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Access to Electricity in Ethiopia

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Addis Ababa



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Focal Slides

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- Depletion of the vegetation
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- National Electrification - Light for all program



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The Country

Ethiopia

- ~1.13 ml sq km
- population > 100 ml
- Pop. growth 2.58 %
(2019, WB)
- ~10 % Av. GDP growth
(~8.4%, 2019 WB)

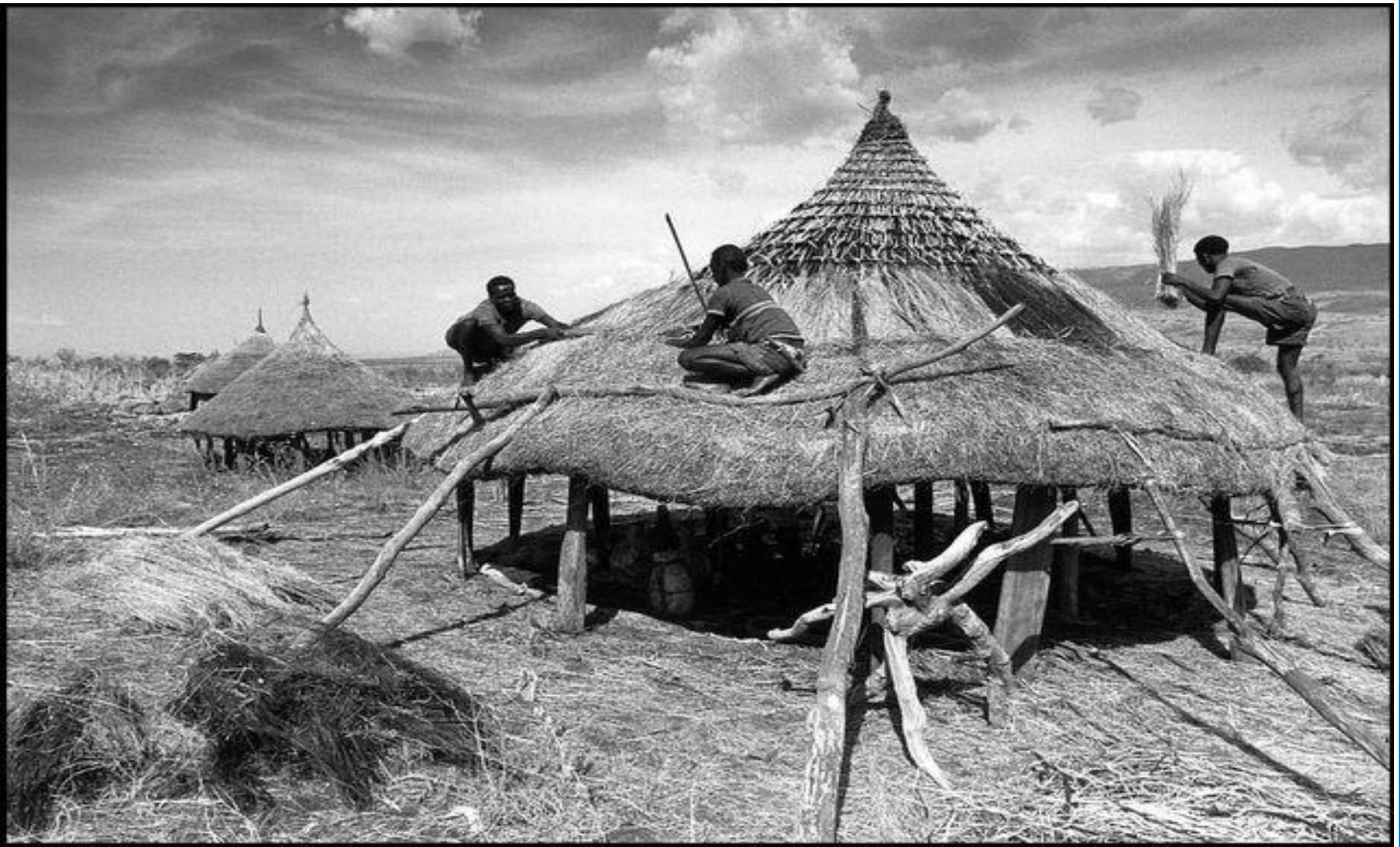




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When did we have Electricity?

- End of the 19th century (during Menilik time)
- The first generator is used in the palace (Menilik) around the Year 1898 (1881, Brush Electric Light Co., is said to be the First electric power plant, Philadelphia)
- Menilik: the first Hydro Power Plant, Akaki River, 1912
 - ✓ Supplied power to small factories and major roads in the vicinity of the palace
- 2005 → ~ 814 MW (~100 years)
- Over 4 GW now; and ~43 % coverage (2016 WB)





