Renewable Energy as an option for rural electrification

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CSIR

our future through science

Background

- Presenter: 15+ years experience in rural / renewable energy – primarily in eastern and southern Africa. Education, research and implementation.
- CSIR: national research council. One of the 6 Research Impact Areas is energy. Clean energy, rural energy, energy efficiency.

Outline

- Overview of energy situation Africa
- Energy access world wide
- The challenge ahead of us
- Recent trends
- Characteristics rural energy
- Supply options
- Case studies
- The way forward

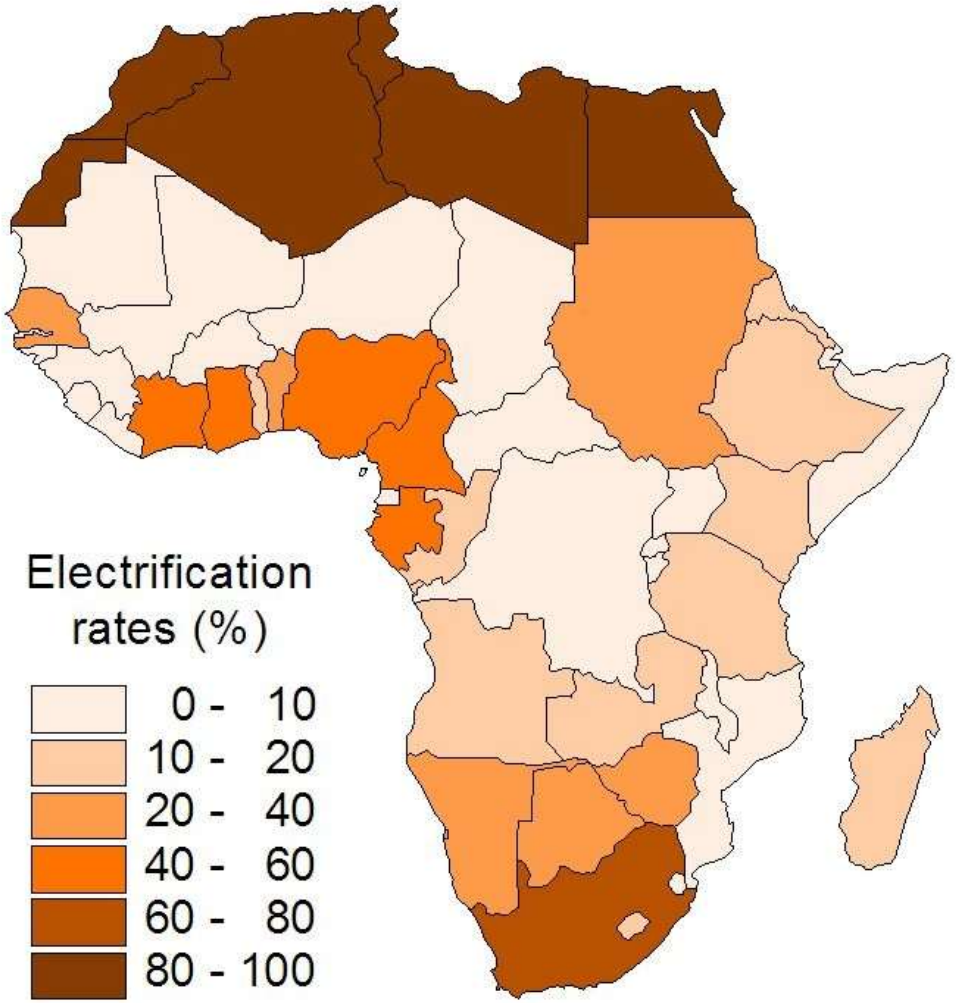
Energy in Africa

- 13% of global population but consumes 5% of global energy and 3% of global electricity
- Only 23% of population in SSA (91% in North Africa) has access to electricity yet world average is 73%
- Lowest energy consumption per capita of 0.7 toe compared to world average of 1.6 toe
- Traditional biomass (wood fuel and charcoal) contributes to over 82% of energy used in SSA-less South Africa
- Between 2000 - 2050, number of people depending on biomass expected to rise from 583 to 823 million
- High dependency on oil with volatile and high price

