



# Indicators for Sustainable Energy Development: Thailand Case Study

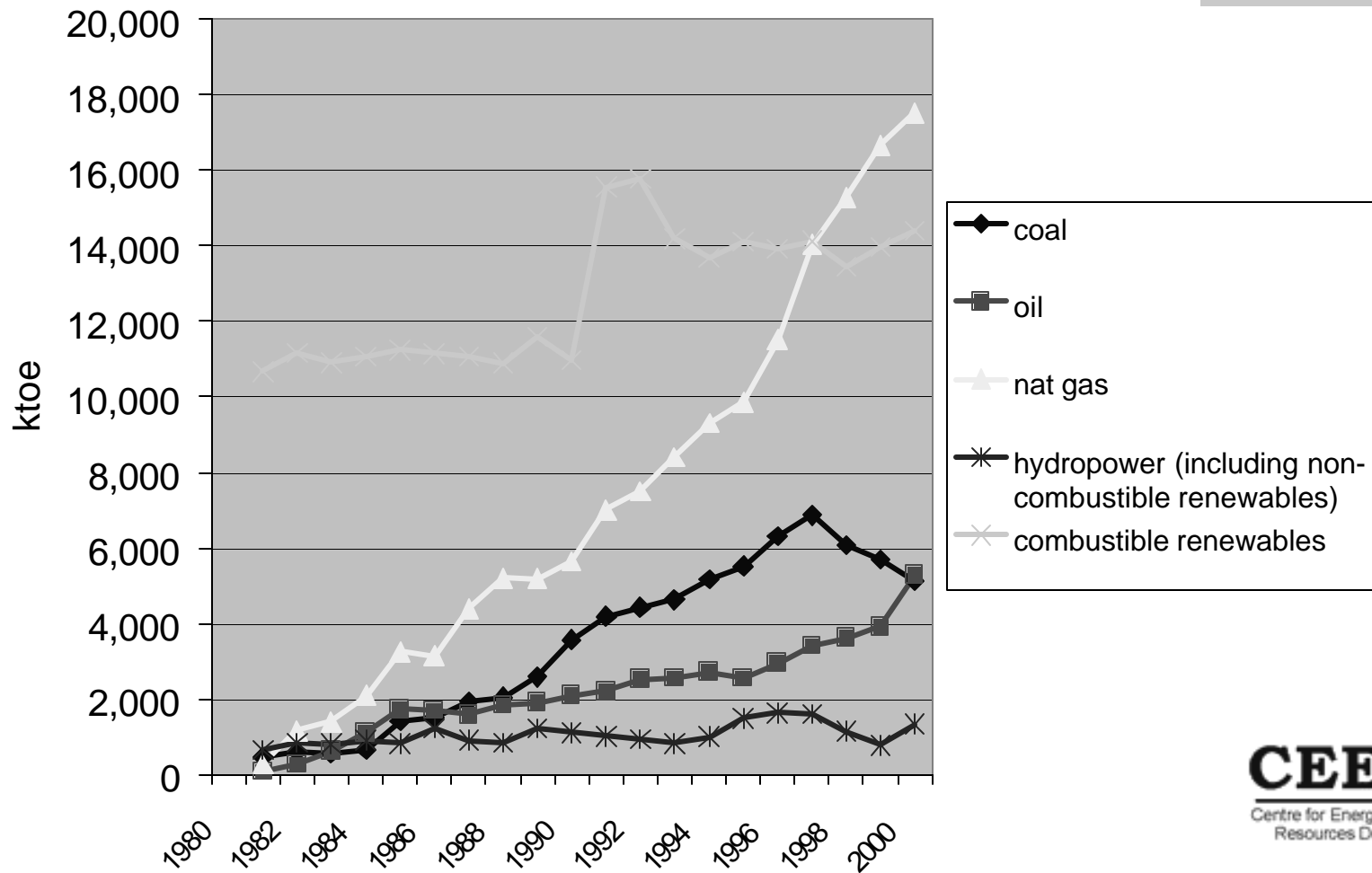
Jessie L. Todoc  
Monaliza Todoc  
Prof. Thierry Lefevre  
**Centre for Energy  
Environment Resources  
Development (CEERD)**  
Bangkok, Thailand

**International Atomic Energy  
Agency (IAEA)**  
**Third Research  
Coordination  
Meeting/Workshop**  
13-16 September 2004  
UNDESA, United Nations  
New York, U.S.A.

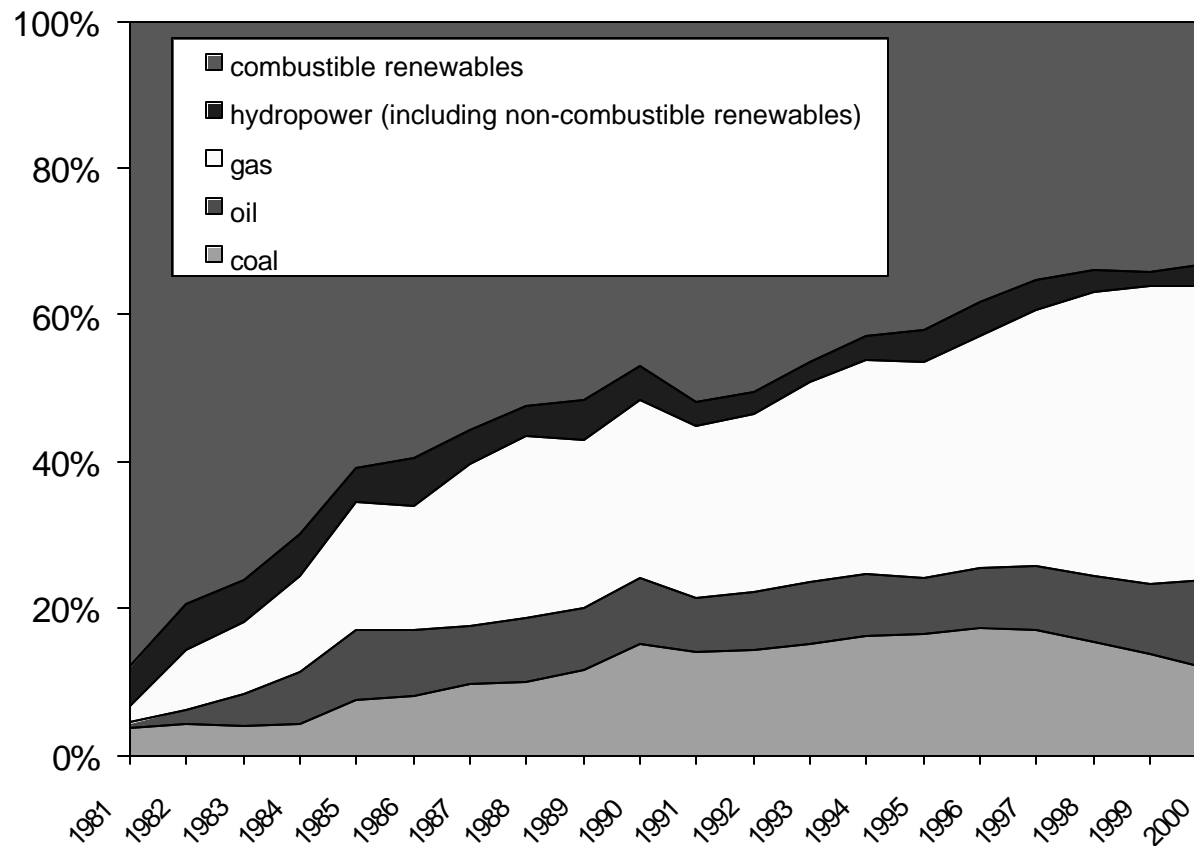
# Contents

- ◆ Overview of Thailand energy situation (using ISED)
- ◆ Energy data capability
- ◆ Major energy priority areas
- ◆ Energy efficiency policy and programs
- ◆ Assessment of energy efficiency performance using ISED
- ◆ Strategies for improvements in priority areas???
- ◆ Summary and conclusions

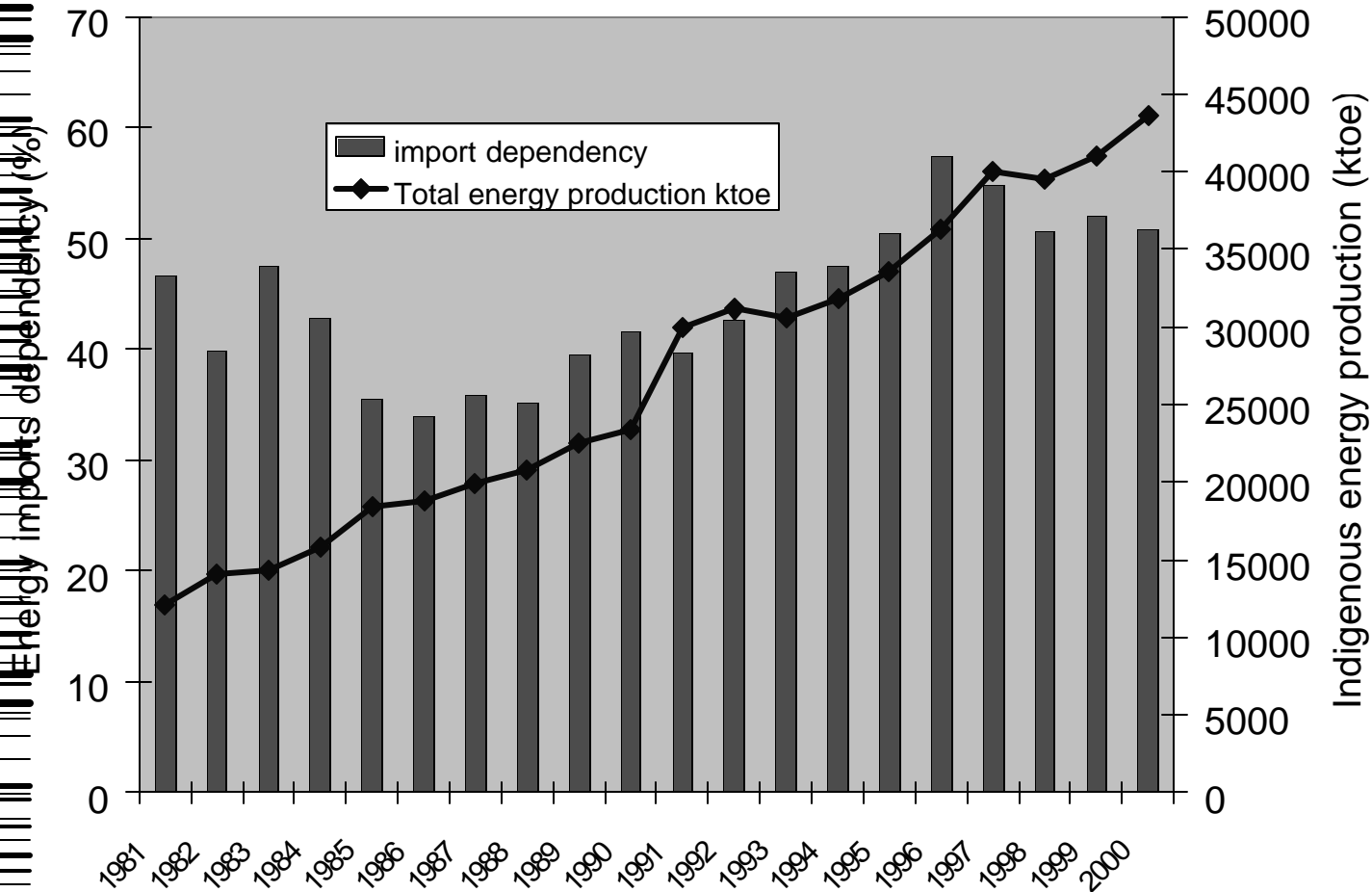
# Fast increasing indigenous energy production



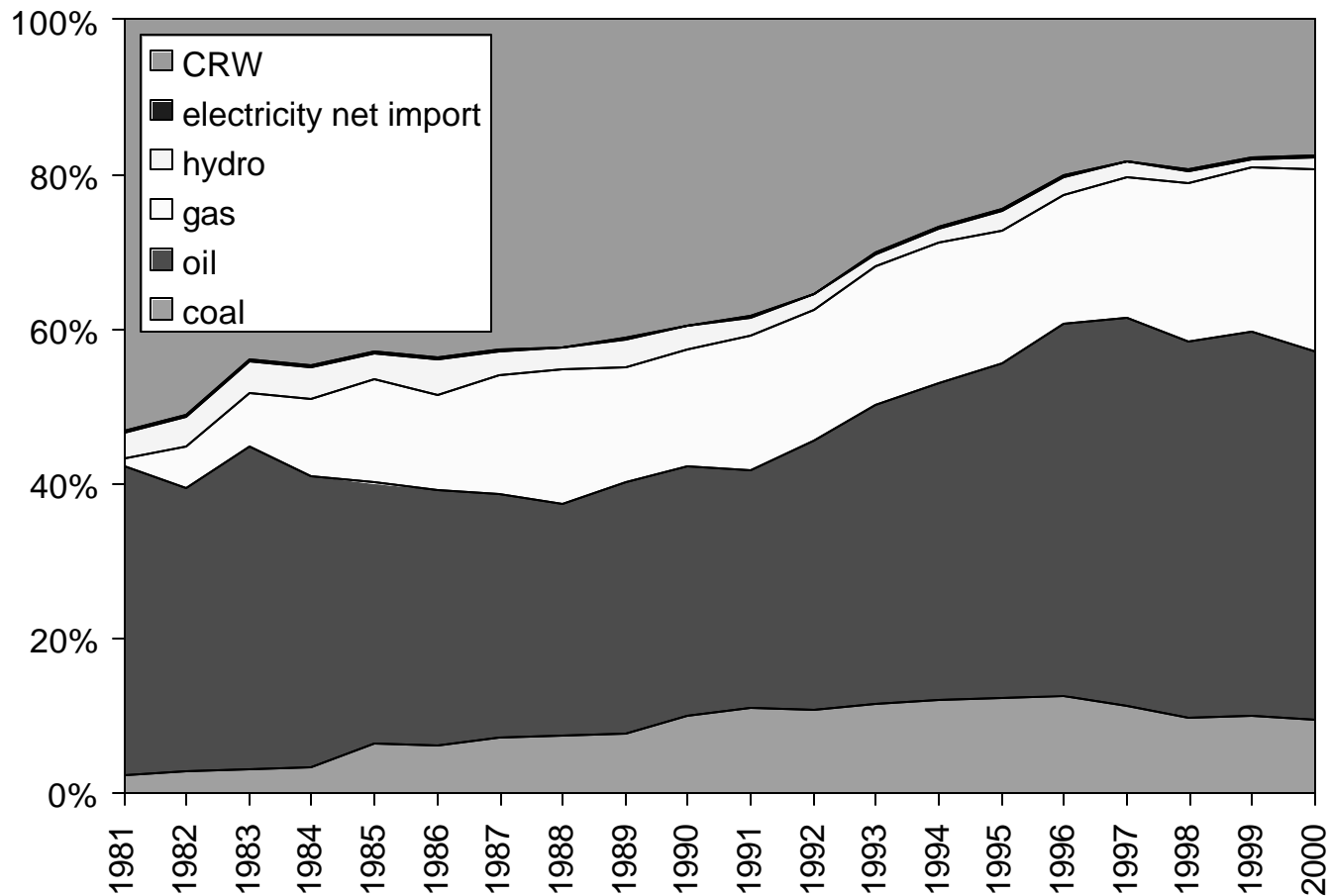
# Fast increasing share of natural gas in the indigenous energy mix



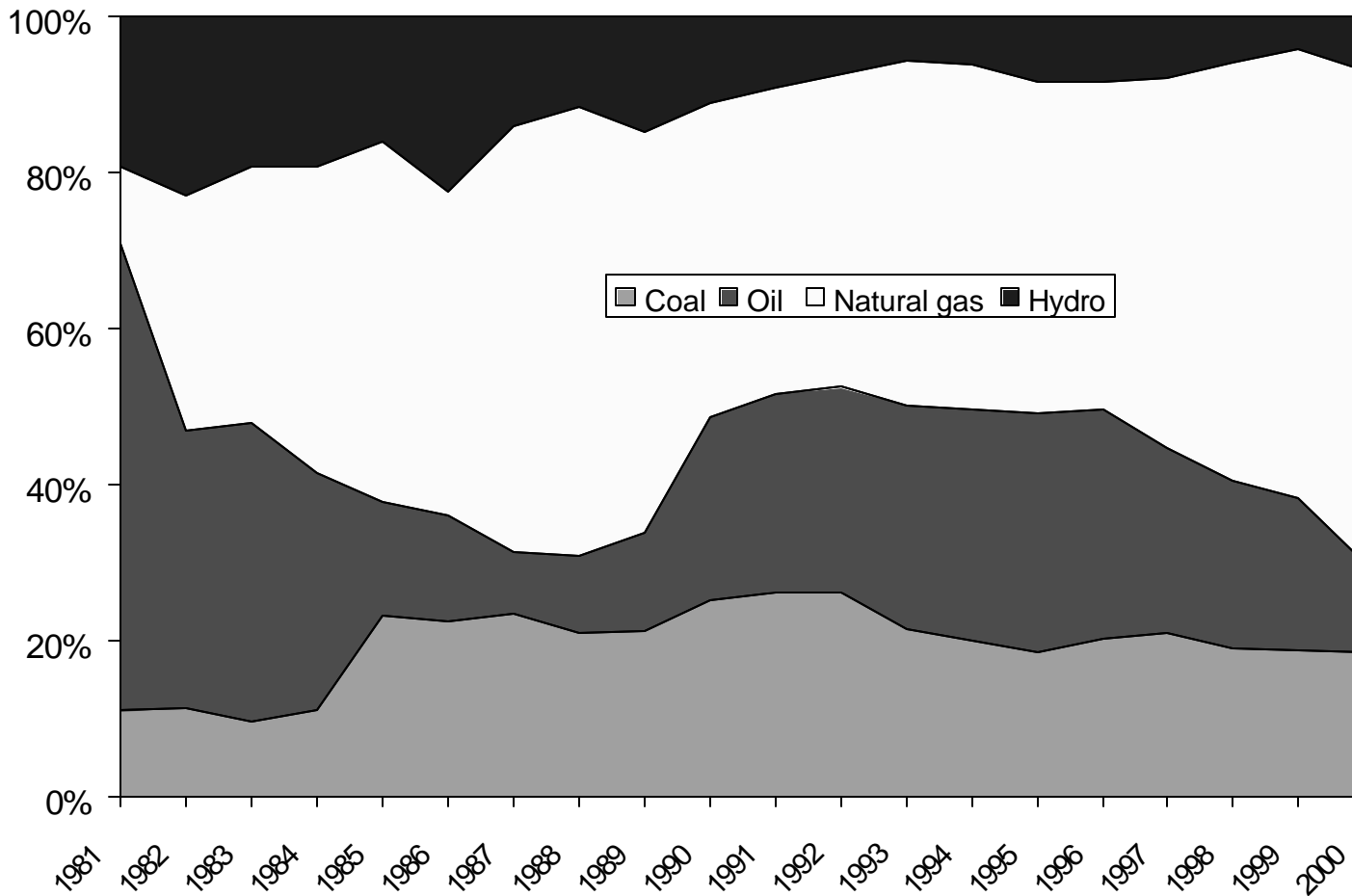
...but energy imports dependency, particularly on oil, remains high



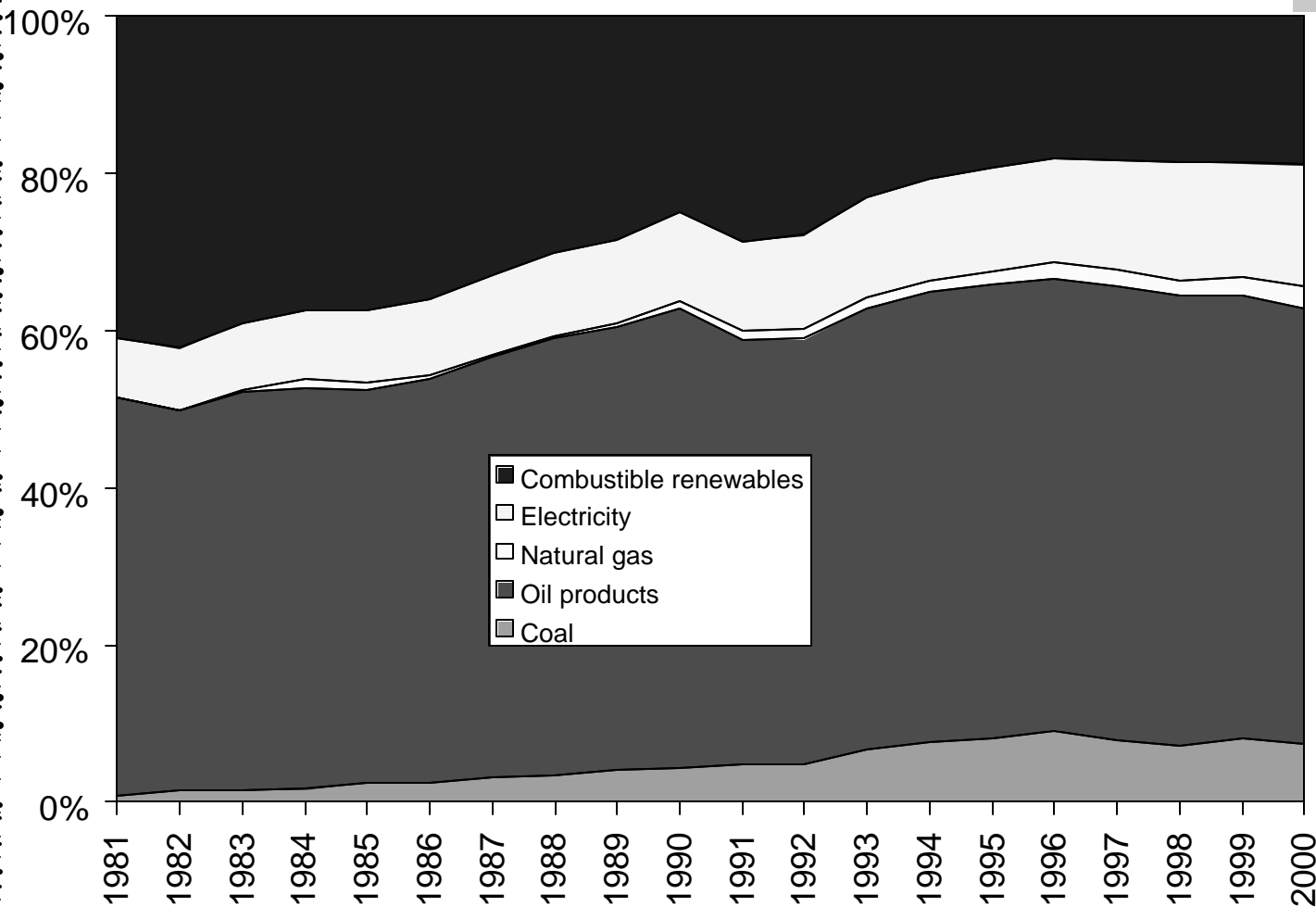
# High share of oil in the primary energy mix



