

# Energy Efficiency Role, Opportunities and Strategies



**SDN Week 2006**  
Environment Day  
**“Clean Energy Development:  
An Example of Infrastructure and Environment Collaboration”**

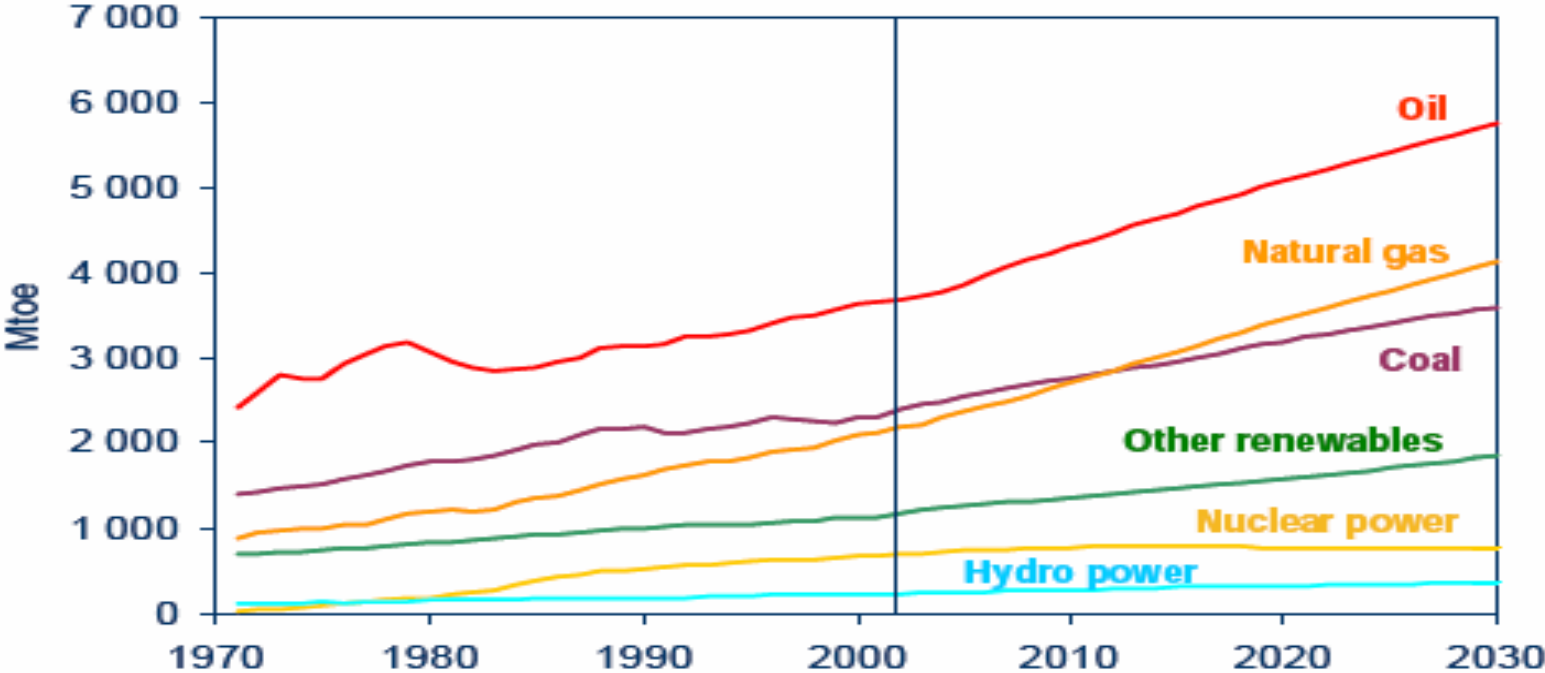
**The World Bank**  
November 8, 2006

# Outline

- **Context:** Energy Efficiency (EE) – Role within energy sector development process and Clean Energy Investment Framework (IF)
- **Experience:** World Bank's EE Profile and Practices
- **Future:** EE Opportunities and Strategies for Scaling Up Investments
- Project Examples

# Global Energy Growth Trends

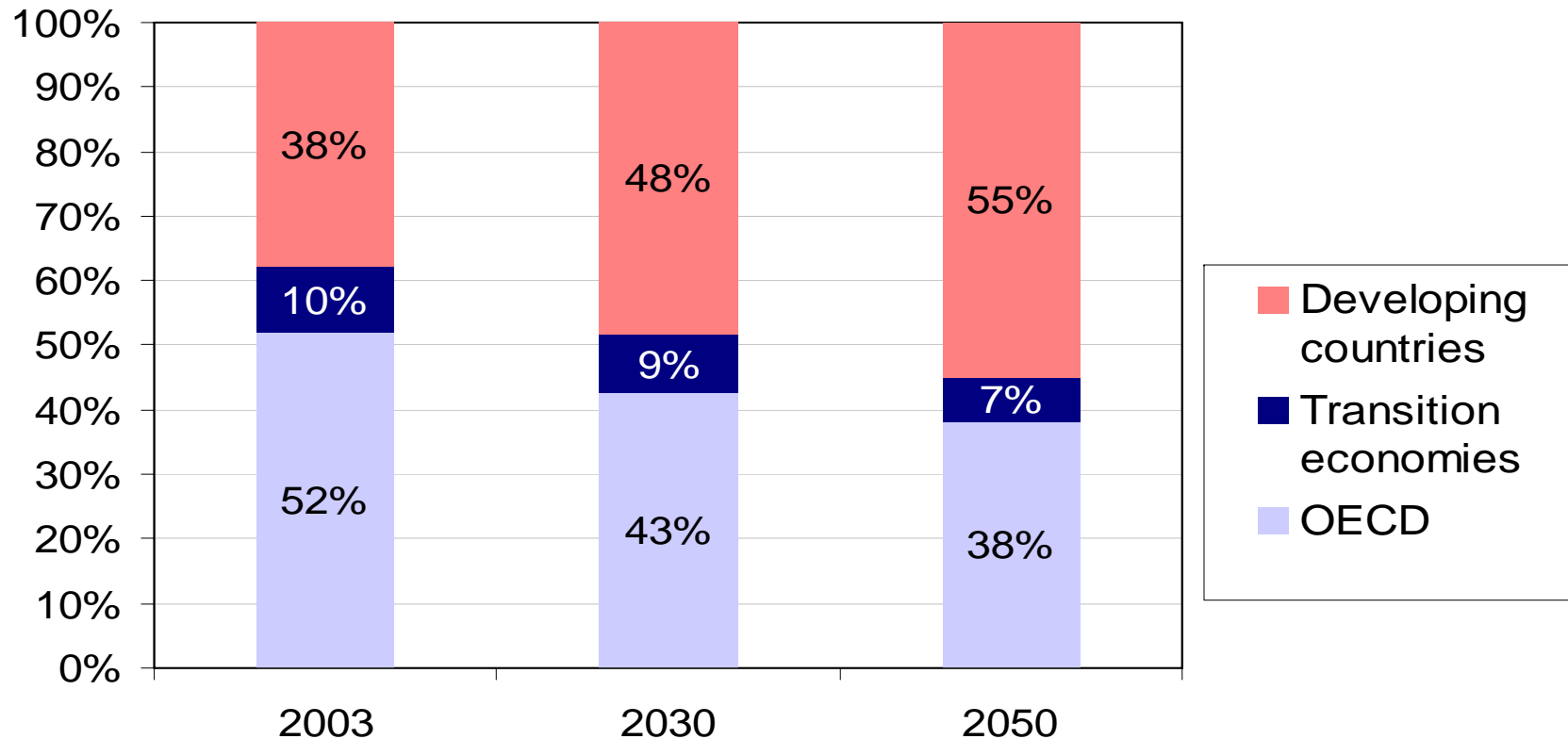
## World Primary Energy Demand



*Fossil fuels will continue to dominate the global energy mix, while oil remains the leading fuel*

