers and the natural environment." In addition to the major environmental and social problems documented by the WCD, research has identified GHG emissions from some hydro reservoirs to be a significant issue.[24] Furthermore, with changing rainfall patterns and hydrological variability, global warming will increasingly threaten the safety and viability of large hydro projects.

Given the extraordinary risks of big dams, the World Bank will only **support large hydropower projects that are demonstrated to comply with the WCD recommendations**. These recommendations include: conducting comprehensive options assessments to identify the best energy solution; respecting the rights of affected communities by negotiating legally binding agreements and ensuring the free prior and informed consent of indigenous peoples; providing for environmental flows to maintain downstream ecosystems and livelihoods; and developing a funded, enforceable compliance plan.

As it prioritizes delivering electricity access to the rural poor, the World Bank will **evaluate opportunities for mini, micro and pico hydro** projects. The use of local materials and labour and community management of these systems can provide additional development benefits. These projects can be grid-connected or off-grid options.[25]

Non-dam hydro technologies will also be explored. Recently, R&D funding for non-dam hydro has increased significantly, improving its potential to become an economically viable part of the global energy mix in the near future. The two sectors receiving the most attention are wave power and "hydrokinetic" turbines that capture energy from the flow of water in rivers, estuaries and ocean currents. It appears that many non-dam hydro projects would have minimal environmental and social impacts compared with conventional generation technologies, like large dams.[26]

The World Bank will work with countries to maximize their existing generation potential and support the rehabilitation of hydropower plants before moving forward with any new dam projects. The Bank will also ensure that the social and environmental legacy of existing dam projects is addressed, by working with the government and project sponsors to address compensation shortfalls, resettlement and livelihood restoration failures and environmental compliance failures.

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[23] Written by Shannon Lawrence of International Rivers.

[24] http://www.internationalrivers.org/en/node/383

[25] See, for example: http://energy4africa.net/klunne/publications/ESI2007_2_SMALL_HYDROPWER_PG36-37_Jonker_Klunne.pdf

[26] .http://www.internationalrivers.org/en/node/5127