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Depletion of the vegetation

Lack of Energy

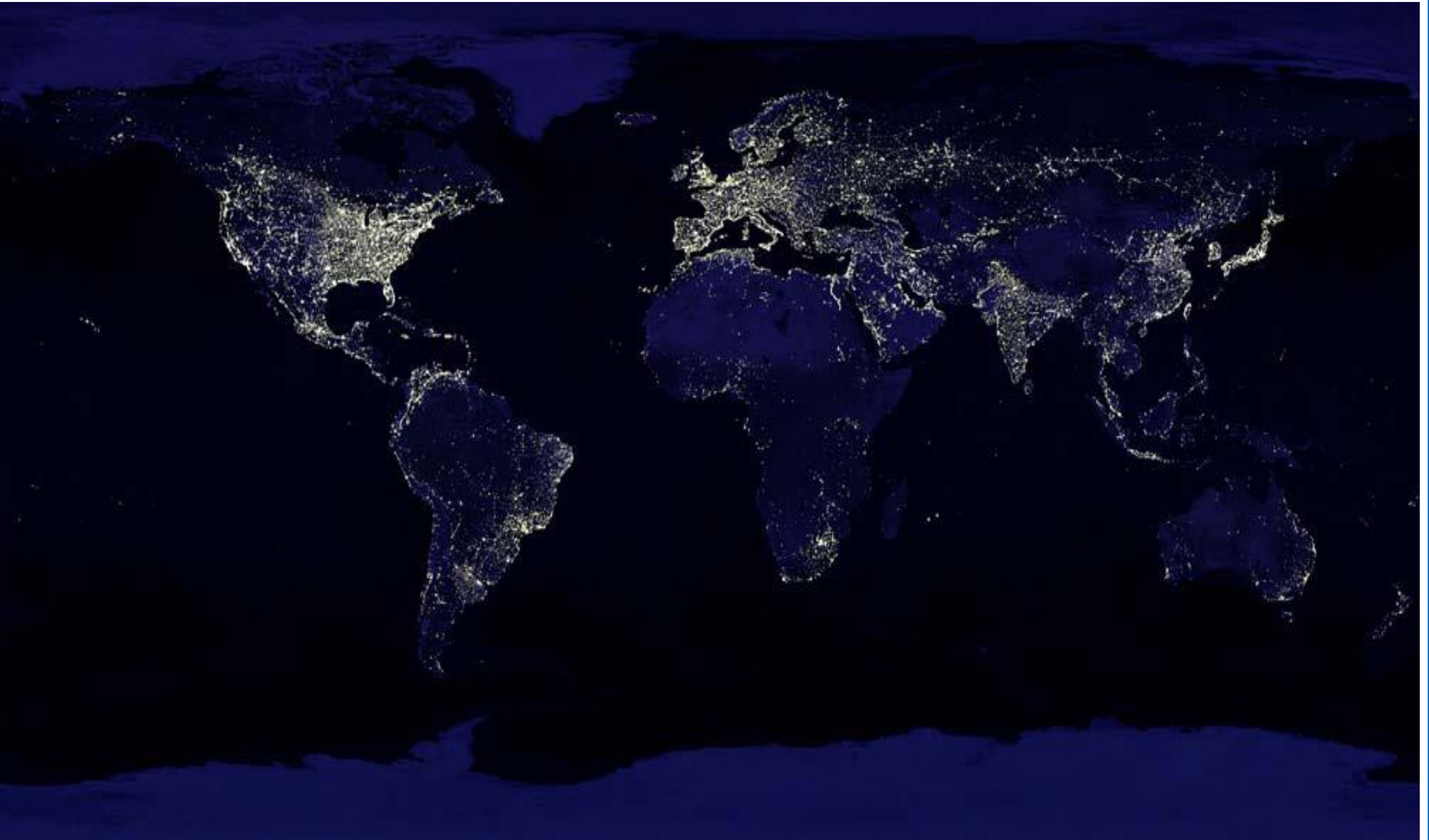
- Fuel wood
- Deforestation
- desertification
- 10 % arable land

Estimated (annually): 39.4 ml tons of fuel wood and 7.6 ml tons of agri-residue and animal waste are used for fuel



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Where are we?





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Where are we...(Cont'd)

country	Population (July 2010)	Electricity production (kWh)	yr.	Av. power per capita (watts per person)	Yr.
<u>China</u>	1 330 141 295	3 221 798 270 000	2008	277	2009
<u>India</u>	1 173 108 018	787 546 450 000	2008	50,5	2005
<u>United States</u>	310 232 863	4 110 259 050 000	2008	1 460	2005
<u>Nigeria</u>	152 217 341	21 920 000 000	2007	14,6	2005
<u>Ethiopia</u>	80 013 491	2 864 000 000	2005	3,8	2005
<u>Somalia</u>	10 112 453	8 228 000	2005	3,48	2005
<u>Djibouti</u>	740 528	793 000	2005	32,6	2005
<u>Sudan</u>	41 980 182	36 233 000	2005	10,4	2005
<u>Kenya</u>	40 046 566	34 256 000	2005	14,9	2005
<u>Uganda</u>	33 398 682	28 816 000	2005	6,63	2005
<u>Mozambique</u>	22 061 451	19 792 000	2005	52,6	2005
<u>Madagascar</u>	21 281 844	18 606 000	2005	5,97	2005
<u>Egypt</u>	80 471 869	74 033 000	2005	130	2005
<u>Botswana</u>	2 029 307	1 765 000	2005	168	2005
<u>Sweden</u>	9 074 055	9 041 000	2005	1692	2005



Power sector Status (Source: EEPCo Report 2014)

- Generation capacity in the grid - 2,268 MW
 - ✓ Hydro - 1,978 MW + 1800 MW
 - ✓ Wind > 300 MW
 - ✓ Geothermal - 7.3 MW (upgraded to 70 MW)
 - ✓ Diesel - 112 MW
- HV transmission line length > 12,000 km
- MV & LV distribution line length - 157,000 km
- Access to electricity grid to Rural Towns and Villages -54%
- Djibouti, Sudan and two Kenyan border towns Connected
- Ethiopia-Kenya 500 KV HVDC transmission line about to start
- MoU is signed with Tanzania, Rwanda, South Sudan, Yemen and the second line to Djibouti

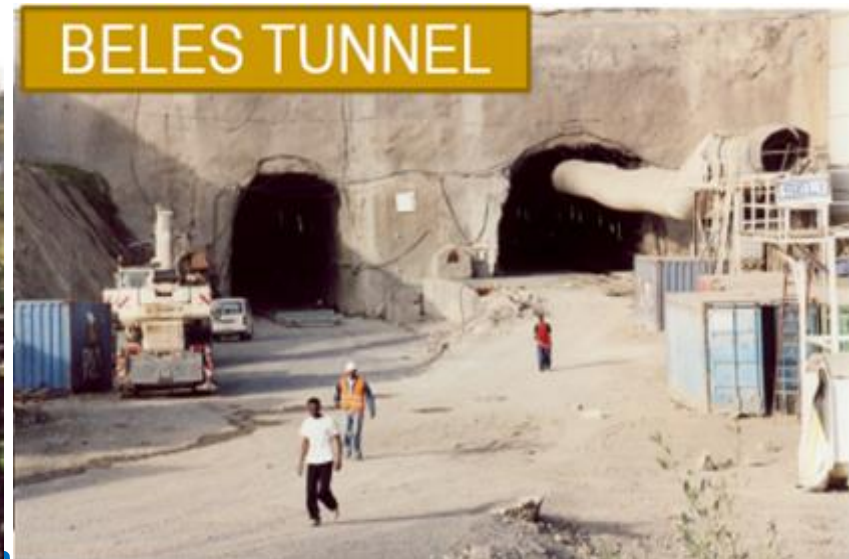
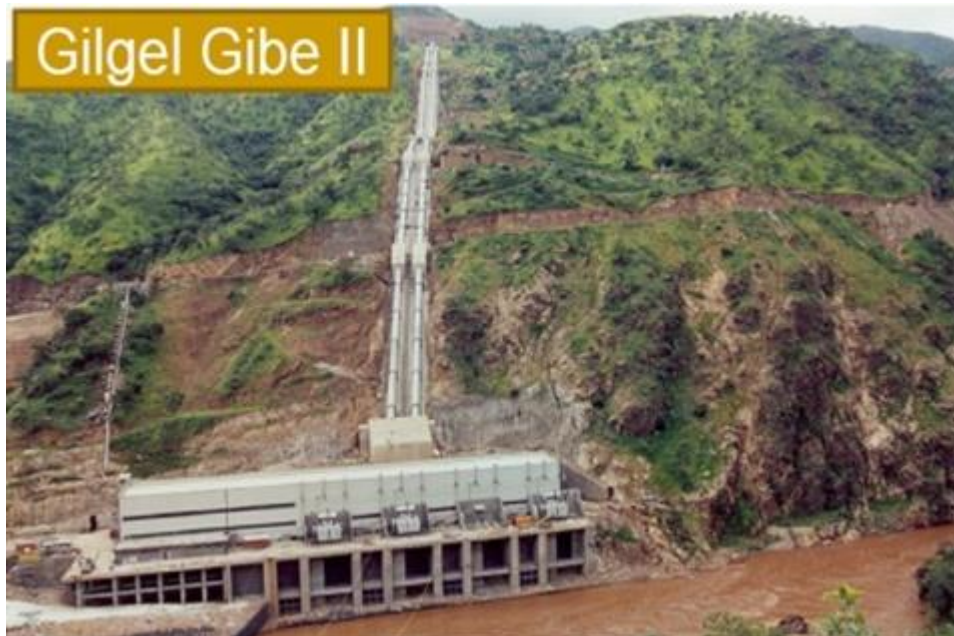


