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Technological Barriers to Climate Friendly Energy Development

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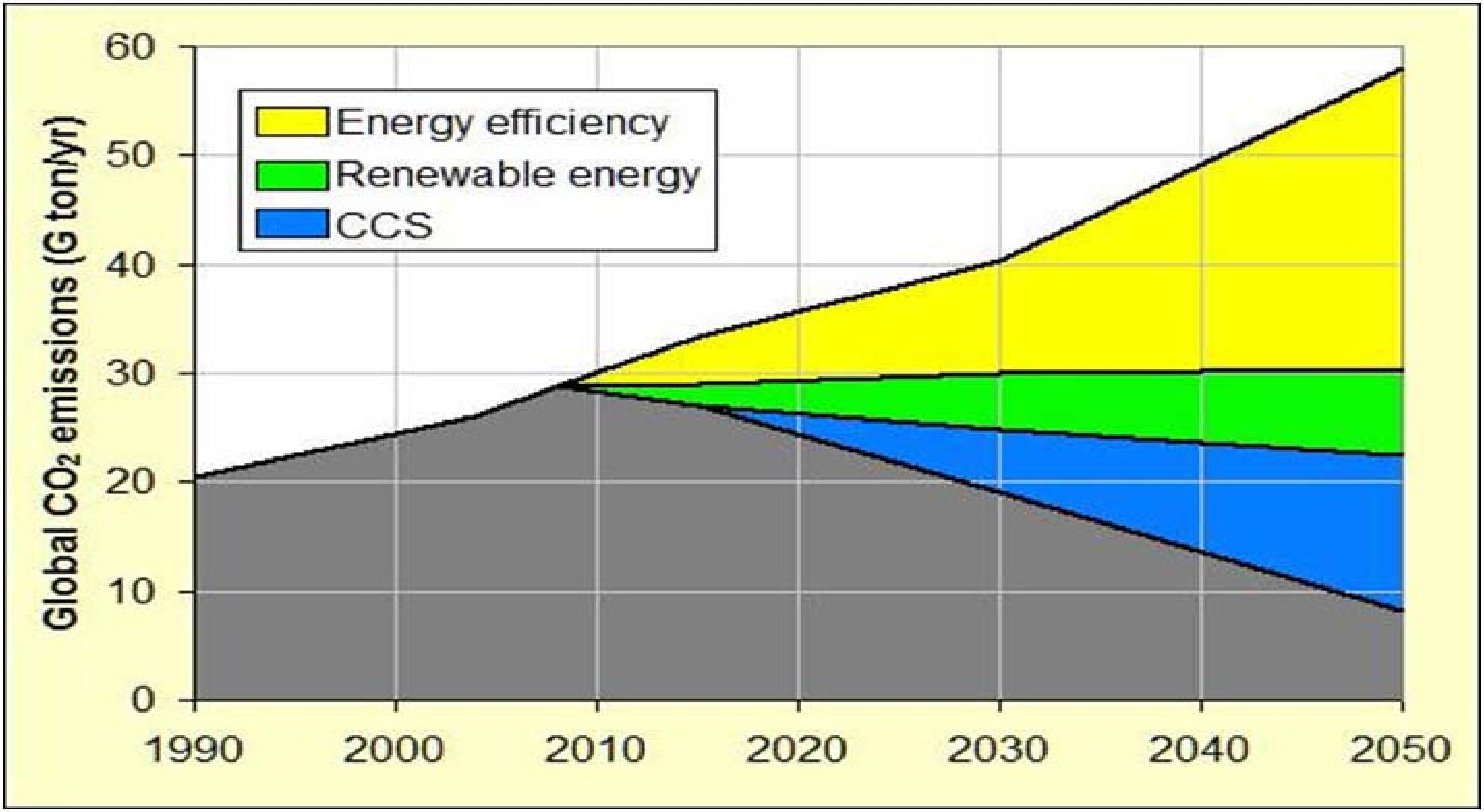
Climate change and energy relationship

- Energy use is the biggest contributor to GHG emission
- In the US 88% of GHG emission is energy related

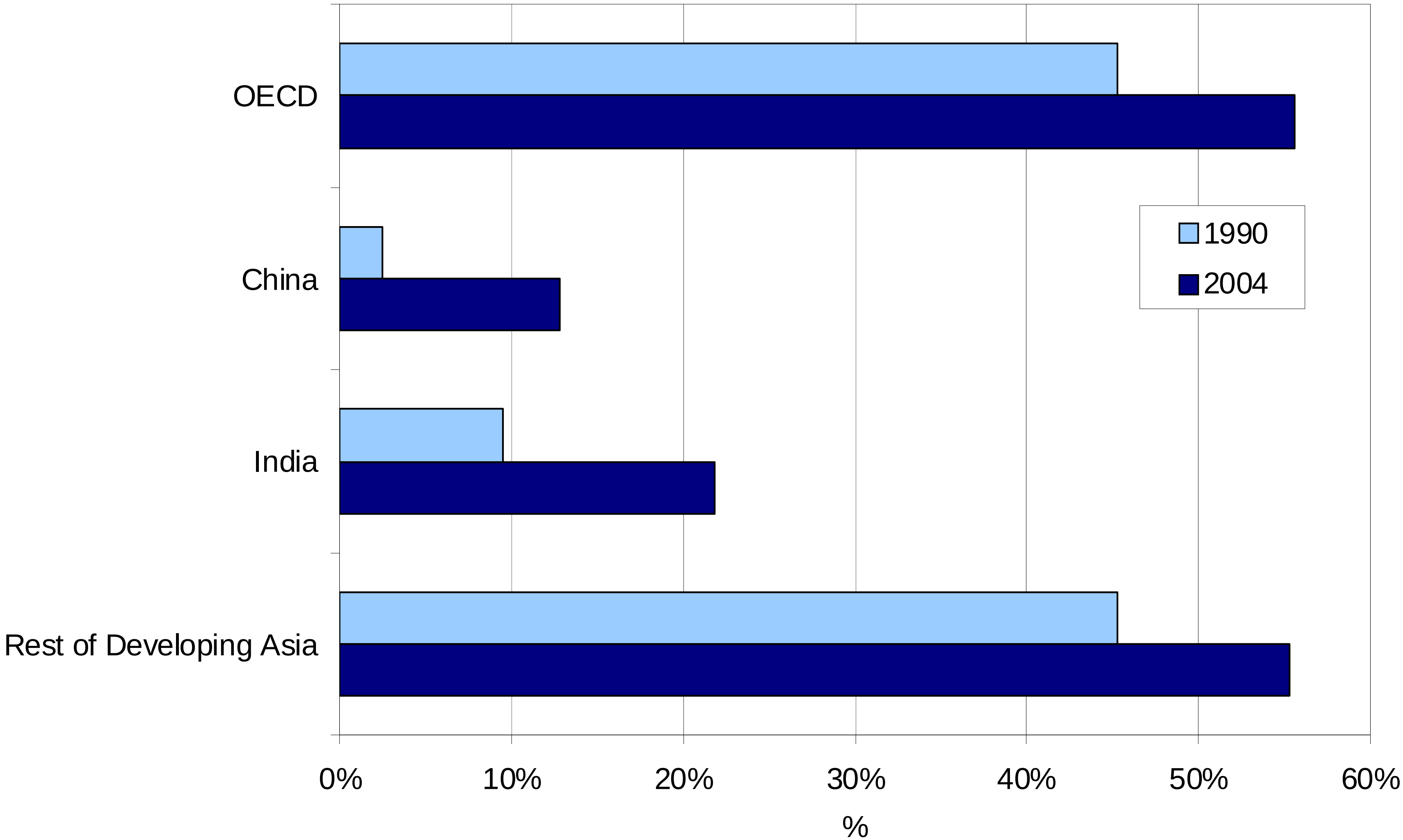
Importance of Different Climate Friendly Energy Technologies in GHG Mitigation



