



Energy Services to Meet the MDGs: Costing tool

Sponsored by the UNDP

International Energy Management & Policy Program
School of International and Public Affairs
School of Engineering and Applied Science
Columbia University

Targets



- **Electricity**
- **Mechanical Power**
- **Cooking fuels**

- **Benefits of scaled up planning**

Contents



- Why a tool? Where in the process?**
- Attempts to address estimated total costs**
- Some assumptions**
- Ability to pay not taken into account**
- Overall Methodology**
- Data requirements**
- Cooking Systems**
- Electricity**
- Mechanical Power**

Contents



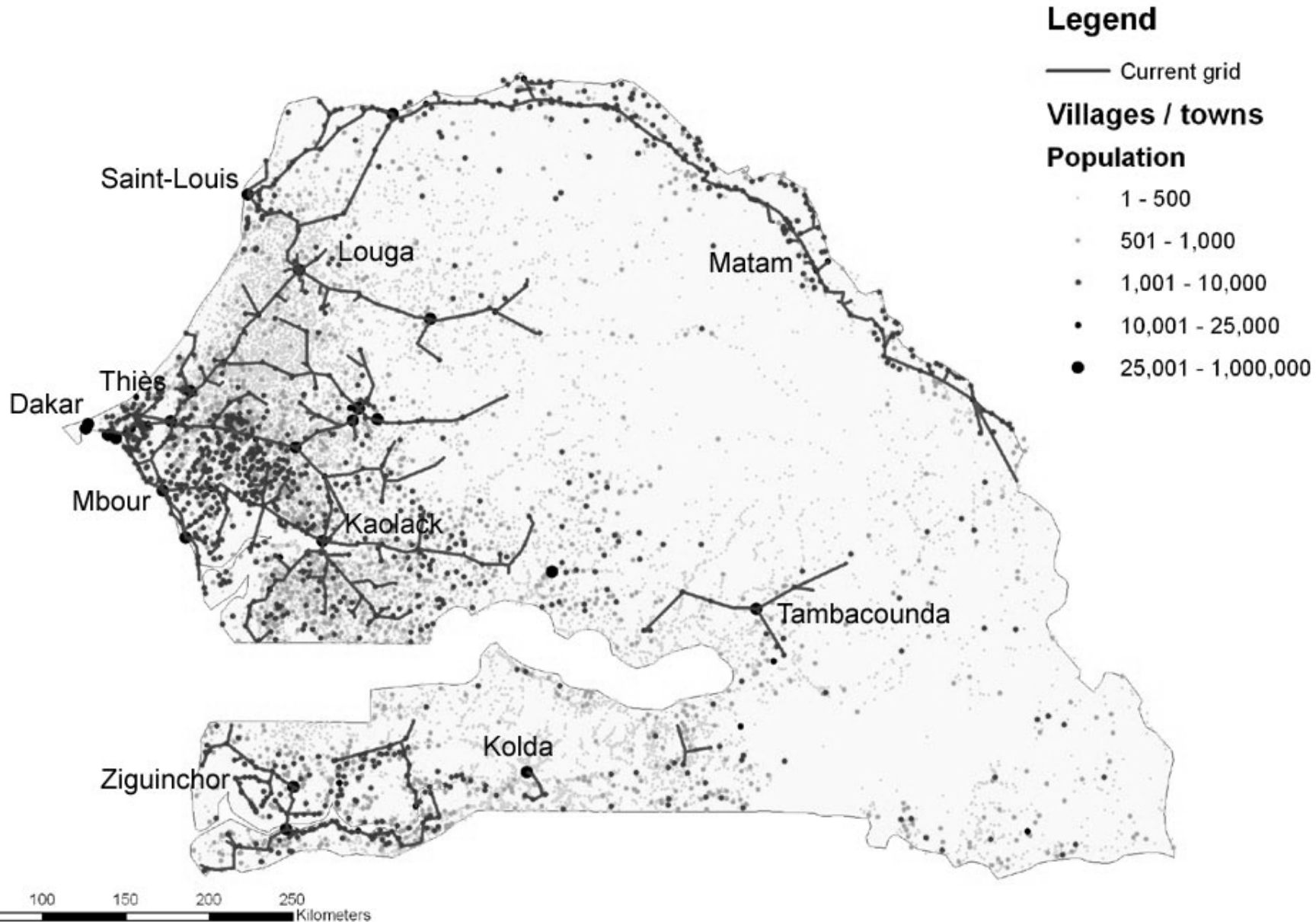
- Data requirements**
- Population growth**
- Existing coverage**
- What is the coverage with**
- How will pop/coverage grow**
- Are there existing economic growth related needs or existing shortfalls**

What is taken into account for electricity for example



- Where the existing grid is?
- Where the institutions and people are?
- What are unit costs of dominant techs
- Generation costs but not investments in generation
- Also facilitates mechanical power
- Facilitates hh electrification
- Demand estimation is critical for tech choice

Senegal- Population and Electricity Grid



What is taken into account for mechanical power



- Where the existing grid is and where will it be?
- What are the services and demands
- For many people
- Balance of distance and cost effectiveness
- Generation costs and/or fuel costs
- Capacity costs for stand-alone units
- Community scale water for nucleated areas



What is taken into account for cooking fuels

- What are existing fuels and stove choices?
- Charcoal, fuelwood and lpg/kerosene
- What is the cost of sustainable biomass
- Subsidies
- Cost of promotion but not supply chains
- LPG not all costs but just subsidies
- Coal/fuelwood- at present all costs



Workshop Methodology (II)

