

Global Electrification: Trends and Challenges

全球电气化：趋势和挑战

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What is Electrification?

电气化的含义

At least three definitions (三种定义) :

1. **Access to Power** (通电)
2. **Use of Power** (用电)
3. **Pervasiveness of Electricity in the Economy** (经济增长的电力支撑)

I will focus on #1 and #2 (本文关注前两种定义).

PESD studies on “Energy Transitions”

PESD关于“能源转换”的研究

- **China: CASS Partnership (中国合作机构:CASS)**
 - **What explains China’s success with rural electrification?**
 - 中国农村电气化成功的原因
- **South Africa: ERC Partnership (南非合作机构:ERC)**
 - **MARKAL/TIMES; market failure analysis; new modeling tools; data assimilation**
 - **MARKAL/TIMES:市场失灵分析;新的模型工具;数据处理**
- **India: several partnerships (印度合作机构)**
 - **Energy and Agriculture: general equilibrium modeling**
 - 能源与农业:一般均衡模型
 - **Assessing electrification policies and patterns: peri-urban and rural**
 - 电气化政策与模式评价:郊区与农村
 - **For profit distributed generation (India & Mexico)**
 - 分散法电的利润(印度与墨西哥)
 - **Advanced metering and rural grid control**
 - 先进的测量方式与农村电网管理

This talk: three points

本文涉及三个焦点问题

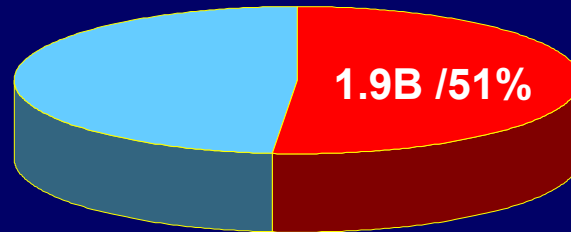
- **Broad Patterns in Electrification**
- 几种突出的电气化模式
 - **Global, Regional, National & Household**
 - 全球范围,区域范围,国家范围,家庭范围
- **Evidence on the Causes and Consequences of Electrification**
- 电气化的原因与结果
- **Industrial Organization & Electricity Policy**
- 产业组织与电力政策

1. Broad Patterns in Electrification

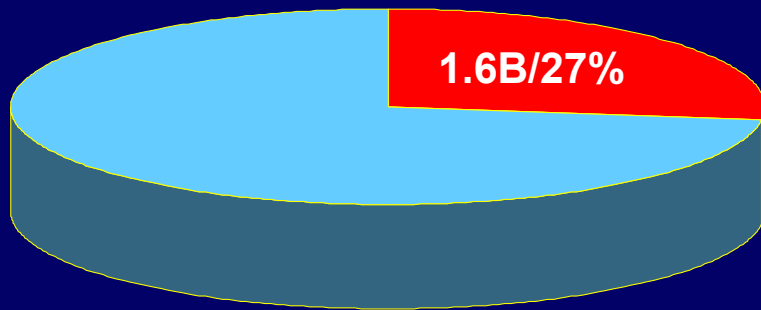
各种电气化模式

Global Access to Electricity: 1970 to 2030

全球通电情况 (1970到2030年)

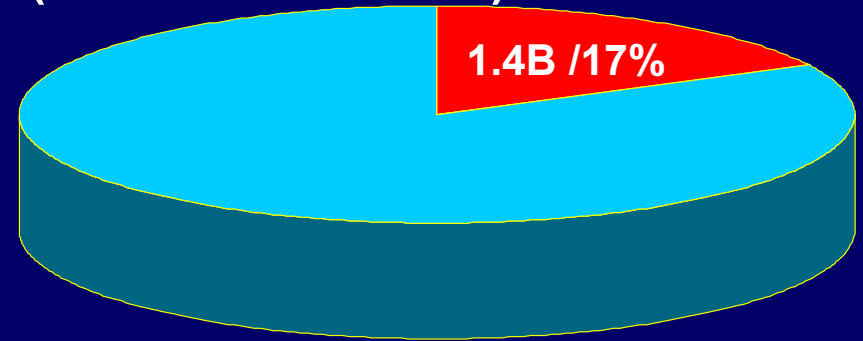


1970 – Total population 3.7B (1970年总人口37亿)



2000 – Total population 6B

(2000年总人口60亿)



2030 – Total population 8.2B

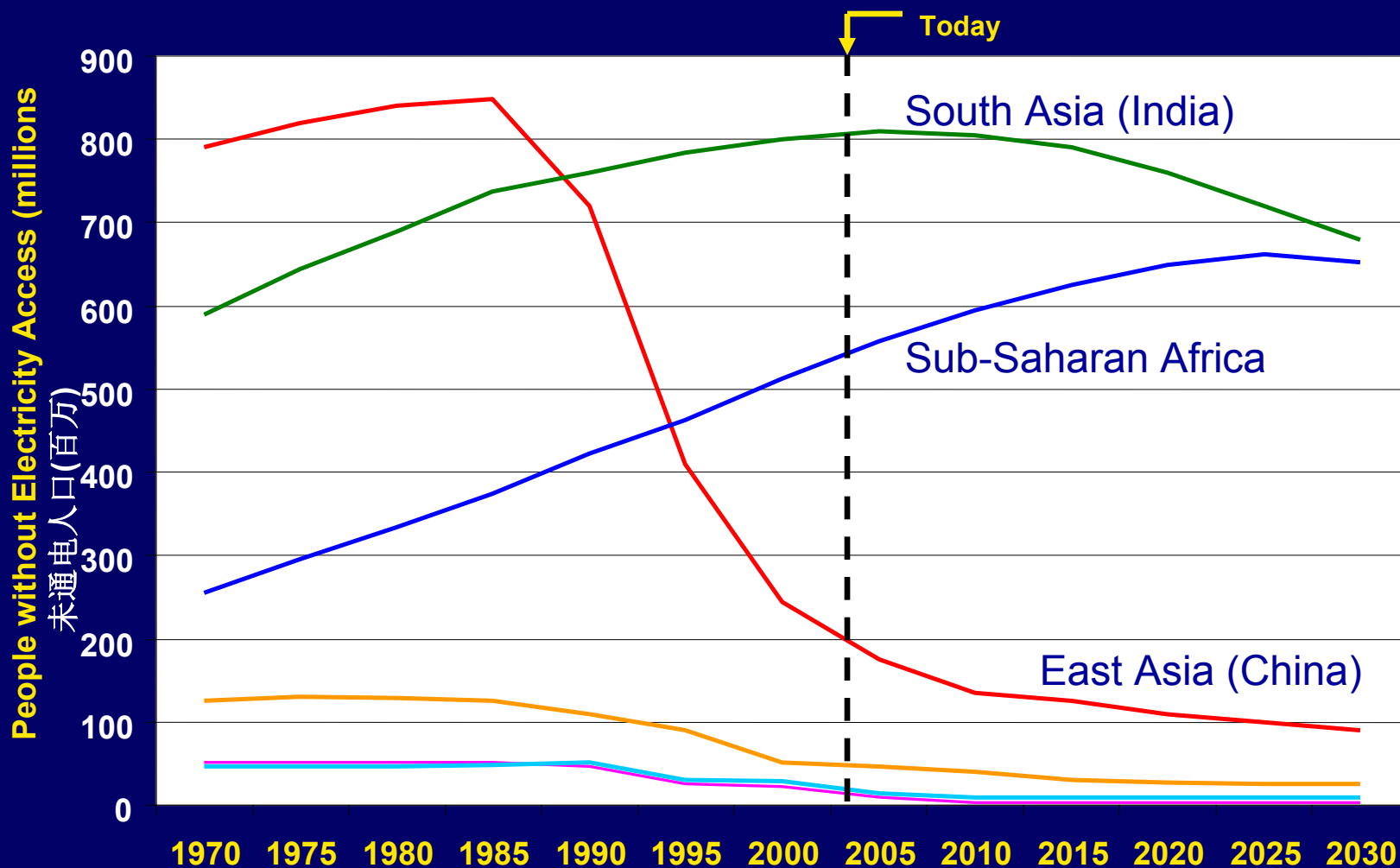
(2030年总人口82亿)

