Renewable Energy and Energy Efficiency Project for Hospitals in Kisumu County, Kenya

IKI INTERNATIONAL CLIMATE INITIATIVE

The Federal Government

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COUNTY GOVERNMENT OF KISUMU — HARBOUR OF PROSPERITY

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The Opportunity – Promote Renewables in the Kenyan Healthcare Sector

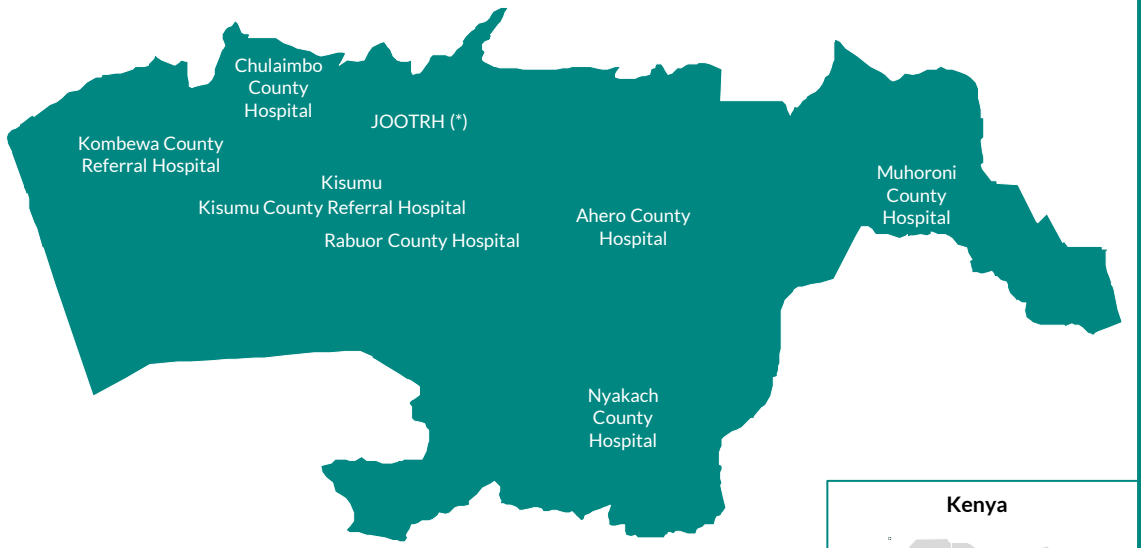
The Development of a Finance-ready Renewable Energy and Energy Efficiency Project in Kisumu County, Kenya – within the framework of the 100% Renewables Cities and Regions Roadmap project

Project Initiator and Funder	Implementing Partner	Kisumu County Hospitals	Technical and Financial
The 100% Renewables Cities and Regions Roadmap Project (100% RE) is implemented by ICLEI and funded by the German Federal Ministry of Economics and Climate Protection (BMWK) through the International Climate Initiative (IKI). The 100% RE Project provides support to local and regional governments to promote progress towards 100% renewable energy strategies. The 100% RE Project works with cities and regions in selected countries to build a pathway for cities in the global south to finance and implement renewable energy (RE) and energy efficiency (EE) measures by assessing local RE and EE potential as well as developing ready-to- finance (bankable) projects.	ICLEI - Local Governments for Sustainability (ICLEI) is a global network of more than 2,500 local and regional governments committed to sustainable urban development. With activities in more than 125 countries, ICLEI influence sustainability policies and drive local action for circular, equitable, resilient, nature-based and low carbon development. ICLEI's network, together with a team of experts, works to provide access to knowledge and partnerships and to build capacity for systemic change in urban sustainability.	Kisumu County, located in western Kenya, is one of 47 counties in the Republic of Kenya. Its headquarters is Kisumu City which is the third largest city in Kenya after the capital Nairobi and the coastal city of Mombasa. It has a population of 1,155,574 (according to the 2019 National Census). The land area of Kisumu County totals 2085.9 km2. The main sources of energy within Kisumu County are grid power and small solar home systems for lighting, whereas for cooking, firewood, charcoal, paraffin and LPG are used. The grid electrification in 2019 was about 52.6%, and grid supplies meet about 77% of the county's electricity demand.	Bazaruto Renewables (Bazaruto) develops renewable energy projects in Sub-Saharan Africa and aims to unlock the region's renewable energy potential by (co-) developing bankable renewable energy projects across a subset of technologies and countries. In addition to project development, Bazaruto also provides renewable advisory services in Sub-Saharan Africa to a select number of clients. ICLEI Africa appointed Bazaruto to provide consulting services for the development, design, engineering and financial matchmaking of this project within the framework of 100% RE.

Activities to Date

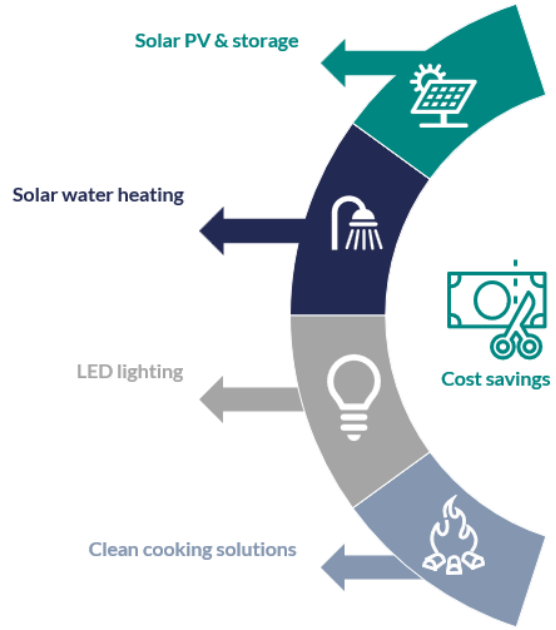
Previous energy audits recommended implementing the following 4 measures across healthcare facilities in Kisumu: solar PV & storage, solar water heating, LED lighting, and clean cooking solutions

7 hospitals in Kisumu County have been audited between 2016 and 2021, updates are completed including one additional hospital audit, resulting in an initial scope of 8 hospitals



(*) Jaramogi Oginga Odinga Teaching & Referral Hospital

Detailed engineering, design, and modelling of the identified measures were completed in Q1 2024



The project is aligned with the following national and local energy policies: Energy Act 2019, National Energy Policy 2018, Kisumu City Sustainable Energy Policy 2021, National Energy Efficiency and Conservation Strategy 2020, County Integrated Development Plan (CIDP) II 2018 – 2022, and Integrated National Energy Planning Framework.

The Project & Methodology

Project scope and expected benefits

Scope

Solar PV & storage
(non-existing
USD 1.4M investment)

Solar water heating
(hot water solution is non-existing
USD 430k investment
152k kWh p.a. additional load)

LED lighting
(USD 30k donated through Signify
307k kWh p.a. savings
USD 70k p.a. savings)

Clean cooking solutions
(USD 16k investment)

Renewable energy & efficiency for 22 hospitals in Kisumu county
with initial focus on 8 hospitals

Impact

GHG emissions reduction
by divesting thermal
(870,894 kg CO2e p.a.)

