The Cambridge-MIT Institute Electricity Project

Reforming the electricity industry in East Africa

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CMIEP Autumn Seminar

Cambridge, 6 November 2004

http:// www.econ.cam.ac.uk/electricity

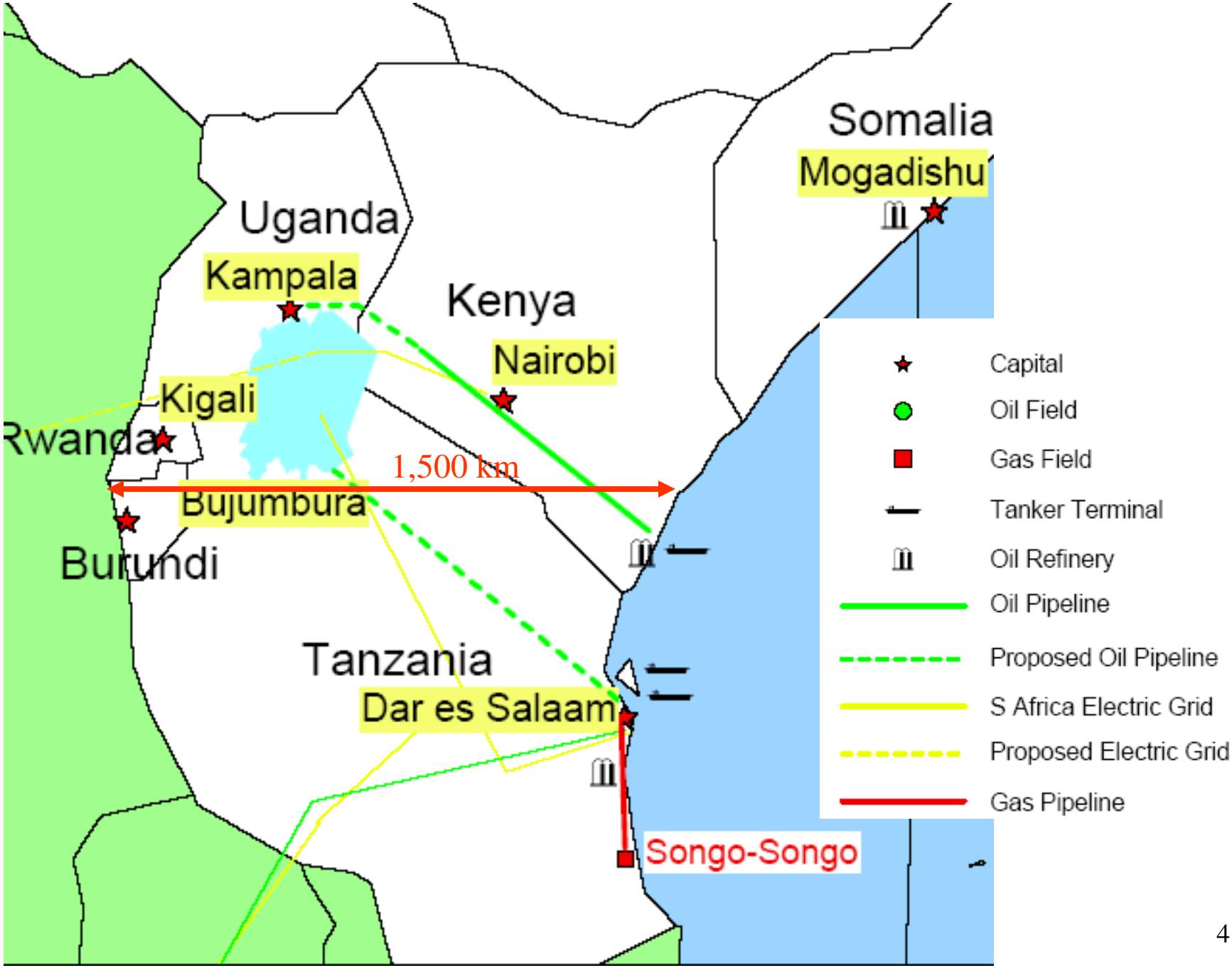
Africa: the Dark Continent

Source: Eskom

Uganda 5%; Kenya 15% electrification

Uganda and Kenya

- visit with World Bank Aug/Sep 2004
- both countries reforming ESI
  - Uganda fully unbundled, concessioned
  - Kenya partly unbundled, mixed
- low electrification, variable costly power, poor interconnections, past inefficiencies, corruption
- lost decades: Uganda civil war, Kenya stagnates
- private management as possible cure?