Source: IEA World Energy Outlook, 2004

# Primary Energy Demand by Region (Business As Usual)

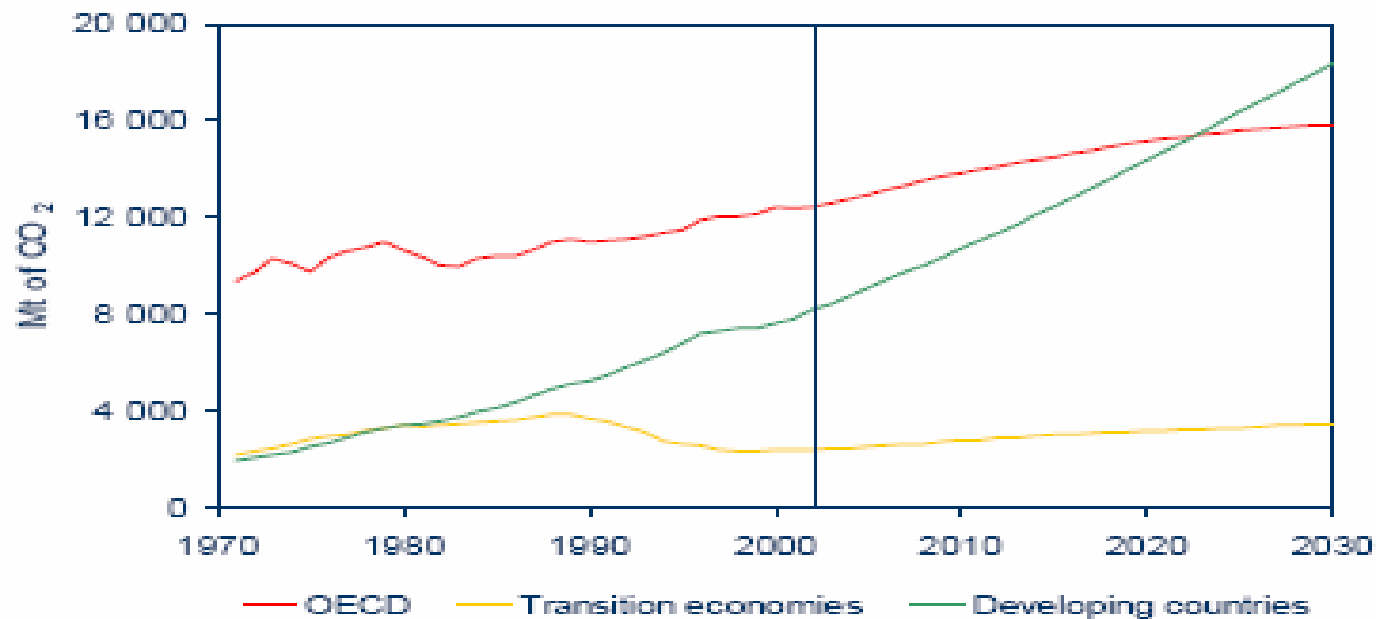


***By 2050 developing countries account for 55% of global energy demand***

Source: IEA Energy Technology Perspectives 2006

# Global Energy-Environment Dynamics

## CO<sub>2</sub> emissions, 1971-2030

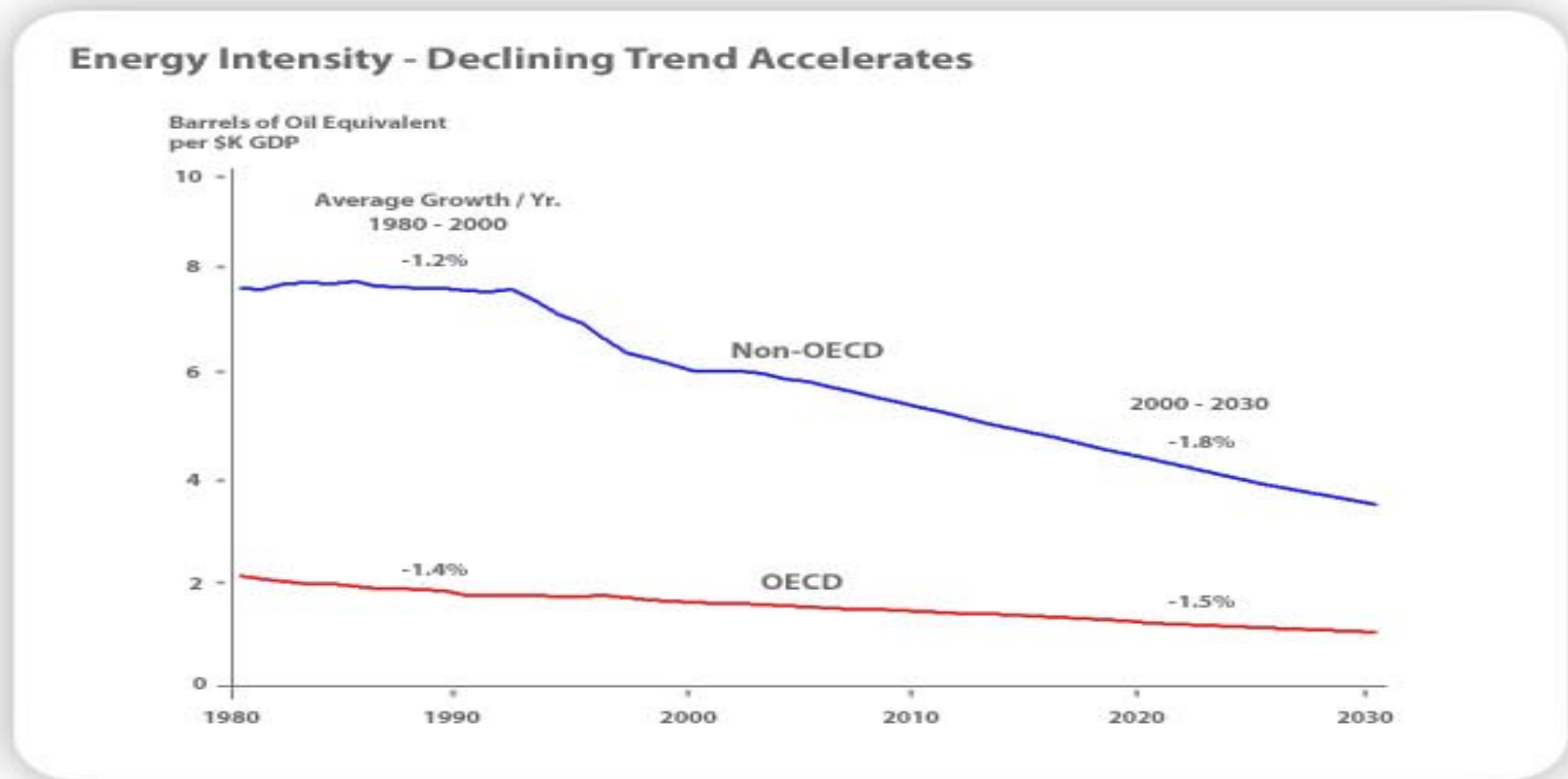


*CO<sub>2</sub> emissions will increase fastest in developing countries, overtaking OECD in the 2020s*