Hydropower	
Aba Samuel	6.6
Gibe I	184
Gibe II	420
Gibe III	1870
Beles	460
Tekeze	300
Melka	153
Wakena	134
Fincha	134
Amerti Neshi	95
Koka	43.2
Tis Abay II	73
Awash II	32
Awash III	32
Total	3802.8

- Average wind speed > 7 m/s at 50 m above ground level
- Potential is estimated to - 1,350 GW

Wind Plant	Installed Capacity (MW)
Ashegoda	30
Ashegoda	90.2
Adama I	51
Adama II	153

The Power ...(cont'd)



The Power ...(cont'd)

Tekeze-
300MW





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The Power ...(cont'd)

Gibe II 420MW





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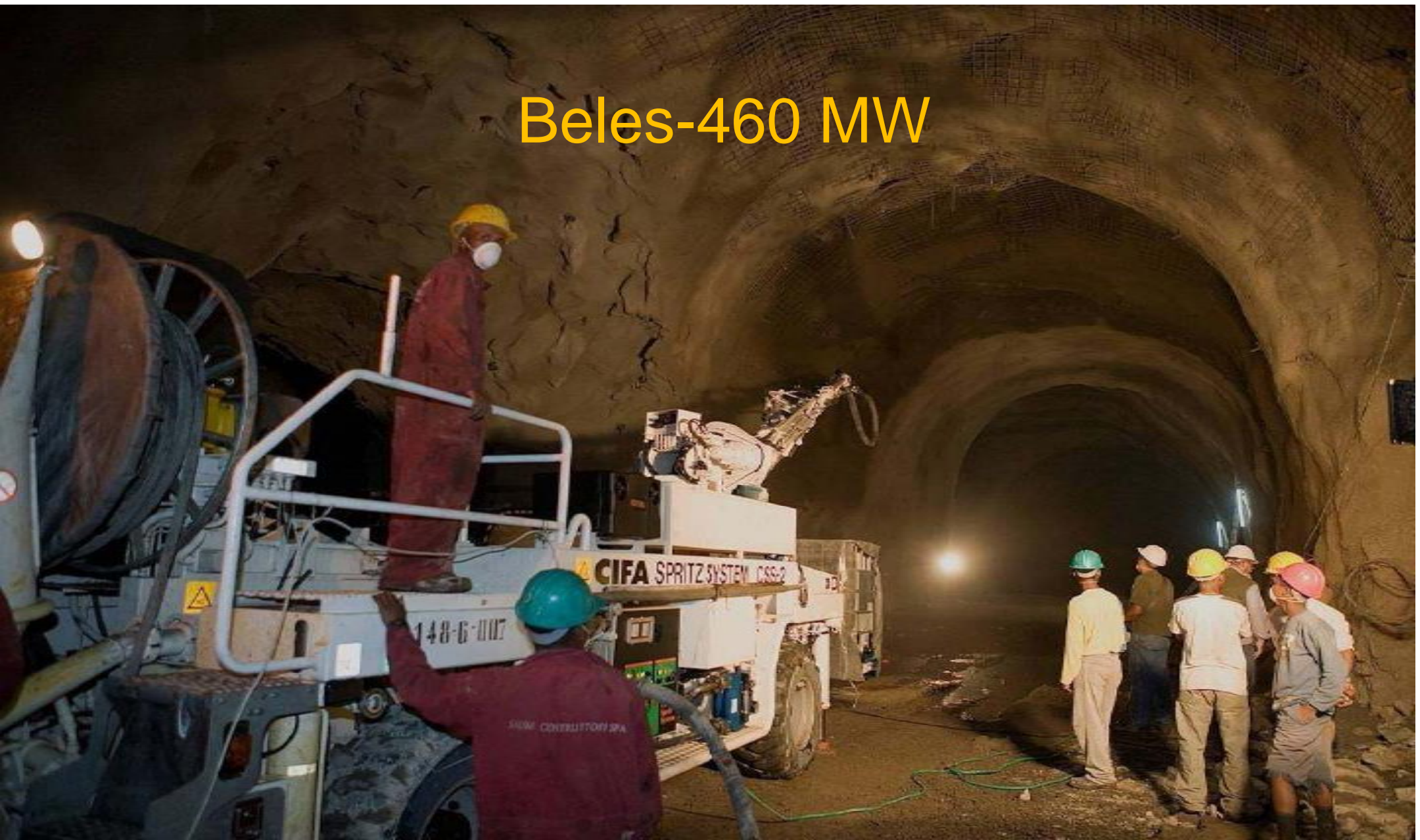
The Power ...(cont'd)

Gibe III-1800MW



The Power ...(cont'd)