# Indigenous natural gas, the main fuel for power generation

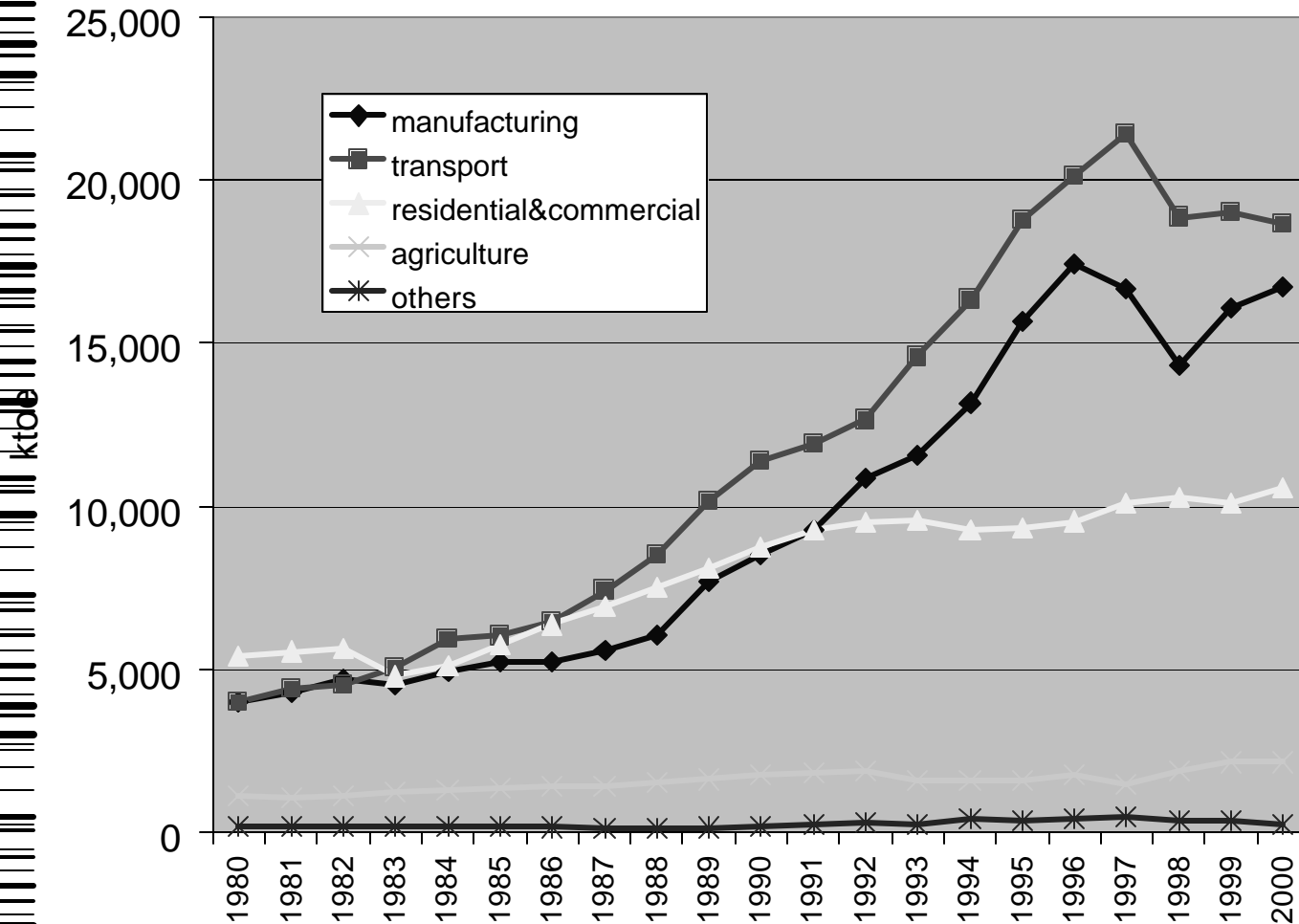


# Imported oil dominates final energy demand

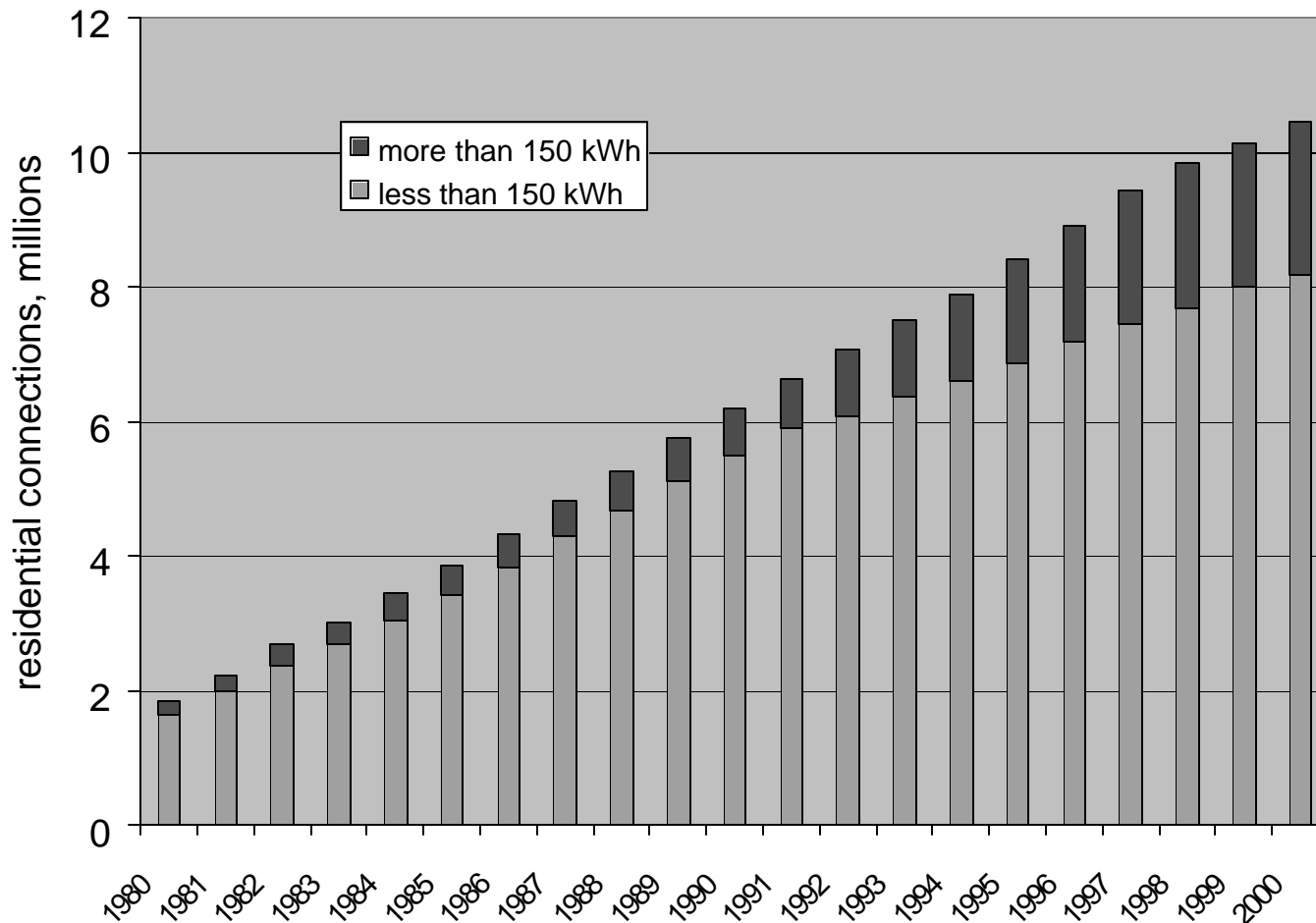




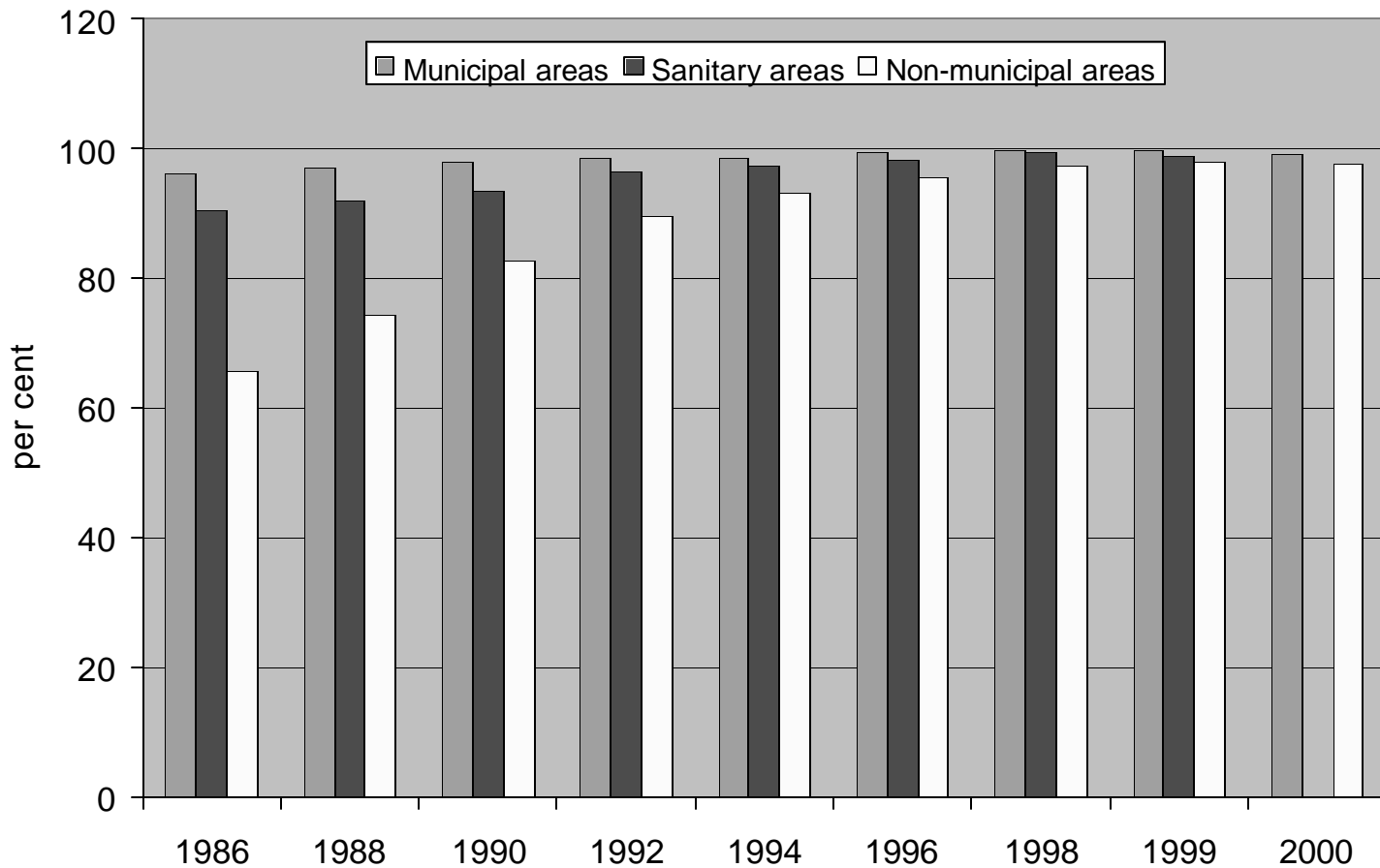
...due to high growth in transport and manufacturing final energy demand



# Successful rural electrification program...



...resulted in high electrification level even in rural areas



Note: Thailand provincial administration is divided into municipal, sanitary, and non-municipal areas.

# High (energy and other) data capability...

## Demographic and Socio-economic data

- National Statistical Office (NSO)
- Population and Housing Census
  - HSES
  - HECS
  - Other surveys

## Industrial statistics

- NSO
- Industrial Census
  - Manufacturing Industry Survey
- Office of Industrial Economics of Thailand
- Semi-annual statistics

## Transport statistics

- Ministry of Transport and Communications (MOTC)
- annual data on all transport modes
- Department of Land Transport
- State Railway of Thailand (SRT)
- Royal Irrigation Department
- Department of Customs
- Department of Aviation

## Energy and environment data

- Department of Alternative Energy Development and Efficiency (DEDE)
- Power in Thailand
  - Oil and Thailand
  - Thailand Energy Situation
- Energy Policy and Planning Office
- National Load Forecast
- EGAT
- Power Development Plan
  - Annual Report
- PEA
- Annual report
- MEA
- Annual report

# ...but still some data are not available

- ◆ NSO census and survey do not include statistics on production of various industries
- ◆ Office of Industrial Economics of Thailand's semi-annual report on industrial statistics (production, sale and sales values) covers only few industries, and publication of these statistics started only in mid-1990s
- ◆ No data available on passenger-kilometer for road and urban transport
- ◆ No pipeline transport statistics available in the country
- ◆ Energy data do not give detailed information beyond the sectoral level
  - energy consumption of road transport is not classified into passenger or freight
  - energy use of cement, glass, and other non-metallic products industries are lumped together



# International sources of data on Thailand

---

---

- ◆ ADB's *Key Indicators*
- ◆ United Nations' various statistics
- ◆ World Bank's *World Development Indicators*
- ◆ IEA/OECD's *Energy Balances and Statistics for Non-OECD Countries and Energy Prices and Taxes*

# Major energy priority areas: *energy strategies for competitiveness*

- ◆ Increase energy efficiency
  - reduce country's energy elasticity from the current 1.4:1 to 1:1 by 2007
- ◆ Develop renewable energy
  - increase the share of renewable energy from 0.5% of the commercial primary energy in 2002 to 8% in 2011
- ◆ Enhance energy security
  - enhance security of electricity supply and energy supply from indigenous fossil fuels
    - expand the availability of domestic energy reserves from 30 years to 50 years
- ◆ Develop Thailand as regional energy center
  - to shift its role from being an energy buyer to energy trader

# Focus on energy efficiency

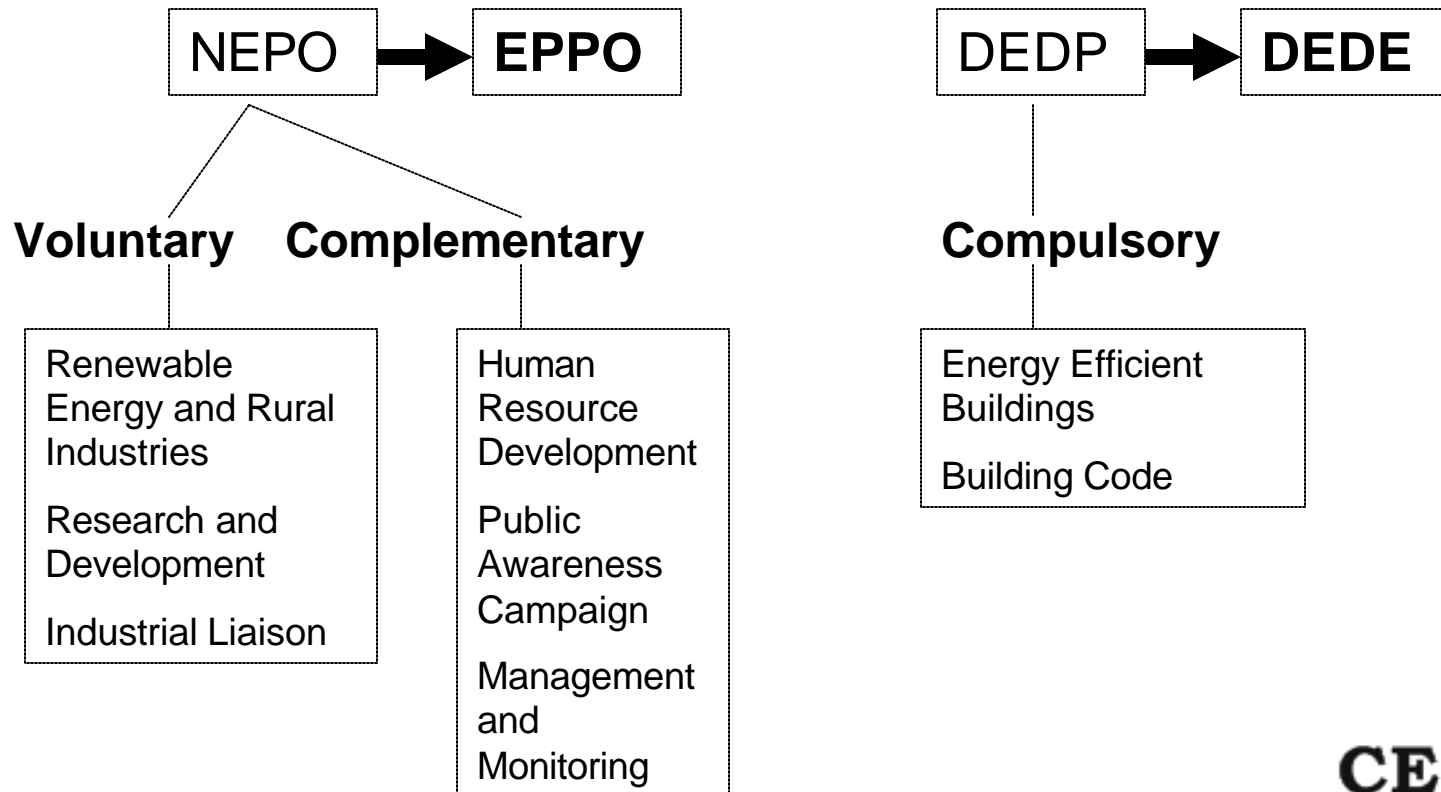
- ◆ Thailand has been a good example in terms of energy conservation efficiency policy implementation;
- ◆ The policy has been introduced since the 1990s so programs are already in full-scale implementation;
- ◆ Energy data is well-established at the aggregate and sectoral level; and
- ◆ It is expected that the analytical framework developed in this study can be applied to other countries.



# Thailand energy efficiency policy and programs

- ◆ Energy Conservation Act of 1992
  - Energy conservation in factories-designated factories
  - Energy conservation in large buildings-designated buildings
  - Efficiency standards for appliances, building materials and control systems-producers and distributors of energy appliances, equipment, and machineries
- ◆ Energy Conservation Program
- ◆ ENCON Fund
- ◆ Demand-Side Management (DSM) Program

# Energy Conservation Program





# ENCON Fund



- ◆ General support
- ◆ 30% subsidy and Standard Measures program
- ◆ Energy Efficiency (EE) Revolving Fund

# DSM phase I (1993-1998)

## DSM targeted reductions (1993)

- 238 MW peak demand
- 1,427 GWh generation
- 1.16 million tons of CO<sub>2</sub> emissions

## DSM achieved reductions (1998)

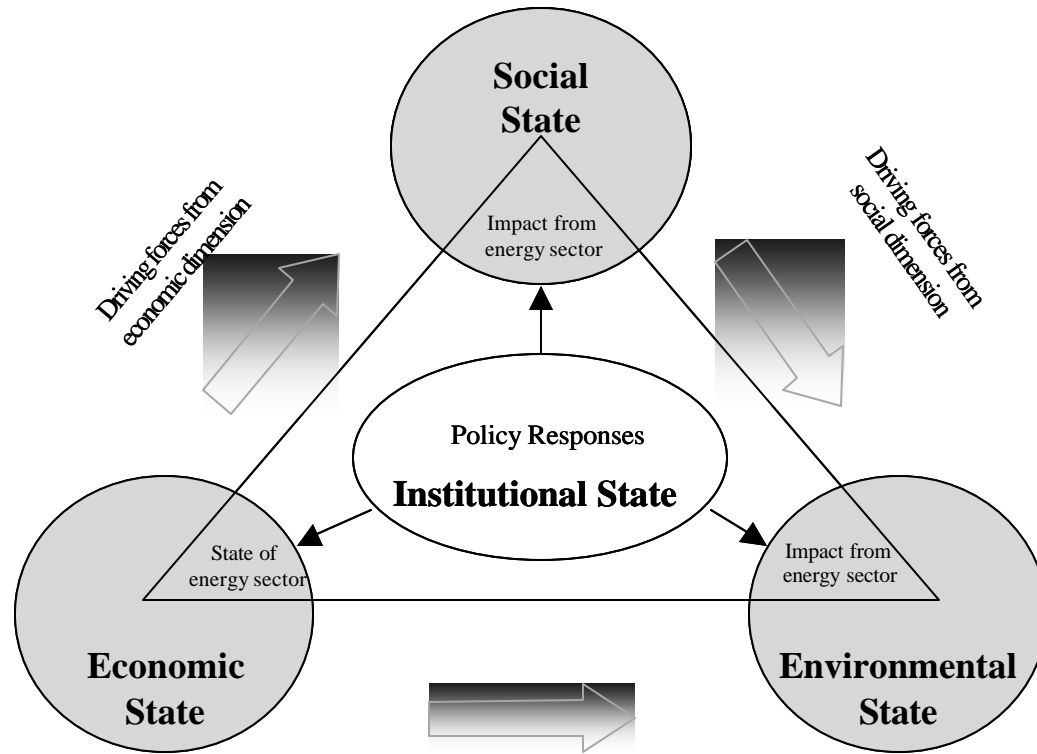
- 468 MW peak demand
- 2,194 GWh generation
- 1.64 million tons of CO<sub>2</sub> emissions

- ◆ 6 sub-programs: Residential Program, Commercial/Governmental Building Program, Industrial Sector Program, Load Management Program, Energy Conservation Attitude Promotion Program, and Program Monitoring and Evaluation
- ◆ first three programs focused on energy-efficient appliances, particularly lighting equipment, high-efficiency refrigerators and air-conditioners, and high-efficiency motors
- ◆ Total budget of US\$189 million, of which GEF = US\$15.5 million, OECF = US\$25 million in concessional loans, and EGAT

# DSM phase II (2002-2006)

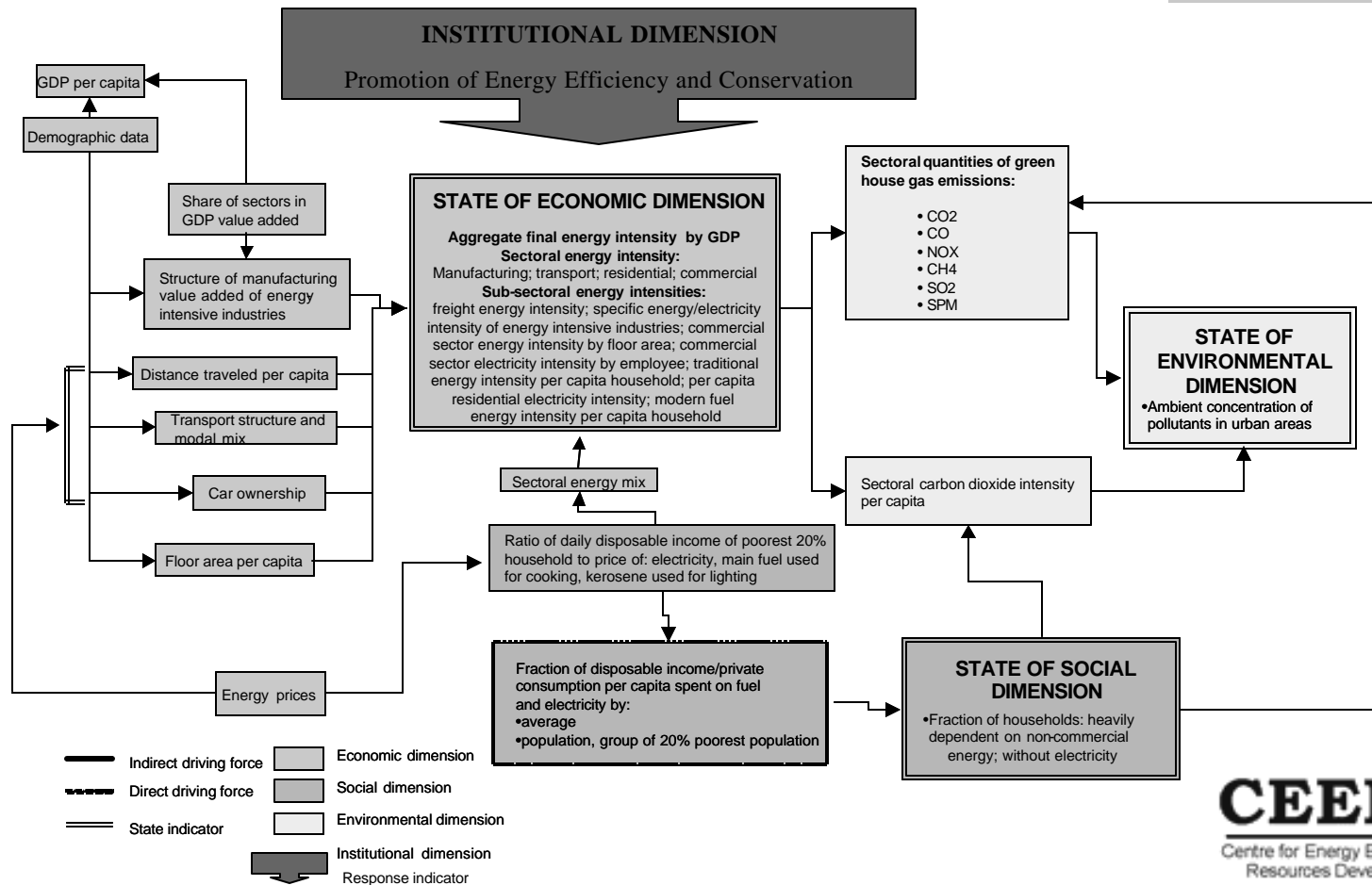
- ◆ 13 sub-programs
- ◆ 330 green learning rooms to create awareness of energy conservation in the curriculum
- ◆ 632 MW peak demand saving
- ◆ 2,508 GWh energy saving
- ◆ 1.85 million tons of CO<sub>2</sub> emissions
- ◆ program will cost Baht 2,155 million (USD53.875 m): Baht 1,700 million (USD 42.5 m) for the 13 DSM programs and Baht 455 million (USD 11.375 m) for the attitude creation programs

# ISED framework to assess energy efficiency performance



Driving forces from energy sector  
of economic dimension

# ISED framework for Thailand



# ISED Indicators Used

- 1 Population
- 2 GDP per capita
- 3 End-use energy prices w/ and w/o tax/subsidy**
- 4 Sectoral share in GDP (sectoral GVA)
- 5 Distance traveled per capita
- 6 Freight transport activity
- 8 Manufacturing value added by selected energy intensive industries
- 9 Sectoral energy intensity**
- 10 Final energy intensity of selected energy-intensive products

Note: In bold are ISED core indicators.



