The way towards universal access - Putting value on electricity services

Key takeaways

The UN-driven Sustainable Energy for All initiative has the objective of achieving universal access to modern electricity by 2030. However, no concretely feasible and financially viable solution and strategy has been proposed to date. In this analysis we argue that universal access is achievable by 2030 – or sooner - within the funding expected to be available.

New approach needed. The approach taken by the International Energy Agency and others to designing the electrification strategies needs to change as it is too focused on costs per unit of power delivered and does not take budget constraints into account.

The way forward needs to:

- define progress by measuring electricity service levels provided - not power supplied;
- assess the expected impact in terms of value creation per dollar invested for different service levels - not just the costs per unit of power delivered;
- determine the blend of different service levels to be provided under an explicit and realistic budget constraint.

An approach not following these principles will most likely fail to provide universal access. It will likely lead to major errors in the electrification strategies, inefficient use of limited public money and hundreds of millions of people unnecessarily left without access to modern electricity services in 2030.

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Summary for policy-makers

There are currently an estimated 1.3 billion people without access to modern electricity. The UN-driven Sustainable Energy for All (SE4All) initiative has the objective of achieving universal access to modern electricity by 2030. However, no concretely feasible and financially viable solution and strategy has been proposed to date. Most studies, including the International Energy Agency's (IEA) report World Energy Outlook 2012, look at the cost of supplying certain predefined amounts of Watts and kWhs to the households around the planet. In its Energy for All Case, the IEA estimates the cost of universal access close to USD 1 trillion. Meanwhile, in its 'most likely' funding scenario, access is provided to only about half a billion people by 2030 - leaving some 1 billion people without access to any form of modern electricity services. Both of the IEA's electrification scenarios are based on an average cost of over USD 2,500 to provide a household with access to modern electricity.

We believe that there are three key flaws in the approach applied by the IEA and others in defining the way towards universal access by 2030. First, the approaches typically take a 'supply perspective', i.e. targeting lowest cost for predefined amounts of watts (W) and kilowatthours (kWhs) to be delivered to each household. Such a supply perspective leads to much higher costs per household than what is truly necessary to provide modern electricity services. This approach also underestimates the current potential in off-grid solutions and fails to provide equal incentives to efforts increasing power generation and efforts improving energy efficiency towards achieving the goal.

Therefore, electrification objectives must take a user perspective' and be defined only in terms of the electricity services to be provided to the different households - like lighting, mobile phone charging and refrigeration - irrespective of the Watts installed and kWhs delivered to provide the services. The SE4All Global Tracking Framework published this year is a good step in the right direction, although the framework has not managed to fully remove the power supply criteria.

Secondly, the IEA approach looks only at the cost of different technical solutions and for the degrees of power to be supplied. However, the objective of electrification is not to provide as much power as possible for the money invested, but rather to maximize the economic and human development impacts. Hence, in order to find the most efficient strategy, decision-makers need to take into account the expected **impact**, i.e. the value created, from providing access to different electricity service levels. The success of electrification efforts must be measured in terms of value created per dollar invested, not amounts of power supplied. Measuring only the power generated, will likely tilt strategies towards providing a lot of power to a few, instead of providing some degree of modern electricity services to many.

Finally, neither the IEA Energy for All Case[1] nor the IEA New Policies Scenario[2] has an appropriate match between the desired output of universal access and the expected availability of funding. In order to make appropriate priorities in terms of which service levels to be developed, the challenge of universal access must be solved under a realistic and explicit budget constraint. Not taking the budget constraint directly into account in priorities and strategy decisions already today could result in a strategy of providing too advanced service levels and consequently not lead to universal access by 2030.

In this paper we show that it is possible to provide universal access to energy by 2030 with the current estimates of available future funding. We further describe how to find the best way forward in order to achieve universal access to modern electricity services as defined by SE4All by 2030, yielding the highest possible value creation in terms of human and economic development from available funding.

The best way forward needs to be defined by measuring electricity service levels - not power supplied; it has to assess the expected value creation per dollar invested for different service levels - not just the costs per unit of power; and it has to assess the blend of different service levels to be provided under an explicit and realistic budget constraint. An approach not following these principles will likely lead to major errors in the electrification strategies, inefficient use of limited public money and hundreds of millions of people unnecessarily left without access to modern electricity services in 2030.