Beles-460 MW



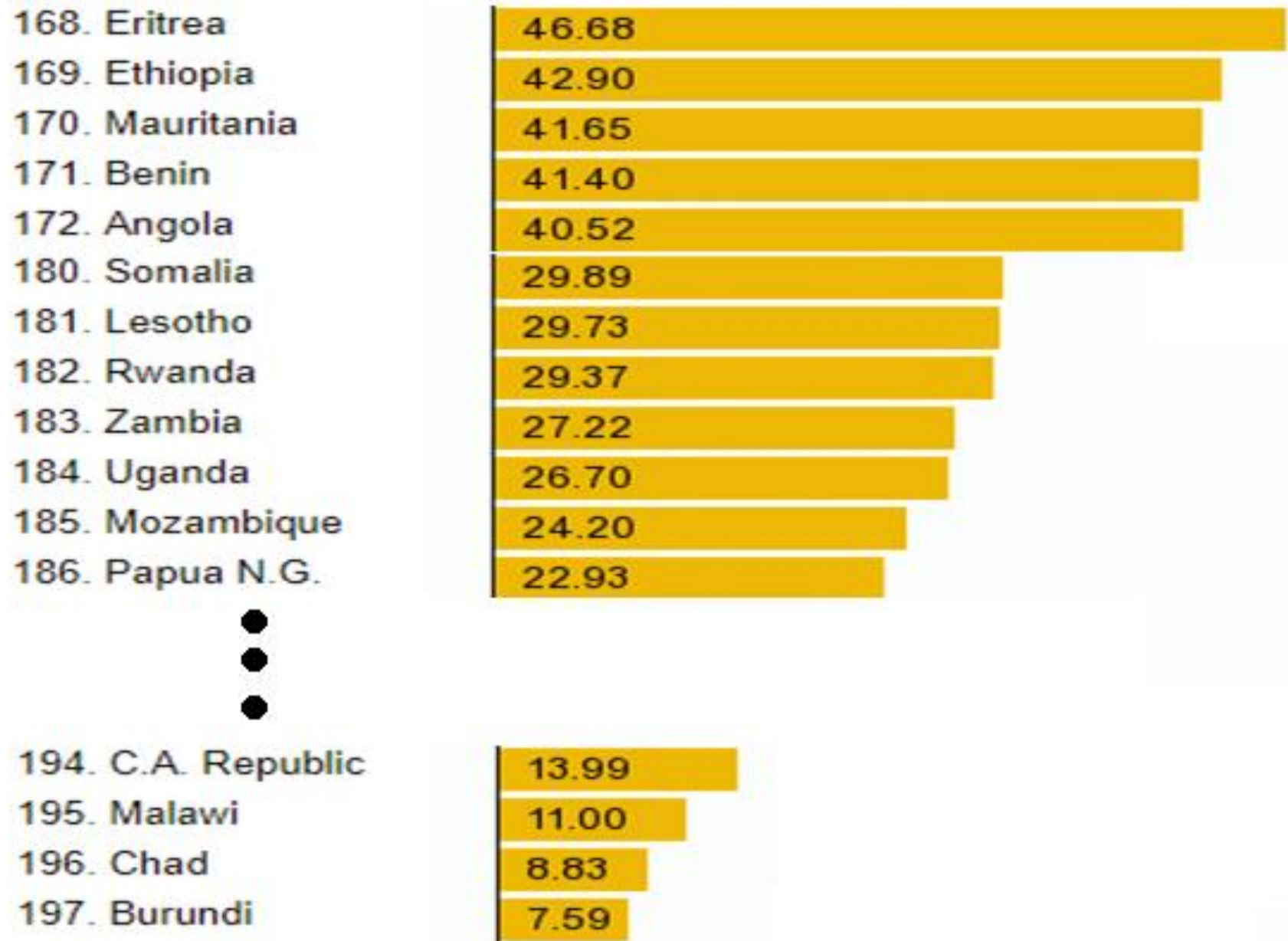
Beles-460 MW





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Access to electricity, % of the population, 2016 WB



Resource	Exploitable reserve	Exploited (%)
Hydropower	48,030 MW	~20
Solar/day	4 - 6 kWh/m ² /d	~0
Wind: Power Speed at 10m	1.35TW 5.6 m/s	~2.4
Geothermal	10,000 MW	~0
Wood	1120 Mts	50
Agricultural waste	15-20 Mts	30
Natural gas	113 Bm ³	0
Coal	300 Mts	0
Oil shale	253 Mts	0

- 92% of the total is traditional biomass energy inefficiently and uneconomically used
- Remained share, 7% & 1%, imported petroleum and electricity respectively

Nuclear?





- Parliament approves a draft proclamation on Nuclear usage
 - The Ethiopian Nuclear Science and Technology Council
 - The Ethiopian Nuclear Science and Technology Institute is/will be established (autonomous federal government Institution)
- A Council is/will be established with the Prime Minister as Chairperson
- Members of the Council shall be nominated by the Minister and appointed by the Prime Minister (relevant technical knowledge related to nuclear science and technology)



Objectives of the Institute

- Enable the country to fully exploit **multidimensional and peaceful uses** of nuclear science and technology
- Promote the **peaceful development of nuclear science and technology** and related expertise
- Develop, **strengthen and implement nuclear science and technology through research** to speed up the comprehensive development of the country
- Develop **training plans and opportunities** to strengthen the nuclear sector and meet the postulate growing demand for ethical, responsible, and capable nuclear professionals, thereby enabling the country to become globally competitive in the sector; and
- **Provide comprehensive consultation and training** to local and foreign clients in matters regarding nuclear science and technology²



Electricity Demand

Recently established (or to be established) demands:

- The railway developments (light rail in AA + long distance)
- Large irrigation Projects
- New Industrial Developments (Industry parks)
- Large scale Dwelling house expansion
- Universal Electricity Access expansion Program
- Electricity export



AAiT Power plants under construction

- Grand Ethiopian Renaissance Dam ~ 6,000MW
- Genale Dawa III - 254 MW
- Aluto Langano geothermal expansion - 75 MW
- Repi Waste-to-Energy power - 25 MW (completed)
- Koysha Power plant 2160 MW, Aisha 125 MW

No.	Project	2020	2021 Plan	so far completed
1	GERD	74.25	7.14	77.65
2	Koisha HP	35.1	13.67	42.62
3	Aisha WP	64.32	27.51	70.29
4	Aluto Geo-th P	19.4	28.8	25.65