■ People with Access to Electricity (通电人口)

■ People w/o Access to Electricity (未通电人口)

Regional Electricity Access: Limits

不同地区的通电情况



Source: International Energy Agency, WEO 2002

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

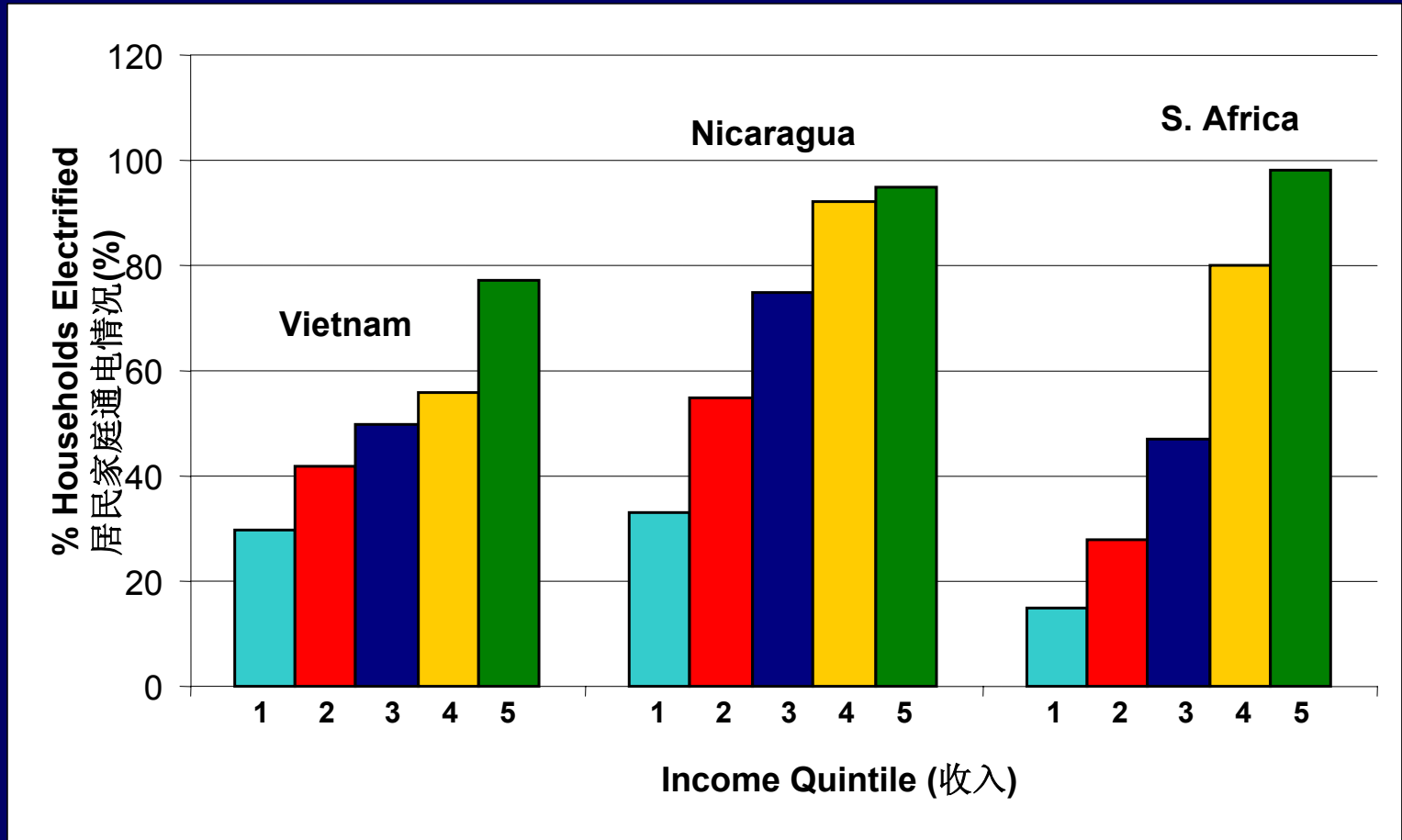
1999年南部非洲电气化情况(%): 按城乡统计

Country 国家	Urban 城市	Rural 农村
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)

