

**From Theory to Reality:
Denmark's Experience
By Peter Dal, DEA**

**Introduction to Energy Indicators Workshop
IEA, 26 April 2006, Paris**

Main Purpose of the Presentation

- To inform about the Danish energy statistics, which has exceeded the limits of a traditional official energy statistics
- To encourage a fruitful discussion of what should be the contents of a good energy statistics
- To encourage a fruitful discussion of how to present energy statistics and energy efficiency indicators for policy makers and the public in general

Steps in an Annual Energy Statistics

- Planning
- Data collection
- Validation and control
- Publishing
- Analyzing how the statistics can be more useful

Indicators and Key Figures should be an Integrated Part of the Energy Statistics

Pure energy statistics cannot stand alone!

- Important supplements:
- Adjusted statistics to reveal the trends
- Key figures
- Factors and human activity behind the energy consumption
- Energy efficiency indicators (EEI)
- International comparisons / Benchmarking
- CO₂ Emissions

Not Easy to give a Precise Definition of an Indicator for Energy Efficiency

- It is not the intention to discuss the difference between a key figure and an (energy efficiency) indicator.
 - Degree of self-sufficiency is a key figure
 - TPES per unit of GDP is an efficiency indicator
 - TPES per capita is both

Often used terminology on energy efficiency indicators:

- Energy intensity: When the denominator is an economic figure (e.g. GDP or value added)
- Unit consumption: When the denominator is a physical figure (e.g. dwelling or m²)

Why focus on EEI? Today Interests in Improved Energy Efficiency is Higher than Ever

Three reasons for the increasing interests:

- Improved energy efficiency is an important way to reduce energy consumption and increase the degree of self-sufficiency
- Improved energy efficiency reduces expenditures for energy at country level and at company level
- Improved energy efficiency has a positive impact at the environment and contributes to reductions of CO₂ emissions

The Danish Prime Minister at the Meeting 23-24 March in the European Council

We would like to stress the need for an ambitious energy efficiency policy. In our minds it is beyond any doubt that increased energy efficiency benefits all three objectives of energy policy: energy security, the environment and the competitiveness of our enterprises. There is a substantial potential for cost-effective energy efficiency measures. Let me suggest here today, that we add another target to the Lisbon-target of becoming the most competitive region in the world: **let's agree to make the EU the most energy efficient region in the world.**

Requirements to a “Good Indicator”

- Well defined
- Relevant and useful information
- Reliable (based on sound statistics)
- Well updated (not later than t-2)
- Easy to explain
- Easy to understand

Recent Work on Energy Efficiency Indicators

- Eurostat, 2000: Energy Statistics Committee: “Energy Efficiency Indicators – Priority List”
- Eurostat, 2003: Meeting of the Working Group “Energy Efficiency Indicators”
- IEA, 2004: EEWP Workshop: Energy Efficiency: “Past Development & Future Potential”
- IEA, 2004: “30 Years of Energy Use in the IEA Countries”
- Odyssee–network: <http://www.odyssee-indicators.org/>
- Odyssee, 2005: “Energy Efficiency- Monitoring in the EU-15”

The Danish Energy Statistics 2004

- The paper version: 52 pages - 24 tables - 88 graphs
- Number of energy efficiency indicators etc. 8-10
- The complete energy statistics is published on internet:

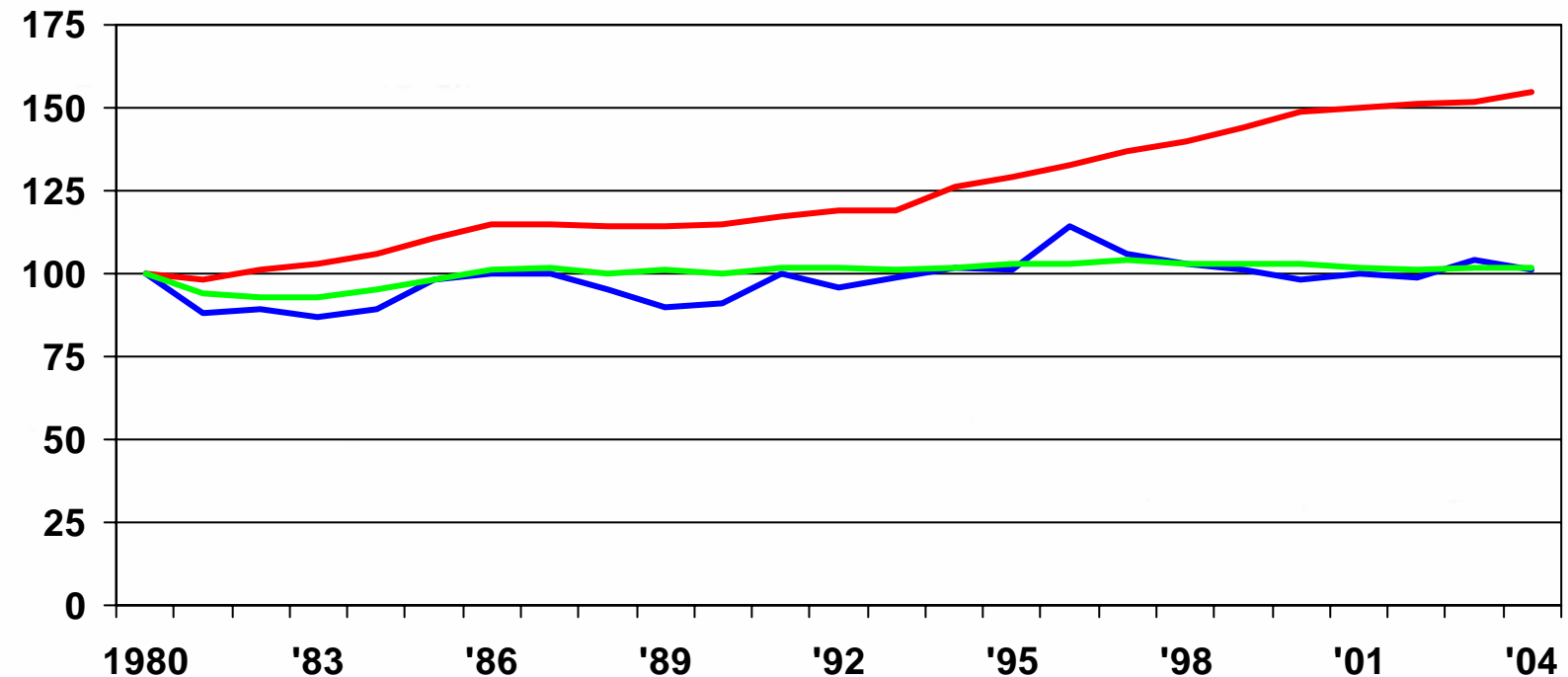
Danish version: <http://www.ens.dk/sw11582.asp>
English version: <http://www.ens.dk/sw12341.asp>

Decoupling of Economic Activity and Energy Consumption/CO₂ Emissions

- A key word in energy and environmental politics is decoupling of the economic development and the development in energy consumption and CO₂ emissions
- The indicator used to monitor the decoupling is the energy intensity measured as Gross energy consumption or TPES per unit GDP in fixed prices (e.g. TJ per DKK million GDP, 2000-prices)
- The Danish energy statistics illustrates the decoupling graphically in two ways

Decoupling of Energy Consumption and Economic Development

Index, 1980=100



— GDP

— Gross Energy Consumption, Actual

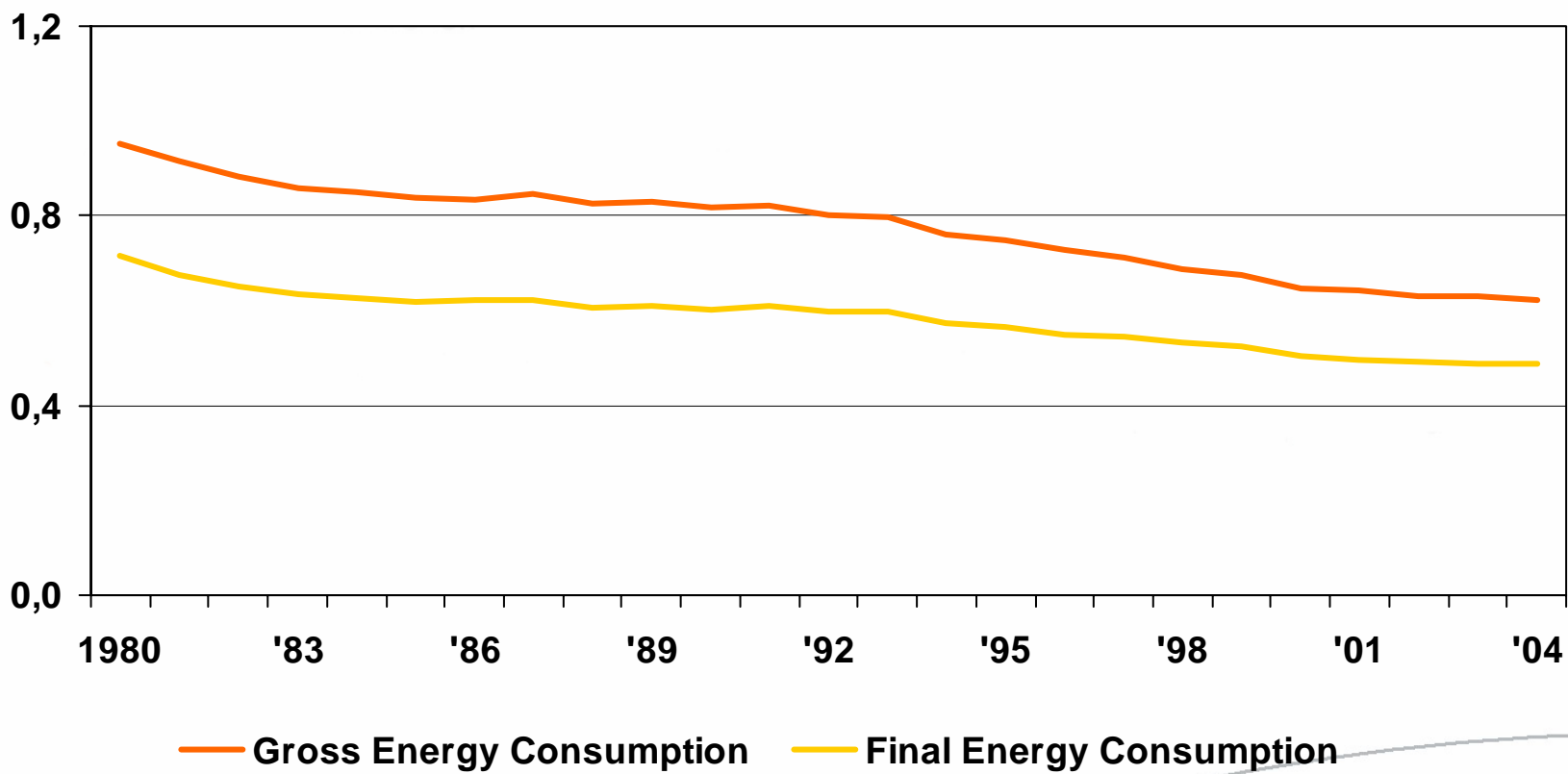
— Gross Energy Consumption, Adjusted

Gross Energy Consumption and Final Energy Consumption per DKK Million GDP

Gross (Final) Energy Consumption
1990-2004: -24.1% (-19.1%)

