Energy Indicators for Sustainable Development

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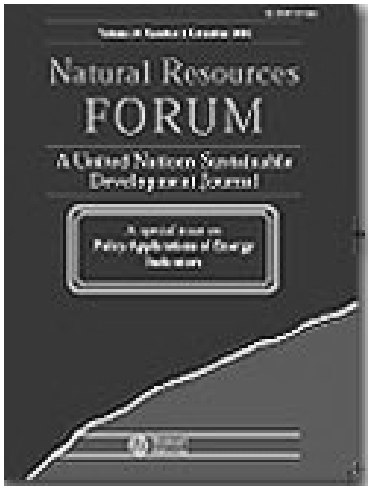
International Atomic Energy Agency

Downloadable from the web

- http://www-pub.iaea.org/MTCD/publications/PDF/Pub1222_web.pdf
- http://www.blackwell-synergy.com/toc/narf/29/4



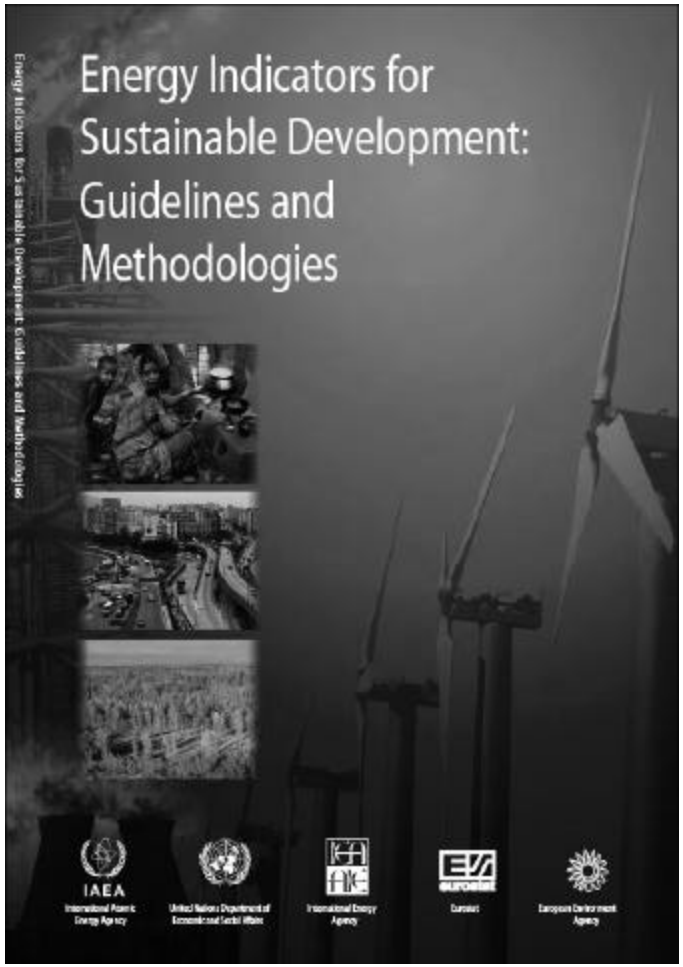
Genesis of EISD

- 1995 work initiated by DESA
- Agenda 21, Chapter 40
  - Development and promotion of indicators for sustainable development
- 3 energy indicators
  - Annual energy use per capita
  - Share of consumption of renewable resources
  - Intensity of energy use

Capacity building for energy analysis

- Transfer analytic tools tailored to developing countries
- Transfer data on technologies, resources and economics
- Train local experts
- Jointly analyze national options
- Help establish continuing local expertise

ISED



- 5 agencies
  - UNDESA, OECD/IEA, IAEA, Eurostat, EEA
- 7 countries
  - Brazil, Cuba, Lithuania, Mexico, Russia, Slovakia, Thailand

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Design objectives

- Match UN format
  - Main themes, sub-themes
  - Social, economic, environmental, institutional
- Match data availability in most countries
- Clarity and consistency
- Relevant to policy assessment for sustainability
- Pilot testing / adjustment for usability

30 indicators

- 4 social
- 16 economic
- 10 environmental

Social (SOC1)

- **Theme:** Equity
- **Sub-theme:** Accessibility
- **Indicator:** Share of households (or population) without electricity or commercial energy, or heavily dependent on non-commercial energy
- **Components:**
  - Households (or population) without electricity or commercial energy, or heavily dependent on noncommercial energy
  - Total number of households or population

Social (SOC2)

- **Theme:** Equity
- **Sub-theme:** Affordability
- **Indicator:** Share of household income spent on fuel and electricity
- **Components:**
  - Household income spent on fuel and electricity
  - Household income (total and poorest 20% of population)

Social (SOC3)

- **Theme:** Equity
- **Sub-theme:** Disparities
- **Indicator:** Household energy use for each income group and corresponding fuel mix
- **Components:**
  - Energy use per household for each income group (quintiles)
  - Household income for each income group (quintiles)
  - Corresponding fuel mix for each income group (quintiles)

Social (SOC4)

- **Theme:** Health
- **Sub-theme:** Safety
- **Indicator:** Accident fatalities per energy produced by fuel chain
- **Components:**
  - Annual fatalities by fuel chain
  - Annual energy produced

Economic (ECO1)

- **Theme:** Use and production patterns
- **Sub-theme:** Overall use
- **Indicator:** Energy use per capita
- **Components:**
  - Energy use (total primary energy supply, total final consumption and electricity use)
  - Total population

Economic (ECO2)

- **Theme:** Use and production patterns
- **Sub-theme:** Overall productivity
- **Indicator:** Energy use per unit of GDP
- **Components:**
  - Energy use (total primary energy supply, total final consumption and electricity use)
  - GDP

Economic (ECO3)

- **Theme:** Use and production patterns
- **Sub-theme:** Supply efficiency
- **Indicator:** Efficiency of energy conversion and distribution
- **Components:**
  - Losses in transformation systems including losses in electricity generation, transmission and distribution

Economic (ECO4)

- **Theme:** Use and production patterns
- **Sub-theme:** Production
- **Indicator:** Rreserves-to-production ratio
- **Components:**
  - Proven recoverable reserves
  - Total energy production

Economic (ECO5)

- **Theme:** Use and production patterns
- **Sub-theme:** Production
- **Indicator:** Resources-to-production ratio
- **Components:**
  - Total estimated resources
  - Total energy production

Economic (ECO6)

- **Theme:** Use and production patterns
- **Sub-theme:** End use
- **Indicator:** Industrial energy intensities
- **Components:**
  - Energy use in industrial sector and by manufacturing branch
  - Corresponding value added

Economic (ECO7)

- **Theme:** Use and production patterns
- **Sub-theme:** End use
- **Indicator:** Agricultural energy intensities
- **Components:**
  - Energy use in agricultural sector
  - Corresponding value added