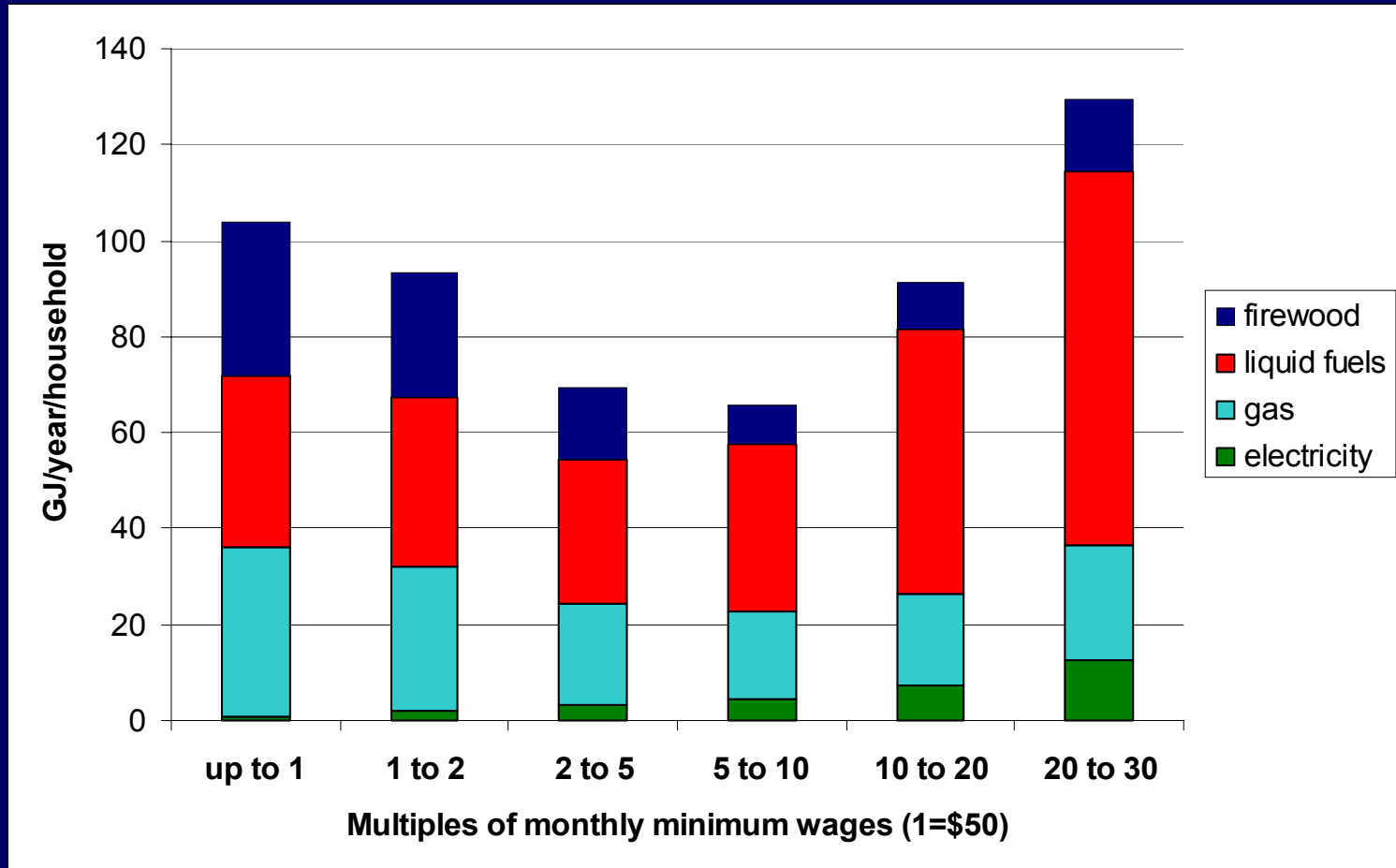
1988年居民家庭通电情况(%): 按照收入等级统计



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

Average Energy Demand by Income Segment: Brazil (1988)

1988年巴西能源需求情况: 按照收入等级统计



Source: adapted from de Almeida and de Oliveira, 1995

Some Additional Issues:

Measurement & Theory

其他问题：测量方法与原则

- **Measurement** 测量方法:

- (eg.) **Village vs. Household electrification in India**

- 比如,印度村庄与家庭通电情况:

- » **85 % villages electrified**

- » 高于85%的农村通电

- » **37% households electrified**

- » 高于37%的家庭已经通电

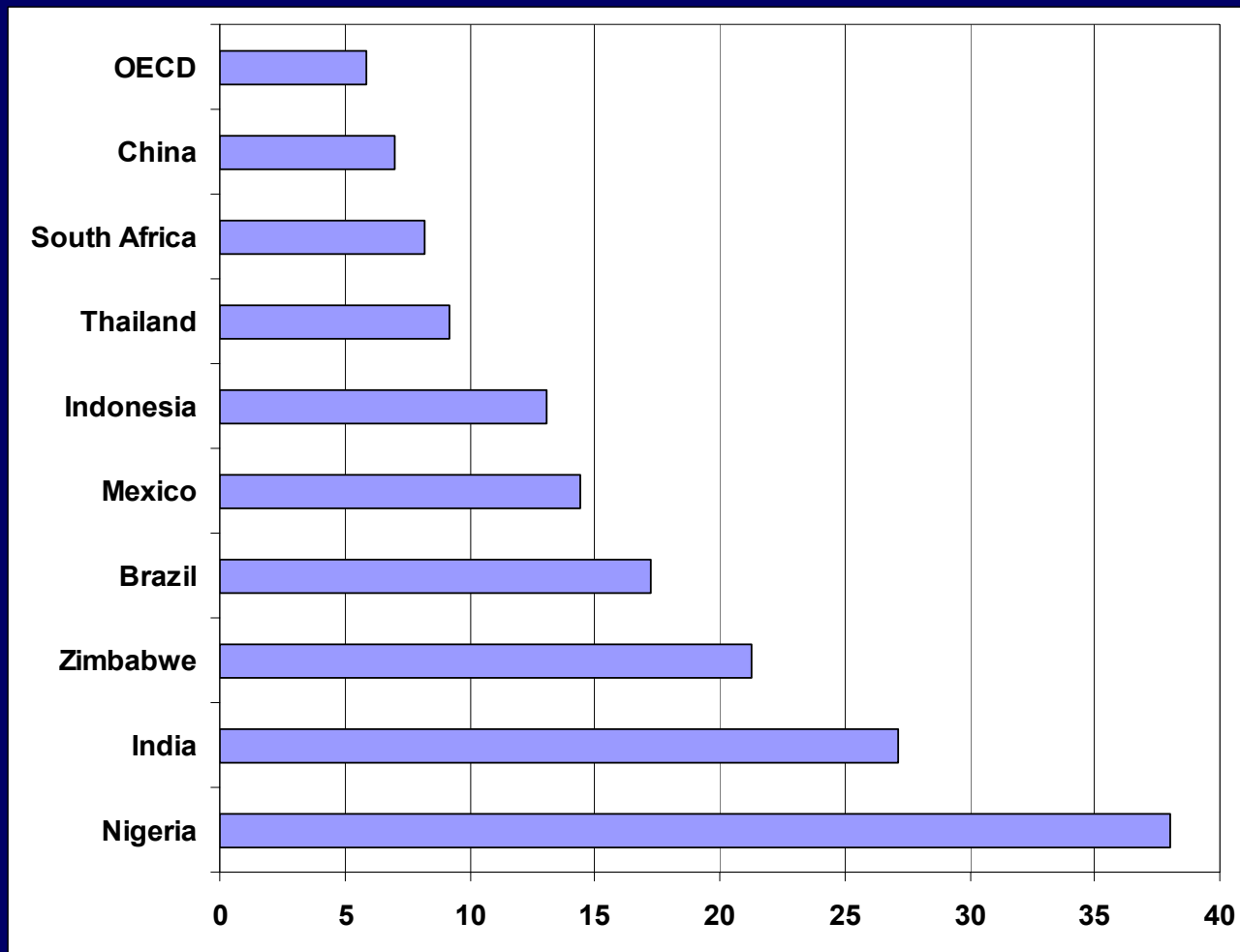
- **Theory** 原则:

- (e.g.) **Is theft an electrification strategy?**

- 比如,偷窃电力行为也能计算在电气化之中吗?