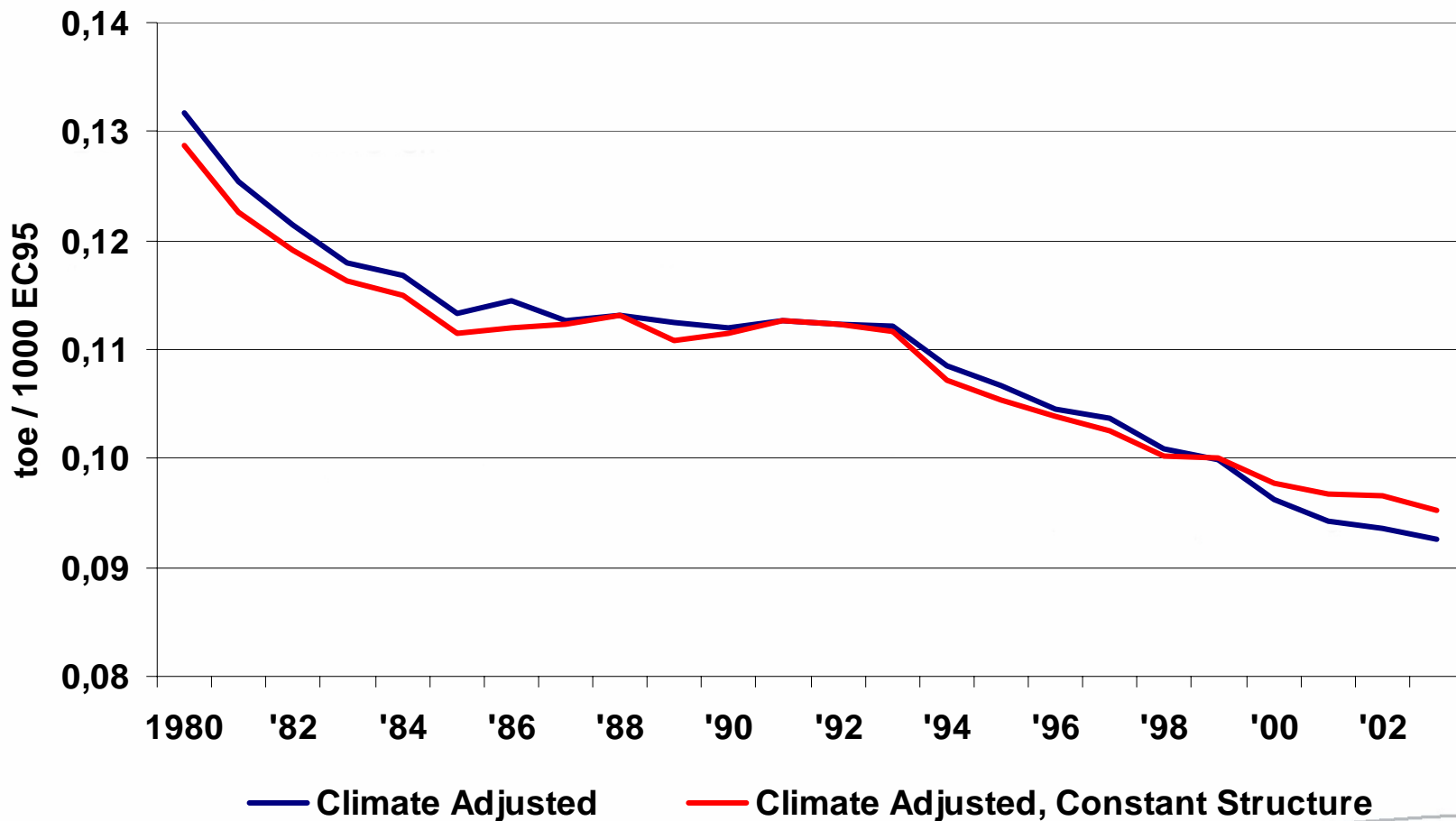
Adjusted

TJ per DKK Million GDP (2000 Prices)



Final Energy Consumption

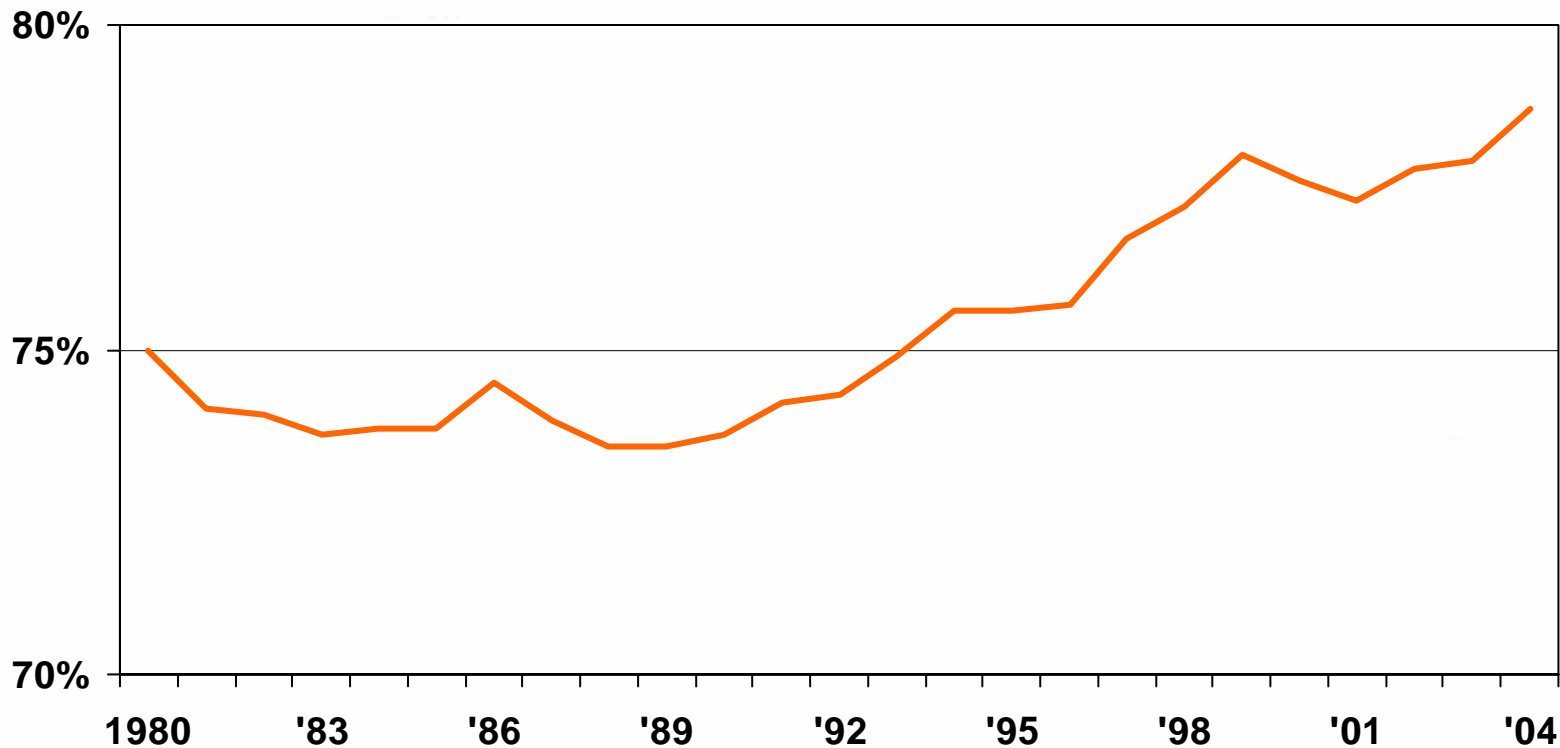
Climate Adjusted 1990-2003: -17,2%
With Constant Structure 1990-2003: -14,6%



