Facts & Figures

ENERGY ACCESS

CURRENT SITUATION, CHALLENGES AND OUTLOOK

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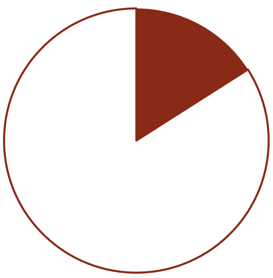
ENEA Consulting provides **energy transition and sustainable development consulting services to industry**. ENEA assists companies with strategy development, provides support to innovation and projects, and also offers training and expertise services on these topics.

This publication is part of our policy to share ENEA's essential knowledge, with the aim to propose keys to understanding the main challenges of energy transition and sustainable development at the global scale.

It is the result of the learnings and experience of ENEA experts on the topic of energy access, which has been acquired in the course of our support services and *pro bono* consultancy work with NGOs and economic and social actors, and from specific research work done in-house.

CURRENT ENERGY ACCESS SITUATION

What is "energy access"?

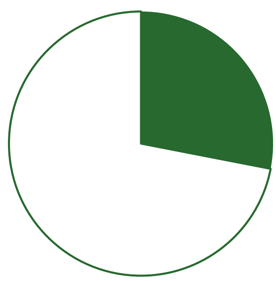


19%

of the world's population does not have access to electricity[1]

A household with energy access is a household *"with a reliable and affordable access to a clean cooking facility, a first connection to electricity with a minimal consumption level […], and then an increasing level of electricity consumption over time to reach the regional average[1]"*.

This definition takes into account two important notions: that of progressive access to energy and that of a plurality of uses (electricity and cooking). This definition is nonetheless limited to a household-focused vision, which is valid for populations in great difficulty, but which must be broadened for longer term economic development.

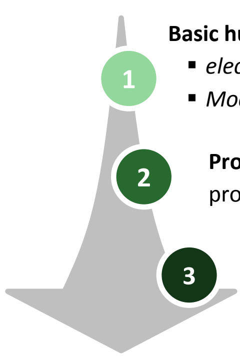


39%

is dependent on traditional biomass resources[1]

Three increasing levels of energy access are differentiated based on services made accessible (cf. Figure 1). The first level of energy access, as described above, concerns households and the meeting of basic human needs. The second level concerns meeting the needs of productive uses and economic activity, and the third level corresponds to meeting individual and collective needs in modern societies.

Energy access is not simply a question of making an energy resource available – the challenge is in fact threefold: allowing growing access to services thanks to the supply of **reliable energy**, which is physically and economically **accessible to all,** with **limited environmental impacts**[2].



Basic human needs:

- *electricity* (50 – 100 kWh_e/pers/yr): lighting, education, health and communication
- *Modern fuel* (580 – 1100 kWh_{th}/pers/yr): cooking and heating

Productive uses: Development of economic activities. Increasing the productivity of producing activities: agriculture, commerce, transport, etc.

Needs of modern societies: Individual and collective needs: refrigeration, heating, sanitation, transport (2000 kWh_e/pers/yr)

Figure 1: The three levels of energy access[3]

[1] *International Energy Agency (IEA), World Energy Outlook (WEO) 2011.*

[2] *This is the aim of the United Nation's Sustainable Energy for All program whose three pillars are universal access to energy, improvement of energy efficiency and development of renewable energies.*

[3] *UN Advisory Group on Energy and Climate Change*

CURRENT ENERGY ACCESS SITUATION

An issue at the center of development challenges

Energy access is a prerequisite for both human and economic development. Improving energy access in developing countries is a necessity in order to meet the different development challenges (cf. Figure 2) and is an essential condition to reach the eight Millennium Development Goals set out by the United Nations.

As an example, for health, the WHO estimates that 4 million people die each year from exposure to toxic smoke that is linked to the use of traditional biomass for cooking[1].

The impact of access to modern energy services is clearly positive when considered at the scale of an individual and remains tangibly positive for development at the national scale – the level of a country's human and economic development (quantified by the Human Development index – HDI) has proven to be strongly correlated to the level of its energy access (quantified by the Energy Development index – EDI).

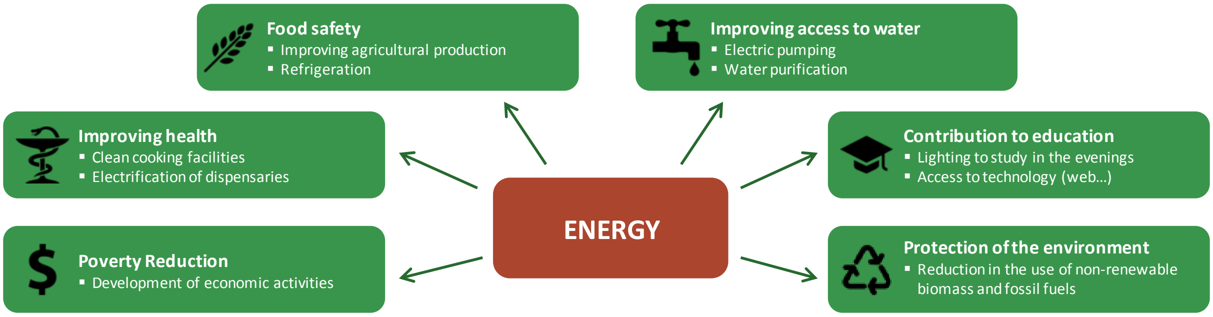


Figure 2: Main links between energy and development

A strategic priority for development actors

This strong link with development explains the growing importance of energy access in the eyes of public and private actors at local, national and international levels (cf. Figure 3). **The main national and international funders – States, multi- and bilateral organizations and economic actors – thus invested 9.1 billion dollars in energy access in 2009[2].**

Energy access has become one of the priorities for public authorities in many countries and is increasingly put forward as a key action by multilateral and national development agencies, which are multiplying the number of projects and programs in this field. NGOs working on poverty eradication have also made energy access one of their strategic initiative focuses in developing countries. Lastly, certain private multinationals are also working towards energy access (see box).