# ISED Indicators Used (cont.)

20 Ratio of daily disposable income/private consumption per capita of poorest 20% of population

**21 Fraction of disposable income**

**22 Fraction of households heavily dependent on non-commercial energy**

**23 Quantities of air pollution emissions**

**24 Ambient concentration**

**26 Quantities of GHG (CO<sub>2</sub>) emissions**

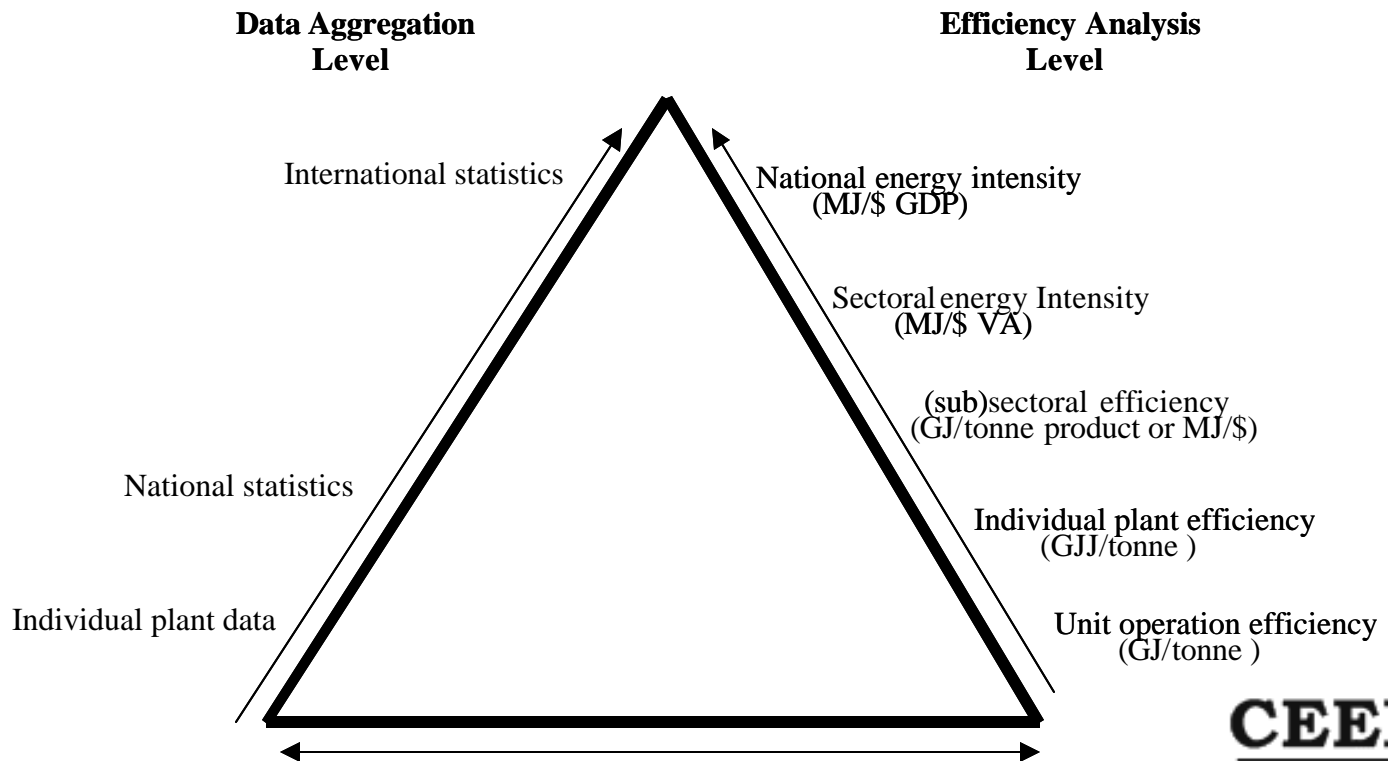
Note: In bold are ISED core indicators.

# Key Derived Indicators

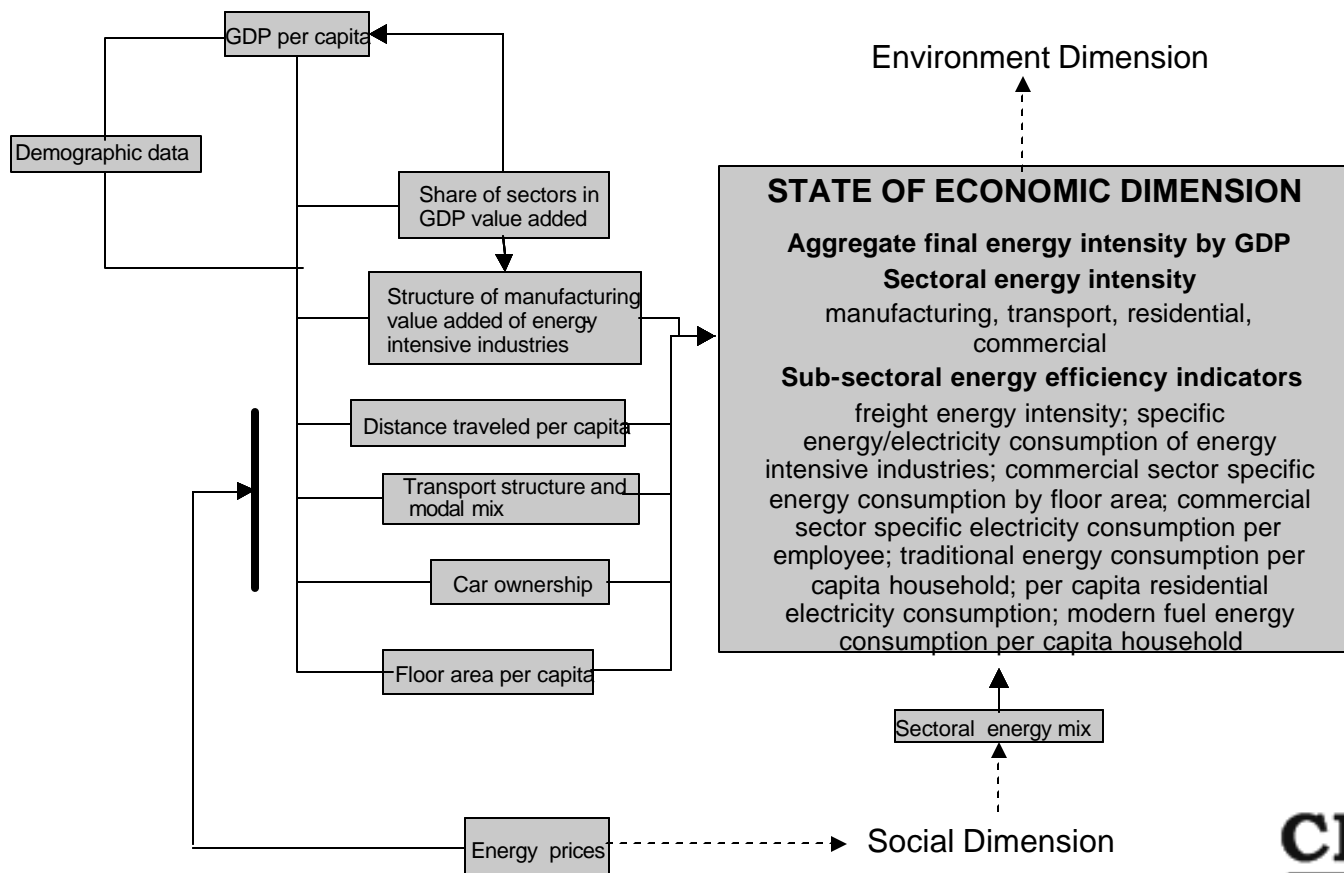
- ◆ Employment population
- ◆ Commercial area per employee
- ◆ Car/motorcycle ownership
- ◆ Per capita transport energy consumption
- ◆ Service sector specific energy consumption per unit of floor space
- ◆ Service sector specific electricity sector consumption per employee
- ◆ Floor area per capita
- ◆ Residential sector energy and electricity intensity by private consumption
- ◆ Proportion of households using traditional and modern fuels by type of fuel
- ◆ Pollutants and GHG emissions from from manufacturing and residential/commercial sectors
- ◆ Sectoral CO2 intensity

# Energy efficiency indicators

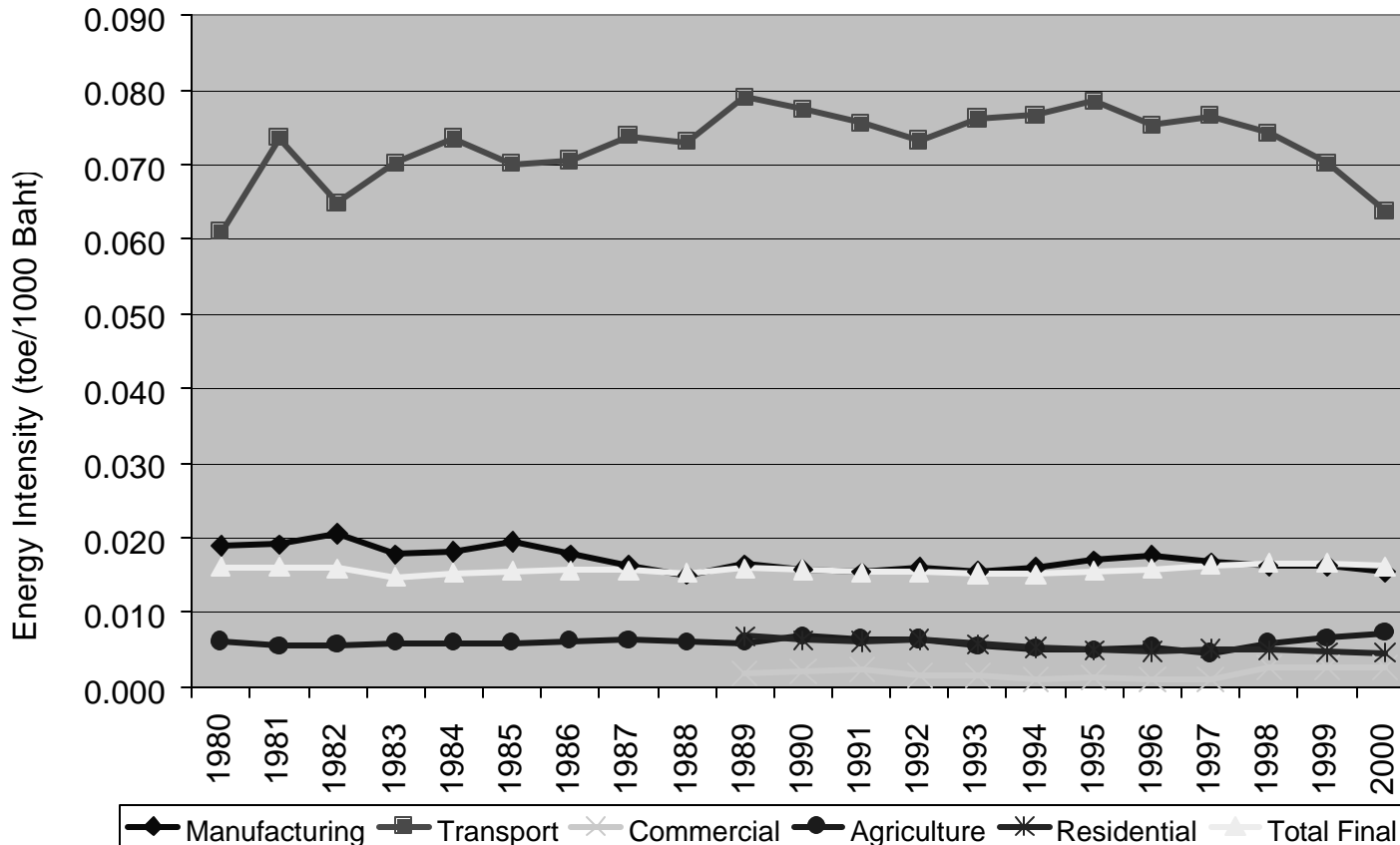
## The Energy Efficiency Indicator Pyramid



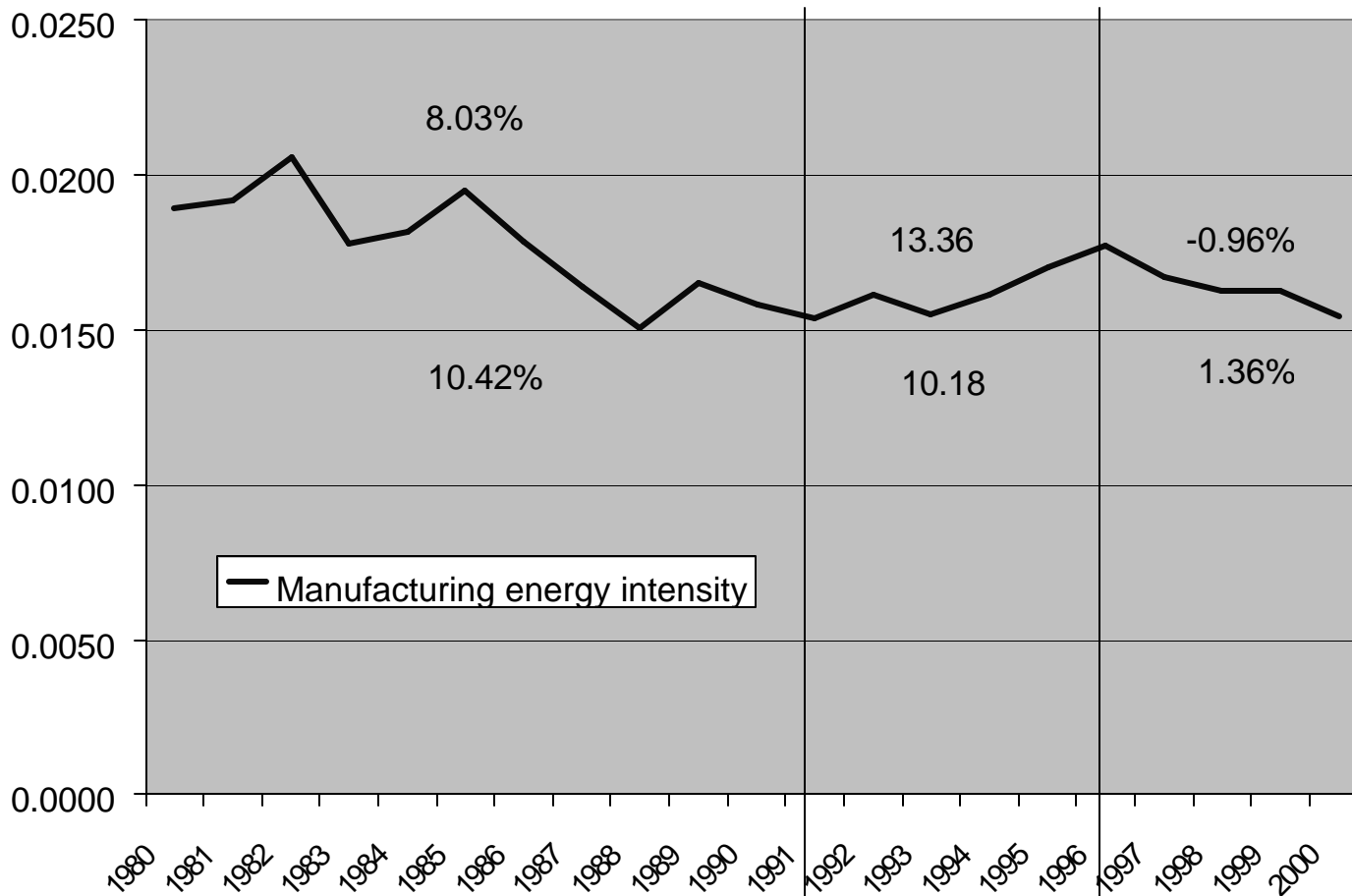
# Economic Dimension



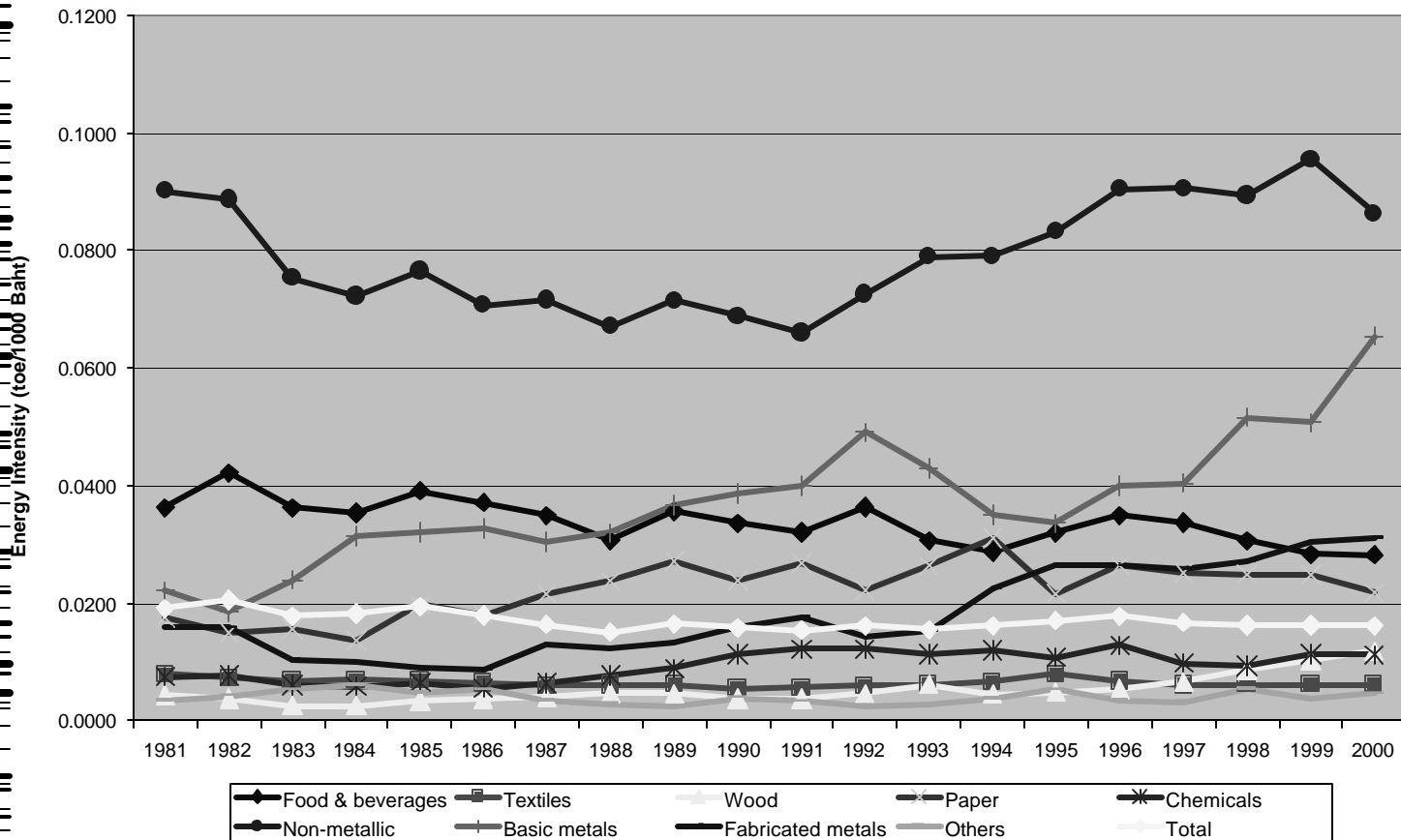
# Aggregate and sectoral energy intensity



