

Global Electrification: Trends and Challenges

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What is Electrification?

At least three definitions:

1. Access to Power
2. Use of Power
3. Pervasiveness of Electricity in the Economy

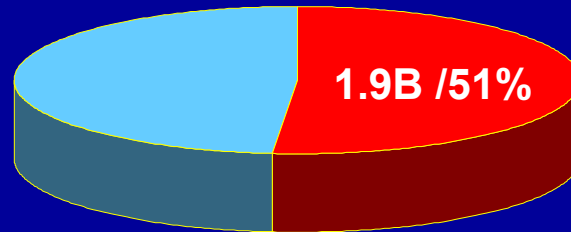
I will focus on #1 and #2.

This talk: three points

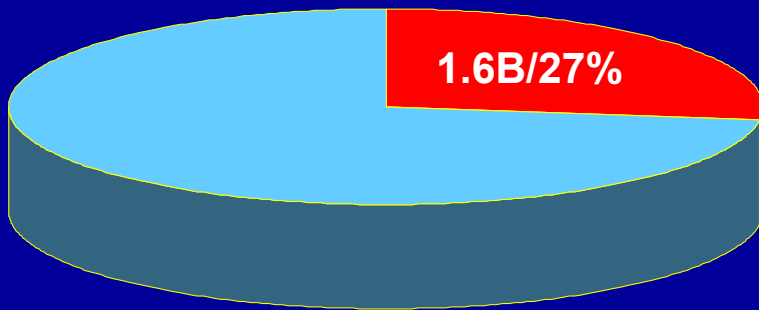
- Broad Patterns in Electrification
 - Global, Regional, National & Household
- Evidence on the Causes and Consequences of Electrification
- Industrial Organization & Electricity Policy

1. Broad Patterns in Electrification

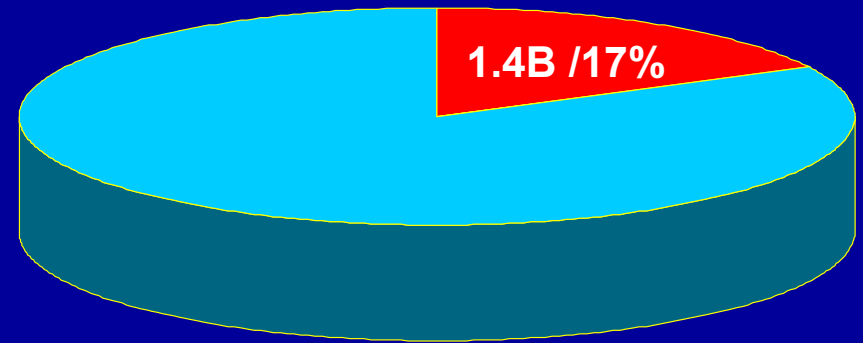
Global Access to Electricity – 1970 to 2030