Electricity Losses (%), 2001

2001年输电过程中的损耗(%)



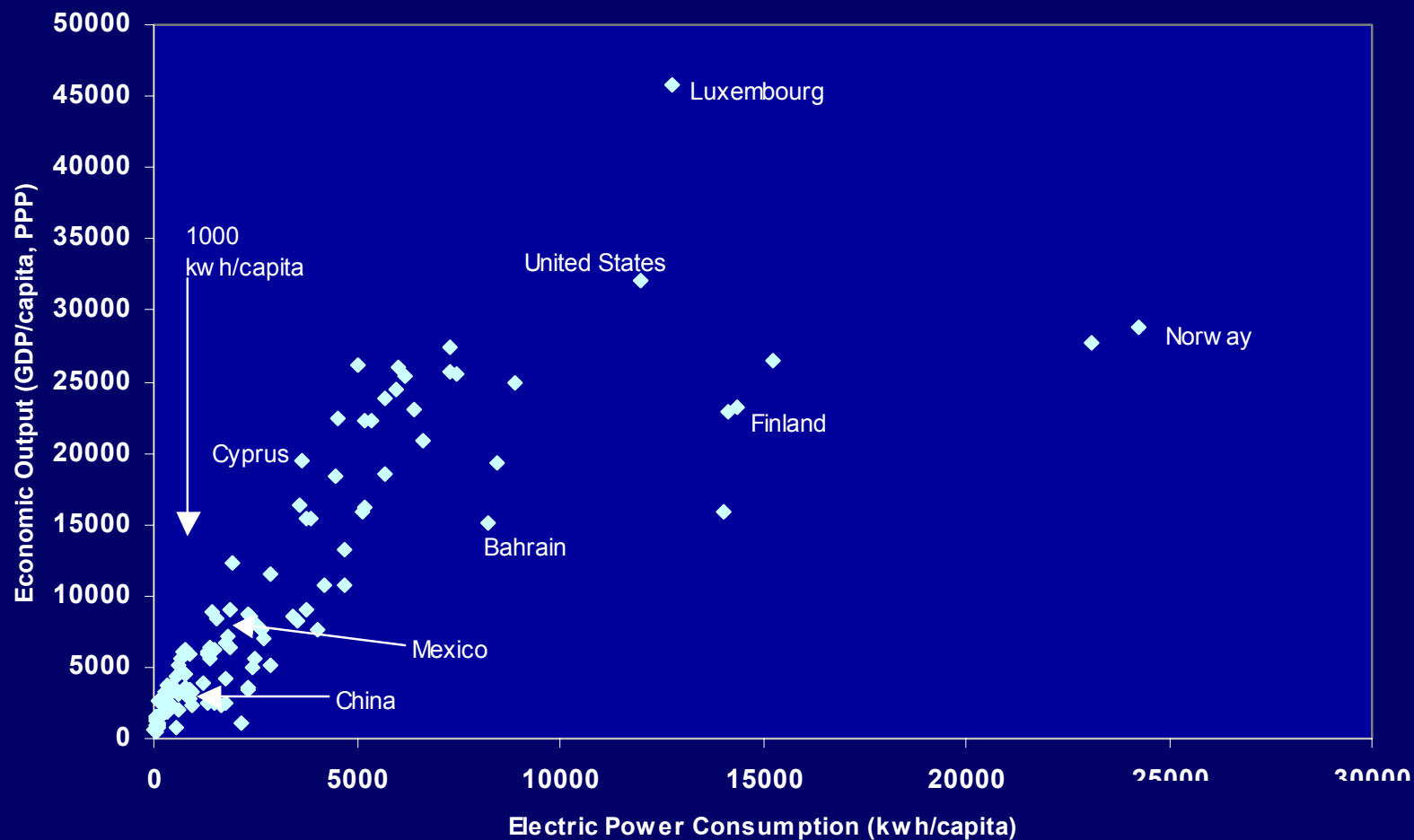
2. On the Causes of Electrification

电气化的原因分析

- **Economy** 经济因素
- **Urbanization** 城市化进程
- **Policy** 政策因素

Cause (and Consequence): Economic Growth

原因(以及结果): 经济增长

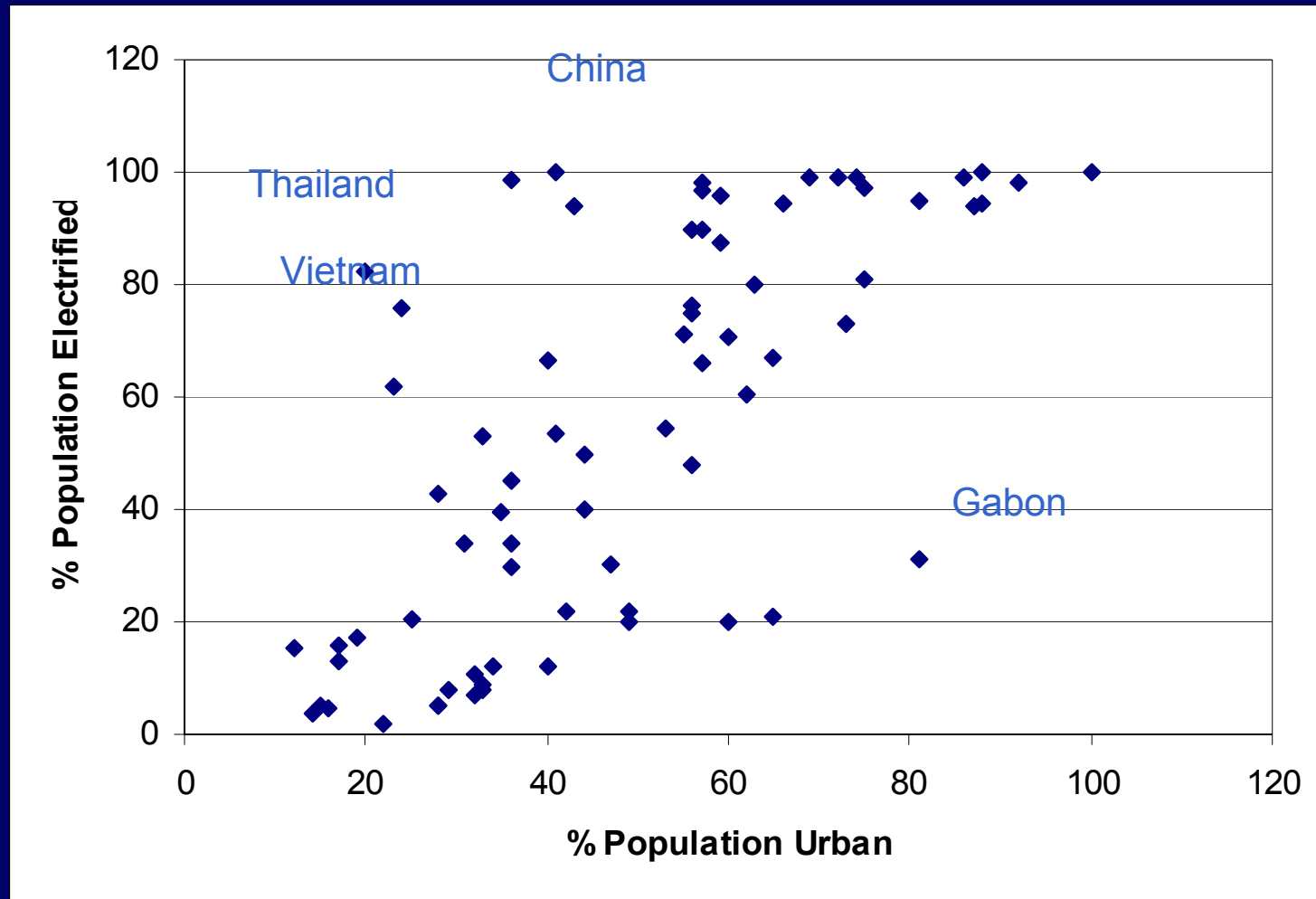