1 **Energy for All Case:** A scenario in the World Energy Outlook 2012 that estimates the additional investment required to meeting the goal of achieving universal modern energy access by 2030, as proposed by the UN Secretary General

2 **New Policies Scenario:** A scenario in the World Energy Outlook 2012 that takes account of broad policy commitments and plans that have been announced by countries, including national pledges to reduce greenhouse-gas emissions and plans to phase out fossil-energy subsidies, even if the measures to implement these commitments have yet to be identified or announced. This broadly serves as the IEA baseline scenario.

Universal access is important, but funding is limited

Having access to modern and sustainable electricity is recognised as one of the most essential drivers of economic and human development in developing countries. There are currently an estimated 1.3 billion people, or nearly 20% of the world's population, without access to modern electricity. In the absence of any efforts through policy measures and money, this number is expected to rise to more than 1.5 billion by 2030.

In November 2011, The UN General Secretary, Ban Ki-moon, launched the Sustainable Energy for All (SE4All) initiative to ensure "universal access to modern energy services by 2030". Access to a modern electricity service is a central part of modern energy services.

In chapter 18 of its report World Energy Outlook 2012 (WEO12)[3], the International Energy Association (IEA) estimates in its Energy for All Case that a cumulative investment of about USD 1 trillion is needed to provide universal access to modern energy services by 2030. This means an average of more than USD 50 billion per year from today until 2030. Of the USD 1 trillion needed, the IEA estimates that USD 898 billion is needed to provide access to electricity; and the remainder to provide clean cooking facilities.

But is it realistic to raise these amounts? In its main scenario, the New Policies Scenario, the IEA projects that only USD 288 billion will actually be invested in energy access between 2010 and 2030 (USD 14 billion per year on average), equalling about 30% of the estimated total investment needed. This is expected to provide access to electricity for about half a billion people by 2030, leaving about 1 billion people still without access to modern electricity.

Further, at the time of the Rio+20 Summit in June 2012, only about USD 30 billion in cumulative investments had been committed by donors, equalling only 3% of the estimated total investment needed. Given today's financial challenges in many of the most common donor countries, such commitments are not easy to increase drastically in the short term.

There is as such an enormous gap between the almost USD 1 trillion the IEA estimates is needed to provide universal electricity access to all and the USD 288 billion they estimate to be available in funding in the somewhat optimistic New Policies Scenario. Despite this gap, in this analysis we show that it is possible to provide universal access by revising the structures of how the electricity is provided through grids, mini-grids and stand-alone solutions.

3 http://www.worldenergyoutlook.org/media/weowebsite/energydevelopment/2012updates/Measuringprogresstowardsenergyforall_WEO2012.pdf

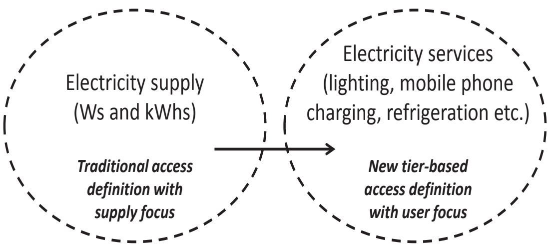
Defining "access to modern electricity"

Most studies to date, including the IEA WEO12 report referred to above, look at the cost of providing universal access by supplying a certain amount of kWhs and Watt capacities to different households. Both the New Policies Scenario and the Energy for All Case describe a way forward based on a blend of technical solutions (grid/mini-grid/stand-alone) with an average cost per household of more than USD 2,500.

However, access to electricity is not binary. There are degrees of access. Typically these degrees of access have been linked to the "electricity supply" - how many kilowatt-hours (kWh) or Watts (W) are made available - but for the purpose of electrification the degrees of access must link to which functions the electricity is providing to the user, the "electricity service". Figure 1 illustrates the two fundamentally different ways of looking at "access".

In order to define and track access under the SE4All, the IEA and the Energy Sector Management Assistance Program (ESMAP) have led the development of a multi-tiered framework for electricity access for households globally. This Global Tracking Framework[4] was published during the spring of 2013 and defines five different electricity service levels (tiers) – see Figure 2.