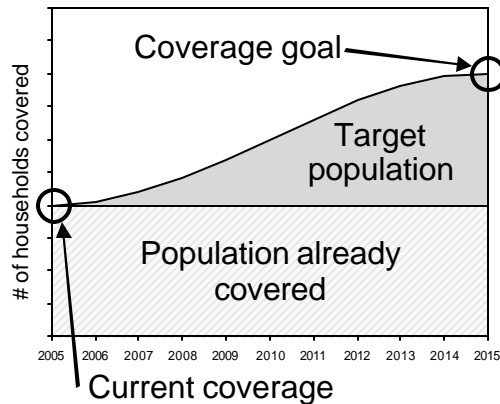
Target population

X

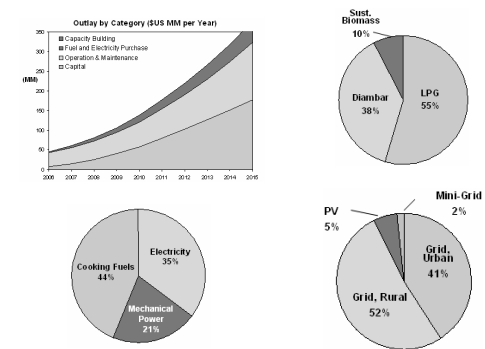
Unit costs

=

Total outlays



Rural Electrification - Unit Costs												
	Mini-Grid			PV								
1	Community			Community								
2	Capital	5,900,000	O&M	295,000	Capital	7,375,000	O&M	368,750	Capital	8,850,000	O&M	442,500
3	Fuel/Elec	14,750	C.Building	-	Fuel/Elec	18,438	C.Building	-	Fuel/Elec	22,125	C.Building	1,106
4	Institutions			Institutions								
5	Capital	150,000	O&M	7,500	Capital	187,500	O&M	9,375	Capital	225,000	O&M	11,250
6	Fuel/Elec	375	C.Building	-	Fuel/Elec	469	C.Building	-	Fuel/Elec	563	C.Building	28
7	Households			Households								
8	Capital	120,000	O&M	6,000	Capital	150,000	O&M	7,500	Capital	180,000	O&M	9,000
9	Fuel/Elec	300	C.Building	-	Fuel/Elec	375	C.Building	-	Fuel/Elec	450	C.Building	23



- **Target population** = Total pop. covered – Pop. already covered

- Unit cost breakdown:
 - Service
Cooking fuel, electricity, mech. power
 - Technology
LPG, charcoal, sustainable biomass - Grid, mini grid, PV
 - Delivery point
Community, institution, household
 - Cost category
Capital, O&M, fuel/electricity purchase, capacity building

- Outlays computed as a function of:
 - Year
 - Service
 - Technology
 - Cost category
 - Rural / Urban



Go to spreadsheet

Objectives

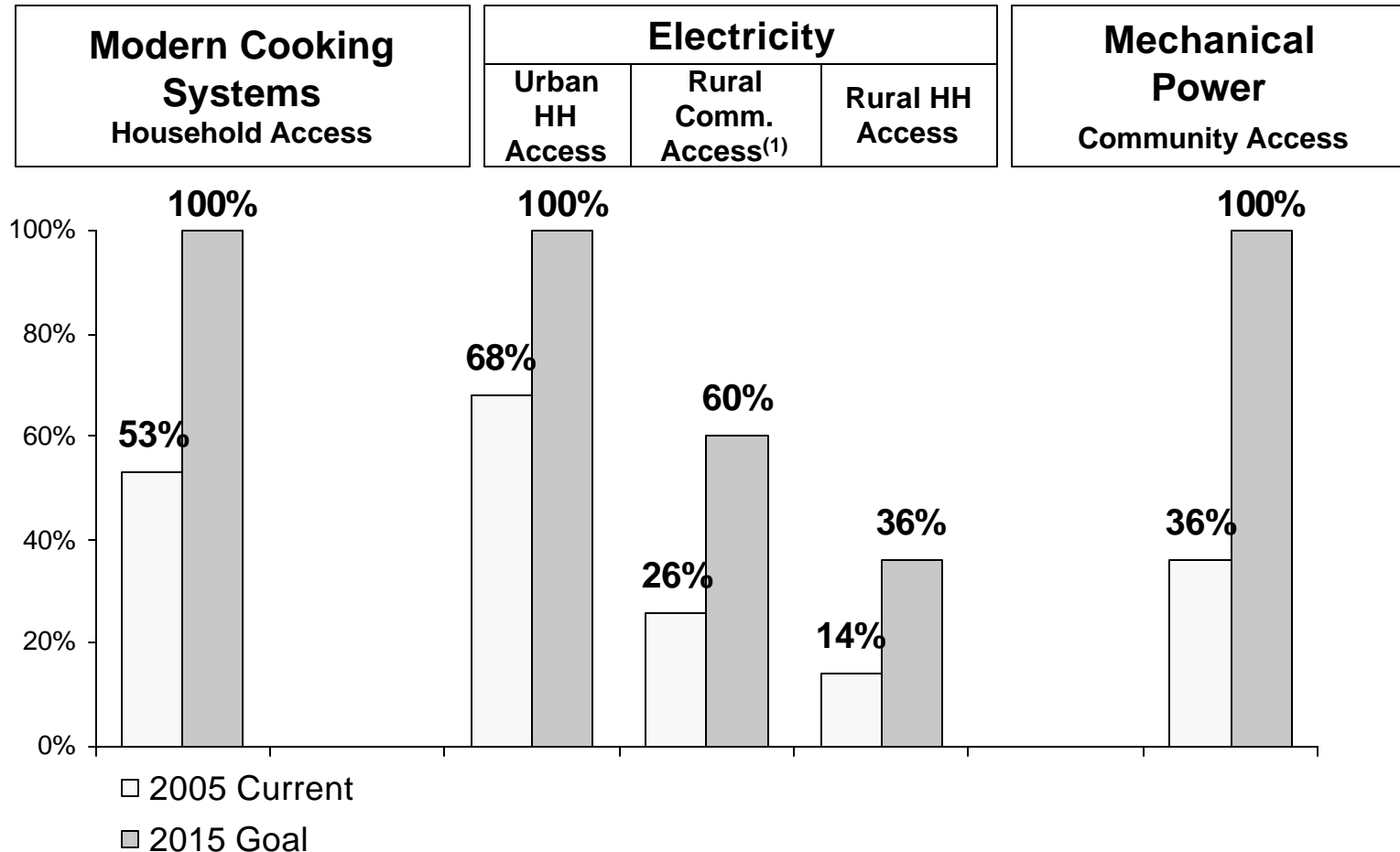


- Estimate outlays needed to deliver energy services necessary to achieve the MDGs
 - Focus on needs-assessment across three service lines
 - Modern cooking systems
 - Electricity
 - Mechanical power for agro- and water processing
- Apply methodology in a **country-specific** setting
 - As one of the first 8 countries chosen by the UNDP and the Millennium Development Project for a pilot needs assessment study, Senegal was used as a case study