Somalia
Mogadishu
Uganda
Kampala
Kenya
Nairobi
Kigali
Rwanda
1,500 km
Bujumbura
Burundi
Tanzania
Dar es Salaam
Songo-Songo
Capital
Oil Field
Gas Field
Tanker Terminal
Oil Refinery
Oil Pipeline
Proposed Oil Pipeline
S Africa Electric Grid
Proposed Electric Grid
Gas Pipeline

Existing grids

Long, fragile
low voltage

Source:
Acres: EAPMP

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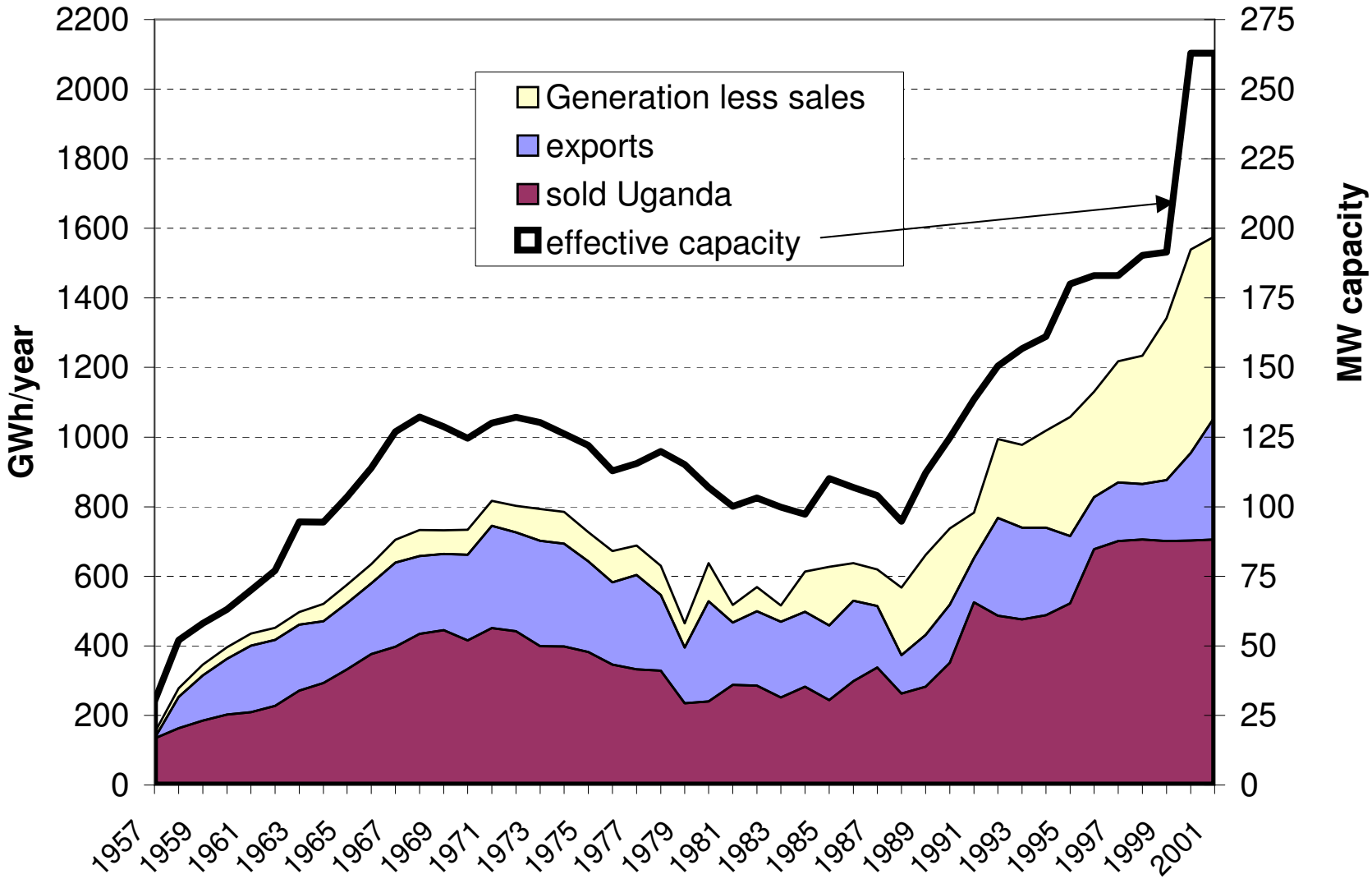
Generation in Uganda 1957-2001



Uganda: history

- Amin coup 1971, GDP collapses
  - capacity deteriorates from 150 MW to 100 MW
  - prices peak 19 cents (1979), losses to 41%
  - corruption: a cancer in ESI
- 1986 Museveni starts recovery
  - FDI returns, growth resumes, capacity needed
- 1994: IPP dam? Implausible without reforms
  - UEB proposes SB with IFI-financed dam
  - 1999: cabinet goes for unbundling, privatisation


SUDAN
Kinyeti
Moyo
Atiak
Albert Nile
Gulu
Moroto
DEMOCRATIC REPUBLIC OF THE CONGO
Kabalega Falls
UGANDA
Lake Albert
GREAT RIFT VALLEY
Soroti
KENYA
Lake Kyoga
Mbale
Mt. Elgon
Bujagali
Victoria Nile
Margherita Peak
KAMPALA
Jinja
Entebbe
Nalubaale (Owen Falls)
Lake George
Lake Edward
Mbarara
Lake Victoria
TANZANIA
RWANDA