Source: IEA World Energy Outlook, 2004

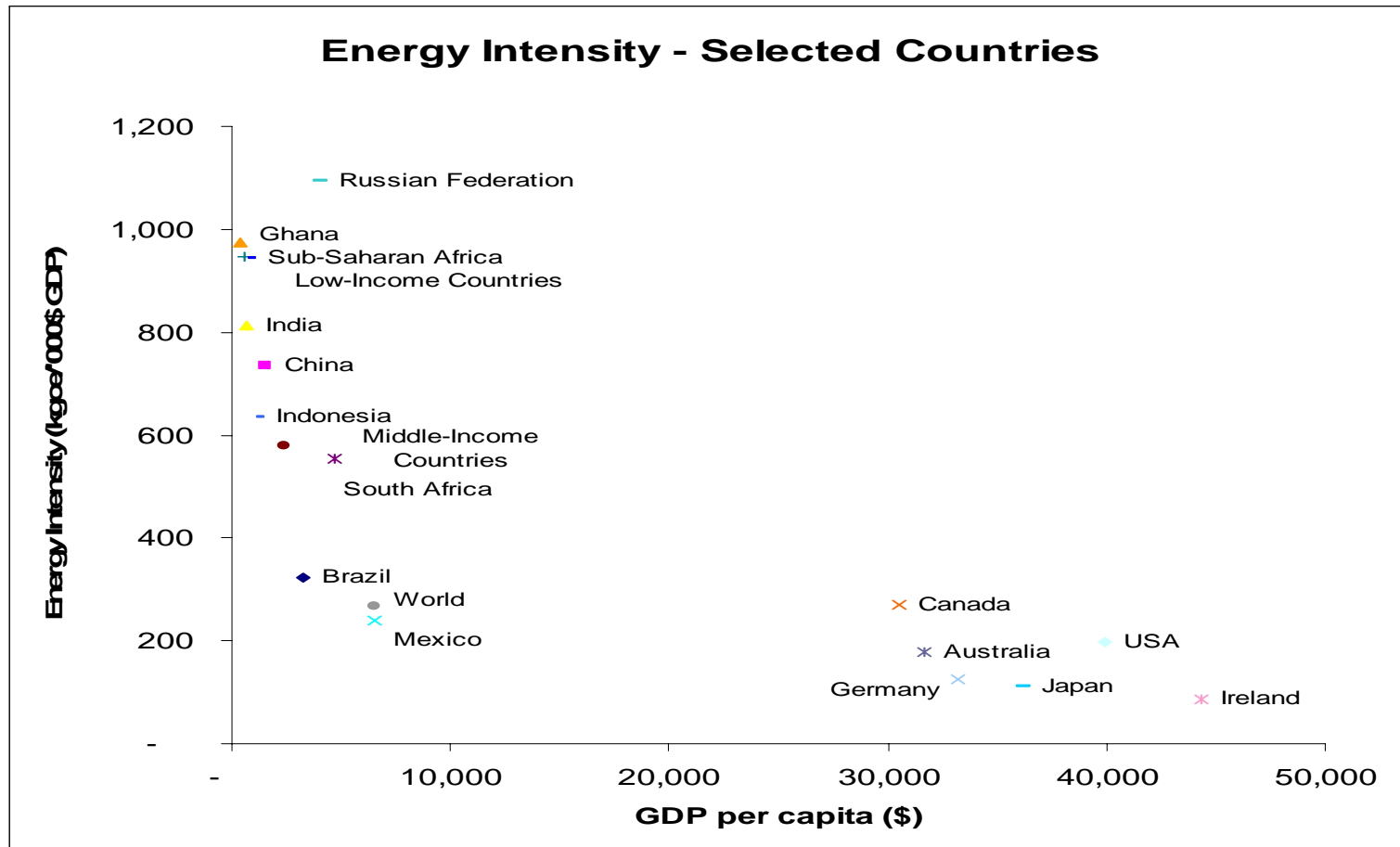
# Energy Efficiency Trends

Energy Intensities have been declining...but gaps remain high



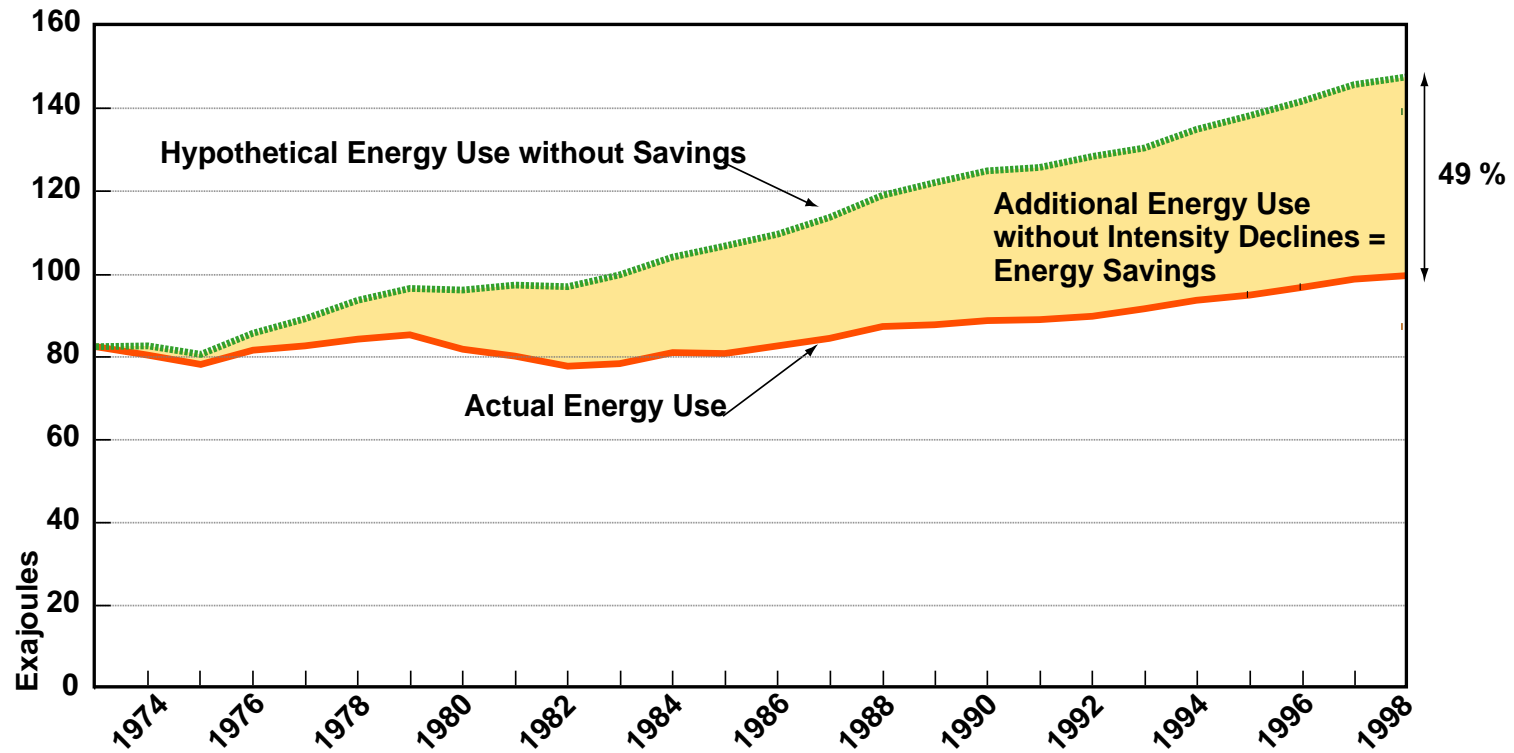
Source: Exxon-Mobil (2005). "The Outlook for Energy- A View to 2030"

# Country Energy Intensity Comparison



Data Source: The Little Green Data Book, World Bank (2006)