Current Situation and Goals in Senegal

Current Access to Energy Services in 2005 and Goals for 2015



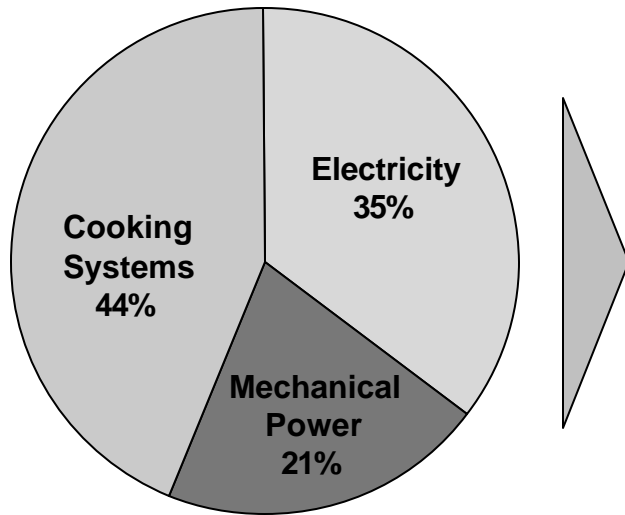
Note: (1) Community access is the percentage of households living in communities with electrified basic social services; with a 60% community access rate in Senegal, 100% of the population will live within 5km of an electrified community.



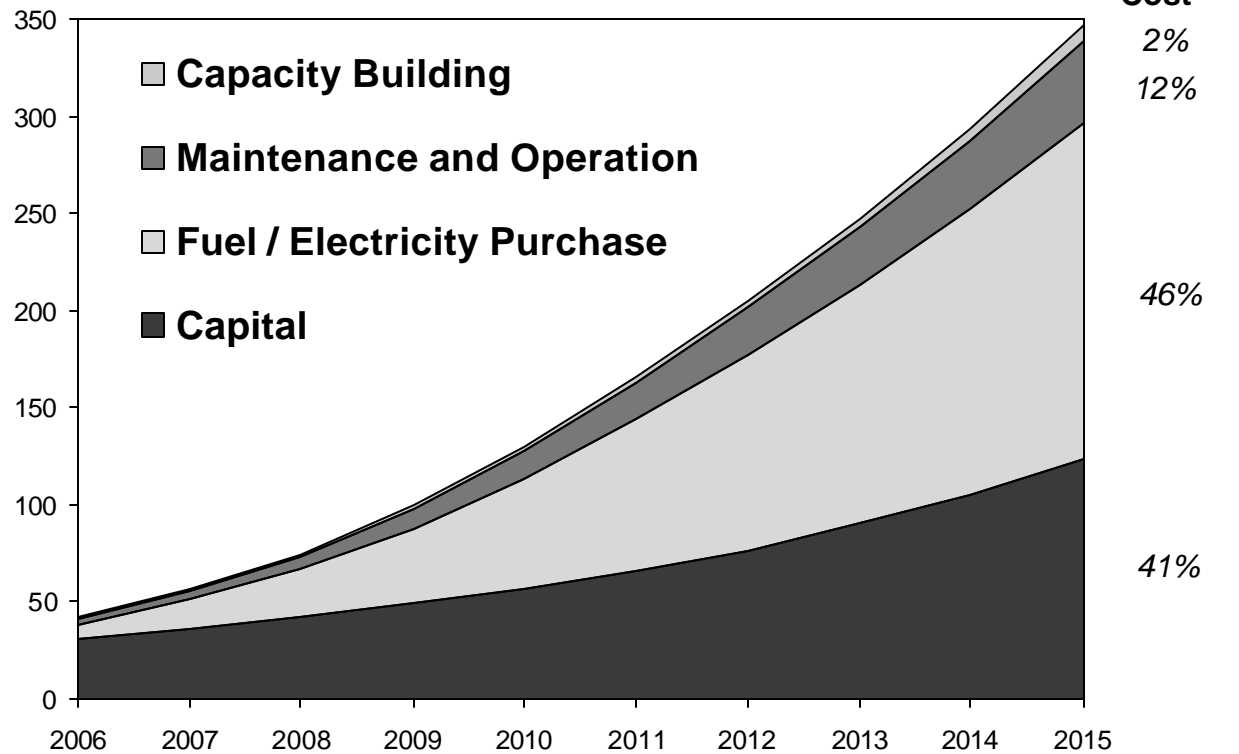
Energy Services Outlays for Senegal (I)