Economic (ECO8)

- **Theme:** Use and production patterns
- **Sub-theme:** End use
- **Indicator:** Service/commercial energy intensities
- **Components:**
  - Energy use in service/commercial sector
  - Corresponding value added

Economic (ECO9)

- **Theme:** Use and production patterns
- **Sub-theme:** End use
- **Indicator:** Household energy intensities
- **Components:**
  - Energy use in households and key energy use
  - Number of households, floor area, persons per household, appliance ownership

Economic (ECO10)

- **Theme:** Use and production patterns
- **Sub-theme:** End use
- **Indicator:** Transport energy intensities
- **Components:**
  - Energy use in passenger travel and freight sectors and by mode
  - Passenger-km travel and tonne-km freight and by mode

Economic (ECO11)

- **Theme:** Use and production patterns
- **Sub-theme:** Diversification (fuel mix)
- **Indicator:** Fuel shares in energy and electricity
- **Components:**
  - Primary energy supply and final consumption, electricity generation and generating capacity by fuel type
  - Total primary energy supply, total final consumption, total electricity generation and total generating capacity by fuel type

Economic (ECO12)

- **Theme:** Use and production patterns
- **Sub-theme:** Diversification (fuel mix)
- **Indicator:** Non-carbon energy share in energy and electricity
- **Components:**
  - Primary supply, electricity generation and generating capacity by non-carbon energy
  - Total primary energy supply, total electricity generation and total generating capacity

Economic (ECO13)

- **Theme:** Use and production patterns
- **Sub-theme:** Diversification (fuel mix)
- **Indicator:** Renewable energy share in energy and electricity
- **Components:**
  - Primary energy supply, final consumption and electricity generation and generating capacity by renewable energy
  - Total primary energy supply, total final consumption, total electricity generation and total generating capacity

Economic (ECO14)

- **Theme:** Use and production patterns
- **Sub-theme:** Prices
- **Indicator:** End use energy prices by fuel and by sector
- **Components:**
  - Energy prices (with and without tax/subsidy)

Economic (ECO15)

- **Theme:** Security
- **Sub-theme:** Imports
- **Indicator:** Net energy import dependency
- **Components:**
  - Energy imports
  - Total primary energy supply

Economic (ECO16)

- **Theme:** Security
- **Sub-theme:** Strategic fuel stocks
- **Indicator:** Stocks of critical fuels per corresponding fuel consumption
- **Components:**
  - Stocks of critical fuel (e.g. oil, gas, etc.)
  - Critical fuel consumption

Environmental (ENV1)

- **Theme:** Atmosphere
- **Sub-theme:** Climate change
- **Indicator:** GHG emissions from energy production and use per capita and per unit of GDP
- **Components:**
  - GHG emissions from energy production and use
  - Population and GDP

Environmental (ENV2)

- **Theme:** Atmosphere
- **Sub-theme:** Air quality
- **Indicator:** Ambient concentrations of air pollutants in urban areas
- **Components:**
  - Concentrations of pollutants in air

Environmental (ENV3)

- **Theme:** Atmosphere
- **Sub-theme:** Air quality
- **Indicator:** Air pollutant emissions from energy systems
- **Components:**
  - Air pollutant emissions

Environmental (ENV4)

- **Theme:** Water
- **Sub-theme:** Water quality
- **Indicator:** Contaminant discharges in liquid effluents from energy systems including oil discharges
- **Components:**
  - Contaminant discharges in liquid effluents

Environmental (ENV5)

- **Theme:** Land
- **Sub-theme:** Soil quality
- **Indicator:** Soil area where acidification exceeds critical loads
- **Components:**
  - Affected soil area
  - Critical load

Environmental (ENV6)

- **Theme:** Land
- **Sub-theme:** Forest
- **Indicator:** Rate of deforestation attributed to energy use
- **Components:**
  - Forest area at two different times
  - Biomass utilization

Environmental (ENV7)

- **Theme:** Land
- **Sub-theme:** Solid waste generation and management
- **Indicator:** Ratio of solid waste generation to units of energy produced
- **Components:**
  - Amount of solid waste
  - Energy produced

Environmental (ENV8)

- **Theme:** Land
- **Sub-theme:** Solid waste generation and management
- **Indicator:** Ratio of solid waste properly disposed of to total generated solid waste
- **Components:**
  - Amount of solid waste properly disposed of
  - Total amount of solid waste

Environmental (ENV9)

- **Theme:** Land
- **Sub-theme:** Solid waste generation and management
- **Indicator:** Ratio of solid radioactive waste to units of energy produced
- **Components:**
  - Amount of radioactive waste (cumulative for a selected period of time)
  - Energy produced

Environmental (ENV10)

- **Theme:** Land
- **Sub-theme:** Solid waste generation and management
- **Indicator:** Ratio of solid radioactive waste awaiting disposal to total generated solid radioactive waste
- **Components:**
  - Amount of radioactive waste awaiting disposal
  - Total volume of radioactive waste

Not a test or a contest

- Unlike some other indicators, ISED are meant to be used for national analyses – UN system.
- They are not meant to set up pass-fail situations or international benchmarking, although others do use indicators in this way.
- Indicators judge according to established criteria – they do not judge between good and bad
- Intended to motivate the question, “Why?”