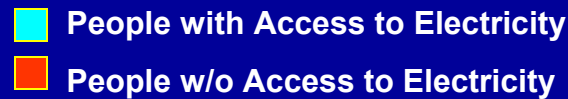
1970 – Total population 3.7B



2000 – Total population 6B

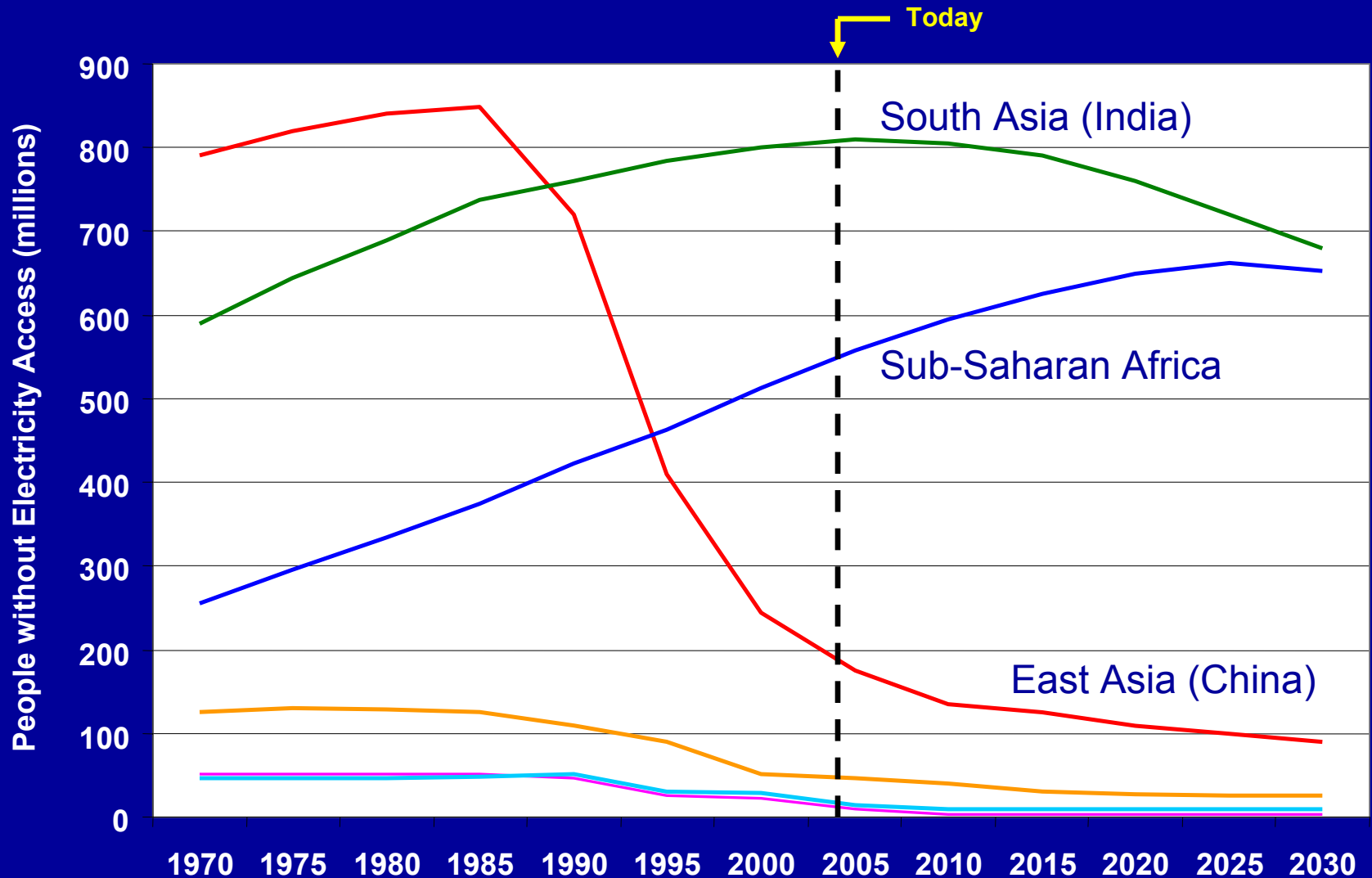


2030 – Total population 8.2B



Source: *World Energy Outlook 2002, IEA*

Regional Electricity Access: Limits



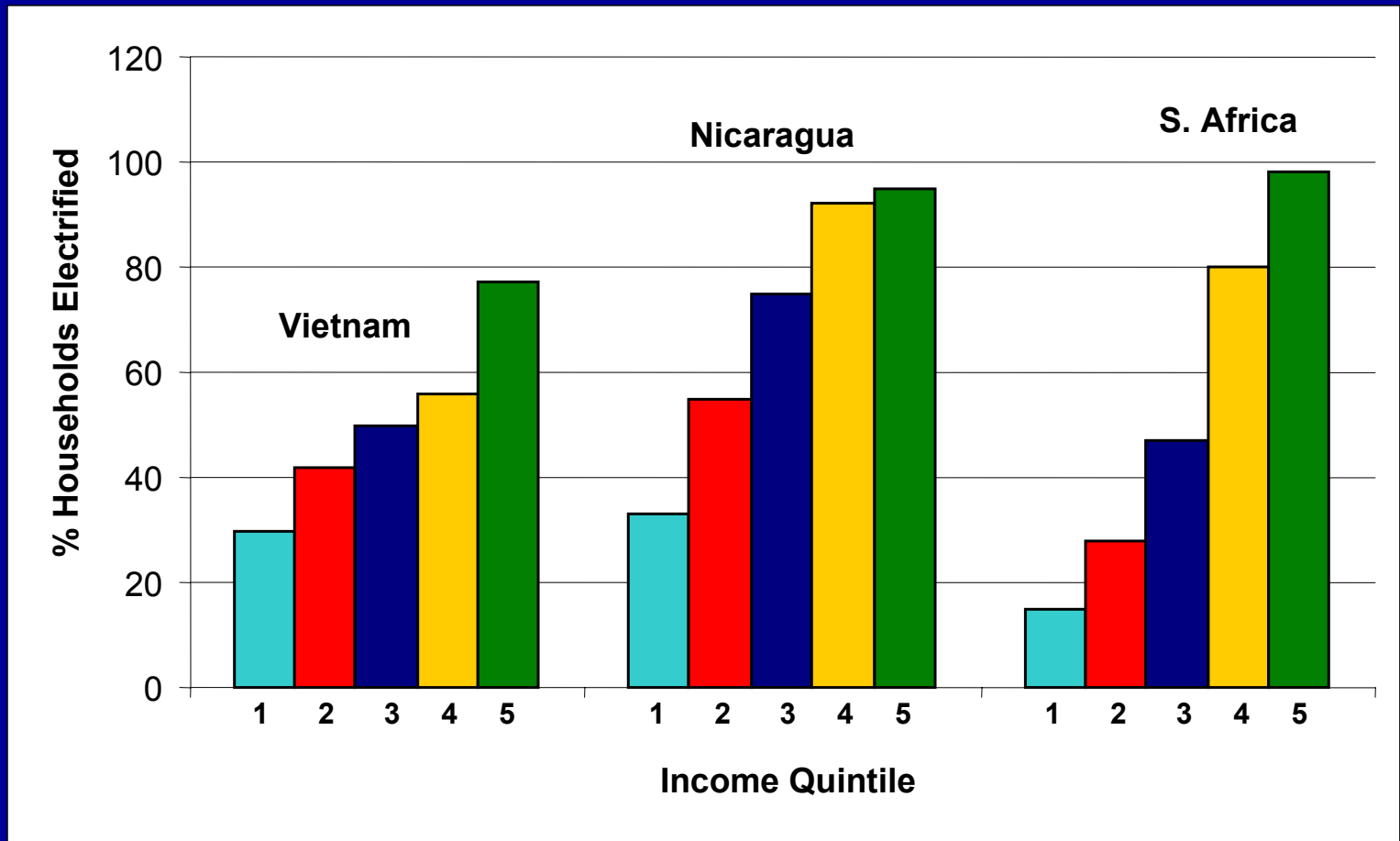
Source: International Energy Agency, WEO 2002

% Electrified, Southern Africa (1999): The Rural-Urban Divide

Country	Urban	Rural
Botswana	26	2
Lesotho	14	4
Malawi	11	<1
Mozambique	17	<1
Namibia	26	5
South Africa	80	46
Swaziland	42	2
Tanzania	13	1
Zambia	18	1
Zimbabwe	65	<1

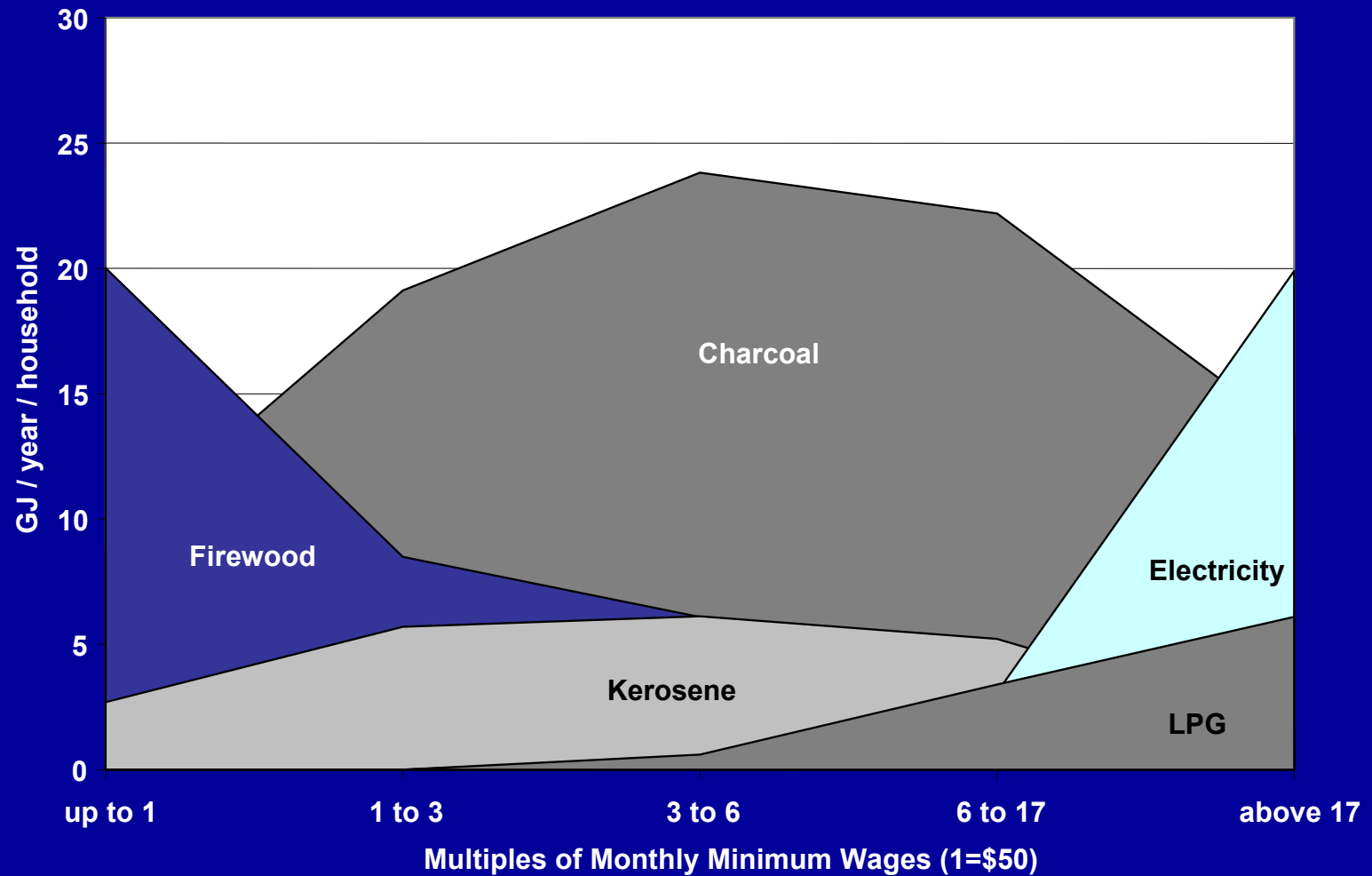
Source: Gaunt, Load Research Programme, Energy Research Centre - Cape Town South Africa,

% Households Electrified by Income Quintile (1988)



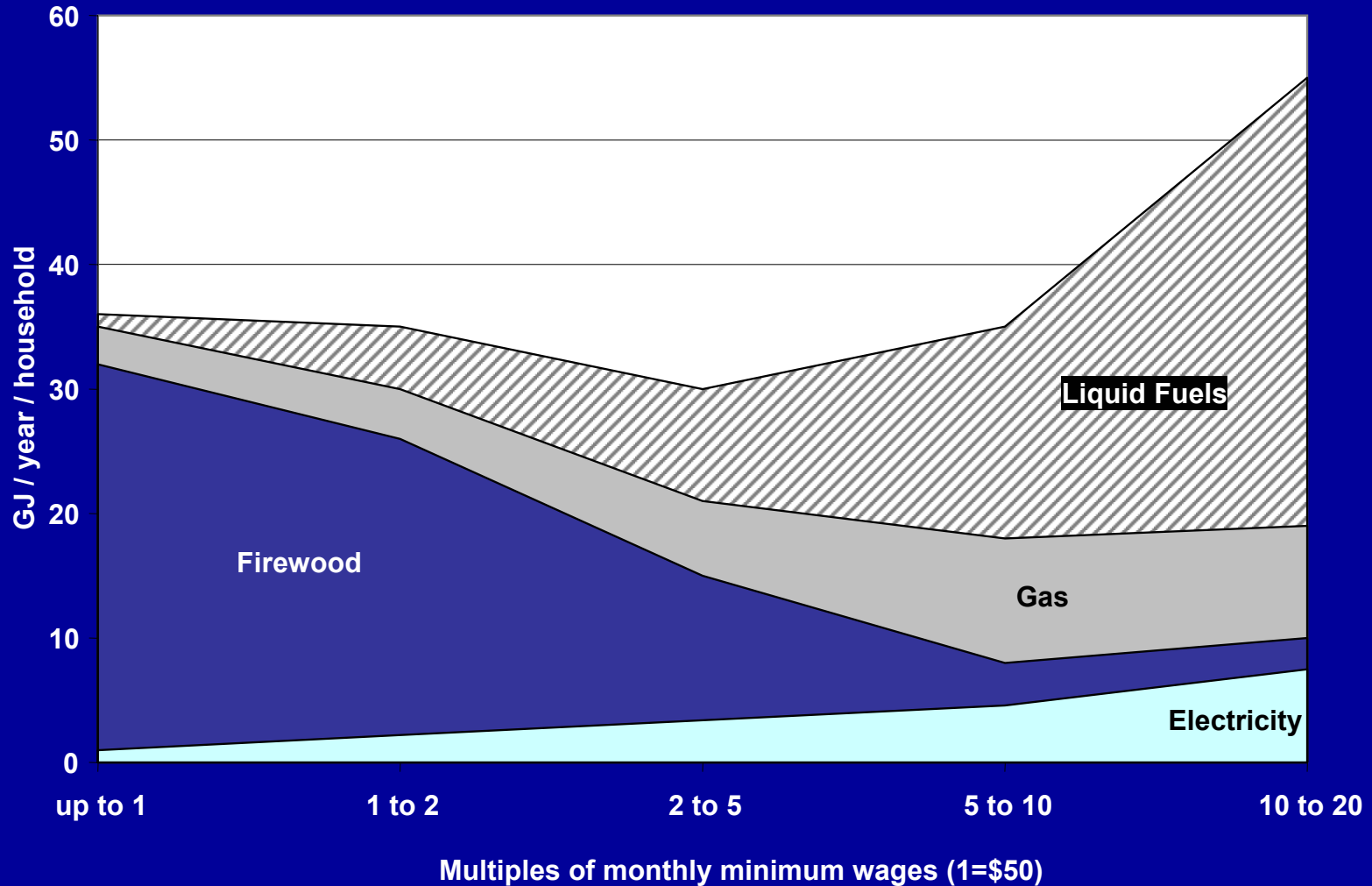
Source: ESMAP, 2002. *Energy Services for the World's Poor*.