Figure 1: Illustration of the difference between the supply and user perspectives of electricity access



4 http://documents.worldbank.org/curated/en/2013/05/17765643/global-tracking-framework-vol-3-3-main-report

Figure 1: The multi-tiered SE4All Global Tracking Framework for household electricity access

Access to electricity supply						
Attributes	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Peak available capacity (W)	-	>1	>50	>200	>2,000	>2,000
Duration (hours)	-	≥4	≥4	≥8	≥16	≥22
Evening supply (hrs)	-	≥2	≥2	≥2	≥4	≥4
Affordability	-	-	√	√	√	√
Legality	-	-		√	√	√
Quality (voltage)	-	-		√	√	√

Index of access to electricity supply:

$\Sigma(P_T \times T)$

where

P_T = Proportion of households at tier T
T = tier number

Access to electricity services					
Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
-	Task lighting and phone charging (OR radio)	General lighting AND television AND fan (if needed)	Tier 2 AND any low-power appliances	Tier 3 AND any medium-power appliances	Tier 4 AND any high-power appliances

The five tiers reflect increasingly advanced electricity service levels. The most basic access, Tier 1, is defined by an electricity service providing temporary task lighting and mobile phone charging or a radio. The highest tier, Tier 5, represents a service level that enables households to run any high-powered appliance continuously in line with the standards of a fully developed country. The tiers in between are defined in natural steps for households at different levels of "the energy ladder".

This framework represents an important step in the right direction. However, the defined service levels are complemented by certain performance criteria in terms of the quality of the supply provided that must be met for the different tiers. As one of these criteria is a minimum peak available capacity (Wp) per tier, the framework has not completely managed to move from supply criteria to user-focused service levels.

What is the cost of access?

Each electricity service level can be met through implementing different technical solutions; grid-based, mini-grids or stand-alone. But what are the costs of providing each of the different service levels? These costs will be the natural starting point for assessing whether it is actually possible to achieve universal access, and at which tiers, given the relevant capital constraints.

In Table 2, we have put together some rough estimates of average investment costs[5] per household for meeting the different service levels using grid, mini-grid or stand-alone approaches respectively. The cost estimates for Tier 3 for grids and mini-grids are based on the IEAs numbers, as used in their electrification scenarios described in WEO11 and WEO12, and for the other tiers we have made some general assumptions on the utility and grid costs respectively (see Text box 1 for key assumptions behind these estimates). Cost estimates for stand-alone solutions are based on some on-going electrification programs as well as our own experiences and insight.

5 We have only looked at the overnight investment cost in line with the costs estimated by IEA.

Table 2: Cost estimates for meeting different service levels with different technological approaches. *) Meet SE4All requirements for use of electricity services for the tier, but not necessarily the supply requirements in terms of Wp

Average costm(USD/HH)	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Grid	2 000	2 250	2 500	7 500	8 250
Mini-grid	2 500	2 750	3 200	8 000	8 800
Stand-alone	70*	300*	500*	9 500	10 500
Minimum	**70**	**300**	**500**	**7 500**	**8 250**

The IEA assumes in WEO12 an average initial consumption of 250 kWh per year for rural households and 500 kWh per year for urban households, which increases over time. The rural consumption of about 5 kWh per week would typically reflect Tier 2 or 3 in the SE4All Global Tracking Framework depending on the peak capacity provided. The urban household is assumed to have the double initial consumption, which would typically reflect Tier 3.

For the grid-based solutions, we have hence conservatively assumed USD 2,500 per household for Tier 3 based on estimates of the average costs per household as used by the IEA. In its New Policies Scenario, the IEA operates with an overall average cost of about USD 2,650 per connected household (WEO12 table 18.2), and assumes a cost of about USD 2,750 per household for additional grid connections in its Energy for All Case (table 13.7 in WEO11[6]). Based on the planned 500 kWhs to be supplied per urban household this is assumed to represent a Tier 3 service level in the SE4All framework. Based on the Tier 3 cost for a grid-based solution we have estimated costs per household for grid-based solutions for the other tiers.

For mini-grid solutions, we assume an average cost per household of USD 3,200 for Tier 3. This is based on an estimate of the average cost as used by the IEA in the Energy for All Case, of about USD 3,200 per additional household connected to mini-grids (table 13.7 in WEO11). Based on the planned 250 kWhs to be supplied per rural household, this could typically represent a Tier 2 or 3 service level in the SE4All framework, depending on the peak available capacity. Based on an assumed Tier 3 cost for a mini-grid solution of USD 3,200 we have estimated costs per household for mini-grid solutions to meet the other tiers.

For stand-alone approaches, solar home systems (SHS) represent the most likely generally available alternative. On the technology side, significant cost reductions have occurred over the last 15 years, due to mainly two reasons. First, the cost per Watt for PV modules is today about 10% of what it was in 2000 and about 20% of what it was in 2007[7]. Second, the introduction of the very energy efficient LED lights, LED TVs and PCs, combined with the substantial cost reduction and technology development of PV solar modules and batteries, is making a dramatic change in terms of the cost per household for a SHS.