Ratio of Final Energy Consumption to Gross Energy Consumption

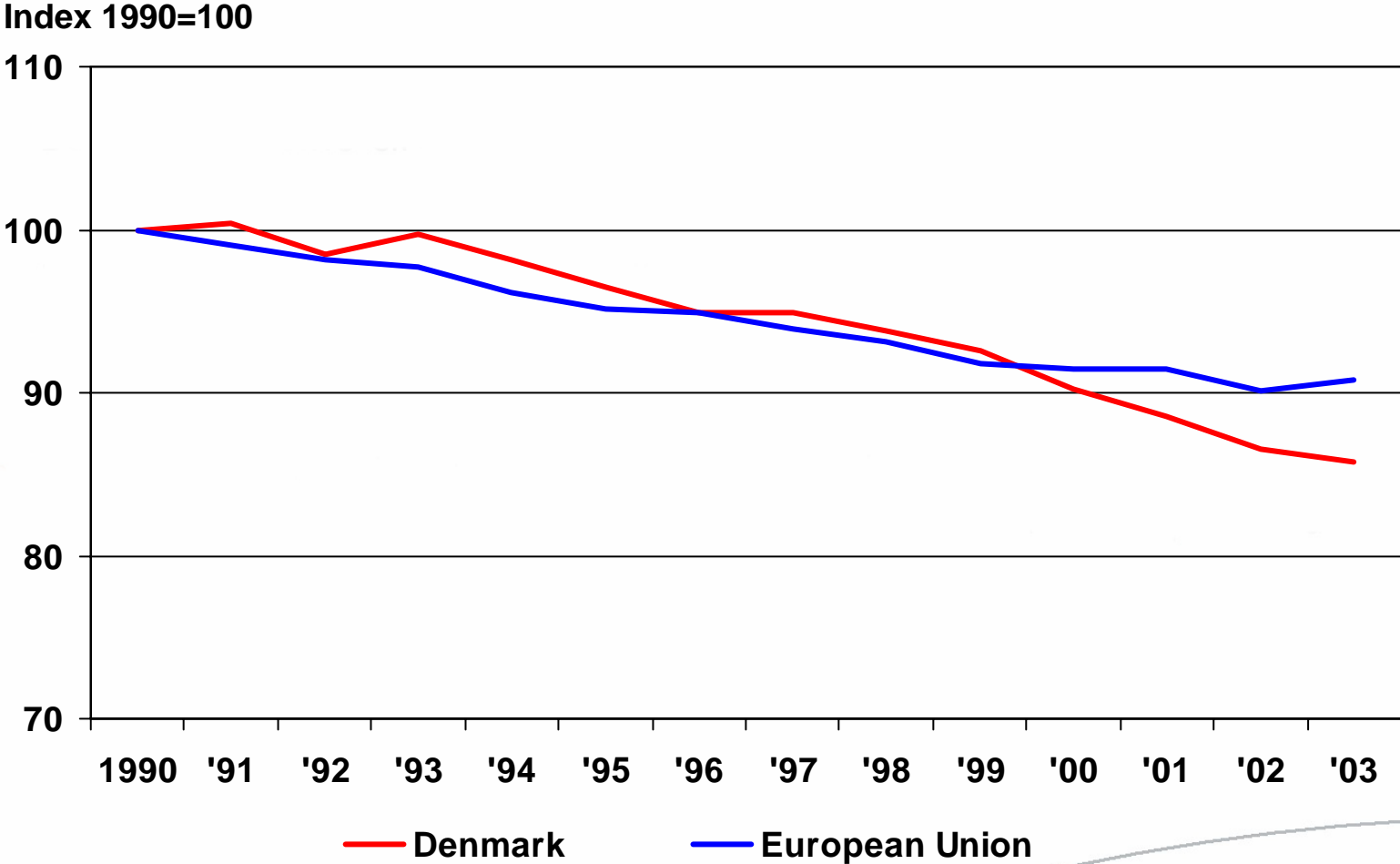
A Measure of the Efficiency in the Transformation Sector

Adjusted



Energy Efficiency Index of Final Consumers

Improvements 1990-2003:
Denmark 14.2% and EU15 9.2%



Source: Odyssee

Energy Efficiency Indicators in Sectors

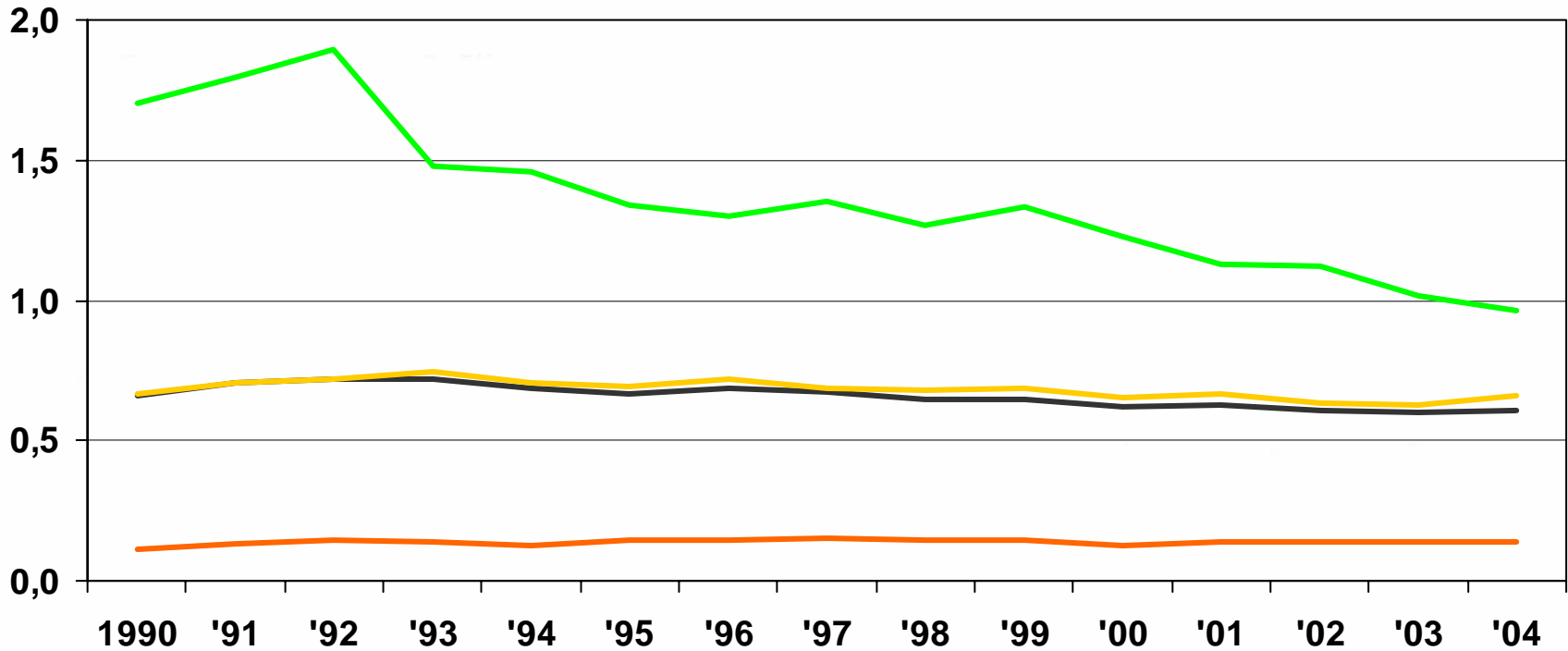
- Agriculture and industry
- Trade and service sector
- Households
- Transport (not included here)

Energy Intensities in Agriculture and Industry

1990-2004: Agriculture and Industry, Total: -8.0%

Climate Adjusted

TJ per DKK Million GVA (2000 Prices)



— Agriculture and Industry, Total

— Agriculture and Horticulture

— Manufacturing

— Construction

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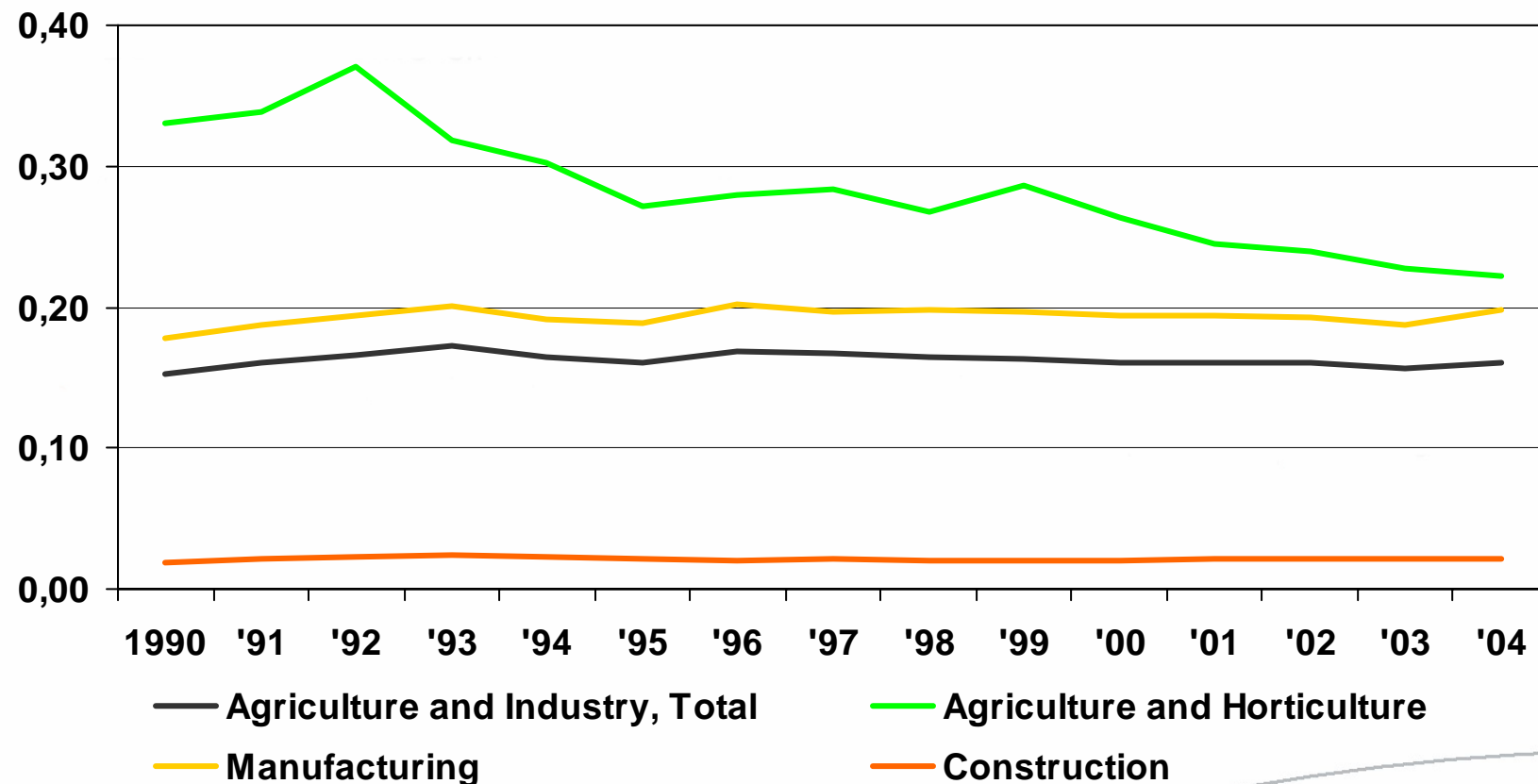
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Electricity Intensities in Agriculture and Industry

1990-2004: Agriculture and Industry, Total: +5.6%

Climate Adjusted

TJ per DKK Million GVA (2000 Prices)