[1] *World Health Organization (WHO), Global burden of disease, 2010.*
[2] *IEA, WEO 2011*

CURRENT ENERGY ACCESS SITUATION

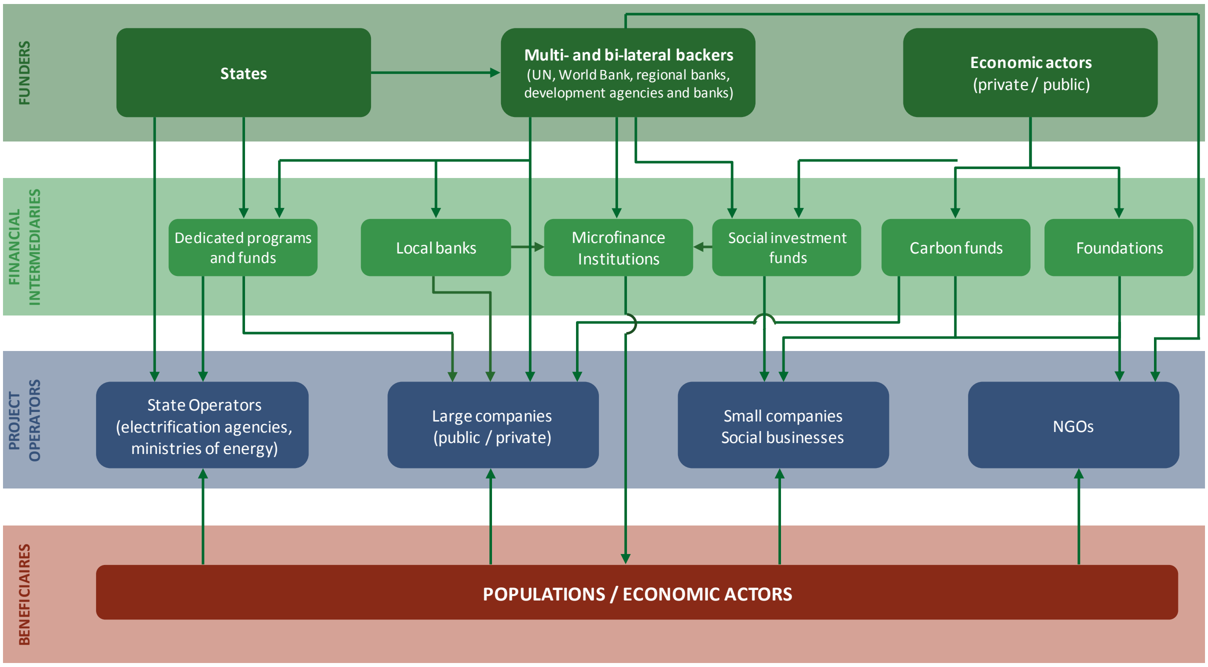


Figure 3: The energy access actors and financial flows

Examples of powerful energy access initiatives

Luz para Todos: This program, launched in 2003, made it possible to supply electricity to 14.5 million additional people in eight years and to bring Brazil's electrification rate up to 99%.

Lighting Africa: This program is a World Bank and IFC initiative launched in 2007 to foster the development of markets for clean off-grid lighting products, mostly solar kits, in 10 countries of sub-Saharan Africa. The goal of the program is to provide lighting to 250 million people by 2030.

AFD (French Agency for Development) opened a line of credit to West Africa in 2013 to support private investment in energy efficiency and renewable energies in the region. The financial commitments for this project total 45 million euros over a 3-year period (co-financed by the European Union and the FFEM – French Global Environment Facility).

In the framework of its *BipBop program,* **Schneider Electric** created the *Energy Access Fund*, dedicated to energy access in developing countries.

TOTAL is selling solar lamps (*Awango by TOTAL*) to the market at the base of the pyramid.

The **GERES – Group for the Environment, Renewable Energies and Solidarity**, with its *StovePlus* initiative, supports project developers and entrepreneurs via technical assistance to facilitate access to improved cooking solutions in Southeast Asia and West Africa.

CURRENT ENERGY ACCESS SITUATION

Energy access needs

By 2030, the number of people without access to electricity should decrease to 1 billion from 1.3 billion in 2010. At the same time, the number of people without access to clean cooking facilities should increase from 2.6 billion in 2010 to 2.7 billion in 2030[1].

The forecasted strong demographic growth in developing countries will temper the efforts made in favor of energy access. Moreover, major electricity generation projects, given their large-scale impact on national generation potential, are often preferred over the supply of clean cooking systems that meet needs at an individual level.

These energy access needs are a fundamental development issue but also represent an important potential market. It is estimated that the **populations at the base of the pyramid (BOP market) currently spend 37 billion dollars per year to buy "traditional energy" supplies**[2].

The countries that are the most affected by energy access issues are of course developing countries and the least advanced countries. However, there are strong regional disparities:

- **Sub-Saharan Africa** alone represented half of the global population without energy access in 2010; it will likely represent two-thirds of it in 2030. Due to demographic growth, the number of people without access to clean cooking systems and to electricity should increase between 2010 and 2030. Despite a problematic regional situation, certain African countries such as Senegal and South Africa have made significant inroads in terms of energy access.

- In **Asia** in particular, energy access has considerably progressed, mainly under the influence of China which has reached almost 100% access to electricity since the early 2000's. However, developing Asian countries and China represent 70% of the global population without access to clean cooking systems (in 2010), with 30% of the Chinese population concerned. There are significant infraregional disparities in Asia: 2% of the Vietnamese population does not have access to electricity while 54% of the Bangladeshi population is without access.

- **Latin America and the Caribbean** are much less impacted by energy access issues, although some Central American countries, like Nicaragua, still have very low Energy Development Indexes. The sub-continent should reach the target of universal access to electricity by 2030. However, the expected increase in access to clean cooking systems by 2030 in the region is low.

Beyond these regional disparities, energy access gaps essentially concern the most isolated rural zones everywhere. **Roughly 85% of the population without energy access (electricity and cooking) lives in rural zones.** Indeed, the main beneficiaries of energy access programs over these last few years have been city dwellers since urban projects take advantage of large economies of scale, bringing down electricity costs and ensuring the economic viability of these projects.