# Gains from Energy Efficiency – OECD Countries (1973-1998)

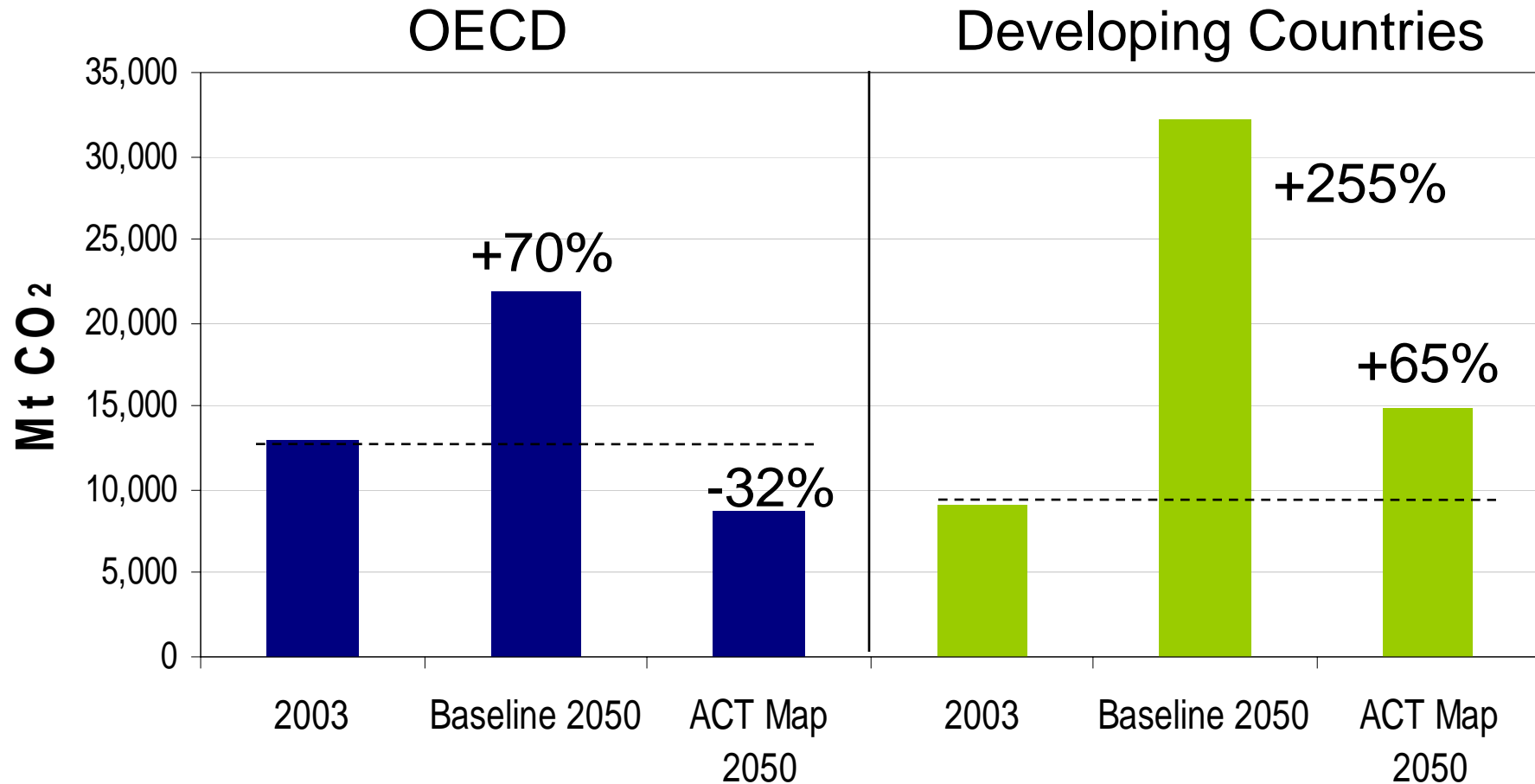


Source: IEA



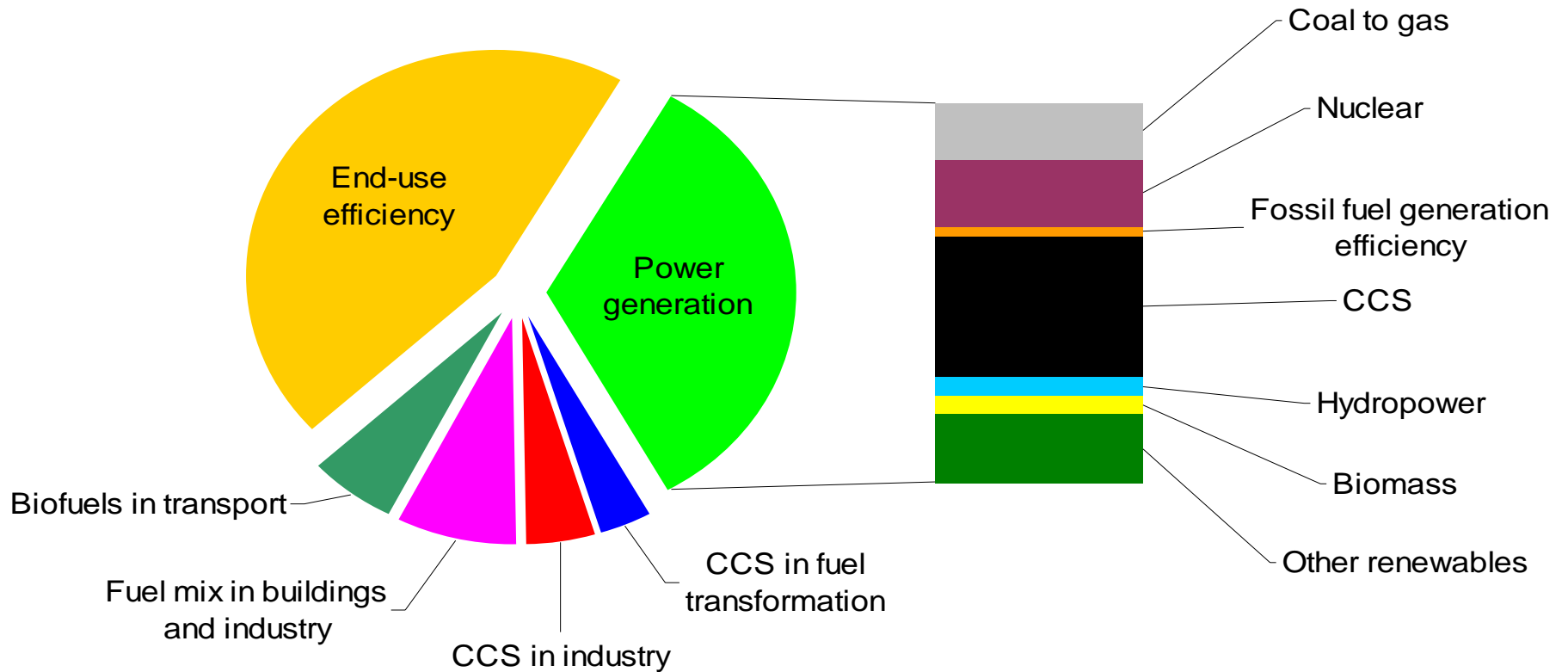
# GHG Emissions in 2025

## Business-As-Usual vs. IEA Scenario



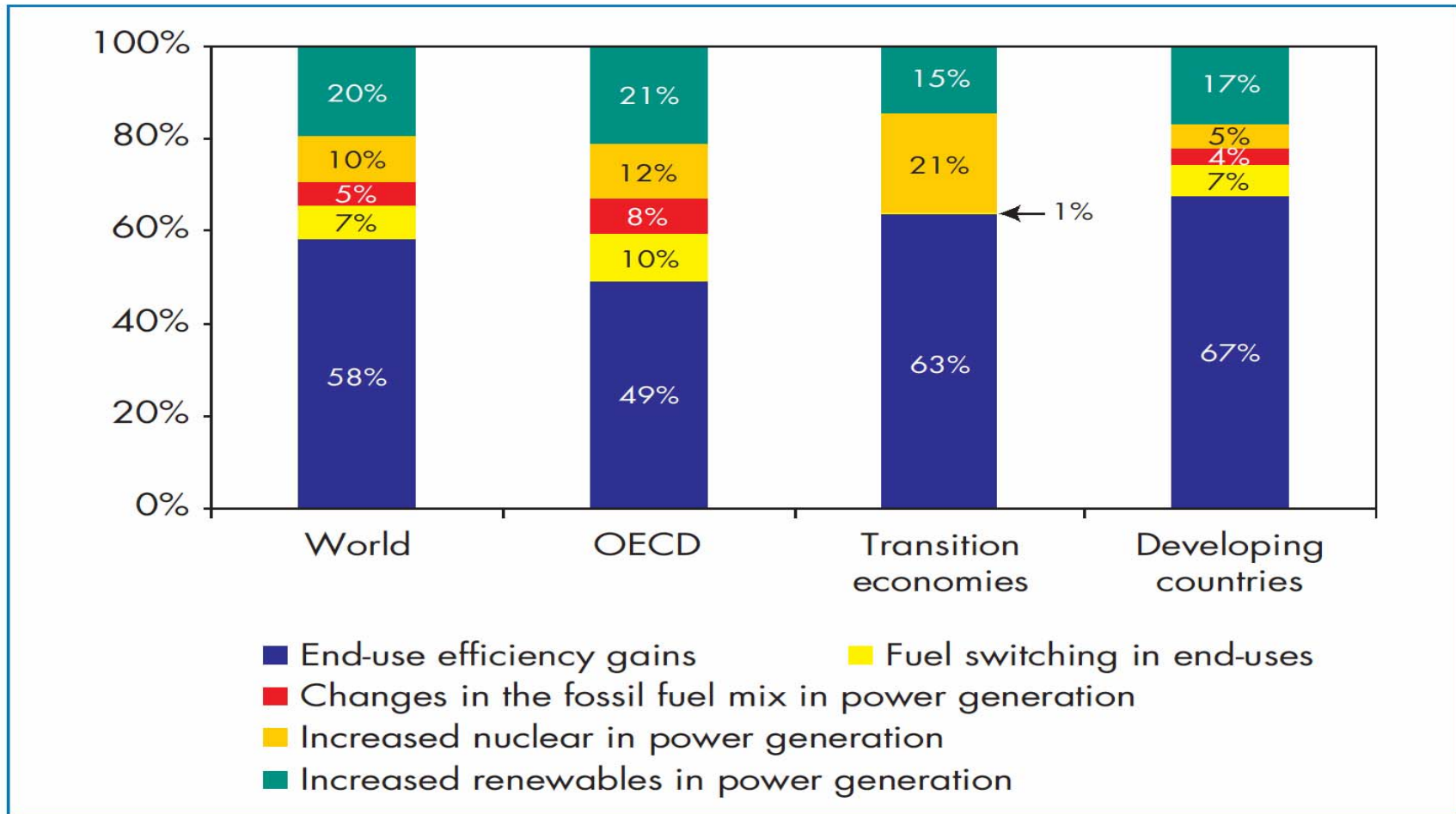
***OECD Emissions one-third below 2003 level, while emissions in Developing Countries are two-thirds higher; Improved energy efficiency saves about 15 Gt CO<sub>2</sub> by 2050 – equivalent to 60% of current emissions***

# GHG Emission Reduction by Technology Areas - Scenario through 2050



*Improved energy efficiency most important contributor to reduced emissions*

# The Role of Energy Efficiency in GHG Reduction (through 2030)



Source: IEA (2004)

# Energy Efficiency Opportunities and Measures Across Sectors

Sector	Energy Efficiency Improvement Opportunities and Measures
<b>Transport</b>	Efficient gasoline/diesel engines, urban mass transport systems, modal shifts to inter- and intra-city rail and water transport, improved fleet usage.
<b>Buildings</b>	Integrated building design and measures such as better insulation, advanced windows, energy efficient lighting, space conditioning, water heating, and refrigeration technologies.
<b>Industry</b>	Industrial processes, Cogeneration, waste heat recovery, pre-heating, efficient drives (motor, pump, compressors).
<b>Municipalities/Urban Local Bodies</b>	District heating systems, combined heat and power, efficient street lighting, efficient water supply, pumping, and sewage removal systems.
<b>Agriculture</b>	Efficient irrigation pumping and efficient water use, such as drip irrigation.
<b>Power Supply</b>	<p><i>New thermal power plants:</i> Combined cycle, supercritical boilers, integrated gasification combined cycle (IGCC), etc.</p> <p><i>Existing generation facilities:</i> Refurbishment and re-powering (including hydro), improved operation and maintenance practices, and better resource utilization (higher plant load factors and availability).</p> <p><i>Reduced transmission and distribution losses:</i> High voltage lines, better insulated conductors, capacitors, efficient and low-loss transformers and improved metering systems and instrumentation.</p>

# Clean IF Pillar 2:

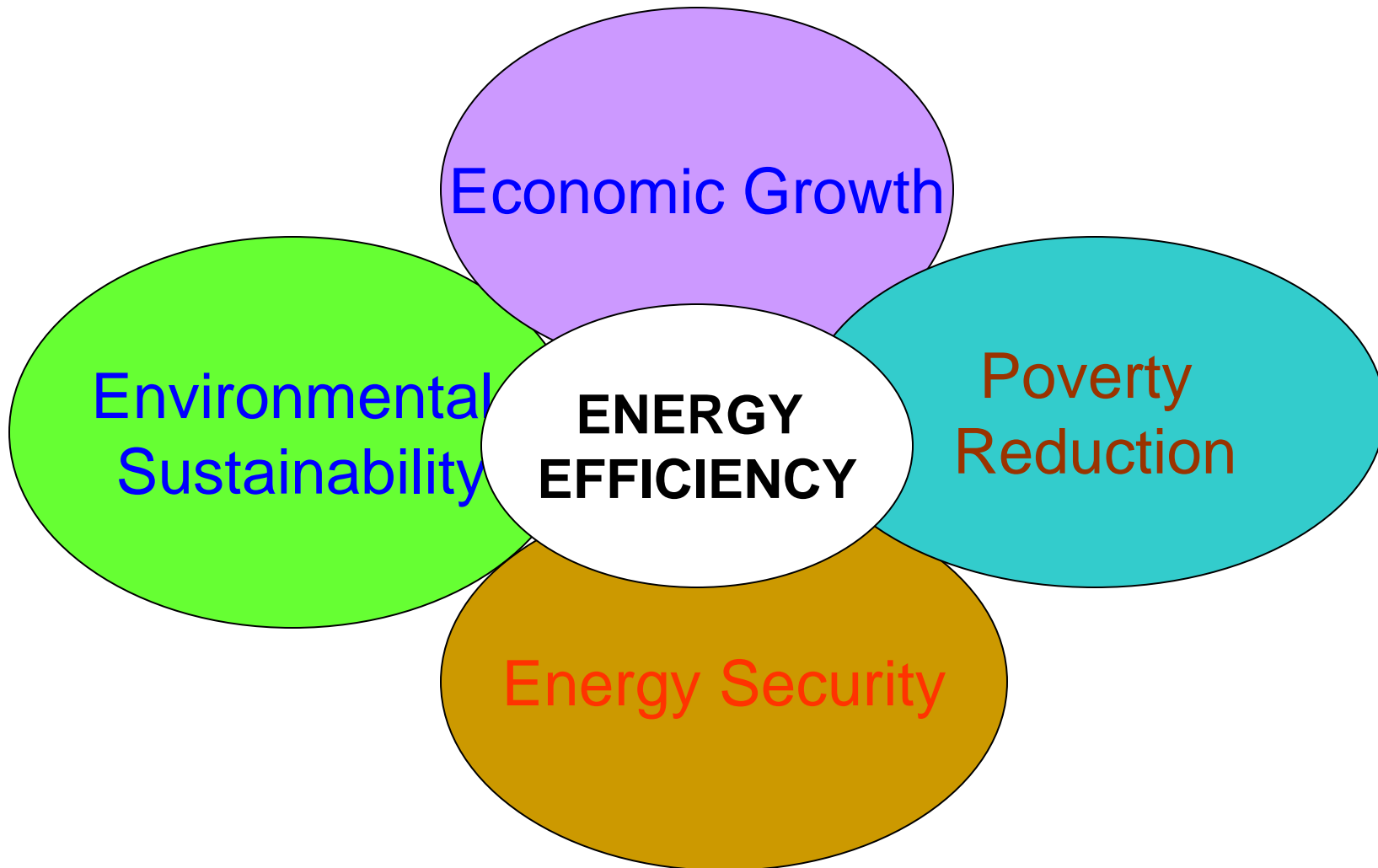
## Transitioning to a Lower-Carbon Economy

- Focus on cleaner technologies, clean coal, renewable energy and energy efficiency
- Energy efficiency as one of the key focus areas and most attractive options (Transportation, Buildings, Industry, Municipalities, Agriculture, and Power generation)
- Existing (including GEF and CF) and New Instruments (CEFV, CESF)

# Renewed Global Interest in Energy Efficiency

- In addition to the ongoing efforts under the development of the Clean Investment Framework.....
- **Bonn Commitments (2004)**
- **EBRD: Sustainable Energy Initiative (€1.5 b, 3 yrs)**
- **Asian Dev't Bank: Energy Efficiency Initiative (\$1 b)**
- **European Union: Green paper on EE**
- **ASEAN Energy Ministers' Final Communiqué (Laos, August 1, 2006)- priority emphasis on EE**
- **Stern Review (last week) – focus on EE**
- **Countries have started setting up EE targets, legislations and institutions, and renewed efforts (China, South Africa, Morocco, India, Vietnam, Tunisia, Thailand, Sri Lanka...)**

# The Bank's Rationale for Energy Efficiency Investments: Convergence of Interests



# Barriers to EE Development

- **Barriers to address at the level of the public authorities:**
  - Non-economic pricing of energy, inappropriate tariff structures, poor collection rates;
  - Market incentives for energy suppliers to supply more rather than less;
  - Lack of EE information campaigns, standards, codes, norms or labelling systems;
  - Inadequate regulatory or legal frameworks to support energy service companies.
- **Barriers to address at the level of end-users (final beneficiaries):**
  - Lack of awareness of the financial or qualitative benefits arising from energy saving measures, together with the skills to implement them;
  - Capital constraints and corporate culture leading to more investment in new production capacities rather than energy efficiency;
  - Greater weight given to addressing upfront (first) costs compared to recurring energy costs; , especially if these costs are a small proportion of production costs.
- **Barriers to address at the level of provision of finance and expertise:**
  - Lack of awareness and experience among investors and financiers of potential financial returns: local banking sectors tend not to prioritise energy efficiency finance, due to inexperience and lack of competition in the area, high transaction costs associated with smaller projects, and risks associated with assessing and securitising revenues generated through energy savings;
  - Limited access to robust systems and skills for measurement, monitoring and verification of energy savings