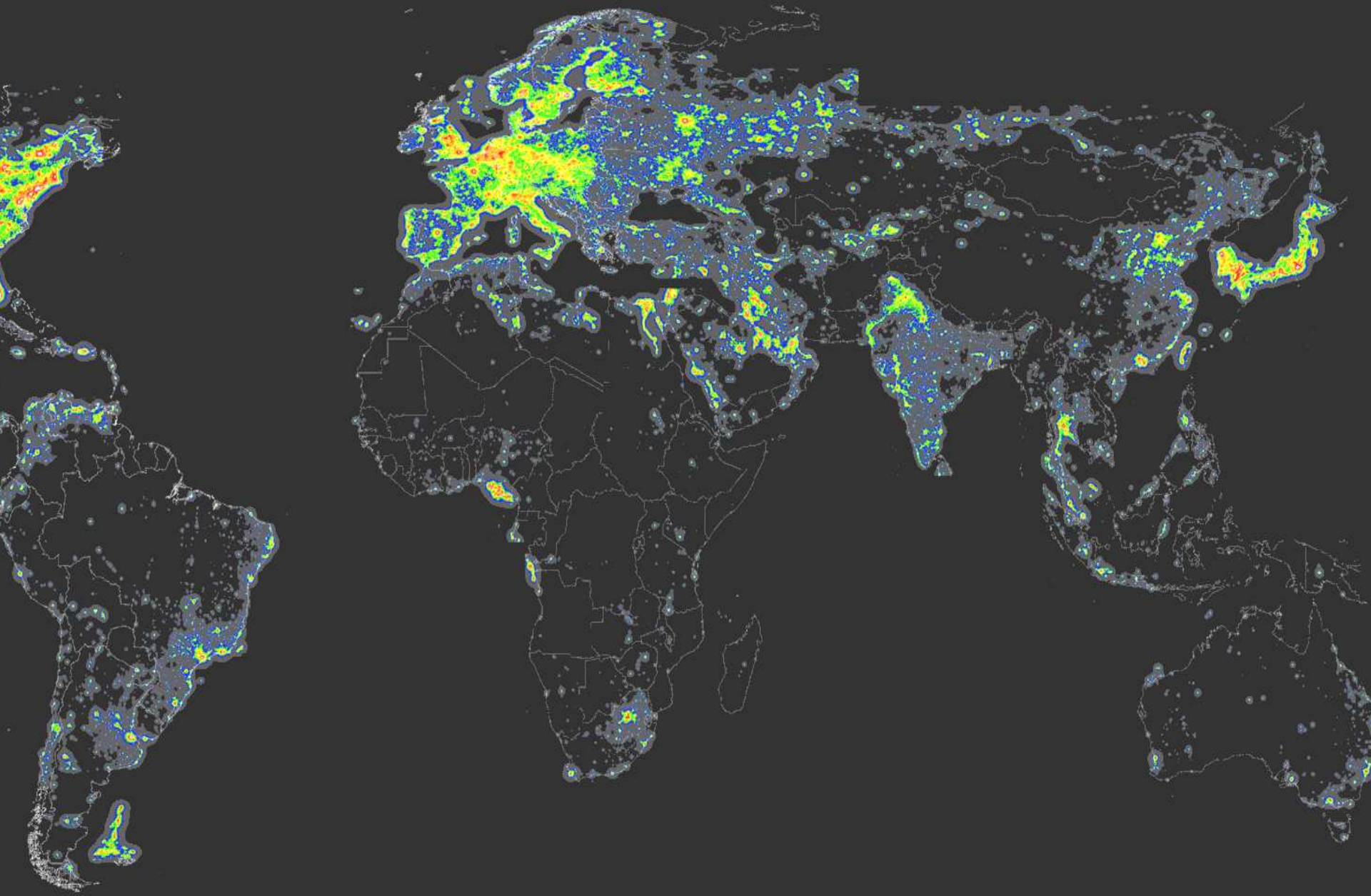
Energy in Africa

- Abundant resources available (hydro, oil, natural gas, biomass) but not developed, hydropower for example only 7% of potential is harnessed
- Unevenly distributed resources yet poor interstate energy trade. (Oil and Natural gas are in North and West Africa and Coal in Southern Africa)