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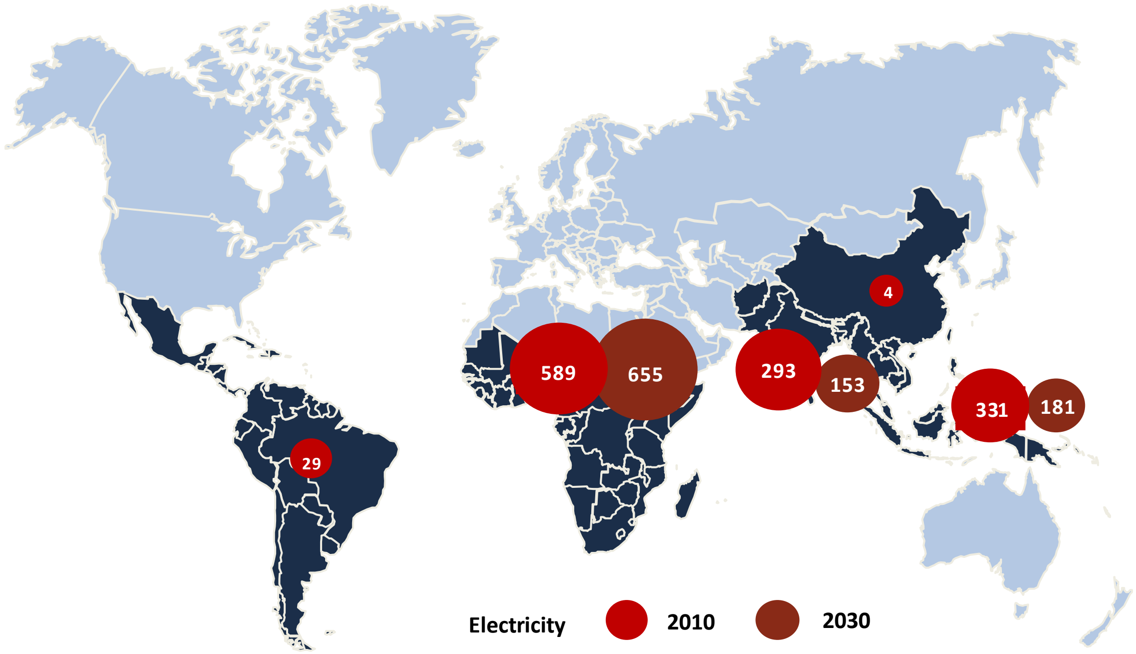
[1] In the IEA's New Policies scenario that takes into account current commitments and energy policies to be achieved by 2030. These figures refer to populations without Level 1 energy access, WEO 2011.
[2] 18 billion dollars for lighting and charging small devices and 19 billion dollars in traditional biomass resources for cooking facilities. IFC, From Gap to Opportunity: Business Models for Scaling-up Energy Access, 2012.

CURRENT ENERGY ACCESS SITUATION



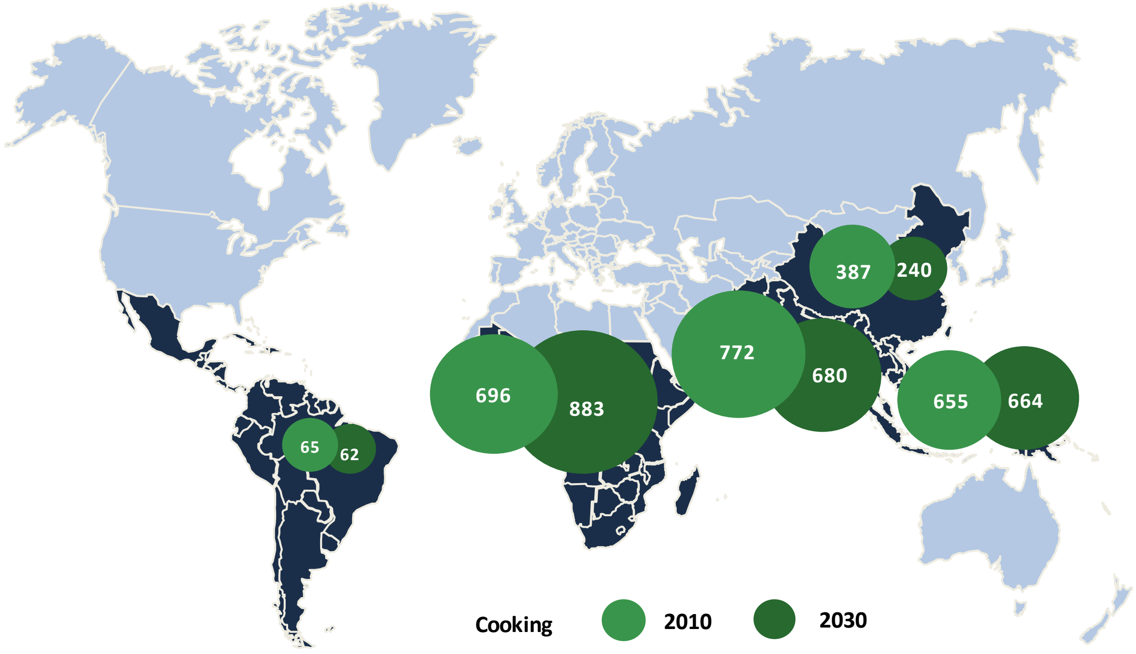


Figure 4: Population (in millions) without access to electricity and without adequate cooking facilities in 2010 and 2030, according to IEA data (New Policies Scenario), WEO 2011

TECHNOLOGICAL SOLUTIONS

	Off-grid systems *< 500 W[1]*	Mini-grids *30 - 500 kW*	Extensions / grid support *Several dozen or hundreds of MW*
Fossil fuels	- Candles - Kerosene lamp - Battery-powered lamp	- Diesel generator	- Thermal power plant (coal, oil, gas)
	- LPG stoves -Improved coal stoves		
Solar	- Solar lantern - Solar kits - Solar home systems	- Solar PV - Hybrid diesel generators / PV	- Solar PV, CPV and thermodynamic power plants
Hydro		- Pico / Micro hydropower	- Hydropower plants
Windpower	- Micro wind power	- Wind power	
Biomass	- Improved woodstoves - Domestic biogas systems	- Biomass power plants - Biogas power plants for electricty generation	

Solar lantern: System integrating a small solar panel, a battery and a LED lightbulb, intended for lighting and also to charge external devices (cell phones, other lanterns)

Solar kit: "plug-and-play" system integrating a portable solar panel, batteries, lightbulbs and outlets for different applications (radio, television)

Solar Home System (SHS)[2]: fixed installation, most often on a roof, supplying storage capacities of several days and with different energy services (lighting, television, refrigerator)

Improved stoves: cooking stove with higher energy efficiency than that of traditional systems, enabling a 30 to 50% reduction in fuel consumption (wood, wood coal, pellets) and a reduction in domestic toxic smoke

Home biogas system: fixed installation for the supply of renewable gas produced essentially from crop and animal breeding residues

Figure 5: The main technological solutions per type of energy resource and project scale. Access-to-electricity technologies are in red and clean-cooking technologies in green.

[1] 20 – 500 Wc for a solar home system in Watt-peak
[2] Solar Home System (SHS)

TECHNOLOGICAL SOLUTIONS

Different technologies adapted to each project scale

There is no single one-size-fits-all solution for energy access but rather many different technologies appropriate for different situations (cf. Figure 5).

The question of locally **available resources** is clearly fundamental and it conditions the use of solar, windpower or hydropower technologies for electricity generation, for example. The same is true for cooking – the availability of different types of biomass and their renewability are structuring criteria for the emergence of supply chains.

Another decisive criterion is **project scale**. While cooking essentially concerns consumption at the household level, electricity access issues must be dealt with at much different scales. The distinction must be made between **off-grid systems** at the scale of a household, **mini-grid** type systems at the scale of a community, and **grid support and extension** projects at a national scale.

