Energy Efficiency in APEC
A Focus on the Power Sector

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Study Background

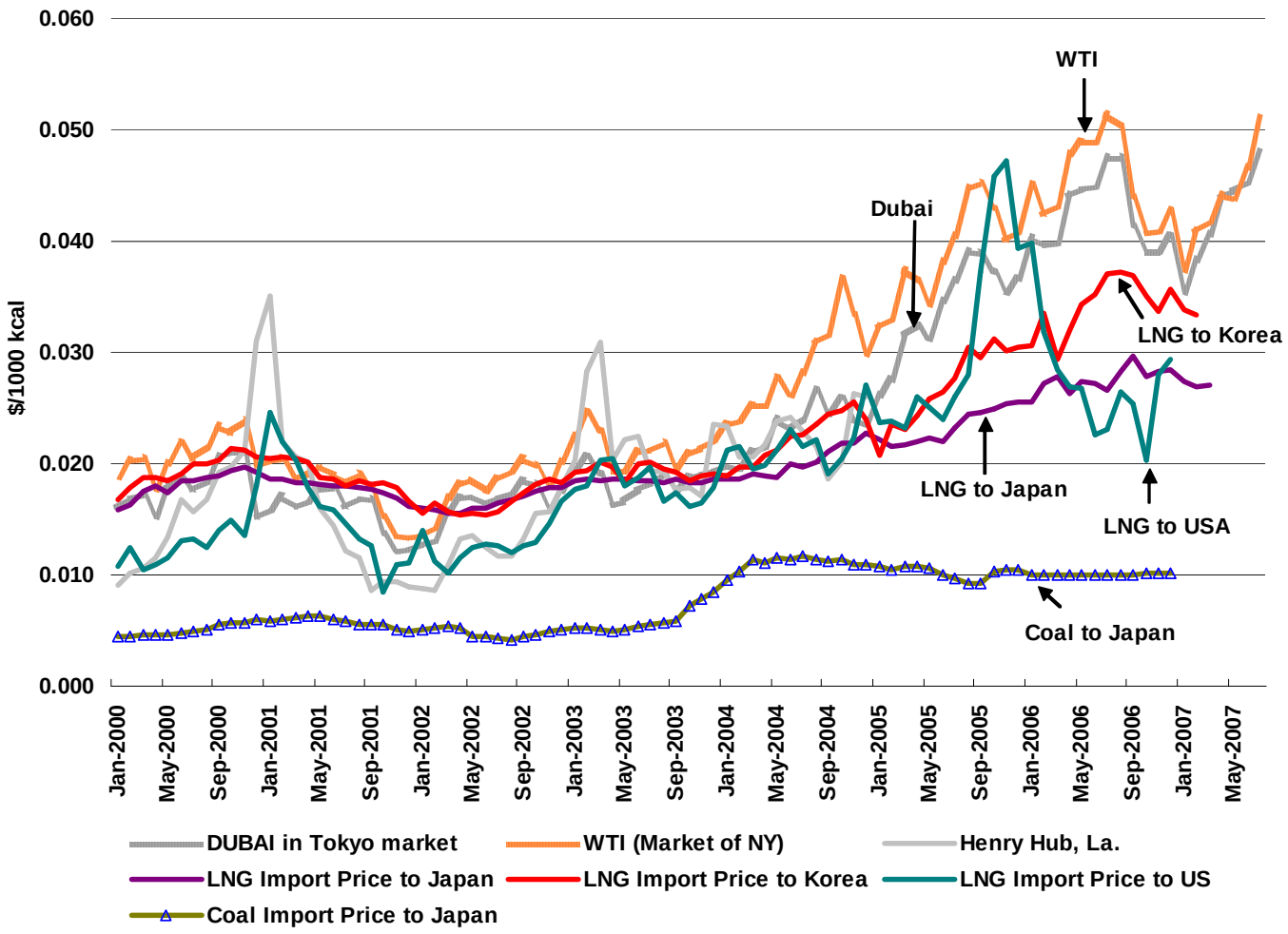
- **Needs for Energy Efficiency Improvement**
  - Rising energy prices
    - Resource issue
  - Increasing energy import dependency
  - Global and local environmental concerns
- **Needs for the Power Sector's Energy Efficiency Improvement**
  - The fastest growing energy source in final energy
  - Ease of policy implementation
    - Limited number of stakeholders
  - Substantial and long-term energy saving potential