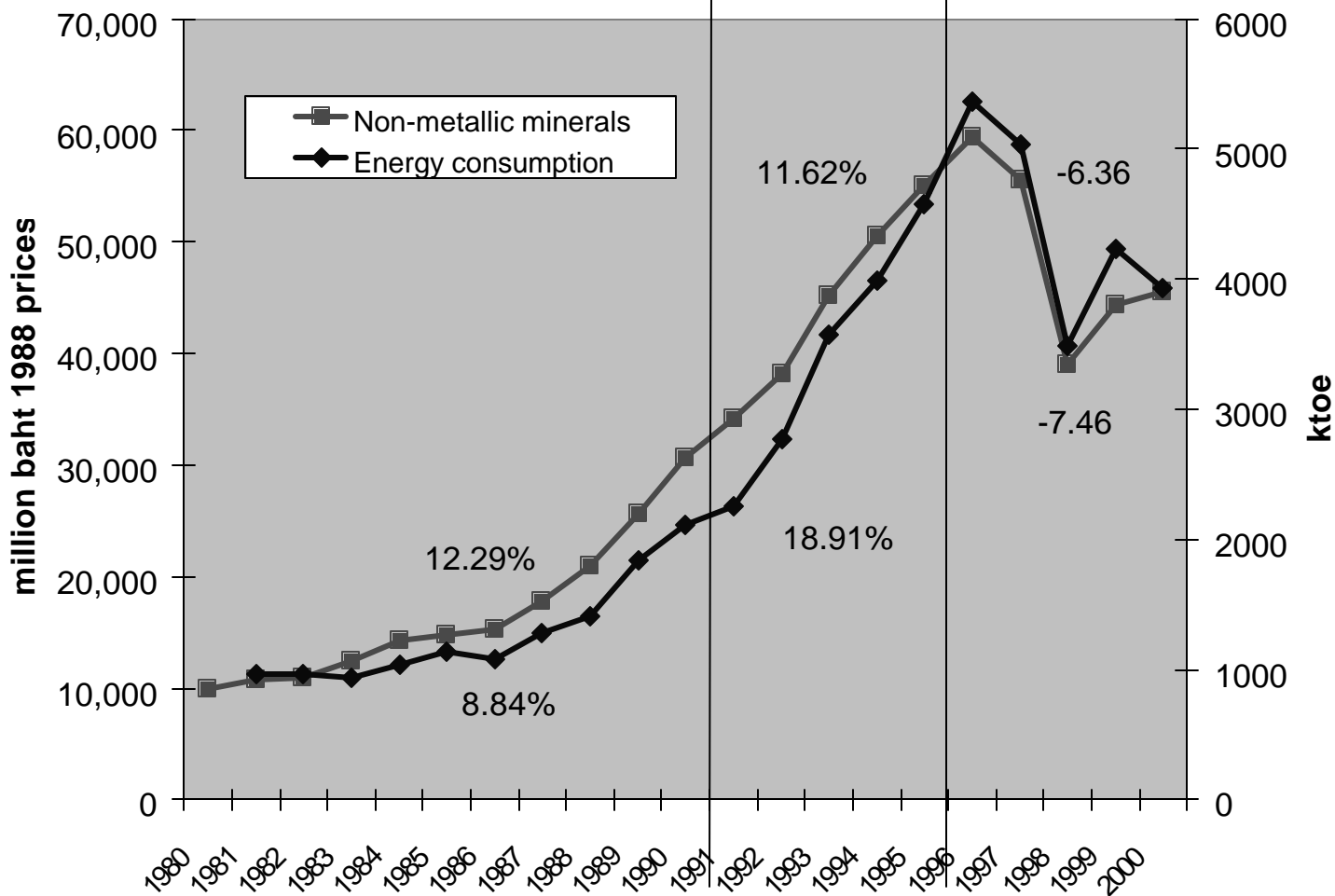
# Energy intensity of manufacturing



# Energy intensity of manufacturing subsectors



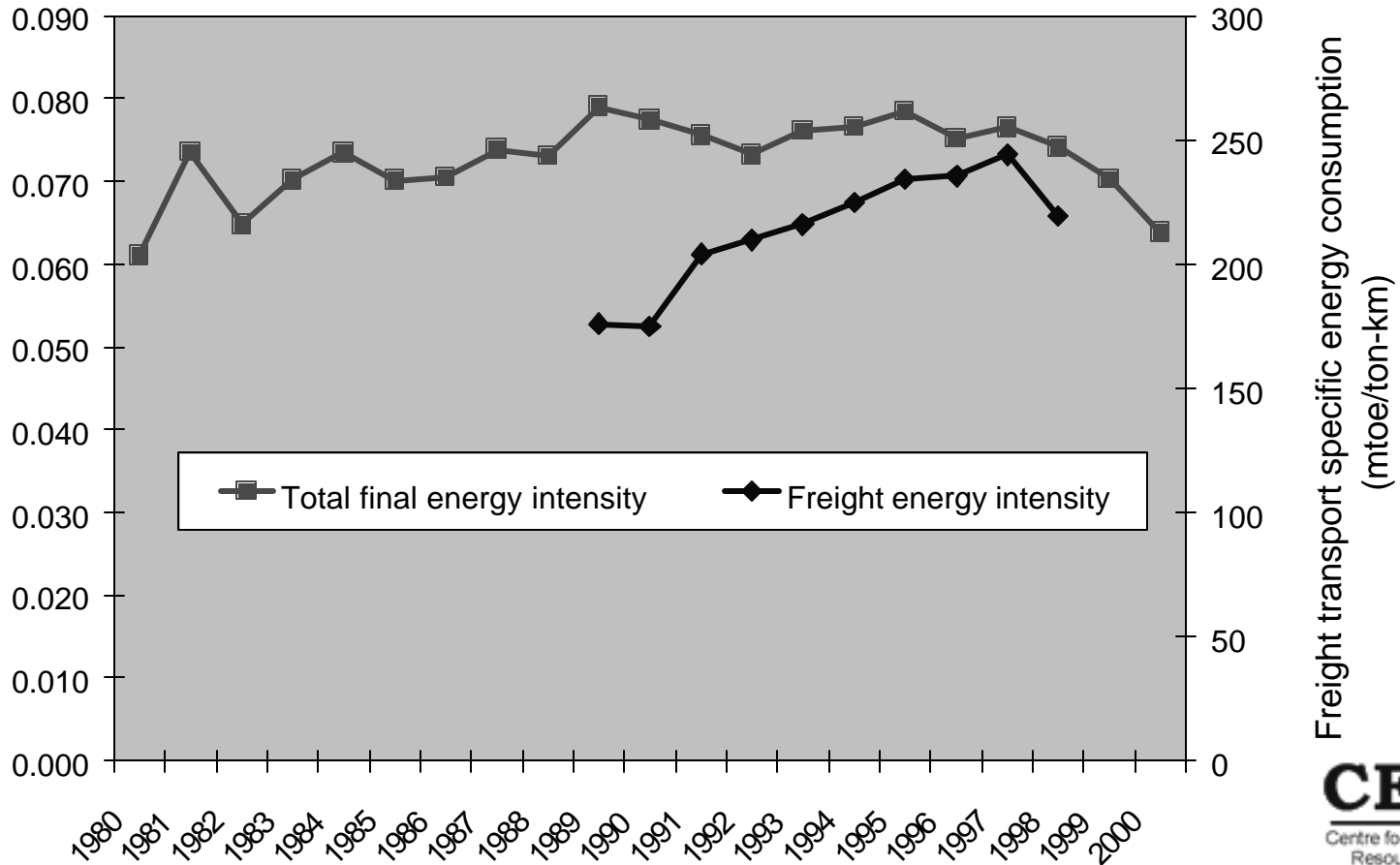
# Energy intensity in non-metallic minerals manufacturing





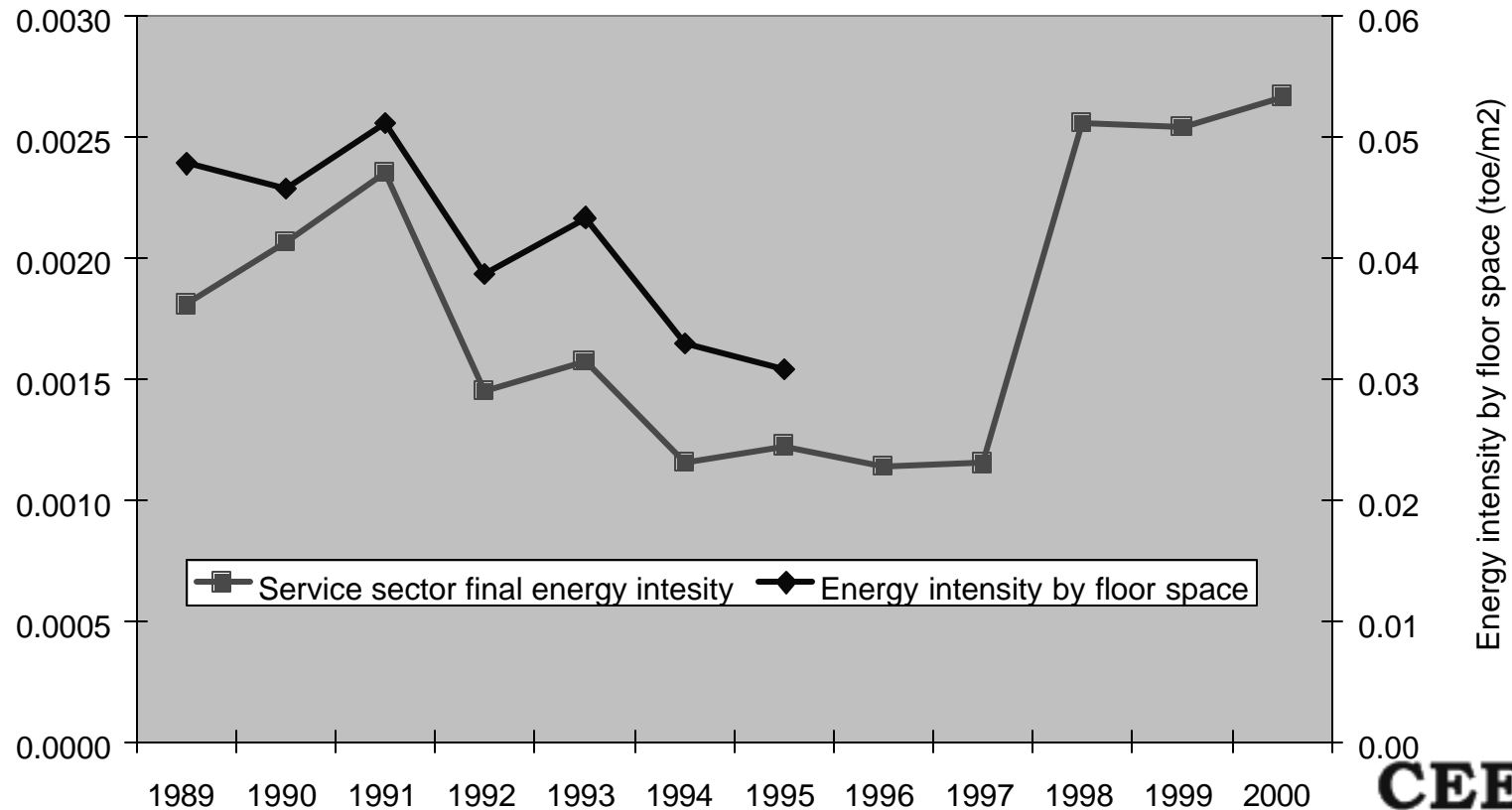
# Transport sector energy intensity

Transport final energy intensity (toe/000 Baht)

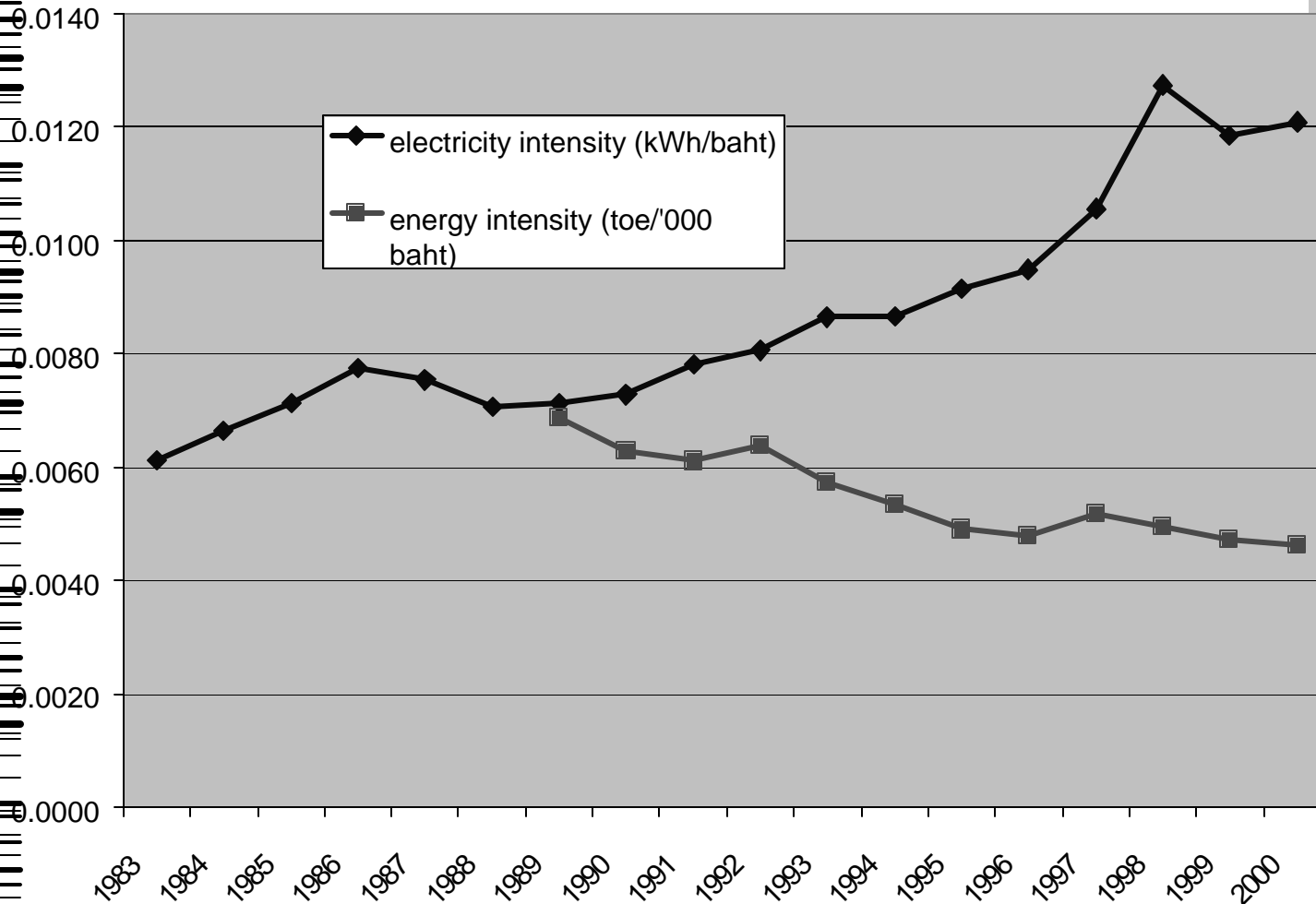


Freight transport specific energy consumption (mtoe/ton-km)

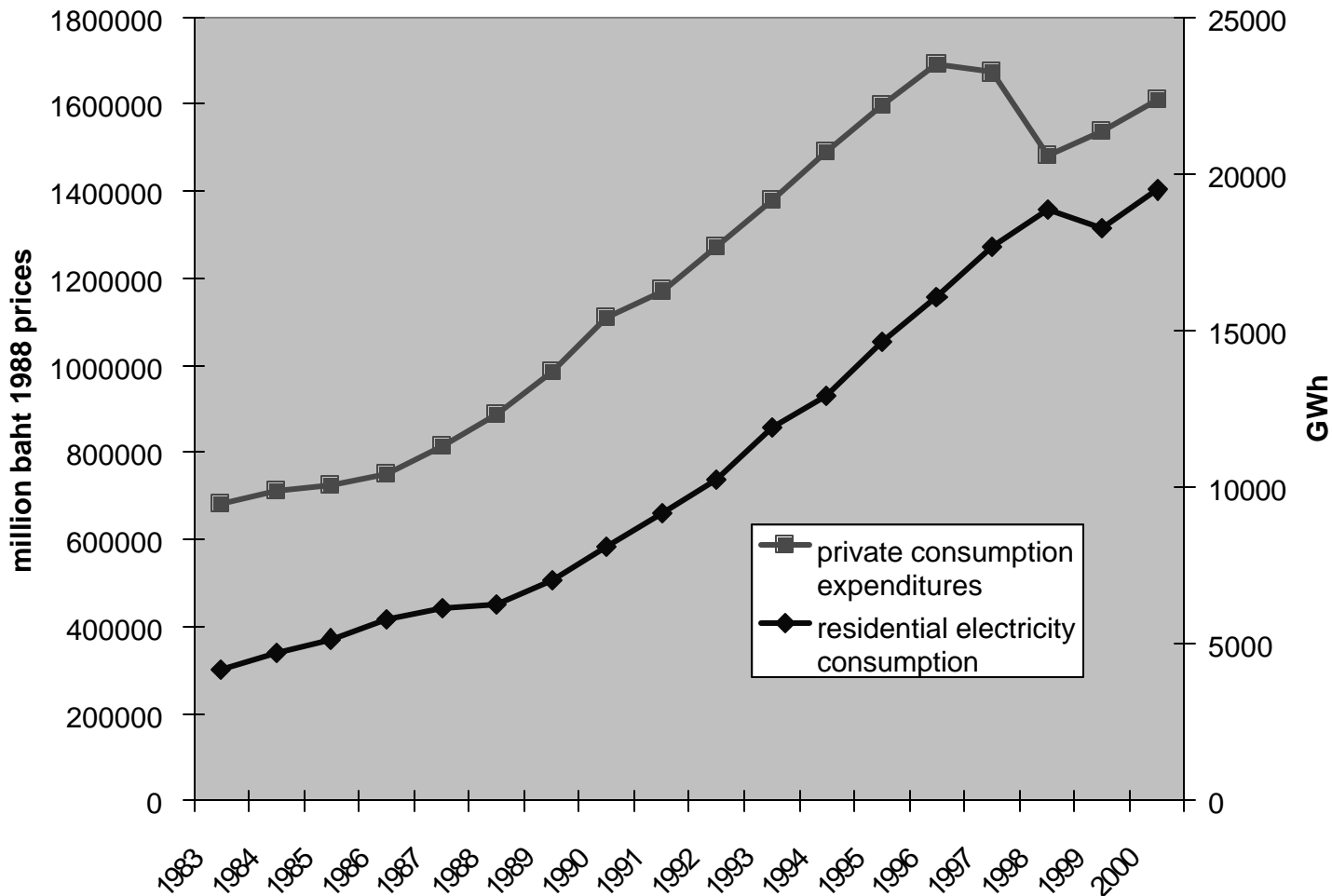
# Service sector energy efficiency indicators



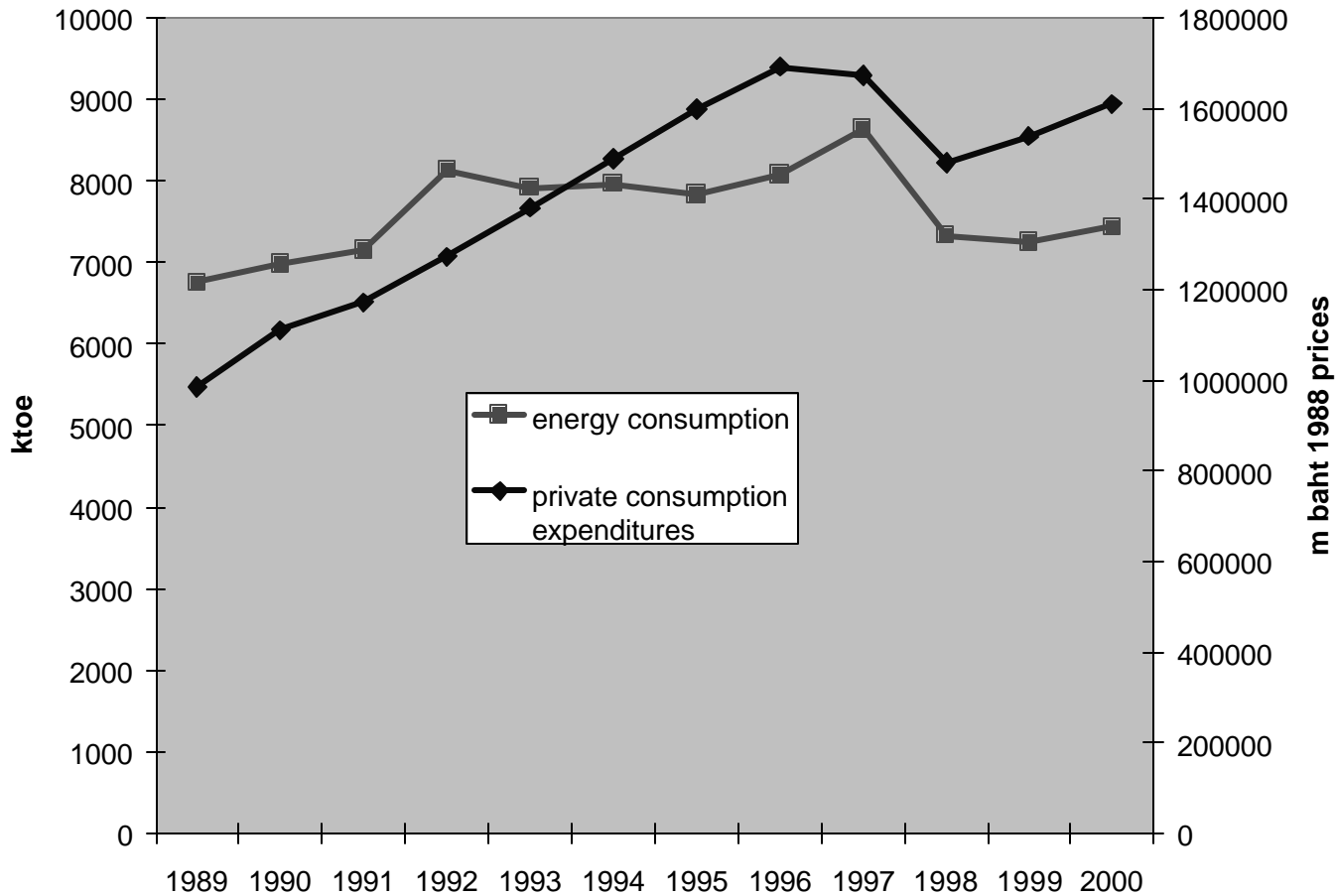
# Residential sector energy and electricity intensity



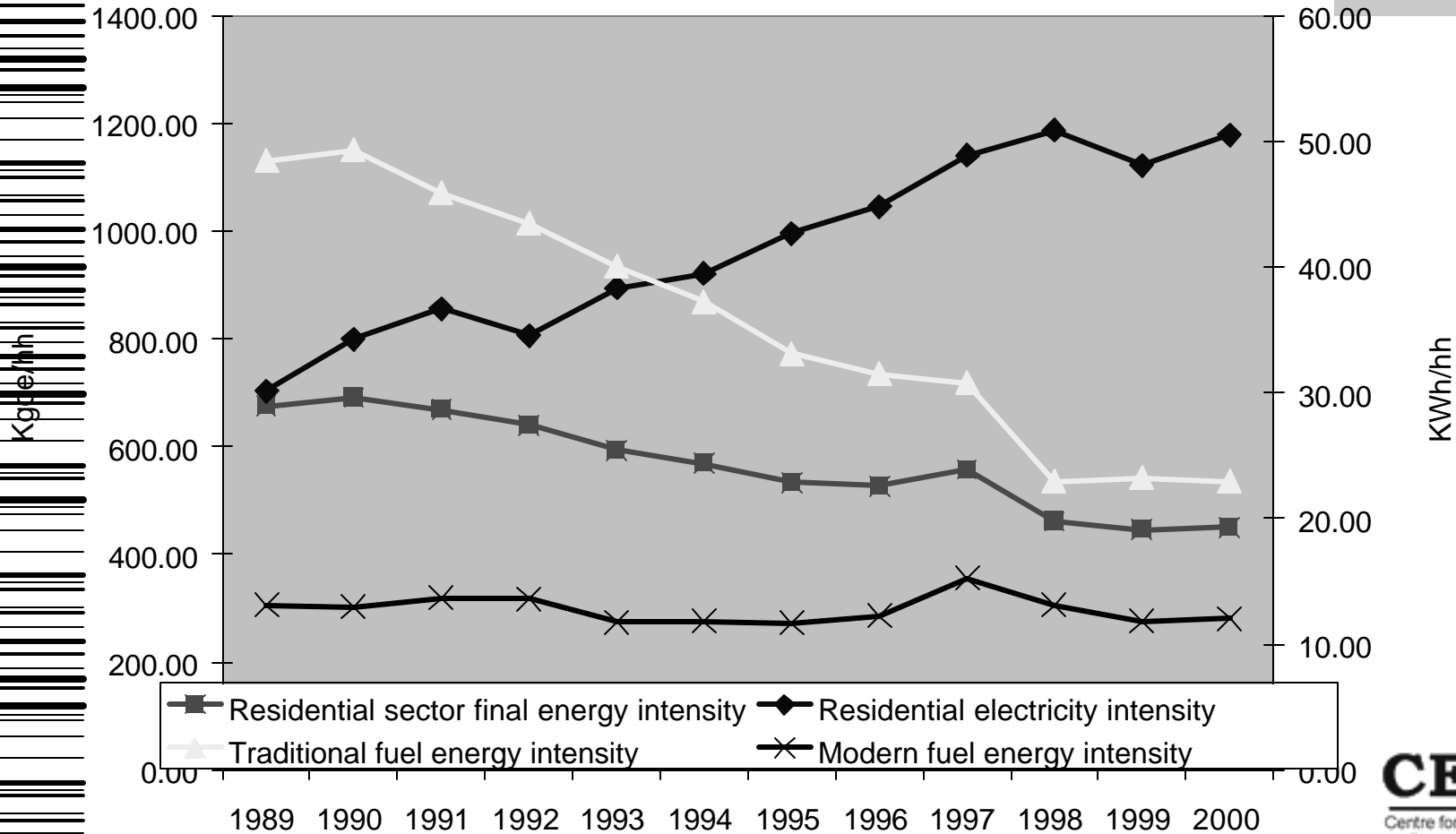
# Residential sector electricity intensity