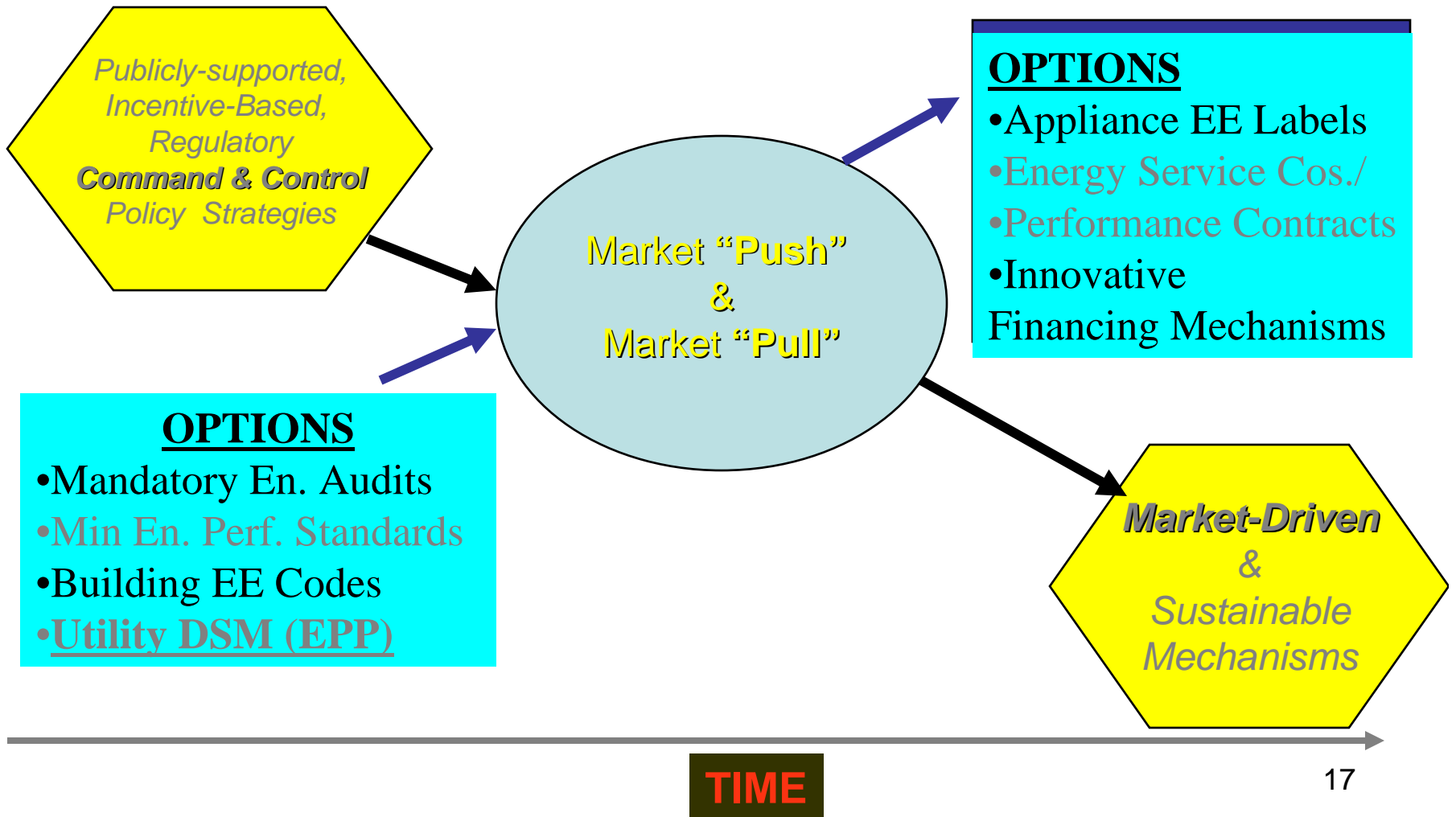
# EE Implementation Strategies

## Menu of Options to Overcome Barriers

Low-Income Countries,...

Middle-Income Countries

Japan, US, Europe,...



# Energy Efficiency Challenge

## Fostering EE Investments...

### POLICY & MARKETS

- 
- Rational Tariffs
  - Subsidies' Removal
  - Economies of Scale
  - Open, decentralized markets
  - Life cycle costing Procedures
  - EE Standards & Labels
  - Building EE Codes
  - Mandatory EE Audits
  - ESCO Development
  - Utility DSM
  - Credit enhancement (Financial) mechanisms

### IDA/IBRD

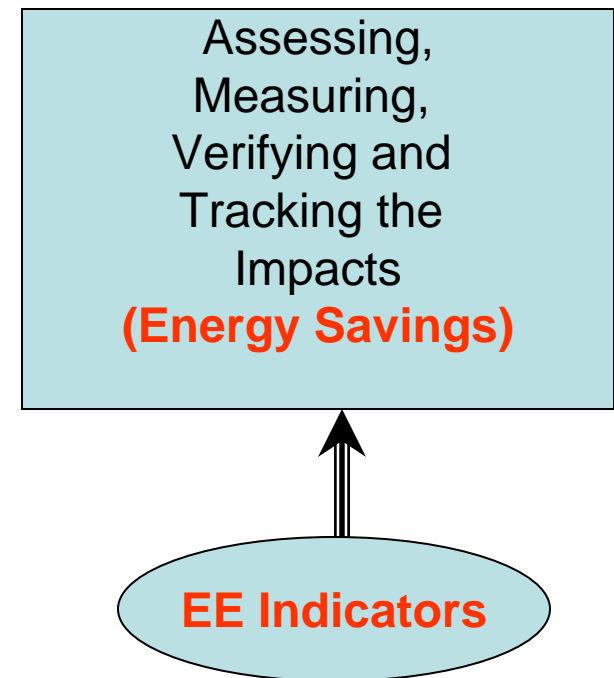
- Investments
- Financial Intermediation
- Policy lending
- AAA/TA
- .....

**GEF**  
Incentives

**CDM**  
Incentives

# WBG's Role in Catalyzing Energy Efficiency Development

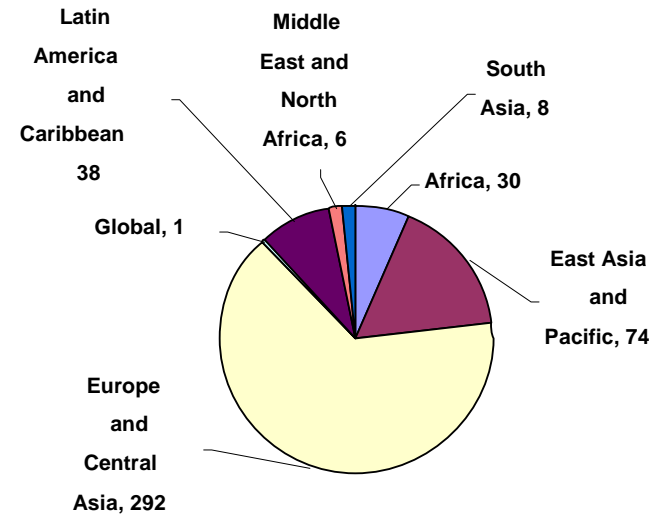
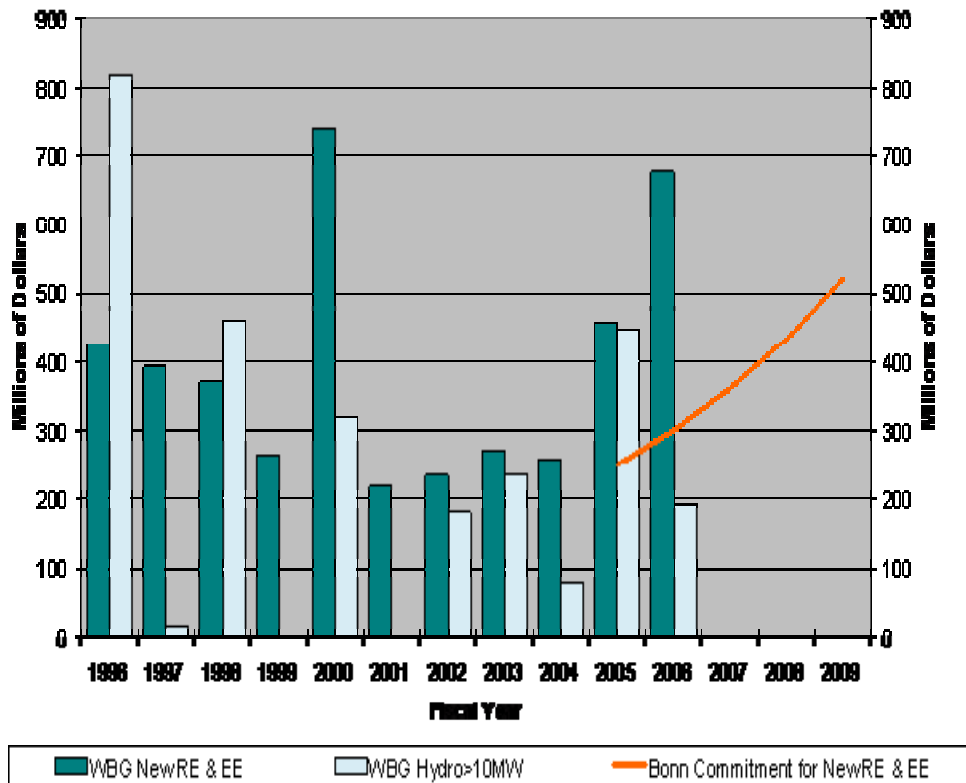
- Policy-based tools
- Regulatory interventions
- Institutional development
- Capacity Building
- Market mechanisms
- Investments
- Financial structuring



EE Portfolio: FY1990 to FY2006 - \$2.9 billion, 140 Projects, 50 countries

# WBG: Growth in Energy Efficiency

**World Bank Group RE and EE Commitments**



FY06 EE Investments: \$449 million  
 FY06 EE Projects: 27  
 Highest in ECA: \$ 292 million, 13 projects (largely District Heating and Industries)  
 IFC-\$309 million; IBRD/IDA-\$114 million  
 MIGA- \$2 million; GEF- \$24 million