For instance, the power needed to provide a certain amount of lumen for household lighting with LED technology is reduced by up to 90% compared to traditional incandescent light bulbs[8].

In total, the installed costs for providing stand-alone electrification services like lighting, mobile charging and TV/PC, have dropped by about 70-80 % over just the last 5 to 7 years and is currently in the range of USD 1 to EUR 1 per Watt[9]. Due to these developments, a SHS is already today capable of providing Tier 2 and Tier 3 service levels for a cost in the range of USD 250 to USD 400 and USD 300 to USD 700 per household respectively - although peak capacity (Wp) required to deliver the services in this case is lower than the requirement specified in the SE4All framework (due to the use of LED technology).

Higher tiers are much more expensive to provide with SHS due to the requirements for usage of high powered tools and the high available peak capacity specified in the SE4All framework. The cost of providing the Tier 1 service level through a Solar Portable Light (SPL) with a cell phone charger is today typically USD 50 to USD 100 per household.

6 http://www.iea.org/publications/freepublications/publication/WEO2011_WEB.pdf

7 European Photovoltaic Industry Association

8 http://www.designrecycleinc.com/led%20comp%20chart.html

9 http://www.pv-magazine.com/news/details/beitrag/epia--photovoltaics-fully-competitive-by-2020_100004232/#axzz2hE3CI9M1 and Differ analysis

Seen case-by-case from a user perspective for each household, and disregarding the criteria for peak available capacity, Table 1 shows that the stand-alone solution is the most cost effective solution for tiers 1 to 3 - by far. However, as tiers 4 and 5 are defined by high-powered tools and hence high Wp, a grid is generally the most cost effective for areas with sufficient population

Mini-grids are not the winners for any of the tiers in terms of household electricity access. However, it is obviously a relevant alternative for certain villages with substantial demand for productive uses combined with sufficient population, population density and available renewable energy sources.

The costs of providing electricity access through grid-based and mini-grid solutions is high per households for all tiers, as a substantial part of the cost is linked to extending the actual grids and hence has a lower correlation with the service level provided. It is worth noting that this also means that a grid or mini-grid solution is more easily scalable from lower to higher tiers, while stand-alone solutions would generally need to be replaced for people moving up the energy ladder. Tiers 4 and 5 are much more expensive per household, irrespective of technical solutions, due to the high requirement for peak available capacity.

Textbox 1: Assumptions for cost estimates

Grid-based

To separate the Tier 3 utility and grid extension costs, we first assume that the solution is designed to meet the minimum peak capacity requirement of 200 Wp as specified in the SE4All framework. Further, we assume the new generation capacity to represent a portfolio of about 50% coal and 50% RES, based on figure 18.6 in WEO12, leading to a utility cost of about USD 3 per Wp. For Tier 3 with a minimum 200 Wp, this means a utility cost of USD 600.

For new grid-based connections we assume a mix of fill-in low voltage lines and new grid extensions with both medium and low voltage lines. Based on an assessment of the cost of grid extension costs in Kenya[1] we assume a cost of about USD 1,600 per household for a fill-in and USD 2,600 per household for a new grid. A 50/50 mix of fill-in and new grid would result in a cost of USD 2,100 per household. With an estimated utility cost of USD 600 for Tier 3 this results in an average cost of USD 2,700 per household – which seems in line with the cost estimates of IEA and our cost table.

For tiers 1 and 2, the grid cost is kept constant, while the utility cost is scaled according to the minimum Wp requirements. For Tier 4, with 10 times the Wp, the average cost would be about USD 7,500 per household assuming the grid extension cost is the same.

For Tier 5 we have simply assumed a 10% increase in the utility cost to reflect the required increase in hours (duration increases from 16 to 22 hours in the SE4All framework), under an assumption that these additional hours are low consumption hours. This gives us an average Tier 5 cost of USD 8,250 per household.

Mini-grid:

For mini-grids we assume the same utility cost per service level as for grid, and we assume that grid cost reflects building new grid from the previously mentioned analysis for Kenya. This results in a cost of USD 3200 for Tier 3 – which seems in line with the cost estimates of the IEA and our cost table. To estimate the costs for the other tiers, we have applied the same methodology as for grid solutions by keeping the grid cost constant and scaling the utility cost.