Total Outlay = \$1.7 billion over 10 years

Total Outlay by Energy Service



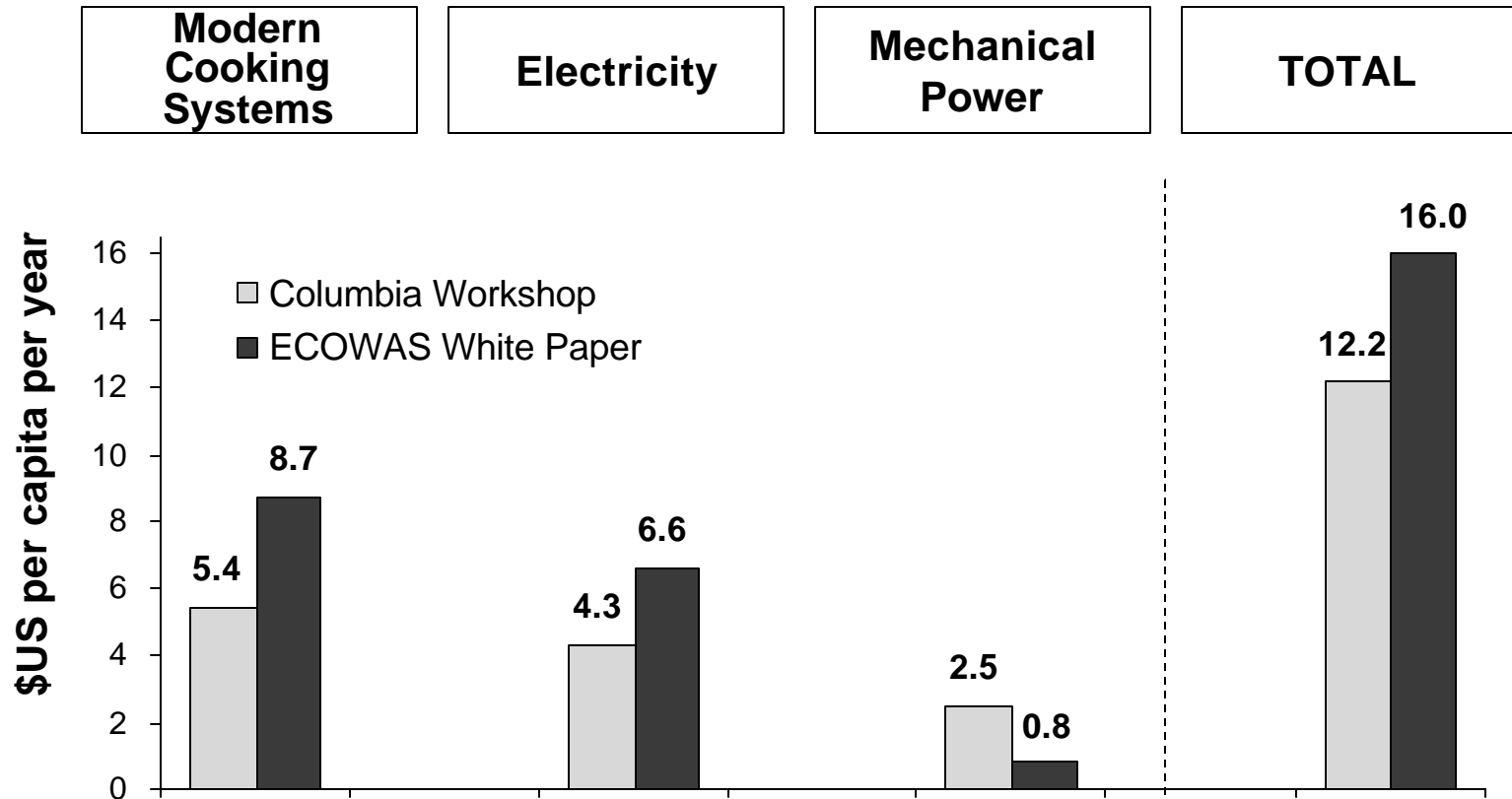
Annual Outlays (\$US MM per Year)





Energy Services Outlays for Senegal (II)

\$12 Annual per capita costs per year⁽¹⁾ in Senegal



Per capita costs are calculated on the basis of total estimated population in 2015



Cost Categories Analyzed

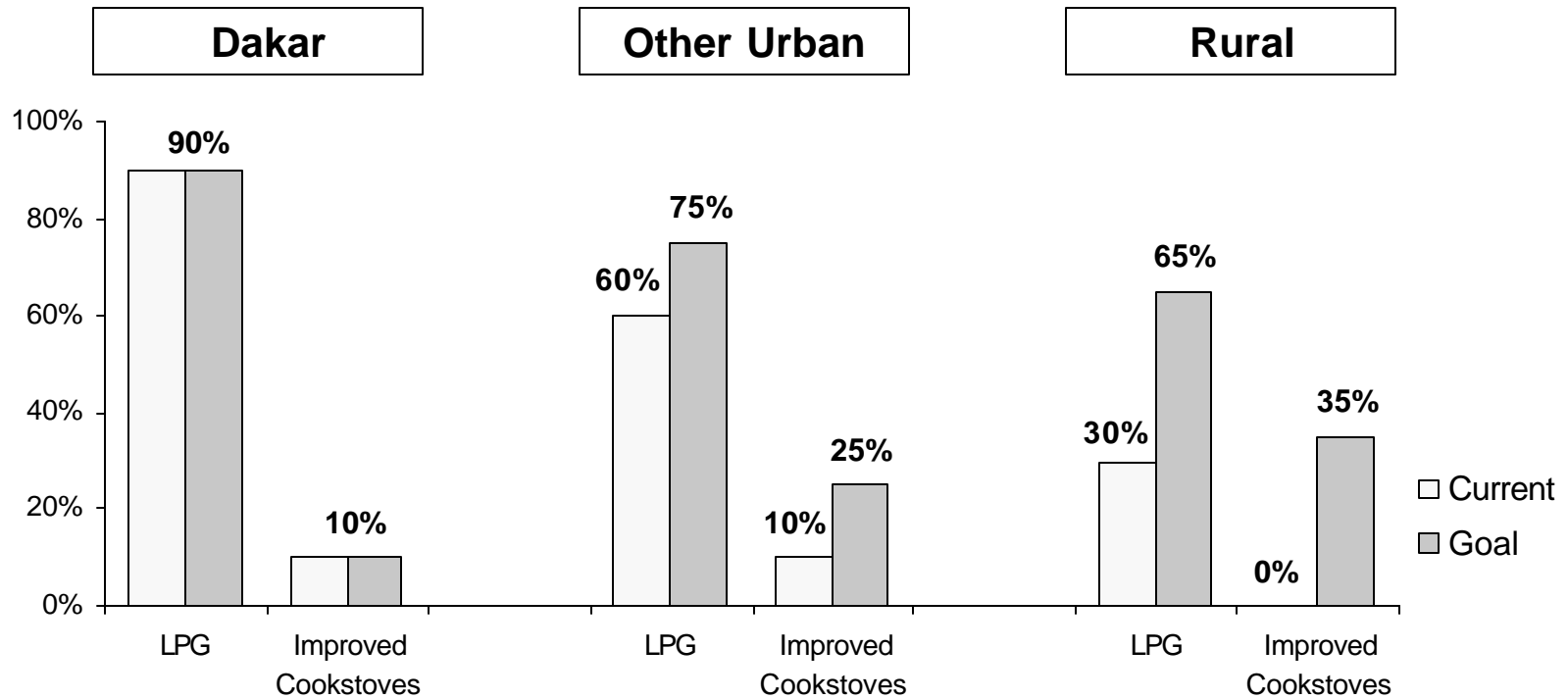
- **Capital equipment**
 - Including replacement where necessary
- **Fuel / electricity purchase**
 - All fuel costs
 - Grid electricity costs (\$0.09/kWh, includes generation and HV transportation costs)
- **Operation and maintenance costs**
 - Includes billing costs
- **Capacity costs**
 - Promotional programs for Diambar stoves
 - Technical training on the use of machinery