Energy and Electricity Growth in Asia

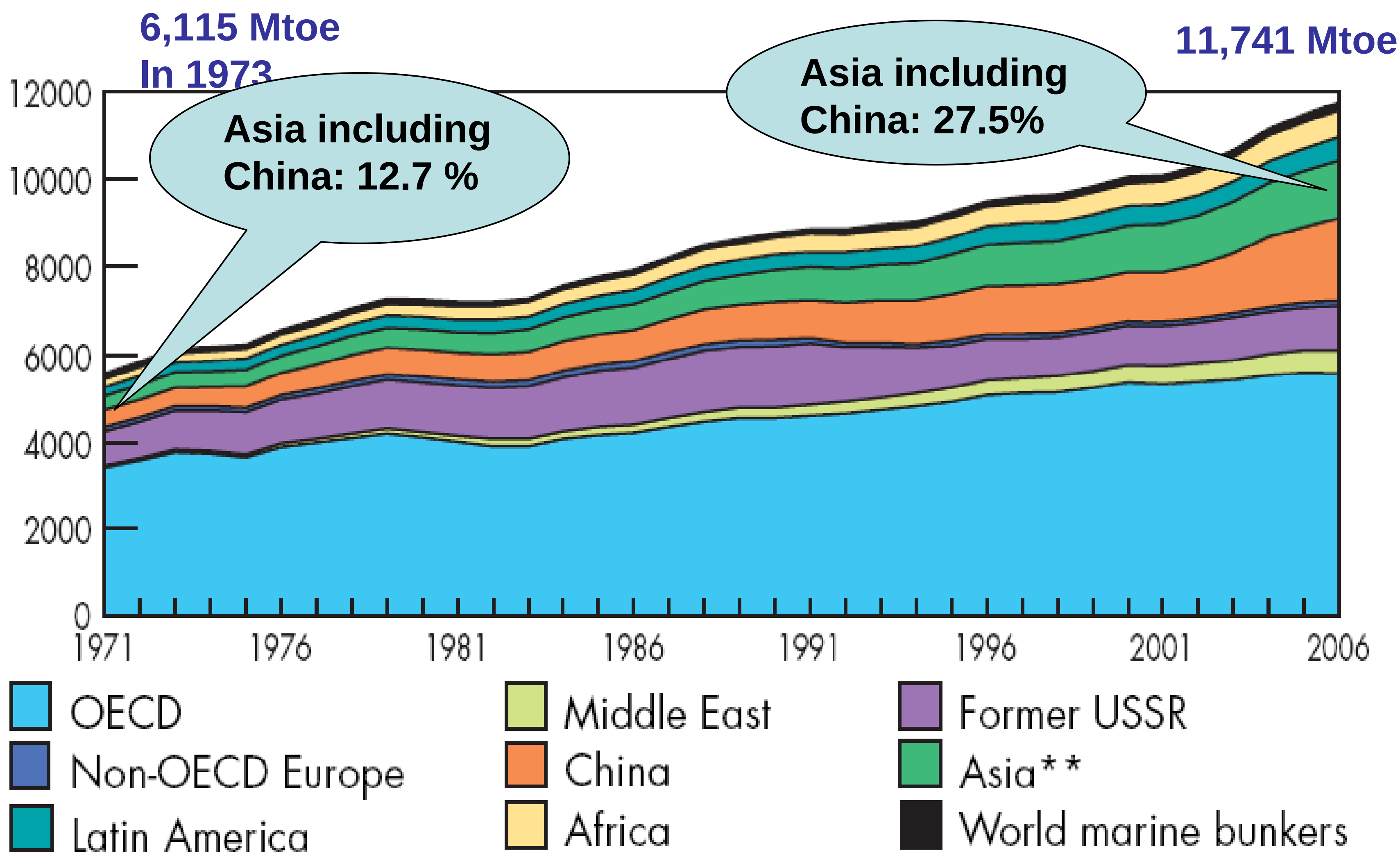
Growing Dependence On Imported Energy

(Energy Import as % of Total Primary Energy Supply)



Source: IEA, 2006

Overview of Primary Energy Supply by Region



**Asia excludes China.

Source: IEA (2008)

- Huge growth in power/energy infrastructure-GW capacity?
- Avoiding lock-in effects—removing barriers important!
- Technological Leap-froging

- Growth in Total Primary Energy Supply and Share of Fossil Fuels
- Growth in Electricity Supply in Asia and Share of Thermal Generation
- Growth in CO_2 Emission in Asia and Share in Global Emission

Climate Friendly Energy Technologies

- Cleaner technologies adopted mainly in industrialized Countries

  e.g., Clean coal technologies (PFBC, supercritical), nuclear, solar PV, wind, micro(self) generation, efficient demand side technologies, Hybrid vehicles, MSW to energy, improved building insulation, passive and active solar designs of buildings