Mitigate grid unreliability
(frequent power cuts of up to 16 hours for 6 smaller hospitals)

Energy & cost savings
(USD 105k p.a. savings 2 big hospitals enable investment 6 smaller hospitals)

Improved healthcare operations
(USD 145k + inpatient & USD 500k + outpatient p.a.)

Results Energy Audit Q4-2023 (As Is Situation)

Summary key observations

Solar	✓ JOOTRH and Kisumu facilities rely on KPLC as its main source (99.5%) of electricity and have reliable supply ✓ 6 smaller hospitals rely on unreliable grid and donated gensets that are often too big for the facility resulting in an expensive and inefficient solution which is often not in use
Water Heating	✓ None of the 8 facilities have (solar/ electric) water heating that is functional due to poor maintenance ✓ Some facilities use firewood for water heating
LED Lighting	✓ 90% of portfolio LED lighting savings potential of USD 55K p.a. can be achieved at JOOTRH ✓ 2 smaller hospitals Kombewa and Nyakach already implemented 100% LED ✓ Assumption that LED will be donated by Signify (https://www.signify.com/global)
Clean Cooking	✓ Cookstoves are often not energy efficient ✓ Most hospitals predominantly cook with firewood and charcoal (which is unhealthy due to toxic emissions) ✓ Majority (67%) of CO2 reductions can be achieved at Kisumu hospital
Power Infrastructure & Energy Management	✓ Most facilities don't have a proper electrical power room and electrical power distribution board to facilitate functional electricity distribution from solar PV ✓ Some facilities lack a functional electricity meter and/or voltage regulator ✓ All hospitals lack proper energy record management systems and comprehensive energy management policies

Proposed Renewable Energy and Energy Efficiency Measures

- ✓ JOOTRH and Kisumu will have a grid connected solar PV system
- ✓ Whilst the other hospitals have a solar PV + battery storage system
- ✓ LED lighting will be implemented for all hospitals except Nyakach and Kombewa (already 100% LED)
- ✓ Rest of the measures are almost comparable across the 8 hospitals

Item	JOOTRH	Kisumu	Ahero	Nyakach	Kombewa	Chulaimbo	Muhoroni	Rabuor
Grid-tied solar PV	✓	✓						
Solar PV + storage			✓	✓	✓	✓	✓	✓
Water Heating System	✓	✓	✓	✓	✓	✓	✓	✓
Power Infrastructure*	✓	✓	✓	✓	✓	✓	✓	✓
Energy Management**	✓	✓	✓	✓	✓	✓	✓	✓
Other***	✓	✓		✓			✓	
LED Lighting	✓	✓	✓			✓	✓	✓
Clean Cooking	✓	✓	✓	✓	✓	✓	✓	✓

Table 1 Recommendations per facility

* Necessary investments in power infrastructure for efficient implementation and performance optimization of the proposed projects, specifically solar PV systems, LED lighting retrofit, and proper monitoring and verification of energy and cost savings.
** Embedding energy management and energy policies in every hospital including trainings on energy efficiency and energy records management.
*** Various measures that were not in the initial scope of the project including improving the design of the incinerator and exploring heat recovery possibilities.

Note on operations & maintenance (O&M): potential O&M implementing partner and associated cost to be defined and not yet included in the recommendations budget.