Stand-alone:

We base the costs for standalone systems in tiers 1 to 3 on empirical figures from on-going rural electrification programs and current market prices for the latest technology solutions (e.g. based on LED appliances and the latest Li batteries). These systems meet all the usage requirements in their respective tier, but provide a significantly lower peak available capacity.

Not using the latest technology, the IDCOL program in Bangladesh assumed costs of about USD 380 per household for 50 Wp (Tier 2 service level) systems in 2011[2]. Meanwhile Ethiopia assumed an average cost of just above USD 400 per SHS in the first phase of its program launched in December 2012[3]. For tiers 4 and 5 we have estimated the cost for a stand-alone system to provide the required Wp capacity and duration as specified in the SE4All framework.

1 http://modi.mech.columbia.edu/wp-content/uploads/2013/04/Kenya-Paper-Energy-Policy-journal-version.pdf

2 http://www.idcol.org/Download/IDCOL%20SHS%20Model_30%20Nov'111.pdf

3 http://allafrica.com/stories/201309010115.html

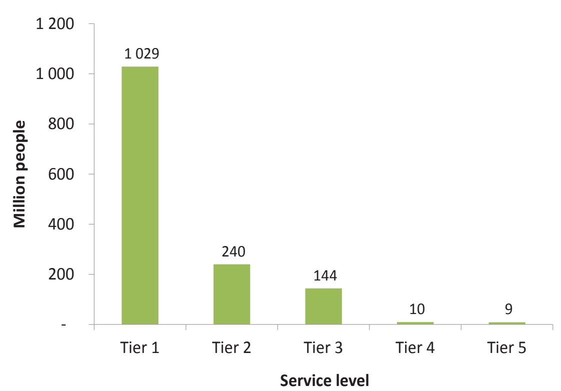
Is expected funding sufficient for universal access?

Given these cost estimates, is it possible to provide universal access to modern energy services with the current estimates of available funds? In its New Policies Scenario, the IEA's approach ends up with an average cost of about USD 2,650 per household. This represents primarily grid connections in urban and suburban areas to provide an average of about 500 kWh per household per year, supplemented by some mini-grids. This approach consequently leaves about 1 billion people without access to any level of modern electricity services in 2030. Following a similar approach, the Energy for All Case ends up with an average cost of about USD 3,100 per additional household. This represents roughly a mix of 50% grid connections, 30% mini-grids and 20% off-grid. The Energy for All Case ends up with universal access, but at a total cost far above what is realistically available.

However, based on the costs presented in Table 1, we can see that 5 times as many people can get access to the Tier 3 service level if stand-alone solutions are chosen instead of grid-based solutions. Looking at the Tier 2 service level, almost 10 times as many people can get access by using stand-alone systems rather than building mini-grids. This clearly shows that if we take a user perspective only (i.e. the service levels provided in terms of lighting etc.) and disregard any criteria linked to kWhs or Watts, then a lot more people can get access to the same levels of modern electricity services for the same cost.

Based on the cost table, we can also look at how many can get access to different service levels for a given budget. In Figure 3, we illustrate how many people can be provided with access per year assuming that a full annual budget of USD 14 billion, as estimated in the IEA New Policies Scenario, is spent on providing households with access to only one of the service levels, and using only the most cost effective technological approach for each service level. As examples, the budget could be either used to provide 240 million people with access to a Tier 2 service level or provide 10 million people with access to a Tier 4 service level. This means that almost 25 times more people would get access if all money is spent on providing households with access to Tier 2 relative to access to Tier 4. Financing universal access at Tier 3 would take around 10 years based on the average available annual budgets as estimated by the IEA.

Figure 3: Number of people provided with access for USD 14 billion invested in each tier



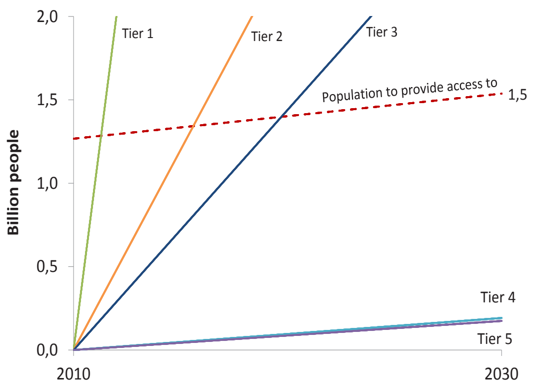
The above cost estimates represent a crude top-down approach. There are regional cost differences, variability in the cost within each technology approach for each service level and differences in required services in different areas. Also, when deciding on which approaches to use, the needs for productive use etc. must to be taken into account. It is also worth pointing out that the development of LED technology and the drop in solar-PV prices is expected to drive down the cost per service level per household for grid and mini-grid approaches also, due to the reduced cost per MW generation capacity for solar power generation and lowered power consumption. On the other hand, grid extension costs are unlikely to be significantly affected. In any case, we believe that using the above cost table provides a reasonable starting point for further assessment.