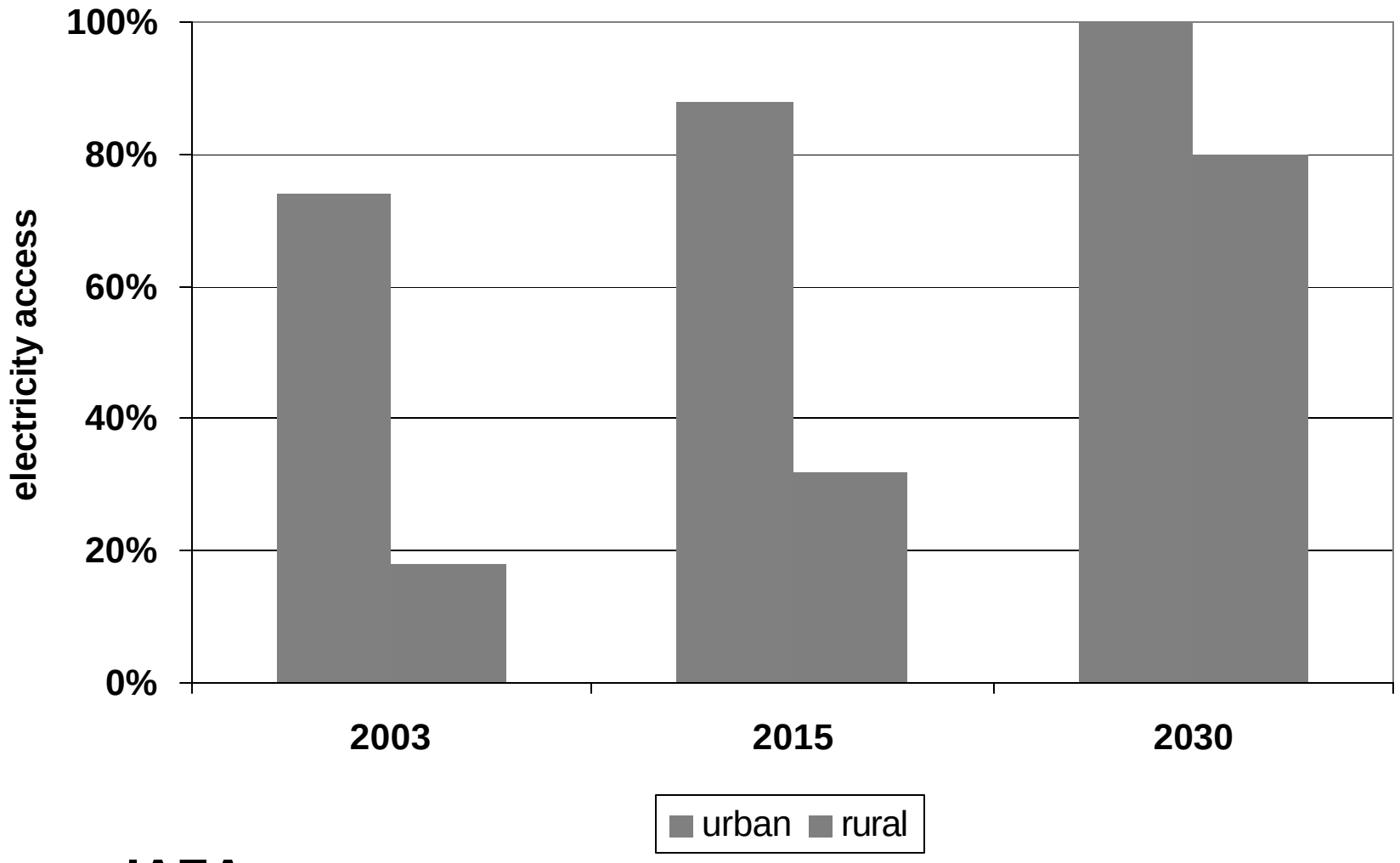
Indicators need context

- Each ISED gives an indication of one aspect of energy use
- Each needs to be read together with other indicators
- Need to be read in the context of each country’s economy and resources
- Indicators have proper applications and limitations

Indicators as a tool

- Indicators are not magic, do not generate magic numbers or magic answers
- Need thoughtful interpretation in context to avoid false identification of causality, etc.
- Can inform policy decisions, help gauge policy effectiveness and unintended consequences