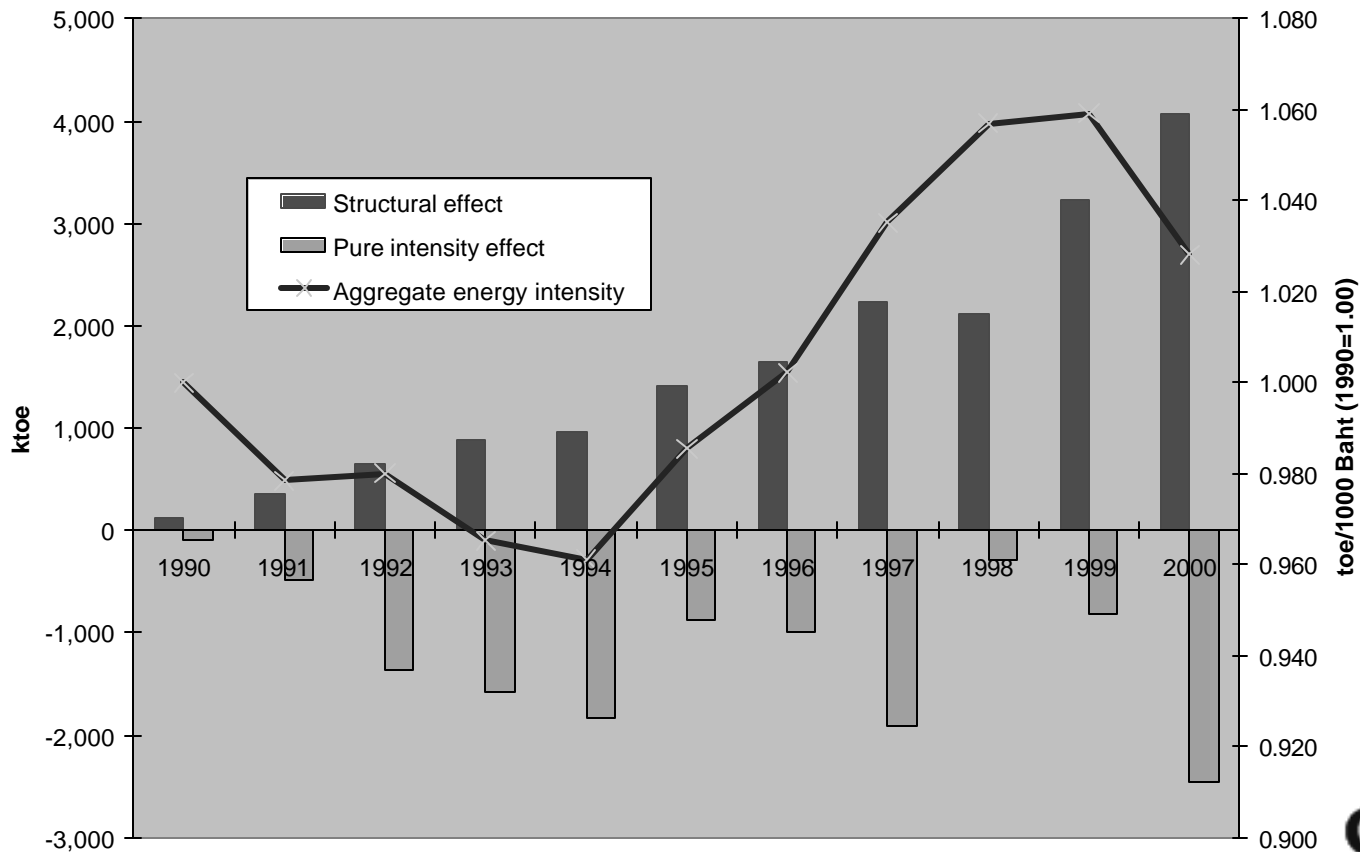
# Residential sector energy intensity



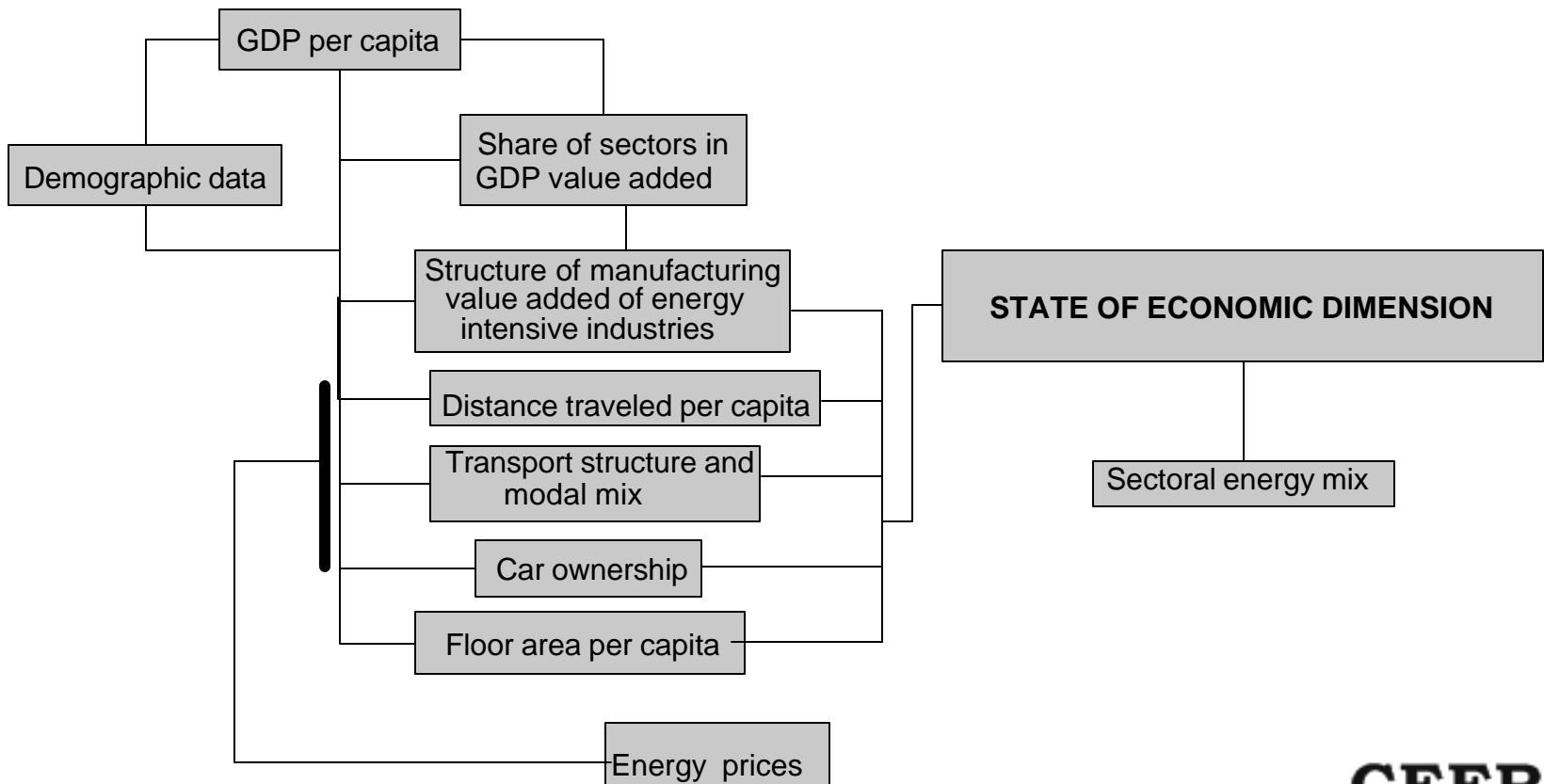
# Household energy consumption



# Decomposition of aggregate energy intensity

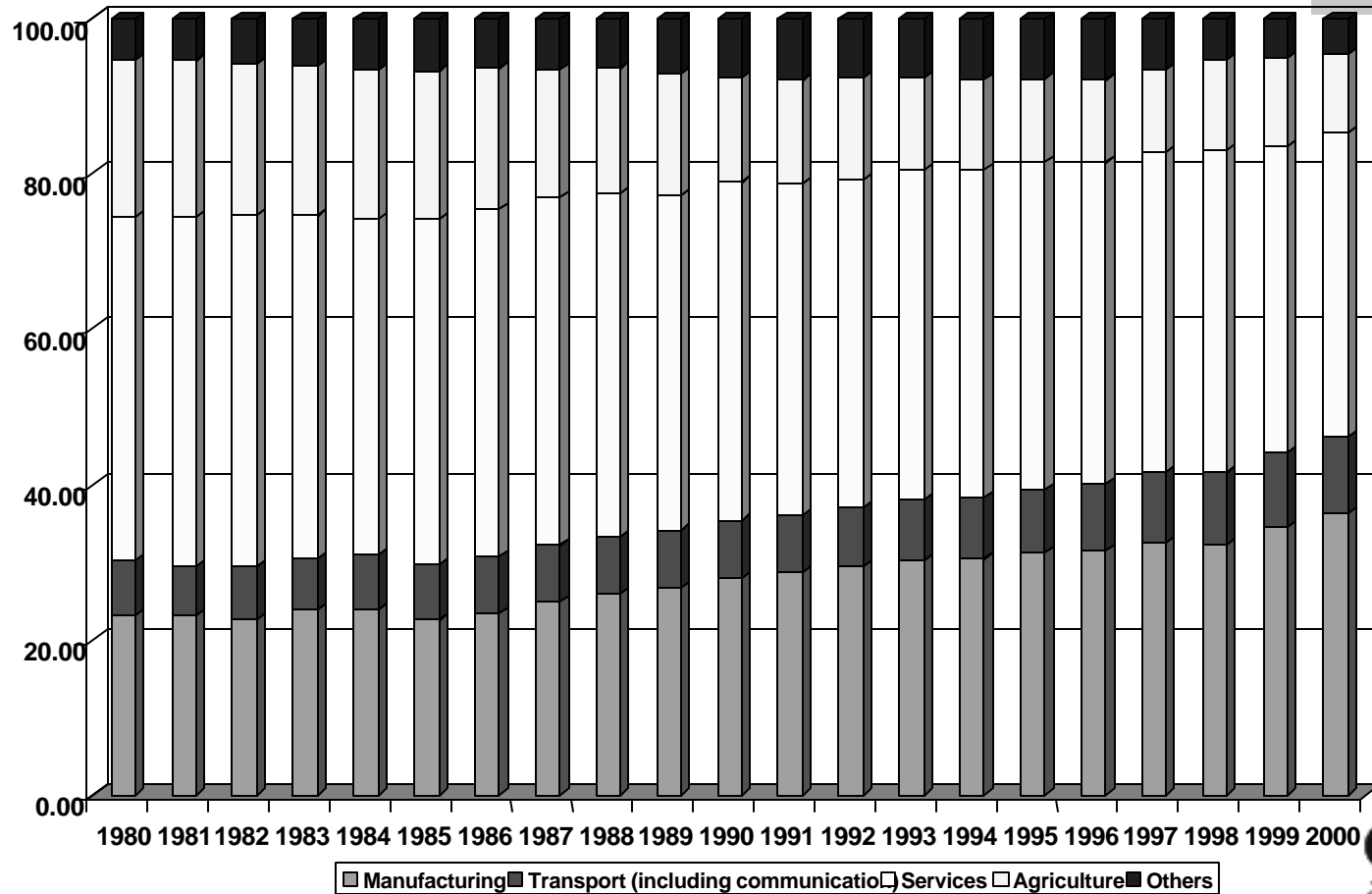


# The economic driving forces

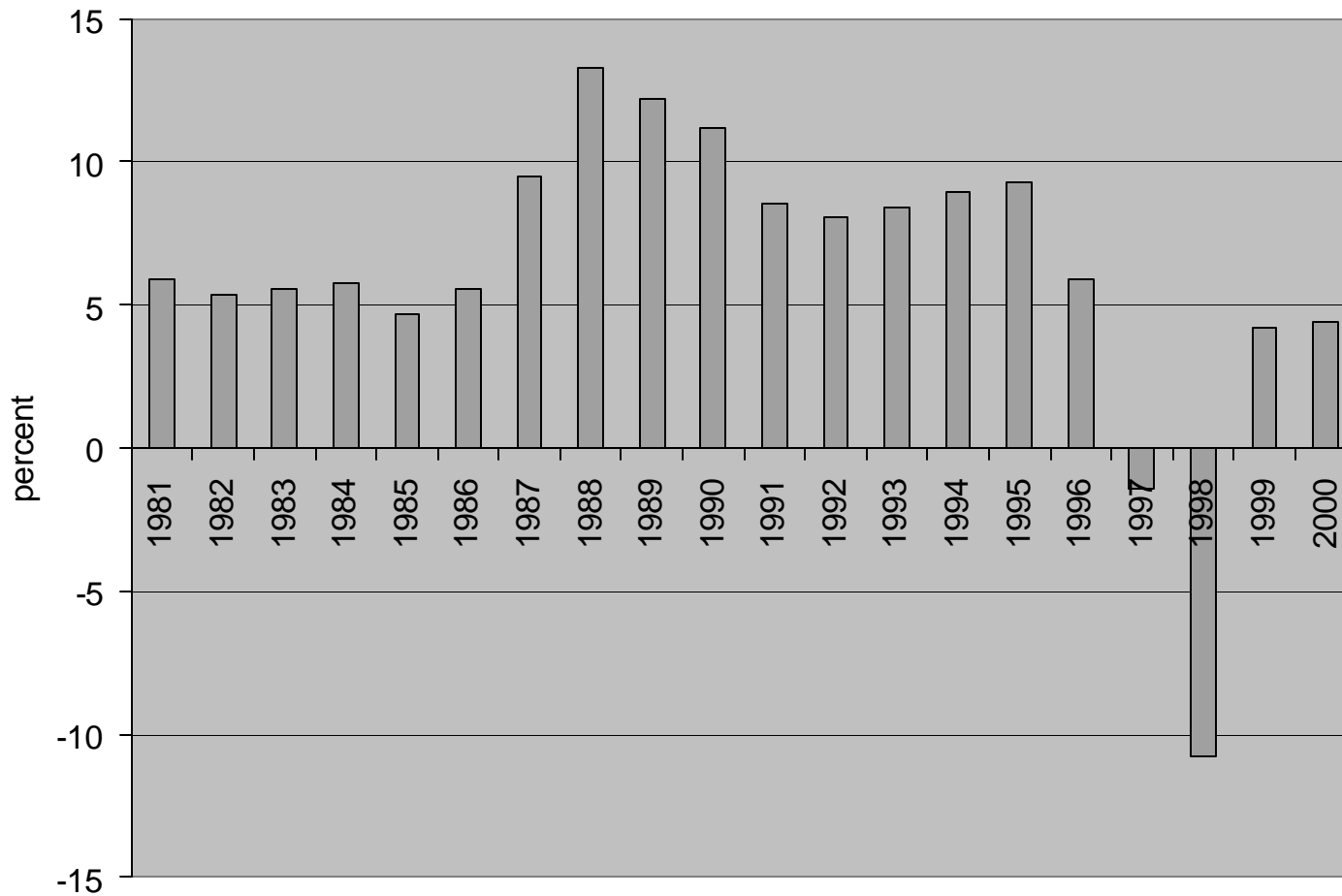




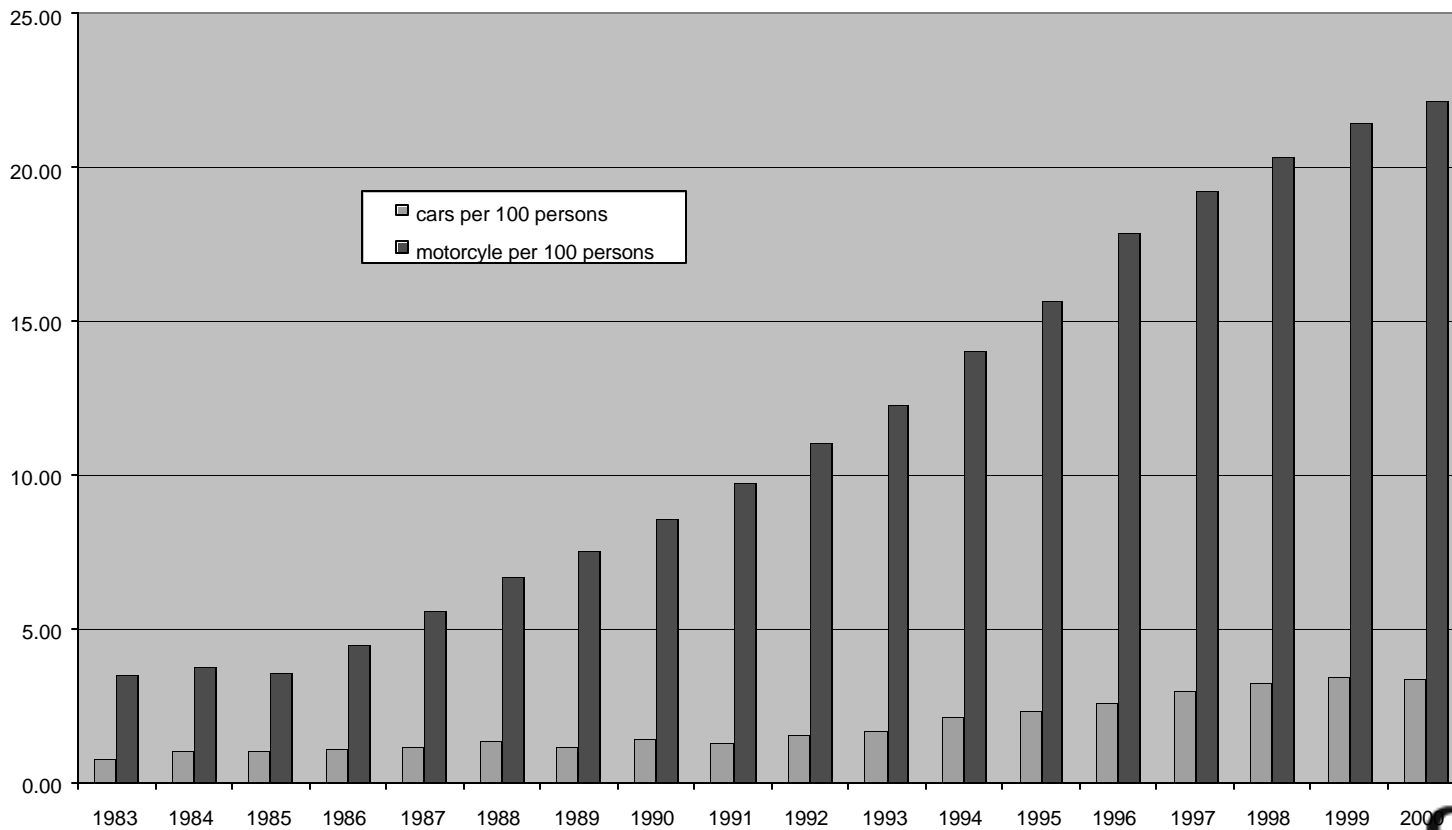
# Structure of GDP



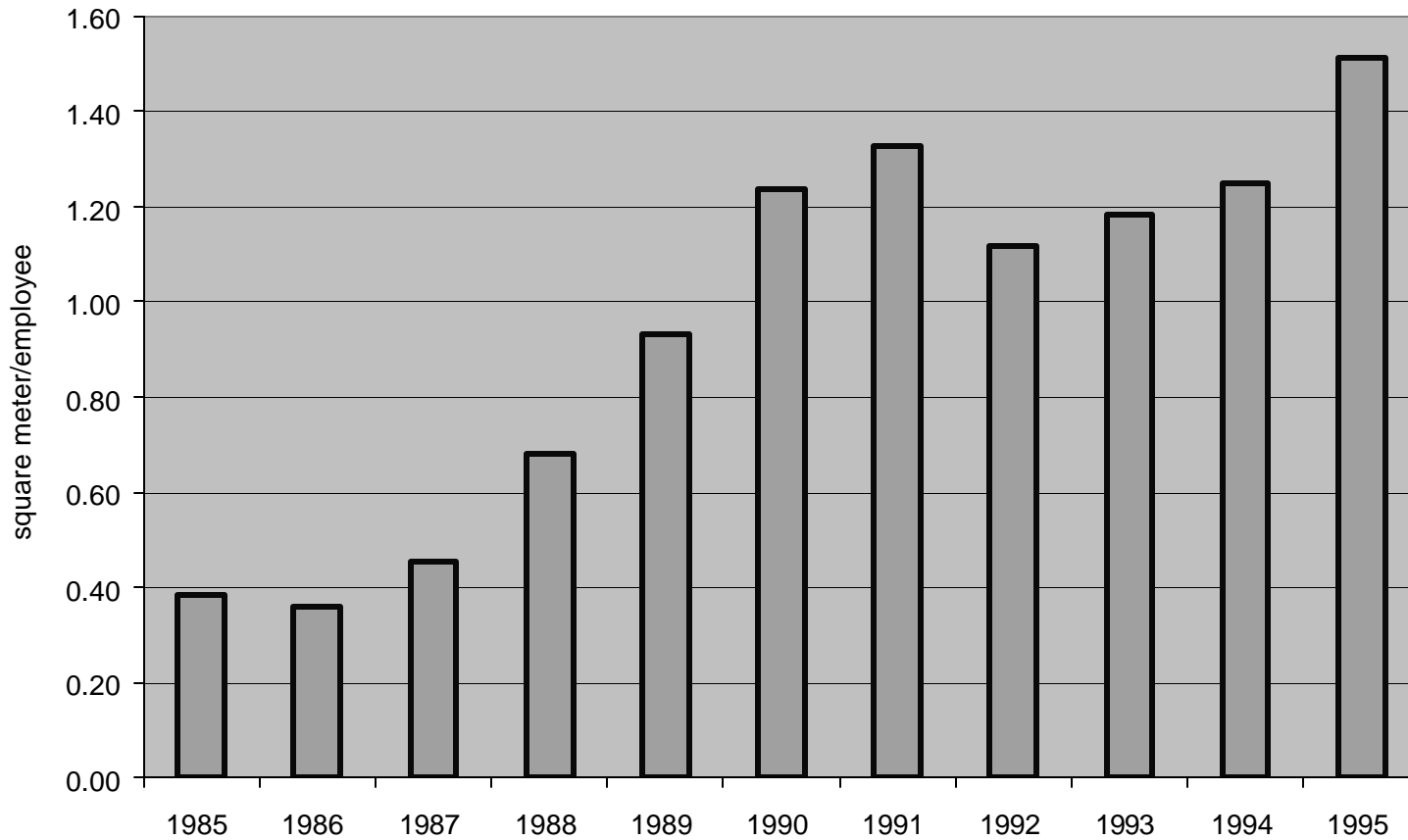
# GDP growth



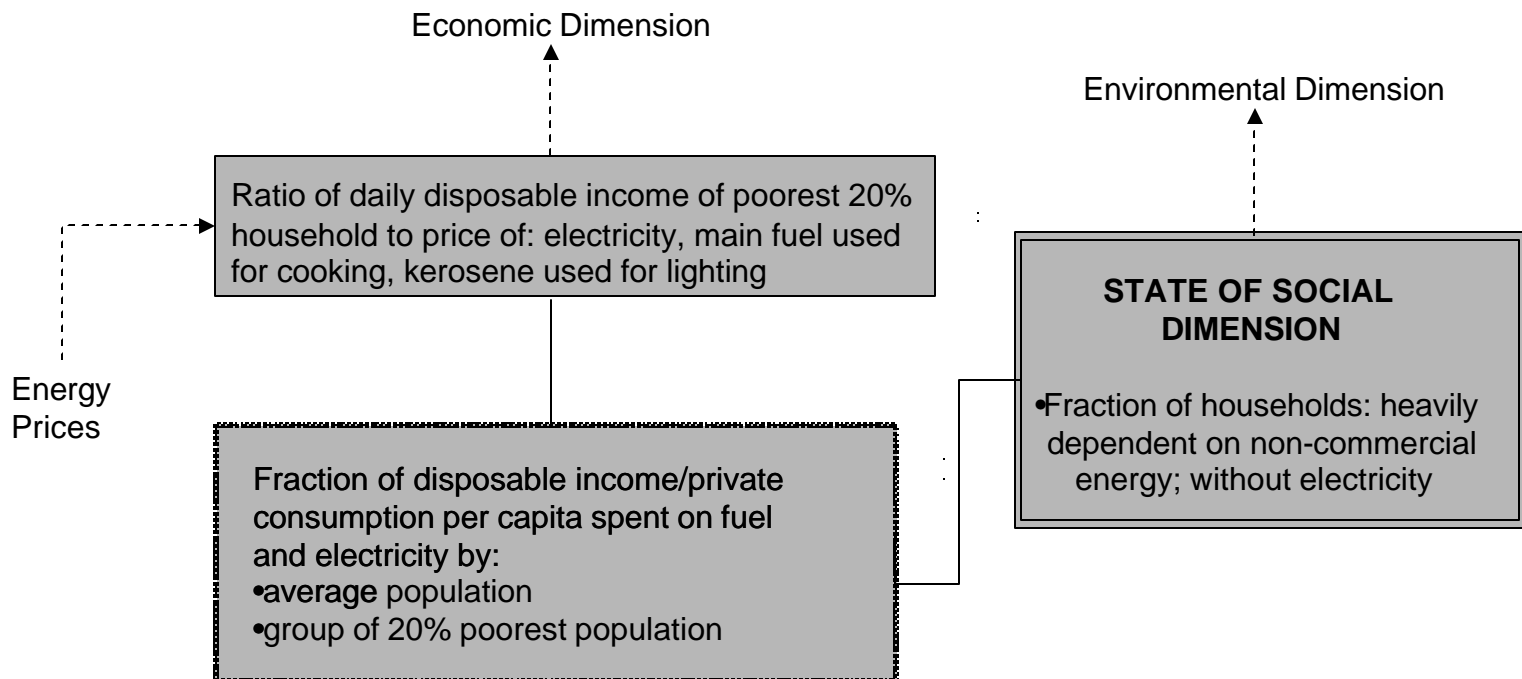
# Car and motorcycle ownership



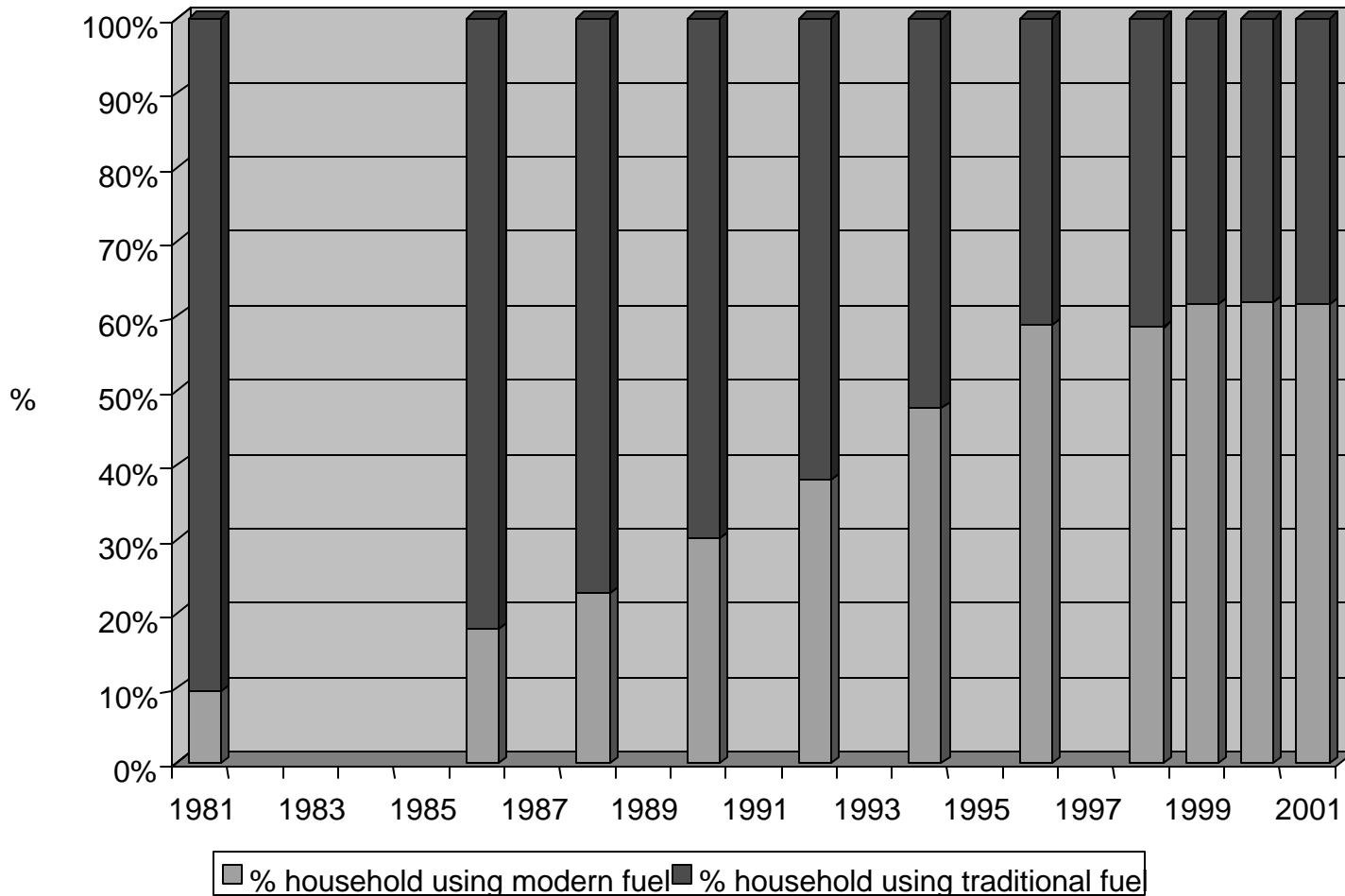