- **Introduction**
 - **Importance of Energy in Meeting the MDGs**
 - **Objectives**
 - **Current Situation and Goals in Senegal**
 - **General Results**
 - **Overall Methodology**
- **Service Specific Results**
 - **Cooking Systems**
 - **Electricity**
 - **Mechanical Power**
- **Conclusion**

Cooking Systems (I)

Current Situation / Goals



Technology Choices and Limitations

- Increase consumption of modern fuels to 76% of energy needs
- The increase in access will be achieved by implementing LPG cook systems and improved biomass cookstoves in equal proportions

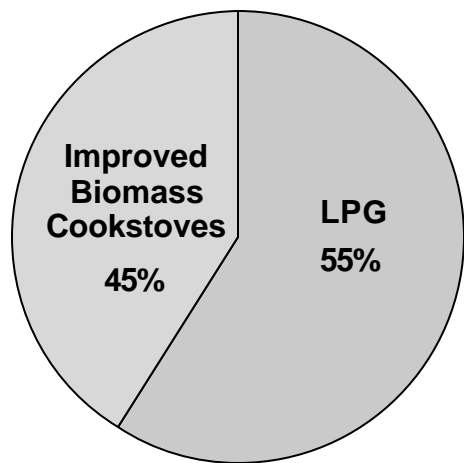
Cooking Systems (II)