Average Energy Demand by Income Segment: Nairobi, Kenya (1988)



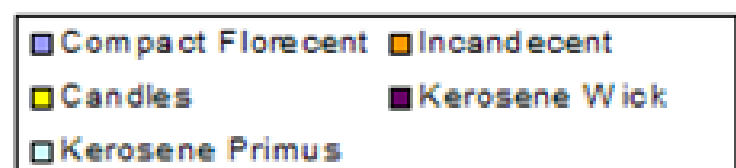
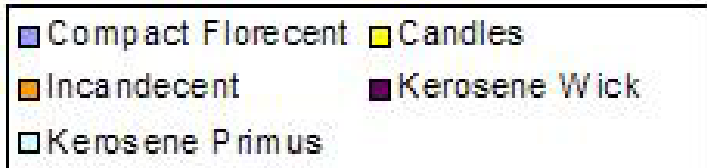
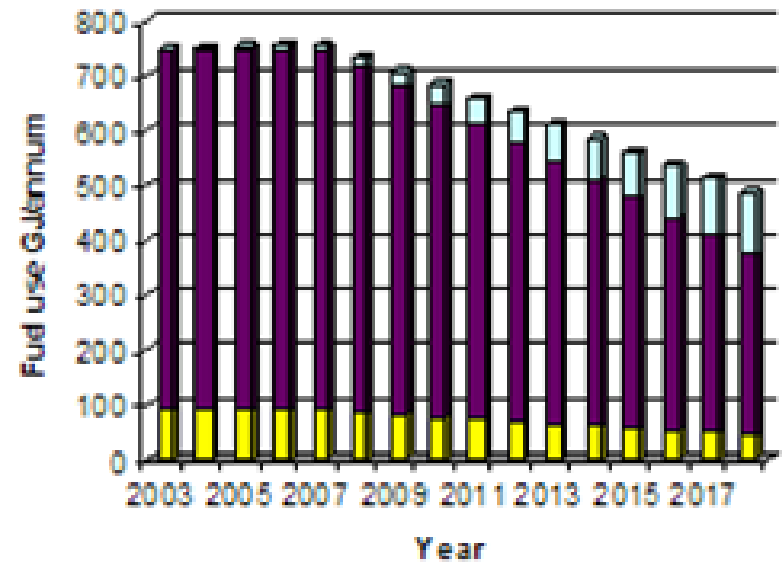
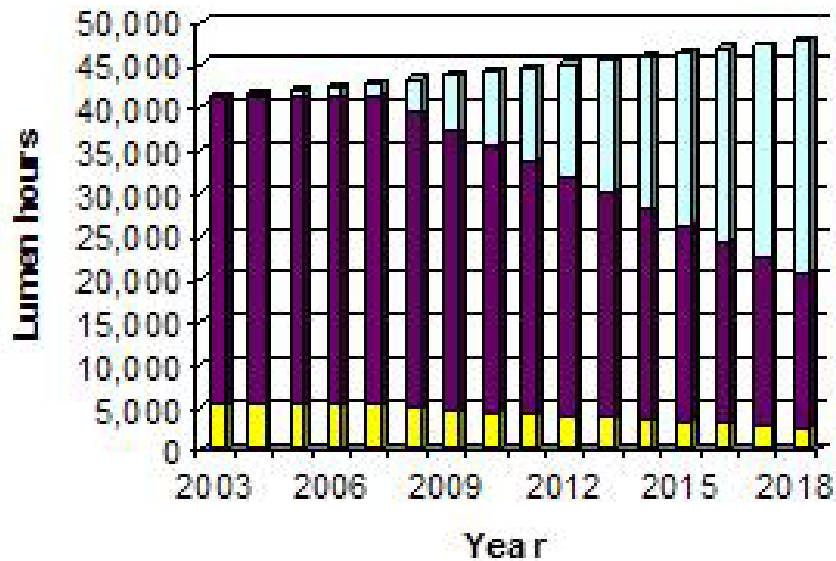
Source: Adjusted from: P.O'Keefe et al, (1984) *Energy and Development in Kenya* Scandanavian Institute of African Studies, Uppsala, Sweden, as adjusted in Gordon Leach. (1992) "The Energy Transition." *Energy Policy* (February): 116-123

Average Energy Demand by Income Segment, Brazil (1988)



Source: De Almeida and de Oliveira (1995), as summarized in WEA 2000.

Lighting Efficiency for a Rural Village in South Africa: Base Case lighting services and fuel use

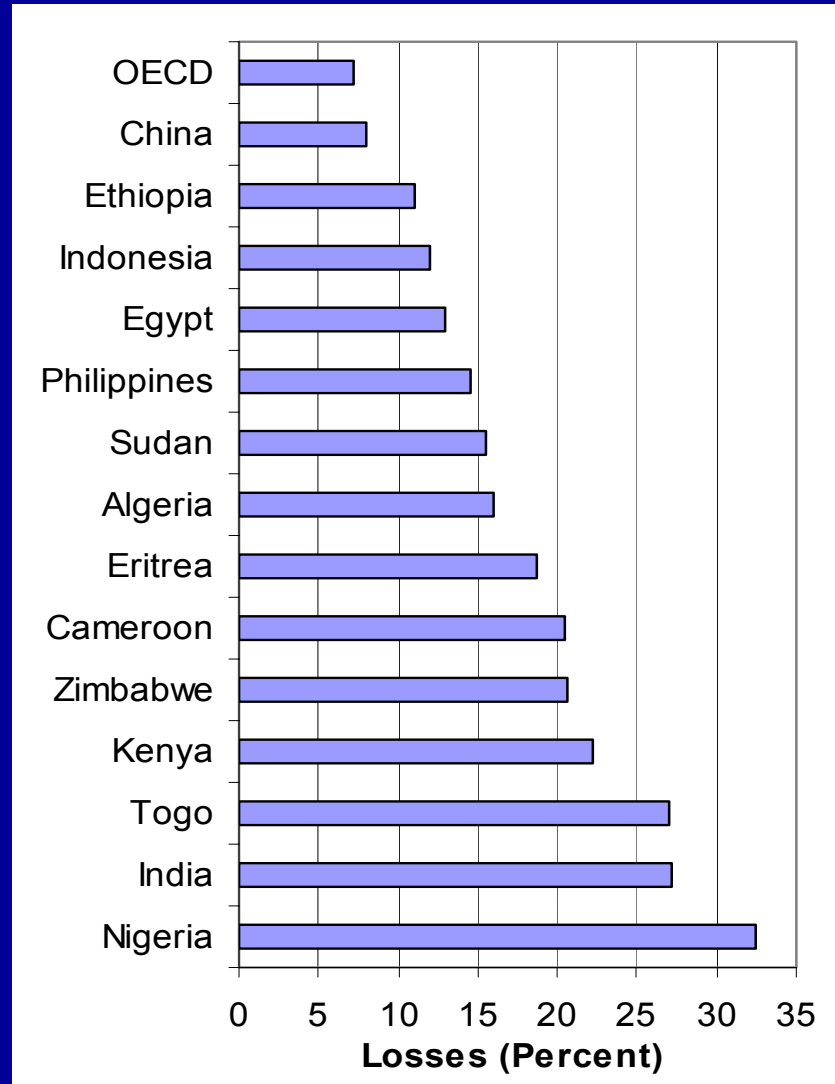


Source: Howells et al., WP18, PESD (<http://pesd.stanford.edu>)

Some Additional Issues: Measurement & Theory

- Measurement:
 - (eg.) Village vs. Household electrification in India:
 - 85 % villages electrified
 - 37% households electrified
- Theory:
 - (eg.) Is theft an electrification strategy?