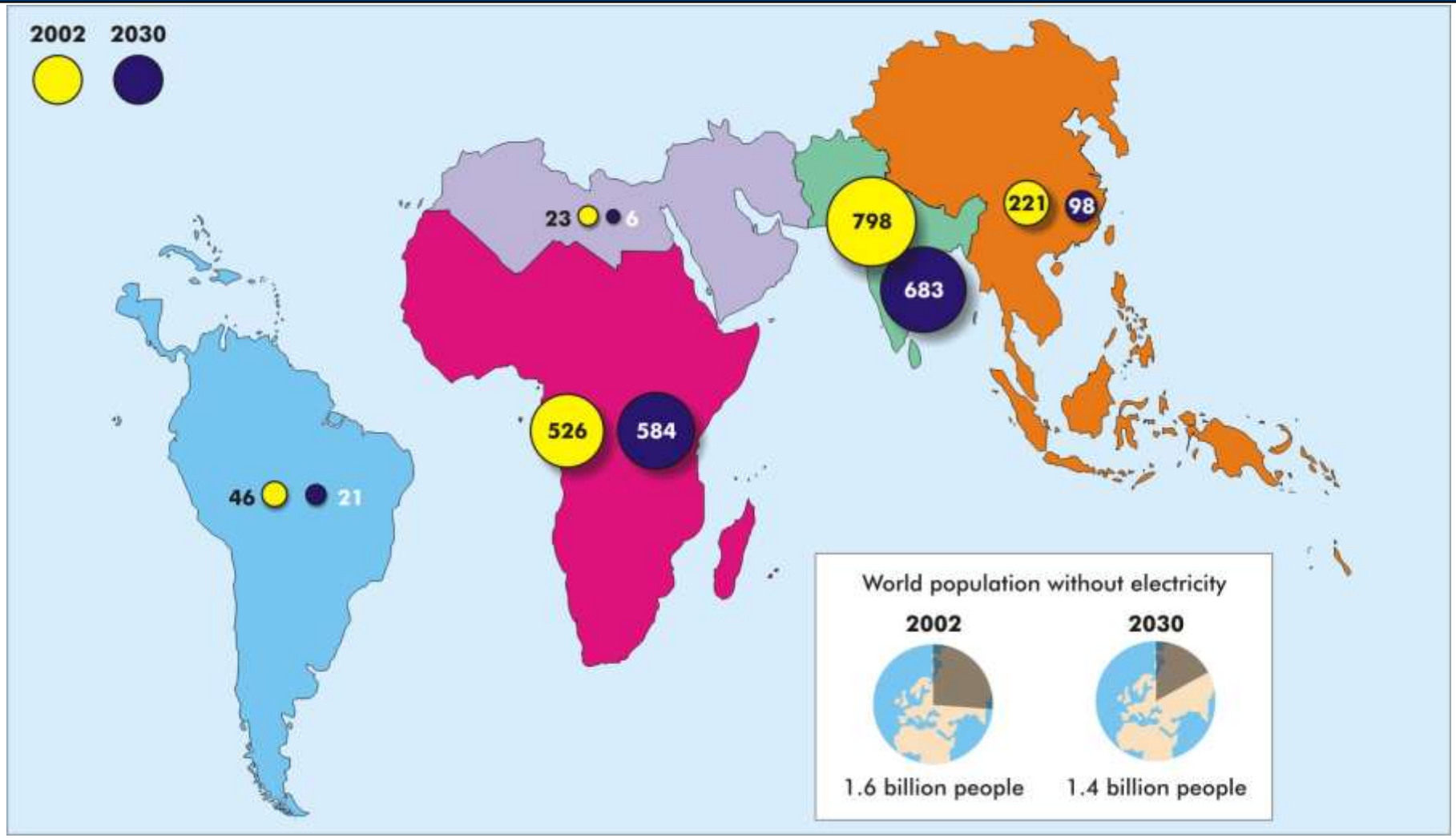
Statistics energy access Africa



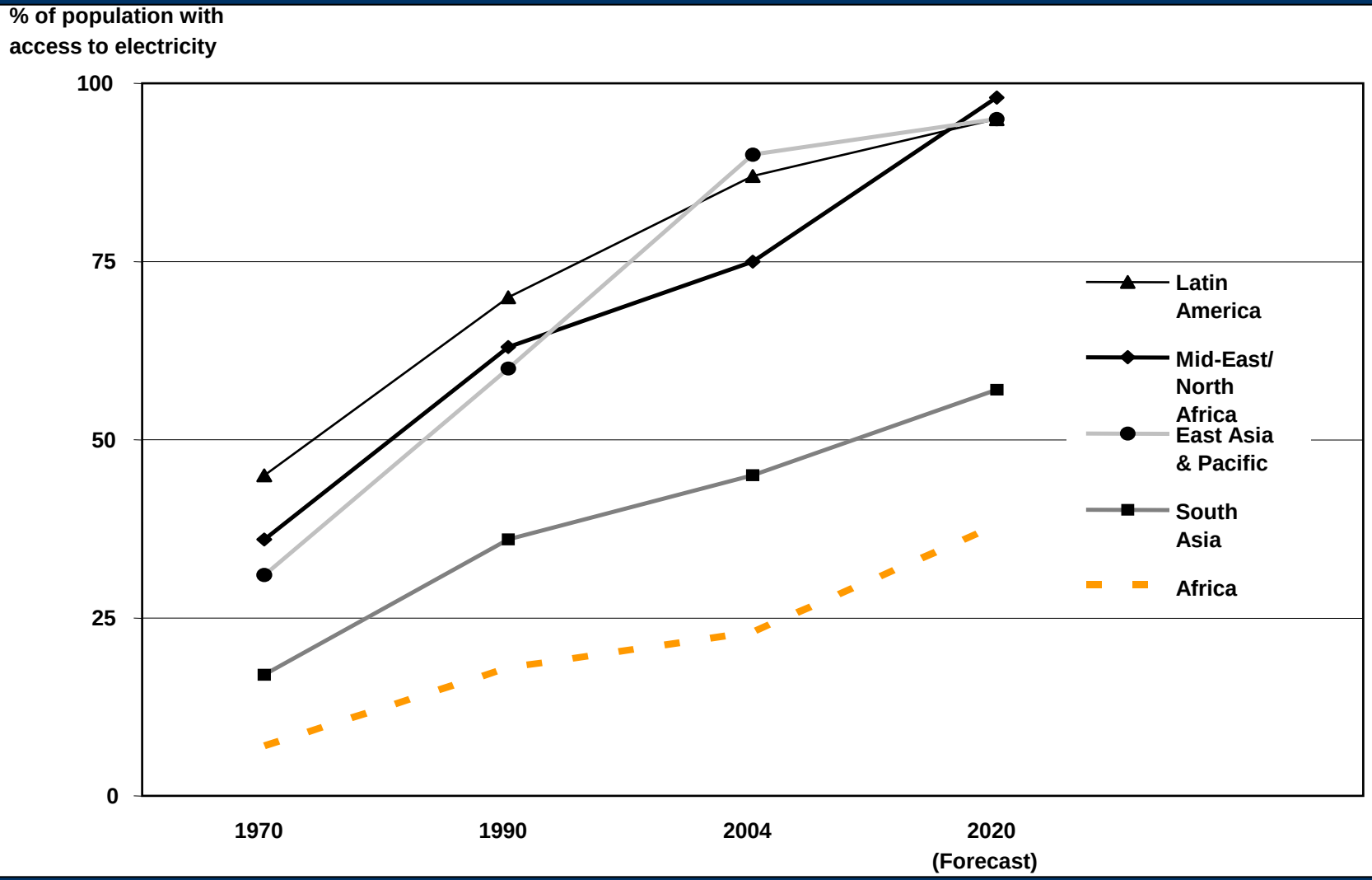
based on the World Energy Outlook 2006



Energy access world wide



Africa is lagging behind