Universal access can be achieved by 2030 – or sooner

If we assume an annual budget of USD 14 billion as estimated by the IEA in WEO12, there is hardly a question of whether universal access to modern electricity can be achieved by 2030. The question is at which service levels and with which technical solutions. The more expensive the access per household, the fewer households will get access. In Figure 4 we show how many people could be provided with access to the different tiers from 2010 to 2030 with an annual budget of USD 14 billion, based on the most cost efficient technical solution as shown in Table 1. In the graph, this is compared with how many people that actually need to be provided with access, in order to achieve universal access. This number is estimated by the IEA to have been about 1.3 billion in 2010 and rising to more than 1.5 billion by 2030.

Figure 4 shows that for the lowest service levels (tiers 1 to 3) it is possible to provide everyone with access well

Figure 4: Number of people provided with access to each tier for USD 14 billion invested annually



before 2030 with an annual budget of USD 14 billion. This shows that there are blends of the different service levels that can lead to universal access in 2030 for the budget available in the New Policies Scenario. However, if all the funds are spent providing people with Tier 4 and 5 service levels, or if primarily using grid or mini-grid, only a fraction of the people who lack access will get access by 2030.

Hence, if we look at an example of such a blend of service levels, e.g. spending 50% of the budget on Tier 3 and 50% on Tier 4, this would lead to universal access exactly in 2030 based on the cost assumptions described earlier. This blend would provide some 100 million people with access to a Tier 4 service level and the remaining 1.4 billion people with access to a Tier 3 service level. This blend is illustrated in Figure 5.

An additional, important aspect when looking at feasible solutions to the challenge is the share of the total investment cost that we can expect to be covered by the households themselves. For example, doubling the number of households that are provided with access annually will double the capital contribution from the households - almost irrespectively of the service level.

For example, with an estimated global annual market size of almost USD 40 billion[10] in 2009 for kerosene and other rudimentary and dangerous fuels to light the homes of the poorest people, there is substantial financial potential also from the households themselves. And importantly, these are not additional expenditures for the households, but a result of switching the expenditure from kerosene, dry batteries and diesel to payment for electricity from the grid or paying e.g. fee-for-service or instalments on a credit purchase for stand-alone systems.

10 http://www.nytimes.com/cwire/2010/10/20/20climatewire-bringing-clean-light-to-poor-nations-and-mov-88428.html

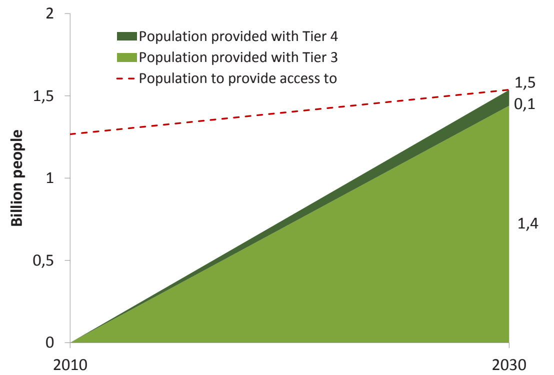
What is the value of access?

Figure 5 illustrates just one blend that would provide 1.5 billion people with access over the years from 2010 to 2030 for an annual budget of USD 14 billion. There are numerous tier-combinations that will provide universal access. In our view, the target combination of tiers should represent the highest total value creation that we can expect to achieve with the funds we expect to have available. Value created would in this regard be a combination of expected impact in terms of e.g. economic development, emission reductions, gender equality and health improvements from access to different electricity service levels - like lighting, TV, mobile phone, internet, air circulation and refrigeration.

Hence, a key question decision-makers, donors and electrification program operators need to ask themselves is: if I have an available budget of about USD 14 billion per year, how should I use these funds to generate the maximum value creation impact? For example, would I expect the highest impact from providing 550 million people with access to electricity using technical approaches with an average cost of about USD 2,500 per household and leaving 1 billion people without access in 2030 (as outlined in the IEA New Policies Scenario); or do I expected a higher impact from providing access to all the 1.5 billion through a blend of tiers 1 to 5 with an average cost of about USD 950 per household. The final strategy would of course need to balance e.g. the value created from productive uses against the value created by actually achieving universal access.

