

Group 1: Renewable Energy and Energy Efficiency

Marrakech, Morocco

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Introduction

- 1.3 billion people (18%) world-wide live without access to electricity.
- More than 620 million without access to electricity live in sub-Saharan Africa (SSA) and more than 80 percent of them live in rural area.
- Average electricity consumption per capita in SSA is less than that needed to power a 50 watt bulb continuously.
- Low income coupled with inefficient and costly forms of energy supply make energy affordability a critical issue.

Source: World Energy Outlook (2014), International Energy Agency

- The presentation covers a case study of a rural electrification programme in **country A** to accelerate electricity access and mitigate GHG emissions



Case Study (Country A) – Current situation

Electricity Access:

- Total population: 13 million
- % of population electrified in end of 2014:
 - a) Urban: 90%
 - b) **Rural : 30%**
- 70% population (9.1 million) live in rural area.
 - About 6.4 million people in rural areas live without access to electricity
- **Energy supply situation:**
 - Grid energy mix: 84% Coal; 4% Gas; and 12% Hydro
 - Diesel generator is common for off-grid electricity supply
 - Kerosene lamps, paraffin candles are common for lighting in areas with no access to grid/off-grid



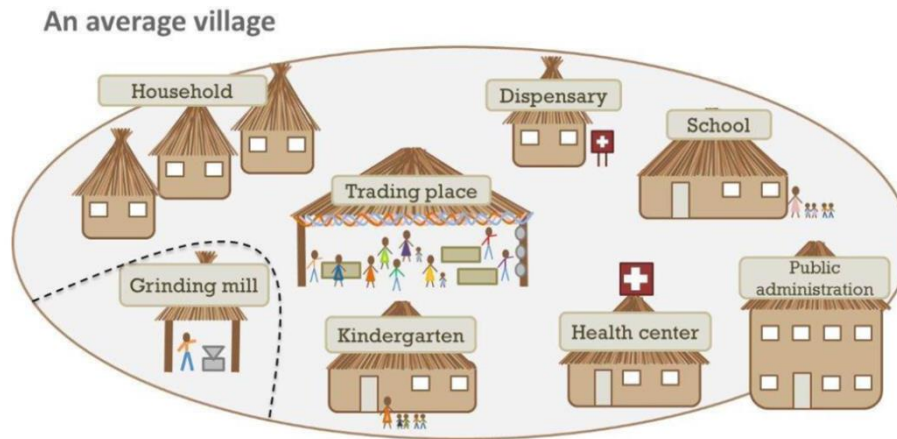
Case Study – Rural Electrification Target

Target:

- Policy makers set ambitious target to double the rural electrification rate to 60% by 2018.
 - Additional 3.1 million rural population to be electrified by 2018
 - This would require 620,000 new connections using grid/off-grid

Target Group:

- Rural communities including households and SMEs/Institutions not connected to a regional/national grid