Energy Prices in Recent Years

Weather and demand surge as the biggest contributors to the current increase in oil price

Widening price gap among oil, natural gas and coal

Steady increase in oil prices since the fourth quarter of 2003



(Source) APERC Analysis (2006)

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Energy Efficiency Policies in APEC Economies

Australia

- Energy Efficiency Opportunities Act 2006 and Regulation 2006 to encourage large energy users to take a more rigorous approach to energy management

China

- Ten key projects for energy launched
  - Target to save 240 million tonnes of coal equivalent
- Top-1000 Enterprise Energy Conservation Action Plan launched
  - Target to save 100 million tce by 2010

Hong Kong, China

- Issue of labels for 2,960 appliances.

Indonesia

- Biofuels programme initiated.

Japan

- New Energy Strategy calls for another 30 percent improvement of energy intensity by 2030.

Korea

- Implementation of a mandatory energy management audit
- Implementation of no driving days for employees of public offices

Malaysia

- Implementation of demonstration projects for energy efficiency improvement in industry and commercial sectors.

New Zealand

- Under the NZ Energy Strategy maximise the efficient use of energy to safeguard affordability, economic productivity and the environment

USA

- Implementation and plan for various measures for energy efficiency improvement
  - Energy efficiency standards for appliances
  - Tax incentives for the purchase of efficient appliances and vehicles
  - Promote energy efficiency and saving at federal agencies
  - Establish renewable fuel standards

Viet Nam

- UNDP and the Vietnam Ministry of Science and Technology will implement a project to raise the effectiveness of energy use at small and medium enterprises (SMEs)

APEC Final Energy Demand Outlook by Source (2002-2030)

Electricity demand to grow at the fastest rate of 3.1 percent per year

	Mtoe					Growth rate (% per annum)				
	1980	2002	2010	2020	2030	80-02	2002-2010	2010-2020	2020-2030	2002-2030
Total Final Energy Demand	**2 336.2**	**3 818.6**	**4 661.2**	**5 648.1**	**6 759.2**	**2.3**	**2.5**	**1.9**	**1.8**	**2.1**
Coal	310.5	336.7	466.8	515.1	560.2	0.4	4.2	1	0.8	1.8
Oil	1 039.8	1 680.0	2 040.2	2 491.8	2 972.8	2.2	2.5	2	1.8	2.1
Gas	396.3	565.6	674.5	832.7	1 010.8	1.6	2.2	2.1	2	2.1
NRE	290.8	373.9	361.5	346.4	340.4	1.1	-0.4	-0.4	-0.2	-0.3
Electricity	290.4	693.3	935.9	1 254.2	1 640.3	**4**	**3.8**	**3**	**2.7**	**3.1**
Heat	8.5	169.1	182.3	207.9	234.8	14.6	0.9	1.3	1.2	1.2

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(Source) APERC Analysis (2006)