Source: World Development Indicators, 2002

(Only countries reporting both series)

Cause: Urbanization (2000)

原因：城市化(2000年)

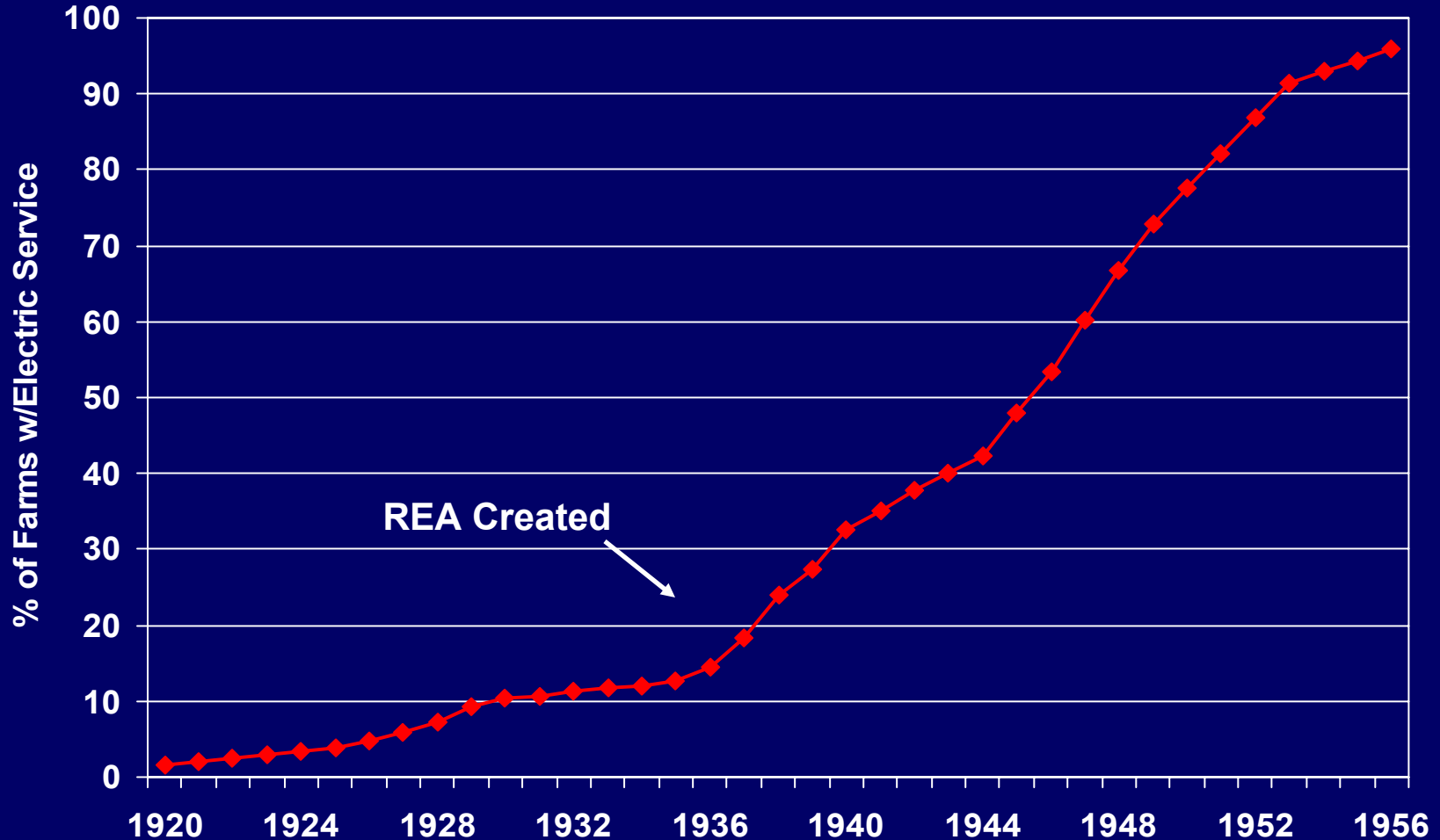


Source: Urban population Data from World Development Indicators, 2004. World Bank.
Electrification Rates from World Energy Outlook, 2002. IEA.