Electricity Losses By Country

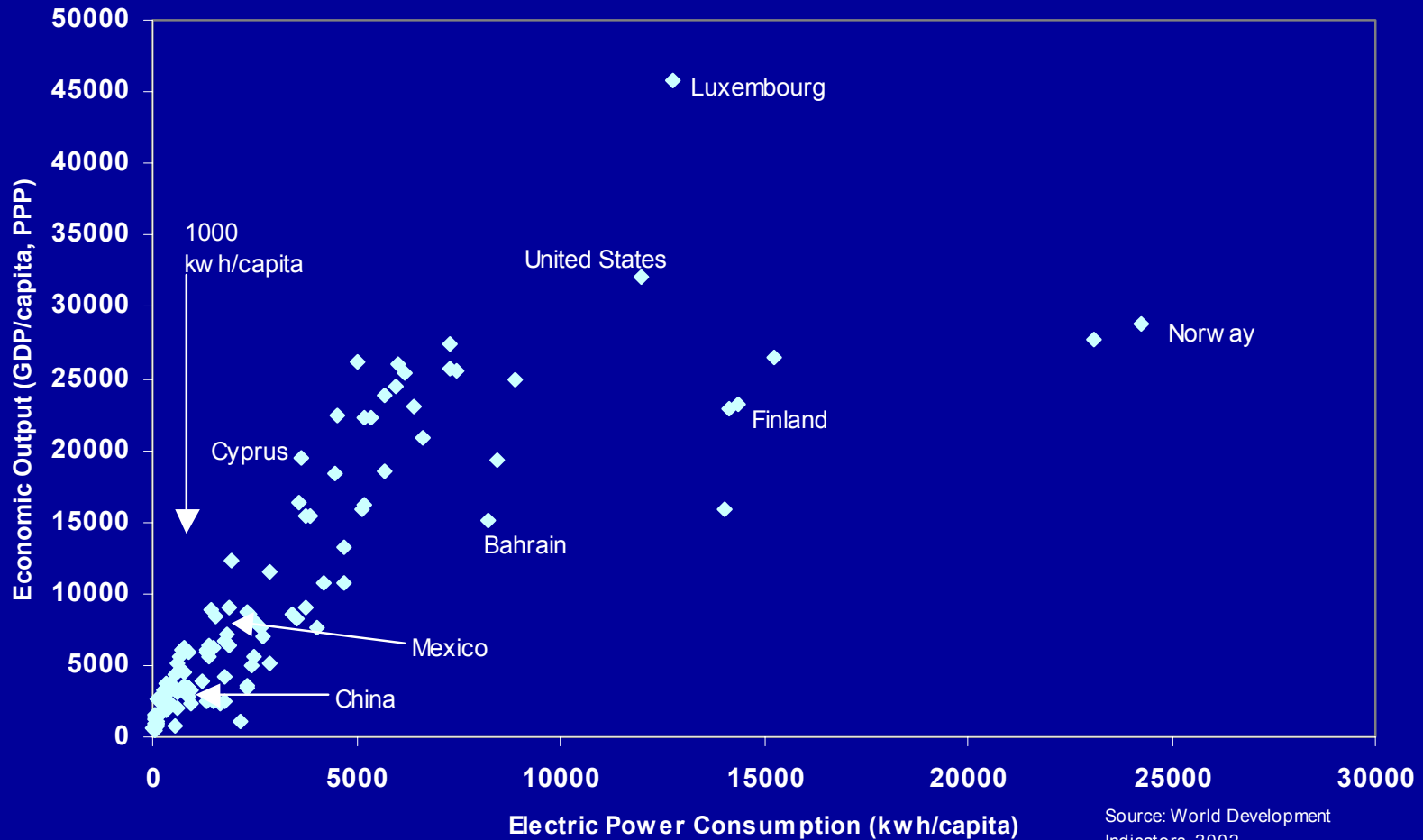


2. On the Causes and Consequences of Electrification

- Economy
- Urbanization
- Policy
- Health
- Literacy

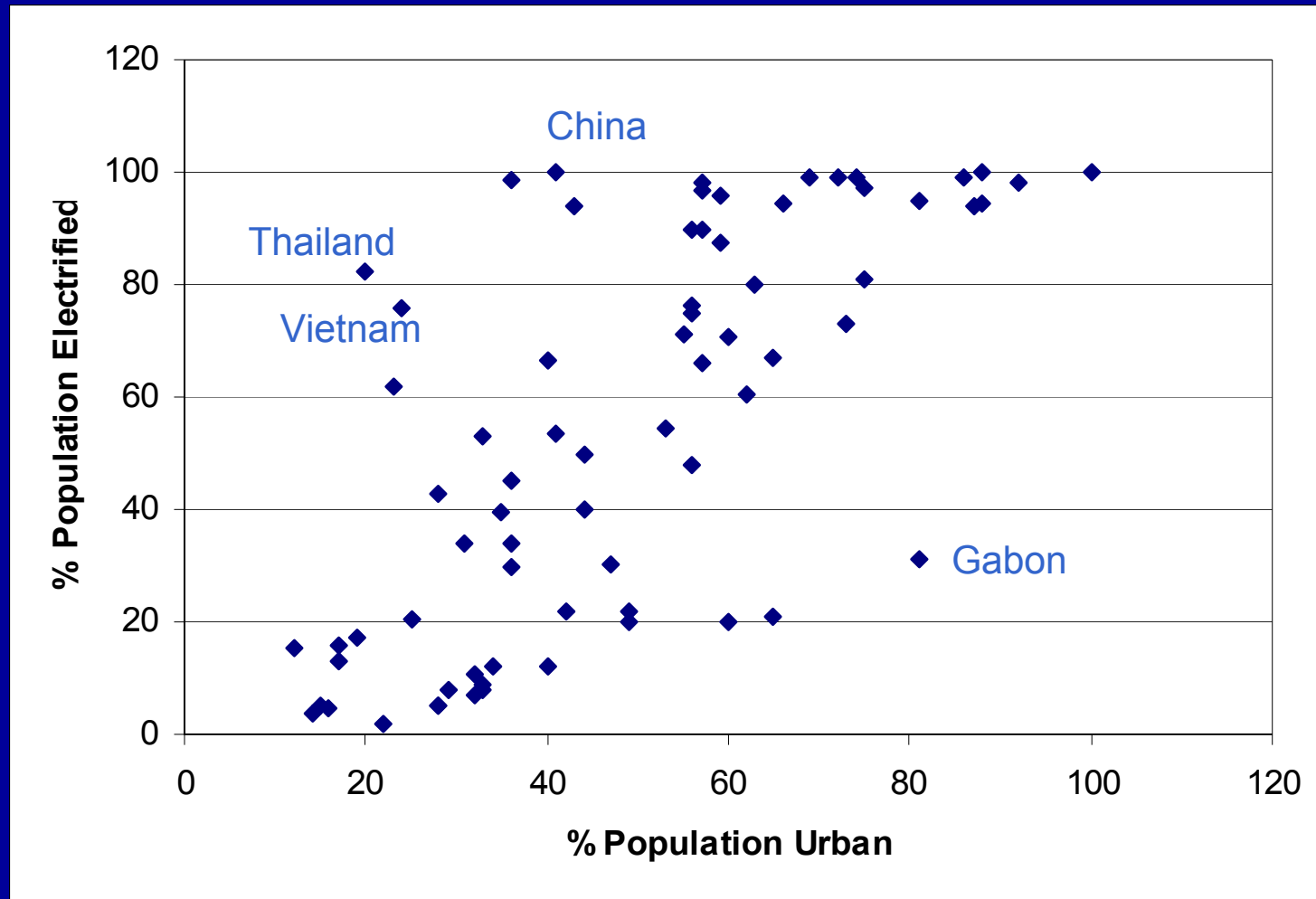
Cause and Consequence: Economic Growth

Consumption of Electric Power and Economic Output, 1999



Source: World Development Indicators, 2002
(114 countries reporting both series)