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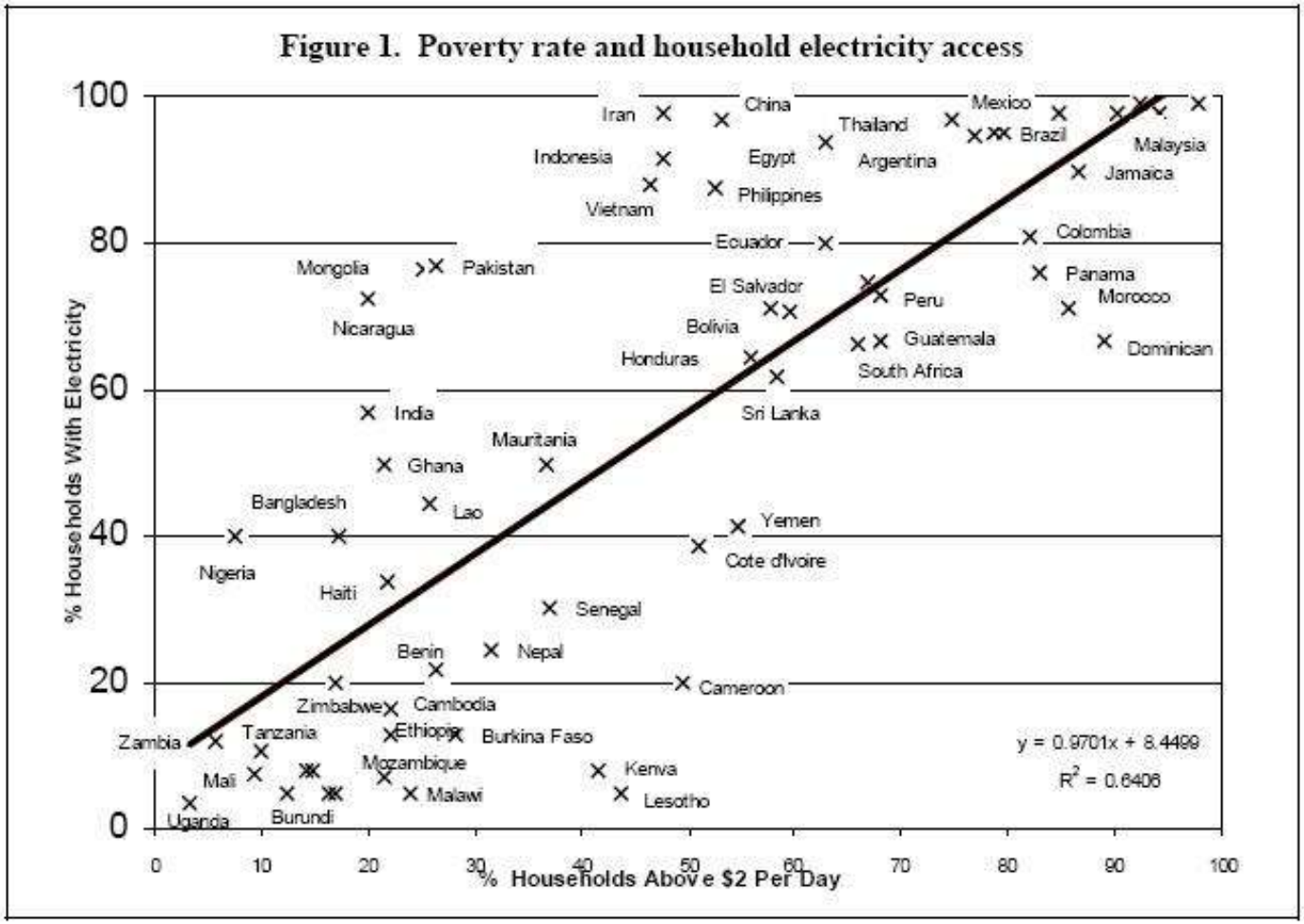


The challenge

- IEA's World Energy Outlook: with current policies ± 1.4 billion people will not have access to electricity by 2030 (current estimate of 1.6 billion)
- The access problem is most acute in sub-Saharan Africa (SSA) with 553 million people without access, and South Asia with 680 million, respectively.