Cause (?): Policy

The U.S. Rural Electrification Experience

原因:政策因素
美国农村电气化的经验



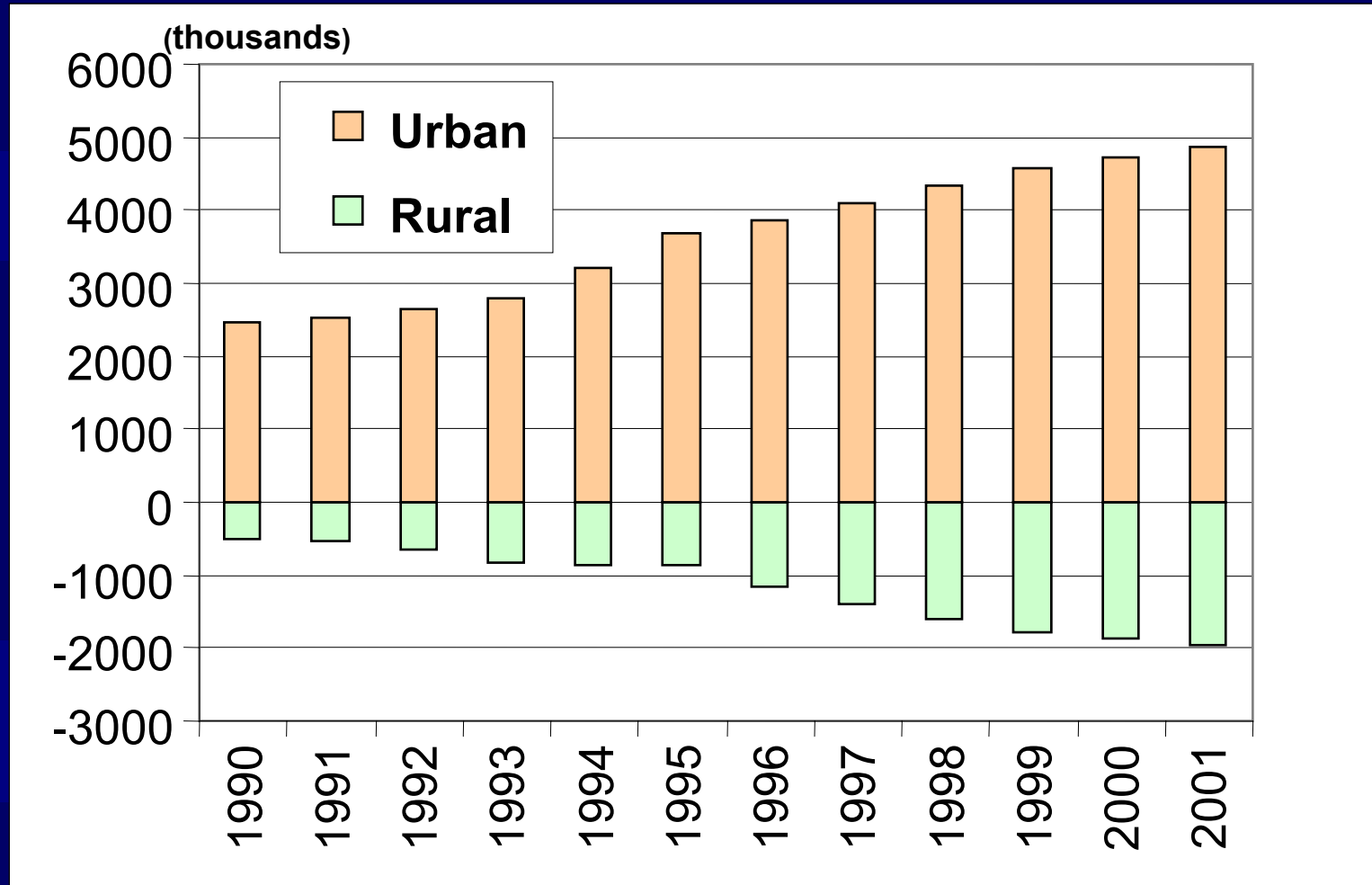
Source: U.S. Census Bureau

Cause: Policy

South Africa's National Electrification Achievement

原因:政策因素

南非国家电气化政策的成果



Additional Slides

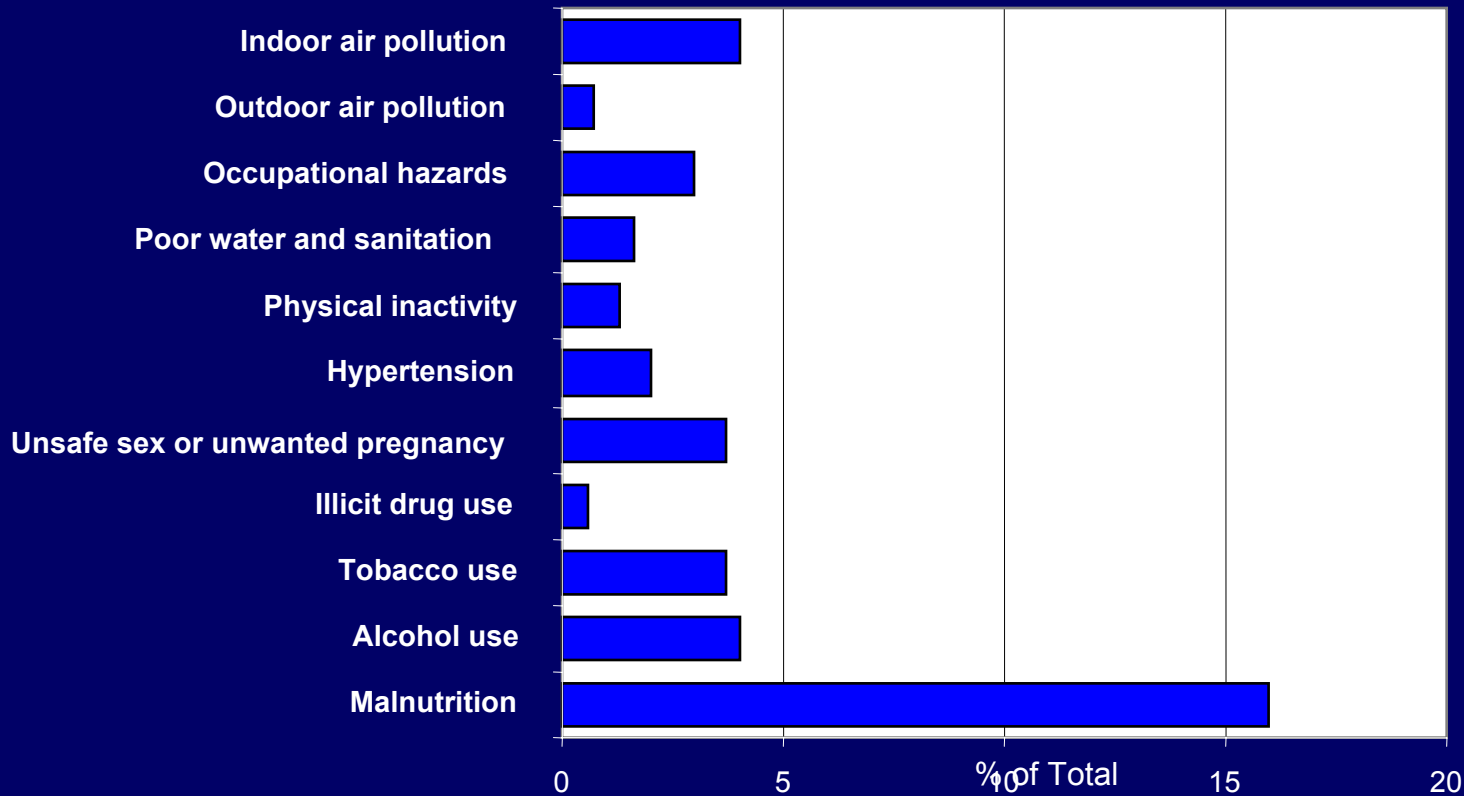
附件

Consequence (?): Health

结果之一:健康