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The Renaissance Dam

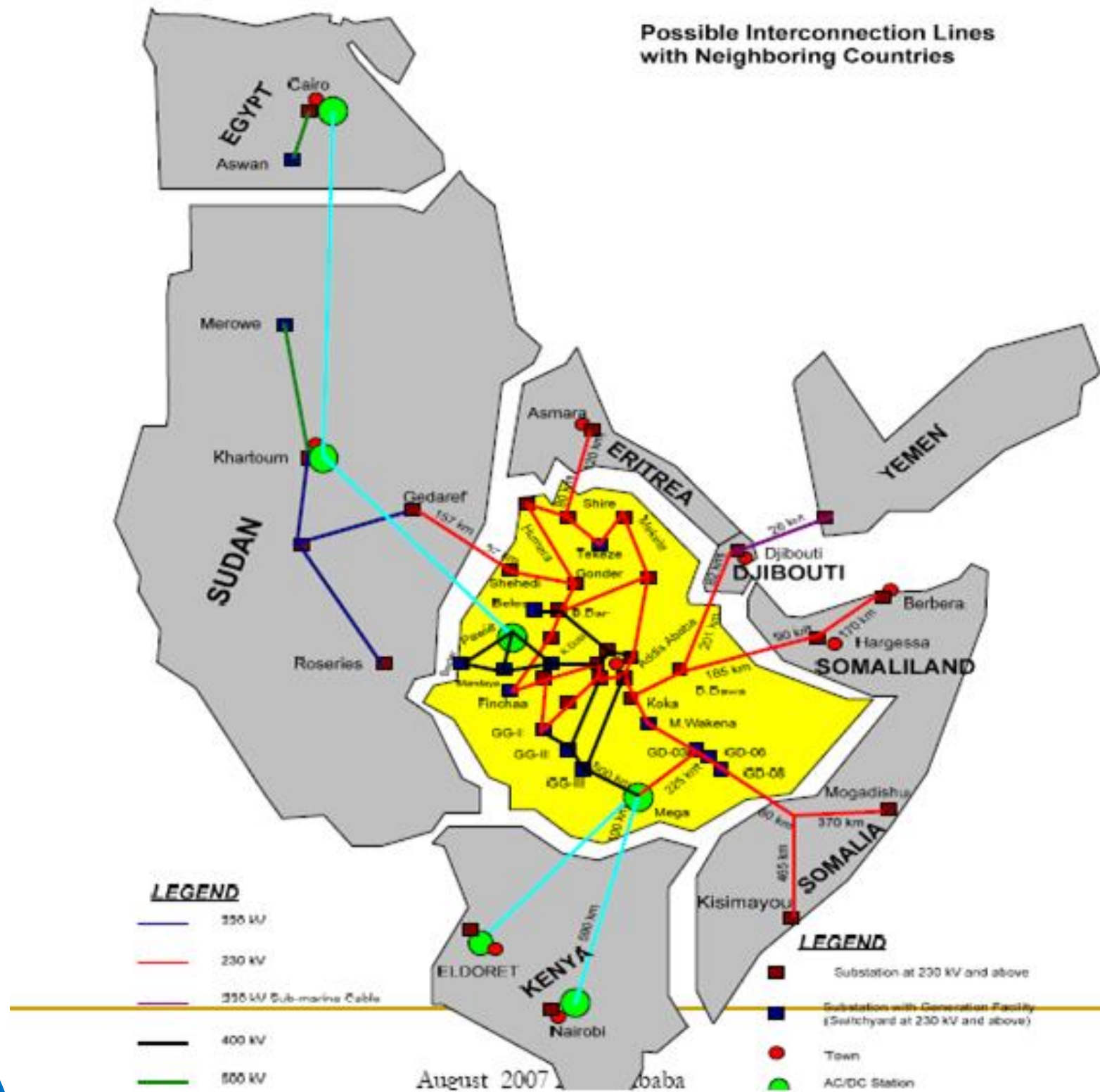


3/12/2021

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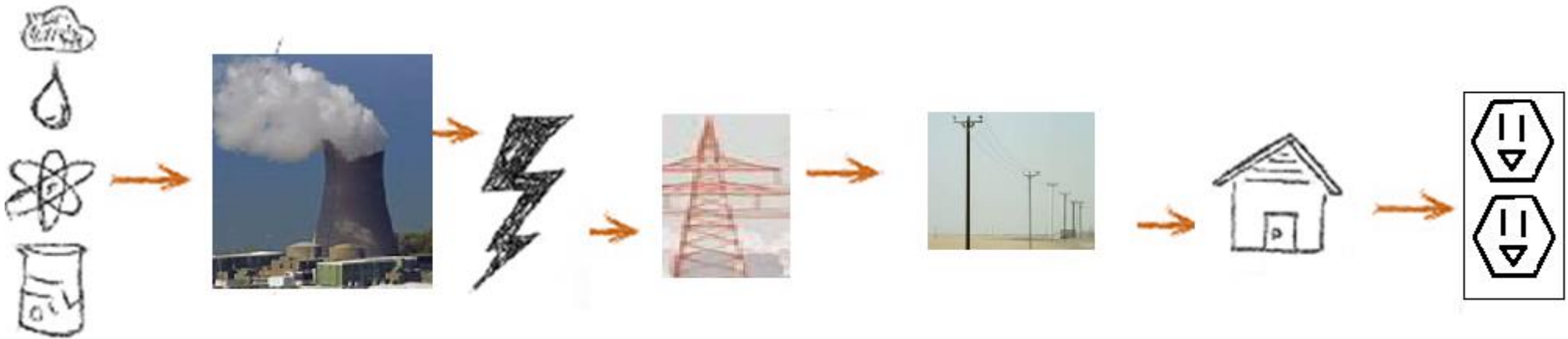


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Electric power System Issues

Source of losses

- *Energy lost in power plants: About 65%*



- *Transmission and Distribution (About 6% - 2% in transmission and 4% in distribution)*
 - Transmission: I^2R (Heat loss) etc.
- *Using Electricity at Home*



Voltage surges/spikes

Voltage Dips

Under voltages

High-Voltage Spikes

Frequency Variation

Power Sag

Electrical Line Noise

Brownouts

Blackouts

Very short interruptions

Long interruptions

Voltage swell

Harmonic distortion

Voltage fluctuation

Noise

Voltage Unbalance



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Electric power TL & DS losses (% of output) 2014

EP Trans. and Dist. Losses	%
Ethiopia	19
Germany	4
India	18
Israel	4
Singapore	0 ?
World	8
EU	6
US	6
Sub-Saharan countries	12
Middle income	10



AAiT Power Sector Reform Roadmap (MOWIE, 2020)

- Guiding document for the next five years.
- Major Components:
 - Institutional Framework and Governance Improvement
 - Regulatory Framework Strengthening
 - Restructuring of Utilities
 - Introducing Contractual Framework
 - Ensuring Financial Sustainability
 - Operational Performance Improvement



ELECTRICITY SECTOR CONTEXT

- 4,500 MW in 2018
(2009—country-wide load shedding, 16-18 hours every day)
- access rate of 44 %,
- country faces the 2nd highest electricity access deficit in Africa (over 60 million people without access)
- Urban: ~ 96 % of households are connected to the grid (99.9 % in Addis Ababa)
- only 27 % for rural households
- high technical and commercial losses impact service reliability



ELECTRICITY SECTOR CONTEXT (Cont'd)

- To finance the expansion of the power sector, the Government is moving from **public generation investments** to independent power producers (IPPs), enabled by public-private partnership (PPP) proclamation passed by the Parliament in early 2018.
- Under the new PPP framework, a dedicated PPP unit has been established at the Ministry of Finance (MoF), which short-lists and approves PPP transactions across all the sectors.
- The GoE is also preparing a transparent and competitive procurement process on auction-based bidding procedures, which is meant to become the default methodology for procuring IPPs.