Uganda: generation sources

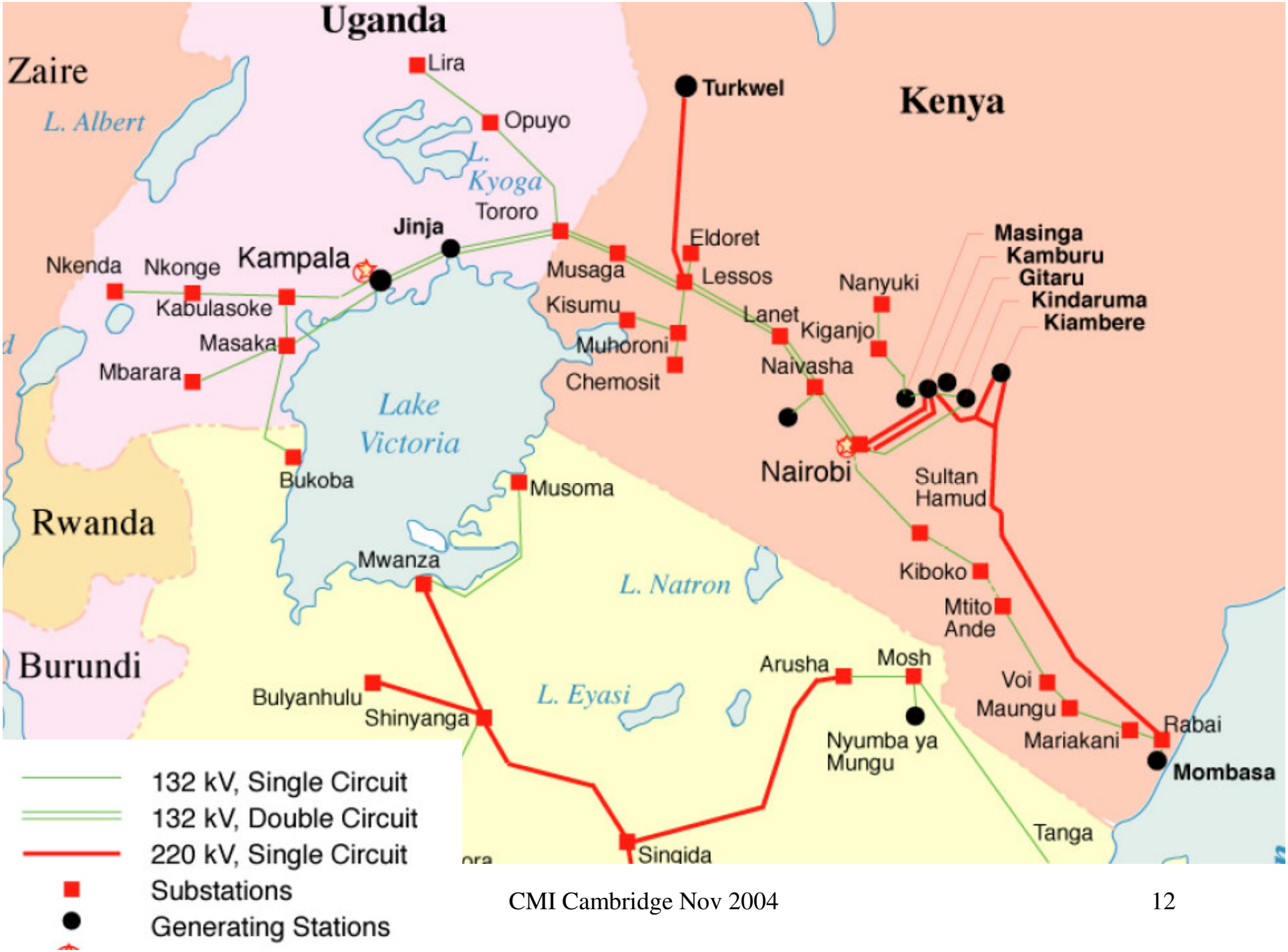
- 285 MW capacity at Nile Source
  - almost run-of-river, output varies with Lake level, October 2004 at 220 MW
  - 2004: peak demand 350 MW, daily load shedding
  - ~100 MW (?) private thermal back-up
- Nile potential: 2,000 - 2,800 MW
- Next choice - Bujagali: 200-250 MW
  - 1998 AES signs PPA with UEB and GoU