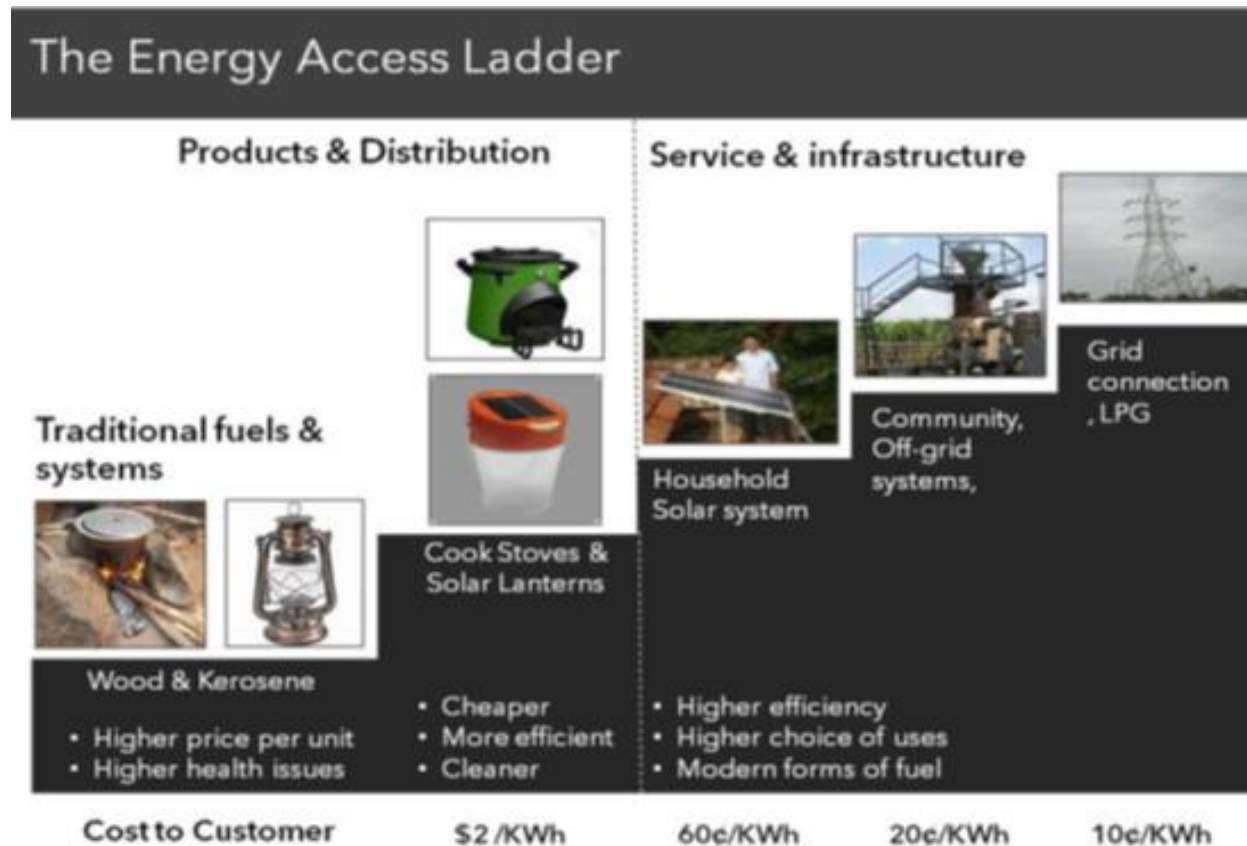
Institutional arrangement:

- To make electricity access affordable, the country has devised an innovative electrification program at concessional rates harnessing private and public sector finance from domestic and overseas sources.
- A CDM PoA with boundaries covering the entire geographic area of the country has been devised and CME to manage the electrification program in the country blending sources of finance with significant leverage arising from carbon finance.
 - Example: CER revenues will subsidize the cost of connections, support the distribution of the technology or capacity building/educate end-users to maintain for sustainable operation of technologies.



Case Study –Assessment of possible technology options

- Use of clean and efficient technologies is cost effective as compared to traditional systems