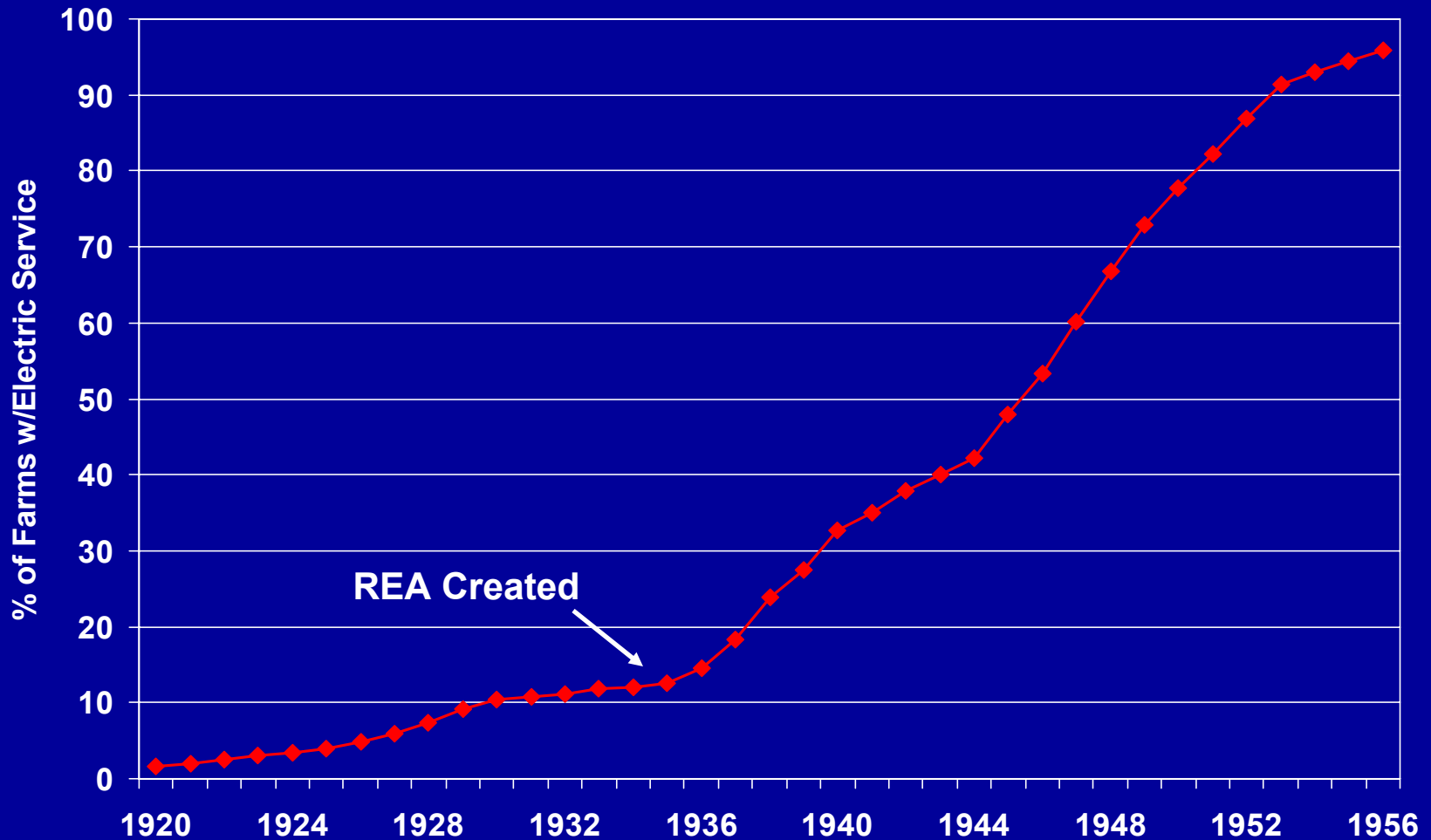
Causes: Urbanization (2000)



Source: *Urban population Data from World Development Indicators, 2004. World Bank.*
Electrification Rates from World Energy Outlook, 2002. IEA.

Cause (?): Policy

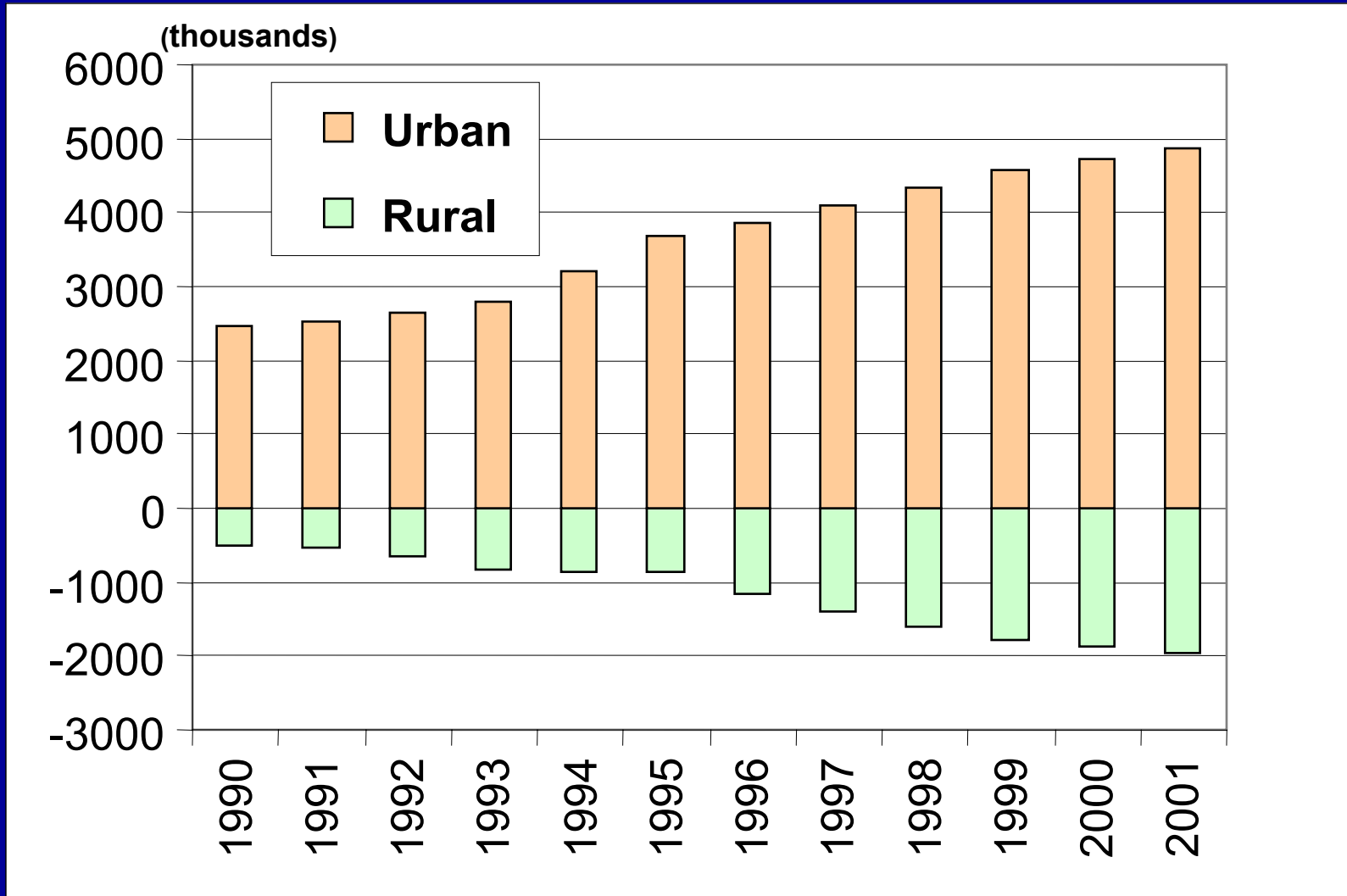
The U.S. Rural Electrification Experience