Global Burden of Disease

全球面临的主要疾病



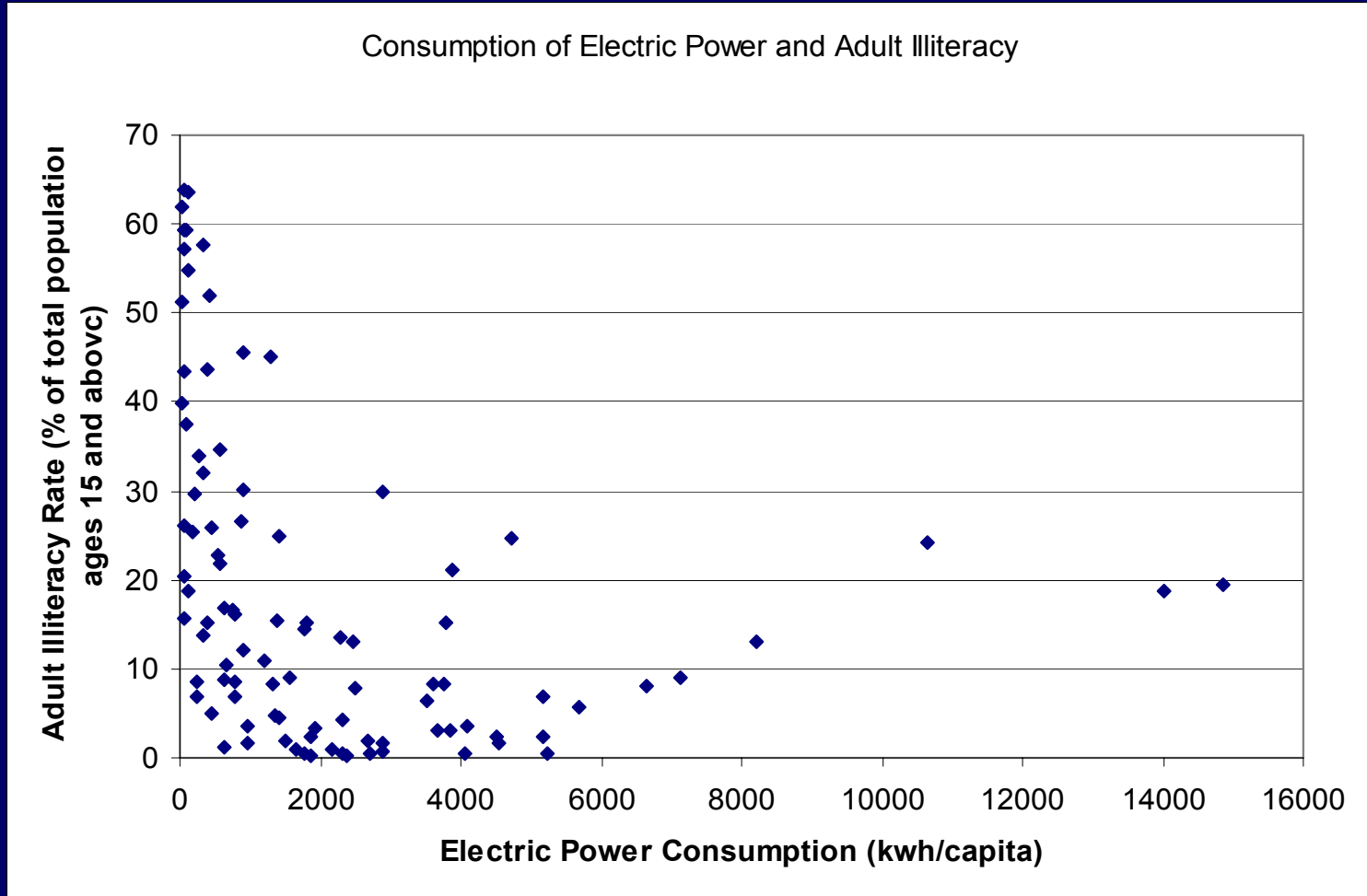
Source: Smith (2000) and Murray and Lopez (1996), as summarized in WEA (2000).

Consequence (?): Education

结果之二: 教育

Electricity Consumption and Literacy (1999)

电力消费与识字率 (1999年数据)



Source: Illiteracy rate, adult total (% of people ages 15 and above) (SE.ADT.ILIT.ZS)