Proposed Renewable Energy and Energy Efficiency Measures

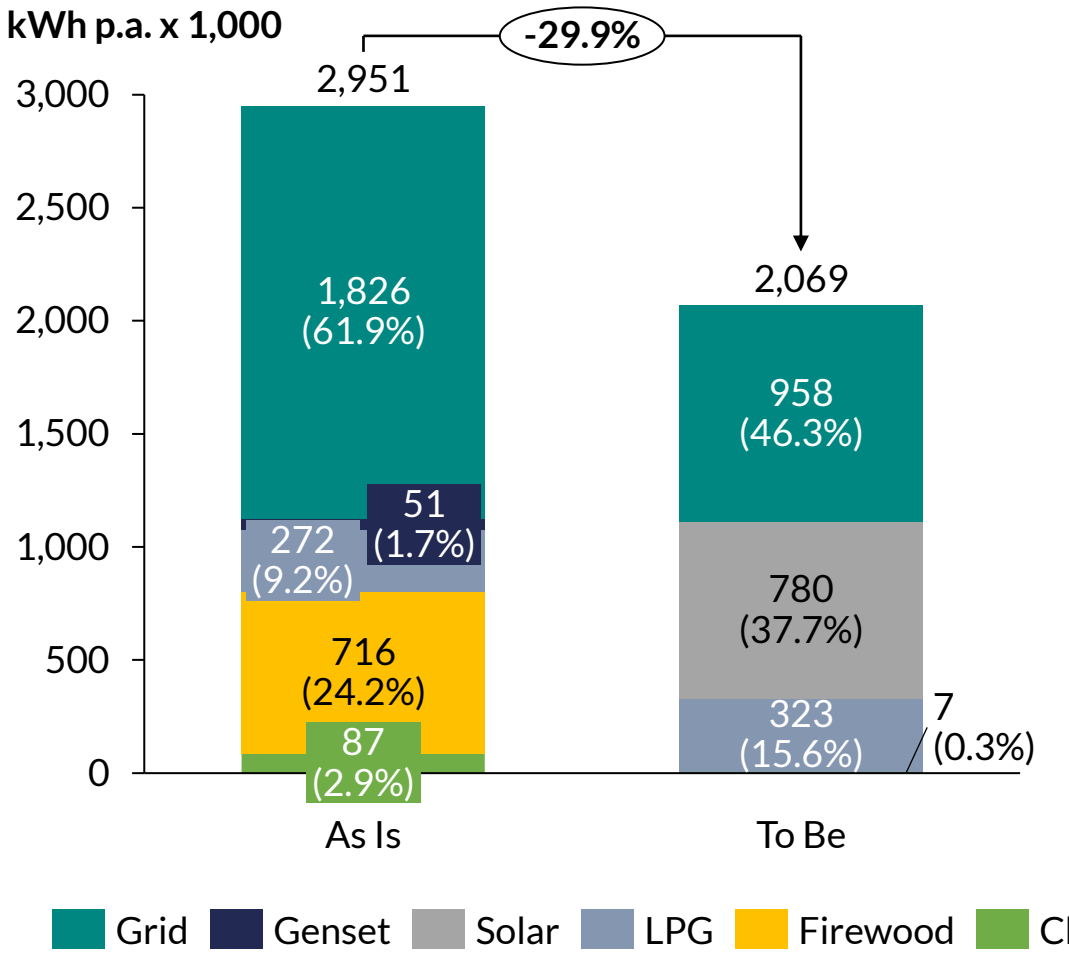
Solar System + Water Heating Design

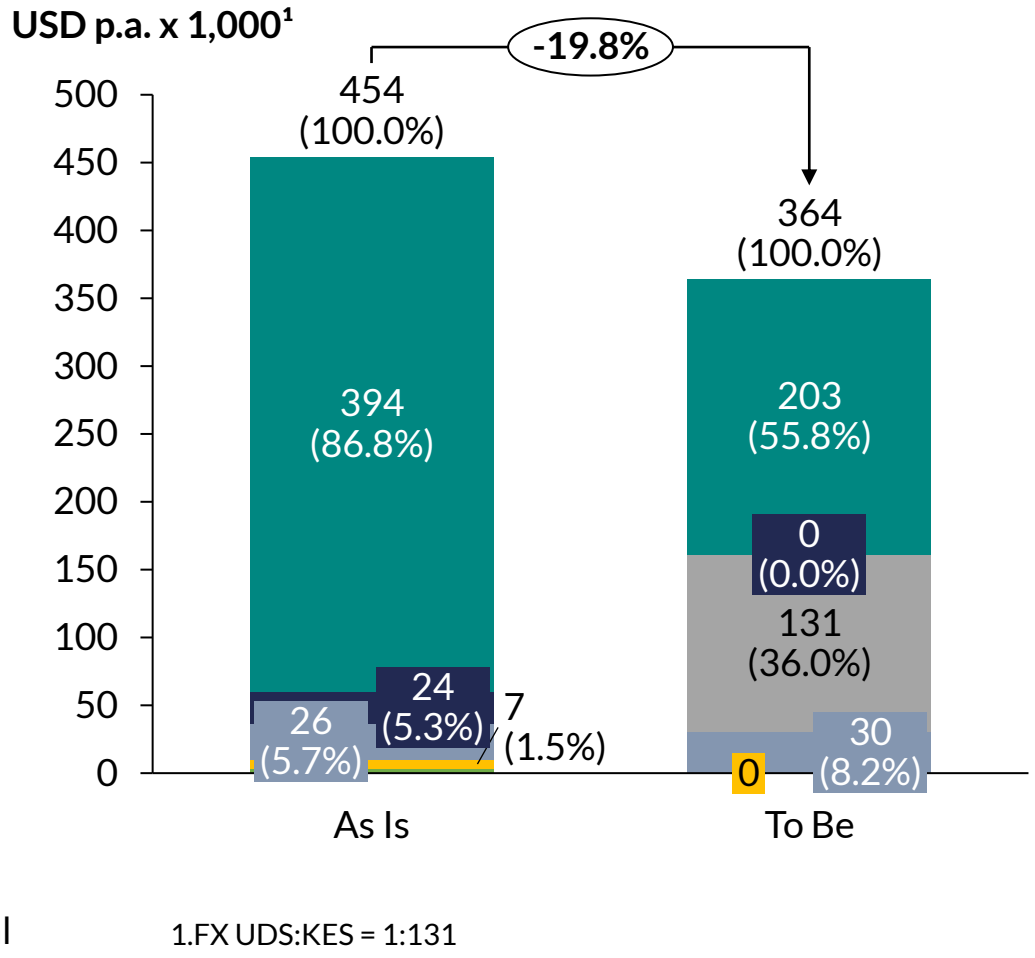
Hospital	Patients x 1,000	Observed Load in kWh x 1,000	Heat pump Load in kWh x 1,000	Battery Bank Size (Hours)	CAPEX (Million KES)	kWh p.a. x 1,000	kWh Daily	System Size AC in KW
JOOTRH	405	288	77	N/A	54	365	1,000	200
Kisumu	121	121	25	N/A	32	146	400	80
Kombewa	22	50	5	16	28	55	151	36
Ahero	36	58	13	16	34	71	195	48
Nyakach	17	36	10	16	27	46	126	36
Chulaimbo	19	25	12	18	20	37	101	24
Muhoroni	12	30	5	18	20	35	96	24
Rabuor	12	20	5	17	15	25	68	24

- ✓ Solar + battery for 6 smaller hospitals
- ✓ Grid-tie system for JOOTRH and Kisumu
- ✓ Significant investments on power infrastructure are needed to implement solar for all facilities
- ✓ Lifetime system 30 years
- ✓ Battery lifetime 10 years

As Is vs To Be Situation

Portfolio comparison 8 hospitals: 30% energy usage decrease p.a. vs a 20% cost decrease p.a.





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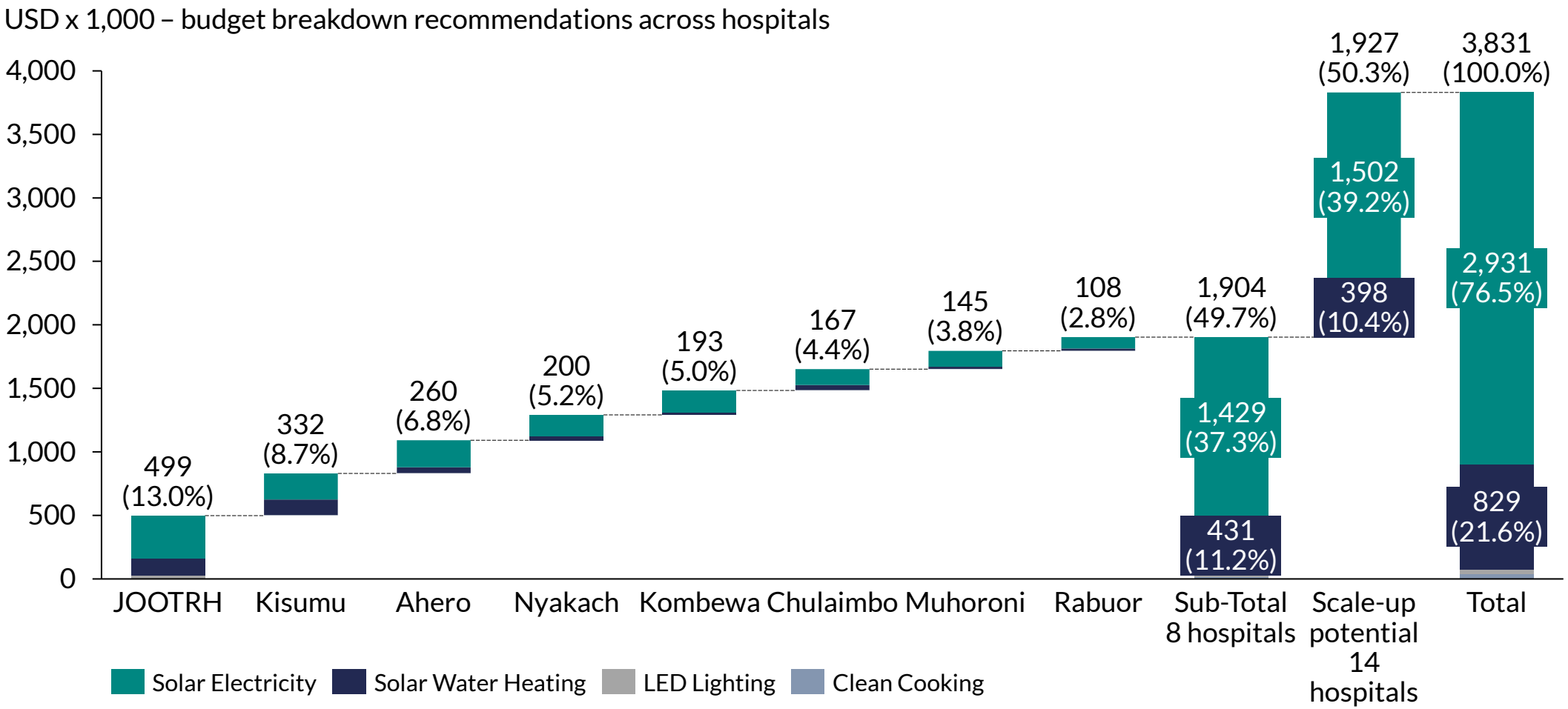
Business Case - Ticket size