Hence, if we want to find the most cost effective strategy in terms of creating human and economic development, by providing electricity access to a defined number of people under an explicit capital constraint, we need to consider the expected impact from each dollar invested

Figure 5: Example blend of service levels that matches available funds and universal access in 2030



in access. We need to move from only looking at what the cost is for providing access to a household, to also look at what the expected impact of providing such access to a household is. Assessing the value creation impact of access versus no access, and the relative value creation impact of access to different service levels, is imperative in this regard. Not taking this perspective into account could lead to major errors in the strategy, inefficient use of limited public money and hundreds of millions of people left without access to modern electricity services in 2030.

This means that we need to assess the value created by providing a household with e.g. access to a Tier 5 electricity services relative to the value created by providing the same household with access to a Tier 2 service level. Only when each of the tiers is assigned with an expected impact per household can we make appropriate cost/benefit decisions. Also, without assigning a kind of negative value to households that are left without access to electricity we cannot balance and prioritize correctly when setting objectives and devising strategies. Below we explain how some 'proxy values' can be deducted fairly easily to reflect the relative expected value creation impact for the different service levels.

How to assess the value created by access?

The proxy values for each service level are not possible to set accurately. The proxy values would represent e.g. the expected general long-term development impact generated by general access to a certain service level, the impact on gender equality, the impact in terms of power for productive uses and community functions, and the impact in terms of limiting greenhouse gas (GHG) emissions. Further, setting the proxy values would include difficult value judgments as it would prioritize between the different impacts.

However, even if the actual proxy value of each tier is impossible to calculate or estimate accurately, it is possible to establish relative proxy values for the different service levels through combining existing research and analysing our general preferences based on these insights. Finally, however difficult the relative proxy values might be to set, anything that is closer to the reality than just assuming that the relative value created by access to each service level is equal to the relative cost of each technical approach implemented would lead to better prioritizations and more effective use of limited funds.
Looking at existing research, there are several studies pointing to the very high development value linked to the initial, basic household electricity access - in terms of economic development, education and gender equality. Access to electricity for charging of mobile phones and for PC/internet use seems to have the highest economic short-term value creation. Access to electricity for lighting is argued by the IEA and others to provide major and economic uplift in the longer term through better reading and studying conditions. Productive uses are clearly of high value in order to contribute to both value creation and job creation. In many rural areas, however, the power distribution lines are just a few kilometres away and more energy intensive business opportunities are therefore often already feasible within short transport distances.

For example, it may be worth noting the following quote from a recent IEA study (IEA, Alexandra Niez, 2010).

"A 2009 case study of Bangladesh for example showed that the total income gain following electrification reached up to 30% (Khandker et al., 2009). But this was not the result of directing electricity to productive end-uses. In fact electricity provision led to a significant improvement in total study time for children in rural households coupled with an increase in the number of completed school years. The income generated was shown to be sustainable over as long as 8 years. These encouraging results are real incentives to target household electrification as a means of attaining social equity which in the long run will lead to economic growth. Indeed, considering only the productive end-uses of electricity as useful for development is obscuring the actual proven development capacity of health services and education (Cabraal et al., 2005)."

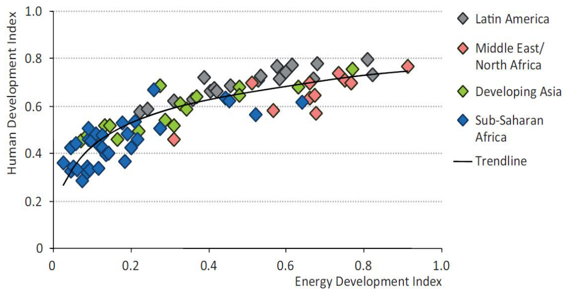
Other similar findings have been made by Millinger et al. (2012)[11], who found that children's study time increased by more than a factor two after solar electrification in Chattisgarh state in India, while Komatsu et al (2011)[12] found that previously remote villages in Bangladesh had been turned into thriving centers after installations of Solar Home Systems.