Eliminating Structural Effects: Decomposition of a Change in the Energy Consumption in Manufacturing: Theory

Multiplicative model: $\Delta EC = \Delta A * \Delta S * \Delta EI$, where

ΔEC = Percentage change in energy consumption

ΔA = Percentage change in activity (value added)

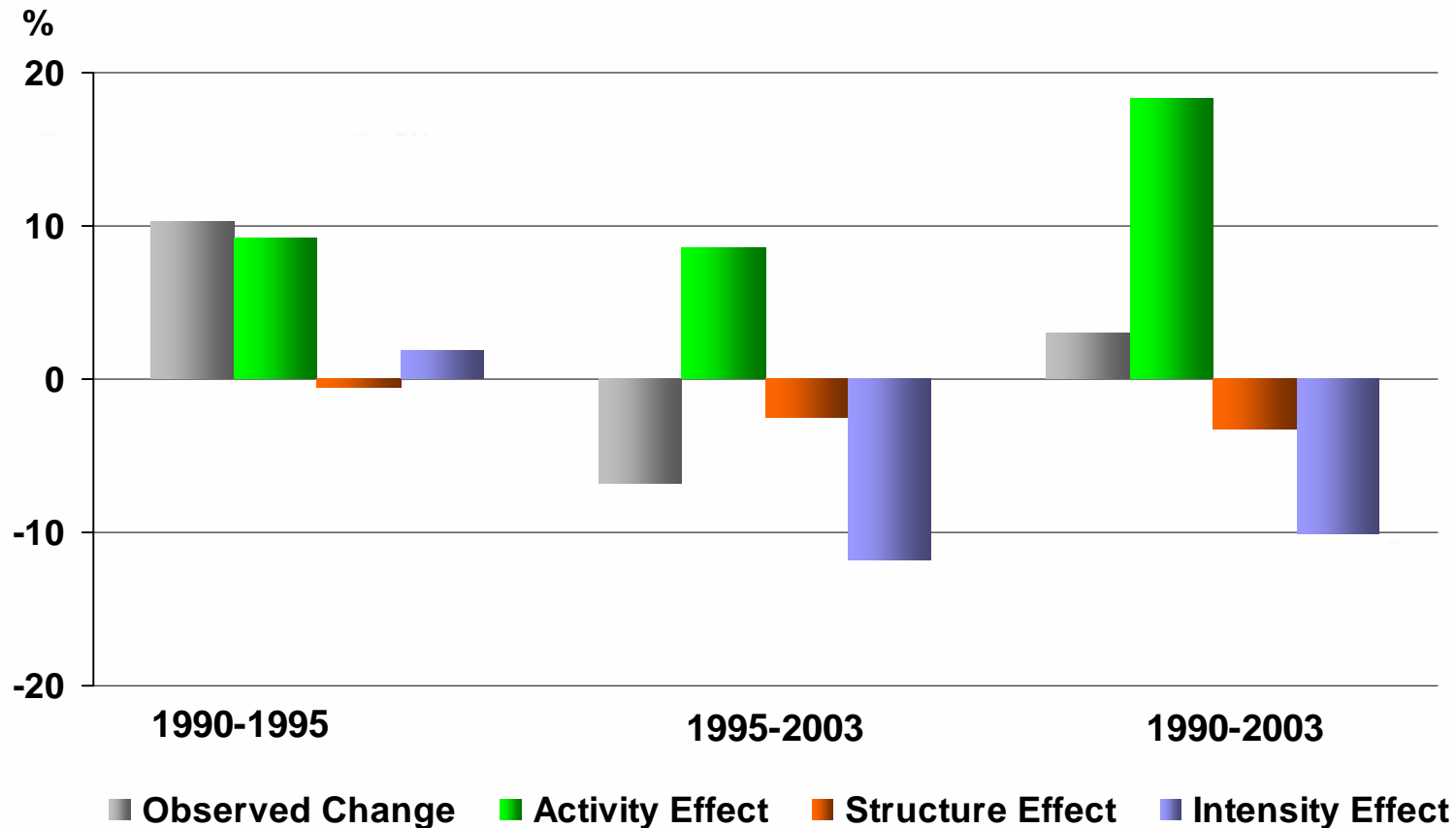
ΔS = Structural effect

ΔEI = Percentage change in energy intensity

Data Needed for the Decomposing

- Final energy consumption in manufacturing by branch (10 branches)
- Value added in manufacturing in constant prices by branch (10 branches)
- All data are reported to Eurostat

Decomposition of the Development in Energy Consumption in Manufacturing



What Should Energy Consumption in the Tertiary Sector be Measured Against?

When the energy efficiency in the tertiary sector has to be evaluated, there are at least three indicators to monitor:

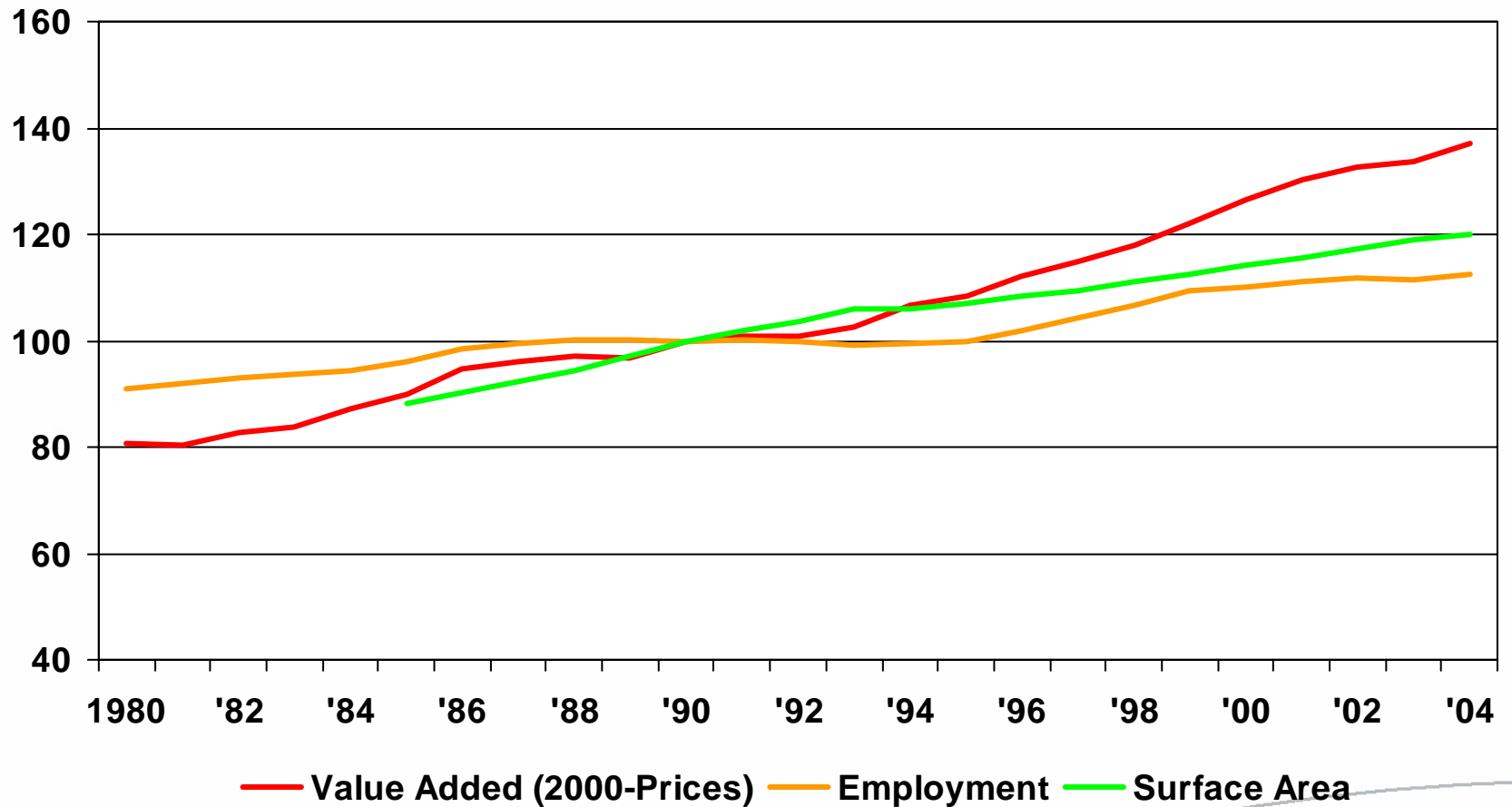
- the energy intensity "toe or GJ per value added-unit"
- the unit consumption "toe or GJ per 1000 employed"
- the unit consumption "toe or per 1000 m²"

(all indicators should be climate adjusted).

The next figure shows that the result of the evaluation can be strongly dependent on the denominator used.