Electricity access in Ghana



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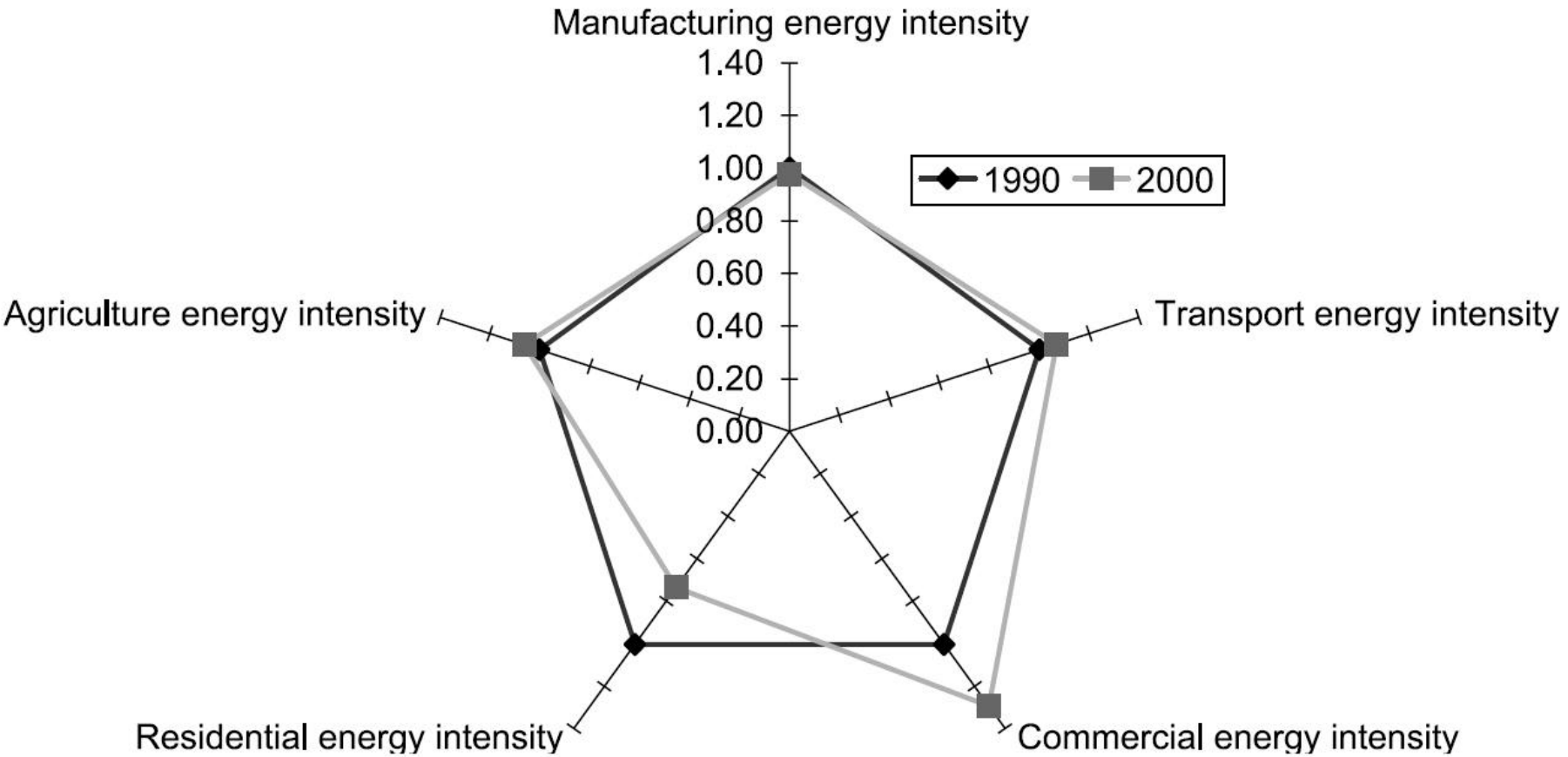