Uganda restructuring

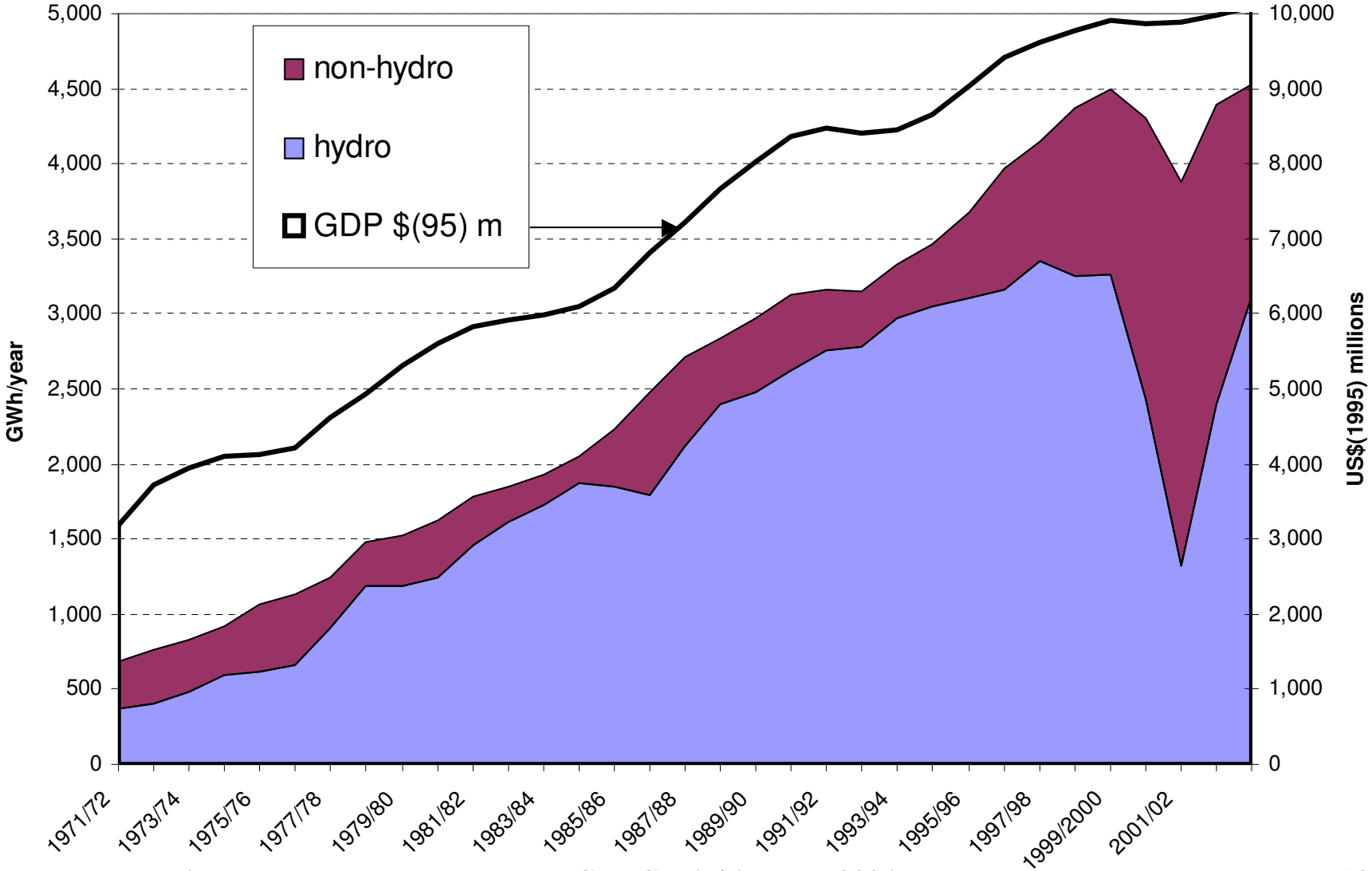
- Electricity Act 1999 unbundles UEB into
  - UEGCL, UEDCL, UETCL (G,D &T) 2001
  - UEGCL: 20 yr concession to Eskom 2003
  - UEDCL: 20 yr concession to Eskom/Globaleq '04
  - T: UETCL 2001 SOE, holds PPAs, exports,
  - Electricity Regulatory Authority
    - issues, modifies licenses, establishes & approves tariffs
    - 2004 Gen capacity fee = $5.4/MW/hr = $47/kW/year
    - domestic tariff 9c/kWh + 52 c/month
    - large industrial: peak = 4c/kWh + $10/month

Pricing and investment

- hydro costly, lumpy $1,400-2,000/kW
  - interest cost (10%, LF:75%) = 2.1-3 cents/kWh
  - op. cost = 0, or export value, or VUE (71 c/kWh)
  - peak demand evenings: voting households
  - transmission expensive ($120 m for Bujagali)
- weak interconnection to Kenya: 50-80MW
  - Kenya has storage hydro
  - strengthen link as part of hydro expansion plan
  - but expensive ~ $500/kW?