Developments in the Danish Service Sector 1980-2004

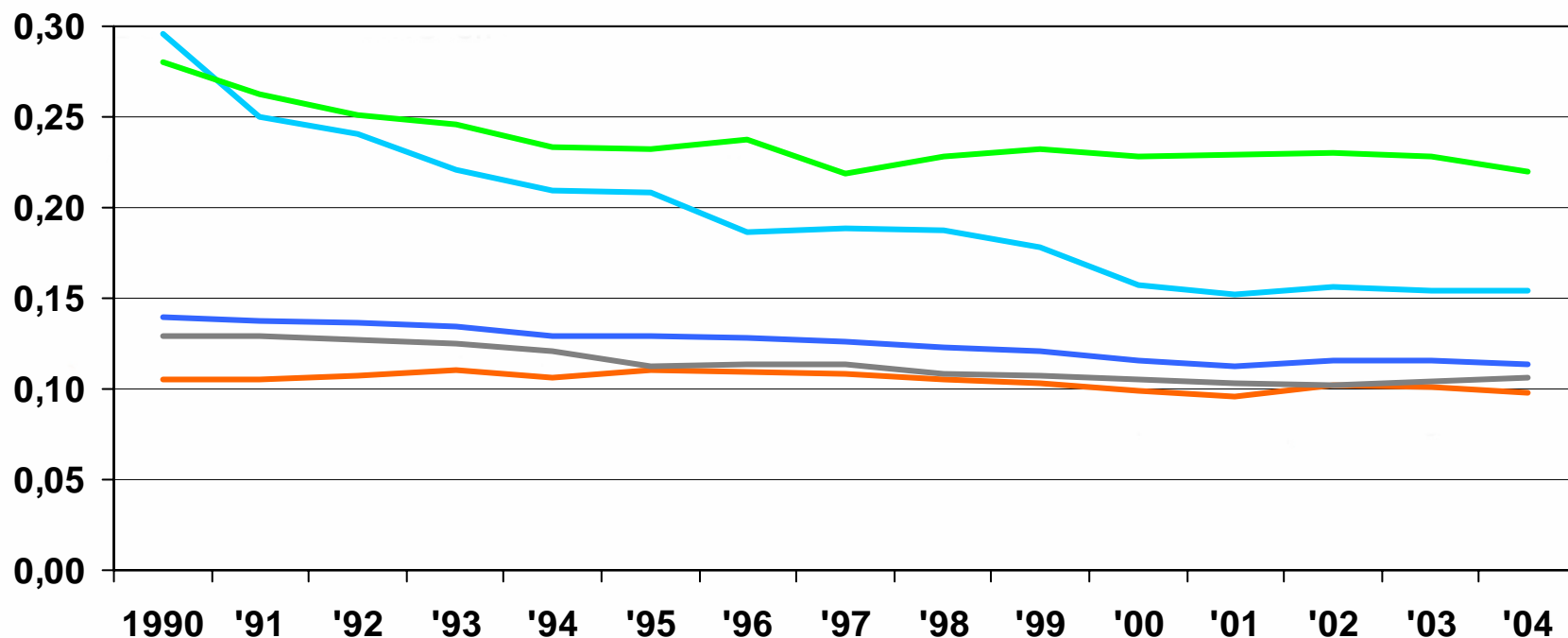
Index 1990=100



Energy Intensities in the Trade and Service Sector

1990-2004: Total Sector -18.4% - Private Service -18.0%
Climate Adjusted

TJ per million DKK GVA (2000 prices)



— Total Trade and Service Sector
— Retail Trade
— Public Service

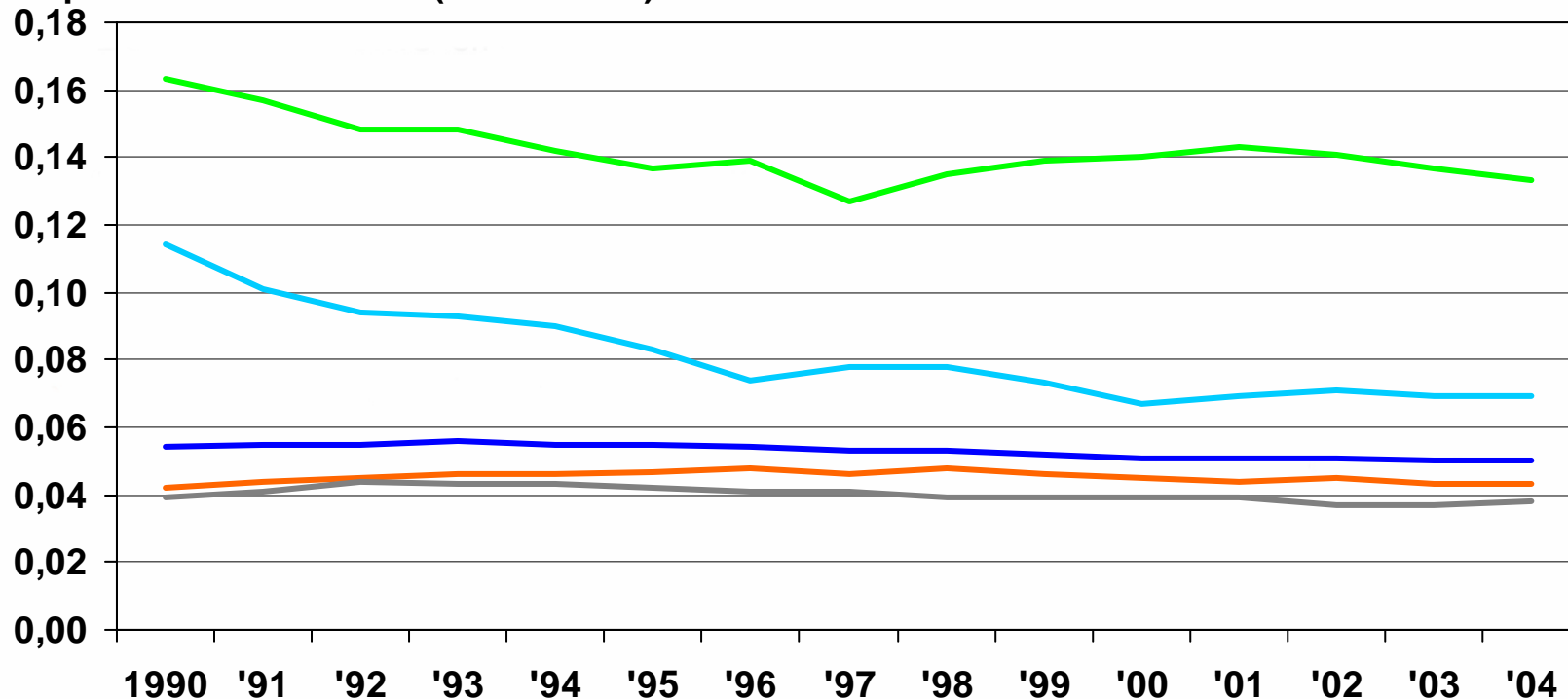
— Wholesale
— Private Service

Electricity Intensities in the Trade and Service Sector

1990-2004: Total Trade and Service Sector: -7.7%

Climate Adjusted

TJ per DKK Million GVA (2000 Prices)



— Total Trade and Service Sector

— Retail Trade

— Public Service

— Wholesale

— Private Service

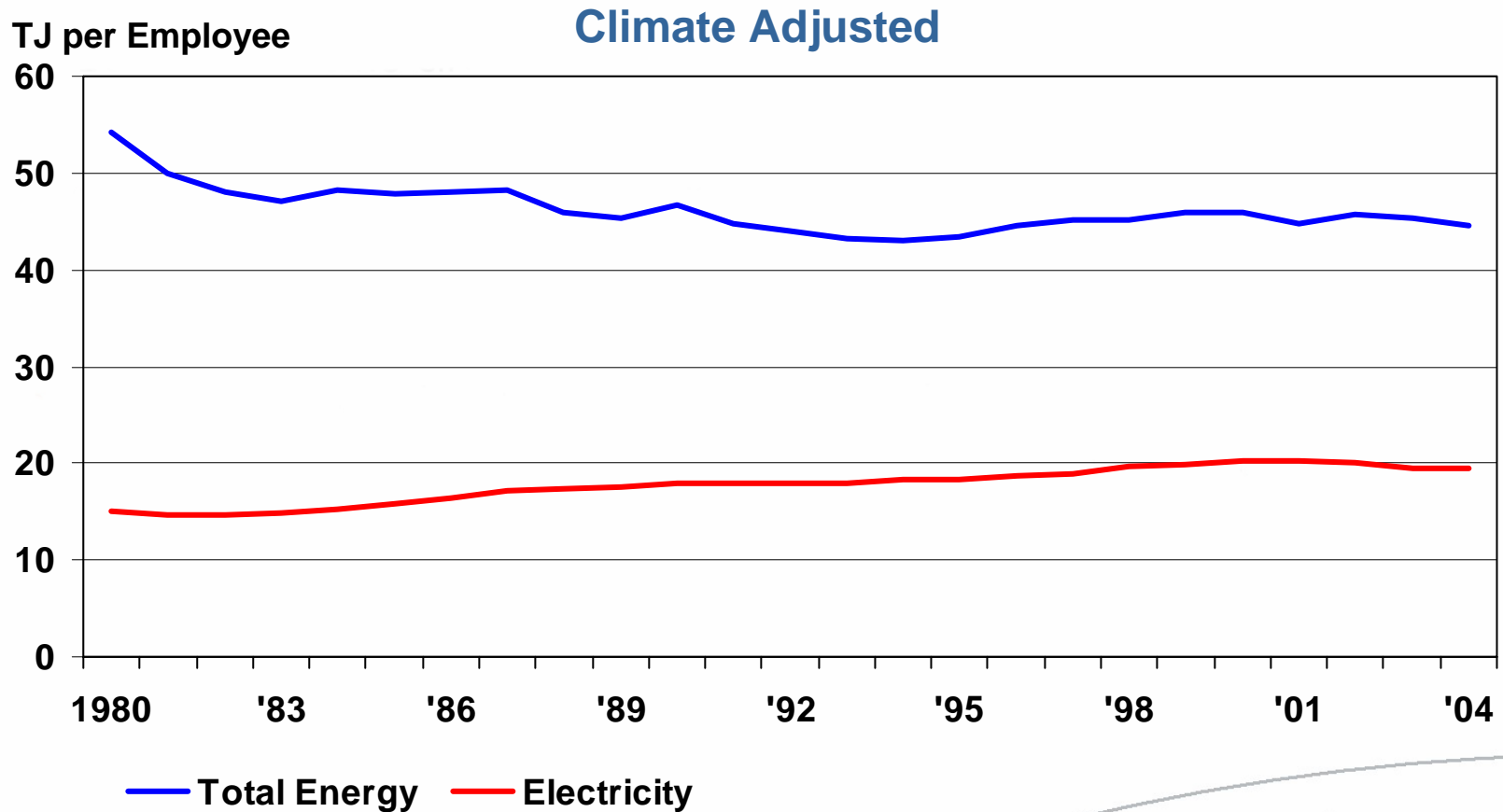
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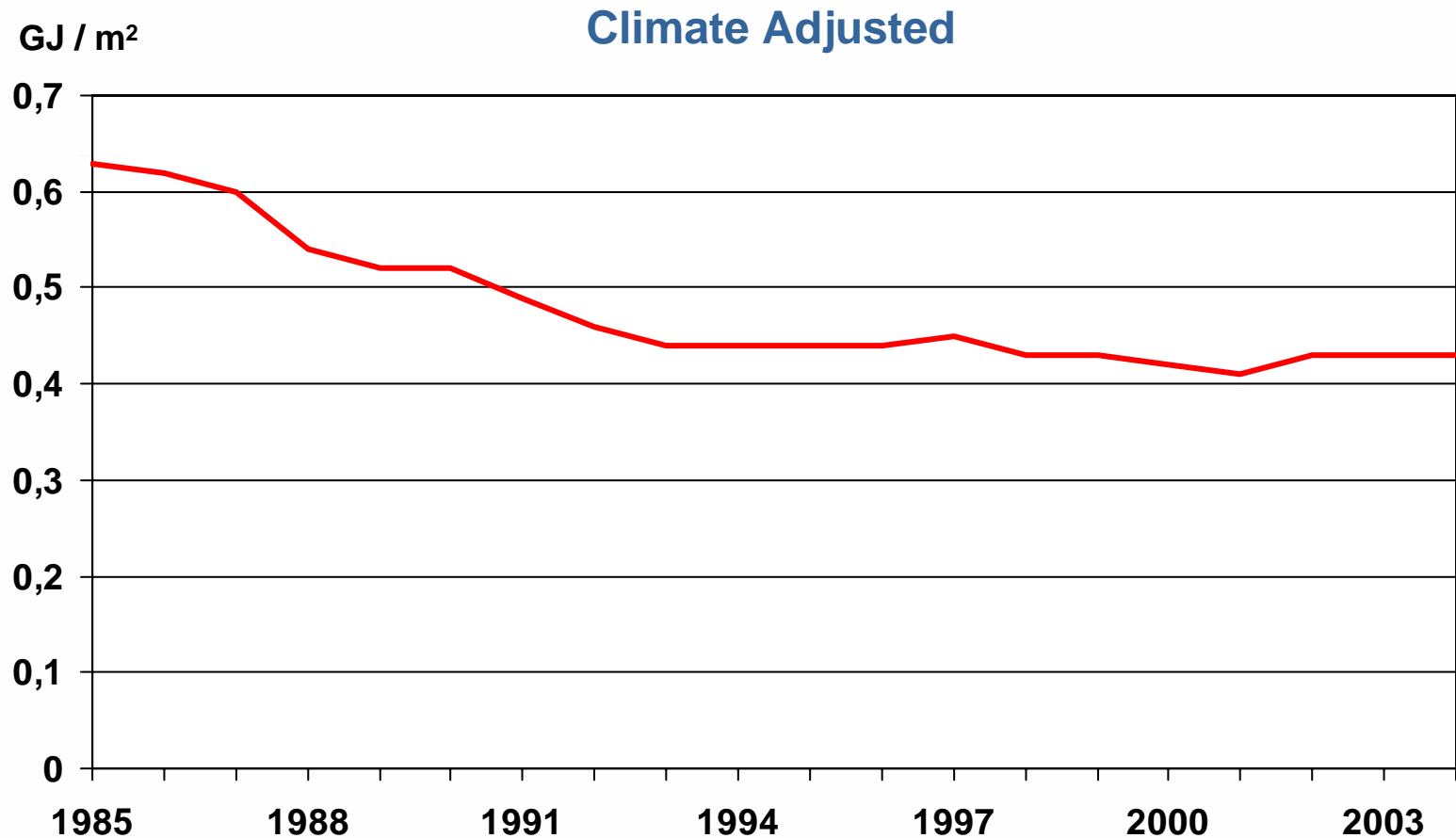
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Energy Consumption per Employee in the Trade and Service Sector