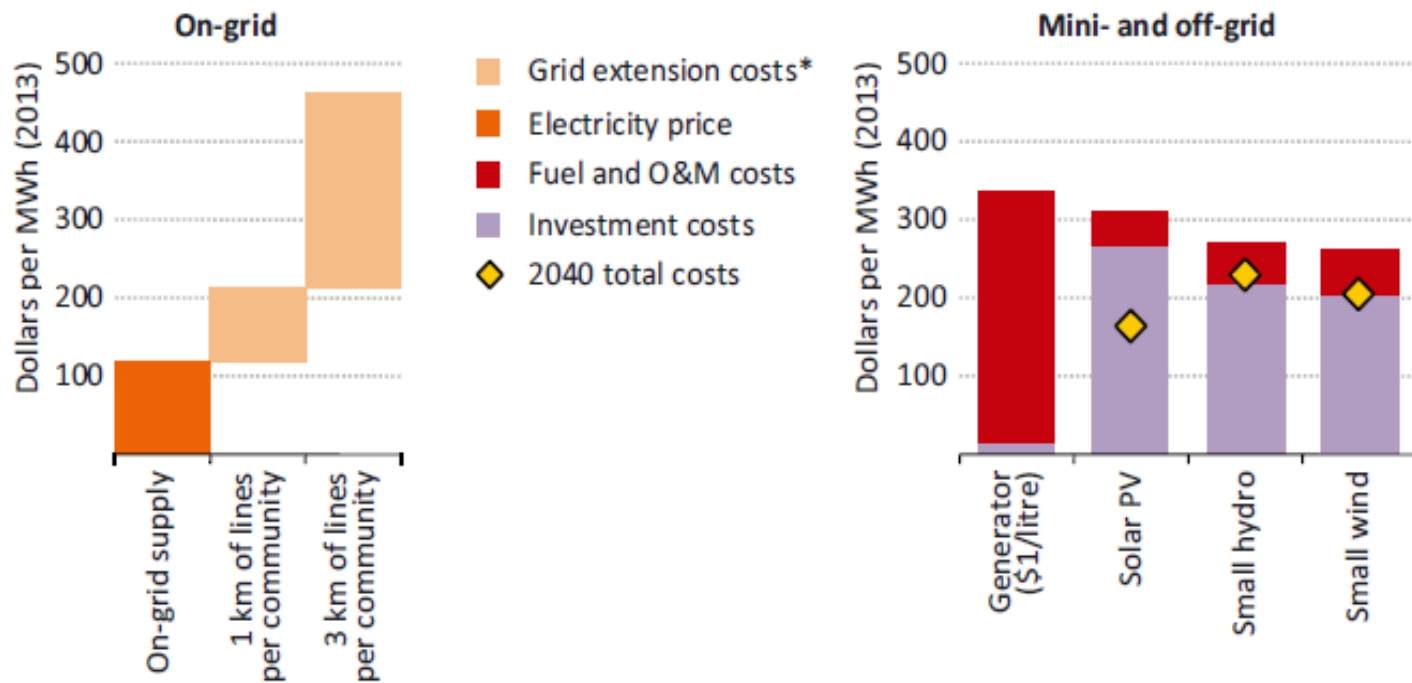


Source: UN Foundation (2014)



Case Study – Assessment of possible technology options

- the cost of grid extension beyond certain distance becomes prohibitive, tipping the balance in favour of off-grid systems



Source: Source: World Energy Outlook (IEA, 2014)



Case Study –Assessment of possible technology options:

- Consideration of range of factors that potentially affect the choice of grid and off-grid options to meet the electrification needs

<i>Generation Solution</i>	<i>Investment Cost</i>	<i>Operating Cost</i>	<i>Implementation Time</i>	<i>Generation Stability</i>	<i>Comment</i>
Grid-Connection	High	Low	High	High	Prohibitively expensive to extend to small communities after approx. 10 km of length
Diesel (Fossil Fuel)	Low	High	Low	High	Most universally implemented solution with high fuel costs and high CO ₂ emissions
Biodiesel	Medium	High	Medium	High	Only recently entering rural electrification as blended fuels or oil only application in small scale
Micro-Wind	Medium	Low	Medium	Low	Highly dependent on geographical winds speeds and requires hybrid generation or storage
Solar / Battery Storage	Medium	Medium	Low	Medium	Neutral solution, but battery replacement and environmental impact should be addressed
Solar / Diesel Hybrid	Medium	Medium	Low	Medium	Typical 30% reduction in fuel costs and CO ₂ emissions from diesel only generation
Micro-Hydro	Medium	Low	Medium	Medium	Highly dependent on close-by geographical water availability and elevation difference



Source: UNDP (2014)

Case Study – Selection of technology options

Technology options (grid /off-grid) are finally selected taking into account cost-effectiveness, users need (application, load demand)

	Stand-alone			Grids		
	DC		AC	AC/DC		AC
<i>System</i>	Solar lighting kits	DC Solar home systems	AC Solar home systems; single-facility AC systems	Nano-grid Pico-grid	Micro-grid, Mini-grid	Full-grid
	Off-grid					
<i>Application</i>	Lighting	Lighting and appliances	Lighting and appliances	Lighting, appliances, emergency power	all uses	all uses
<i>User</i>	Residential; Community	Residential; Community	Community; Commercial	Community; Commercial	Community; Commercial; Industry	
<i>Key component</i>	Generation, storage, lighting, cell charger	Generation, storage, DC special appliances	Generation, storage, lighting, regular AC appliances. Building wiring incl. but no distribution system	Generation + single-phase distribution	Generation + three-phase distribution + controller	Generation + three-phase distribution + transmission