Source: U.S. Census Bureau

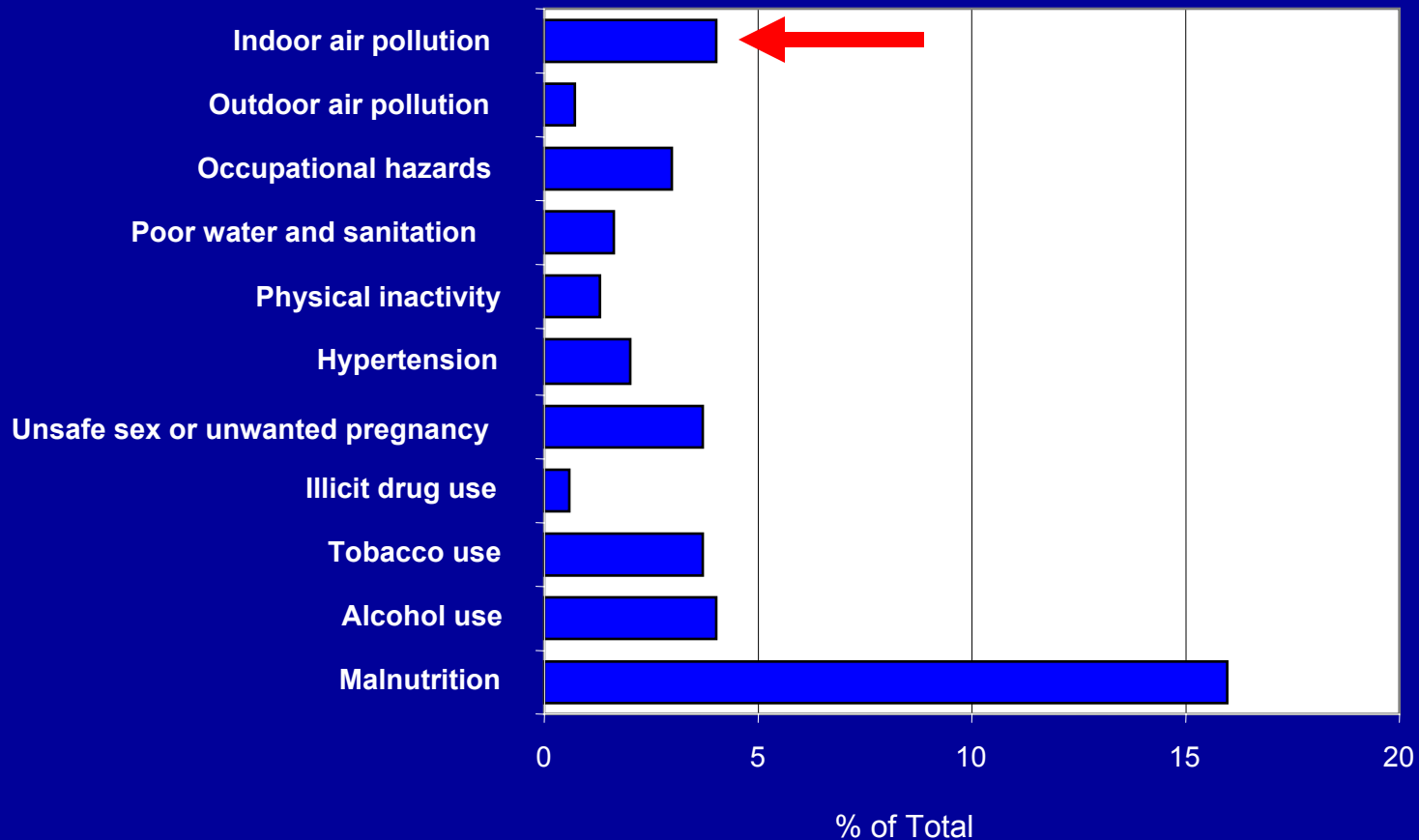
Cause: Policy

South Africa's National Electrification Achievement



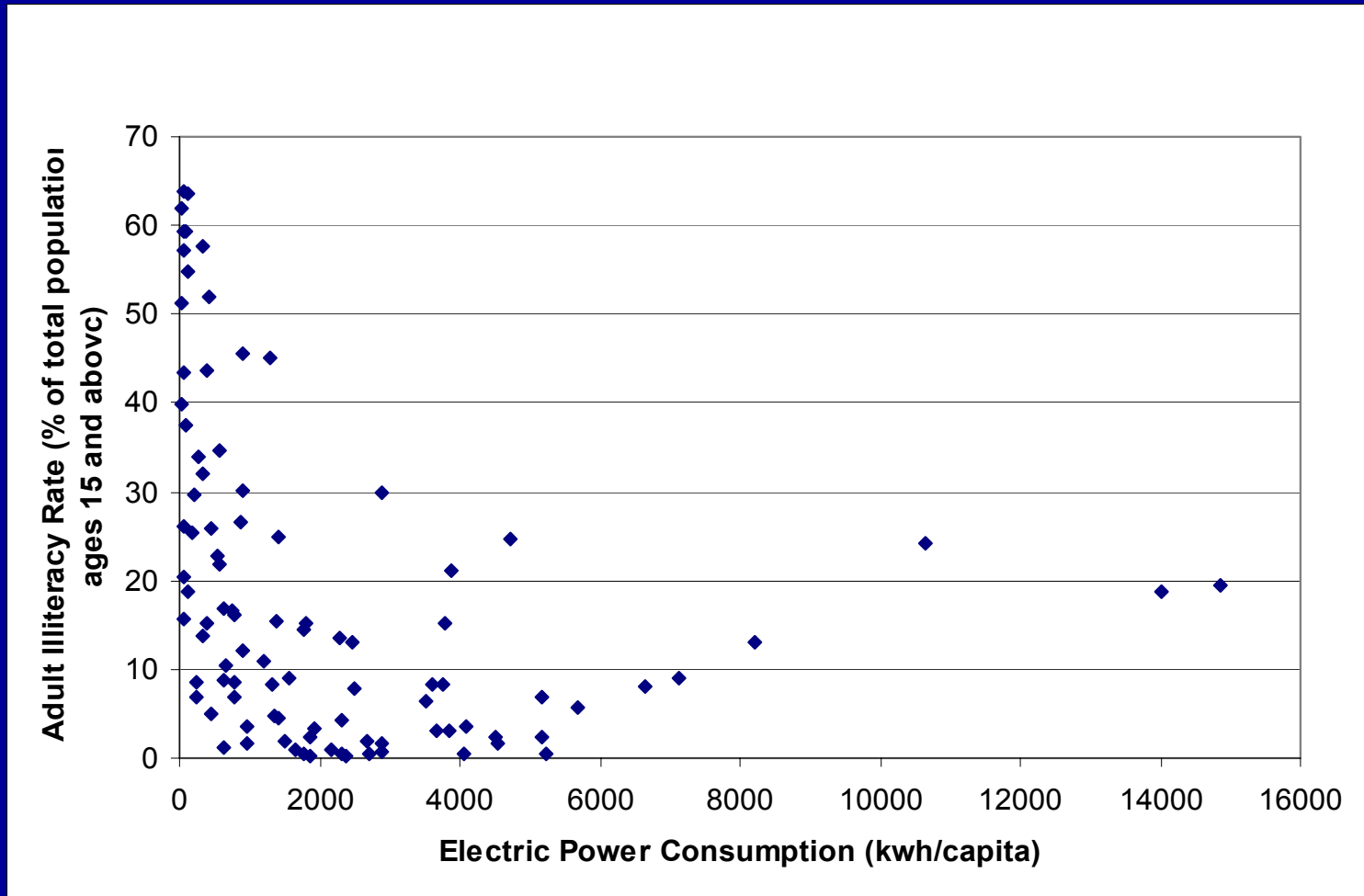
Source: Gaunt, Load Research Programme, Energy Research Centre - Cape Town South Africa,

Consequence (?): Health Global Burden of Disease



Source: Smith (2000) and Murray and Lopez (1996), as summarized in WEA (2000).

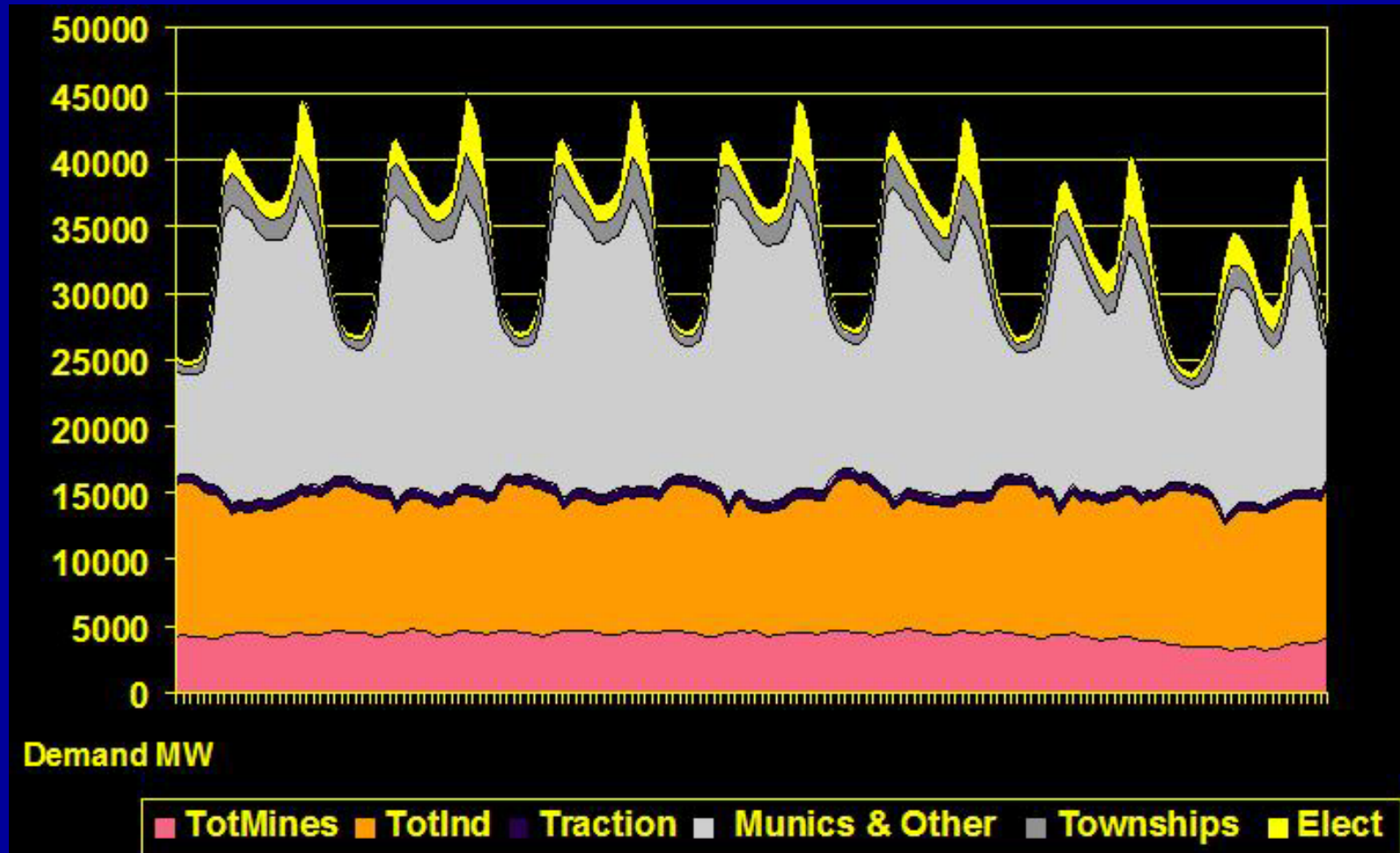
Consequence (?): Education Electricity Consumption and Literacy (1999)