The challenge

- *The World Health Organization (WHO): more than three billion people use wood, dung, coal and other traditional fuels* inside their homes to meet cooking and heating needs → resulting indoor air pollution is responsible for 1.5 million deaths per year
- Over half of all people relying on biomass live in India and China, but the proportion is largest in SSA.

The challenge

Daily over 1100 people die in Africa as a result of respiratory diseases !

Recent trends

- Countries that have managed rapid increases in access have done so at a rate of between 1% and 3% per annum above population growth.
- Tunisia's electrification rates rose from 6% in 1976 to 88% in 2001 (average 3.3% per annum)
- South Africa's program expanded access from 44% in 1995 to 66% in 2004 (average 2% per annum)
- Ghana's program expanded access from 28% in 1989 to 54% in 2004 (average 1.7% per annum).

Recent trends

- In SSA the number of people without electricity is either static or increasing because population growth is outstripping the pace at which households are being connected
- Uganda: national utilities connects about 10,000 new households per year but population growth, at 2.9%, adds 140,000 households
- Mozambique, new connections at about 10,000 new households per year but population growth, at 2.2% per year, adds 90,000 more new households per year

Energy access in South Africa

- Since 1993 electrification rate rose from 36% to 80% in 2007
- BUT rural electrification still 50% – 60%
- 2 million households without access to electricity grid

Characteristics of rural energy

- Geographically dispersed population
- Low (initial) consumption of electricity
- Limited ability to pay
- Long distance from the national grid
- Difficult geographical conditions
- Locally available renewable energy sources

Rural energy components

- Rural electrification
  - extension of national grid
  - off grid electrification using mini grids (fossil, RE, hybrids)
  - household electrification (diesel generators, Solar Home Systems, bio digesters, wind energy, hydropower, etc)
- Energy and productive uses (SMMEs / agro-processing)
- Energy and health
  - energy for health centres
  - safe energy sources for households (fire hazards, indoor air pollution, risk of accidental swallowing by small children, etc)
- Energy and gender
- Energy and communication

Why renewables?

Advantages of renewable energy over conventional energy systems

- can supply energy to remote and secluded areas with no need for grid connection.
- decentralised/stand alone systems that make use of local resources.
- diversified energy resources – enhance energy security.
- reduce dependence on costly energy imports.
- modular nature – demand specific defray unnecessary investments.

Supply options

- Grid extension
- Off-grid applications:
  - Individual household solutions
  - Institutions / communal facilities
  - Local mini grids