As a summary

- Providing quality service to its customers. (A recent customer satisfaction survey (2019) concluded that more than 60% of customers expressed dis-satisfaction.
- Achieving electricity access by the year 2025 (on-grid 65% and off-grid 35% households)
- Maintain meaningful improvement in the energy mix
- Achieving the vision of becoming key electricity exporter in the region
- Maintaining strong credit worthy companies that can finance investment
- Establishing a strong, full-fledged and independent regulatory body (last tariff was adjusted after 12 years?)
- **International experiences have contributed to the Roadmap**



AAiT National Electrification - Light for all program

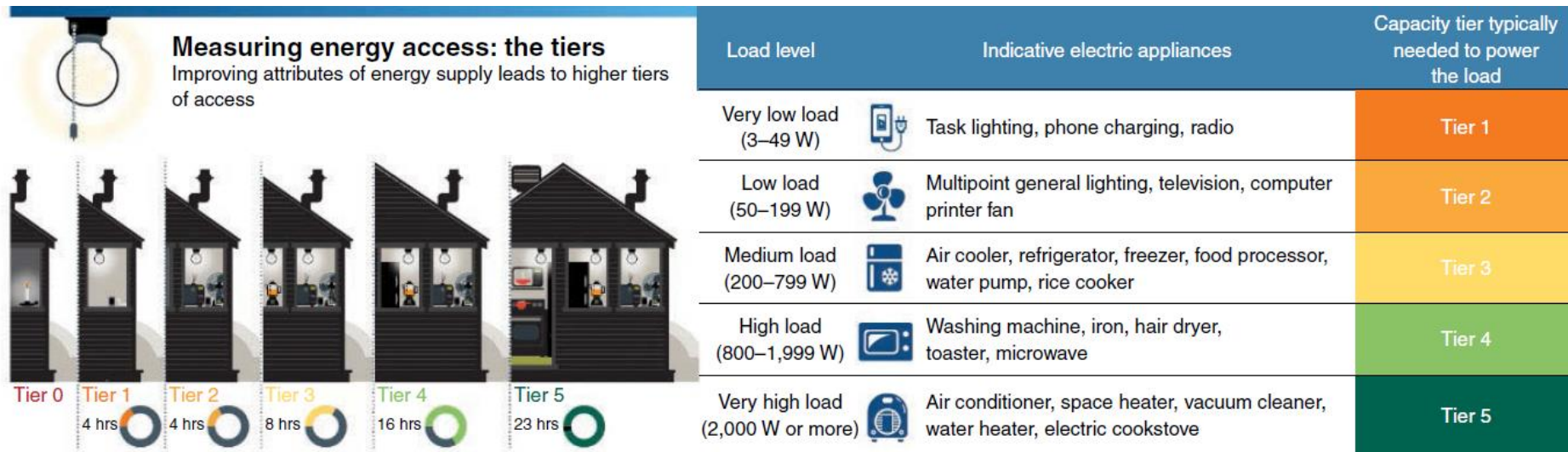
Achievements of UEAP

- An impressive electric infrastructure development
- Construction and upgrading of 58 substations and construction of 1395 km, of 132 kV and 522 km of 230 kV transmission lines completed.
- Totally, 7012 towns and villages are electrified through out the country.
- Local Capacity building in construction and manufacturing sectors
- Job opportunities for citizens

Why NEP 2.0 ?

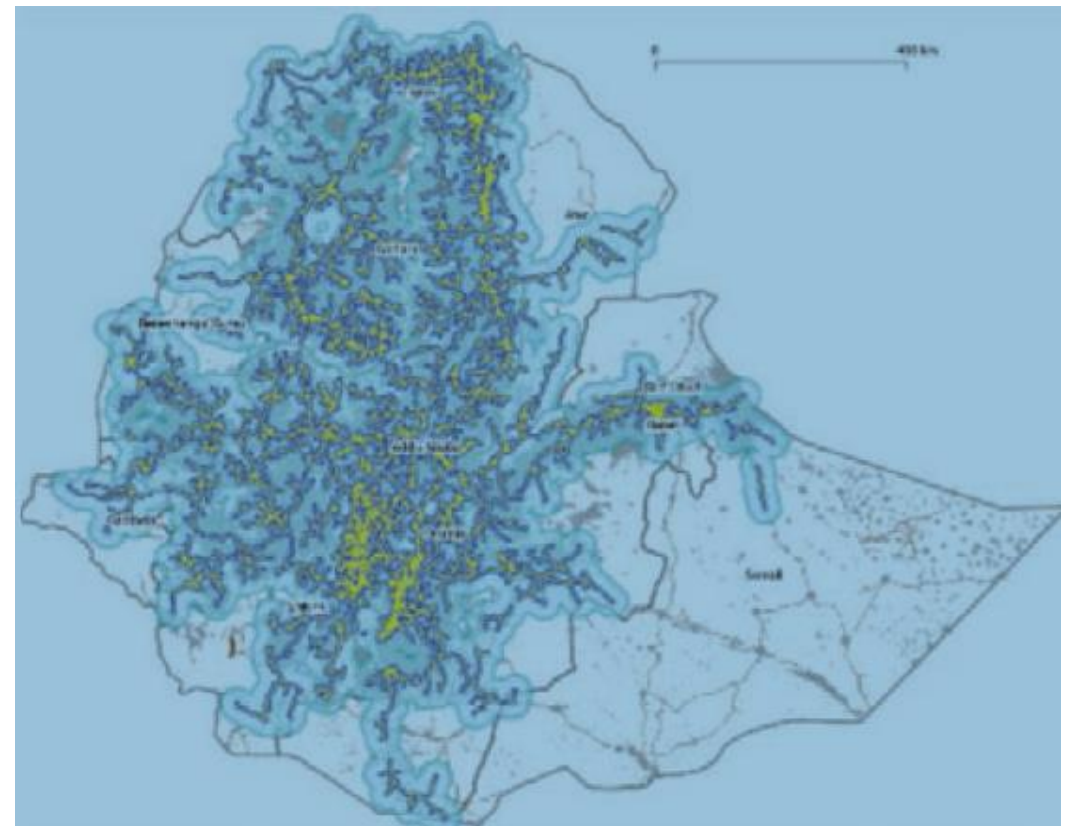
NEP 2.0, is an updated version of the NEP 1.0 after its release in 2017 and following new two assessments