3. Industrial Organization & Policy: Implications for Electrification

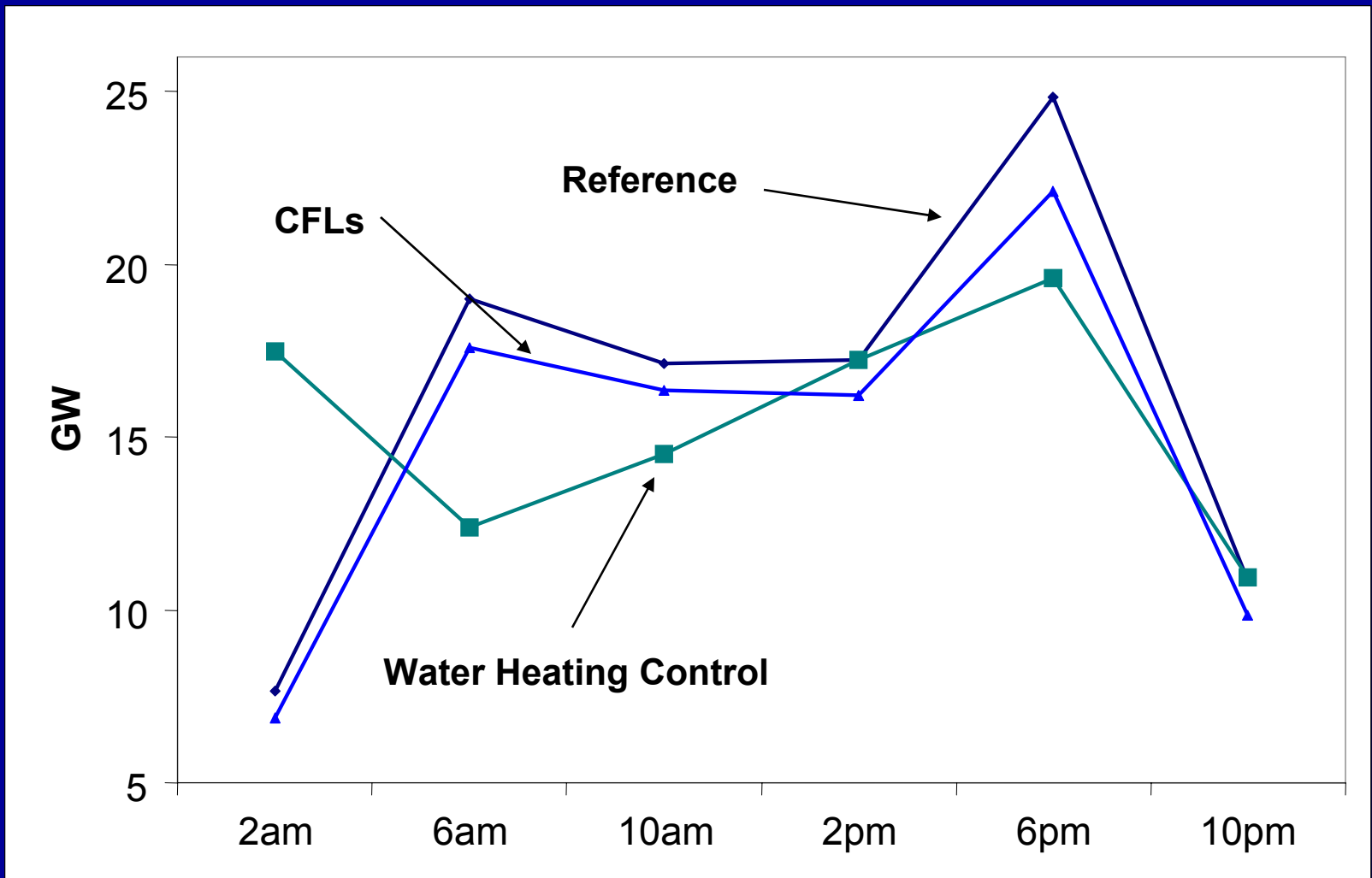
- Load Management
- Organization of the Power System
 - Markets
 - The Social Contract

South Africa, estimated typical winter week peak cycle, 2015



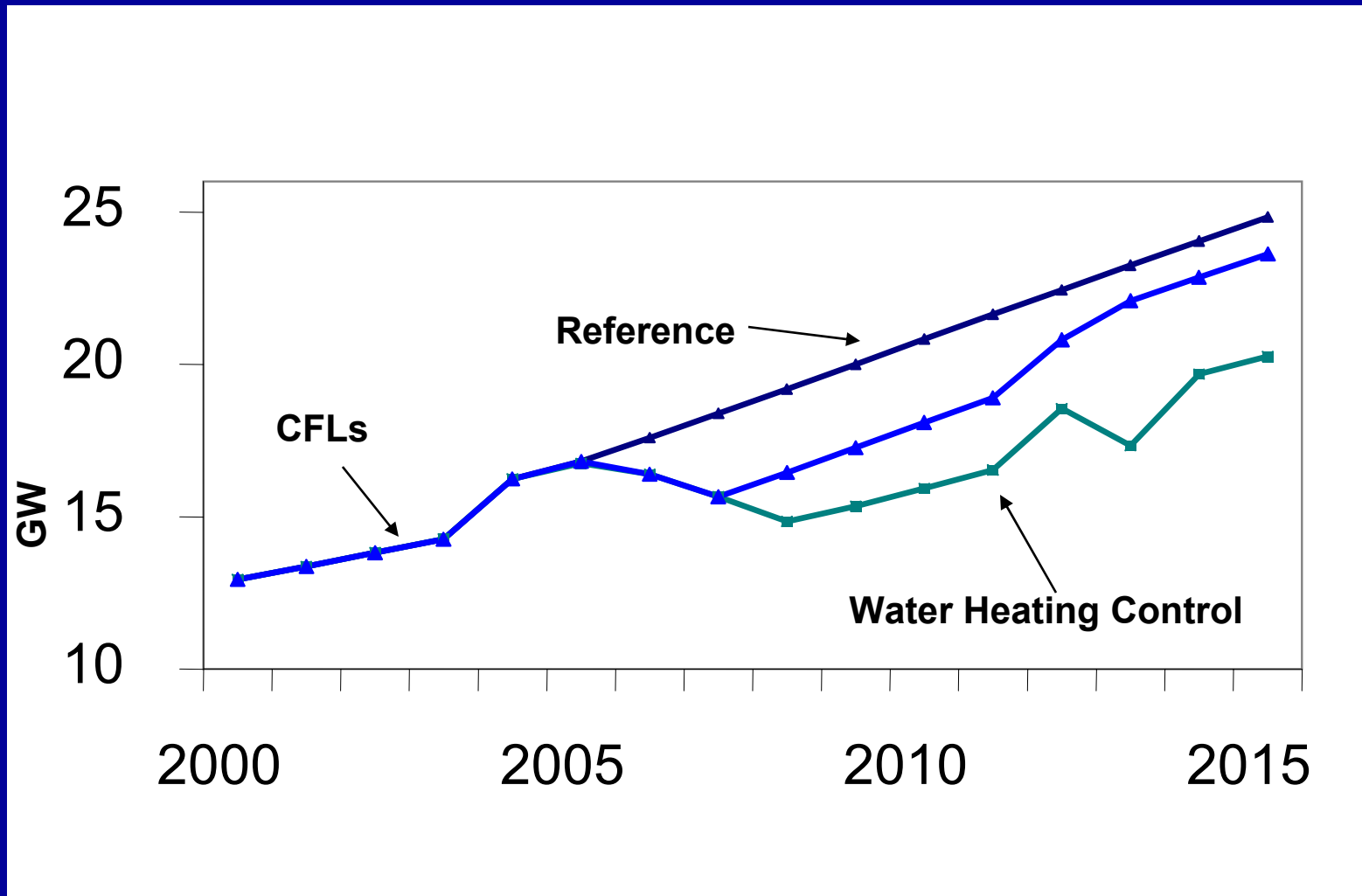
Source: Eskom (draft)