1990-2004: Total Energy: -4.4%



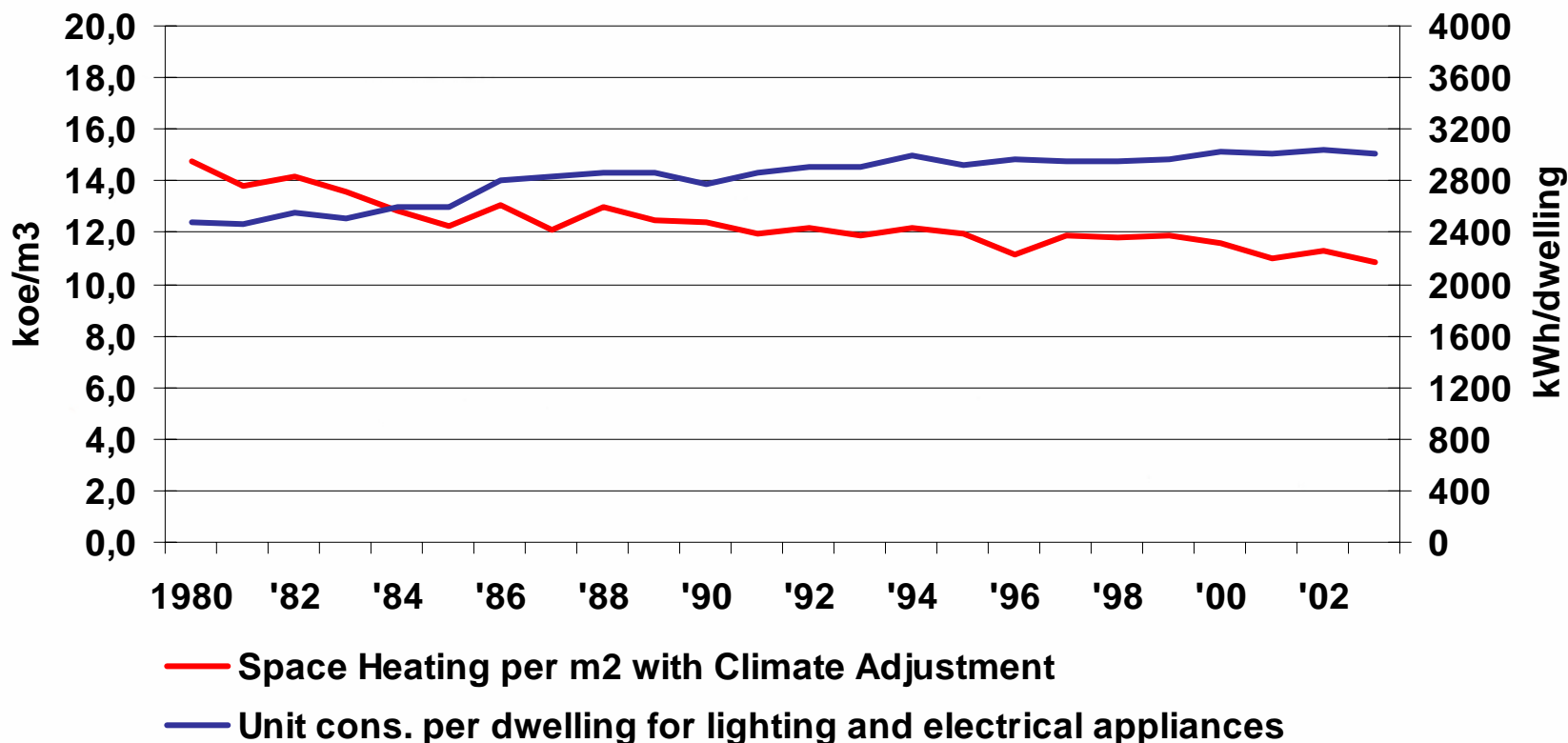
Energy Consumption for Space Heating per m² in the Trade and Service Sector



Unit Consumption in Households

Developments 1990-2003:

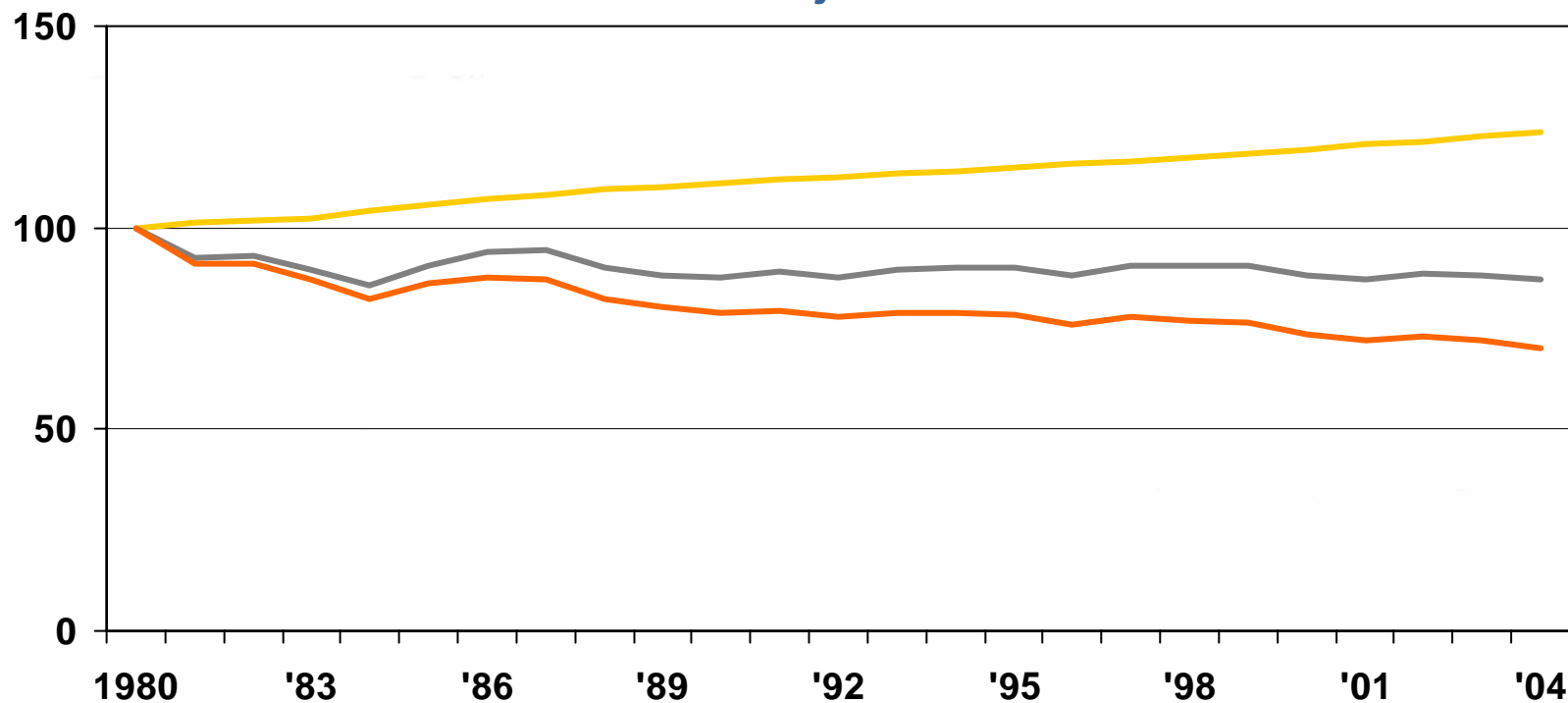
Space Heating -9.0% and Electricity +5.4%