# Floor area per employee



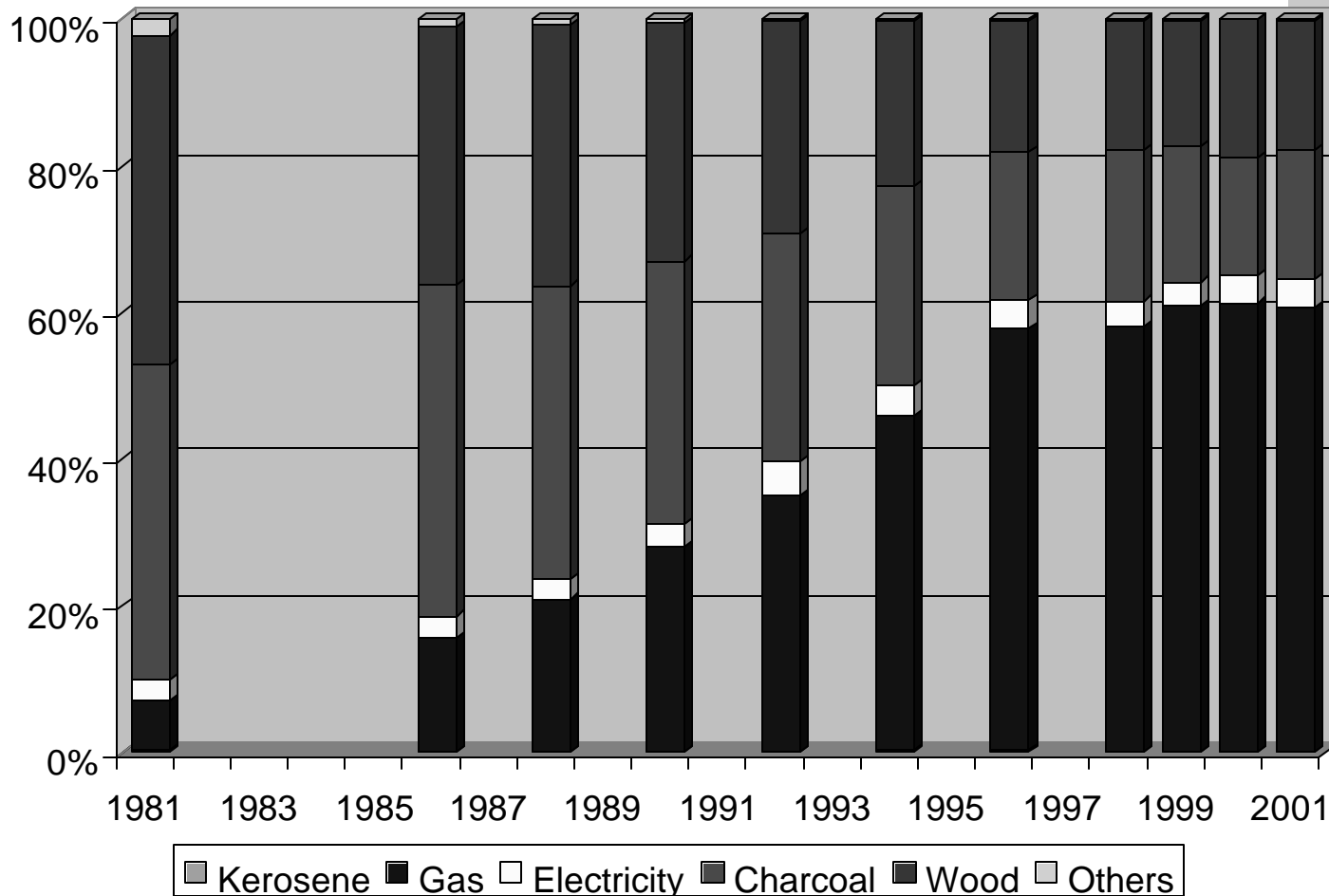
# The social dimension



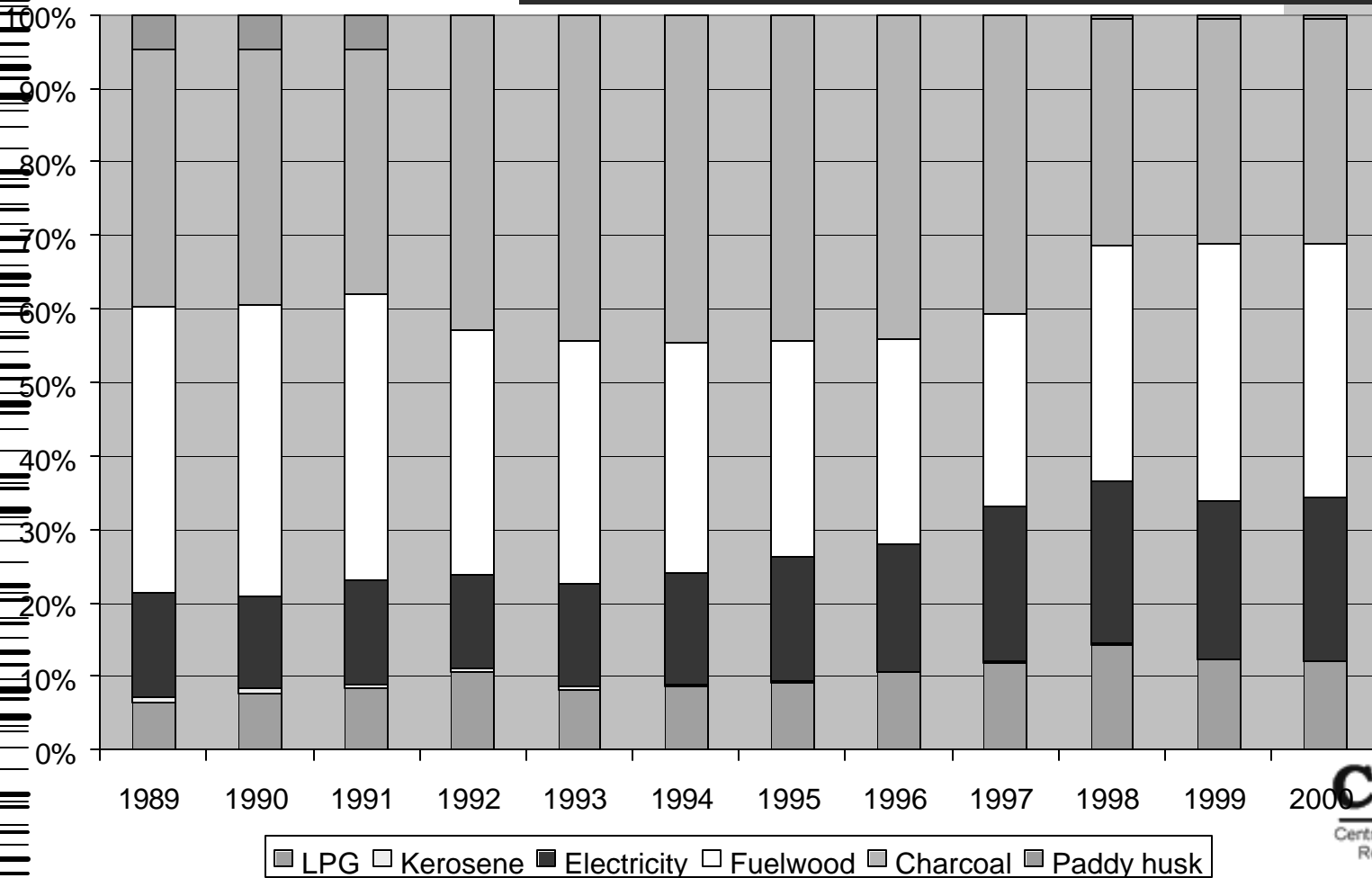
# Household structure for cooking



# Proportion of households using each type of fuel for cooking

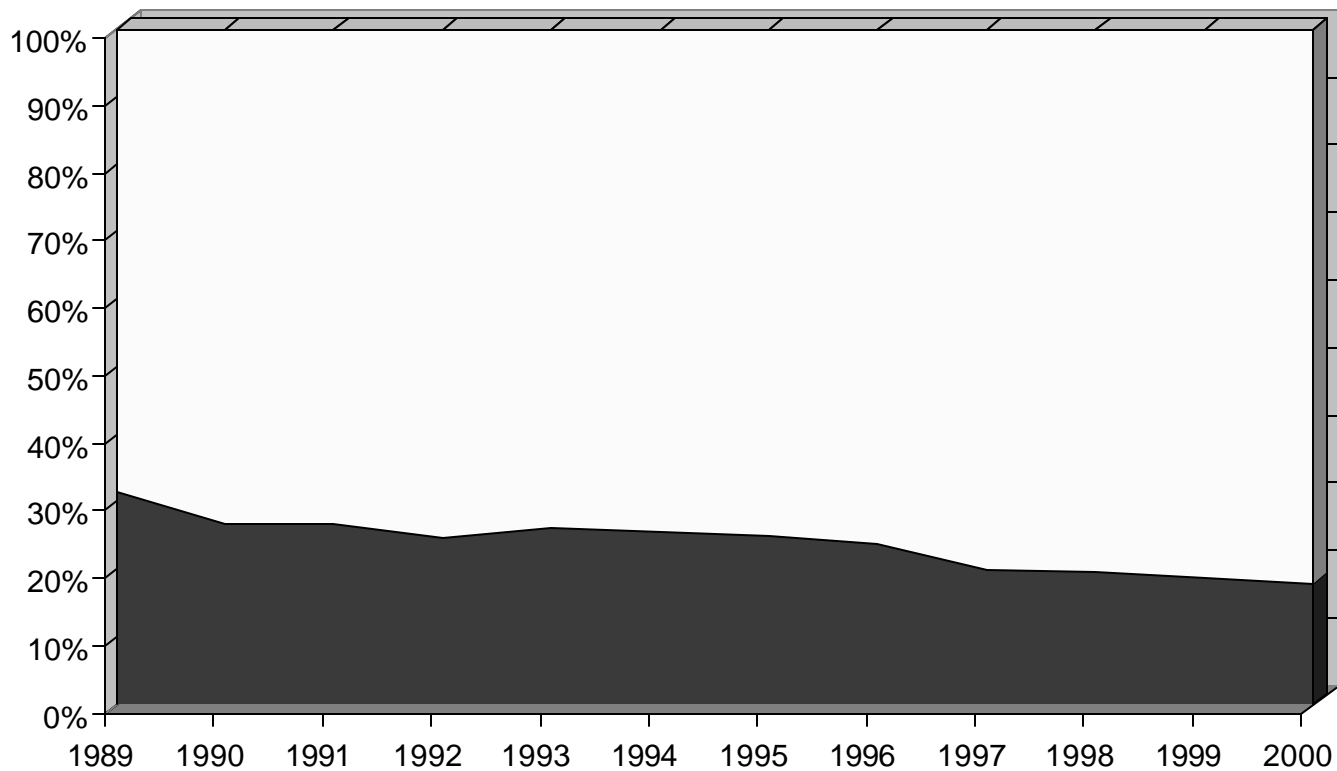


# Structure of residential energy consumption



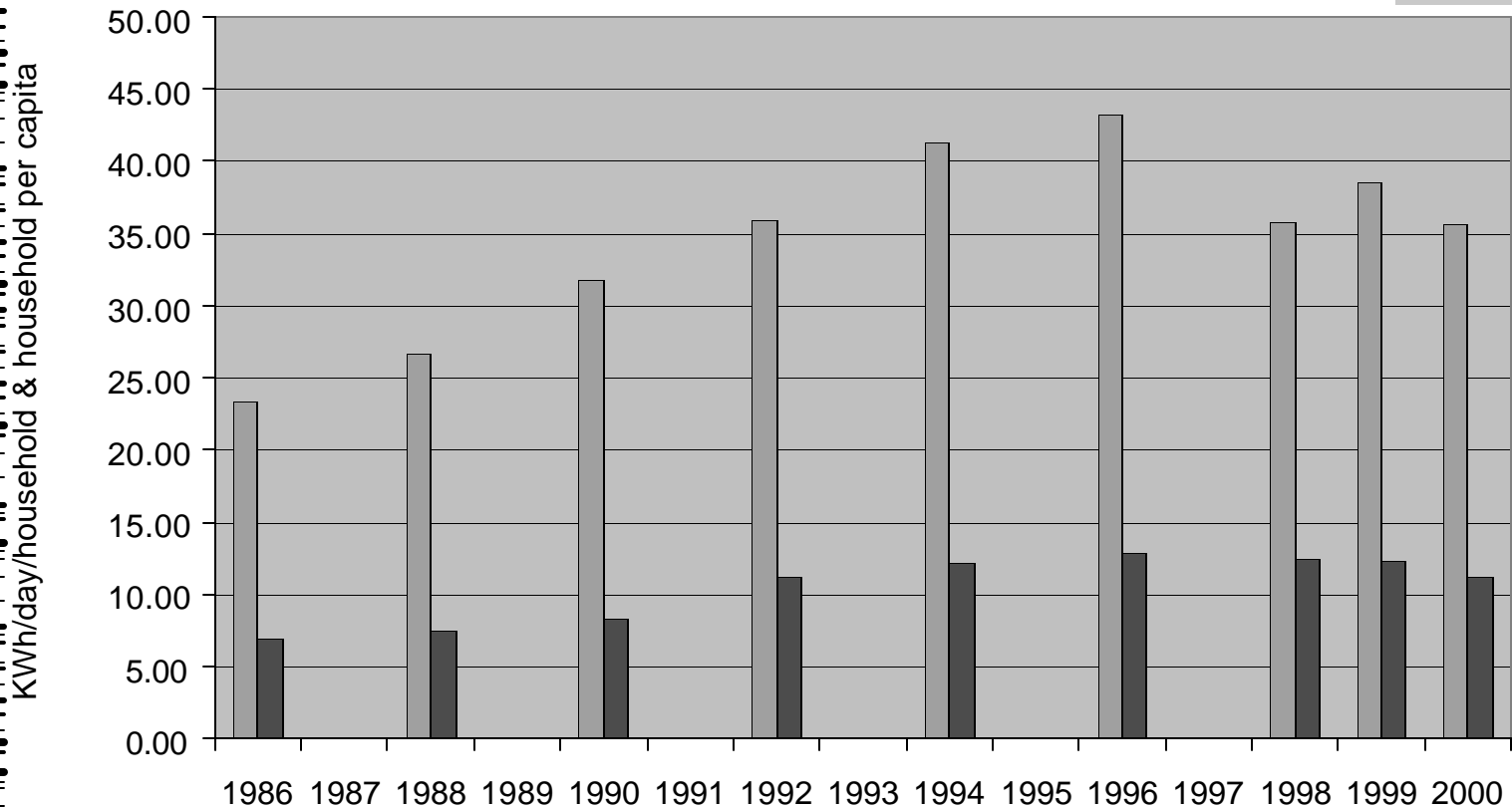


# Fraction of households electrified



■ % of household without electricity □ % of household with electricity

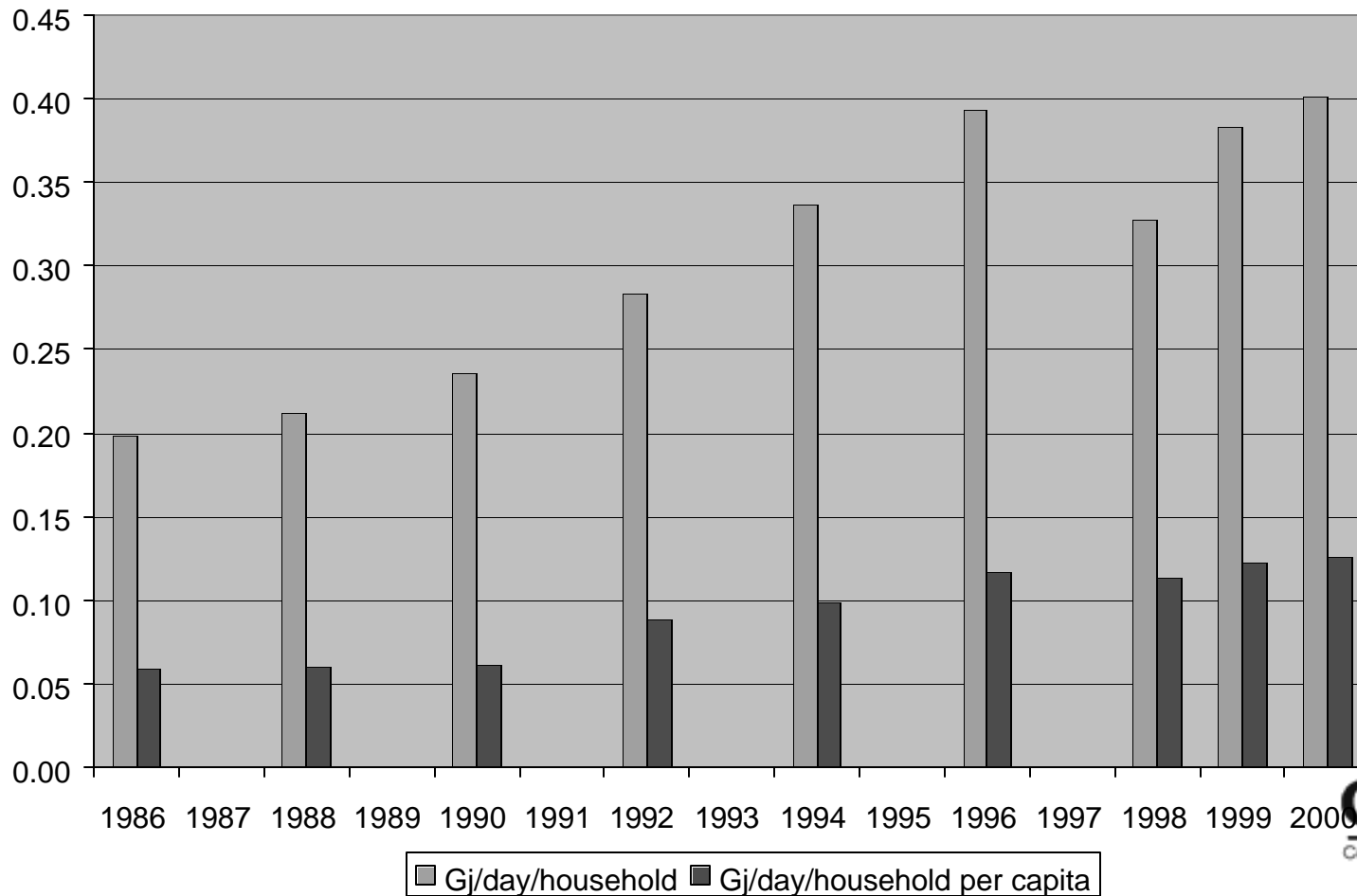
# Daily kWh consumption of the poorest 20% population