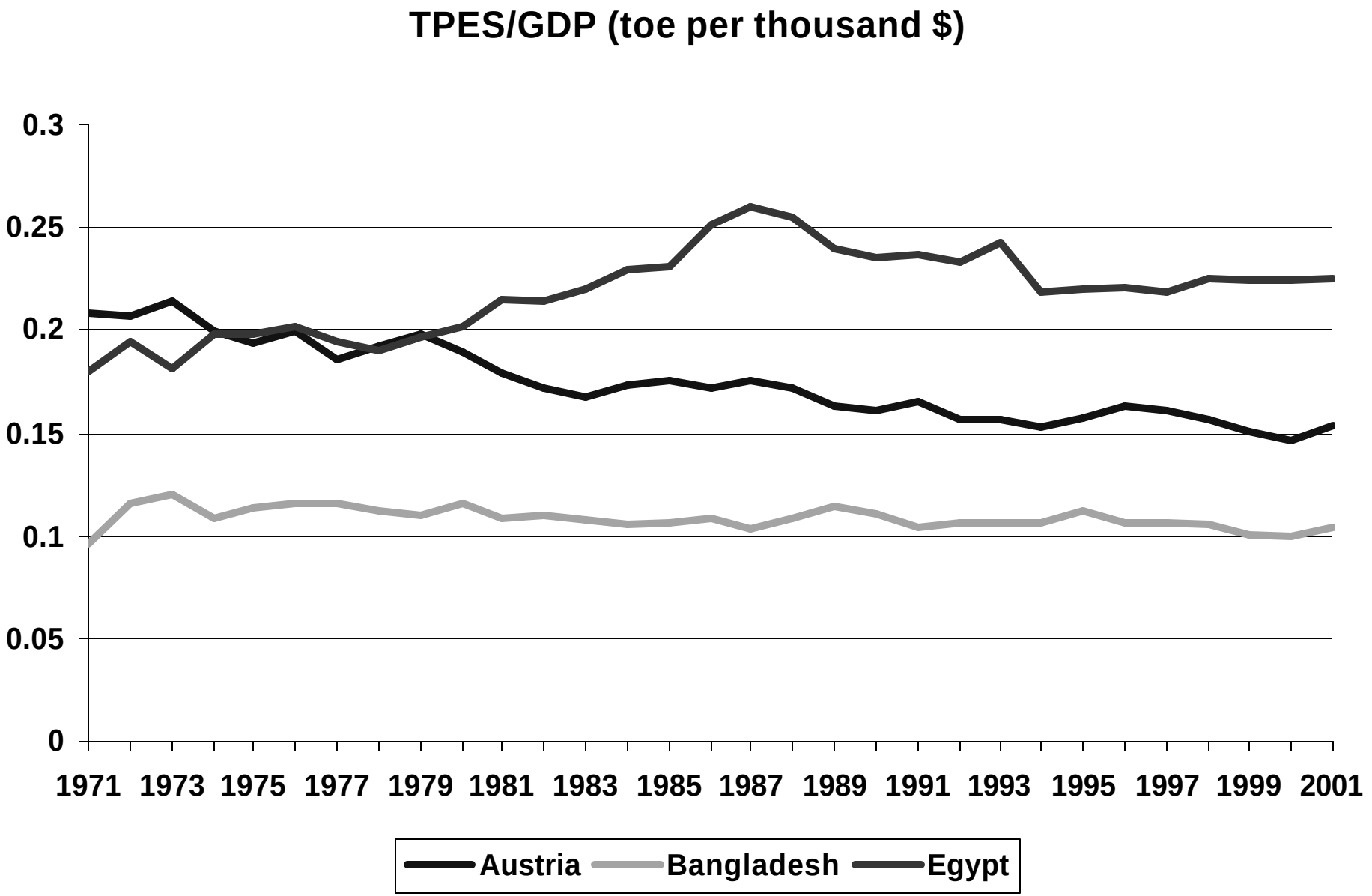
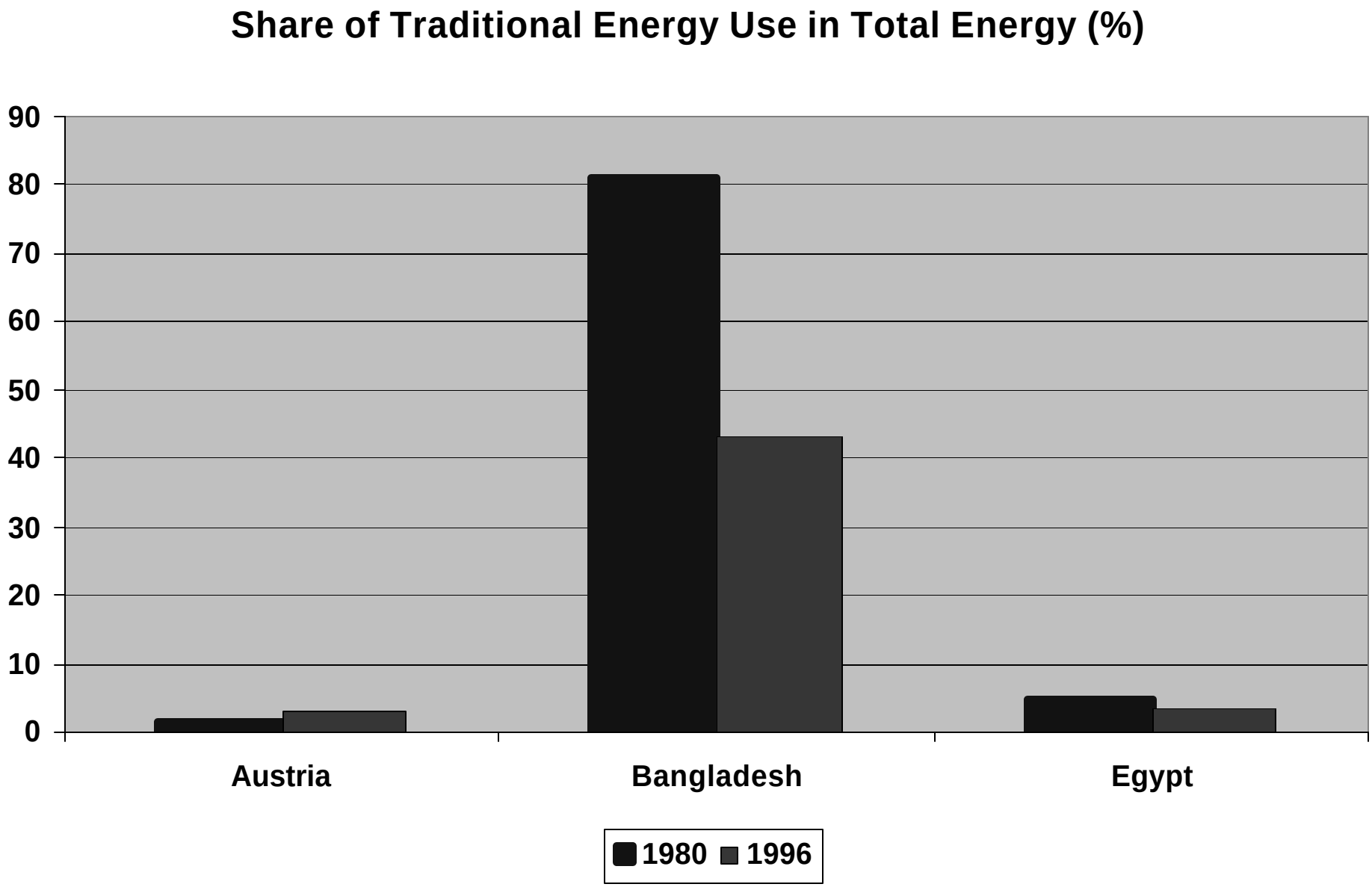
Energy intensities in Thailand