Energy Consumption for Space Heating in Households

Index 1980=100

Climate Adjusted

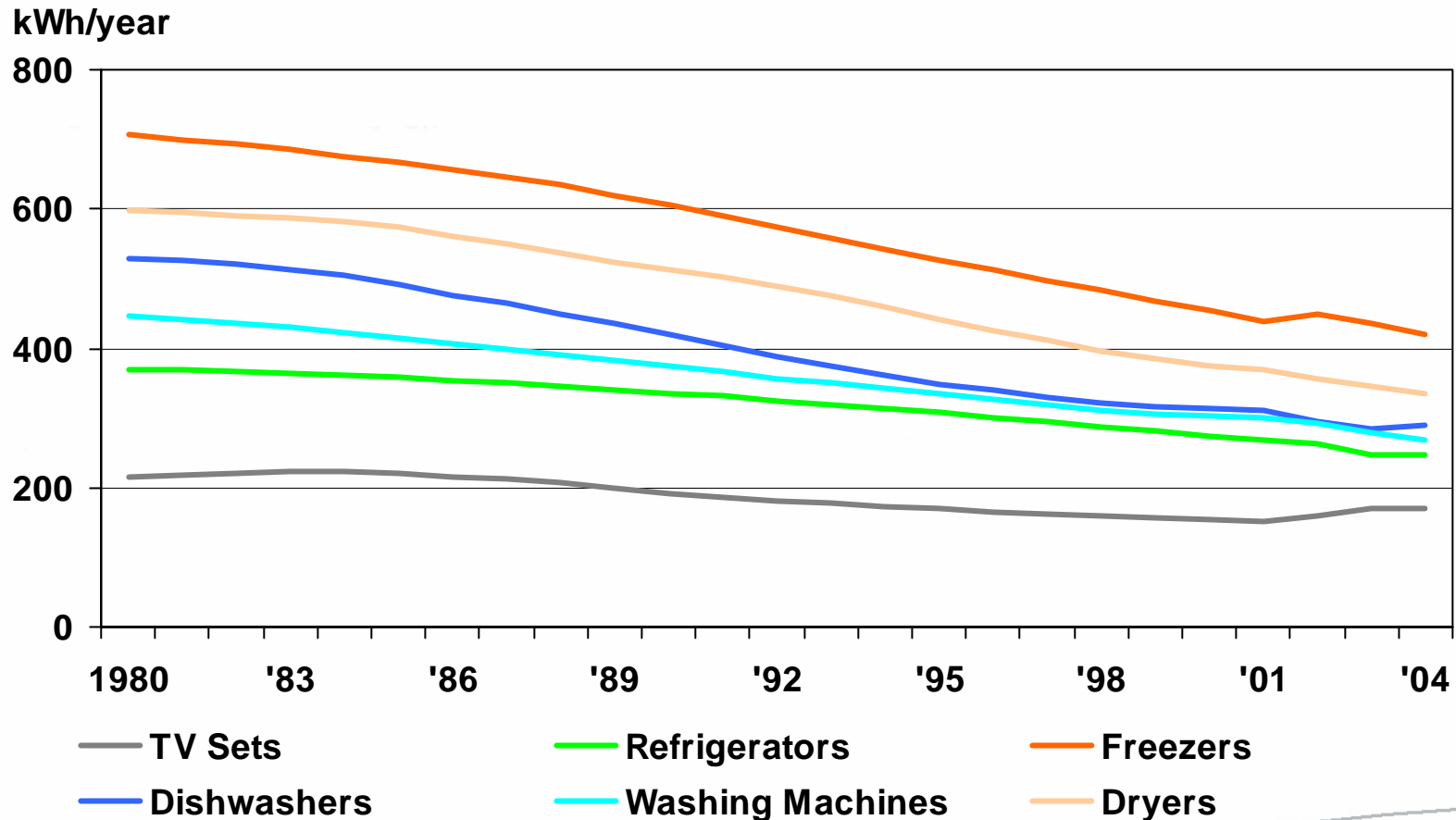


— Heated Floor Space

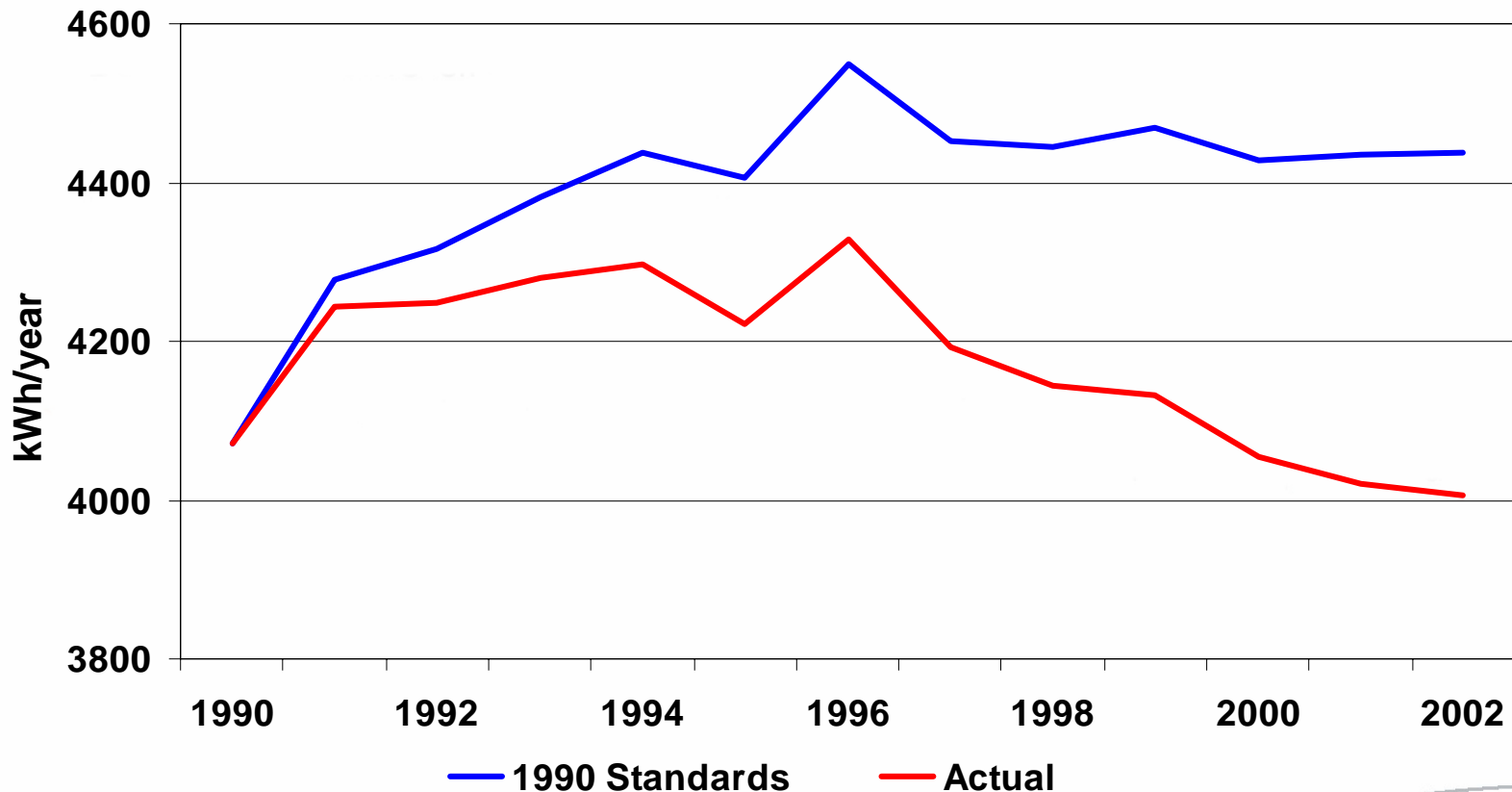
— Final Energy Consumption

— Final Energy Consumption per m2

Specific Electrical Consumption of Households Appliances



Unit Consumption of Electricity per Dwelling: Actual and Unchanged Specific Consumption for Appliances