In just the past five years, Africa's mobile phone market has rapidly expanded to become larger than each of the EU or the United States with some 650 million subscribers. This development is dramatically impacting Africa in a positive way by providing much better communication, transparency and insight into prices for rural products and markets. This is well described in many documents

11 Evaluation of Indian rural solar electrification: A case study in Chattisgarh, by M. Millinger, T. Mårlind, and E.O. Ahlgren in Energy for Sustainable Development, Volume 16, Issue 4, Pages 486 - 492, December 2012

12 Energy Policy, Volume 39, Issue 7, July 2011, Pages 4022-4031, Satoru Komatsu, Shinji Kaneko, Partha Pratim Ghosh.

Figure 6: Correlation between Energy and Human Development Indexes. Source: WEO12



including a recent report[13] by the World Bank and the African Development Bank describing that "Information and Communication Technology (ICT) innovations are delivering home-grown solutions in Africa, transforming businesses and driving entrepreneurship and economic growth". None of these mobile phones work without electricity, and it could be argued that this electricity usage economically represents the most productive energy usage in Africa – in terms of driving and increasing economic value creation. The introduction and usage of TV and PC is clearly also contributing both to entertainment and enhanced access to information and is part of the same major ICT transformation of Africa as described above.

To sum up, it is likely that the initial electricity usage per household, shop or health center is among the most productive electricity usages. This is supported by figure 18.10 in WEO12 displaying the correlation between the IEA Energy Development Index and the Human Development Index (see Figure 6), which clearly shows that the highest impact on the Human Development Index is created by the initial steps on the Energy Development Index. In addition, the initial use of renewable electricity has the highest emission reduction in tCO2e per kWh generated and used as it replaces kerosene, dry batteries and highly inefficient diesel.

Based on the research presented above, we can investigate our preferences and prioritizations. This can be done by comparing different sets of outcomes and selecting the alternative that we think has the highest expected value creation impact. For instance, if we have USD 1 billion at hand, we could provide about 16.5 million people with access to Tier 2 service level though stand-alone systems at an average cost of approximately USD 300 per household. Alternatively, we could provide less than 1 million people with access to Tier 4 service level though a grid connection at an average cost of approximately USD 7,500 per household, and leaving more than 15 million people without access to any electricity at all. Selecting which of the two alternatives described above we would believe is the one providing the highest value creation impact would represent the first step towards assigning relative proxy values to the different tiers.
To emphasise further, if we e.g. consider providing three households with access to Tier 2 has higher value creation impact than providing one household with access to Tier 4 - and thereby leaving two household without access to electricity - the proxy value assigned to Tier 4 should not be higher than three times the value assigned to Tier 2. If we then for example say that the proxy value of Tier 2 is 1.0 and the relative proxy value for Tier 4 is 2.5, then the relative expected value created per dollar invested in the Tier 2 connection is 1/300 versus 2.5/7,500 per dollar invested in the Tier 4 connection. By setting up a range of such comparisons, we would be able to assign a set of relative proxy values to the different electricity service levels. The results of such an assessment should be an integral part of the input used to decide what the best way forward is, as it will more clearly show what strategy will yield the highest total value creation impact for the money available.

The value of access is pivotal – and ultimately political

This is just the methodology for assessing the value of access to modern electricity. Importantly, it is not up to us to assign these proxy values for the different tiers of electricity access. It is up to policy-makers, donors and operators of electrification programs to assign these values as they would serve as crucial input into finding the approaches that will maximize the expected impact and value generated from the funds invested. It will not be possible to calculate exact values. However, any conscious decision is likely to provide better guidance than basing the value of each service level on the cost of providing such a service level or just saying that Tier 5 access is expected to have five times the impact of Tier 1 access (as implicitly indicated by the 'Index of access to electricity supply' in the SE4All framework, see Figure 2). Ultimately, solving the challenge of universal access needs to be done by looking at the available budget, the estimated costs associated with providing the different electricity service levels as seen from a user perspective, and the expected value creation impact from each service level. Only then will we ensure that available funds yield the highest possible impact on human and economic development - and realistically lead to universal access to modern electricity services by 2030.

13 eTransform Africa, World Bank, 2012 (http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/0,,contentMDK:23262578~pagePK:210058~piPK:210062~theSitePK:282823,00.html).

About us

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Differ's business idea is to help scale up small-scale carbon reduction technologies (e.g. renewable energy and energy efficiency) in selected developing countries through i) providing free in-depth analysis on e.g. market conditions, feed-in-tariffs, financing and business opportunities, ii) advising project developers, project owners, investors and other decision makers, iii) developing our own concepts and companies and iv) investing in start-ups.

Differ was founded in November 2010 by entrepreneurs that previously have started and developed companies like Renewable Energy Corporation (REC) and Point Carbon.

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