The most appropriate project scale depends on several factors, chiefly population density in the target zone, distance from the existing grid, available revenue and the target population's willingness to pay.

- A **grid support and extension project** is generally preferred in highly-populated urban and periurban areas, where population density allows economies of scale. Beyond serving households, this type of project makes it possible to grow the electrical capacity available at the regional scale, ensuring electricity supply to the economic and industrial sectors.
- The **development of a mini-grid** is an alternative to the extension of an existing electrical grid (particularly if the grid is far away from the target populations) that is appropriate for communities of a dozen to several thousand households in a rural area.
- For small populations living in remote rural areas distant from existing electrical grids, the supply of **off-grid systems** is the most appropriate solution. This is also the case when the available revenue of the target population is very low, since these systems allow access to the most basic services (solar lamps, telephone recharging, etc.).

Africa, the land of smart grids?

In the same way that the development of ICTs in Africa was based on wireless technology thus limiting the development of wireline infrastructure, the electrical systems resulting from the implementation of projects at these three scales could be very different from electrical systems that currently exist in industrialized countries.

Renewable production, storage and smart grid technologies will indeed allow an increasingly efficient electricity supply based on off-grid systems and small infrastructures supplying mini-grids. The development of these technologies at a decentralized scale, with limited unit costs, is a real opportunity for developing countries that are very often confronted with financing problems.

In the long run, the deployment of part of the national grid could be done in a progressive manner through the connection of different off-grid systems and mini-grids, resulting in an interconnected, intelligent and decentralized electrical system that makes very good use of renewable energies and storage. This type of progression would make it possible to sequence investments over time while providing basic energy services to a large part of the territory.

THE FIVE ENERGY ACCESS CHALLENGES

As seen in the previous sections, technical solutions to energy access do exist and are being promoted by a growing number of national, international and private initiatives. However, in order to reach the objective of universal energy access, five major challenges will have to be addressed:

- Energy prices
- Equipment financing
- Distribution
- Change of scale
- Environmental performances

Energy prices

Available energy access technologies are already competitive. Improved stoves are already very affordable systems that are rapidly paid for by the fuel savings that they enable (roughly 6 months in an urban area). Similarly, recent improvements in and price reductions for PV solar technologies and their associated electronics and storage make it possible to offer populations a sustainable source of energy that is fairly competitive with traditional alternatives.

In many cases, the total cost of energy access systems turns out to be lower than the cost of traditional energy sources, with a service level that is at minimum equivalent (cf. Figure 6). Of course, different factors, such as locally available resources, distance from the grid, local price (possibly subsidized) of fossil fuels or the existence of trade barriers will have an influence on the relative position of the different solutions. Finally, to be truly competitive, the energy access systems, which are often more complex (especially electrical systems) than their traditional counterparts, require a local maintenance capacity.

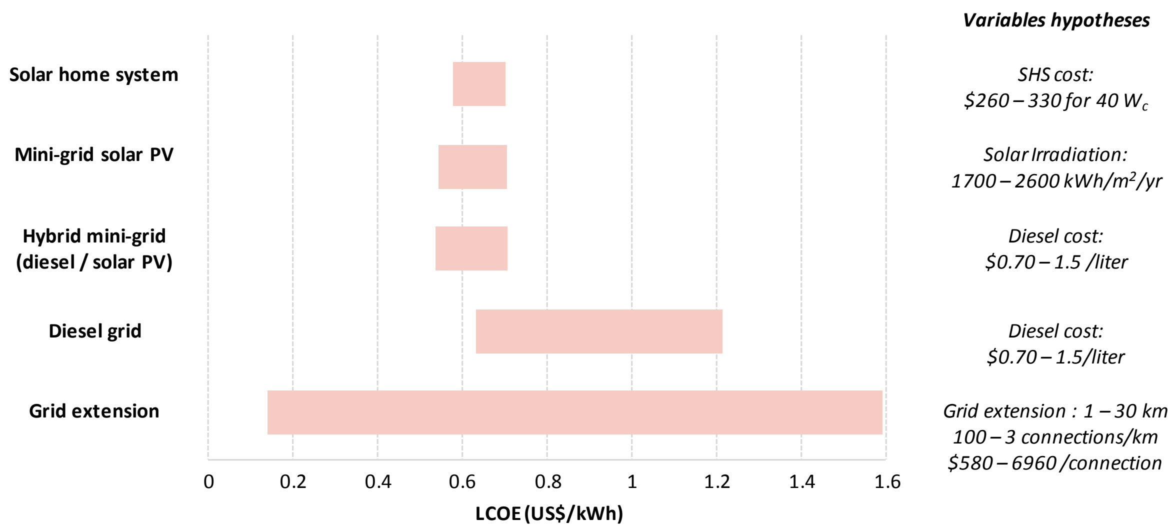


Figure 6 : Ranges of total costs (LCOE – Levelized Cost Of Energy) for several electrification solutions in cases representative of sub-Saharan Africa[1]

[1] *Ryan Anderson, Marissa Jackson, Piyush Sanju (NORPLAN), Cost-benefit analysis of rural electrification, 2012.*

THE FIVE ENERGY ACCESS CHALLENGES

With this level of competitiveness, **a substantial share of energy access needs could already be met with sustainable technologies, representing a market of over 37 billion dollars** (cf. Figure 7).

Technological improvements and cost reductions will make it possible to improve the competitiveness of sustainable energy access technologies when compared with traditional energy sources and to propose a better service level to populations. Serving the populations with the lowest income levels will remain a challenge that cost reductions alone will not be able to solve.

	Ø	Stand-alone systems: Solar lanterns	Stand-alone systems: Solar kits	Stand-alone systems: SHS	Mini-grids	Grid extensions
Market (in billions of $)	Absence of a viable market	4	7	1	4	2
Impacted households	18 million	112 million	86 million	9 million	28 million	21 million
Monthly household energy expenditures	*< $1.25*	*$1.25 - 5.50*	*$5.50 - 8.50*	*> $8.50*	*>$8.50*	*> $8.50*

	Ø	Improved wood stoves	Improved coal stoves	Alternative fuels (pellets, LPG)
Market (in billions of $)	Absence of a viable market	19		
Impacted households	32 million	298 million	76 million	20 million
Monthly household energy expenditures	*< $1.30*	*$0.90 - 9*	*$1.30 - 9*	*> $9*

Figure 7: Potential market for access to electricity and clean cooking facilities, according to IFC data[1]

[1] *IFC, From Gap to Opportunity: Business Models for Scaling-up Energy Access, 2012.*

THE FIVE ENERGY ACCESS CHALLENGES

Equipment financing

Hence, competitive energy access solutions are already available; the often higher investment costs of sustainable energy access solutions are quickly made cost-effective when compared with the expenses generated by traditional solutions.