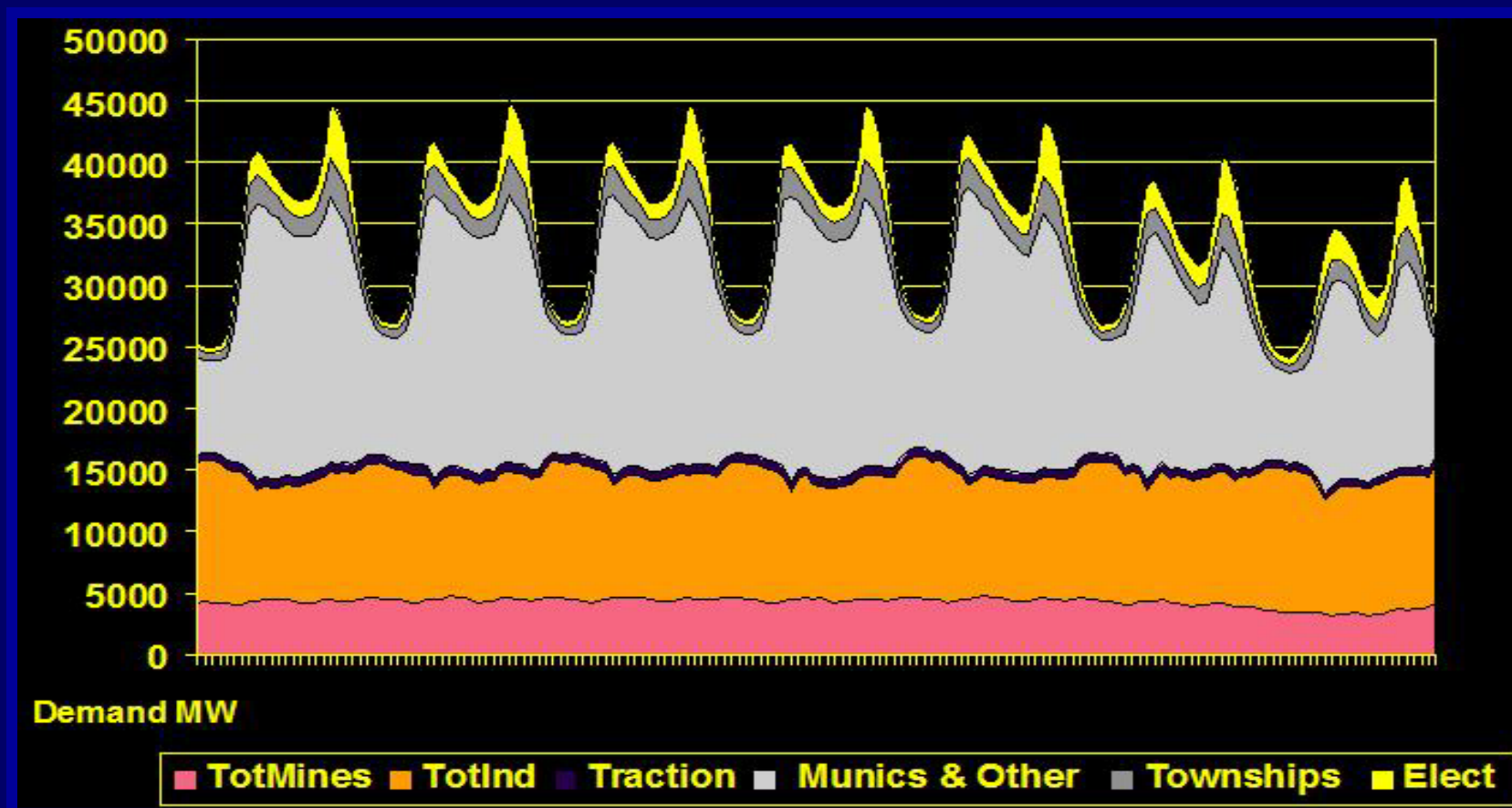
Industrial Organization & Policy: Implications for Electrification

产业组织与政策: 电气化的含义

- Load Management
- 负荷管理
- Organization of the Power System
- 电力系统组织

South Africa: estimated typical winter week peak cycle, 2015

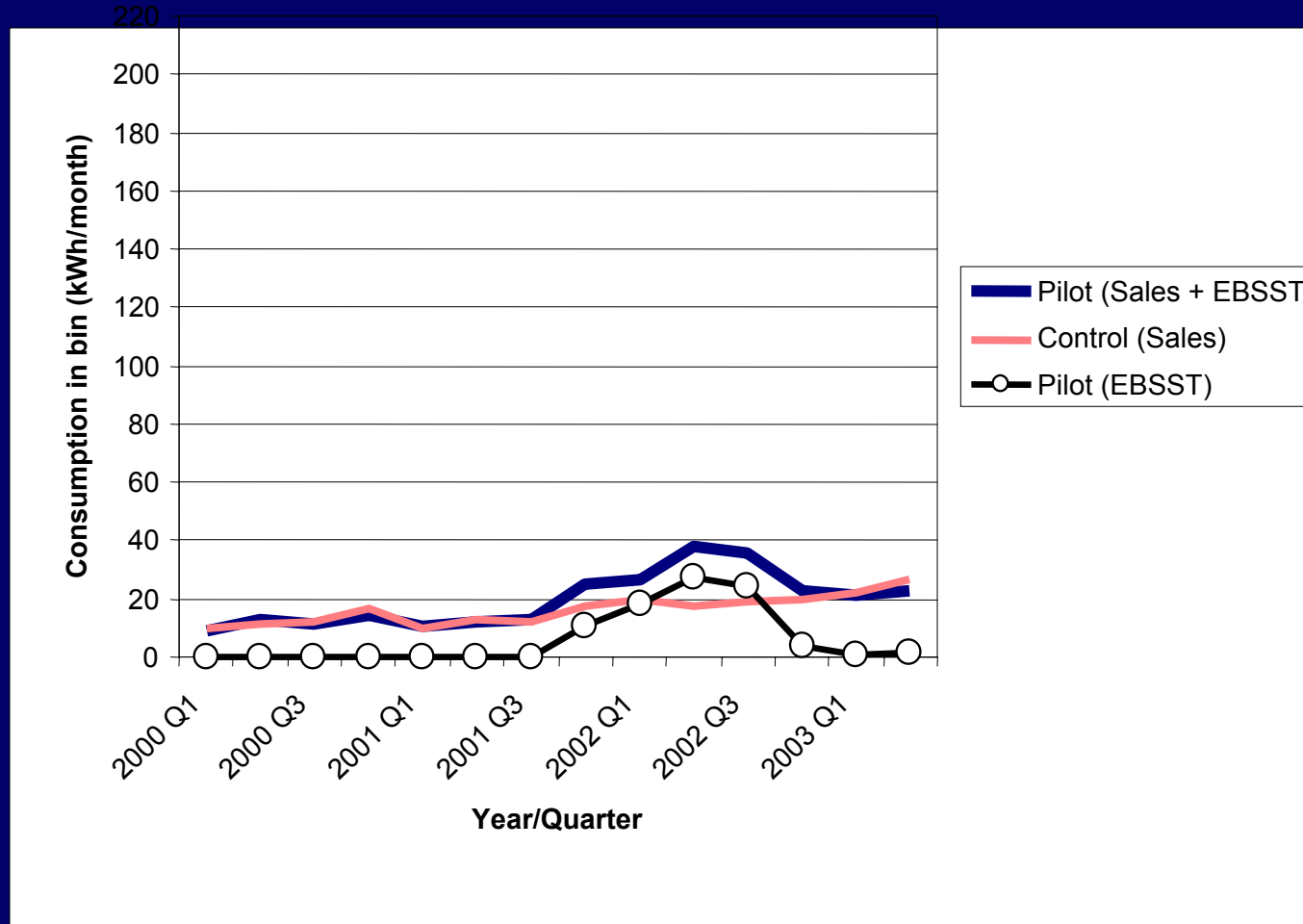
2015年南非冬季每周用电高峰负荷估计情况



Source: Eskom (draft)

South Africa's Free Electricity Experiment: Measured Effects (7-15 kWh/month)

南非进行“免费电力”试点的效果



Cost-saving Alternatives to Free Electricity: LPG

降低“免费电力”成本的方法: **LPG**

Peak Co-incident Factor	Annualized Savings (Rand)
100%	401
90%	353
80%	305
70%	258
60%	210
50%	162

Source: Howells et al., 2005. Draft