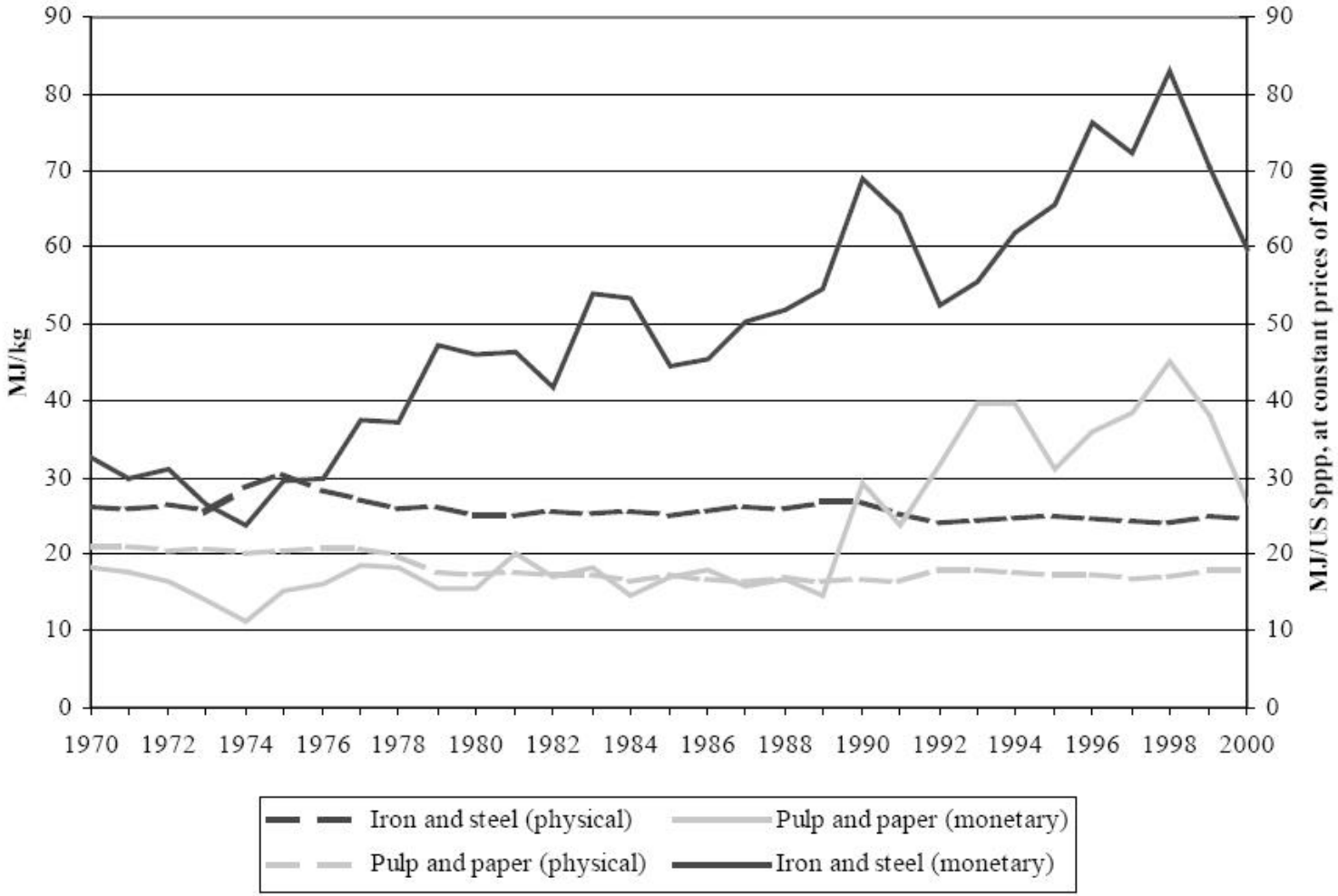
Energy intensity of GDP



Traditional energy use



Commodity prices



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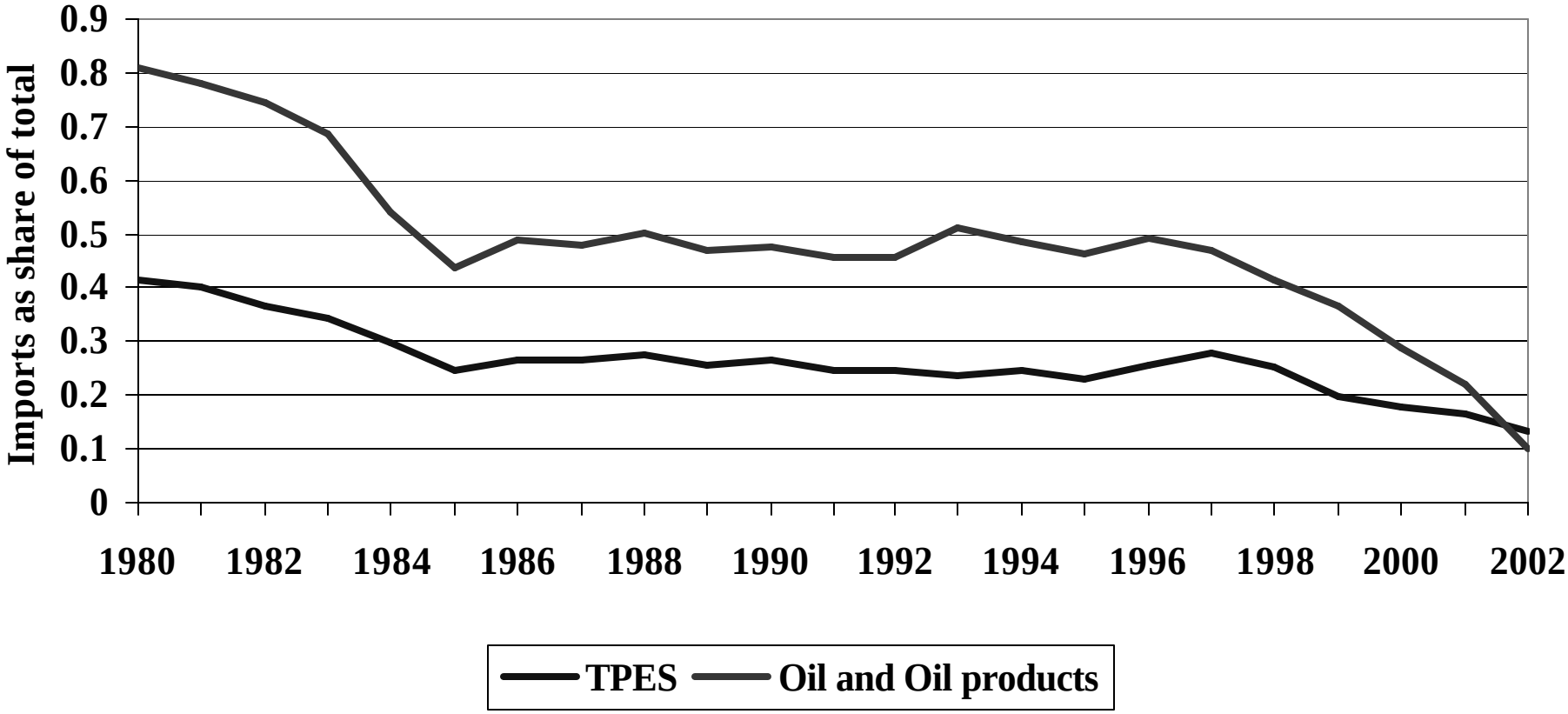
Brazil net import reduction (1/2)



Brazil net import reduction (2/2)

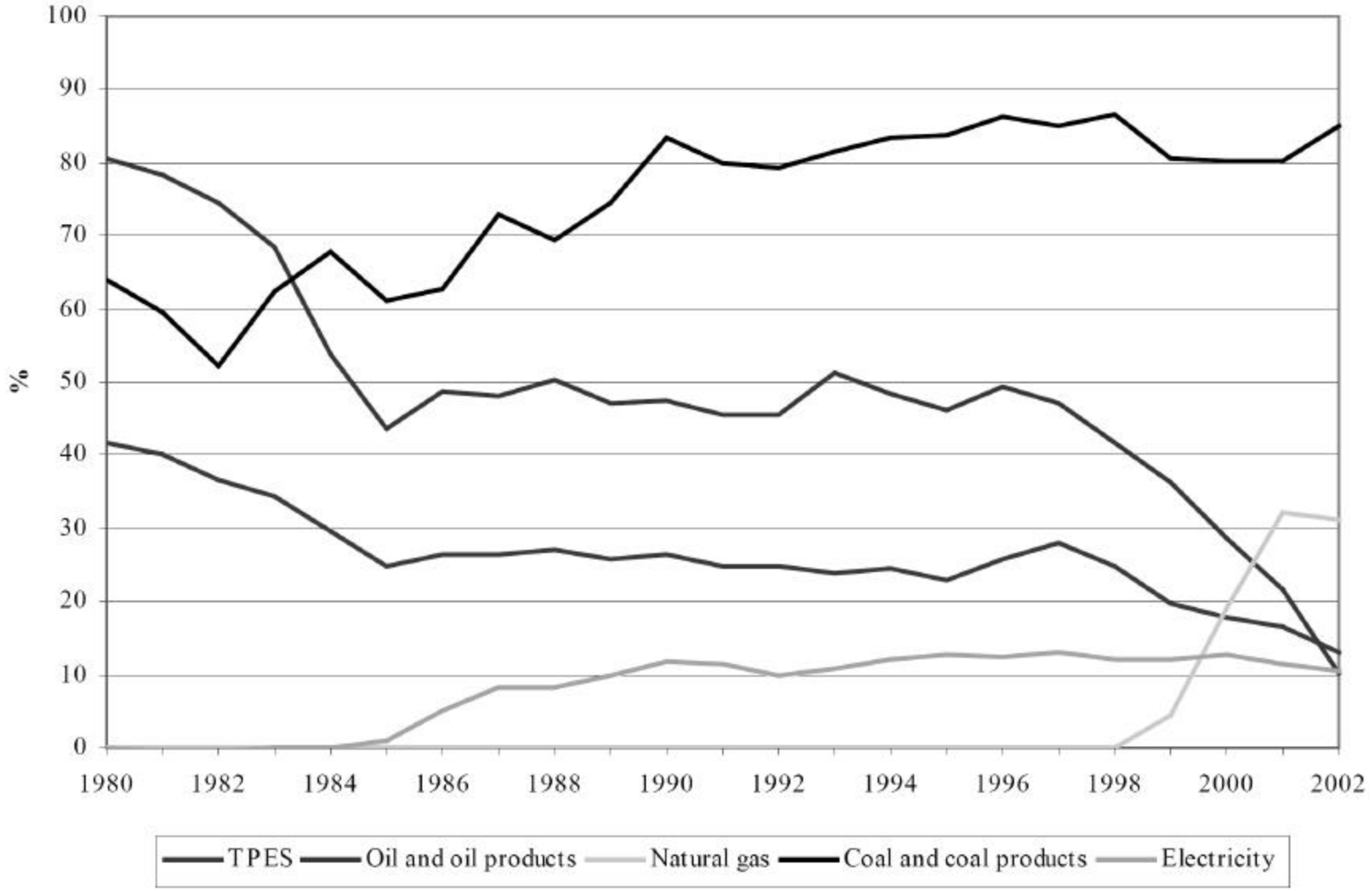


FIG. 8.1. Net energy import dependency (EISD ECO15) [10].

Checking assumptions

- One case study checked the assumptions and results of a national energy plan by analysing the ISED.