One is based on multi-tier Framework (MTF) assessment the Overall electricity access of Ethiopia is found to be 44%, 33% grid connected and 11% off grid connected



Why NEP 2.0? (cont'd)

- *Two is based on Geospatial analysis and map reflecting the digitized location of the existing MV network and the results of geospatial analysis:*
- 75-80 % of the population are within 5 km distance
- 10 - 15%, within 10 km
- 4 - 5 % of the current and future are estimated to be within 25 km





National Electrification ...(Cont'd)

NEP2.0 Targets and Time Table

Time Period		Total House-holds	Grid Conn. Added	Cumul. Grid Conn.	Grid Access Rate	Off-Grid Conn. Added	Cumul. Off-grid Conn.	Off-Grid Access Rate	Total Conn. Added	Total Cumul. Conn.	Total Access Rate
Program	Year	(millions)	(millions)	(millions)	(pct)	(millions)	(millions)	(pct)	(millions)	(millions)	(pct)
GTP II	2017	19.9	0.2	6.6	33%	0.0	2.2	11%	0.2	8.8	44%
	2018	20.4	0.3	6.9	34%	0.0	2.2	11%	0.3	9.1	45%
	2019	20.7	0.5	7.4	36%	0.1	2.3	11%	0.6	9.7	47%
	2020	21.1	0.7	8.1	38%	0.5	2.8	13%	1.2	10.9	52%
	2021	21.6	0.9	9.0	42%	0.7	3.5	16%	1.6	12.5	58%
GTP III	2022	22.0	1.3	10.3	47%	0.9	4.4	20%	2.2	14.7	67%
	2023	22.4	1.5	11.8	53%	1.0	5.4	24%	2.5	17.2	77%
	2024	22.8	1.6	13.4	59%	1.2	6.6	29%	2.8	20.0	88%
	2025	23.2	1.7	15.1	65%	1.5	8.1	35%	3.2	23.2	100%
GTP IV	2026	23.6	1.8	16.9	72%	-1.4	6.7	28%	0.4	23.6	100%
	2027	24.0	1.8	18.7	78%	-1.4	5.3	22%	0.4	24.0	100%
	2028	24.4	1.9	20.6	84%	-1.5	3.8	16%	0.4	24.4	100%
	2029	24.8	1.9	22.5	91%	-1.5	2.3	9%	0.4	24.8	100%
	2030	25.2	1.8	24.3	96%	-1.4	0.9	4%	0.4	25.2	100%

National Electrification ...(Cont'd)

NEP2.0 connection Targets for Social institutions

- Health centers and schools represent two key priorities in the electricity access program
- An estimated ~1,300 secondary schools and ~2,700 health centers lack access to electricity

Planned electrification for social institutions

	2018	2019	2021	2023	2025
Education facilities					
Secondary schools	70%		90%	100%	
Primary schools	24%		45%	70%	100%
Health facilities					
Hospitals	70%	80%	100%		
Health centers	28%		50%	80%	100%
Health posts	5%		30%	50%	75%



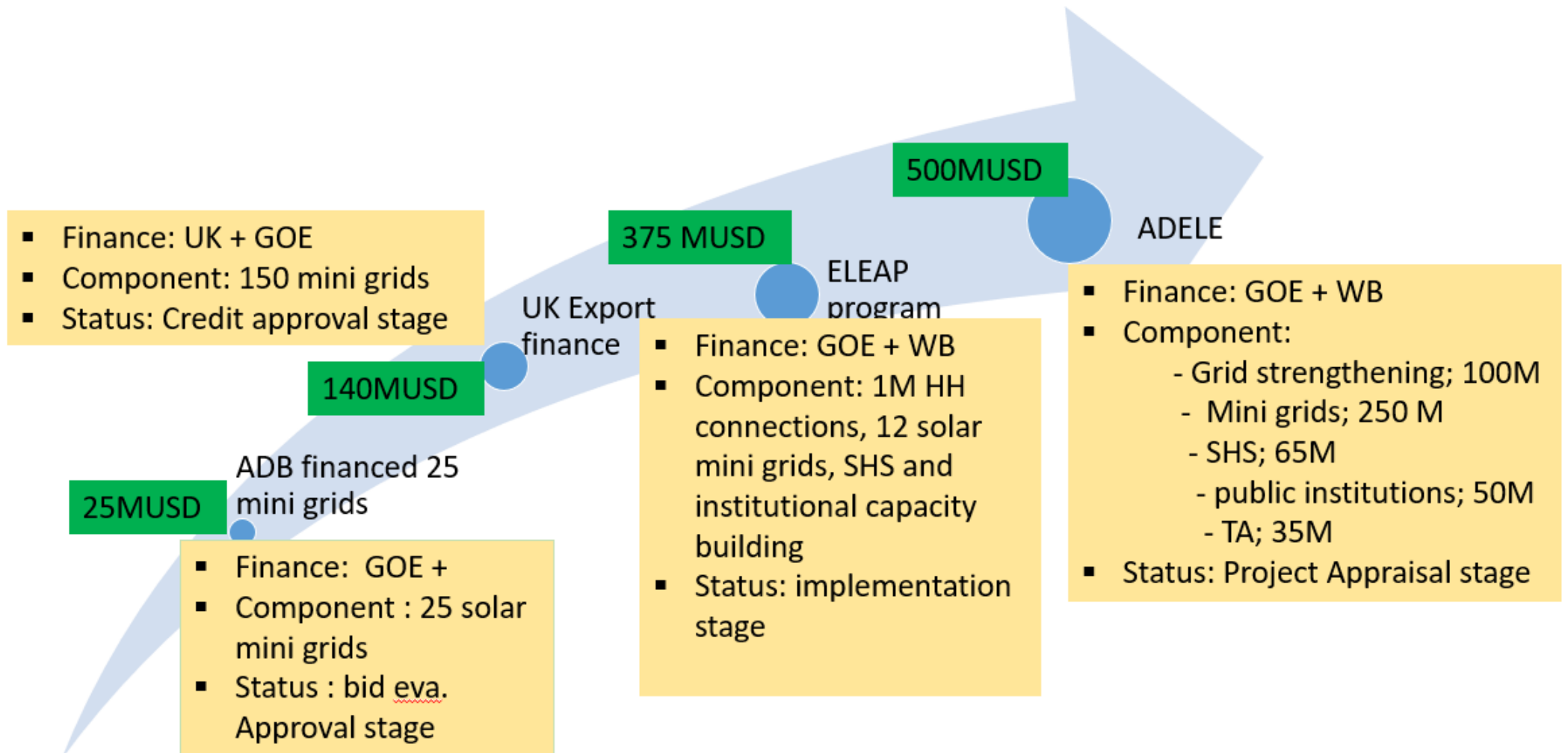
Financing requirement of National Electrification Program