This economic competitiveness based on service life is far from sufficient: the high purchasing costs of sustainable energy solutions create a significant barrier for disadvantaged populations. **An essential challenge for energy access is to make these energy solutions affordable for the end users.**

There are many possible solutions to solve the financing issue for end users, which can make the difference for energy access projects targeting the most impoverished communities.

Microfinance has played a fundamental role in the financing of energy systems in developing countries for over a decade now, since microfinance institutions (MFI) adapted their standard operations to the financing of energy systems. In rural areas of Bangladesh, Grameen Shakti, a non-profit enterprise linked to Grameen Bank, has helped to provide electricity to 8 million people via "solar houses" as well as 500,000 improved stoves. The end users benefit from monthly payment facilities to acquire these off-grid systems, particularly through the microcredit instruments developed by the Grameen Bank.

MFIs now work in a tripartite manner with micro-entrepreneurs who use loans to buy energy systems from suppliers. However, the penetration rate of MFIs in remote rural areas remains very low and the poorest households are often excluded from these financial measures.

To eliminate both dependence on a third party and the transaction costs associated with microfinance, **some companies have developed financing capacities that are integrated into their business model via *leasing* and *pay-as-you-go* practices** (cf. box on next page). They thus internalize the financial risks and enable populations to have access to energy services without having to immediately come up with all of the required capital.

These solutions have been very successful in the development of mobile telephone networks in developing countries and are largely replicable in the energy sector.

Prepaid or **dematerialized payment** solutions guarantee suppliers and distributors of energy solutions a reliable payment system for energy bills.

THE FIVE ENERGY ACCESS CHALLENGES

The initial cost barrier can also be overcome by end users through **pooling structures such as rural electric cooperatives,** around which mini-grids can develop. These organizations played an important role in rural electrification programs in southern Asia (Indonesia, Philippines and India in particular) thanks to their ability to benefit households and productive activities in a vast number of villages.

"Pay-as-you-go" and recharging of mobile phones in Tanzania *ENEA feedback*

Example of a solar kit for phones (Eternum Energy)

In rural areas of southern countries, the telephone represents a real driving force for development with **90% of usages dedicated to the management of micro-enterprises or money transfers by SMS**. In Tanzania, in the rural region of Lake Victoria, the low level of electrification (roughly 6%) means that almost half of all mobile phone users must travel from 4 to 18 km in order to recharge.

Many local micro-entrepreneurs saw that there was a way of earning subsistence incomes in their villages (by selling recharging from 0.1 and 0.3 dollars per unit). Yet, they were not able to pay the 200 to 400 dollars required to buy solar kits, and **without capital or guarantees of solvency, lending agencies and solar system distributors were not prepared to propose a loan or a leasing arrangement.** It was therefore the technology developers themselves who overcame this problem with "***Pay-As-You-Go***" leasing offers to make solar kits available to entrepreneurs in exchange for a down payment.

To recharge telephones, **the entrepreneur activates the device for several days or several recharges by sending a surcharged SMS to the technology developer.** Thanks to this system, the entrepreneur gradually becomes the owner of the solar kit as s/he makes payments. The technology developers agree to spread their turnover out over time in exchange for a higher overall price and the right to cash in on all of the information collected (telephone numbers).

In the framework of its pro bono energy access program, ENEA worked in Tanzania for GVEP International to analyze the value chain of this market: to characterize the business models of the main actors as well as the relationships that they have with each other. This assignment made it possible to establish recommendations for NGOs aiming to develop the sector and foster micro-entrepreneurship within isolated communities.

THE FIVE ENERGY ACCESS CHALLENGES

Distribution

Suppliers and distributors of energy solutions must also deal with the challenge of physically reaching their potential customers. This is called the **last-mile logistics problem.**

This distribution challenge concerns in particular the developers of off-grid system projects in remote and lowly populated rural areas. These geographic and demographic constraints lead to the parceling of distribution networks and make it difficult and costly for energy solution suppliers to establish a local presence. What's more, the lack of road infrastructure is often an obstacle to the development of distribution networks and supply chains, in addition to generating higher energy system costs for the end users.

The distribution issues with regard to cooking are, on the contrary, worse in urban and periurban areas due to their distance from biomass resources.

To overcome the geographical constraints and to reach rural populations, some companies have developed **franchise networks** using the existing local economic fabric, such as service station networks, to sell solar kits.

Local **NGOs** and **MFIs** are also good relay points for the distributors.

In the most remote areas, energy solution suppliers can count on **resellers** who sell door-to-door and self-finance through a percentage on the sales made. Their excellent knowledge of the local contexts and the relationship of trust that they have with the local communities are often crucial to reach potential customers.

Beyond the logistics difficulties as such, geographic distance often means that developers of off-grid systems only have very fragmented knowledge of potential rural markets. This difficulty in acquiring information on potential markets in rural areas represents an entry barrier for suppliers and distributors and an obstacle to the efficient distribution of energy access systems in these areas.

THE FIVE ENERGY ACCESS CHALLENGES

A strategy to gain access to remote rural markets in Uganda *ENEA feedback*

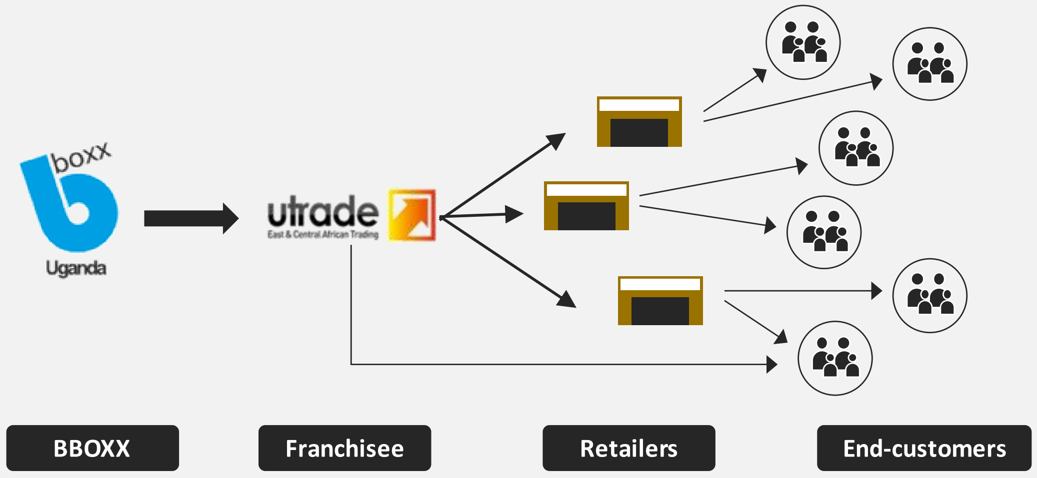


Figure 8: value chain of BBOXX Uganda

BBOXX, an English company that makes and distributes solar kits, signed a partnership agreement in 2012 with a local franchise (U-Trade) in Uganda to gain access to the isolated rural areas market via the development of a network of local retailers that would propose BBOXX products in their points of sale.