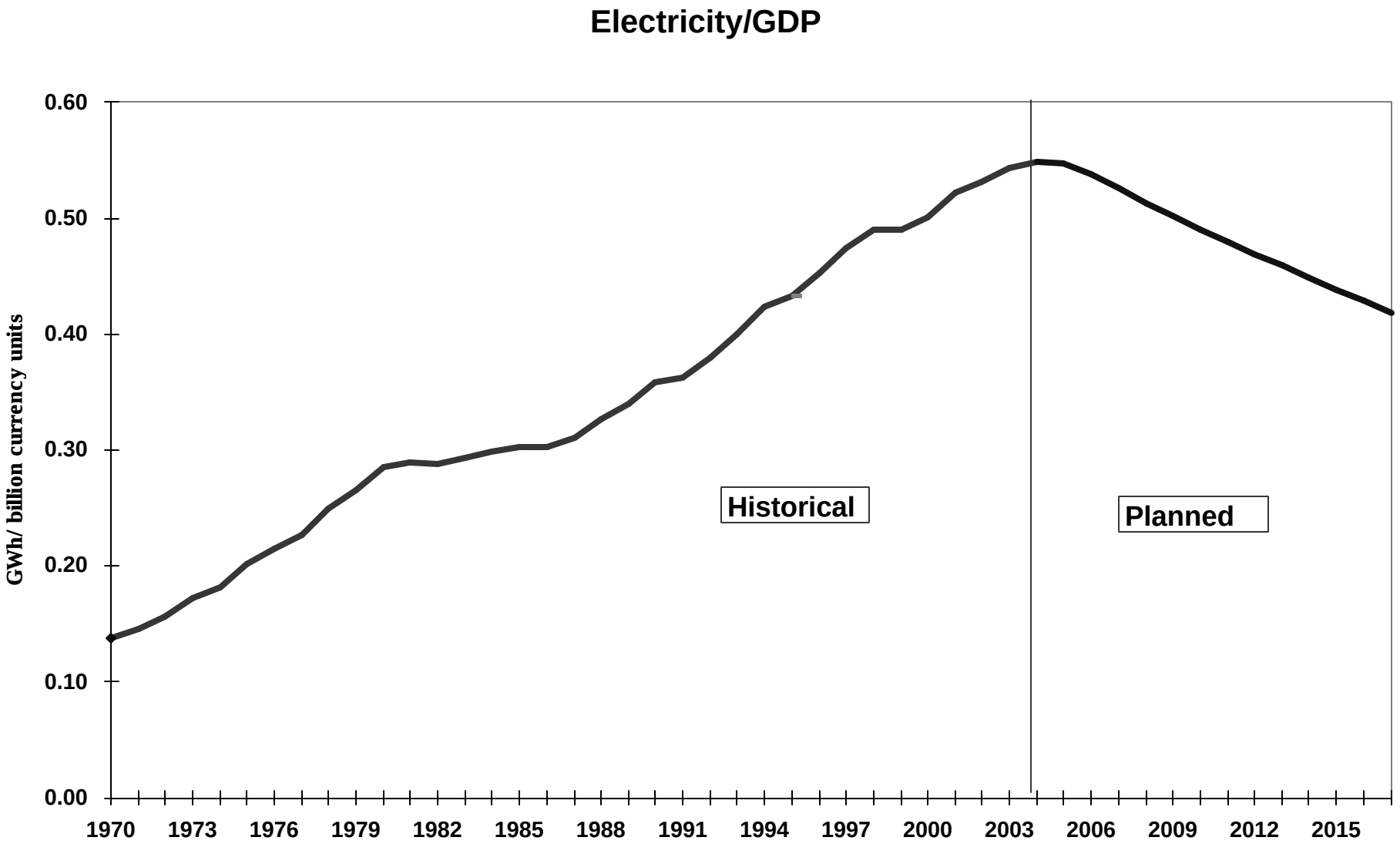
- The plan makes separate and inconsistent assumptions for electricity/GDP intensity, electricity supply and GDP growth.

The assumptions

- The plan assumes a reduction in electricity intensity per unit of GDP.

- The assumed level of reduction implies a dramatic and sudden reversal of the long term trend in electricity consumption per unit of GDP.

Electricity intensity of GDP



National plan - implied decoupling

- Current National Electricity Plan
  - Ratio of growth rates 0.43 between 2011 & 2015
  - Low compared to Japan & U.S.A

	GDP growth rate (A)	Electricity demand growth rate (B)	Ratio of growth rates (B/A)	U.S.A	Japan
1971-1980	7.5	15.6	2.09	1.03	1.13
1981-1990	8.7	11.2	1.29	0.78	0.95
1991-1995	7.5	11.6	1.55	0.77	-
1996-2000	5.0	8.1	1.64		
2001-2005	5.1	5.4	1.05		
2006-2010	5.0	2.7	0.54		
2011-2015	4.0	1.7	0.43		

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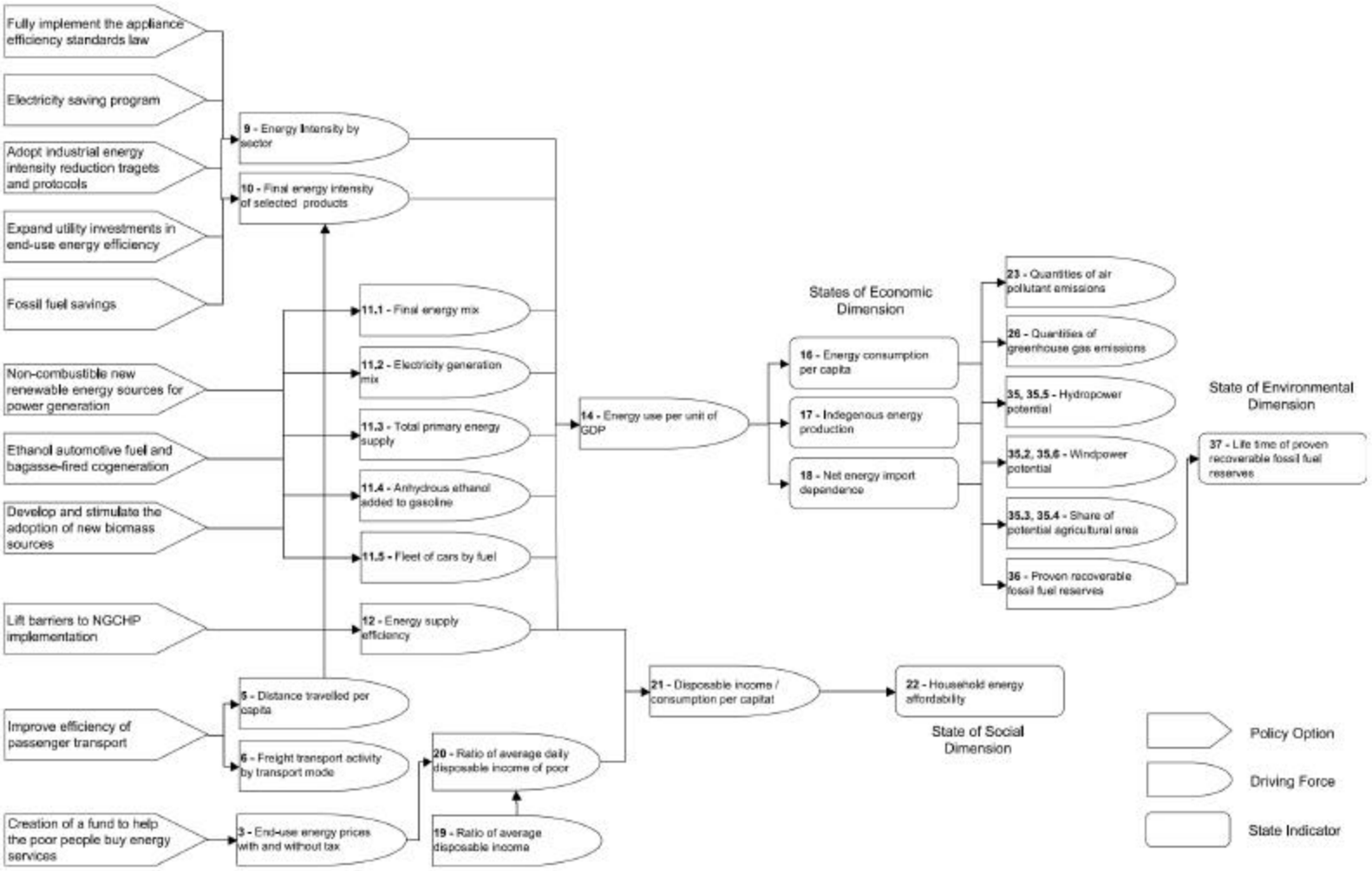
Effect of assumed intensities