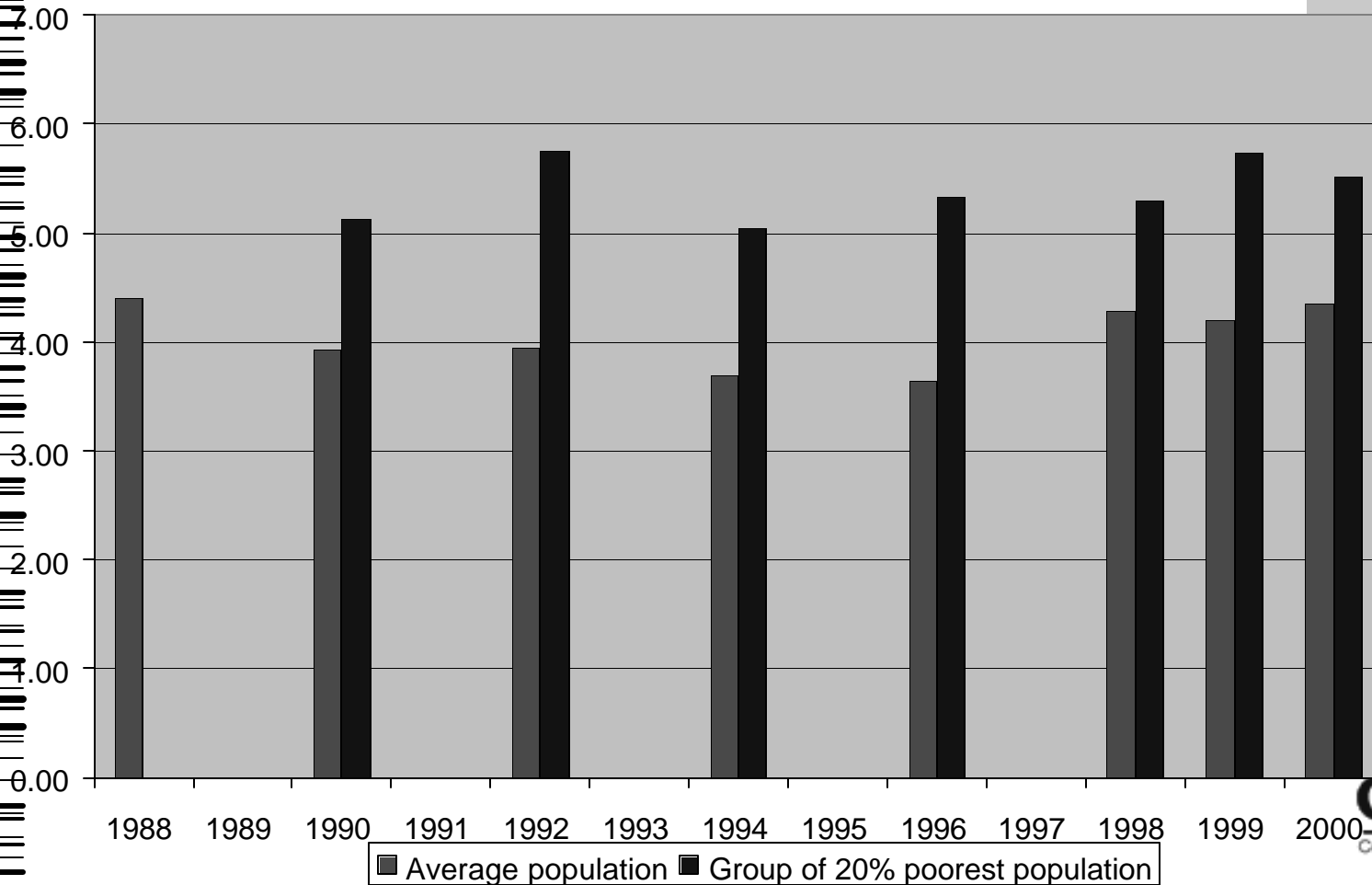
■ KWh/day/household ■ KWh/day/household per capita

# Daily consumption of LPG

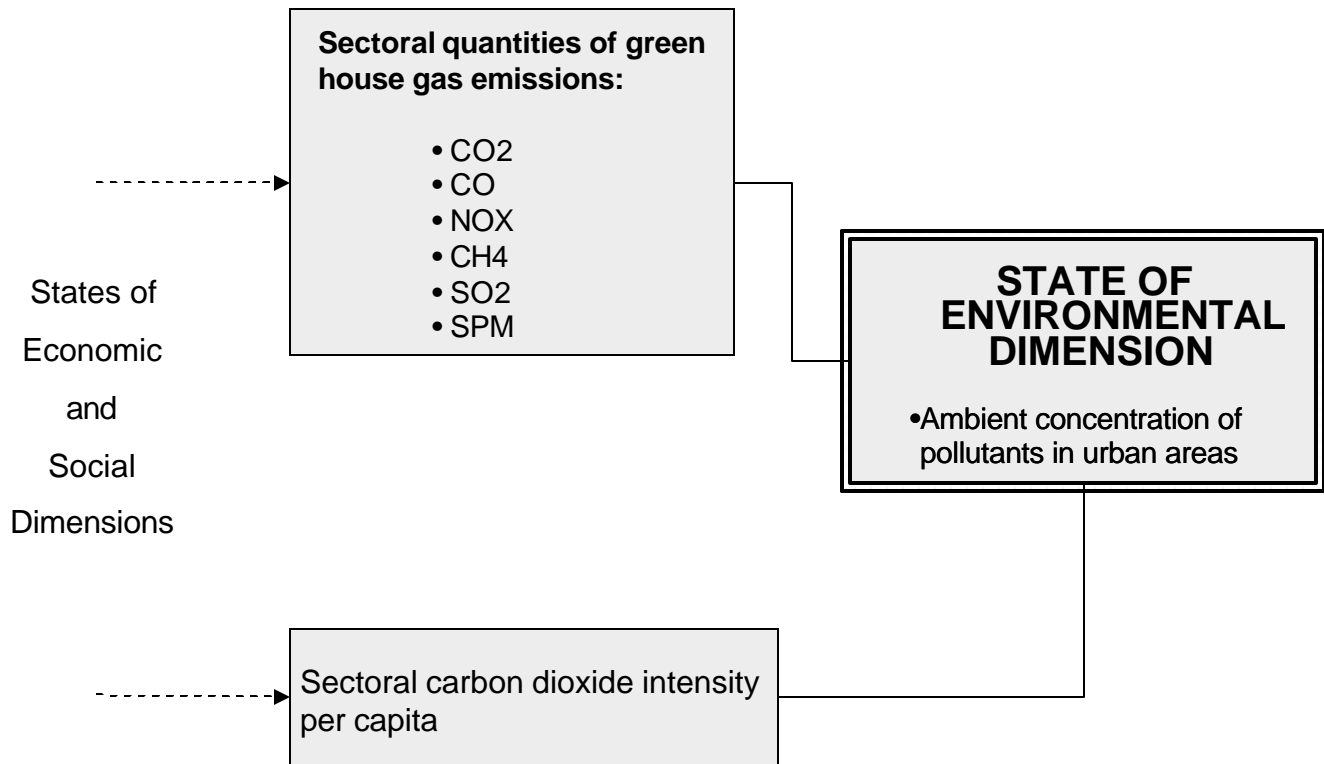
Gj/day/household & household per capita



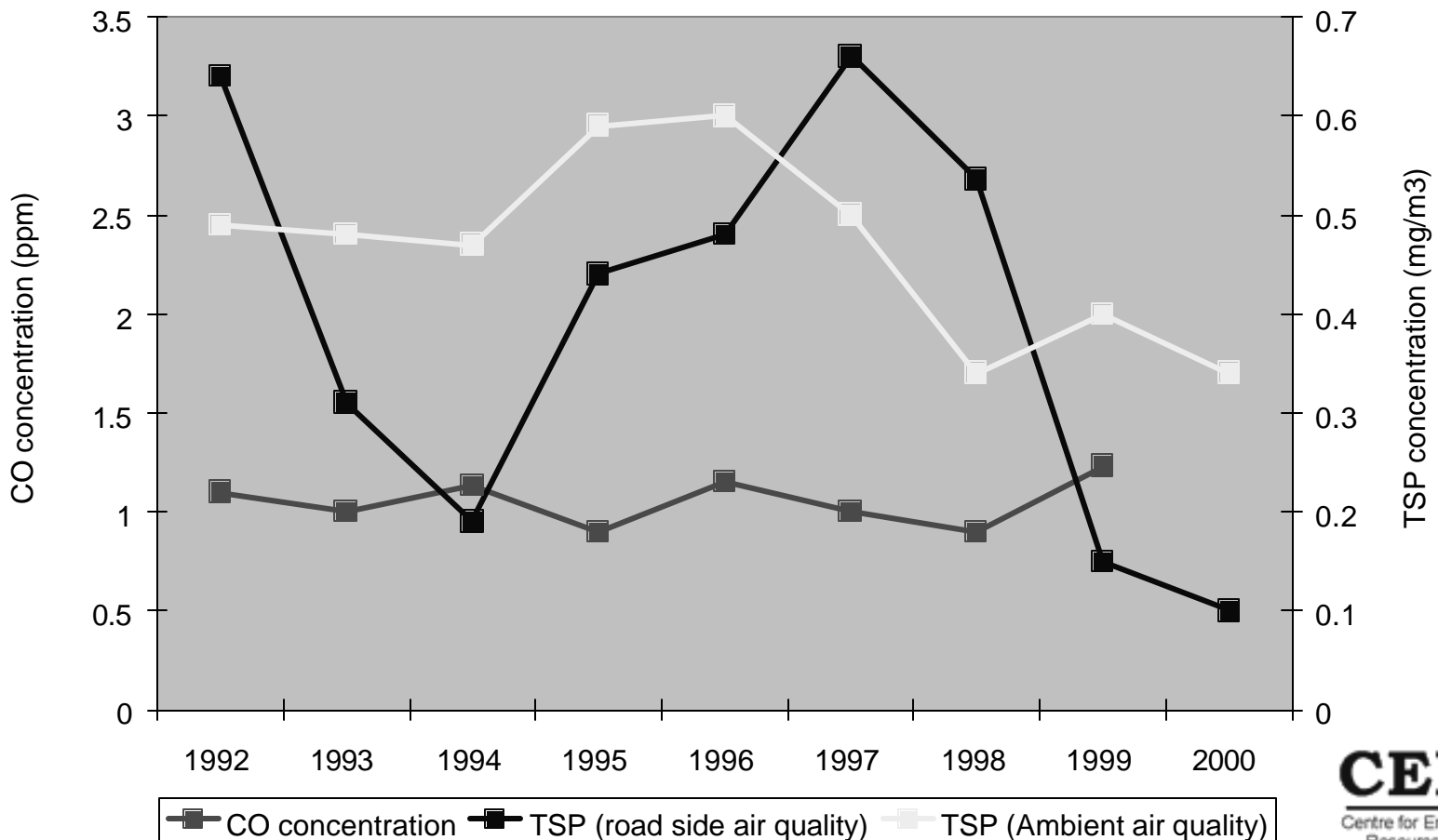
# Fraction of disposable income spent on fuel and electricity