# Evolution - WBG EE Portfolio

## TRENDS

- Sector – Often looked upon as only a Core Energy Sector Issue
- Focus Areas – District Heating, T&D, some Industry (IFC)
- Regions – EAP and ECA
- Mostly with GEF support
- CF support - modest

## REALITIES

- Larger opportunities in other sectors (Transport, Urban, Rural, Water...)
- Street Lighting, Buildings, Irrigation Pumps, Industry...
- Other regions have untapped opportunities
- Evolving GEF modalities, Also many cost-effective opportunities in markets where barriers have been removed
- Many more EE projects (and programs?) may qualify for CDM

# Energy Efficiency Scale Up Strategy

- Three levels of interventions to help EE scale up:
  - Policy and Institutional
  - Sectoral
    - **Track 1**- Core energy practice
    - **Track 2** - Other non-energy sectors – transport, urban/ municipalities, agriculture/ rural, water)
  - Equipment (EE Lights, EE Motors, etc.)
- Key Approaches:
  - Operational focus on expanding existing and developing new “Business Lines” for EE lending – EE Lighting Scale Up (e.g., in AFR region), EE Motors (e.g., in Asia, G+-5), Standards and labeling programs through Carbon Finance
  - Policy and Institutional Support (AAA, TA and KM activities)
  - Promoting cross-sectoral linkages

# Operational Practices:

## Example: Building Up on EE Lighting Successes

- WBG engagement in EE Lighting started in 1995-98 with **Poland Efficient Lighting Project (PELP)** and **Mexico High Efficiency Lighting Project (ILLUMEX)**
- Continued with **Efficient Lighting Initiative** program in 2002-2005 (Argentina, Czech Republic, Hungary, Latvia, Peru, Philippines, South Africa) – Led to standardization of specifications and product quality certification of Compact Fluorescent Lamps (CFLs)
- Bank supported CFL projects in other countries – Vietnam, Sri Lanka
- In 2006, several EE lighting projects have been designed:
  - **Uganda** – 600,000 CFLs bulk procurement (under ERT Project, approved FY02)
  - **Rwanda** – 400,000 CFLs procurement (under UER project, approved FY05)
  - **Ethiopia** – 200,000 CFLs component under Accelerated Electricity Access [Rural] Expansion project (approved FY06)
  - **East Timor** – 27,000 CFLs to pre-paid meter customers under Power Sector Priority Investments Project
  - **Kenya, Ghana** – IFC's "Lighting the Bottom of the Pyramid Project" to promote LED based lighting to replace fuel oil-based lighting
- EE lighting projects to be scaled up by replicating the experience based on the recently-implemented successful design approaches and implementation models
- Potential for EE Motors and Motor Systems in Asia – Planned

# World Lighting Demand

- The worldwide demand for lighting grows  $> 5\%$  p.a. with highest growth rates in Emerging Markets.
- Depending on the level of development of each individual country, 10% - 20% of all electrical energy is used for lighting.

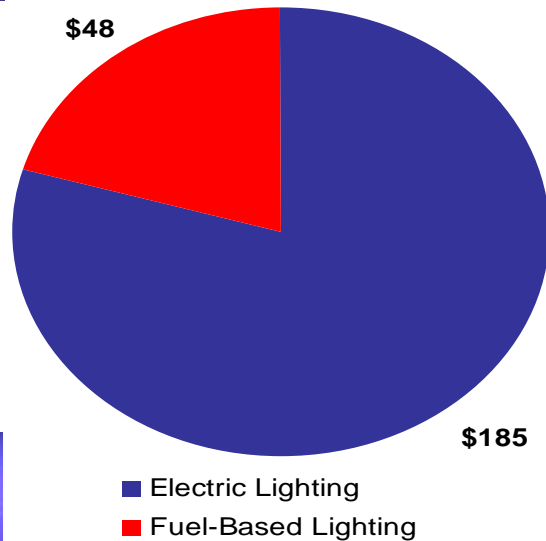




# Lighting: A Global Opportunity



A \$230 billion Market



■ Electric Lighting  
■ Fuel-Based Lighting

## Global Lighting Electricity Use

- Residential – 28%
- Service/Commercial 48%
- Industry – 16%
- Street Lighting – 8%

## Global Lighting Savings Potential

	Savings Potential	% of total savings
• Residential:	40-60%	27%
• Commercial	25-40%	31%
• Industrial	15-25%	7%
• Streetlighting	25-30%	6%
• Residential (Fuel-based)	92-99%	29%



Source: Evan Mills, 2002

# Motor Systems Energy Consumption (~ 50% of Industry Energy Cons.)



Source: UNIDO

# Pumping Systems ( Motor + Pump + Valve)

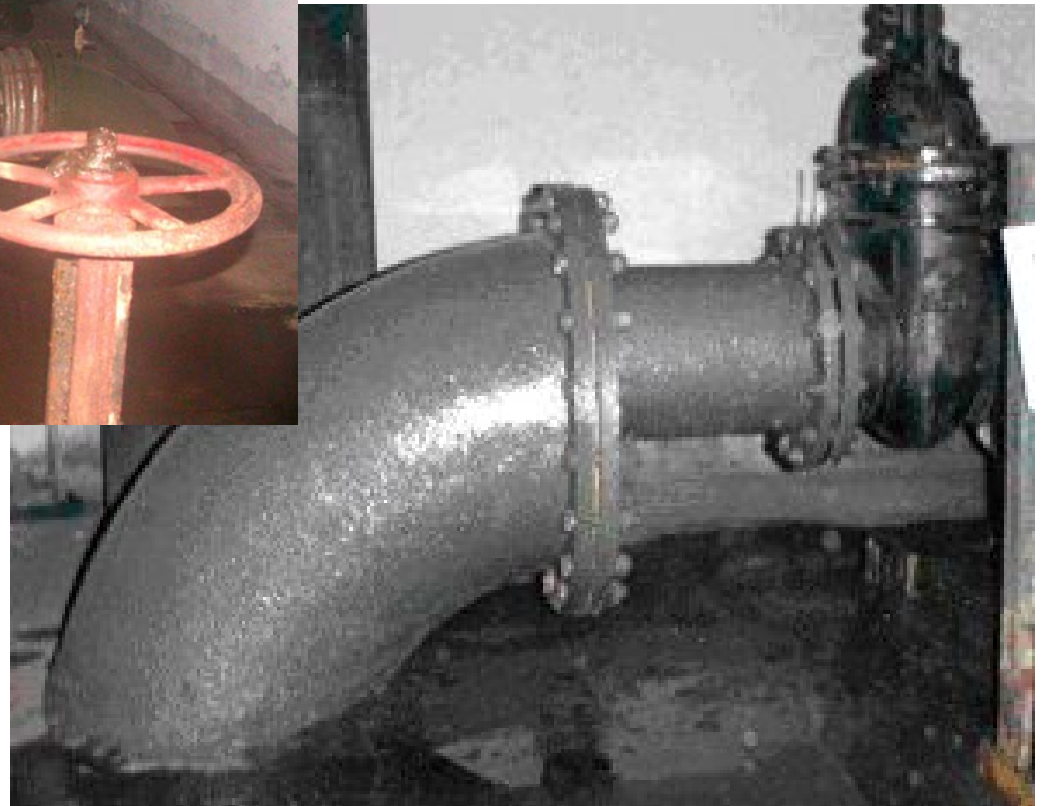
More than 40 psig  
drop across the  
throttle valve



$$\begin{aligned} \text{Package efficiency} &= \\ \text{Hydraulic output} / \text{Motor input} &= \\ 2.7 / 14.9 &= 0.18, \text{ or } 18\% \end{aligned}$$