BBOXX Uganda has developed training programs for the retailers and continuously adapts its payment terms to the specific situations of the retailers in order to set up to a flexible distribution network. The retailers are provided with BBOXX marketing tools to generate local interest in solar kits, which is vital for the viability of this selling model.

BBOXX also established a partnership with a coffee producer coop (Great Lakes Coffee) that has an extensive footprint in Uganda. This partnership enables the coffee producers to install electricity in their drying and cleaning rooms and enables BBOXX to have access to a large, already structured network of points of sale. Moreover, this strategic alliance gives BBOXX the possibility to gain a foothold in the market of coffee producers living in remote and non-electrified rural areas. This strategy of converting customers into distributors allows BBOXX to overcome its distribution problems.

ENEA performed a socio-economic impact study of the BBOXX value chain in Uganda. This original distribution model enables BBOXX to optimize its socio-economic impact on local communities, notably through its proximity with the end-users and the financial innovations proposed to the distributors.

THE FIVE ENERGY ACCESS CHALLENGES

Change of scale

Energy access solutions must be rolled out at a large scale if we hope to reach the objective of universal energy access. This means **reconciling adaptation to local contexts with standardization**, by designing energy solutions that are in line with the specific cultural, geographic, demographic and economic characteristics of local populations while at the same time being replicable.

Two routes are possible to move towards large-scale energy access :

- the **growth of projects that start at a small scale,** managed by entrepreneurs that are part of a local context and have a limited potential for reproducibility
- the **dissemination of standardized energy solutions** that are designed to be used in very different contexts.

Burdensome administrative procedures and transaction costs linked to scaling up a project can considerably slow the development of local projects. Moreover, the initial business plans of pilot projects rarely contain financing solutions for future phases involving changes of scale. Nevertheless, we are seeing the development of initiatives from private companies, national governments and international organizations to provide financial assistance and technical and organizational support to entrepreneurs (cf. box).

The steady reduction in the cost of decentralized renewable energy production equipment and the progressive standardization of products such as solar kits represent new opportunities to widely disseminate energy solutions that are simple but appropriate for many different local contexts. What's more, the capitalization on and dissemination of best practices under the aegis of international organizations represent a significant driver to increase the reproducibility of these energy solutions.

The GACC *Spark Fund*: supporting a change of scale *ENEA feedback*

Char-briquettes factory
Sustainable Green Fuel Energy (Cambodia)

The United Nations Foundation's Global Alliance for Clean Cookstoves (GACC) initiative set the objective of equipping 100 million families with improved cookstoves by 2020.

To do so, in 2012, the GACC created the **Spark Fund**, endowed with 2 million dollars per year. Its role is to deliver financial and operational support to companies with significant growth potential in the clean cookstoves and fuels sector in order to support them with their scalability and sustainability strategies.

ENEA is working with 4 clean fuel producers and distributors in Africa and southern Asia that were selected by the Spark Fund (biogas, bioethanol, char-briquettes production) to accelerate their change of scale, in particular via actions to improve the environmental and social efficiency of their technologies and to optimize their organizations to prepare for future development phases. This support also enables them to attract other funders to finance their future scale-up.

THE FIVE ENERGY ACCESS CHALLENGES

Environmental performances

It makes good sense to take into account the environmental impacts of energy access solutions, by integrating a reasoning based on the complete life cycle of the systems, particularly since energy access projects are financed by public authorities.

Let's take the example of Solar Home Systems (SHS). **Contrary to the generally-accepted view that SHS have a "zero carbon" footprint, a life cycle assessment of SHS shows that their impact on climate change is not neutral,** and perhaps, in the least favorable cases, is even comparable with that of a genset. While SHS emissions are effectively nil in the usage phase, as opposed to a genset, they are high for their production, shipping and end-of-life processing and depend heavily on service life and renewal needs.

At the same time, **the shortage of local recycling channels** generates potential impacts on human health that go beyond those due to genset emissions. The setting up of local battery reconditioning and recycling channels would both reduce the impact on human health and the carbon footprint of these systems.

This example demonstrates the importance of **eco-designing energy access projects** to ensure their sustainability and to reconcile development objectives with environmental protection objectives.

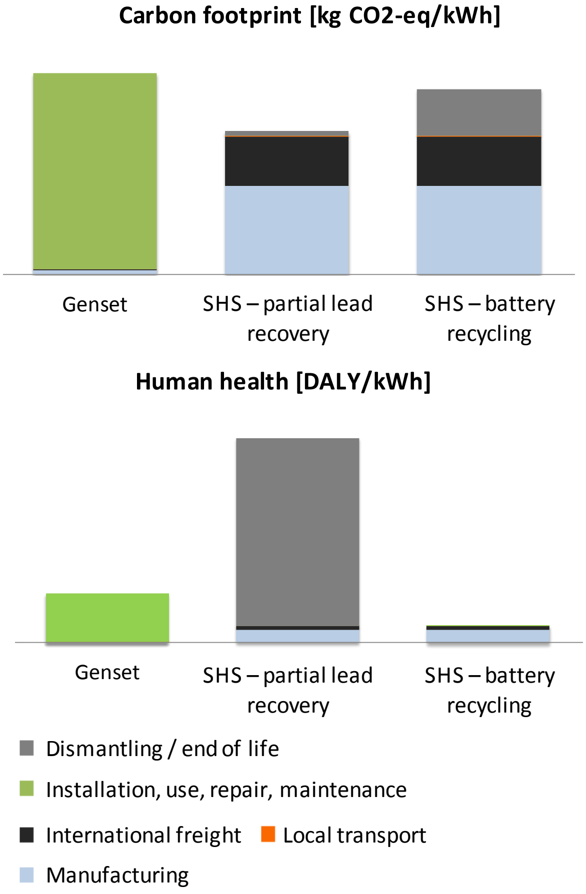


Figure 9 Comparison of the carbon footprint and impacts on human health from electrical solutions throughout their service lives: genset and SHS (main hypotheses: manufacturing of systems in China, sea freight, use in Uganda to produce 10 kWh/day for 20 years – battery life of 2 years with recycling in China)