Access Technology and Outlay Breakdown

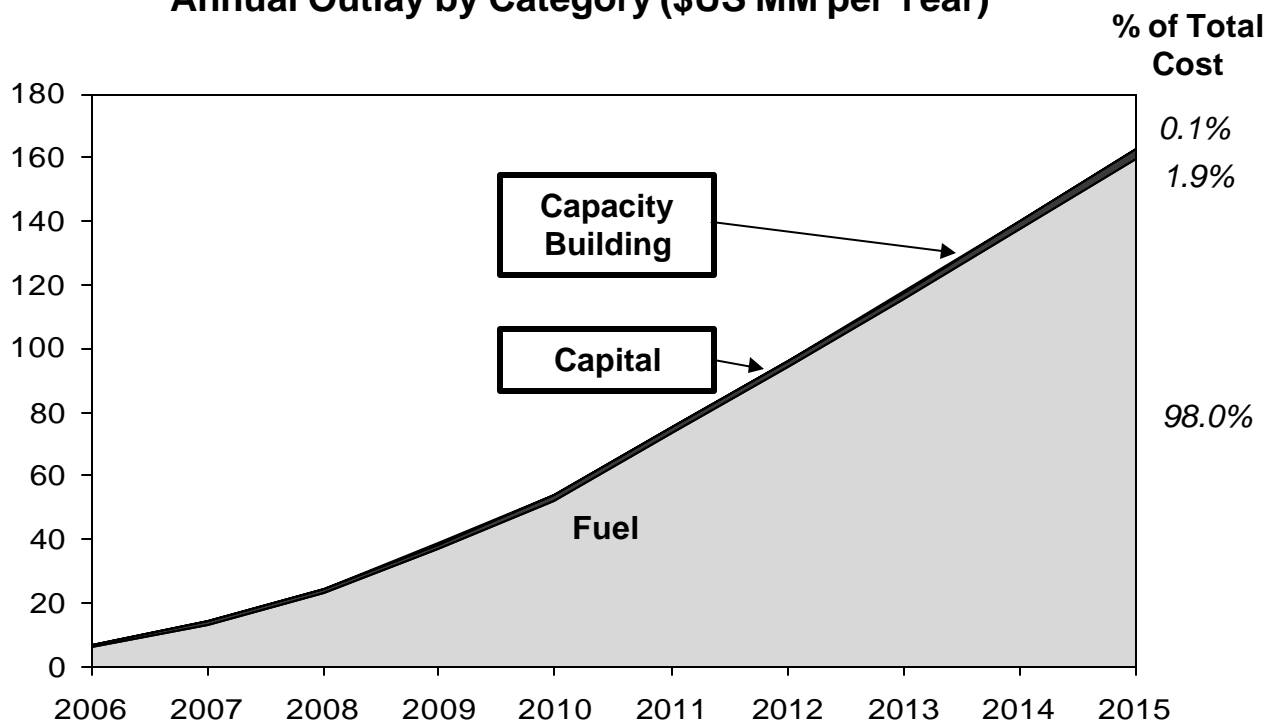


Total Outlay = \$730 million over 10 years

Total Outlay by Technology

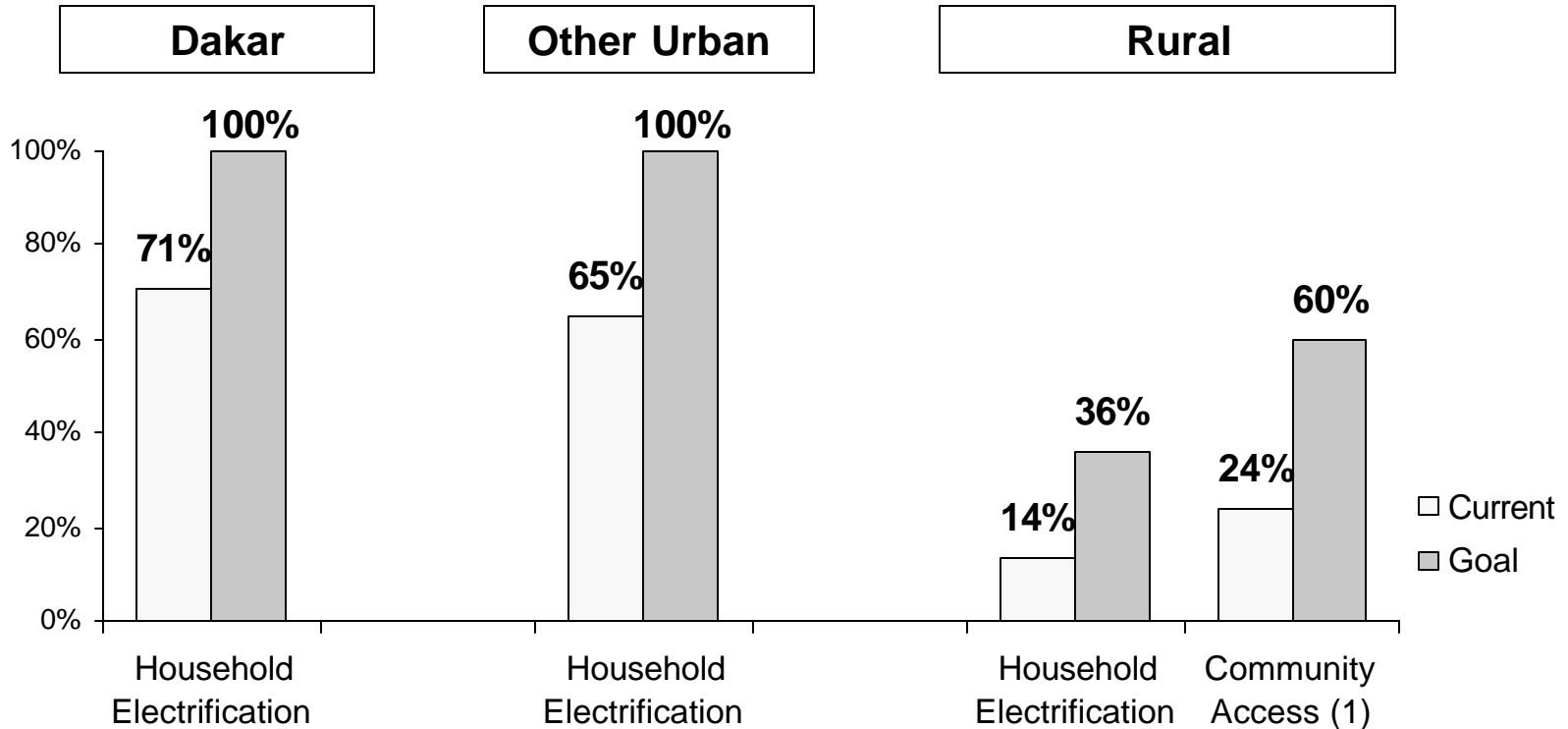


Annual Outlay by Category (\$US MM per Year)



Electricity (I)

Current Situation / Goals



Coverage

Technology Choices and Limitations

- Three technologies were chosen
 - Grid, diesel mini-grid and photovoltaic systems
- Increases in access will be accomplished by extending the national grid in areas where it is the most cost-effective solution, and implementing stand-alone systems elsewhere

Note: (1) Community access is the percentage of households living in communities with electrified basic social services. With a 60% community access rate in Senegal, 100% of the rural population will live within 5km of an electrified community.

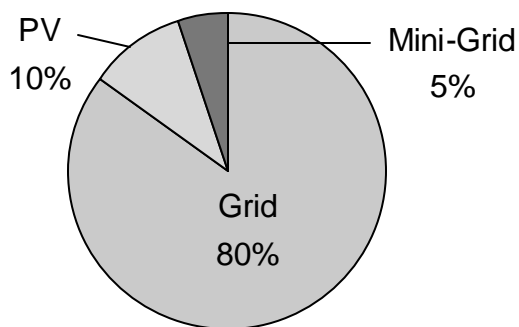
Electricity (II)