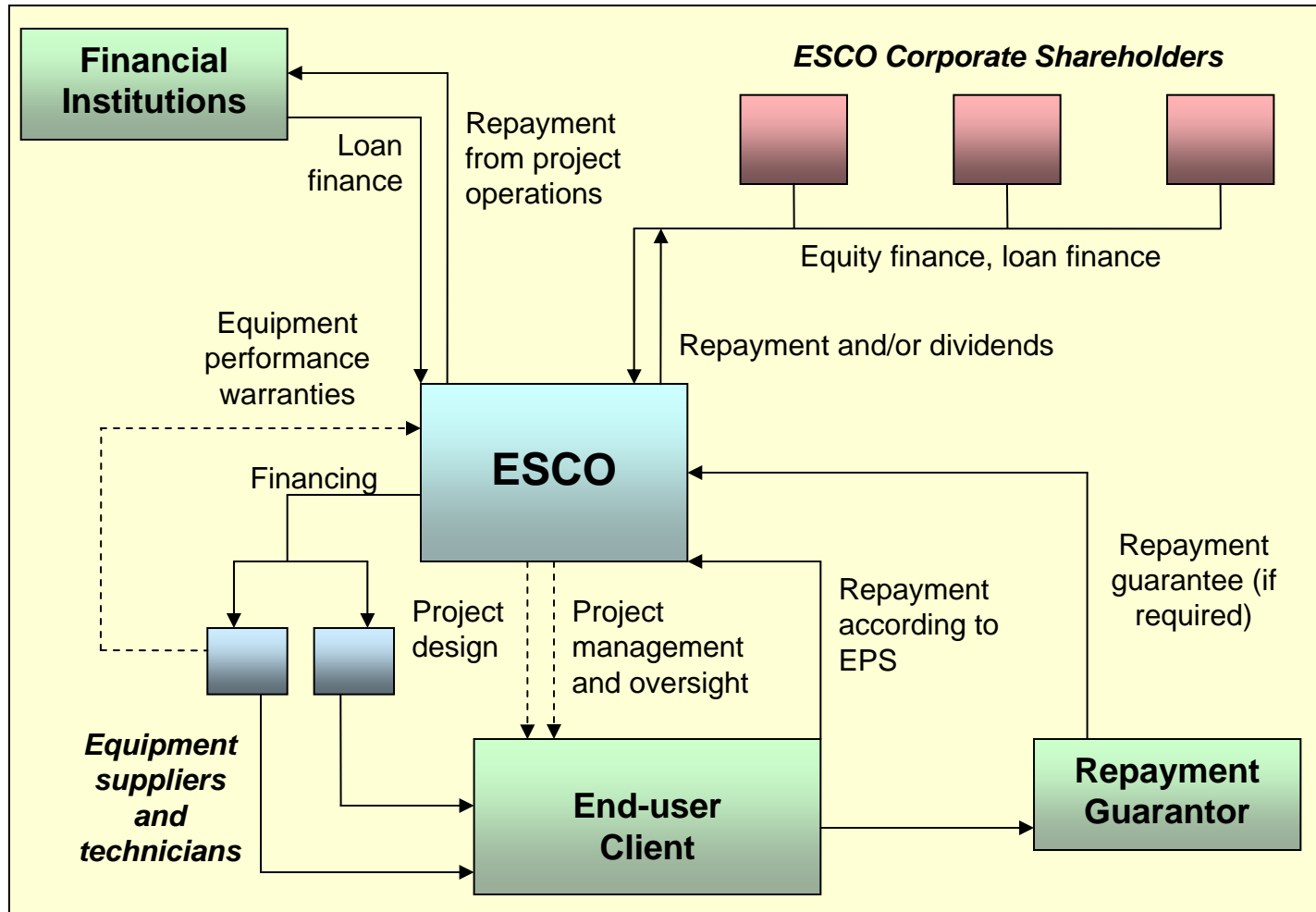
Source: UNIDO

# Pump System Optimization



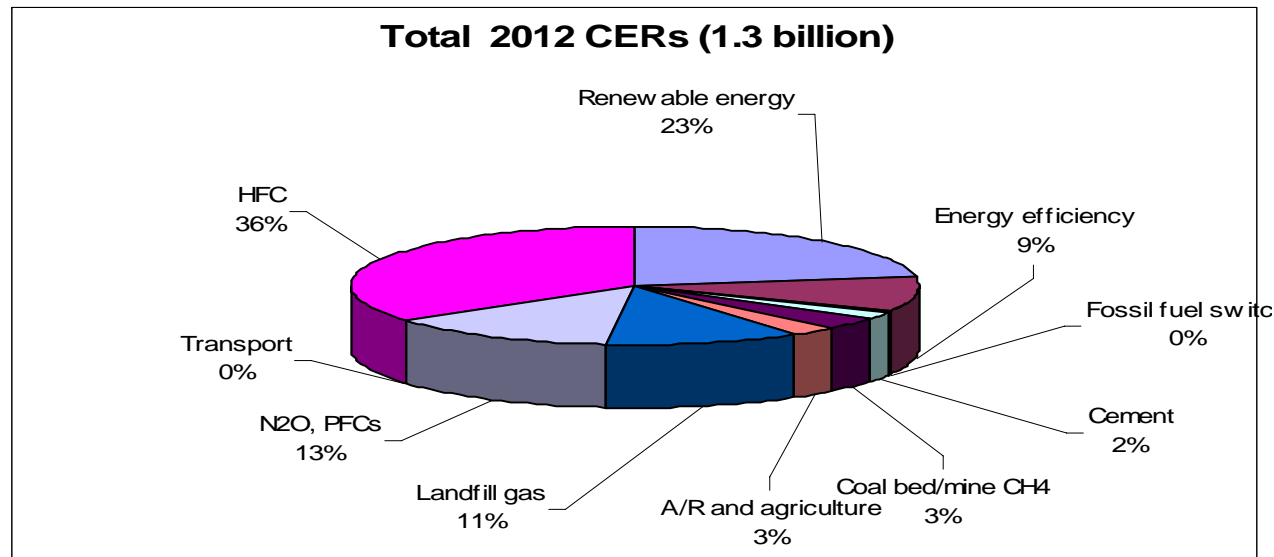
Source: UNIDO

# China: Full-Service Shared Savings ESCO Model



Source: Three Country Energy Efficiency Project, Draft Report, World Bank, April 2006

# Energy Efficiency in the CDM Pipeline (at PDD stage)



Total of 164 Energy Efficiency Registered Projects (out of 1,145 projects):

- EE industry: 138 projects 14.6 MtCO<sub>2</sub>e/yr
- EE households: 4 projects 0.09 MtCO<sub>2</sub>e/yr
- EE service: 10 projects 0.06 MtCO<sub>2</sub>e/yr
- EE supply side 12 projects 2.3 MtMtCO<sub>2</sub>e/yr

# Ghana AC EE Labeling Program

- MEPS for Room Air-conditioners
- CDM incentives for implementation infrastructure (testing, labeling, and QA)
- Main project participant: Ghana Standards Board (public) invests in testing lab and has operating costs (total costs for the program about USD 2 Million)
- Estimated ERs: more than 3 Million tCO<sub>2</sub>e in 7 years
- Beneficiary: consumers, more efficient ACs do not cost (significantly) more than BAU ACs, energy savings for consumers: more than USD 60 Million per year



# Policy and Analytical Support: Examples

- **Plus Five Countries Energy Efficiency Indicators Project** (ESMAP, Jointly with IEA, IADB, USAID, etc) being launched with ESMAP support: focusing of developing a consistent framework of EE metrics for various supply and end-use sectors which would help in effective EE policy development and monitoring of EE policy impacts. Initial focus – Brazil, China, India, Mexico, South Africa. Would be expanded to other countries in the medium term.
- **Building Up on EE Institutional Best Practices** (ESMAP Study): Analysis of various public sector institutional models based on experiences from various countries and best practices that can help in effectively transforming energy efficiency markets in developing countries. Results will help EE institutional development assistance being provided by the Bank in Jordan, Thailand, Sri Lanka, Morocco, Serbia, and South Africa in the immediate term. Could be used for potential scale up in other countries in the medium term.
- **ESCO and EE Financial Intermediation Models** – The 3 Country EE Project work



# ESMAP - EE Portfolio FY06

## Ongoing Activities

Region	Theme/Title
Latin America and Caribbean	<ul style="list-style-type: none"> <li>• Mexico - Energy Design Guidelines for Housing (P099763)</li> <li>• Innovative Financing Mechanism for Energy Efficiency in Mexico (P086790)</li> </ul>
East Asia and Pacific	<ul style="list-style-type: none"> <li>• China: Policy Advice on Implementation of Clean Coal Technology projects. Phase II (P074684)</li> <li>• Shanghai Energy Conservation Promotion Project (P100847)</li> <li>• Mongolia Urban Heat Pricing and Regulation (P100209)</li> <li>• China Municipal Heat Regulation –Phase 1 Pre Investment (P099609)</li> <li>• China Energy Efficiency Policy, Regulation and Institutional Framework Study ) Phase I (P099547)</li> <li>• China Coal Bed Methane Strategy (P096826)</li> </ul>
Middle East and North Africa	<ul style="list-style-type: none"> <li>• Energy Efficiency Policy in Morocco (P099733)</li> <li>• Morocco - Global Efficiency in Sidi Bernoussi Industrial &amp; Peri-Urban Area (P065461)</li> <li>• Regional Workshop At Sidi Bernoussi, Morocco - Dissemination of the results of the ESMAP Sidi Bernoussi industrial park study (P083648)</li> <li>• Egypt – Demand Management Workshop (P098092)</li> </ul>
Africa	<ul style="list-style-type: none"> <li>• Uganda Energy Efficiency Activity/ Emergency Response (P069996)</li> </ul>
Eastern Europe and Central Asia	<ul style="list-style-type: none"> <li>• Poland - Innovative Energy Efficiency Financing Mechanism (P086790)</li> <li>• Lithuania - Heating Supply to Small Cities/Towns (P073366)</li> </ul>
Global	<ul style="list-style-type: none"> <li>• Developing Financial Intermediation Mechanisms for Energy Efficiency Projects in Brazil, China and India (P073016).</li> <li>• Review of World Bank Energy Efficiency Activities (2050421)</li> <li>• Energy Efficiency Good Practice Note (2050331)</li> <li>• Energy Efficiency Investment Forum at CSD-14 (P100181)</li> <li>• G-8 Clean Investment Framework on Energy Efficiency (2050329)</li> <li>• Energy Efficiency Needs and ToolKit Assessment (P101646)</li> <li>• Building Up on Energy Efficiency Institutional Best Practices (P101113)</li> <li>• Win-Win: Demand Side Management Options in Developing Countries (P090271)</li> </ul>

# Promoting Cross-Sectoral Linkages in EE

- Upstream AAA for EE potential and investment mainstreaming opportunities in Transport, Agriculture, Industry and Urban – could draw from IFC's best practices of mainstreaming EE.
- Synergies between EE and Programmatic CDM
- Study on Costs of Delivering End-Use EE/ DSM measures in various sectors and through different routes in developing countries
- Tracking EE investments/shares in projects in other sectors – this could draw from IFC methodologies and systems
- Energy Efficiency Thematic Group launched in August 2006 – to facilitate cross-sectoral exchanges on EE operational practices and models across sectors

# Example: Chemical Industry

- **Ethylene Production: steam cracking of hydrocarbon feedstocks to produce ethylene, propylene, butadiene and BTX**
- The choice of a particular feedstock, together with processing conditions determines the yield of ethylene, propylene, and other co-products

	Feedstock for ethylene	Energy consumption (GJ/tonne)
U.S.	Ethane/propane account for 70% production	68
Europe	Naphta accounts for 75% production	58
China	Heavy feedstocks	73-90

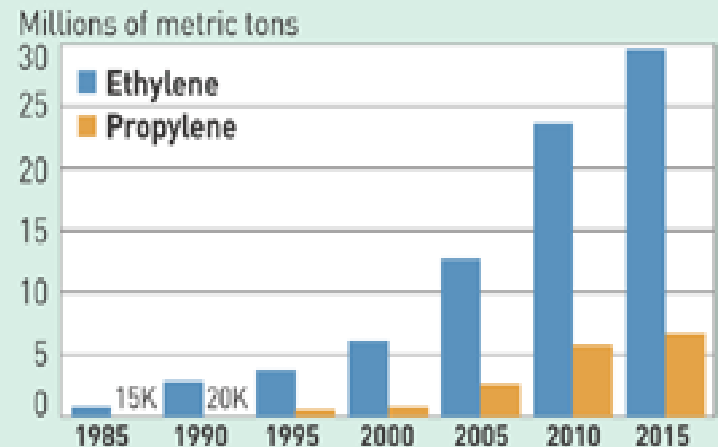
**Over the next 10 years, roughly 30 million metric tonnes of ethylene capacity will be added to current production**

**➤ Of that additional capacity, 40% will be set up in the Middle East**

Source: ENVGC, World Bank

## CAPACITY BOOM

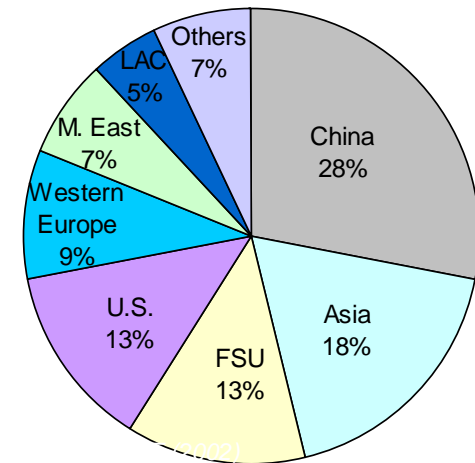
Expansion in Persian Gulf promises to be dramatic



SOURCE: Chemical Market Associates Inc.