Total ticket size for implementing all measures across 8 hospitals will be USD 1.9M CAPEX, for which 50% grant funding will be sought + USD 2.5M O&M over total lifetime to make the project viable

Scale up potential to 14 small hospitals with USD 1.9M CAPEX & USD 2.9M O&M



Business Case

Assumptions and results portfolio 8 hospitals (1/2)

Financial model assumptions (USD)	
CAPEX	
Solar system	1.4M
Water heating	0.4M
Lighting	0.28M
Clean cooking	0.16M
Total	1.9M
Contingency	25%
OPEX	
Lifetime solar system	30 years
Lifetime solar battery	10 years
Lifetime heat pumps	20 years
Annual O&M	2%

Financial model assumptions (USD)	
Total CAPEX	1.9M
Grant (50%)	0.95M
Loan	0.95M
Total annual OPEX	1.5M
Total maintenance reserve accounts	1M
Loan interest rate	5.98%
Loan tenor	10 years
Payback method	Annuity
FX Rate (USD : KES)	131
Inflation p.a.	2%
Annual county energy cost in USD (year 1)	340k
Project lifetime	30 years

Note: whilst a relatively high IRR could be achieved in theory considering the full 30-year cashflow profile of the project (with significant positive amounts in the last 10 years + factoring in yearly inflation as well), the payment capacity of the loan is conservatively sized at the as-is county instalments for year 1 of the project lifetime and needs to be repaid in 10 years. This conservative approach is needed to cushion for currency and payment risks which are difficult to factor in.

Business Case

Assumptions and results portfolio 8 hospitals (2/2)

Key impact results	
# of hospitals:	8 (scale up potential 22 to 60)
# of beds:	1,063
Total inpatients:	144k
Total outpatients:	500k
Total patients:	644k
Hours of power cut prevented:	No hard data recorded, but various interviews with hospital staff confirmed blackouts occur frequently and up to 16 hours a day
Carbon emission savings (kg CO2e):	871k

Results Energy Audit – Q4 2023

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Results Energy Audit Q4-2023 (As Is Situation)

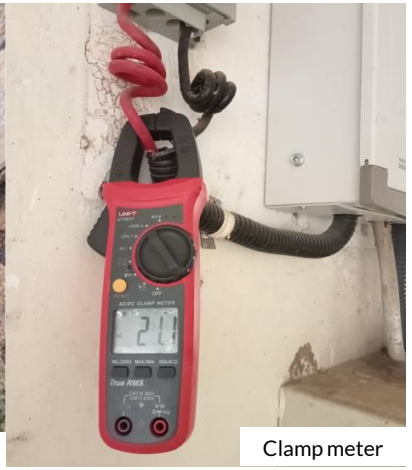
Methodology

Technical

- ✓ Data availability short-survey
- ✓ Initial site visit: including detailed walk-throughs at each of the 8 facilities
- ✓ Power logging; for in total 2 weeks at various facilities to design the (hybrid) solar PV systems
- ✓ Energy audit (update): including addition recommendations on energy management & power infrastructure
- ✓ BoQ and designs: of the (hybrid) solar PV systems

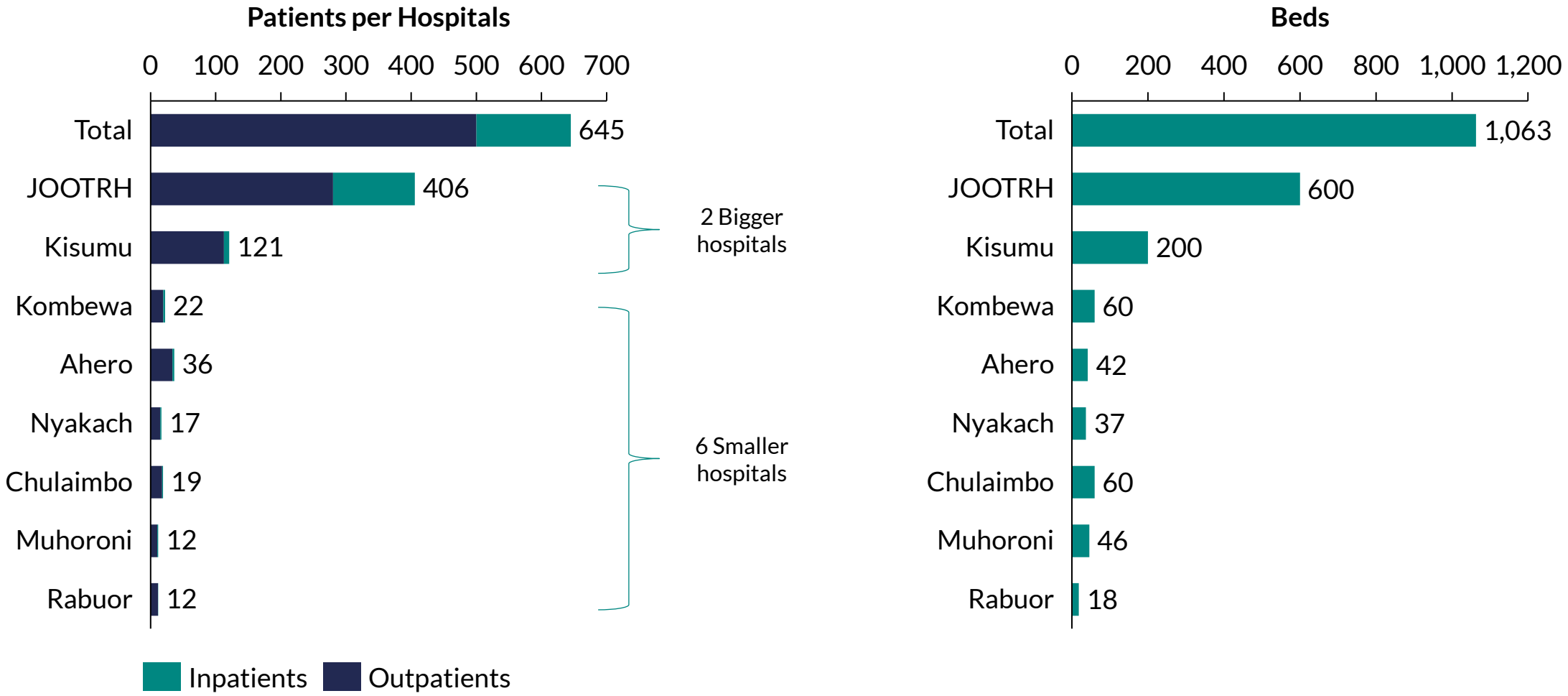
Air quality meter


Moisture content meter


Clamp meter

Results Energy Audit Q4-2023 (As Is Situation)