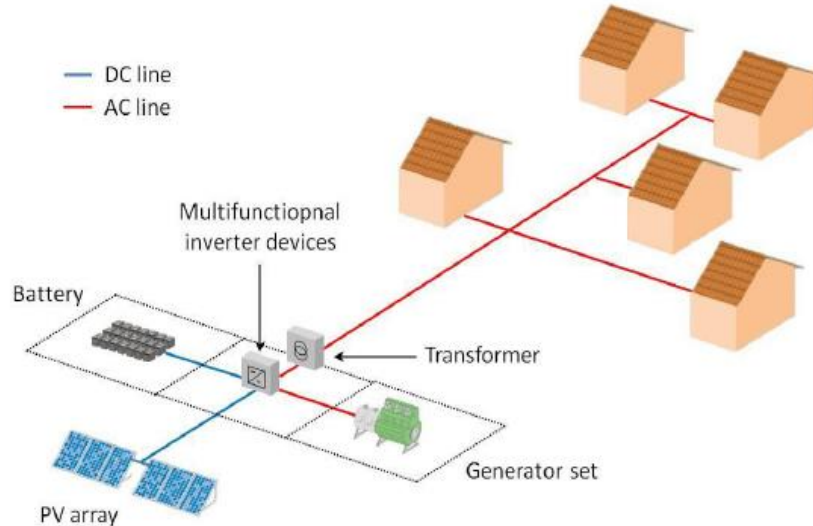
Source IRENA (2015)



Case Study – Selected technologies for Rural Electrification

- The programme will electrify 620,000 rural households (HHs) by 2018 through:
 - a) solar home systems and solar-powered lighting systems equally distributed to 334,473 HHs (54%)
 - b) PV-Diesel hybrid mini-grid to 138,684 HHs (22%)
 - c) extensions of grids to 146,842 HHs (24%),
- Hydro and wind resources are not viable options- not economically exploitable

PV-Diesel Hybrid System:



Source IRENA (2015)



Case Study – Application of CDM methodologies

The proposed PoA will combine three methodologies:

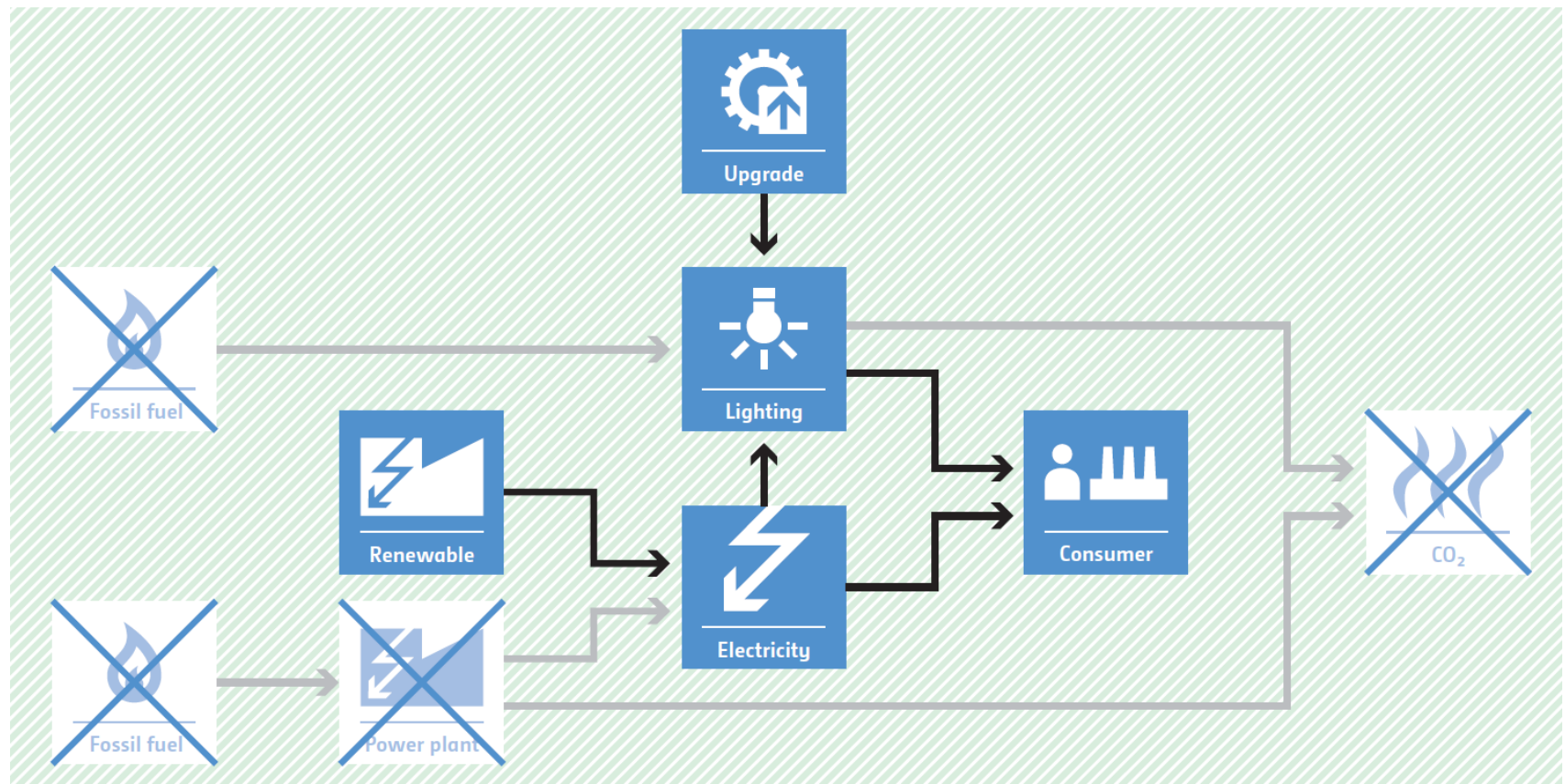
- **Component 1: AMS-I.L** “*Electrification of rural communities using renewable energy*” > for solar home system
 - **Component 2: AMS-III.AR** “*Substituting Fossil Fuel Based Lighting with LED/CFL Lighting Systems*” > for solar portable lighting systems (LED/CFL)
 - **Component 3: AMS-III.BB** “*Electrification of Communities Through Grid Extension or Construction of New Mini-Grids existing grids*” > for grid and hybrid-mini-grid
 - Methodologies **predefine baseline** and provide **default emission factors** to determine baseline emissions taking into account **suppressed demand scenario**:
 - a) Energy services available are **insufficient to meet basic human needs** (e.g. **have** only a few kerosene lamps, or just use candles due to low income and lack of infrastructure)
 - b) communities to **leap-frog dirty technologies** to a low or no-emitting clean efficient technology
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Component 1: Electrification through solar home system (AMS-I.L)