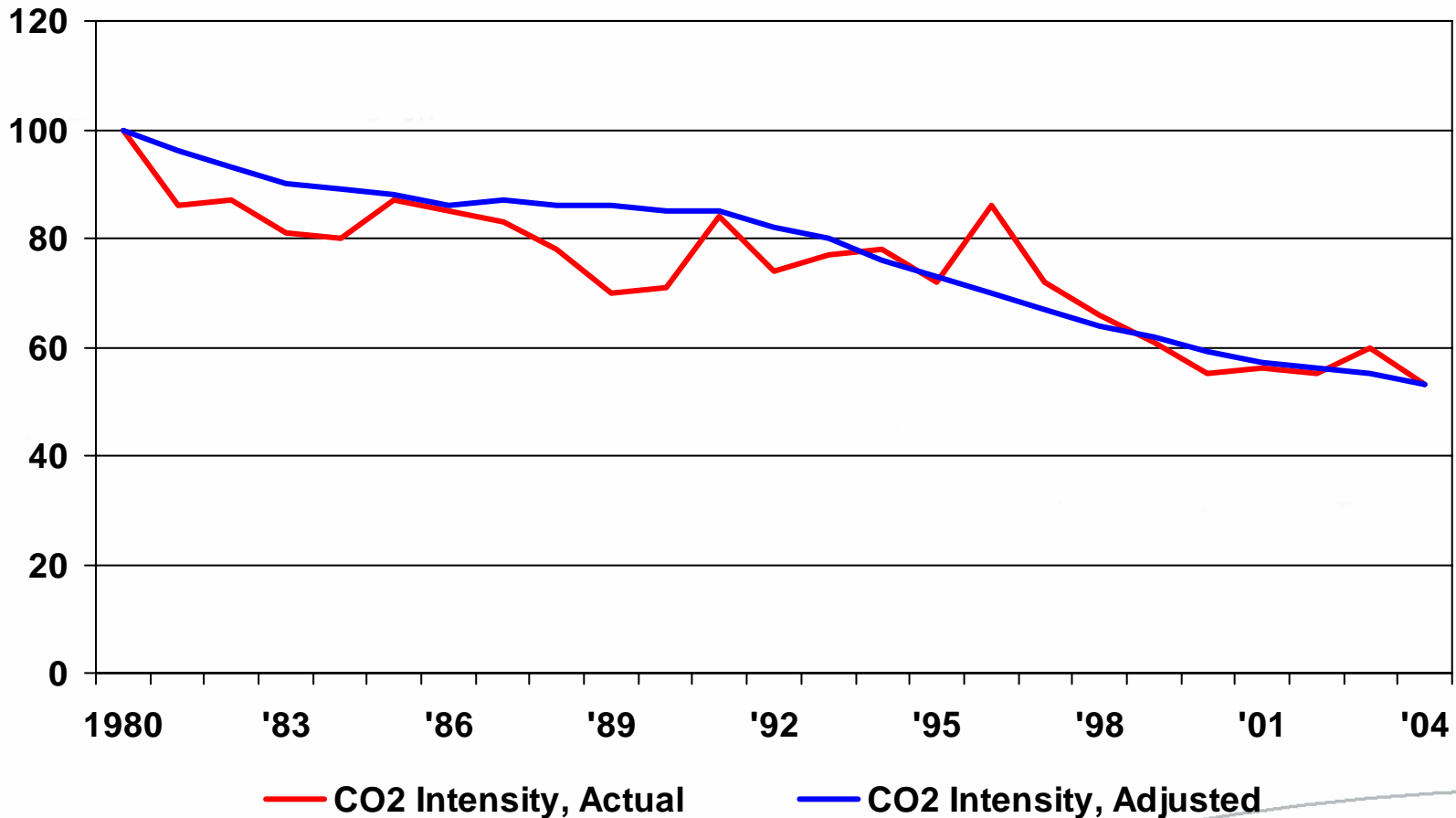
Indicators for CO₂ Emission

- Knowing the CO₂ emission factors it is easy to transform energy efficiency indicators to CO₂ efficiency indicators
- In Denmark (and many other countries) the CO₂ intensity declines much more than the energy intensity due to fuel switching (coal and oil are replaced by natural gas and renewables)
- Many interesting key figures and indicators in this area. But here only a few examples.

CO₂ Intensities (Gross Energy Consumption)

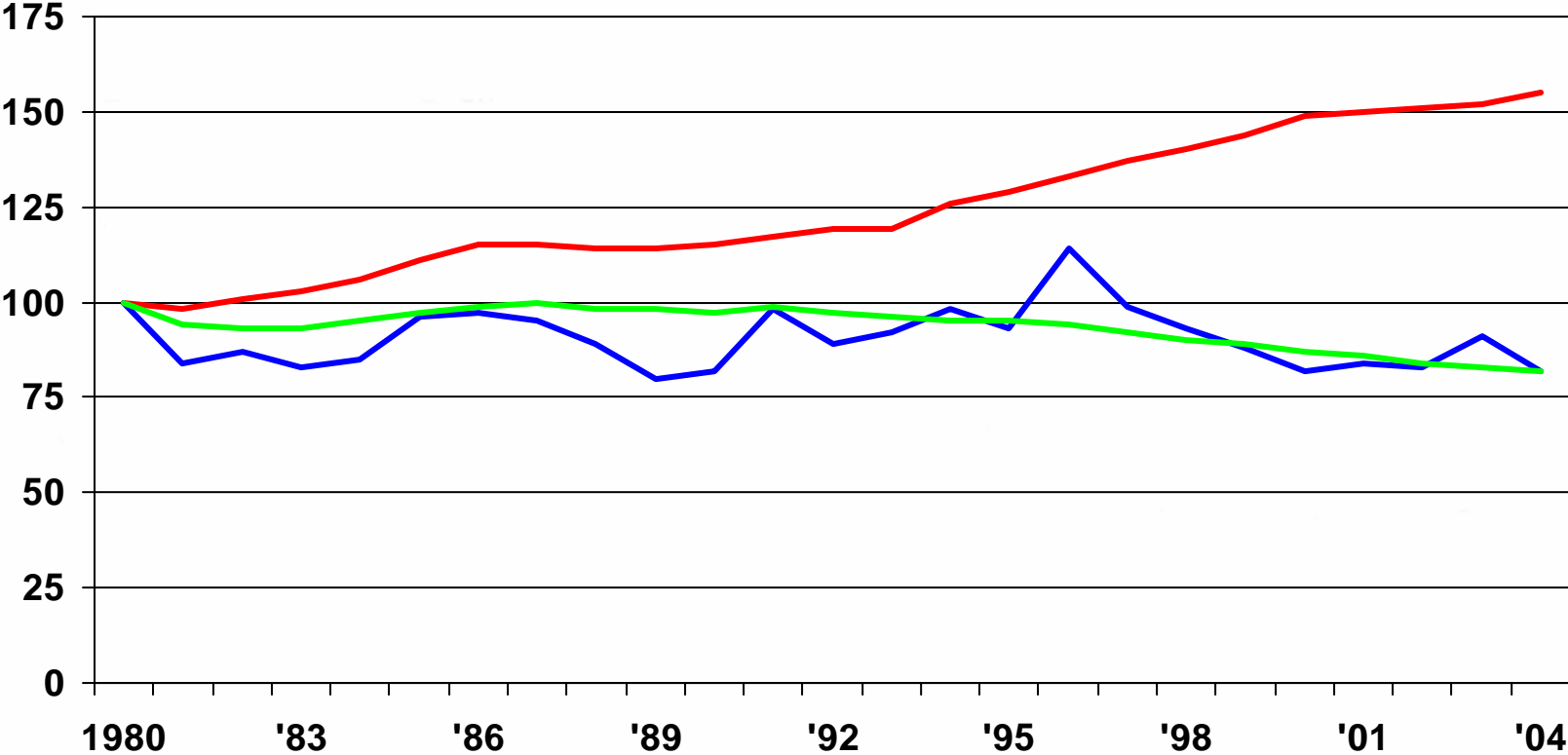
Adjusted CO₂ Intensity 1990-2004: -37.4%

Index, 1980=100



Decoupling of CO₂ Emissions and Economic Development

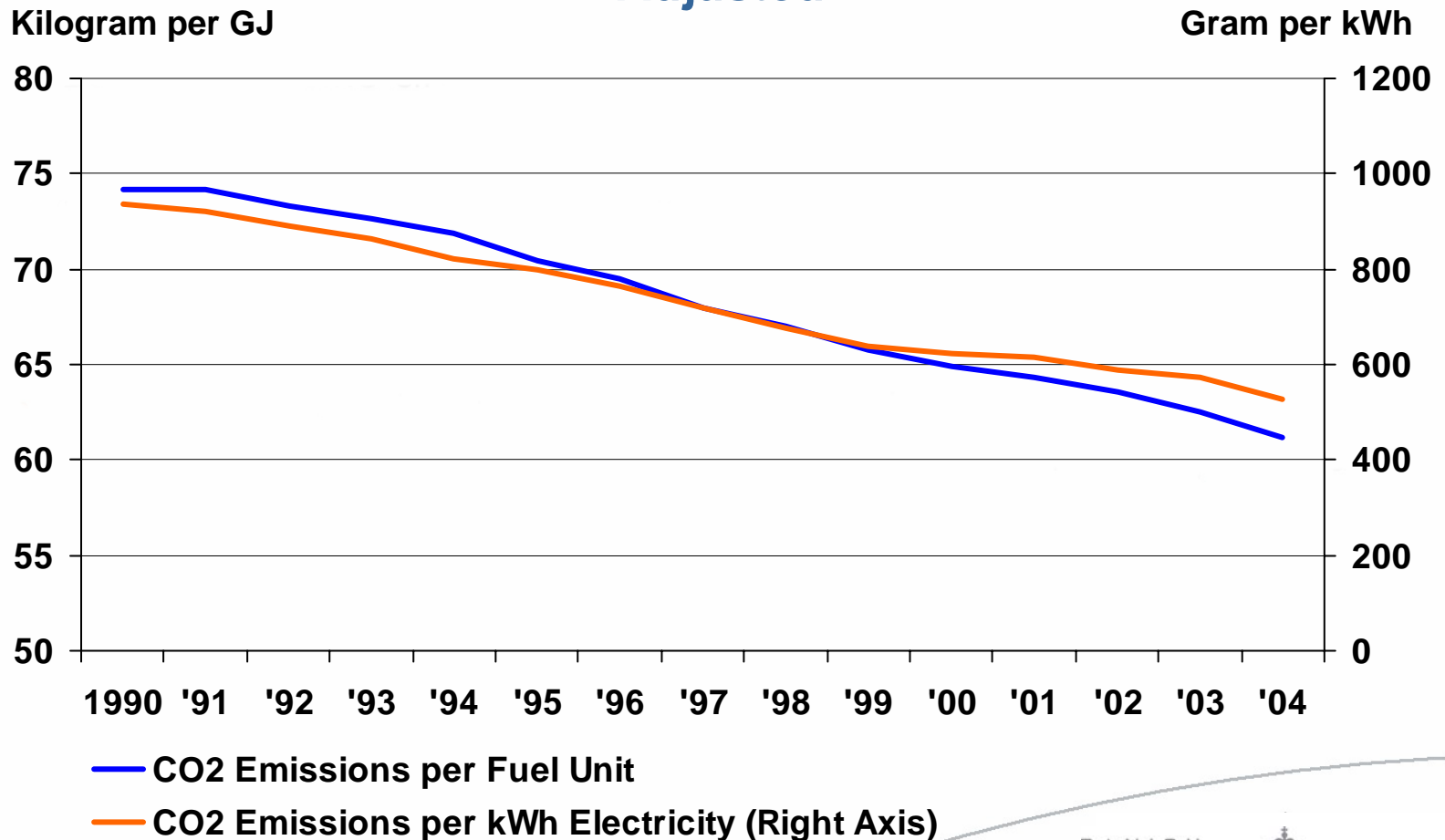
Index, 1980=100



— GDP — CO2 from Energy, Actual — CO2 from Energy, Adjusted

CO₂ Emissions per Fuel Unit and per kWh of Electricity

Adjusted



- CO2 Emissions per Fuel Unit
- CO2 Emissions per kWh Electricity (Right Axis)