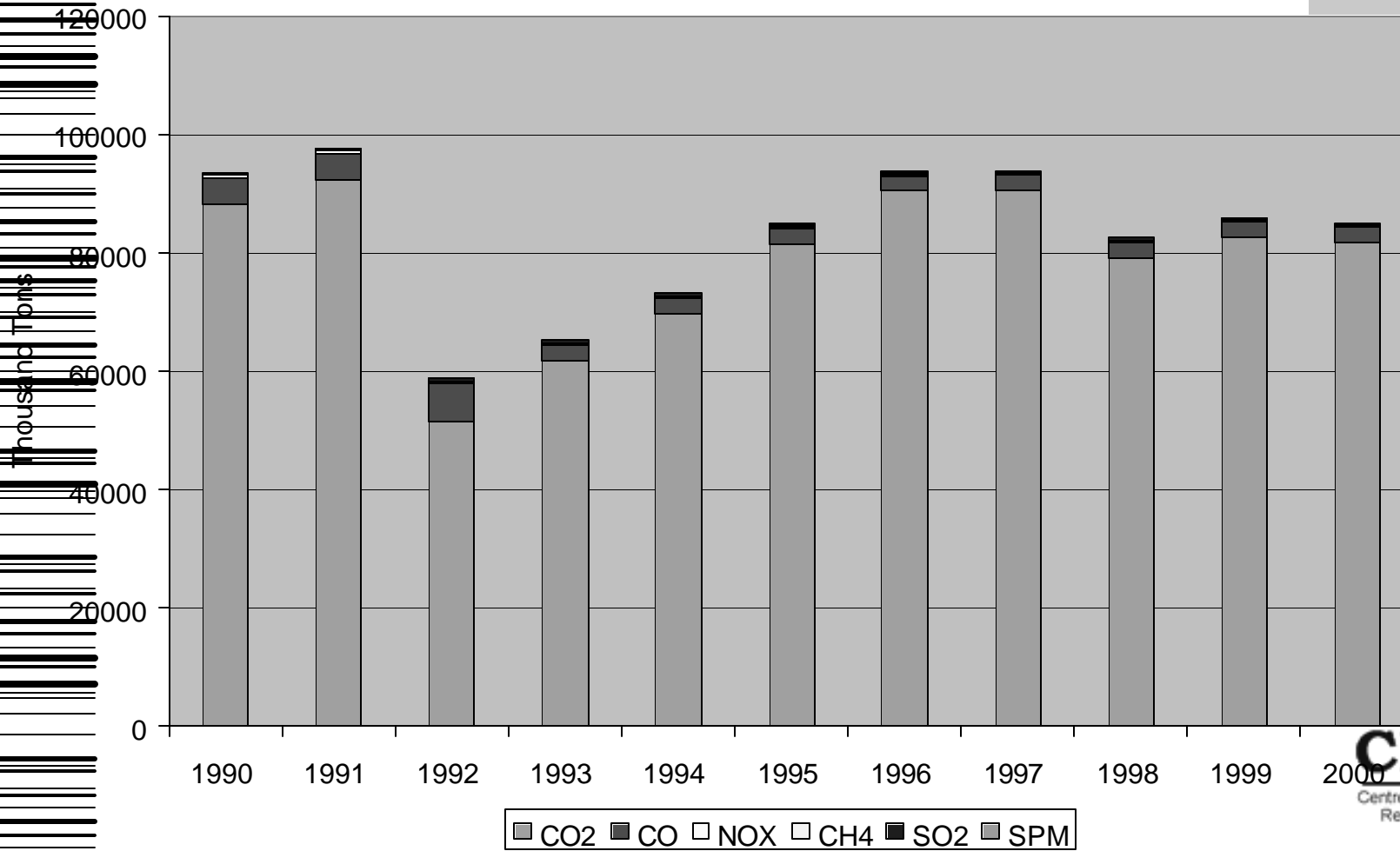
# The Environment Dimension



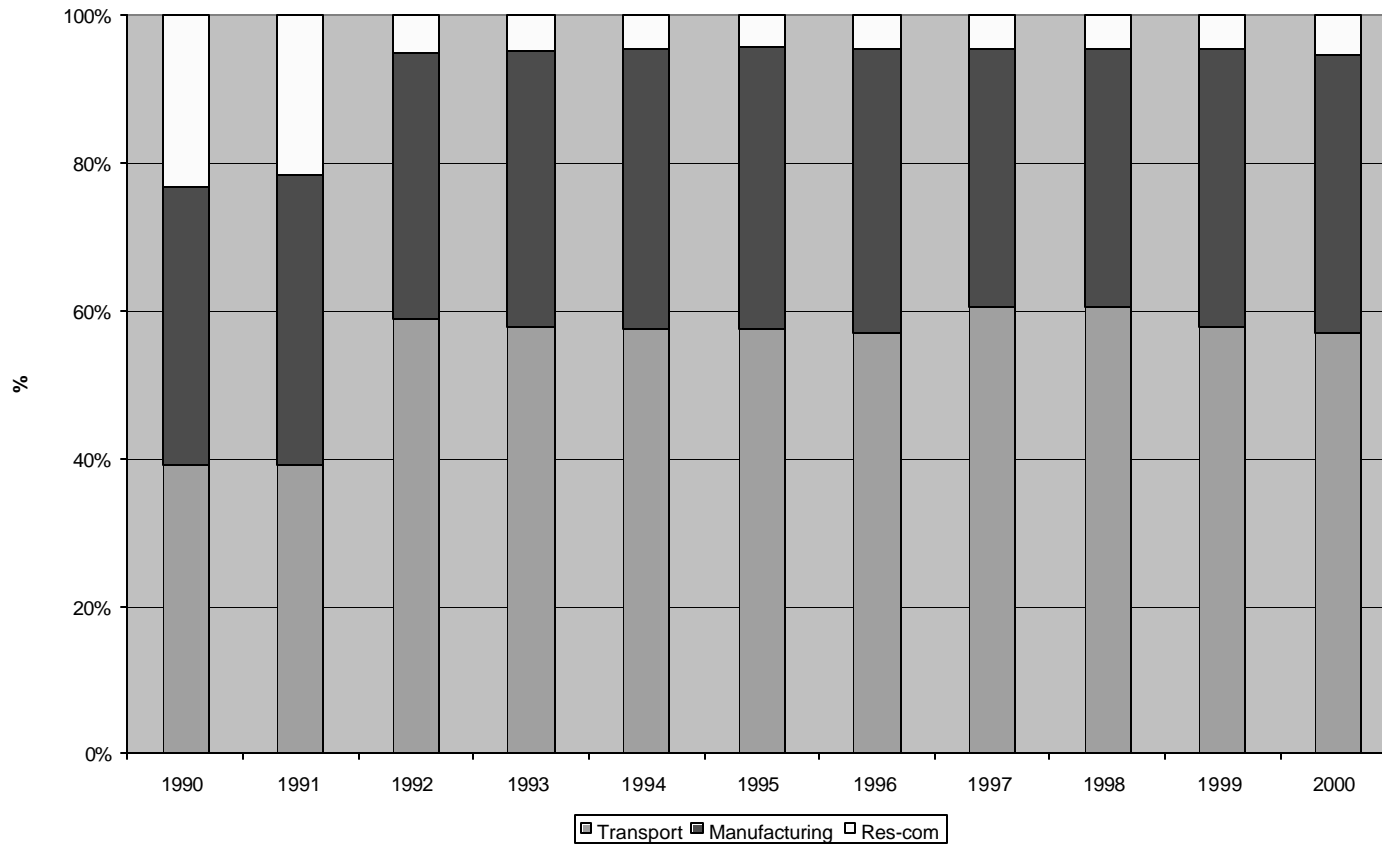
# Ambient concentration of pollutants



# GHG emissions



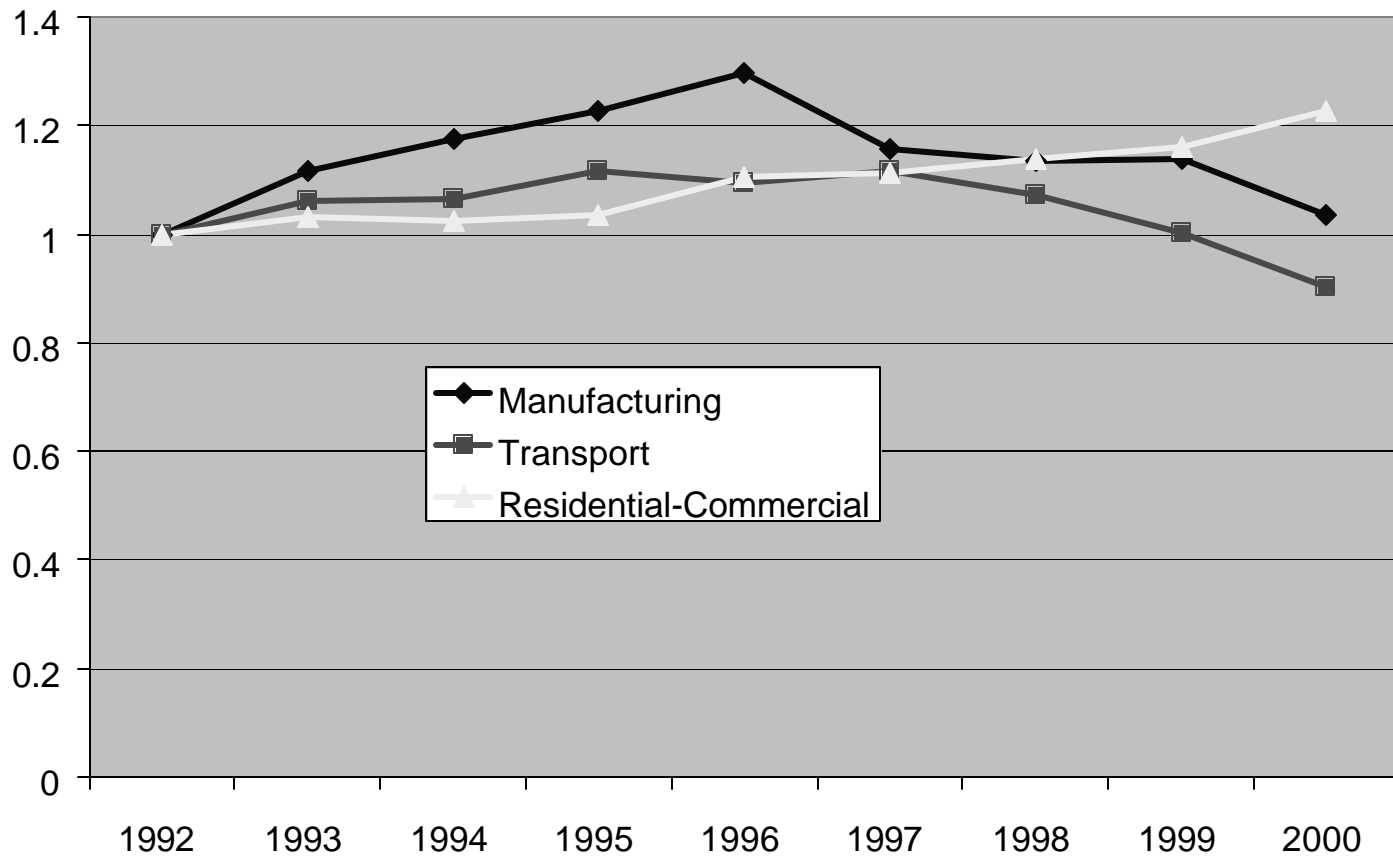
# Sectoral CO2 emissions



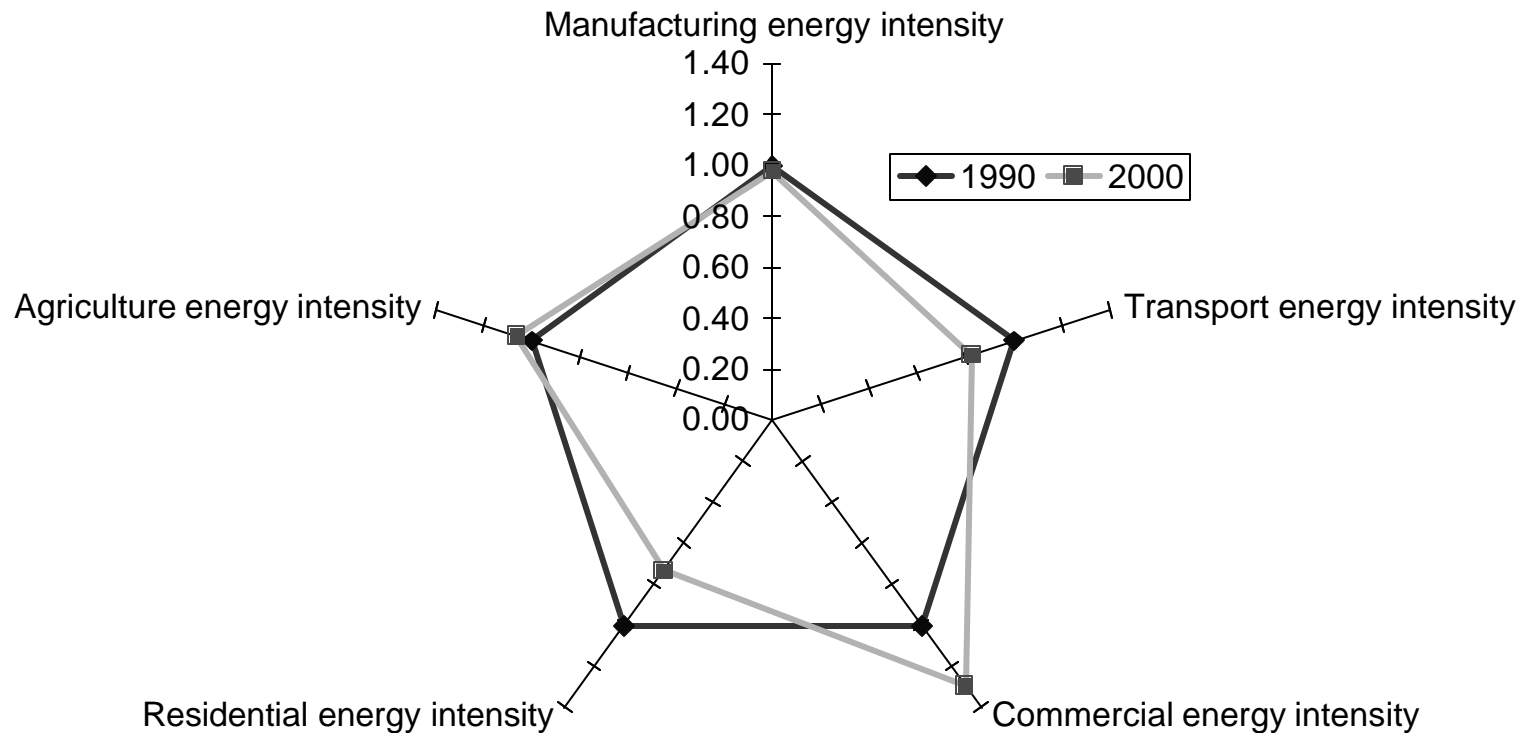


# Sectoral CO<sub>2</sub> intensity

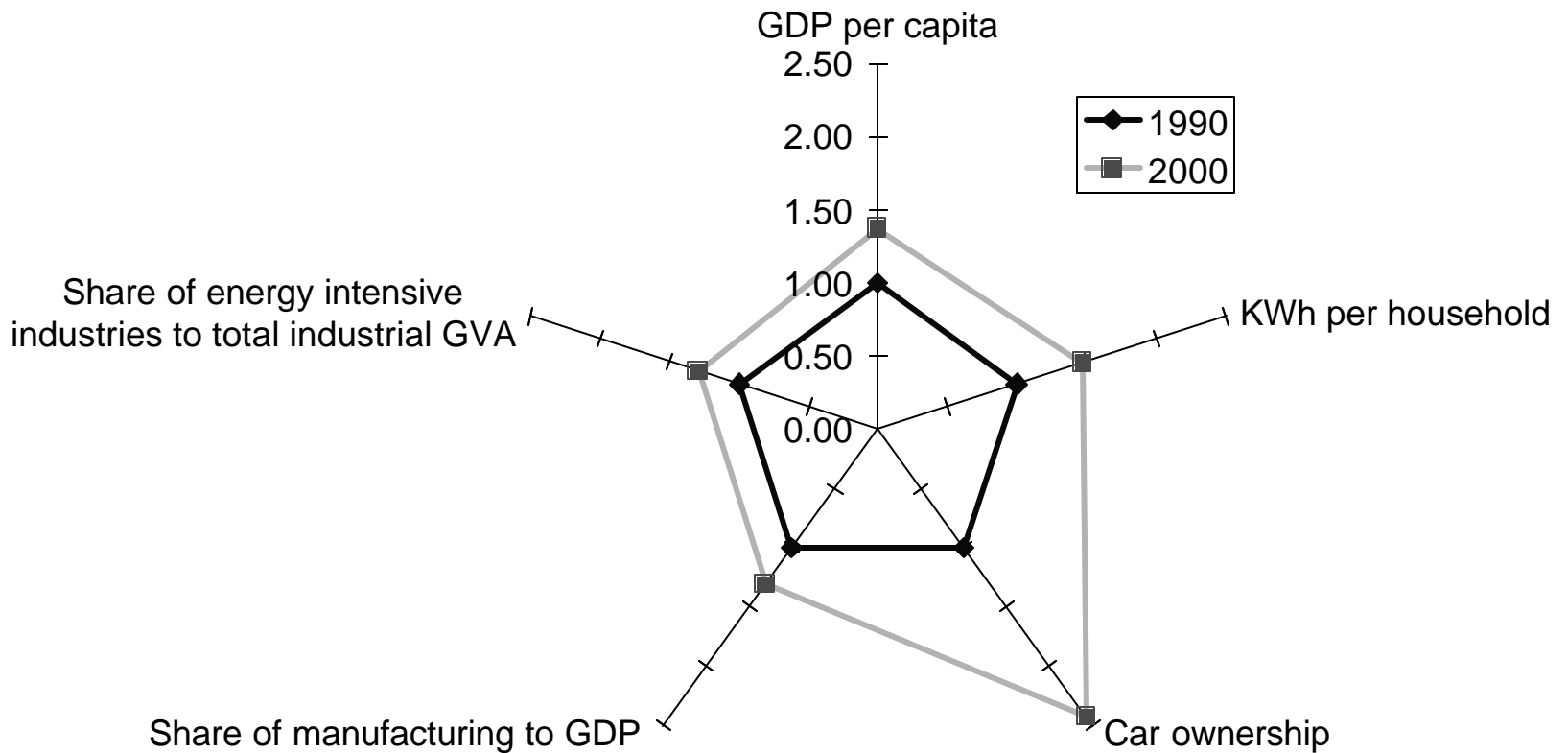
CO<sub>2</sub> Intensity



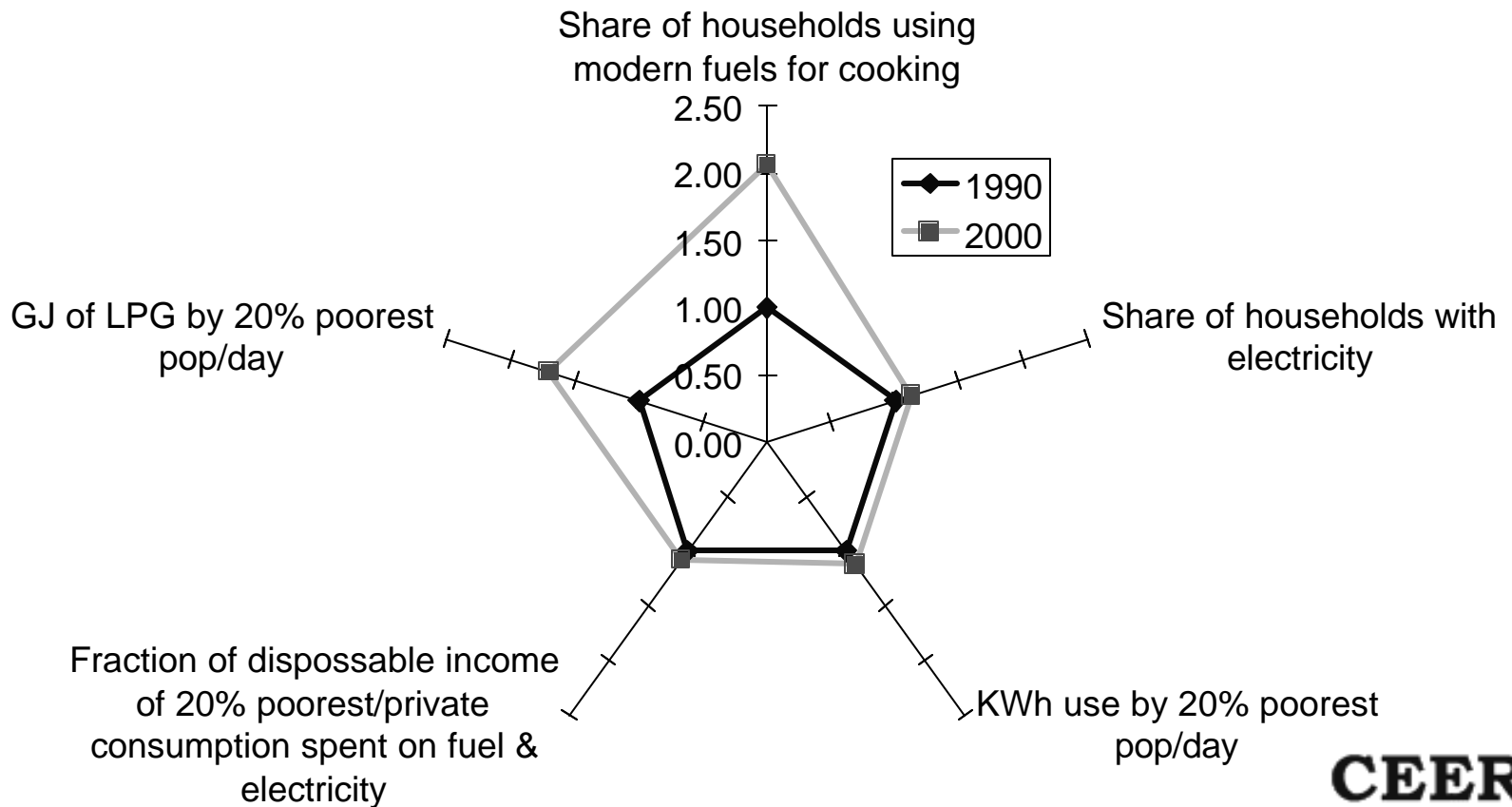
# Synthesis: energy efficiency achievements



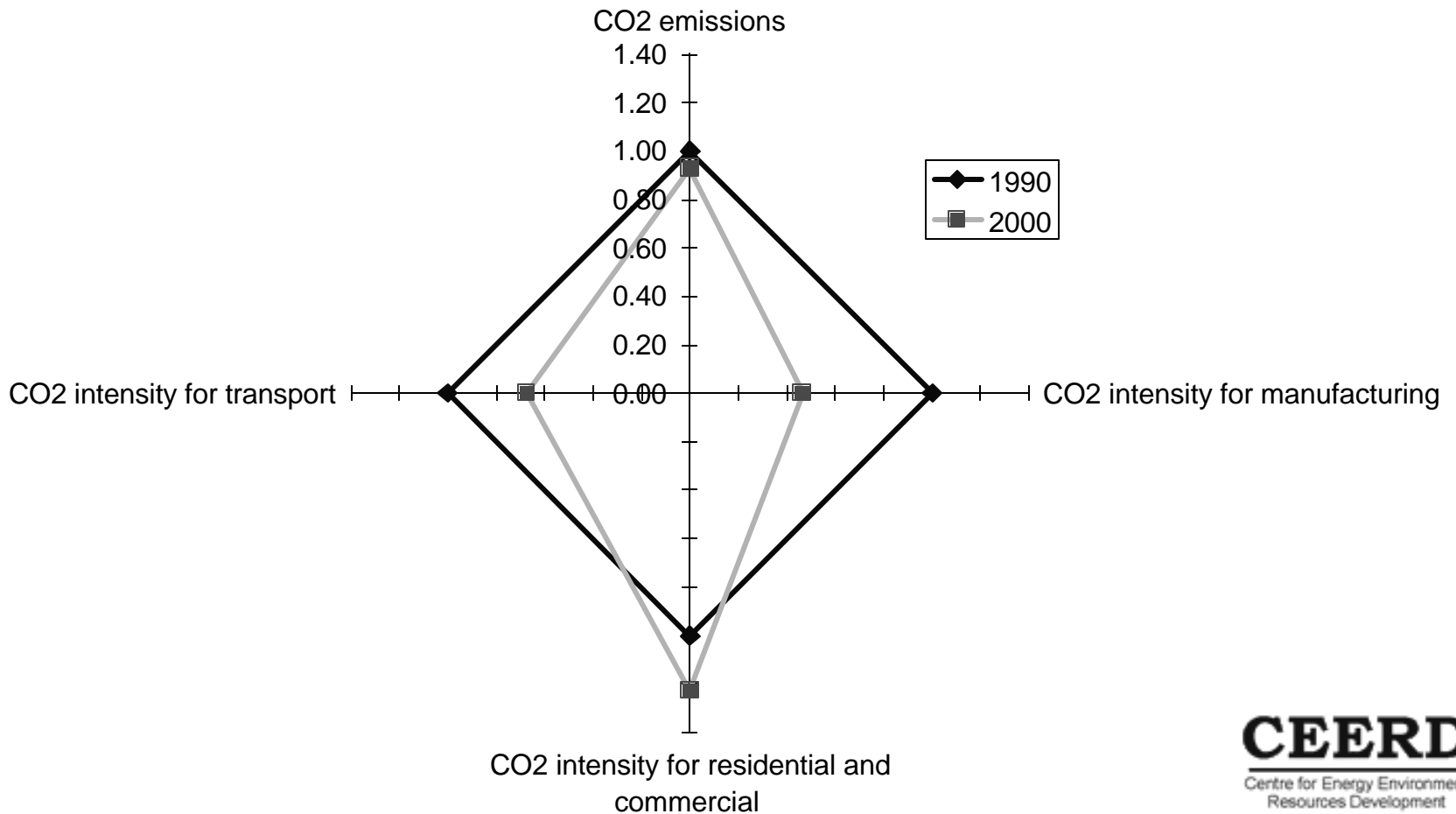
# Synthesis: progress towards economic sustainability



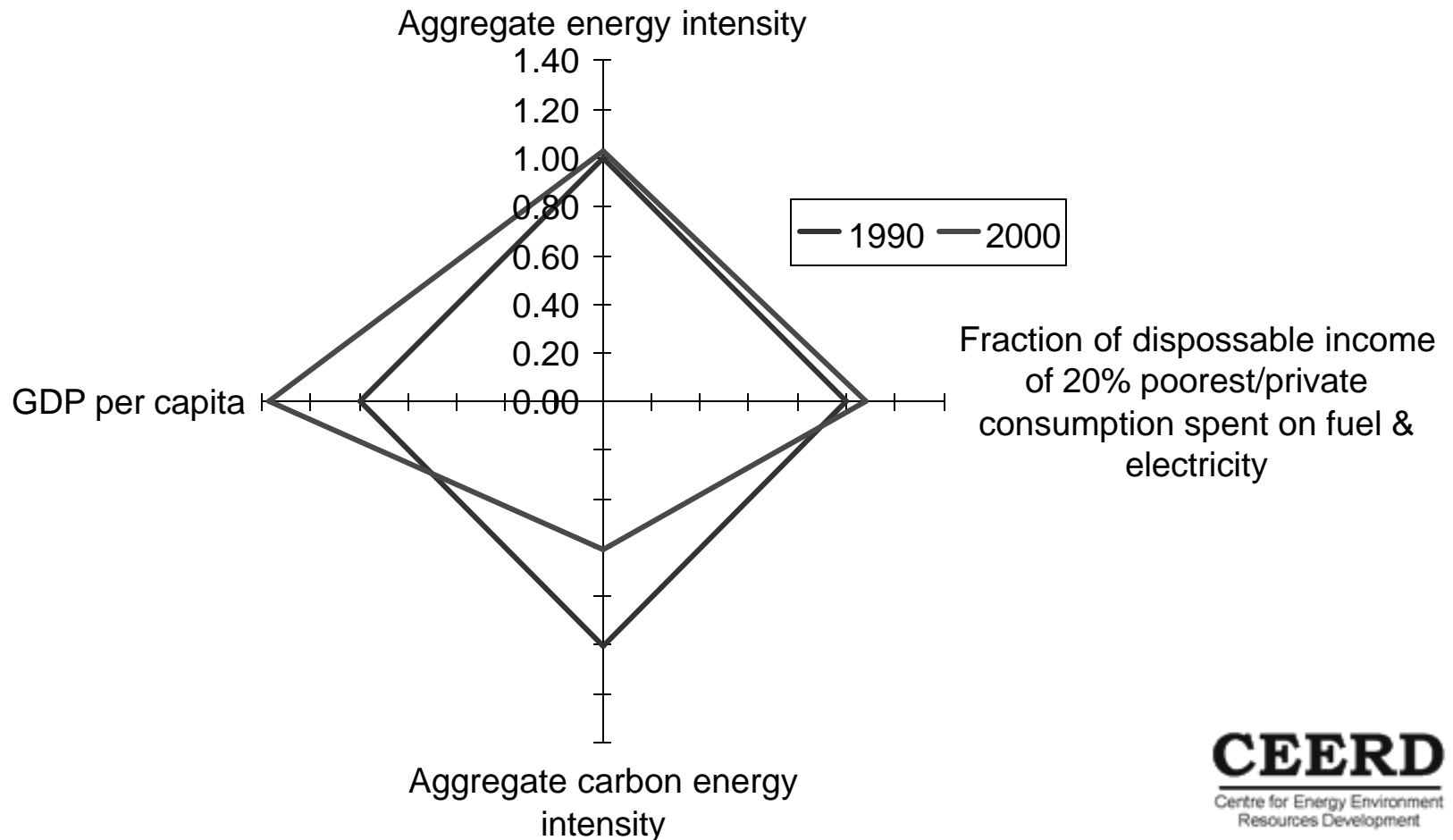
# Synthesis: progress towards social sustainability



# Synthesis: progress towards environment sustainability



# Overall assessment of sustainable energy development



# Strategies for improvements in priority areas???

<b>Programme/Sector</b>	<b>2006</b>	<b>Target 2011</b>	<b>Units</b>	
<b>A. Energy Conservation in Factories, Buildings, and Households</b>				
Total energy saved	1142.21	1862.8	ktoe/yr	
Total value of energy saved	20574.55	32509.97	M baht/yr	12.91%
<b>B. Energy Conservation in Transportation</b>				
<b>Total energy saved</b>	<b>2792.28</b>	<b>7094.65</b>	<b>ktoe/yr</b>	
<b>Total value of energy saved</b>	<b>51304.35</b>	<b>129563.55</b>	<b>M baht/yr</b>	<b>51.46%</b>
<b>C. Renewable Energy</b>	1645.17	5068.89	ktoe/yr	
Total value of energy saved	33005.39	89691.87	M baht/yr	35.63%
<b>D. Grand Total Energy Saved</b>	5579.66	14026.34	ktoe/yr	
<b>E. Grand Total Value of Energy Saved</b>	104884.29	251765.39	M baht/yr	100.00%

# Strategies for improvements in priority areas???

<b>C. Renewable Energy</b>	<b>1645.17</b>	<b>5068.89</b>	<b>ktoe/yr</b>	
<b>Percentage of total energy demand</b>	<b>3.52</b>	<b>9.39</b>	<b>%</b>	
Savings by type of NRSE				
solar	24.16	71.61	ktoe/yr	
wind	0.87	2.64	ktoe/yr	
biogas	37.86	125.32	ktoe/yr	
<b>biomass</b>	<b>630.14</b>	<b>1098.56</b>	<b>ktoe/yr</b>	
hydro	19.22	22.82	ktoe/yr	
geothermal	0.39	3.06	ktoe/yr	
fuel cells	0.22	0.38	ktoe/yr	
<b>biodiesel/ethanol</b>	<b>877.51</b>	<b>3678.67</b>	<b>ktoe/yr</b>	
others (waste-to-energy)	55	66	ktoe/yr	
<b>Total value of energy saved</b>	<b>33005.39</b>	<b>89691.87</b>	<b>M baht/yr</b>	<b>35.63%</b>



# Conclusion: value of ISED framework

- ◆ Analysis of policy effectiveness
- ◆ Environmental and social “implications” of energy policy
- ◆ Future policy responses
- ◆ Methodology compatible with other frameworks
- ◆ Offers flexibility to derive more indicators when necessary