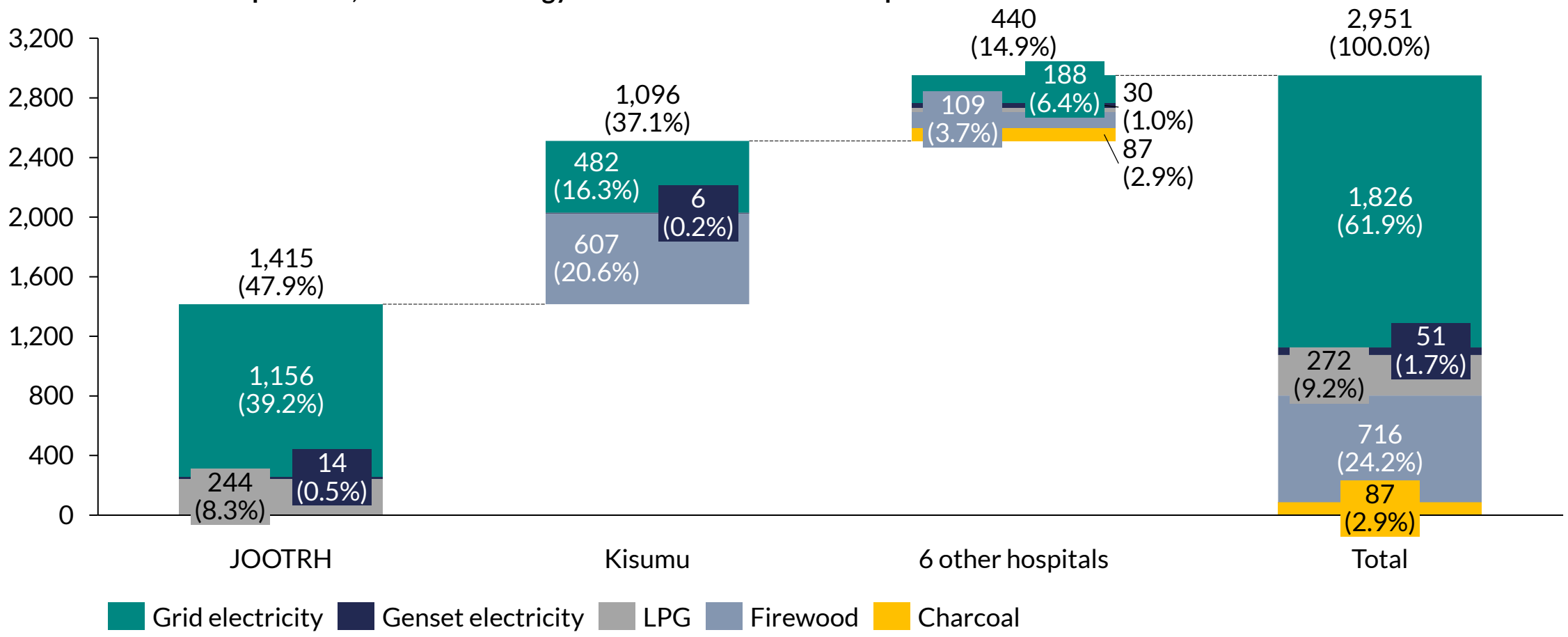
8 hospitals have been audited and included in the business case, the hospitals can be clustered in two clusters the bigger hospitals JOOTRH & Kisumu and 6 smaller hospitals



Results Energy Audit Q4-2023 (As Is Situation)

- ✓ JOOTRH and Kisumu account for most of the energy consumption with 85% across all hospitals
- ✓ Electricity accounts for most of the energy consumption with 63.6% across all hospitals

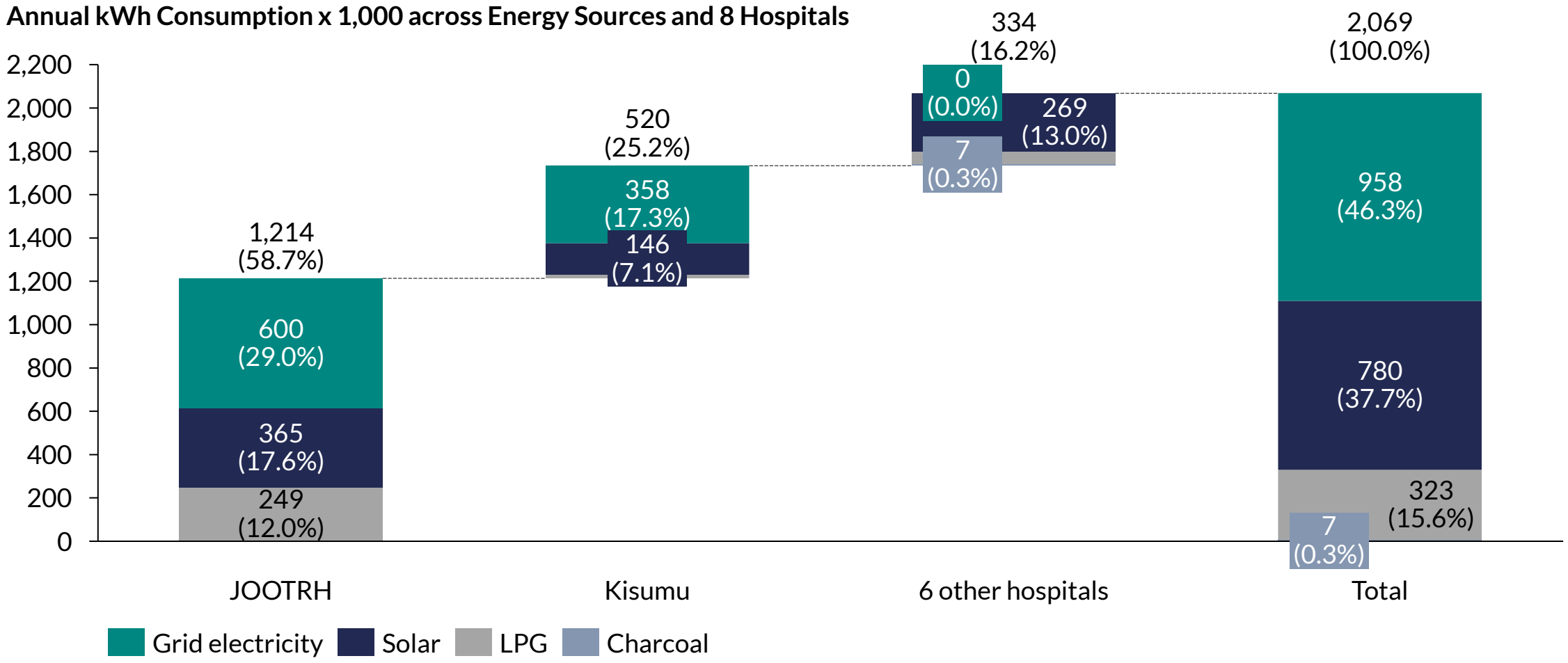
Annual kWh Consumption x 1,000 across Energy Sources and 8 Audited Hospitals



Results Energy Audit Q4-2023 (Projected)