Baseline: use of fossil fuel based lighting and stand-alone diesel electricity generators

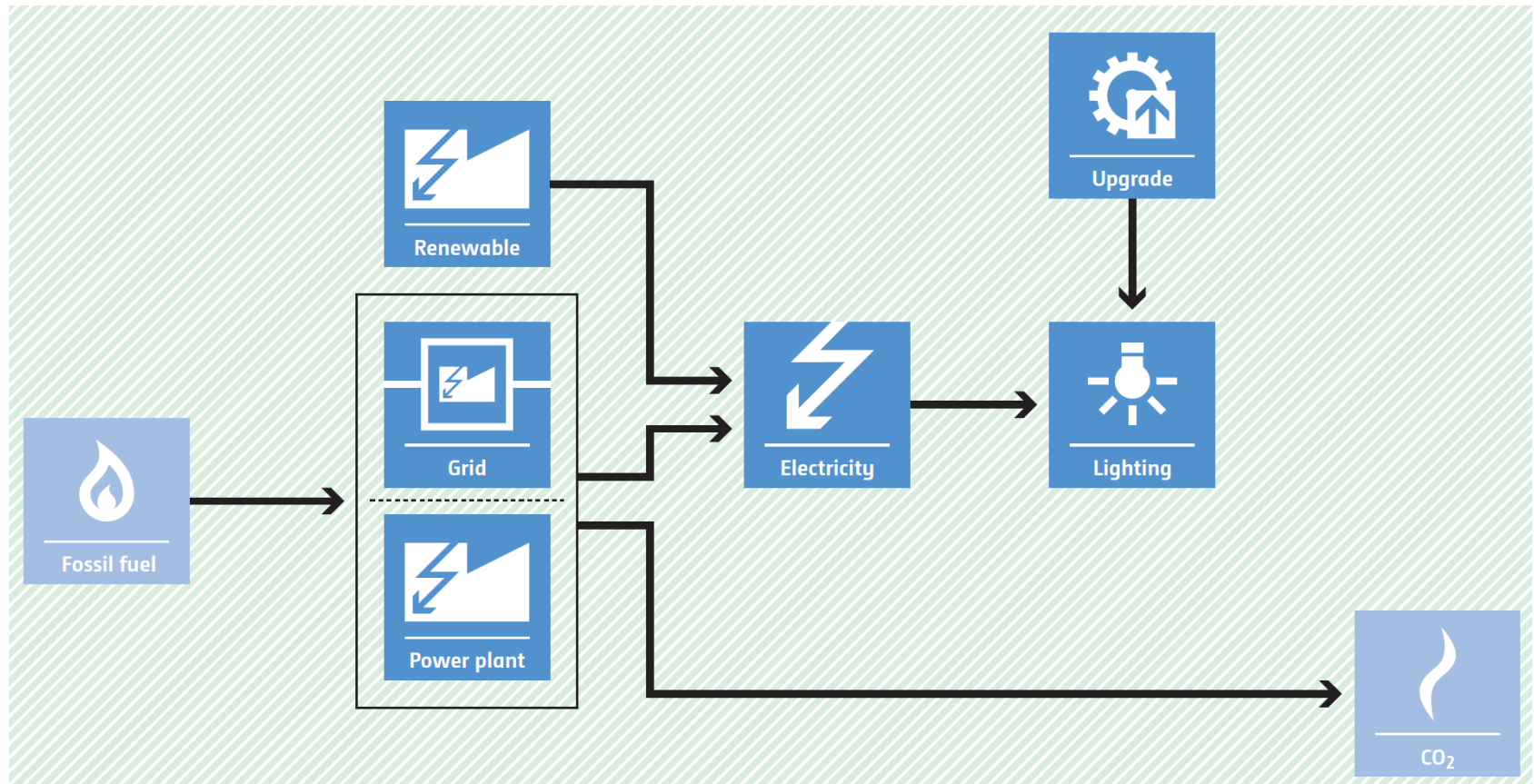
Project scenario: electricity from renewable based energy systems (solar home systems)