Controlling Peak Electric Power Demand



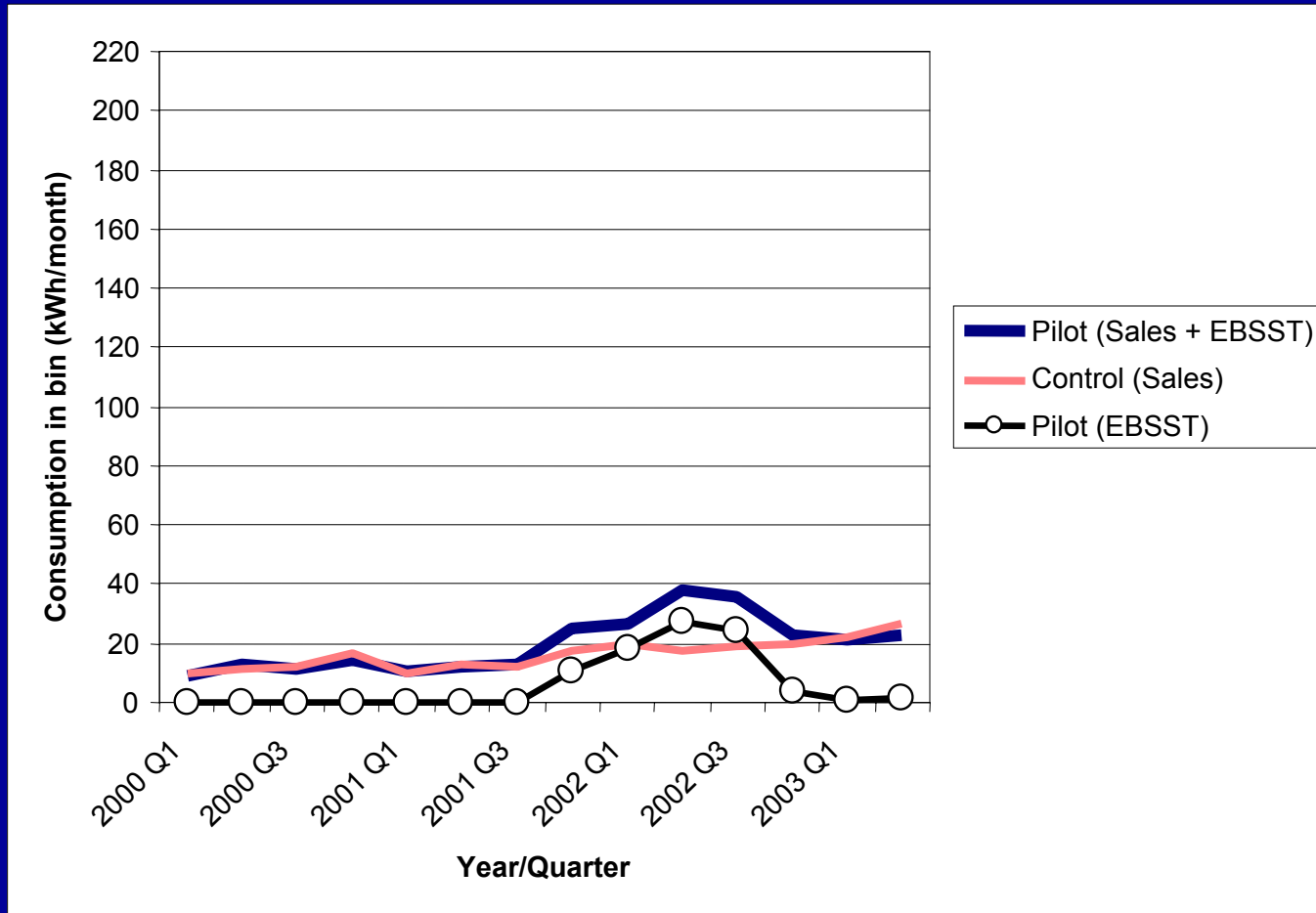
Source: Bushinsky, Joshua M. 2004. Optimizing Residential Demand-Side Management in the South African Electricity Sector. Stanford University Honors Thesis.

Peak Residential Load



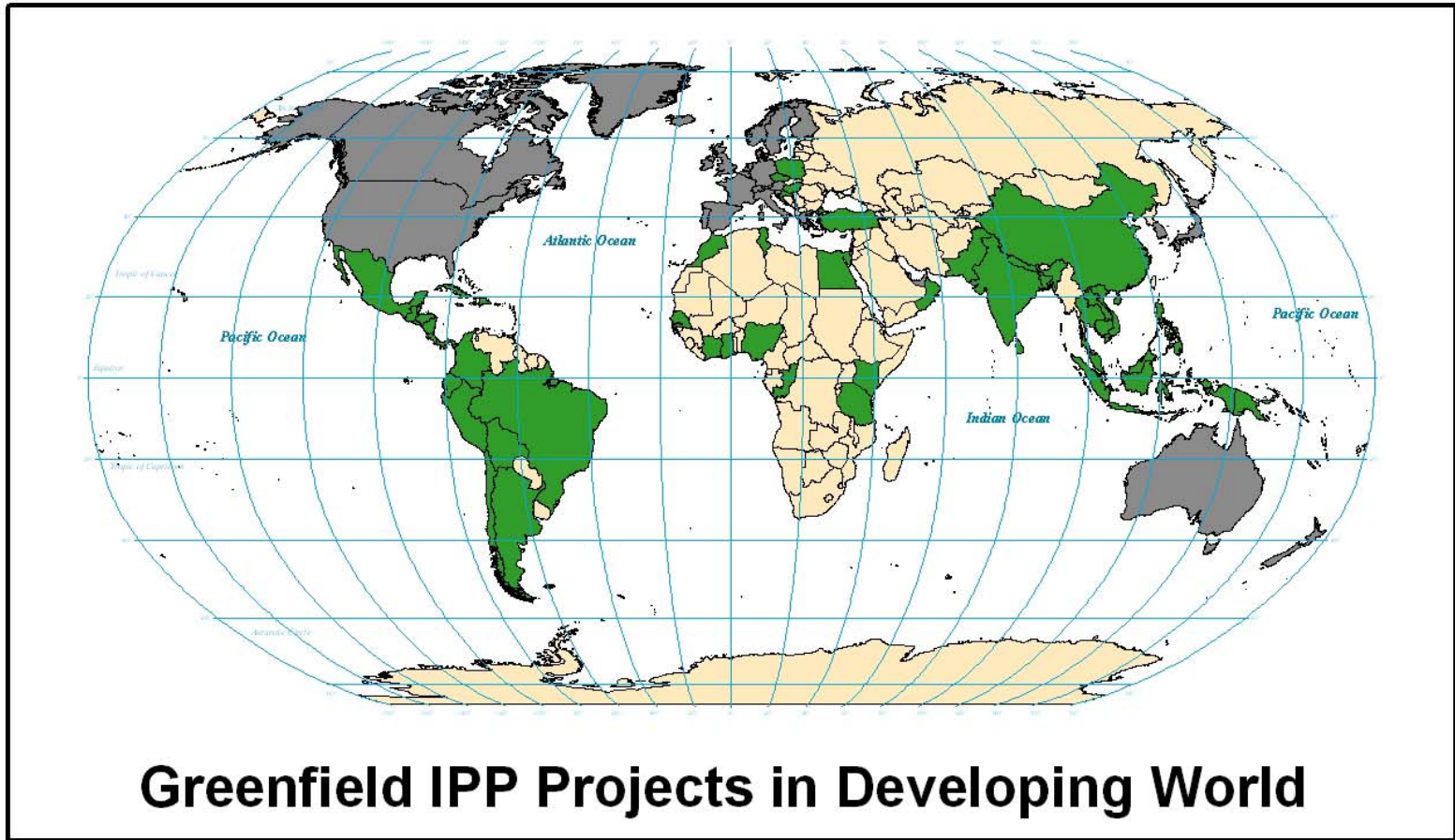
Source: Bushinsky, Joshua M. 2004. Optimizing Residential Demand-Side Management in the South African Electricity Sector. Stanford University Honors Thesis.

BEST Electricity Subsidy: Measured Effects (7-15 kWh/month)



Source: Gaunt, Load Research Programme, Energy Research Centre - Cape Town South Africa.

Organization of the Electric Power System: Markets



Source: World Bank. PPI Project Database.