# Example: Chemical Industry

- **Ammonia Production:** Anhydrous ammonia is produced in about 80 countries. In 1974 the developing countries accounted for 27% of ammonia capacity. Today their share is 52%
- Types of feedstock used around the world for the production of ammonia include natural gas, naphtha, fuel oil and coal



➤ **The choice of feedstock influences energy efficiency. Using coke to manufacture ammonia consumes roughly 70% more energy than using natural gas**

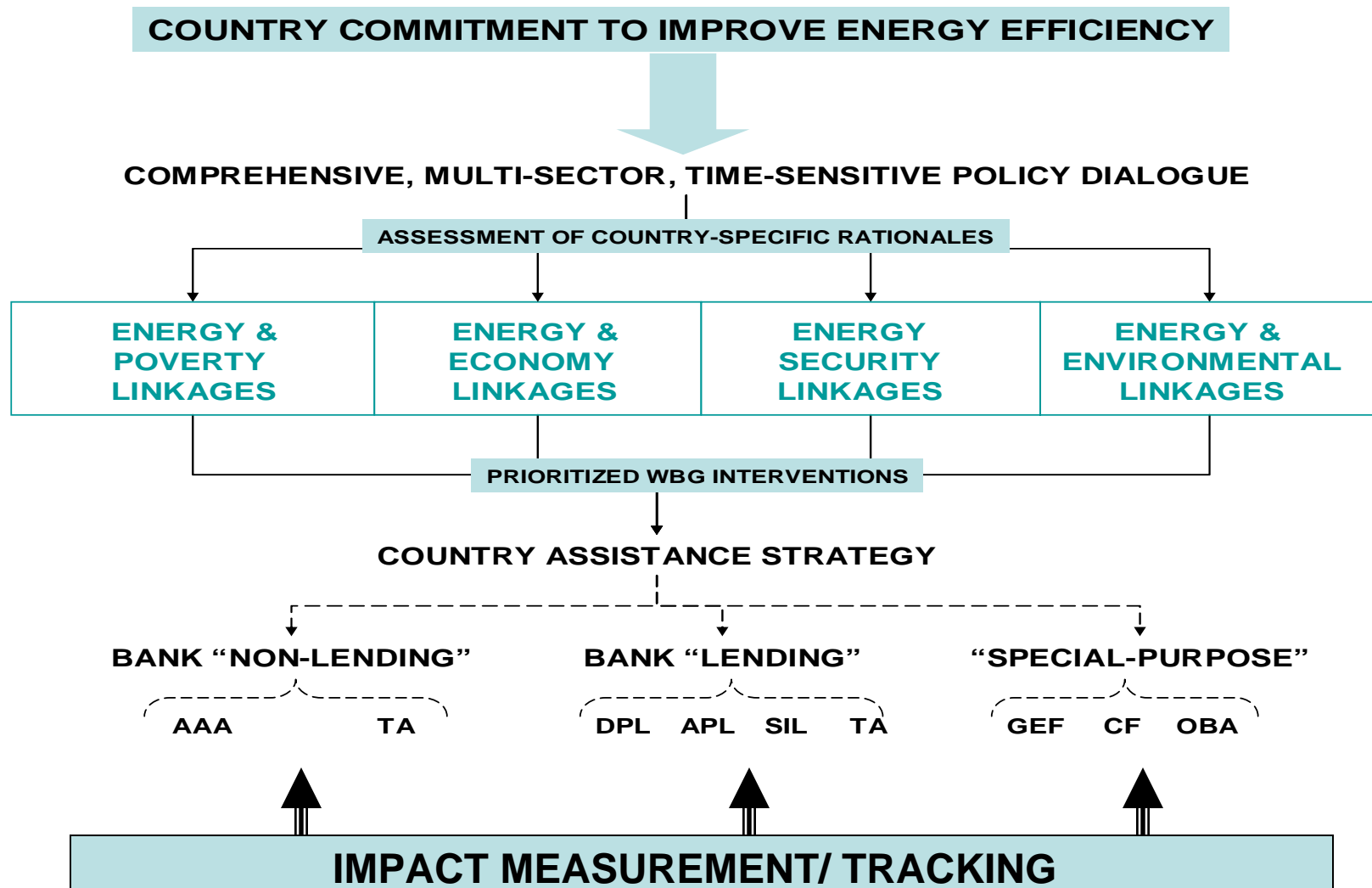
- **China produces 66% of its synthetic ammonia using coke, while the U.S produces 98% of its ammonia using natural gas**
- Ammonia production in China is dominated by small and medium-size plants, which typically use coal and coke as the primary feedstock
  - **Energy consumption per unit output for small plants can be more than 76% higher than that of large plants**

Source: ENVGC, World Bank

# Energy Efficiency Opportunities and Measures Across Sectors

Sector	Energy Efficiency Improvement Opportunities and Measures
<b>Transport</b>	Efficient gasoline/diesel engines, urban mass transport systems, modal shifts to inter- and intra-city rail and water transport, improved fleet usage.
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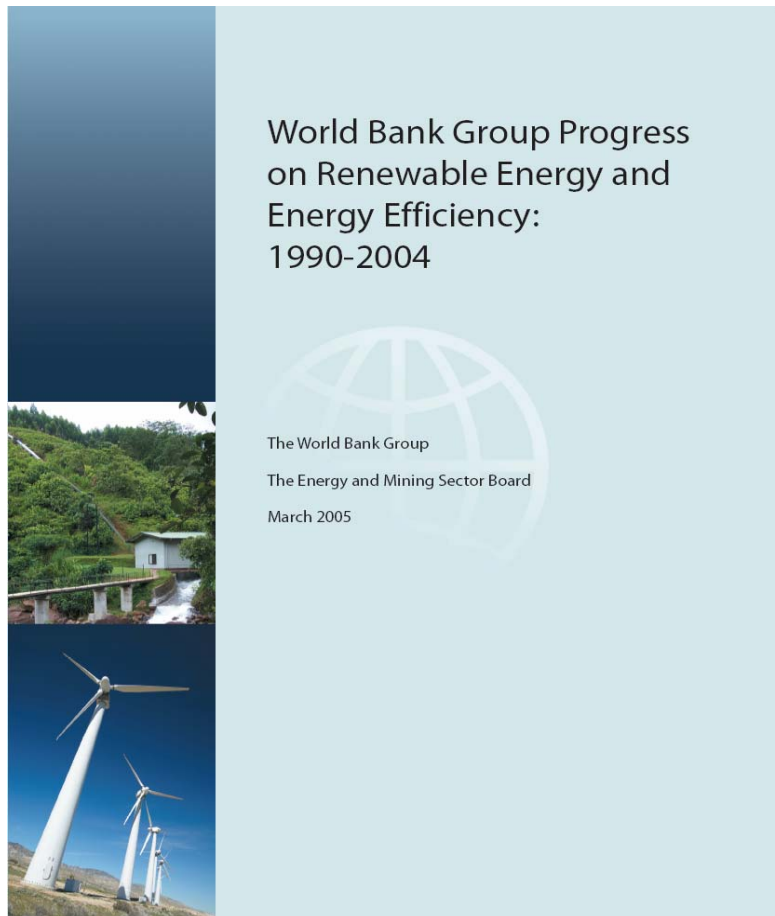
# Scaling Up EE Investments; Mainstreaming Across Sectors



# Energy Sector Operational Priorities with EE Focus, FY07

Region	Proposed Lending Activity	Non-Lending (AAA, TA, KP)
<b>ECA</b>	<b>Turkey</b> -Electricity Distribution Rehabilitation <b>Macedonia</b> – Sustainable Energy <b>Ukraine</b> - District Heating	<b>Macedonia</b> —Heat Market Study
<b>AFR</b>	<b>Sierra Leone, Guinea Bissau, Liberia, Burkina Faso, Ghana, Rwanda</b> – Improved energy efficiency as a part of the 3-4 year package (“Uganda” Model) <b>Kenya, Ghana</b> - IFC “Lighting the Bottom of Pyramid” Project based on EE Lighting	<b>South Africa</b> - Electricity Sector; <b>Sierra Leone</b> – Efficiency and Corporate Governance
<b>SAR</b>	<b>Pakistan, Bangladesh</b> – Electricity Distribution <b>India</b> - Coal-based Power Plant Rehabilitation <b>India</b> – Programmatic Framework Fund for Cleaner Energy and Low Carbon Development	<b>India</b> – Low Carbon Growth Study
<b>MENA</b>	<b>Morocco</b> – Energy Sector DPL <b>Tunisia</b> – Cogeneration	<b>Morocco</b> – Energy Efficiency Policy
<b>EAP</b>	<b>China</b> – Yantai IGCC (GEF supported) <b>China</b> - Liaoning Heating <b>China</b> – Energy Efficiency Financing (FY08) <b>Vietnam</b> – Rural Distribution (FY08) <b>Solomon Islands</b> – Sustainable Energy (FY08) <b>Indonesia</b> --Electricity Access (FY09)	<b>Thailand</b> – Sustainable Energy Policy Development <b>China</b> – Heat Pricing <b>China</b> - Heat Regulation and Pre-Investment Framework
<b>LCR</b>		<b>Mexico</b> – Housing Energy Efficiency Guidelines

# For more information on WBG's EE Projects...



## World Bank Group Progress on Renewable Energy and Energy Efficiency: Fiscal Year 2005



The World Bank Group  
The Energy and Mining Sector Board

November 2005

<http://www.worldbank.org/energy>



# Thank You



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