Component 2: Electrification through Solar powered lighting system (AMS-III.AR)

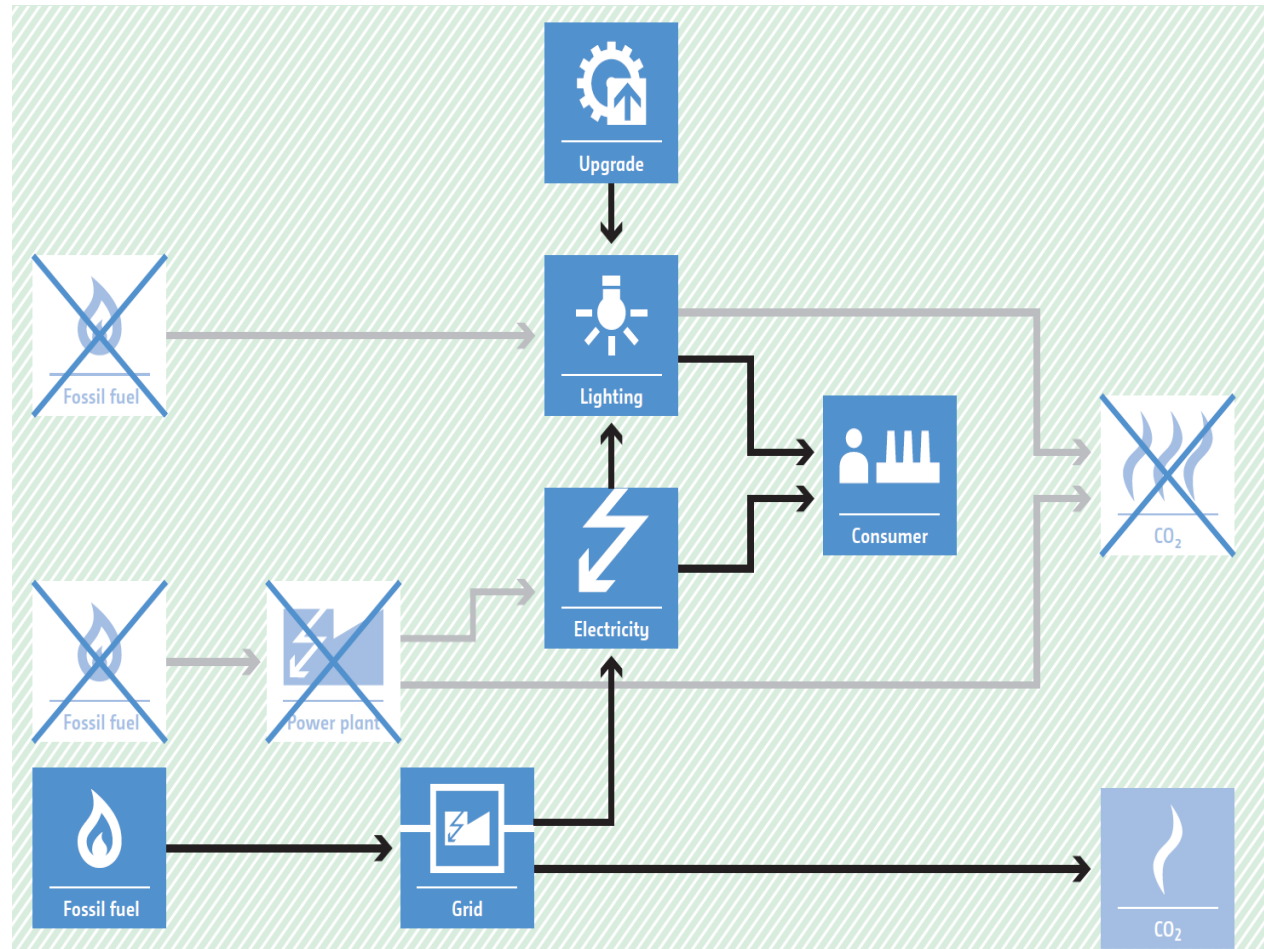
Baseline: use of fossil fuel based lighting