- Cleaner technologies adopted in both industrialized and developing Countries

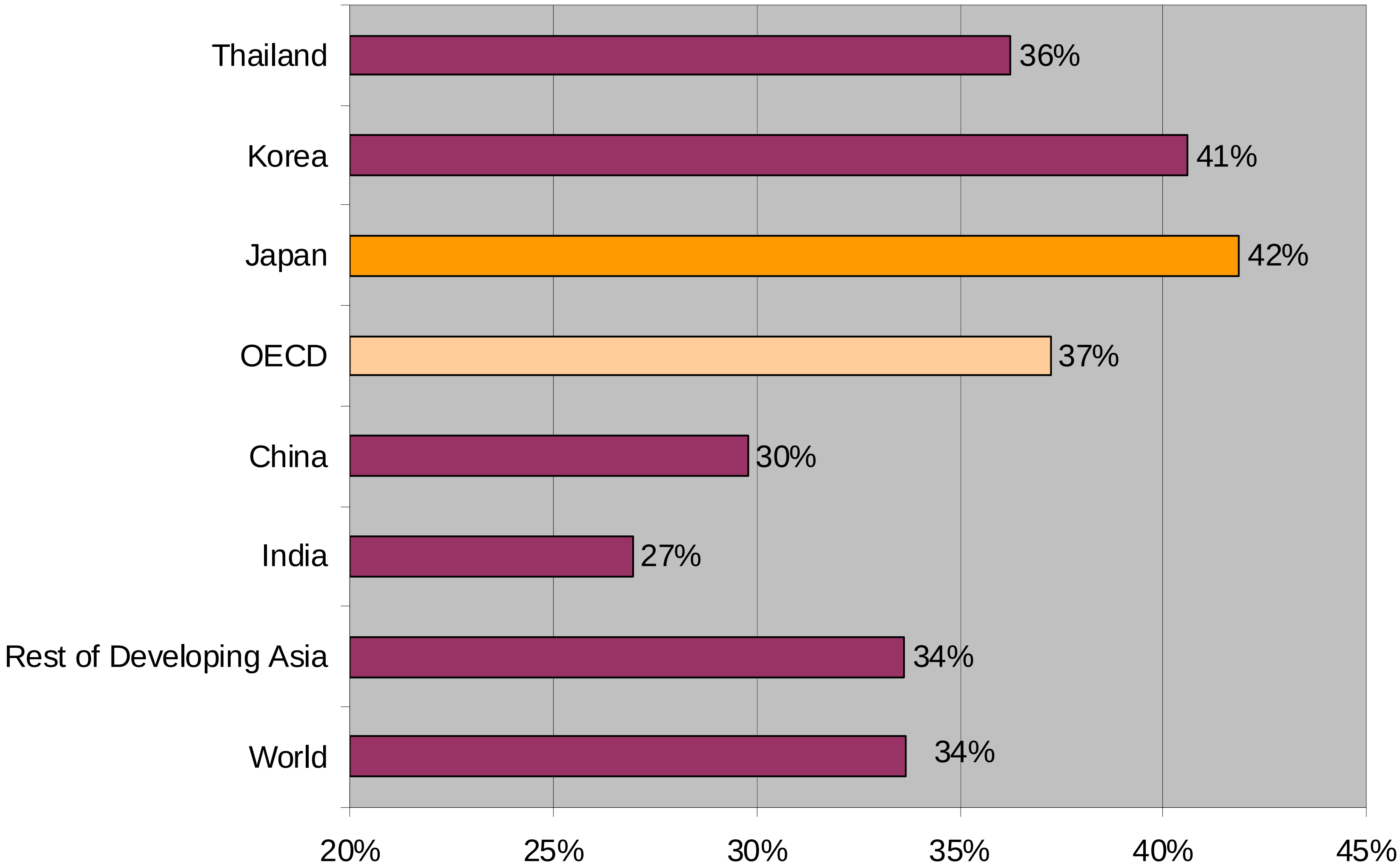
  e.g., Hydropower, wind(?), combined cycle, selected efficient demand side technologies

- Cleaner technologies, yet to be widely adopted in developing countries
  - e.g., CCTs, solar, wind, nuclear, efficient demand side technologies
- Emerging technologies
  - e.g., CCS, Fuel cell

Energy Use and Efficiency in Power Sector

- Dominance of fossil fuels--coal
  - Power generation efficiency
- Transmission and Distribution Efficiency

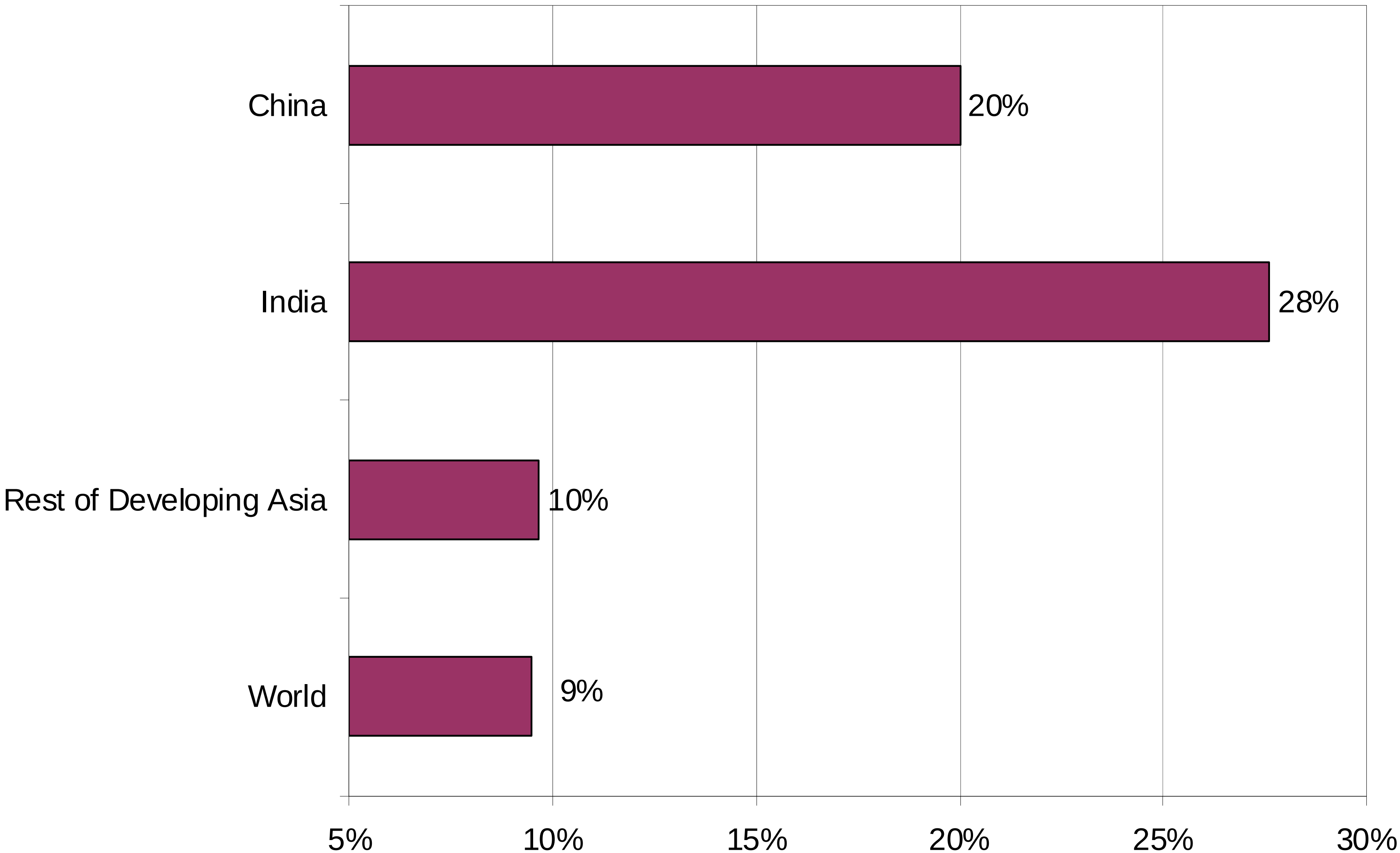
Energy Efficiency Gap in Coal Based Power Plants in 2004



Large energy efficiency gap in Asia including China and India.

Source: IEA, 2006

Potential Coal Savings in Power Generation by Improving Energy Efficiency to the OECD level in 2004



Barriers to CCTs

- Some clean coal technologies (CCTs) like IGCC are yet to prove to be suitable for use of low quality coal in countries – e.g., India and China.
- Transfer of CCTs -- a major barrier for their wide scale use in predominantly coal based developing countries.
- Perceived risk and lack of demonstration plants

Barriers to Nuclear Power

- Local capability to absorb (operate, maintain, manage) the technology
- Technology transfer problem
- Monitoring capability
- Disposal and treatment of nuclear waste

Barriers to Renewable Energy (RE) Based Electricity

- Lack of utility acceptance of RE options
- Lack of reliable location specific RE resource (solar, wind, biomass, geothermal) assessment and data
- Lack local RE technology know-how and technical capacity to produce, operate and maintain RETs.
- Lack of demonstration facilities
- Lack of technology transfer
- High initial cost, high perceived risk and lack of financing
- Lack of transmission access etc.