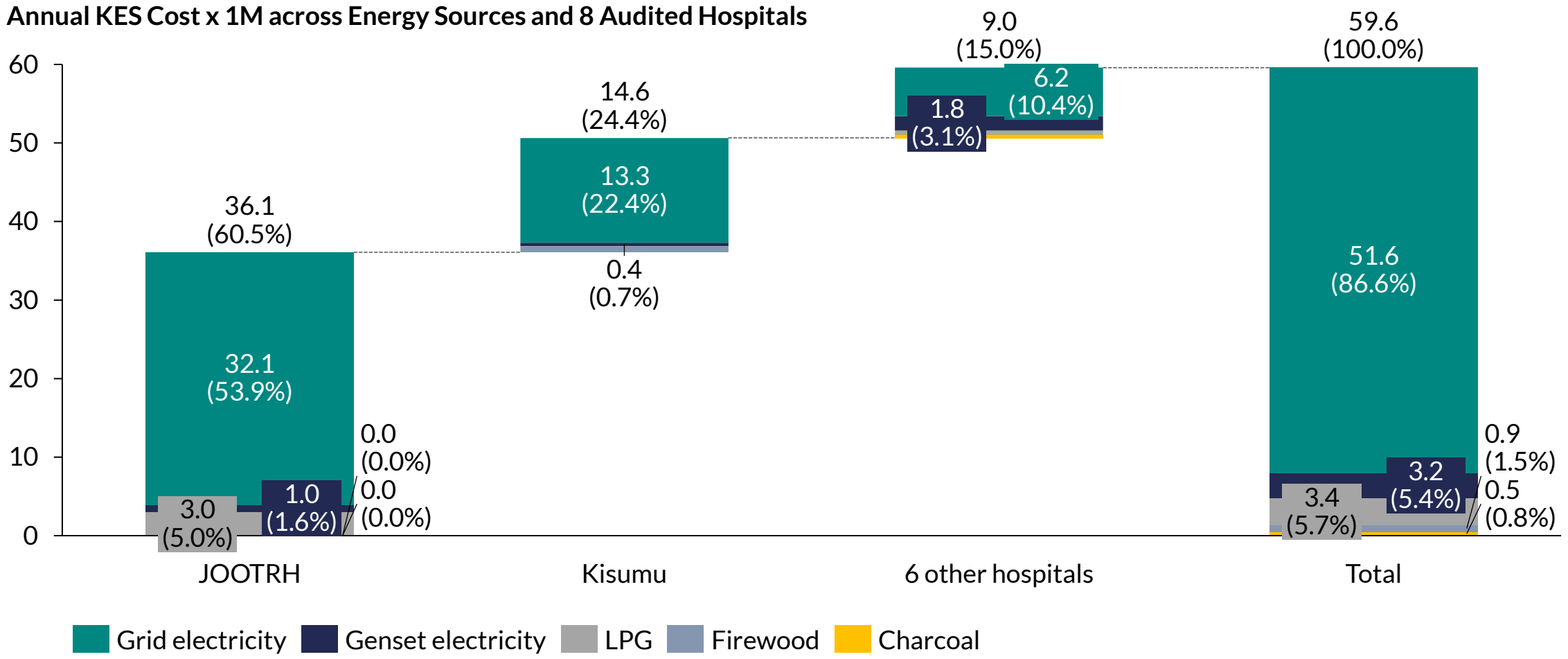
✓ JOOTRH and Kisumu account for most of the energy consumption with 84% across all hospitals

✓ Electricity accounts for most of the energy consumption with 84% across all hospitals



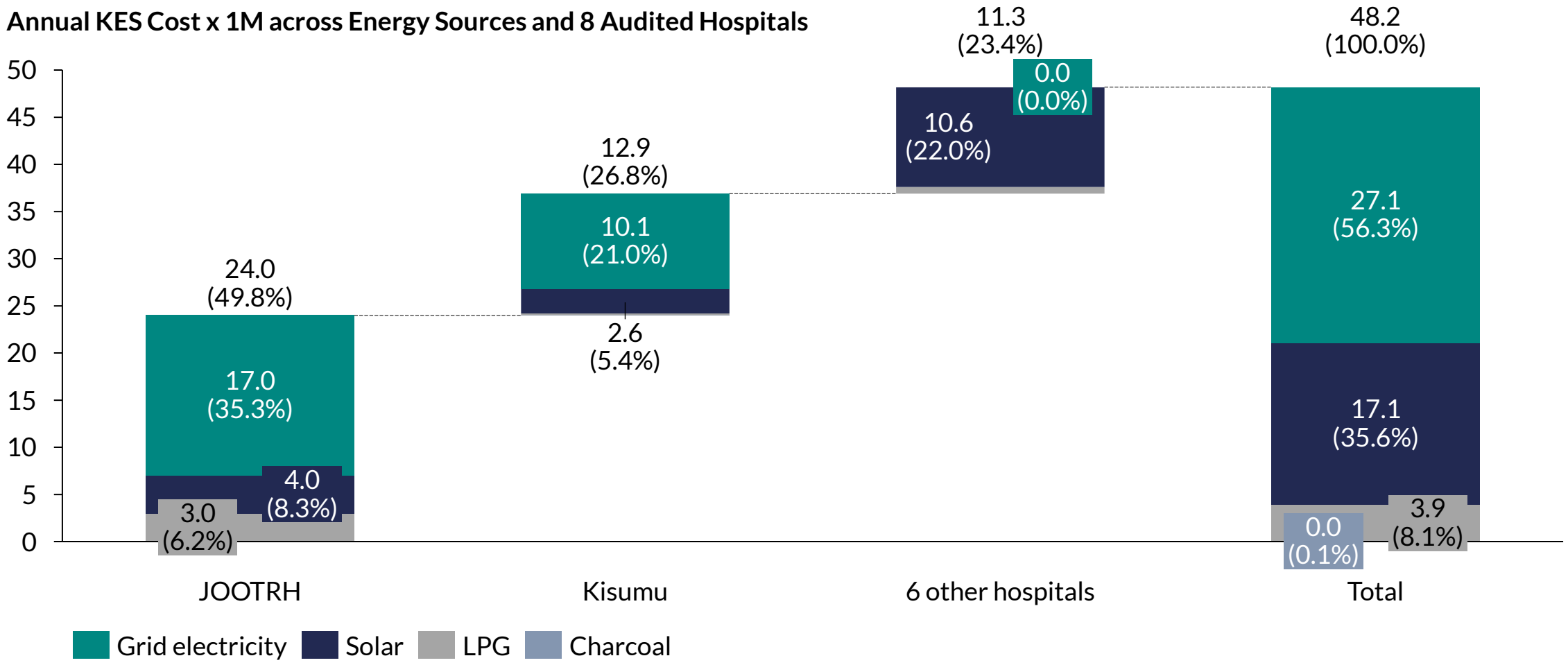
Results Energy Audit Q4-2023 (As Is Situation)

- ✓ JOOTRH and Kisumu account for most of the annual energy cost with 50.7M (85%) across all hospitals
- ✓ Electricity accounts for most of the annual energy cost with 54.8M (93%) across all hospitals