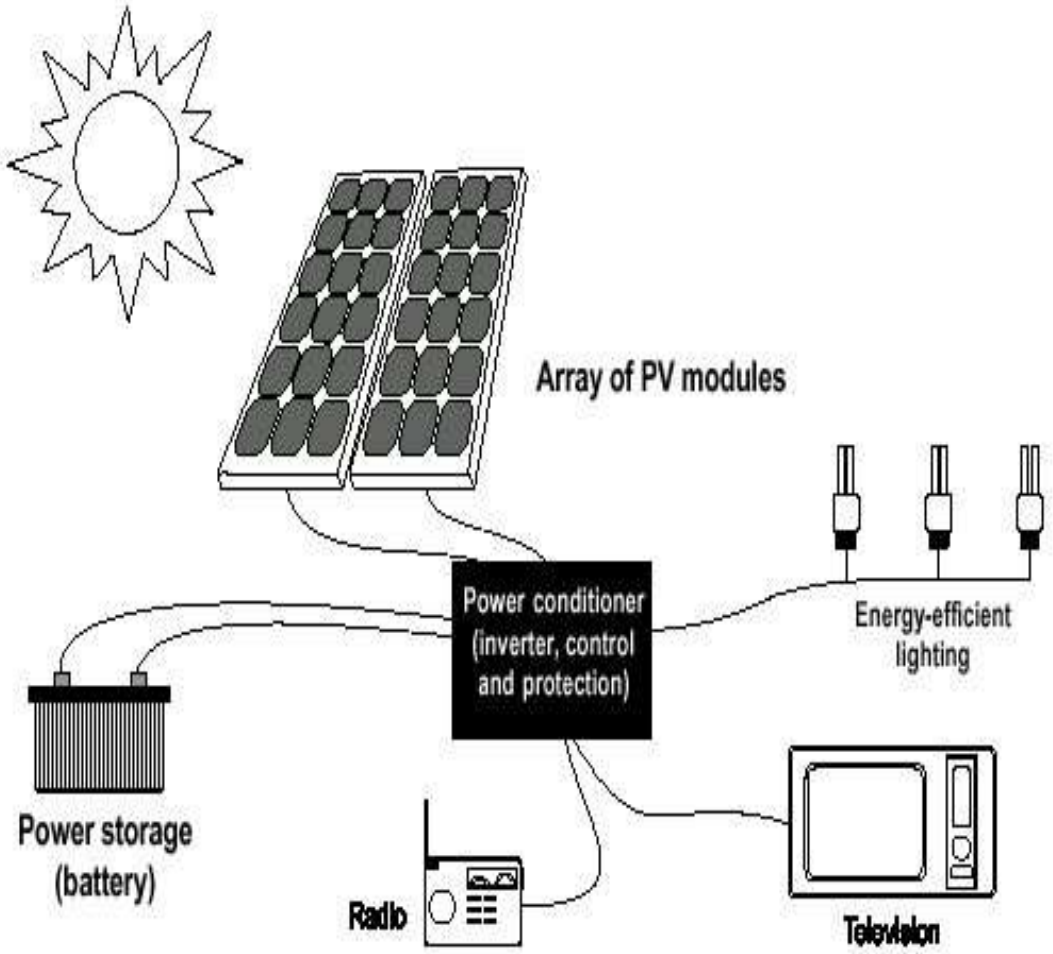
National grid

- For areas not far from the national grid
- Large customer base required
- Preferably including high consumption customer
- Alternative technologies to be considered to lower cost

Off-grid – solar home systems

- Households to be provided with individual systems ranging from solar lanterns to cell phone charging only to full PV systems
- Ownership models:
  - Private ownership
  - Financing models
  - Fee-for-service