Measures to promote RE

- Policies that appear to have contributed the most to renewable energy development during the 1990s and early 2000s are:

  (a) direct equipment subsidies and rebates, net metering laws, and technical interconnection standards in the case of solar PV;

  (b) investment tax credits, production tax credits, and European electricity feed-in laws in the case of wind;

  (c) grid-access and wheeling policies supporting independent power producers and third party sales in the case of biomass and small hydro power.

Barriers to Efficient Demand Side Technologies (DSTs)

- Efficient DSTs reduce the energy demand at source.
- Barriers include:
  - High initial cost and financing
  - Lack of utility acceptance of DSTs
  - Supply based planning rather than IRP
  - Lack of technical information
  - Unreliable supply/
  - Power quality
  - Unreliable equipments/low quality products
  - Lack of standards

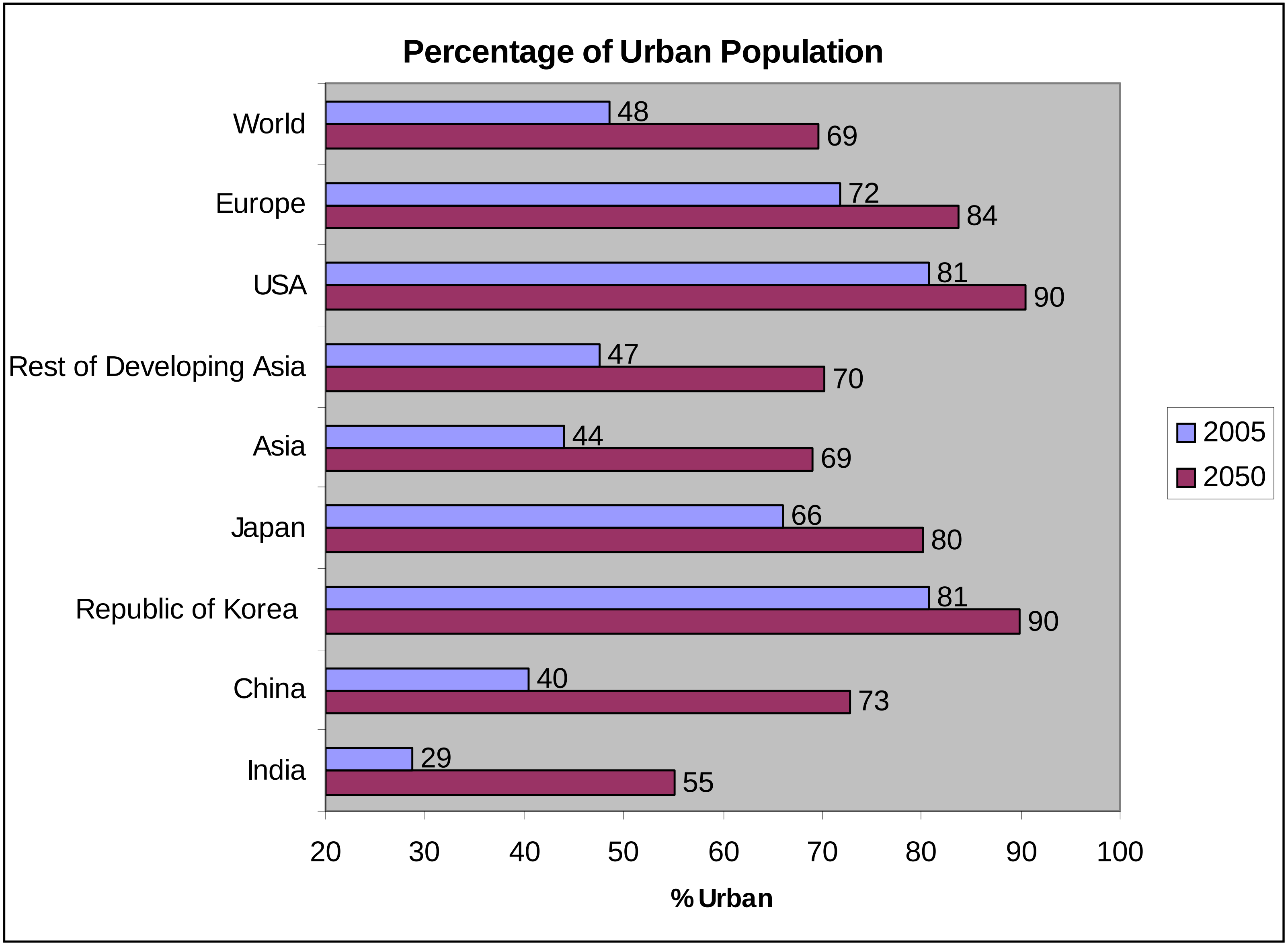
Energy Efficiency in Industry

Energy intensities of some industrial processes in different countries compared to the most efficient country (index: 100 = most efficient)

	Steel	Cement	Ammonia
Japan	100	100	-
Europe	110	120	100
United States	120	145	105
China	150	160	133
India	150	135	120
Best available technology	75	90	60

Buildings Sector Energy Efficiency and Renewable Energy Use

- Buildings sector a large contributor of GHG emission (39% in the US); growing importance in developing Asia
- Rapid urbanization
- Building Energy Implications



More than 70% of Asian population projected to live in urban areas by 2050. Urban residential energy/capita is high; total energy use to increase drastically.

Building Energy Efficiency

- Building design and construction practices ignore energy efficiency consideration in most developing countries.
- Significant amount (about 30% in some cases) of the projected GHG emissions in the building sector could be economically avoided.

- Co-benefits of energy efficient buildings:
  - improved indoor and outdoor air quality,
  - improved social welfare
  - improved energy security.

Barriers to Building Energy Efficiency Improvements

Barriers in developing countries include:

- **Lack of building energy code in many countries; promoting lock-in**
- **Non-availability of technology for EI (materials and equipments),** financing,
- Lack of reliable information
- **Lack of know-how on energy efficient building design and construction**

  (i.e., Lack of knowledge among local architects, construction engineers/workers)

Barriers to Building Energy Code implementation: ECBC in India

- Technical barriers: Lack of market or underdeveloped market for the energy efficient products (glazing, chillers, insulation) and product availability to meet the code requirements is a major barrier. Associated barrier is inadequate testing facilities to certify products as per code requirement.
- Inadequate technical capabilities of code implementing agencies to support code implementation and verification.
- Lack of knowledge among designers to analyze designs based on code requirements.
- Limited energy simulation capability to quantify savings based on energy efficiency parameters as defined by the code.
- The building construction industry (contractors, services providers) not geared to apply these measures practically on site.

Micro-generation – A Major Emerging Option

- Domestic micro-generation, i.e. the generation of electricity (and heat) in individual homes, could contribute as much as 40% to UK electricity demand by 2050.

- In UK, it could reduce household carbon emissions by up to 15% by 2050, and could also enhance energy security by generating energy close to the point of consumption.