Project scenario: Use of LED/CFL based lighting systems.



Component 3: Electrification through grid extension or hybrid mini-grid (AMS-III.BB)

- **Baseline:** use of fossil fuel based - lighting, mini-grid or stand- alone diesel generators
- **Project scenario:** electricity supply by connection to a national grid or hybrid mini-grid



Quantification of GHG impacts using CDM

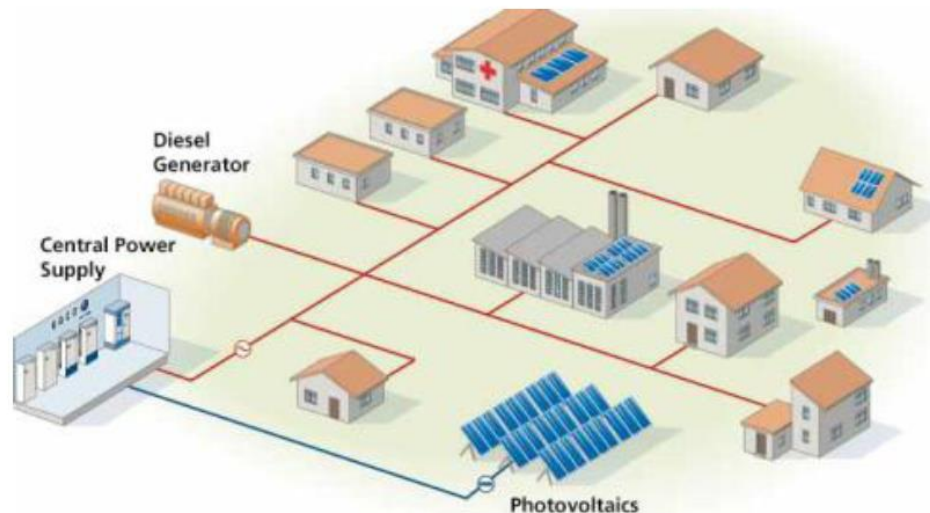
- Potential annual **emission reductions achieved per household per year** through rural electrification programme:
 - Component 1 (Solar home) : **0.51 t CO₂**
 - Component 2 (Solar portable lighting): **0.37 t CO₂**
 - Component 3 (Grid/mini-grid) : **0.26 tCO₂**
- Total average annual emission reductions achieved ~ **140 kt CO₂/year**



Sustainable development impact

The implementation of the program potentially contributes in:

- Increasing access to electricity in rural areas by providing access to modern and affordable lighting
- Enabling productive uses of electricity and income generating activities for example tourism projects, such as eco-lodges; agro-processing units, ice making units
- Economic growth in rural areas, Increased employment,
- Improvement of services in health, education and social institutions,



Source IRENA (2015)



Potential areas for feedback:

- Gaps in available methodologies or methodological approaches
 - a) Baseline
 - b) Monitoring
 - c) Additionality
- Project cycle improvements specific to RE and EE
- Modular methodologies (with limited applicability) vs Broadly applicable modular methodologies
- Opportunities for standardization including digitization