Household system

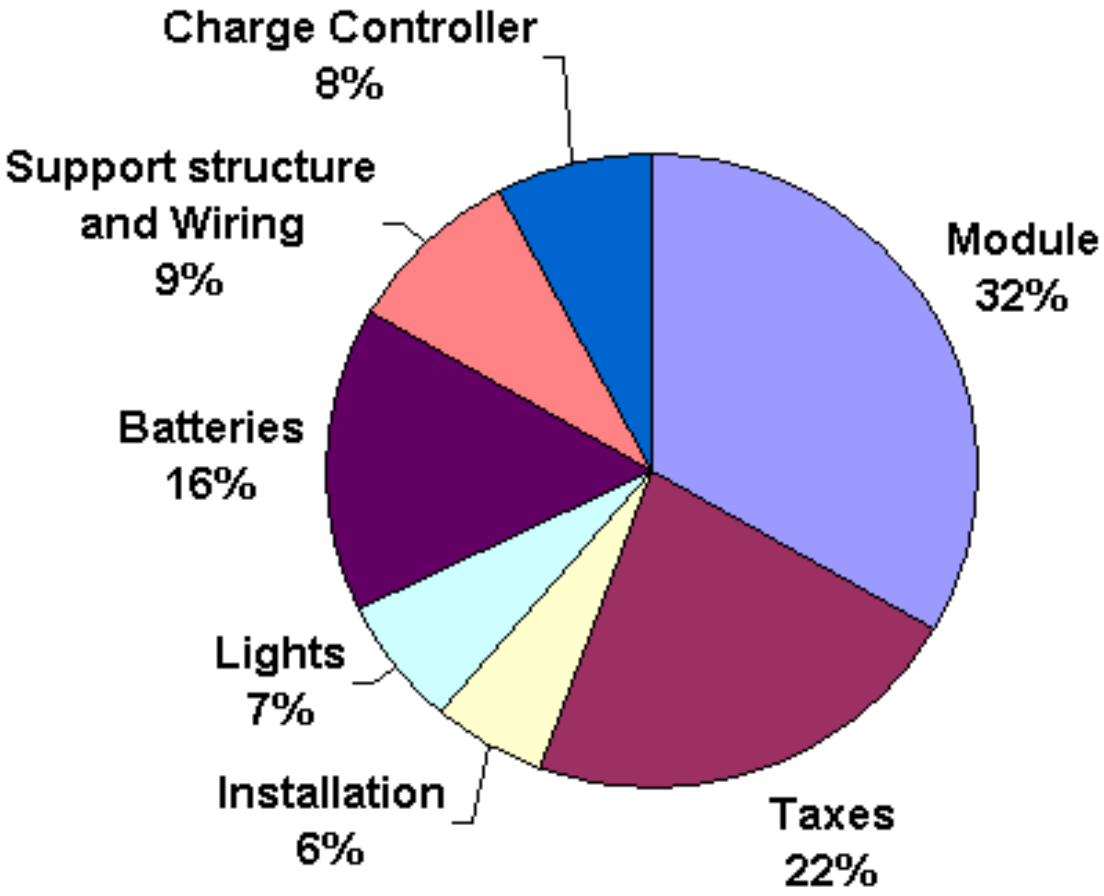


Household system

System Cost Breakdown

•BOS components may be locally made.

• India now manufactures solar panels



Off-grid – mini grids

- Localised electricity grids not connected to national electricity grid
- One of more power sources (fossil fuel based, renewable or combination)
- Can be prepared for future connection to national grid

Case study: microhydro Kenya

- 18 kW system built with assistance of Practical Action
- Local community formed management committee
- Electricity produced for micro enterprise centre only (barber shop, battery charging, cell phone charging, entertainment, welding shop)


UNGU-KABIRI COMMUNITY MICRO
HYDRO POWER PROJECT
TUNGU RIVER KABIRI FALLS
Funded by
undp
UNDP, GEF/SGP
P. O. BOX 30218
NAIROBI
Implemented by
MINISTRY OF ENERGY
P. O. BOX 30582
NAIROBI
ITDG
INTERMEDIATE TECHNOLOGY
DEVELOPMENT GROUP
P. O. BOX
NAIROBI

Case study: Lucingweni mini grid

- Eastern Cape South Africa
- Mini grid serving 150 households
- Hybrid system with 6 wind turbines of 6 kW each and 560 PV panels of 100 W_p

The way forward

- Rural energisation essential to foster local development
- Recognition that renewable energy sources can play an important role in rural electrification
- Need for appropriate institutional and legal framework
- Need for appropriate financing models

Thank you

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Characteristics of rural energy

Technology	energy production 2001	turnkey investment (2001 US$ per kW)	current costs	future costs
Biomass energy				
electricity	170 TWh (e)	500-6000	3-12 c/kWh	4-10 c/kWh
heat	730 TWh (th)	170-1000	1-6 c/kWh	1-5 c/kWh
ethanol	450 PJ			
bio-diesel	45 PJ			
wind electricity	43 TWh (e)	850-1700	4-8 c/kWh	3-10 c/kWh
solar photovoltaic	1 TWh (e)	5000-18000	25-160 c/kWh	5 to 6 - 25 c/kWh
solar thermal electricity	0.9 TWh (e)	2500-6000	12-34 c/kWh	4-20 c/kWh
low temperature solar heat	57 TWh (th)	300-1700	2-25 c/kWh	2-10 c/kWh
hydro energy				
large	2600 TWh (e)	1000-3500	2-10 c/kWh	2-10 c/kWh
small	100 TWh (e)	700-8000	2-12 c/kWh	2-10 c/kWh
geothermal energy				
electricity	53 TWh (e)	800-3000	2-10 c/kWh	1 or 2 - 8 c/kWh
heat	55 TWh (th)	200-2000	0.5-5 c/kWh	0.5-5 c/kWh
marine energy				
tidal	0/6 TWh (e)	1700-2500	8-15 c/kWh	8-15 c/kWh
wave	0	2000-5000	10-30 c/kWh	5-10 c/kWh
tidal stream / current	0	2000-5000	10-25 c/kWh	4-10 c/kWh
OTEC	0	8000-20000	15-40 c/kWh	7-20 c/kWh