Barriers:

- Transmission access to micro generated power;
- Buyback Pricing
- Reliability of the equipment

(SR Allen et al.: Prospects for and barriers to domestic micro-generation: A United Kingdom perspective

- **Jim Watson et al: Domestic micro-generation: Economic, regulatory and policy issues for the UK)**

Emerging Technologies

- Energy efficiency is expected to play a key role.
- Future deployment of carbon capture and storage (CCS) for electricity generation and for other industries with high levels of direct emissions (cement, ammonia, and iron manufacturing) has potential to reduce emissions substantially.
- In order to stimulate deployment of these and other technological advances, larger investment in research and development is necessary during the next few decades.
- As fossil fuel prices increase, more of these low-carbon alternatives will become competitive.
- However, high fossil fuel prices can spur the extraction of oil from oil sands and shales, and the development of synthetic fuels derived from coal and natural gas, leading to increased emissions of GHGs.
- CCS is yet to be commercialized; Problem of finding the appropriate carbon storage mechanism.

Role of technology transfer in CC

- Role of technology development and technology transfer is fundamental and critical in effectively combating climate chance and to avoid the lock-in effect.
- Weak capacity of developing countries in technology development and deployment; hence need for the transfer of climate-friendly technologies very high.

Technology Transfer

- Supply of Technology
  - Capital goods and equipment
  - Skills and know-how for operating and maintaining equipment
  - Knowledge and expertise for generating and managing technological change
- Building of Technology Absorption Capability
  - capacity for production and technological innovation
  - ensure successful and long term technology development in recipient countries

Source: Worrell et al.(2001)

Barriers to technology transfer

- High incremental costs of climate friendly technologies (CFTs), lack of funds and funding channels.
- Low capacity of developing countries in absorbing, developing and deploying CFTs.
- License fees are too high, and additional conditions for technology transfer.
- Insufficient transfer of knowhow and the technology for manufacturing key components.
- No substantial technology transfer through the Clean Development Mechanism.
- Technology owners have no will for technology transfer.
- Concerns about intellectual property rights.
- International climate policies are excessively market-based and the market is weak (low carbon prices!).

Technology Barriers in General

- Intellectual Property Rights (IPRs) may hamper technology transfer if it is not addressed through proper mechanism. Insufficient protection of IPRs can be a deterrent to international firms transferring technologies.
- Absence of local technical capacity and supportive regulations to promote, adopt and absorb new technology (RETs and EEI)
- Long term and costly dependence on technology suppliers.
- Risks and uncertainties related with new technologies may hinder technology diffusion. This is particularly important for many low carbon technologies that are either pre-commercial, supported commercial or commercial but slowly diffusing.
- Lack of knowledge on adoptability of new technology on local environment and worldwide successful commercial demonstration of new technology.

Role of CDM

CDM and Carbon Price

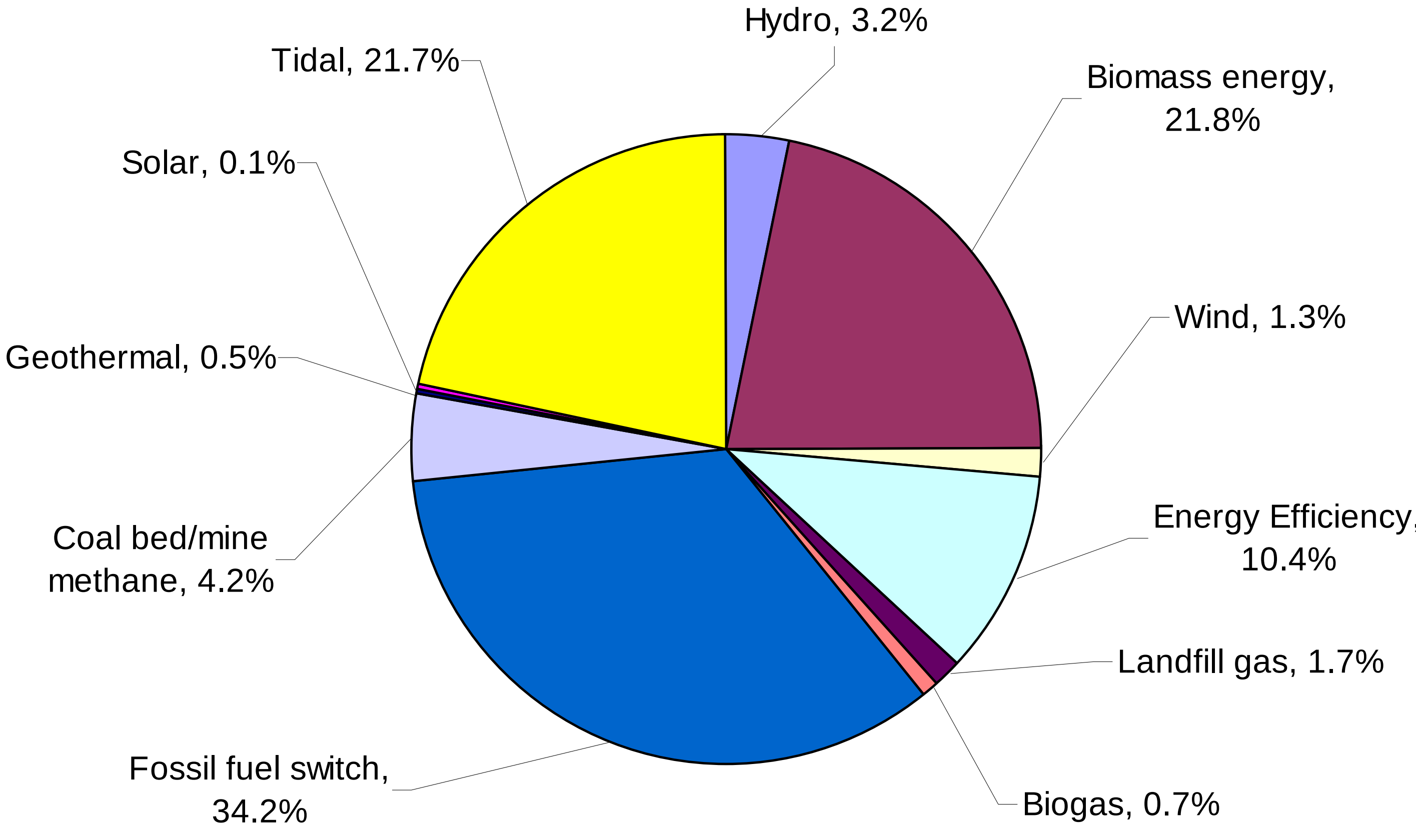
- CDM – yet to be effective to promote large scale adoption of CFTs.
- Slow and complicated approval process.
- High transaction costs
- Weak carbon market (low carbon price) makes CDM even less effective.