- These ratios imply an unrealistic rate of GDP/electricity decoupling, inconsistent with growth aspirations.
- The kind of efficiency ratios assumed could probably only be achieved through extremely high taxes, neither acceptable nor feasible to impose.
- Such taxes would result in inefficient factor substitution, major sectoral shifts, ultimately capital flight, and lower GDP.

The consequences

- If the intensity goals are enforced, the supply of electricity will be reduced, and GDP growth will dampen.
- GDP growth as assumed can never be attained, and in fact falls over time.
- Electricity /GDP intensity may in fact settle into a new equilibrium close to its original value, but at a lower level of economic growth.

Brazil: matching indicators to policies



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QC tool for analytical thinking

- **In summary: ISED have multiple uses**:
  - Clarifying statistical information
  - Checking progress of past policies
  - Providing a reality check on SD policies
  - All three, combined with energy system modelling, can be of great benefit. This marriage of indicators and scenario modelling is now our focus.

Current implementation

- Add indicators to IAEA analytic tools
  - Models calculate indicators
  - Include in databases
  - Include in transfer and training
- Two more possibilities
  - CDM assessment by countries
  - Used by individual partnerships where appropriate

New Brazil and South Africa studies

- “Designing Country Profiles on Sustainable Energy Development”
  - Partnerships Fair
  - Thursday, May 4
  - 4:30 – 5:10 pm
  - Conference Room 6

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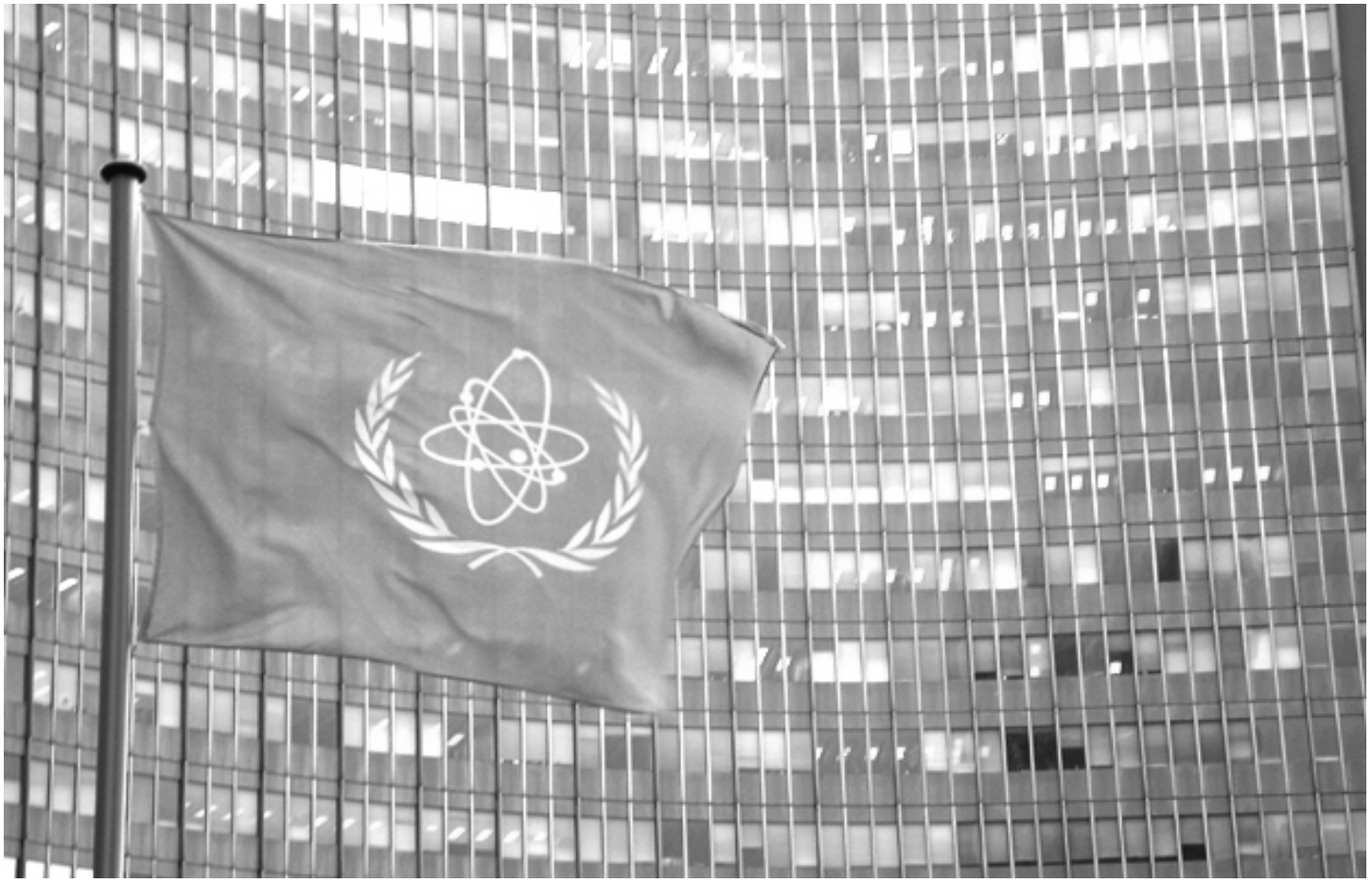

…atoms for peace.

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