Uganda
Zaire
Kenya
Rwanda
Burundi
L. Albert
L. Kyoga
Lake Victoria
L. Natron
L. Eyasi
Lira
Opuyo
Turkwel
Tororo
Jinja
Kampala
Nkenda
Nkonge
Kabulasoke
Masaka
Mbarara
Bukoba
Musoma
Mwanza
Bulyanhulu
Shinyanga
Singida
Musaga
Kisumu
Muhoroni
Chemosit
Eldoret
Lessos
Lanet
Naivasha
Nairobi
Nanyuki
Kiganjo
Masinga
Kamburu
Gitaru
Kindaruma
Kiambere
Sultan Hamud
Kiboko
Mtito Ande
Arusha
Mosh
Nyumba ya Mungu
Voi
Maungu
Mariakani
Rabai
Mombasa
Tanga
132 kV, Single Circuit
132 kV, Double Circuit
220 kV, Single Circuit
Substations
Generating Stations

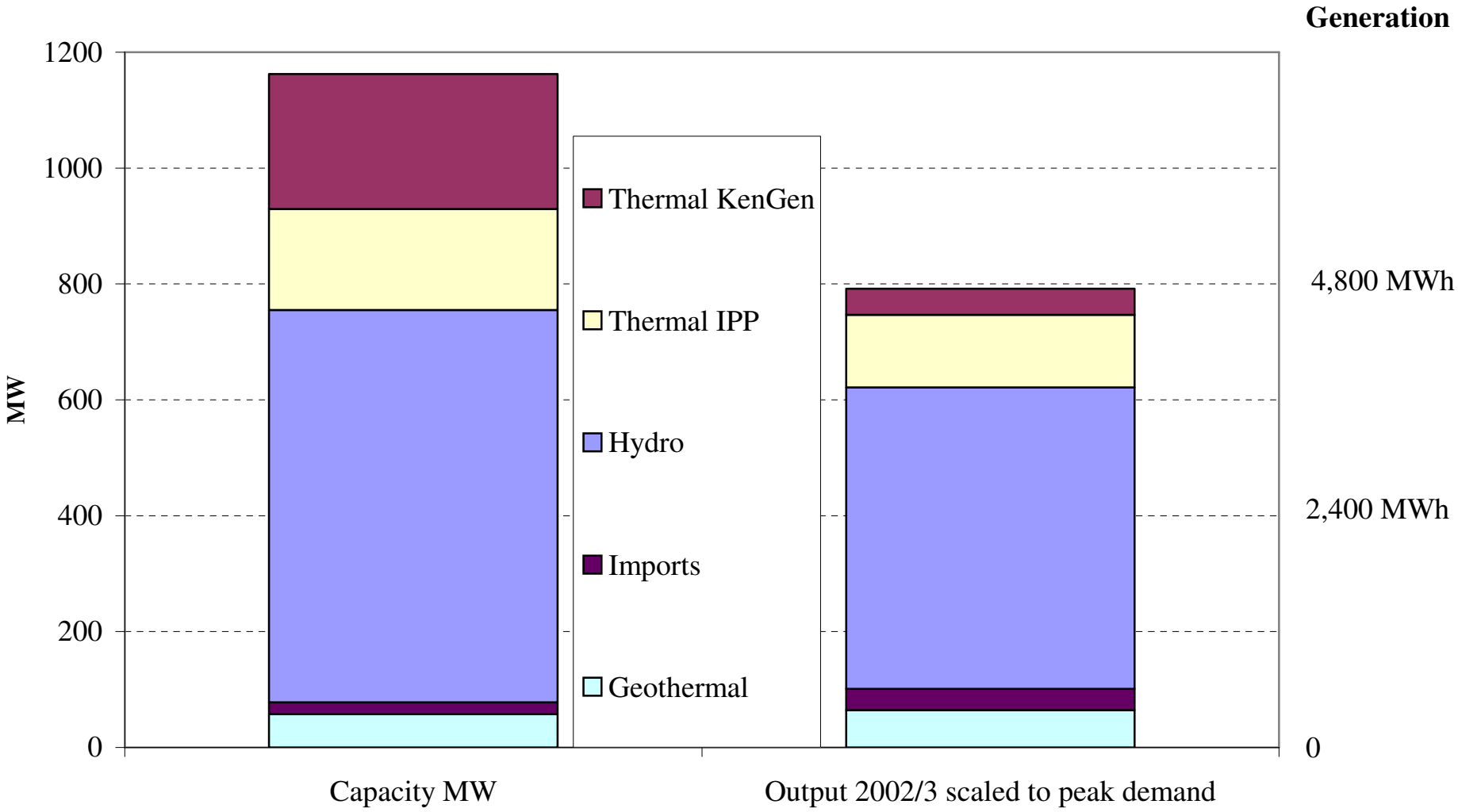
Kenya electricity production



Kenya: brief history

- KPLC as SB, SO,T&D; various G authorities
  - 1994-5 EdF advises separating commercial from regulatory functions
  - Tariffs < 30% LRMC, WB presses to raise
- Electric Power Act 1997 unbundles G, allows IPPs
  - expensive IPP PPAs signed 1998
  - 2004 barge mounted plant towed off
- 1997 KenGen established
- 1998 ERB established “not independent”
  - responsible for merit order
- 2001 drought, emergency G leased, KPLC losses