Registered Energy Related CDM Projects (till 1st March 2009)

Type	Number of Project	Total Installed Power (MW)	CER ktCO2e/yr	CER by 2012 (ktCO2e)	CER by 2020 (ktCO2e)
Biogas	31	114	1,724	9,430	19,835
Biomass energy	211	3,051	11,620	77,261	150,280
Coal bed/mine methane	13	265	6,531	33,826	84,619
Energy Efficiency	101	3,535	19,137	97,263	213,494
Fossil fuel switch	16	9,989	15,091	69,667	170,646
Geothermal	7	329	1,590	9,878	21,482
Hydro	331	8,975	26,587	129,344	331,447
Landfill gas	41	273	10,666	66,030	139,678
Solar	5	14	43	246	432
Tidal	1	254	315	1,104	3,631
Wind	210	9,432	19,620	103,293	240,844
Total	967	36,232	112,924	597,341	1,376,388

Source: UNEP RISOE (http://cdmpipeline.org/)

Distribution of Energy Related Registered CDM Projects (till 1 March 2009)



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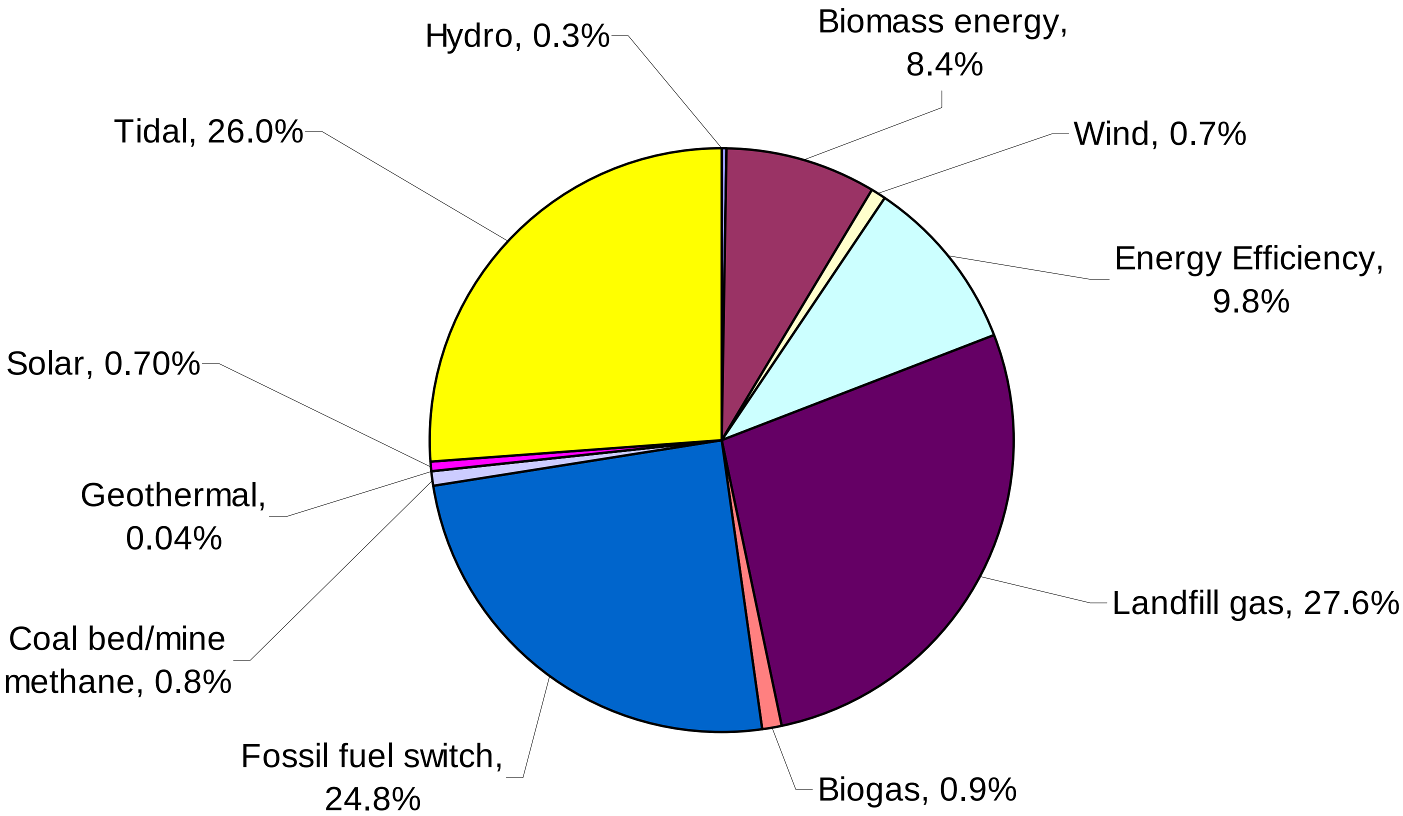
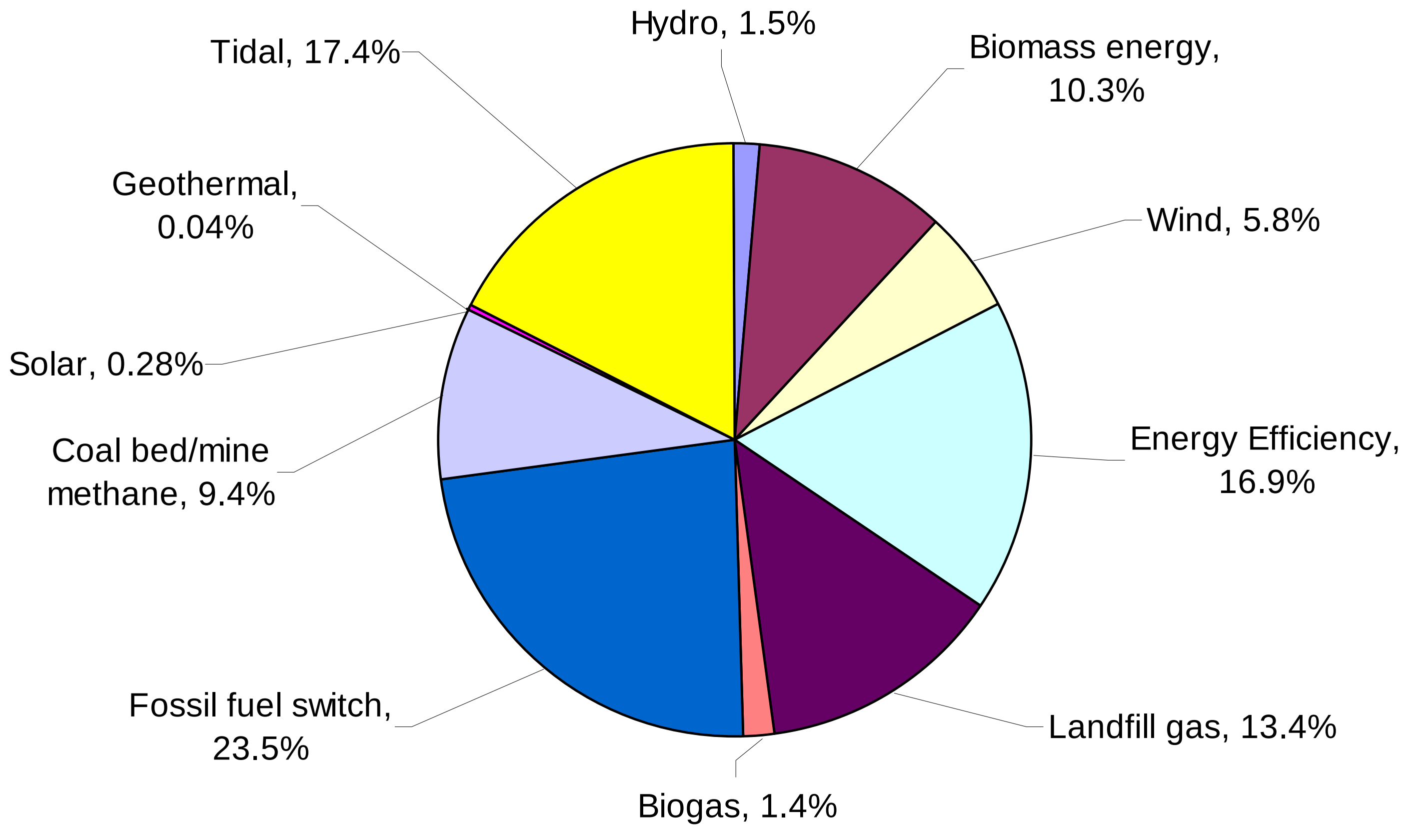
Distribution of Installed Capacity (MWe) of Energy Related CDM Projects (till 1 March 2009)