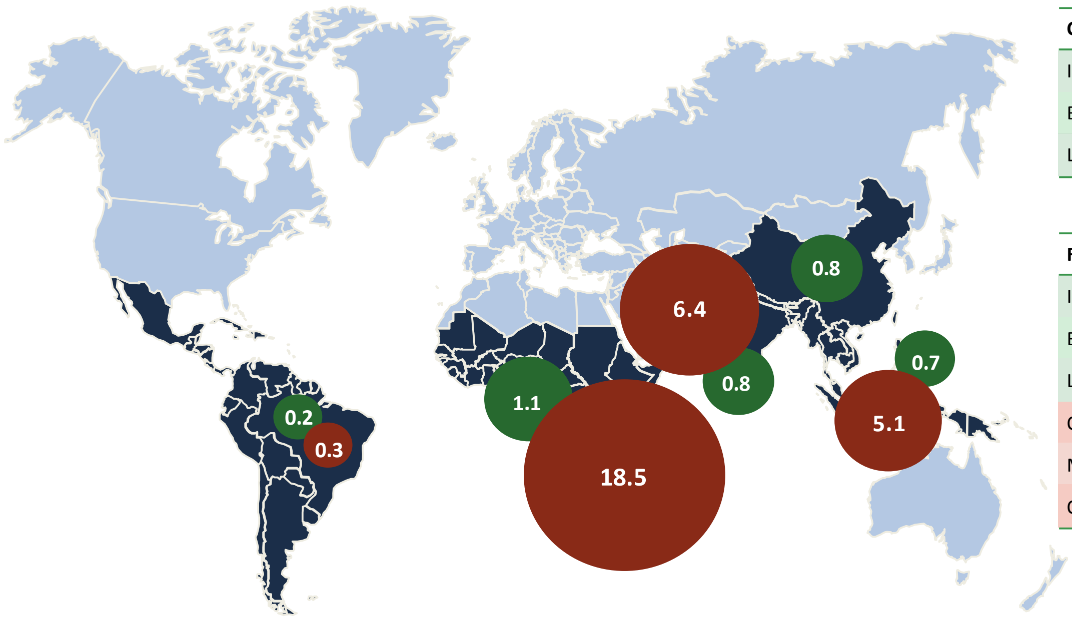
Environmental and social performance assessment *ENEA feedback*

To help entrepreneurs and manufacturers with their eco-design approach, ENEA developed environmental impact assessment models in partnership with Quantis as well as socio-economic assessment impact models for electrification and improved cookstove projects, covering their entire life cycles.

For the environmental aspects, the method is based on an LCA approach with 5 indicators (climate change, water, ecosystem quality, non-renewable resources, human health) with an adaptation of the parameters to the energy access context.

The same type of approach was adopted to design a socio-economic performance assessment tool for energy access projects via a detailed analysis of their value chain, based on the analysis of 4 impact categories (local economy, education, health & safety, and household comfort).

TOWARDS UNIVERSAL ENERGY ACCESS



China	
Improved stoves	0.04 B$
Biogas	0.66 B$
LPG stoves	0.1 B$

Rest of Asia	
Improved stoves	0.22 B$
Biogas	0.27 B$
LPG stoves	0.21 B$
Off-grid	2.2 B$
Mini-grid	2 B$
On-grid	1.3 B$

Latin America	
Improved stoves	0.02 B$
Biogas	0.15 B$
LPG stoves	0.03 B$
Off-grid	0.1 B$
Mini-grid	0.1 B$
On-grid	0.1 B$

Sub-Saharan Africa	
Improved stoves	0.27 B$
Biogas	0.45 B$
LPG stoves	0.37 B$
Off-grid	4.5 B$
Mini-grid	7 B$
On-grid	7 B$

India	
Improved stoves	0.3 B$
Biogas	0.3 B$
LPG stoves	0.2 B$
Off-grid	2.2 B$
Mini-grid	2.4 B$
On-grid	1.8 B$

World	
Cooking	**3.5 B$**
Electricity	**30.5 B$**

Cooking systems

Electricity

Figure 10: Additional annual investment needs (in billions of dollars) per region and per technology in the Universal Access scenario in 2030 compared with the New Policies scenario, based on IEA – WEO 2011 data.

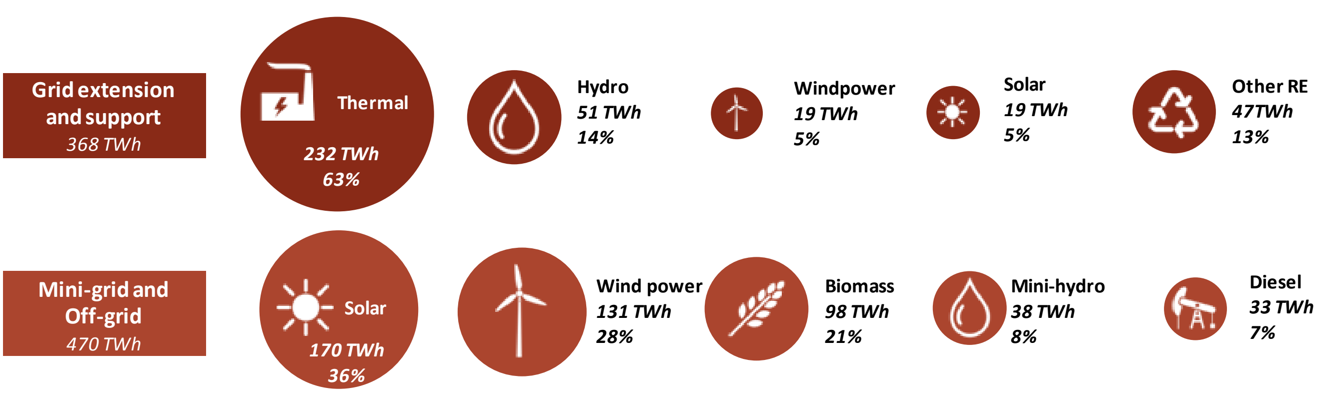


Figure 11: Additional electricity generation needs (in TWh) to reach the objective of Universal Access scenario in 2030 compared with the New Policies scenario, based on IEA – WEO 2011 data

TOWARDS UNIVERSAL ENERGY ACCESS

Most current financing is directed at large grid support and extension projects that do not always make it possible to reach the poorest populations. The development of local financing structures is essential to support mini-grid and off-grid projects that often have a higher direct impact on the target populations, and especially on the poorest populations in remote rural areas.