Access Technology and Outlay Breakdown

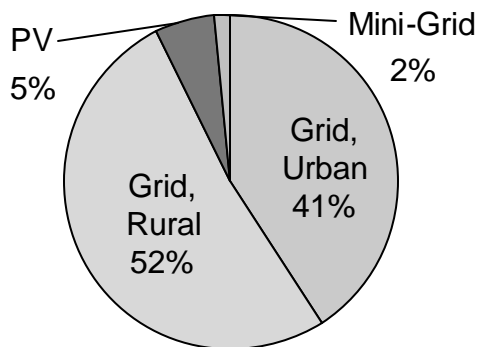


Total Outlay = \$588 million over 10 years

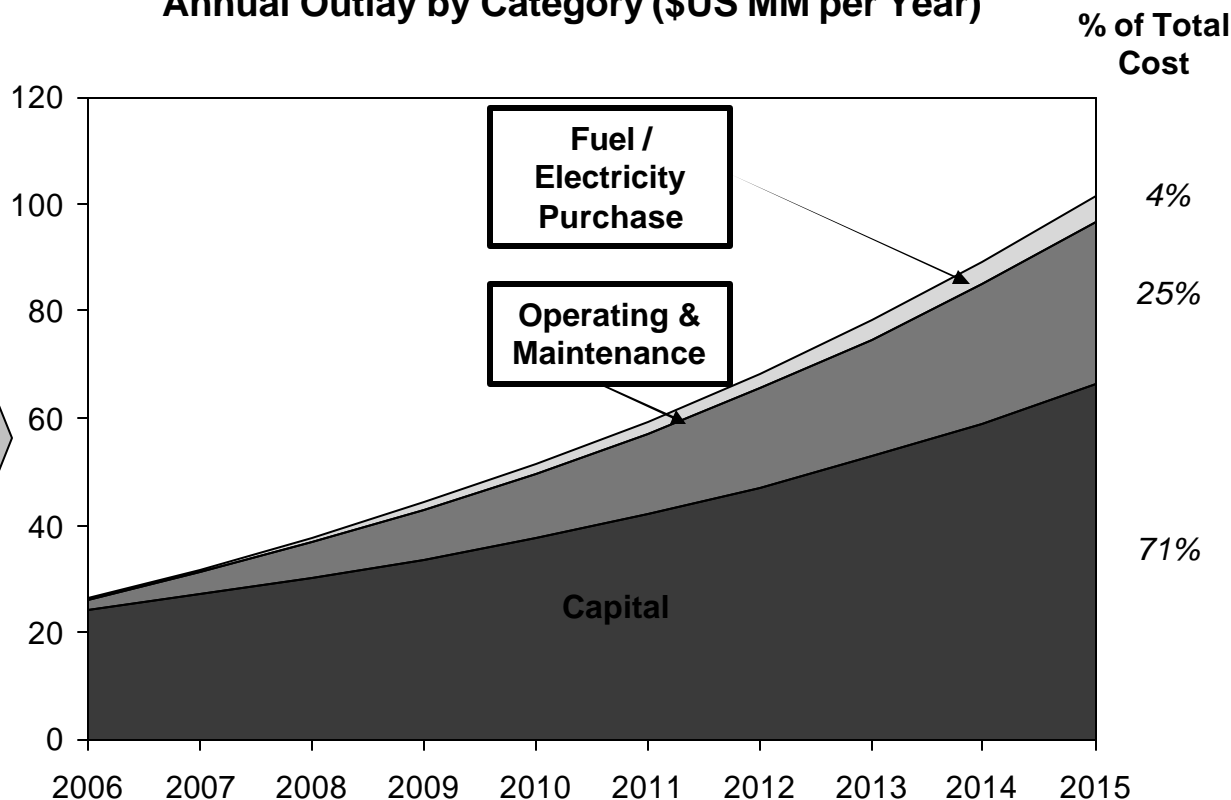
Rural Community Access by Technology



Total Outlay by Technology



Annual Outlay by Category (\$US MM per Year)



Note: An outlay of \$588 million for an increase of the electrified population of 4.5 million people implies a cost of **\$130** to electrify one person. IEA estimate for Africa is **\$400** per capita, where large-scale transportation, generation and capacity costs (not included in this workshop) represent roughly \$200.

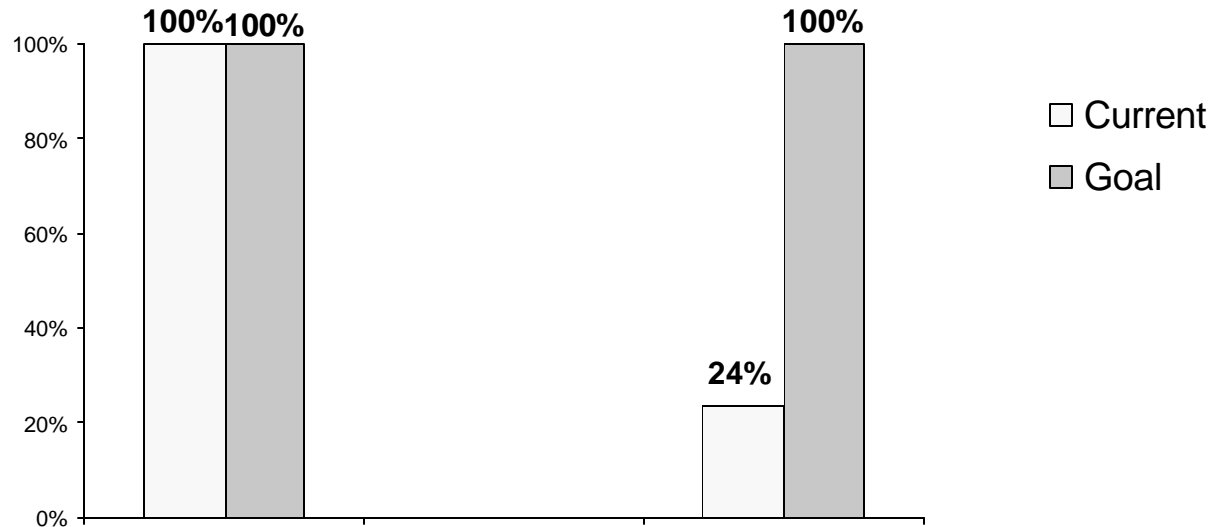
Mechanical Power (I)

Current Situation / Goals



Dakar and Other Urban

Rural



Coverage

- All communities provided with mechanized agro-processing
- 100L of water per person for potable, animal and garden use
- Assumes all communities with grid access have mechanical power access
- Diesel Engine/Multi-Functional Platform: each module serves 500-1500 people
- Water processing includes only above ground technology