Data Source: UNEP RISOE (http://cdmpipeline.org/)

Share of Certified Emission Reduction (tCO_2e) of Energy Related CDM Projects (till 1st March 2009)



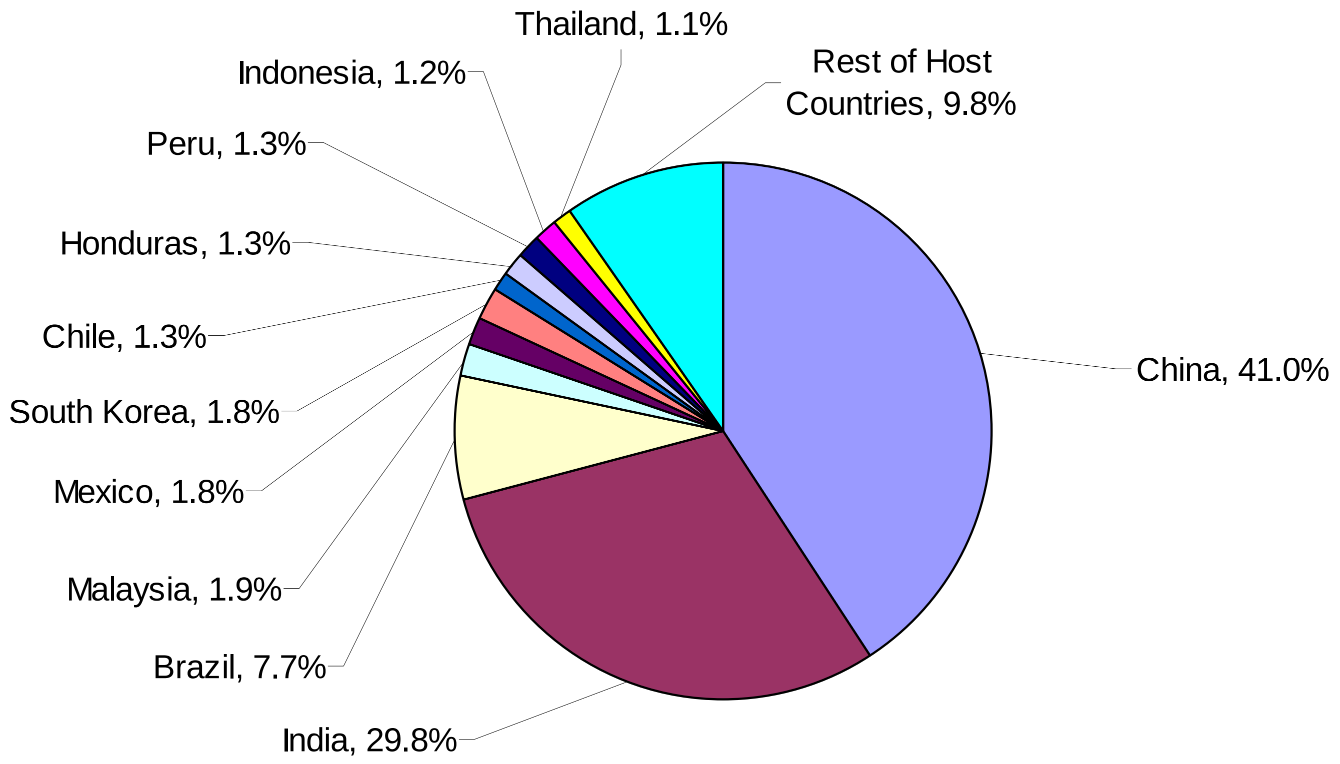
Data Source: UNEP RISOE (http://cdmpipeline.org/)

Country wise Registered Energy Related CDM Projects (till 1st March 2009)

Country	Number of Project	Total Installed Power (MW)	CER (ktCO2e/yr)	CER by 2012 (ktCO2e)	CER by 2020 (ktCO2e)
China	396	22,793	68,502	325,599	838,046
India	288	6,092	17,979	110,396	189,590
Brazil	74	2,358	6,732	50,279	102,970
Malaysia	18	144	2,065	11,606	27,069
Mexico	17	1,240	3,281	15,127	36,700
South Korea	17	491	2,242	12,649	24,759
Chile	13	433	1,825	11,028	25,640
Honduras	13	86	252	1,868	3,396
Peru	13	319	1,129	5,302	14,130
Indonesia	12	192	1,290	7,436	17,548
Thailand	11	149	919	6,772	9,826
Rest of Host Countries	95	1,934	6,709	39,280	86,212
Total	**967**	**36,232**	**112,924**	**597,341**	**1,376,388**

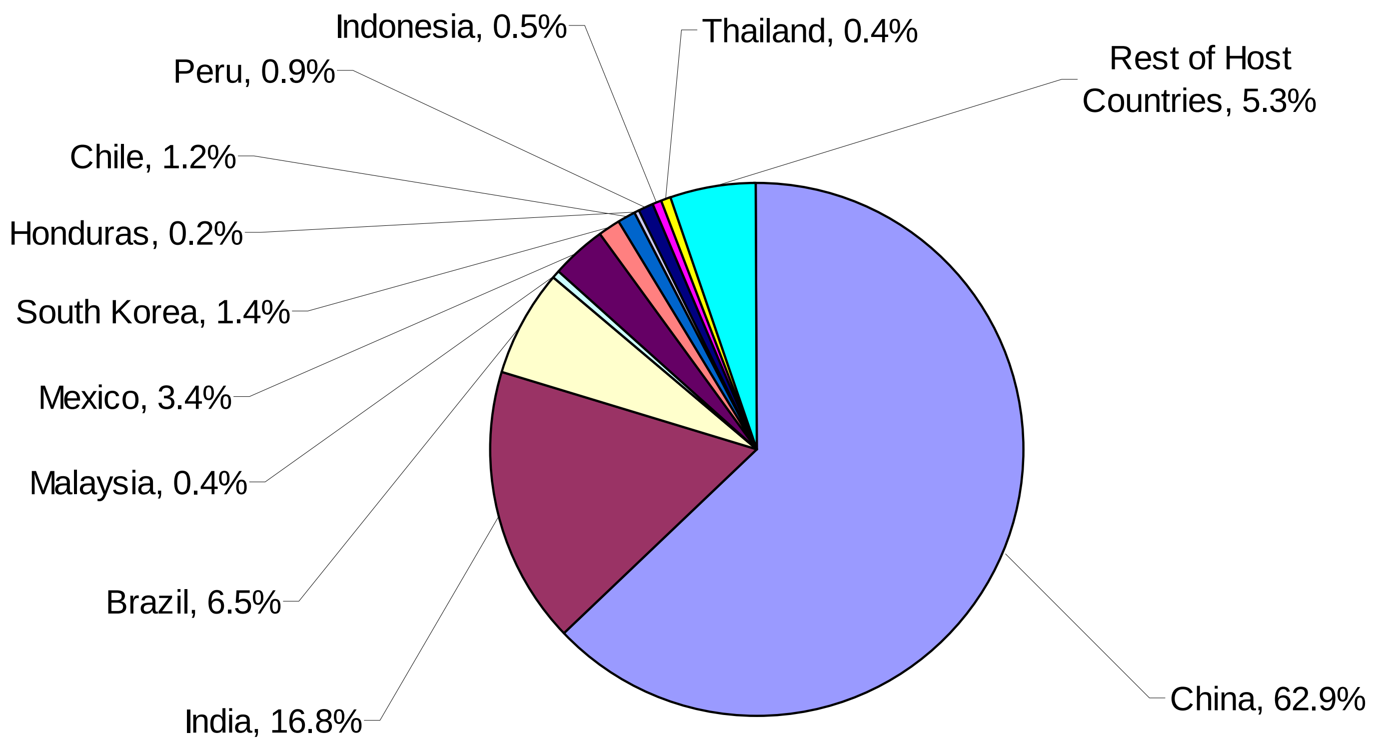
Source: UNEP RISOE (http://cdmpipeline.org/)