In its *New Policies* scenario, based on the hypothesis of the realization of all the currently engaged policies, the IEA estimates that global investments in energy access will represent 296 billion dollars from 2010 to 2030 (i.e. 14 billion dollars per year, 56% higher than the 2009 level). However, in this scenario, 1 billion people would remain without access to electricity (60% in sub-Saharan Africa) and 2.7 billion without access to clean cooking systems. **According to the IEA, the objective of universal energy access by 2030 could be reached with annual investments of 48 billion dollars from 2010 to 2030, which is 5 times higher than the 2009 level.**

The additional annual investments required to reach the objective of universal energy access compared with the *New Policies* reference scenario represent 3.5 billion dollars per year for clean and sustainable cooking systems and 30.5 billion dollars for electricity, even though cooking issues concern far more people. Undeniably, the infrastructures required to increase production capacities and to grow and support electrical grids at a national scale are very capital intensive.

International investments must mainly be focused on sub-Saharan Africa, which will require over half of the global investments in electricity. The differences in financing needs per electrical project scale reflect regional differences: the majority of investments in sub-Saharan Africa are intended for mini-grid and grid extension projects, while they are mostly intended for off-grid systems in developing Asian countries (excluding China and India).

To reach universal energy access, 220 GW of additional electricity generation capacity is required at a global level, corresponding to 2.5% of the global installed capacity forecasted in the *New Policies* scenario. 60% of the electricity generated by grid support and extension projects will remain of fossil origin. However, 93% of the investments in mini-grid and off-grid systems will be intended for renewable energies, thus reconciling the needs of universal energy access with environmental protection.

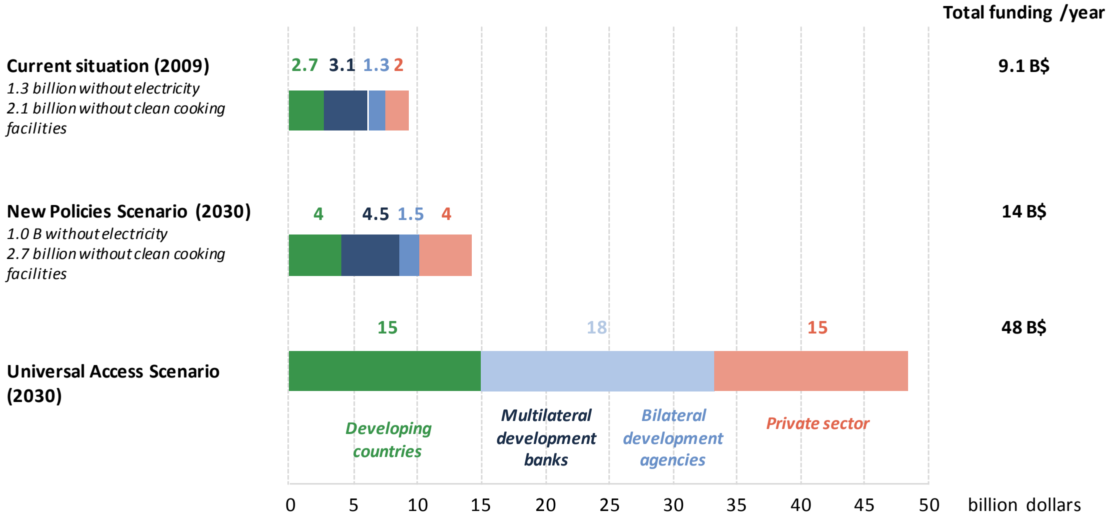


Figure 12: Current financing and annual financing requirements per type of financial backer, according to IEA / WEO 2011 data

TAKEAWAYS

Improved energy access is a major driver for human and economic development at both the individual and national scales. There are two sides to the energy access issue – access to reliable and sustainable electricity and access to clean cooking systems.

There are currently 1.3 billion people in the world without access to electricity and 2.6 billion people who depend on traditional biomass resources for uses such as cooking. Sub-Saharan Africa represents half of this population without energy access and, due to its demographic growth rates, it will represent two-thirds by 2030. There are major disparities at the scale of each continent, as some countries have made huge progress over the last few years, but beyond these regional disparities, it's essentially the rural areas that suffer the most from energy poverty.

There are more and more different development aid actors involved in energy access, including States and multi- and bilateral funders. **In 2009, 9 billion dollars were invested in energy access**. The multilateral funders are currently the biggest financial backers of energy access projects and should continue as such. However, private actors are increasingly positioning themselves on energy access projects since there is **a market of base of pyramid (BOP) households that currently spend over 37 billion dollars per year to buy "traditional energies".** There are more synergies between public and private actors that participate in the optimization of local, national and international initiatives to reach the objective of universal energy access.

The energy access market offers major opportunities to companies that know how to innovate in terms of their technology but also their business models, since new product distribution and financing systems will be necessary to reach these potential clients who are often in isolated areas and have limited income.

There is no one-size-fits-all solution to meet the energy access challenge – each local context requires specific solutions based on the energy resources available, the population density in the target areas, income levels, the end users' willingness to pay, and the financing available.

Household-scale solutions exist that can cover basic individual energy needs, however they only marginally meet collective productive needs, which often require the development of mini-grids and/or the extension of the national grid.

The development of renewable energies and advances in technology offer new possibilities to project operators. Specifically, the progressive interconnection of off-grid systems and mini-grids could turn out to be more adapted to local economic constraints and socio-demographic situations, and lead in the long term to energy systems that are very different from those that currently exist in industrialized countries.

The objective of universal energy access raises the challenge of the **very large-scale dissemination** of competitive and sustainable energy solutions that are affordable for the end user. To reach it, it will be indispensable to **improve the reproducibility of energy solutions**, at the local scale via support to entrepreneurs and at the international scale via the use of standardized solutions. Huge investments will be required: in order to reach the objective of universal energy access by 2030 **almost 50 billion dollars in annual investments will be required, which is well above the 9 billion dollars per year currently invested.**

FOR MORE INFORMATION:

Sustainable Energy For All site: www.se4all.org

GACC site: www.cleancookstoves.org

IEA, *Energy for all: Financing access to the poor - WEO 2011*

IEA, *Measuring progress towards energy for all - WEO 2012*

IFC, *From Gap to Opportunity: Business Models for Scaling Up Energy Access*, 2012

ENEA Publication: The solar photovoltaic industry in Mali, 2011

ENEA Publication: Electrical valorization of bamboo in Africa, 2012

ENEA Publication: Domestic biogas development in developing countries, 2013

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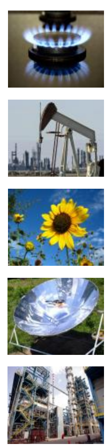

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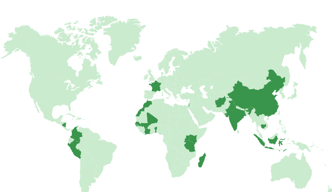

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