Kenya capacity and output

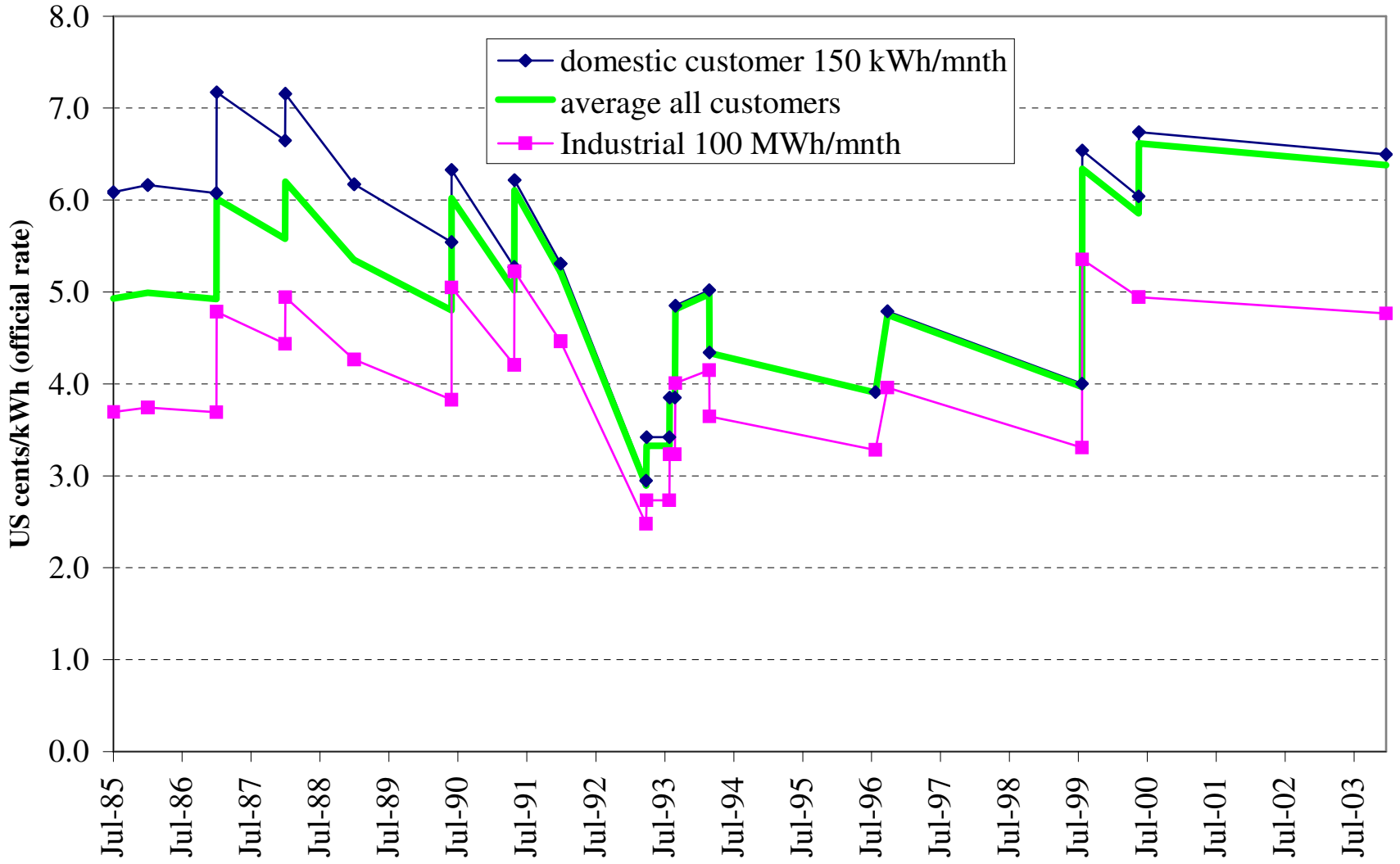


Kenya: generation options

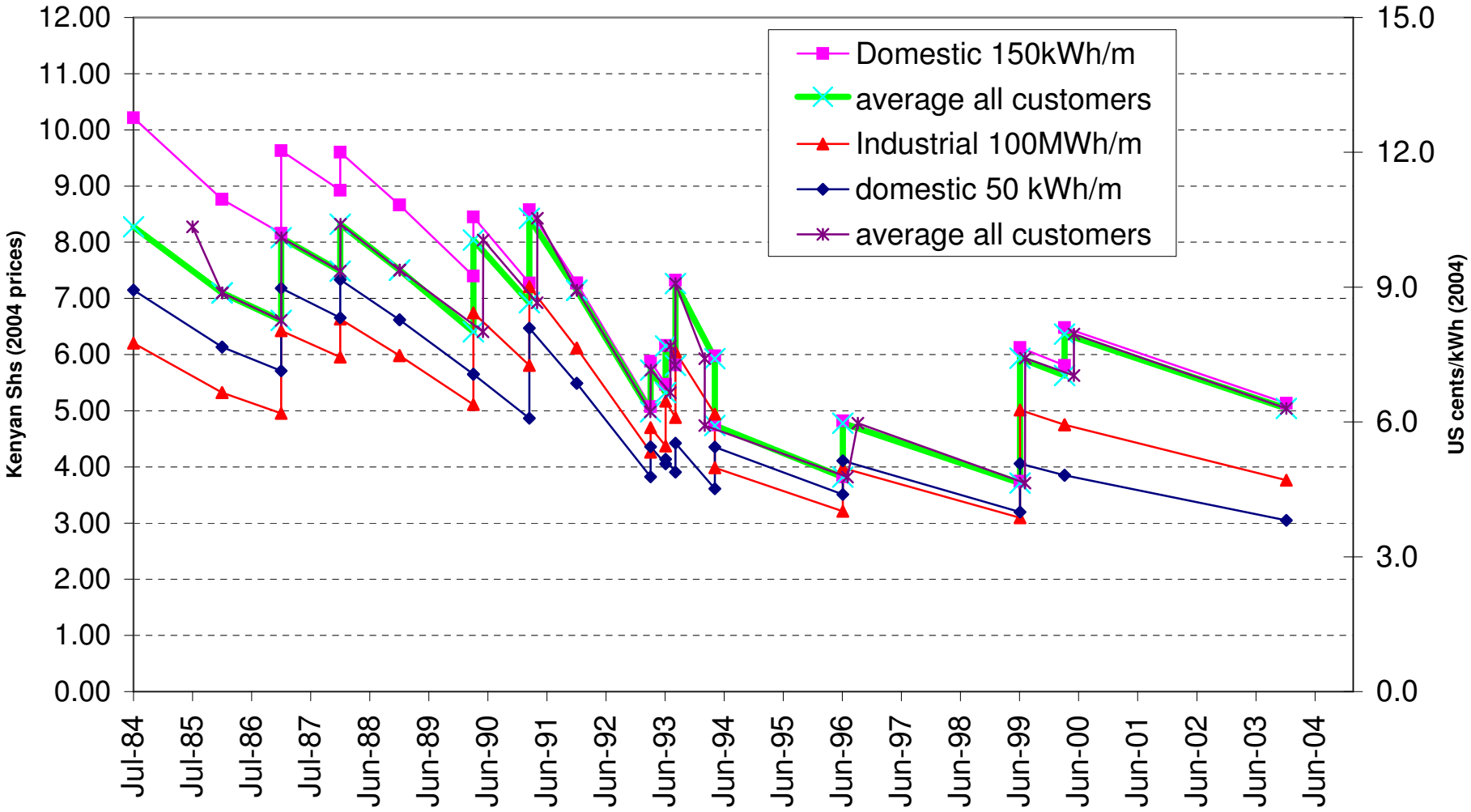
- peak demand 833 MW, supply 1121 MW
- dominated by hydro, some storage (months)
  - little left unexploited, remainder expensive
- geothermal costs $3000/kW = $73/MWh
- thermal $70-90/MWh (MS diesel cheapest)
- IPPs: capacity payments:
  - $213/kW OCGT; $305 MSD; $502 geothermal

  + (high) variable fuel cost

Kenya: average nominal electricity costs US cents/kWh



Kenya: real average tariffs



Where next?

- New Energy Act due 2004 to establish:
  - independent regulator, State Geothermal co. sells steam
  - IPO of 30% of KenGen
  - Rural Electrification Agency
  - Unbundle T from KPLC, eligible customers
- Still need a BST and sensible tariff
- Better trading with Uganda
- Medium speed diesels least cost?
  - Lends itself to IPPs
  - Could KenGen do it cheaper?

East Africa Co-operation?

- East Africa Federation
  - collapsed acrimoniously after independence
  - East African Community restored 2000
  - develops EA Power Master Plan Study 2004
- Uganda: run-of-river hydro
- Kenya: some storage hydro, geothermal
- Tanzania: gas, potential access to SA
- but transmission weak, distances long

Existing and planned inter-connectors

Source:

Acres EAPMP

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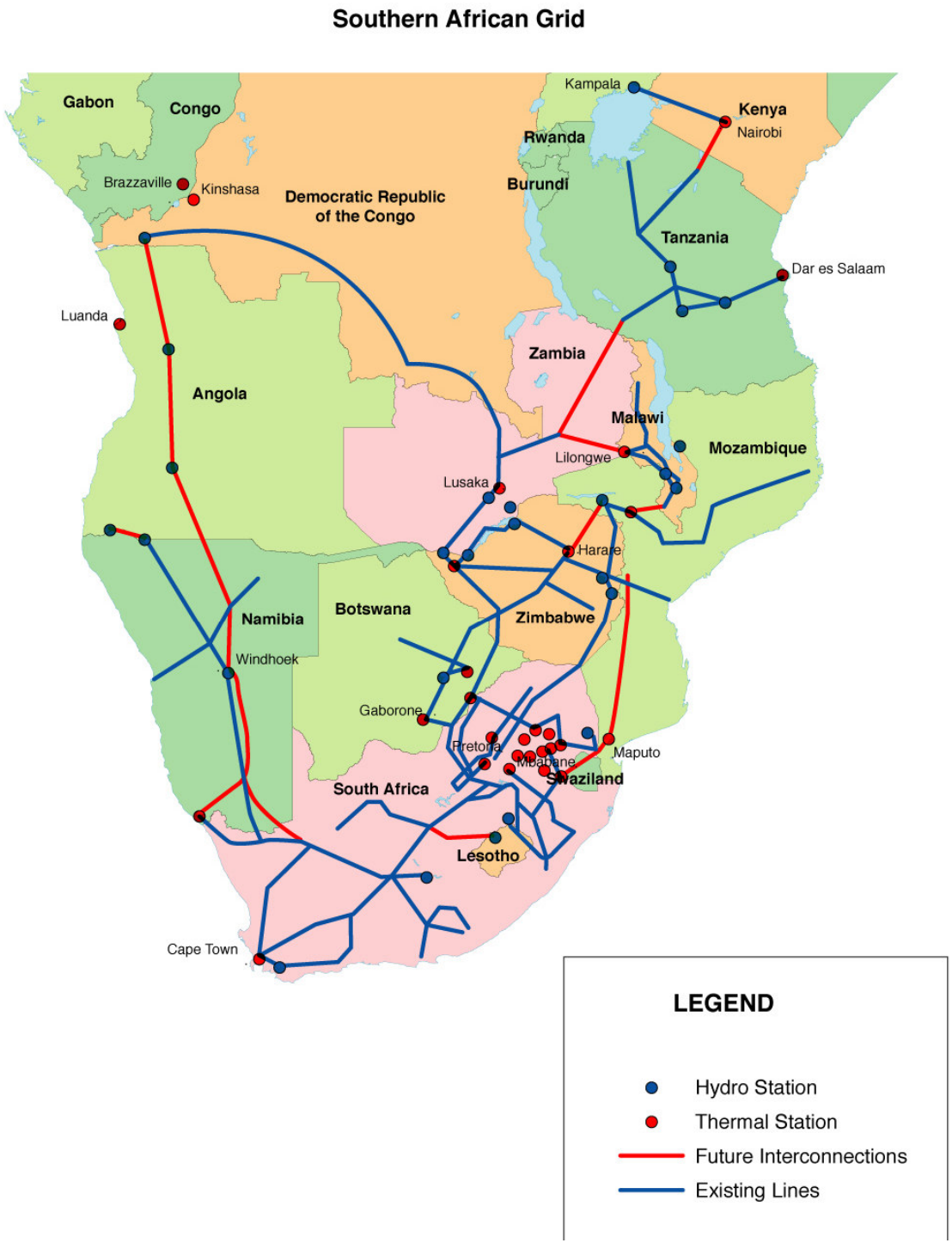

Alternative links

100 MW

200 MW

Source:
Acres EAPMP

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East Africa Power Master Plan

- Least cost expansion plan for region 2003-4
- aim at 220+ kV
- Upgrade Uganda-Kenya to support Bujagali
  - interconnector for increments in capacity (200MW)
- connect Arusha-Nairobi
  - GoK and GoT jointly finance study
- EA Power Pool until integrate with SAPP
  - needs Govt MOU, coordination, control, settlement

Rural electrification

- very expensive, very low demand (50 kWh/m)
  - quite high solar panel penetration
  - no tradition of cooperatives as in Asia, US,
- commercial use to justify local distribution
- bids for best value capital subsidy

– tariff needs to cover running cost

- Output-based aid promising (Mozambique)
- Uganda ahead of Kenya with REB

What do we learn?

- At independence vertically integrated ESIs OK (?)
- corruption undermined management, investment
- hydro, geothermal hard to sell to private investors
- IPPs and private finance costly
  - separate building/drilling from concession to operate?
- Management contract works well in Tanzania
  - is it sustainable? Or only if it evolves into a concession?
- Concession for D and G looks promising
  - takes care, time to negotiate, few potential players
- Donor financing still needed?

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Acronyms - 1

BST: Bulk supply tariff

D, G, T: distribution, generation, transmission

EAPMP: **East Africa** Power Master Plan

ERB: Electricity Regulatory Board (Kenya)

ESI: electricity supply industry

GoK, GoU: Govt of Kenya, Uganda

IFI: International Financial Institution

IPP: independent power producer

KPLC: Kenya Power and Light Company

LF: load factor

Acronyms - 2

MOU: Memorandum of Understanding

MSD: Medium speed diesel

PPA: Power Purchase Agreement

OCGT: open cycle gas turbine (can run on jet fuel)

SB: Single Buyer

SO: System Operator

REB: Rural Electrification Board

SAPP: **South Africa** Power Pool

UEB: Uganda Electricity Board

VUE: value of unserved energy