Minimum Needs, Technology Choices and Limitations

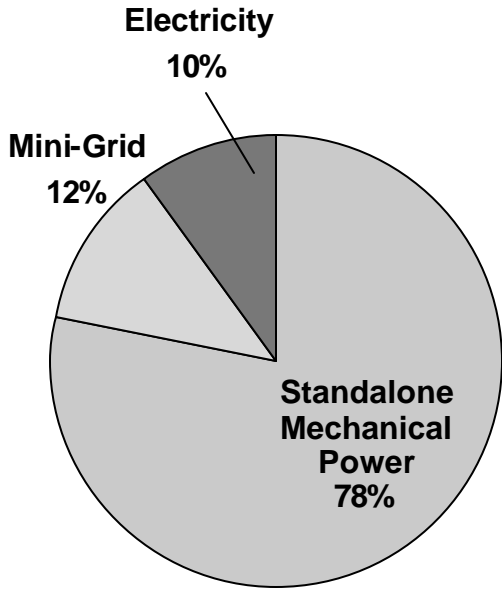
Mechanical Power (II)

Access Technology and Outlay Breakdown

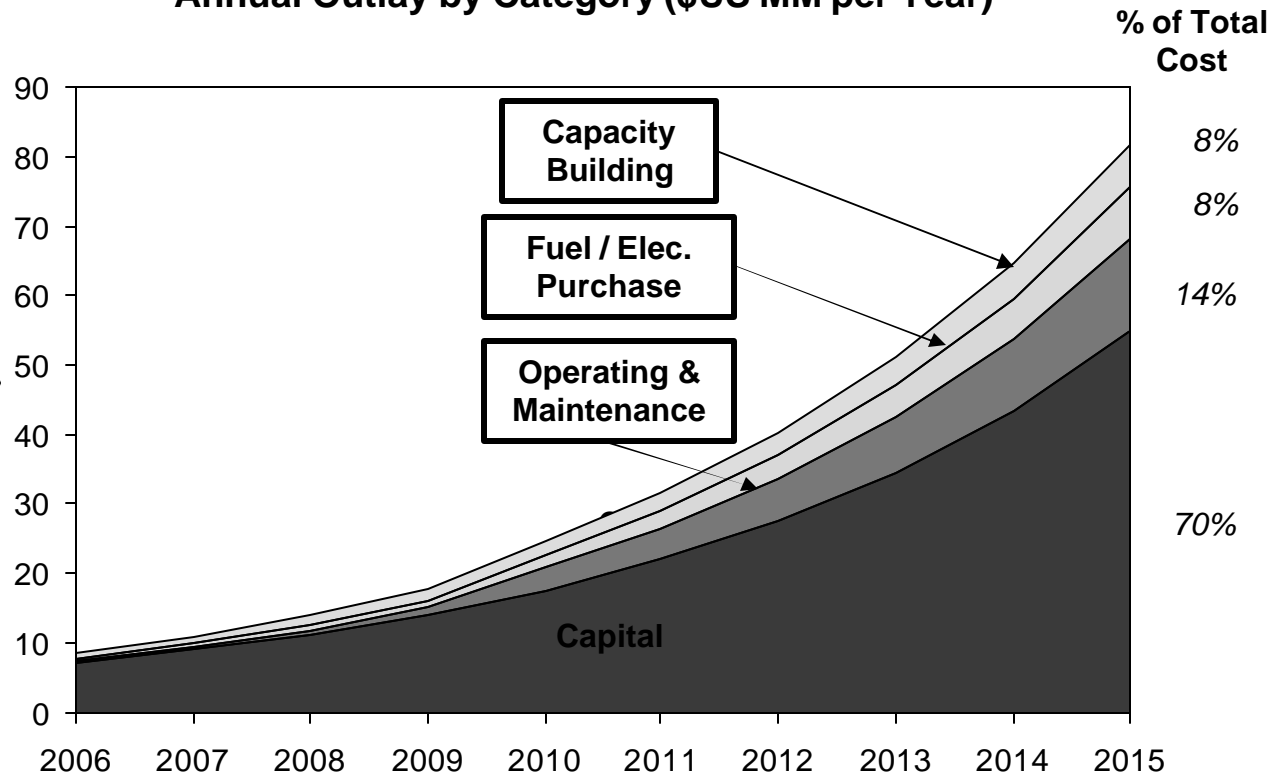


Total Outlay = \$345 million over 10 years

Total Outlay by Technology



Annual Outlay by Category (\$US MM per Year)



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How much will it Cost?



*Increasing energy access in Senegal to meet the MDGs will cost **\$1.7 billion** over ten years*

- **Access levels**

- From 58% to 100% access to Cooking Systems
- From 68% to 100% individual household access to electricity in urban areas
- From 26% to 60%⁽¹⁾ community access to electricity in rural areas
- From 14% to 36% household access to electricity in rural areas
- From 36% to 100% access to mechanical power for agro and water processing

- The methodology is a **general tool** that can be used by other countries
 - Accuracy of results is highly dependent on the quality of population data available

Note: (1) Community access is the percentage of households living in communities with electrified basic social services.
With a 60% community access rate in Senegal, 100% of the population will live within 5km of an electrified community.

Is it Feasible?



*At only **\$12 per capita per year**, increasing energy access is **highly feasible***

- **\$12 / \$40 = 30%** of IEA estimated investment in energy services
\$40 per capita per year is the capital investment in energy services needed on average to meet projected demand growth in African countries for the next 10 years
- **\$12 / \$100 = 12%** of annual anticipated ODA for Africa
\$100 per capita per year is the amount of aid outlays for sub Saharan Africa if aid commitments at the Gleneagles summit are included
- **\$12 / \$700 = 1.7%** of Senegal's annual GDP
\$700 = Senegal's GDP (current US\$) per capita in 2004



What is the Impact?

Increased access to energy will substantially improve people's lives

- **Cooking Systems**

- Decreases time spent gathering wood for women and girl children
- Lowers child mortality and improves maternal health
- Promotes environmental sustainability

- **Electricity**

- Powers refrigeration for essential vaccines and medicines to clinics, allows improved sterilization
- Supplies lighting for schools, emergency rooms and households
- Allows water supply and purification, and sanitation

- **Mechanical Power**

- Saves women considerable time and effort
- Provides income generating opportunities such as agro and water pumping



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