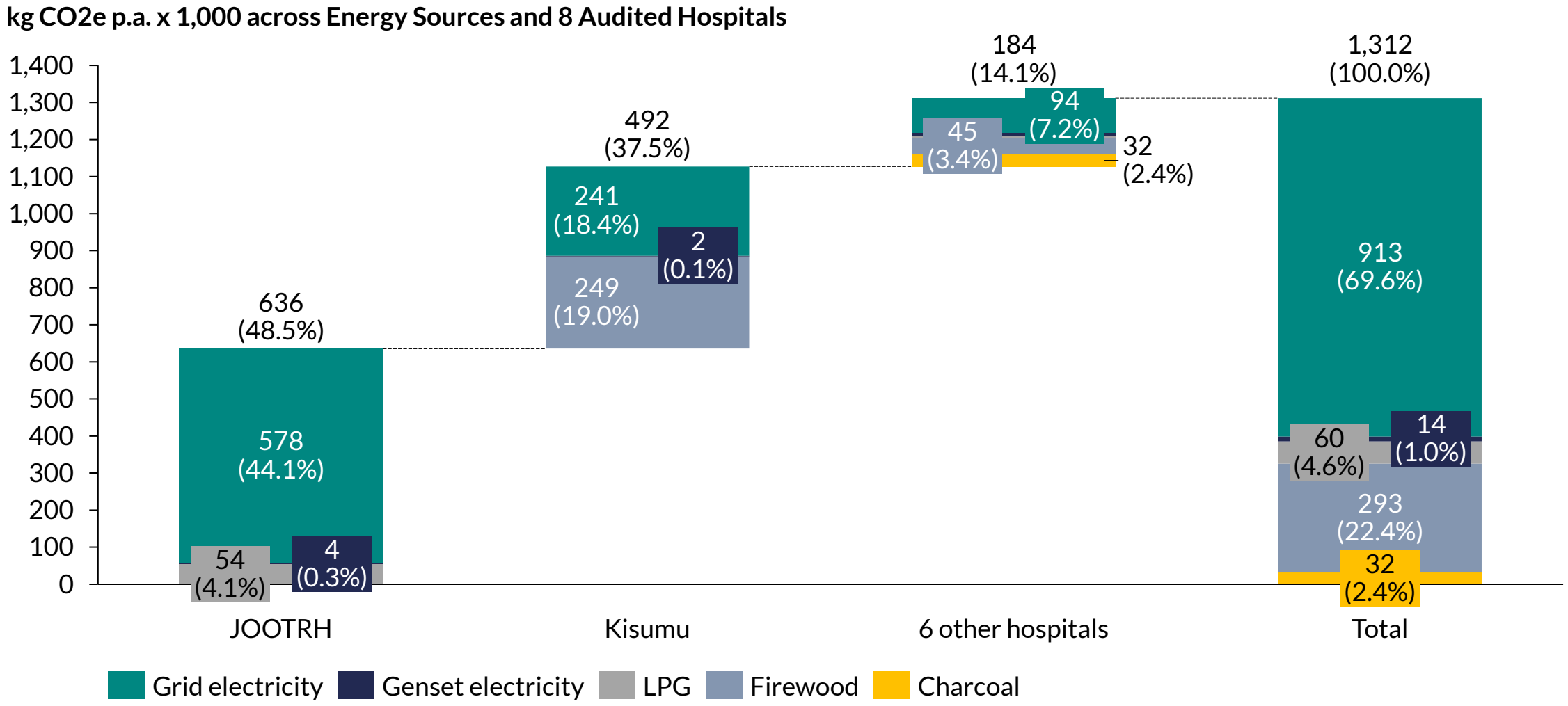
Results Energy Audit Q4-2023 (Projected)

- ✓ JOOTRH and Kisumu account for most of the annual energy cost with 36.9M (77%) across all hospitals
- ✓ Electricity accounts for most of the annual energy cost with 44.2M (92%) across all hospitals



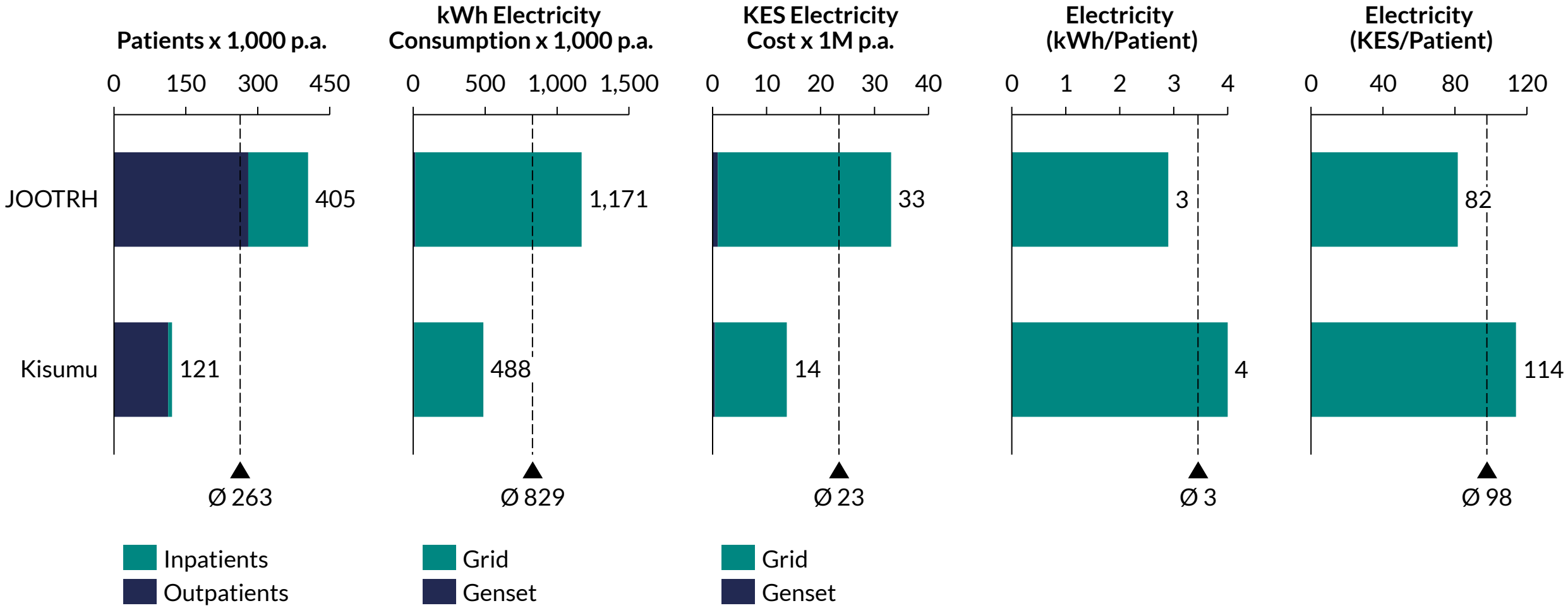
Results Energy Audit Q4-2023 (As Is Situation)

Biggest win in CO2 emissions reduction can be found in clean cooking by phasing out firewood