Country-wise Share in Total Number of Energy Related Registered CDM Projects (as of 1 March 2009)



Data Source: UNEP RISOE (http://cdmpipeline.org/)

Country wise Share of Installed Capacity (MWe) of Energy Related CDM Projects (till 1st March 2009)

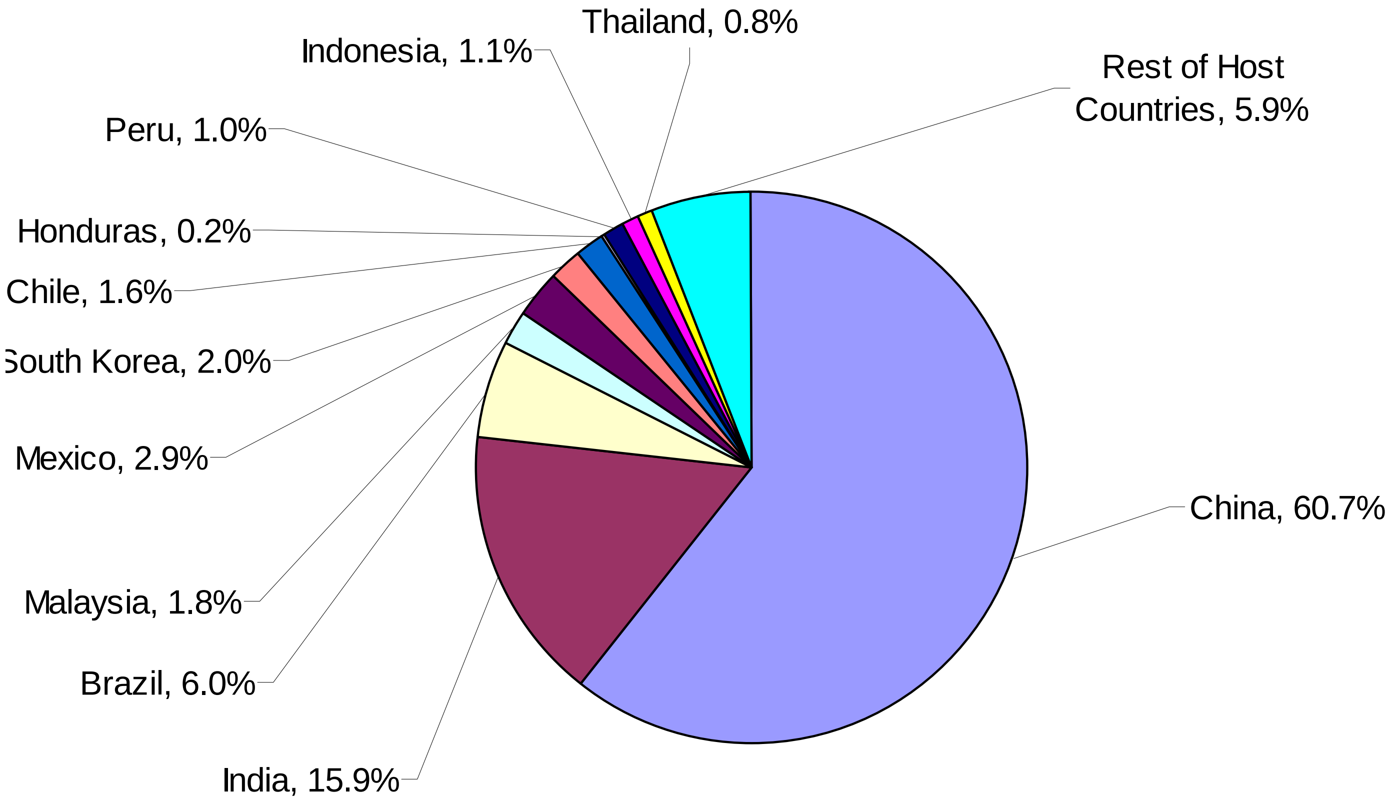


Total capacity: 36,232 MWe

Combined share of China, India and Brazil: 86.2%

Data Source: UNEP RISOE (http://cdmpipeline.org/)

Countrywise Share of Certified Emission Reduction (tCO_2e) from Energy Related CDM Projects (as of 1 March 2009)



Data Source: UNEP RISOE (http://cdmpipeline.org/)

Prof. R. M. Shrestha

How big is CDM contribution in Clean Energy Development ?

During January 2000 – January 2007			
Type of Energy Technology	CDM based Installation (MW)	Total Installation in Non-OECD (MW)	Percentage contribution by CDM
Hydro	1,582	95,972	1.7%
Wind	2,628	16,737	32.7%
Biomass energy	1,791		
Energy Efficiency	489		
Geothermal	275		
Fossil fuel switch	120		
Landfill gas	93		
Biogas	48		
Coal bed/mine methane	25		
Solar	9		

Data Sources: EIA (http://www.eia.doe.gov/), UNEP RISOE (http://cdmpipeline.org/)

Key Measures

- Setting standards
- Support for demonstration facilities
- Support for resource assessment
- Local technical capacity building
- Energy code
- Renewable portfolio standard (RPS)
- Green Certificates
- Feed-in tariffs/laws
- Green Pricing
- Energy reduction target and “white certificates”
- Net metering
- Carbon tax and Energy tax
- Technology transfer

Enabling environment and policies/support measures essential!

- Many RETs, energy efficient technologies and other climate friendly technologies would need policy intervention and support (financial and others) to overcome technological and other barriers for wide scale adoption.

  That has been the experience of developed countries; the need is even more stronger in developing countries.

- Moreover, due to weak capability to develop cleaner energy technologies, technology transfer to developing countries is a key to combat climate change.

Thank you

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