- The achievement of universal access by 2025 will require an overall investments of about US\$6 billion.

	Investment (US\$ million)	GoE Contribution (US\$ million)	Syndication (US\$ million)
A. Grid program			
Grid total investments*	3,200		
Costumer contribution (-)	(1,100)		
Total	2,100	480	1,620
B. Off-grid program			
Access to finance (with a revolving fund)	1,760	530	1,240
End-user subsidy	72	72	-
Social institutions	230	70	160
MST off-grid solar	133	41	92
Mini-grids (MST and EPC) ^a	300	280	20
Off-grid total investment syndication	~2,500	~1,000	~1,500
Program implementation support	50	20	30
Total Investment syndication (A + B)	~4,650	~1,500	~3,150

National Electrification ...(Cont'd)

NEP implementation Progress made so far





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National Electrification ...(Cont'd)

Albasa (Benushangul Gumuz reg. state) solar mini grid during construction

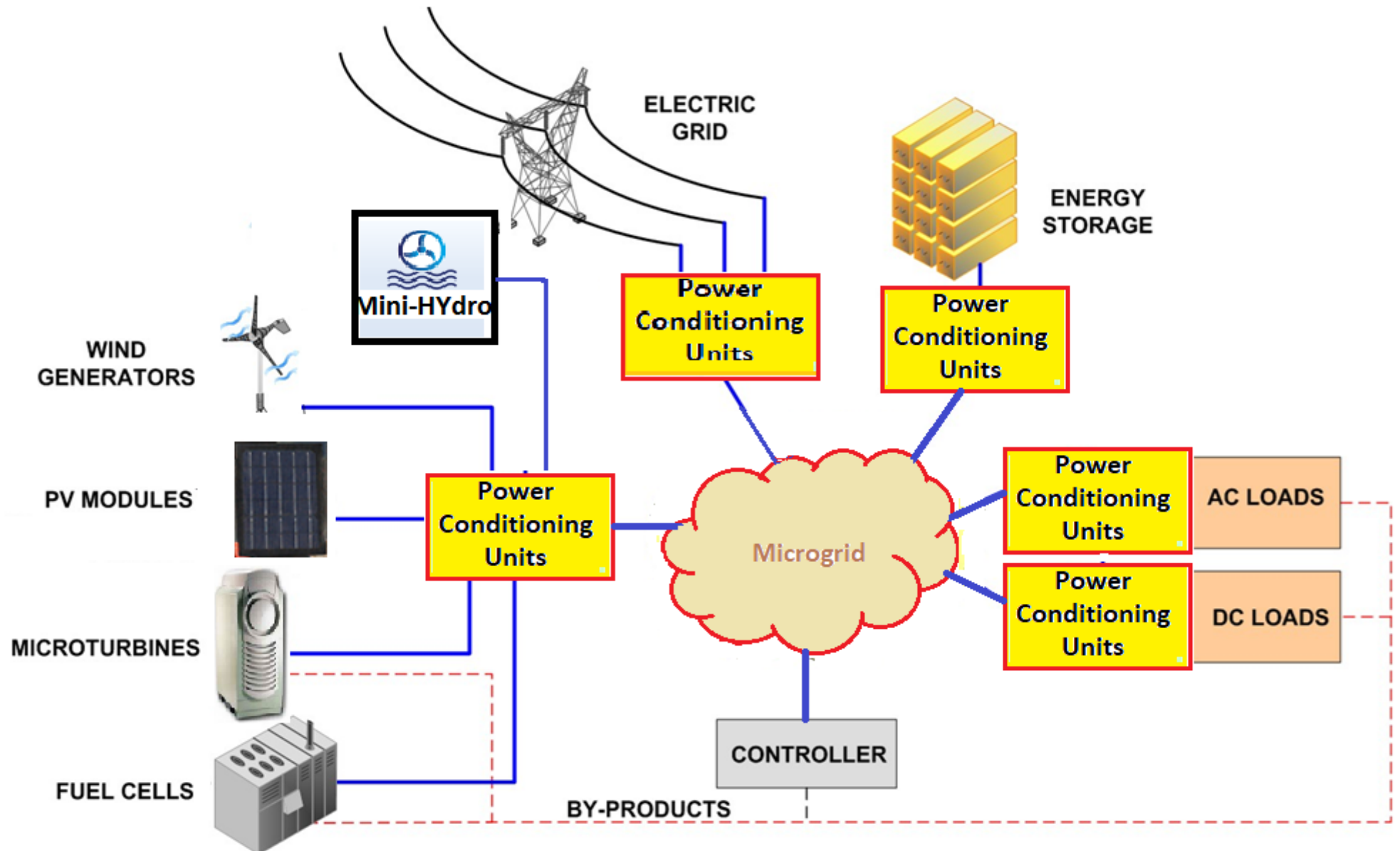


- 12 towns (PV standalone) with WB, eight (67%) completed
- Another 25 towns (PV Standalone) with ADB negotiation underway



Qurale town (Somale reg. state) Solar mini grid in operation

REN Option in Rural Context The DG concept





Development Plan in 10 years

- Capacity building: 4.515 - 17.56 GW in 10 years. Tr. Line: 19746 - 33497 km
- Higher than 132 kV Sub Stan.: 176 - 265
- Losses on TL: 6% - 3.5
- Income 300 ml USD - 5.32 bl
- Grid connection: 33% - 96%
- Hydro power 93% - 73% wind, geothermal, solar will be increased
- Estimated cost: 35.6 bl USD



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for your attention!