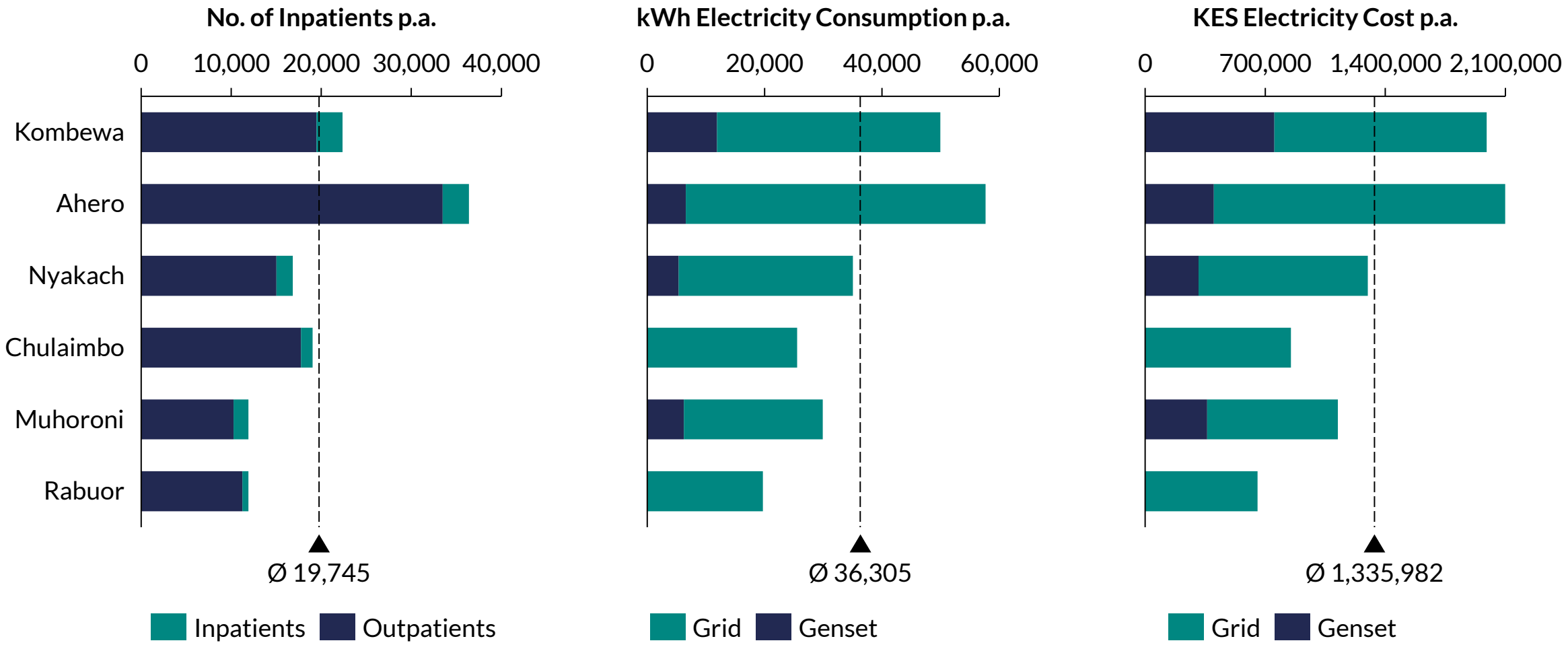
Results Energy Audit Q4-2023 (As Is Situation)

JOOTRH is ~3 times as big as Kisumu in terms of patients and electricity consumption, both hospitals are in an area with a reliable grid connection, resulting in almost zero genset consumption (1%)



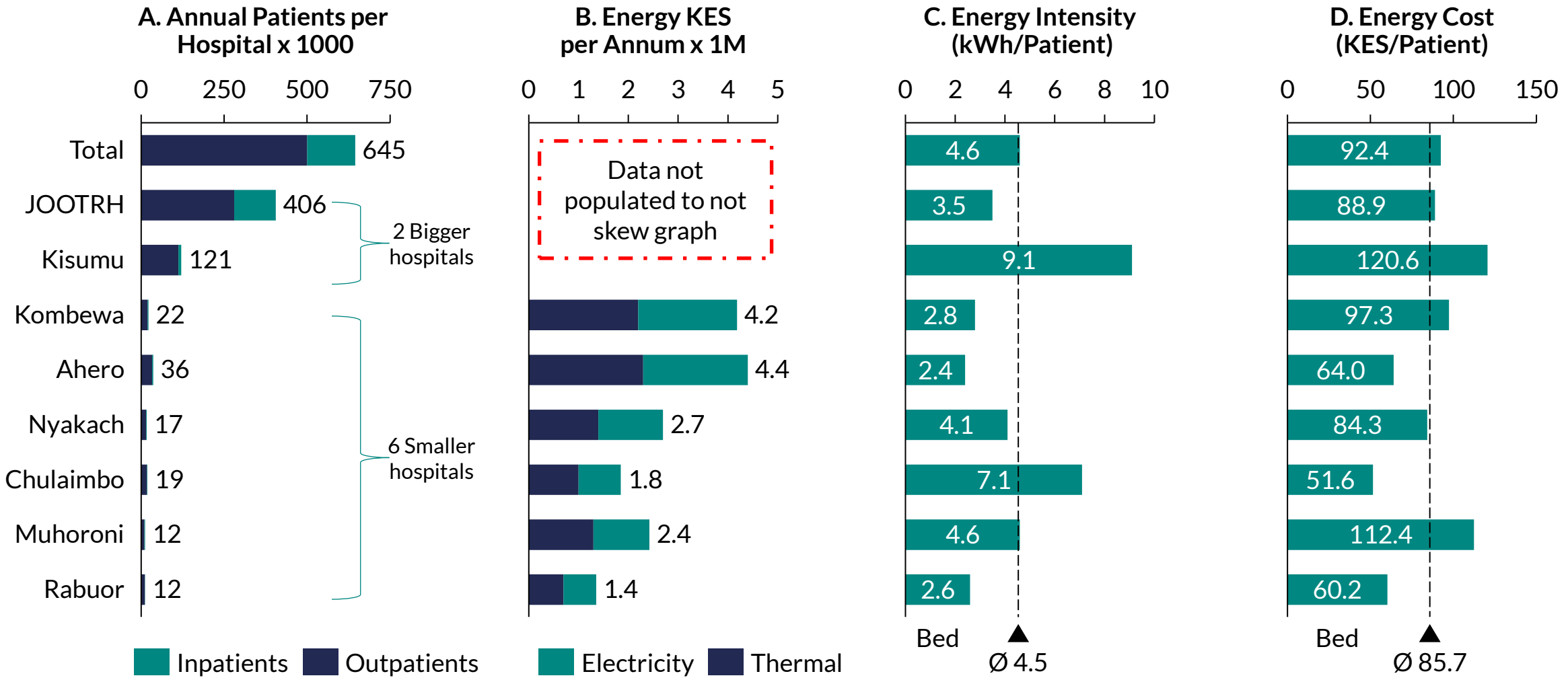
Results Energy Audit Q4-2023 (As Is Situation)

The 6 smaller hospitals have similar electricity consumption patterns in line with number of patients
All 6 hospitals have severe issues with grid reliability resulting in blackouts of up to 16 hours per day



Results Energy Audit Q4-2023 (As Is Situation)

Energy metrics comparison



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