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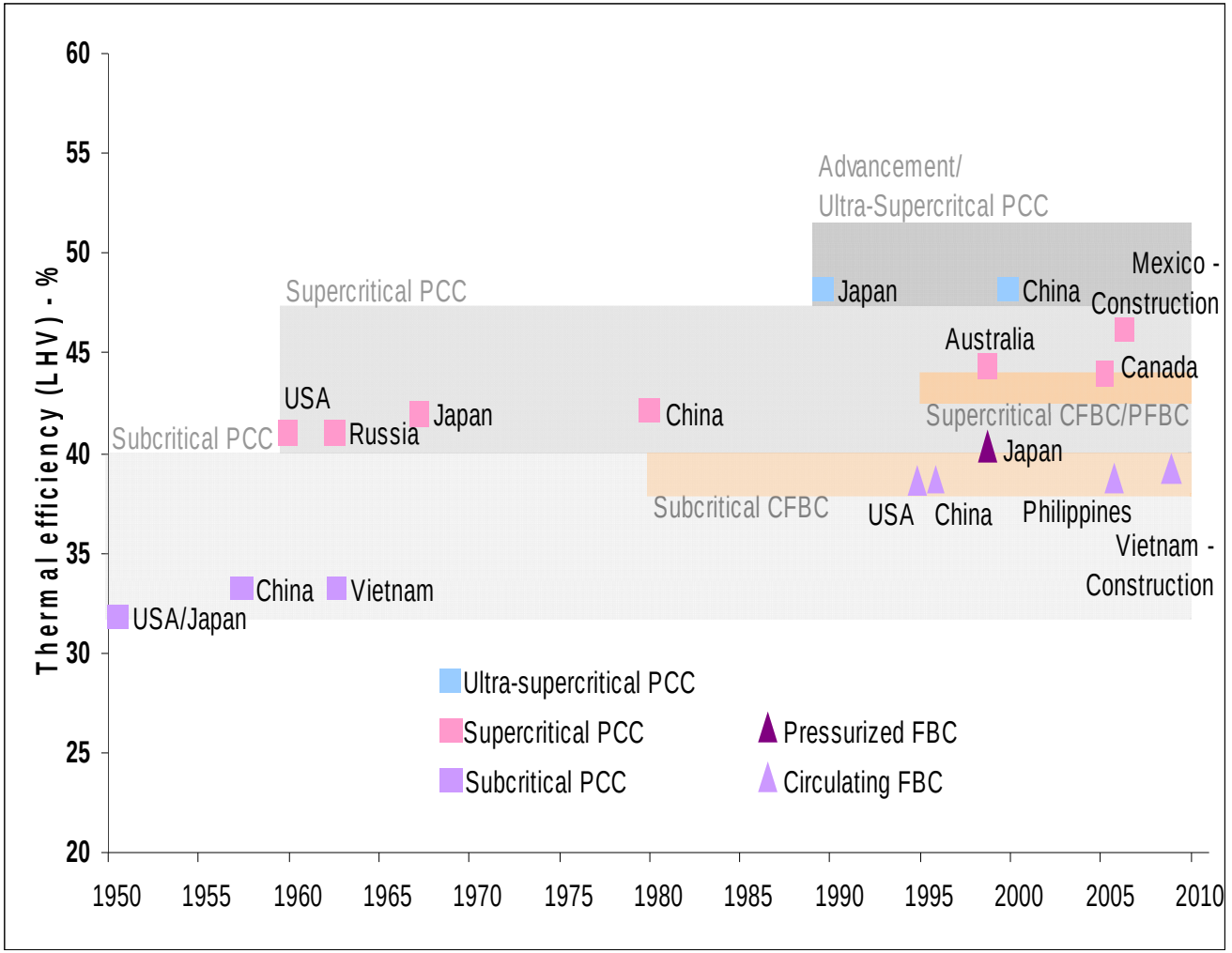
Utilization of coal-fired power generation technology



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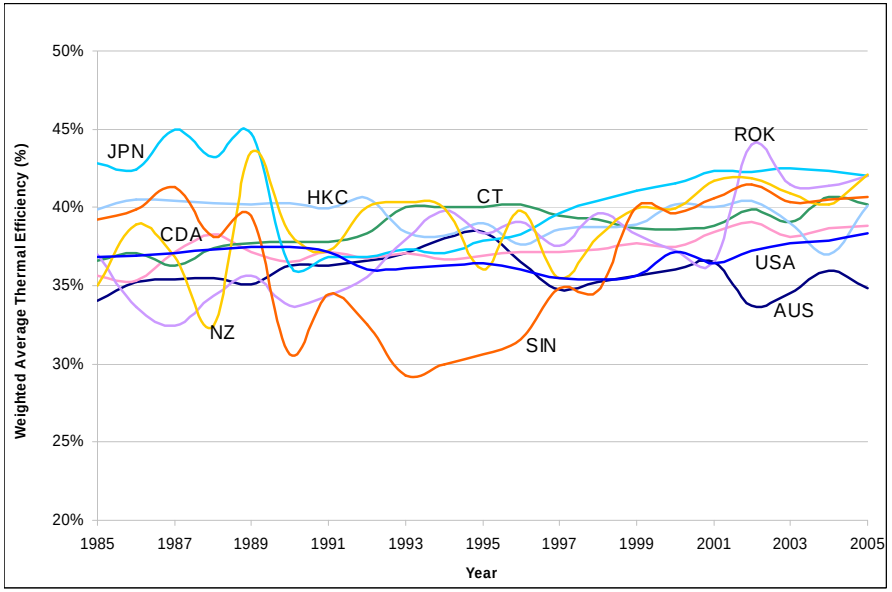
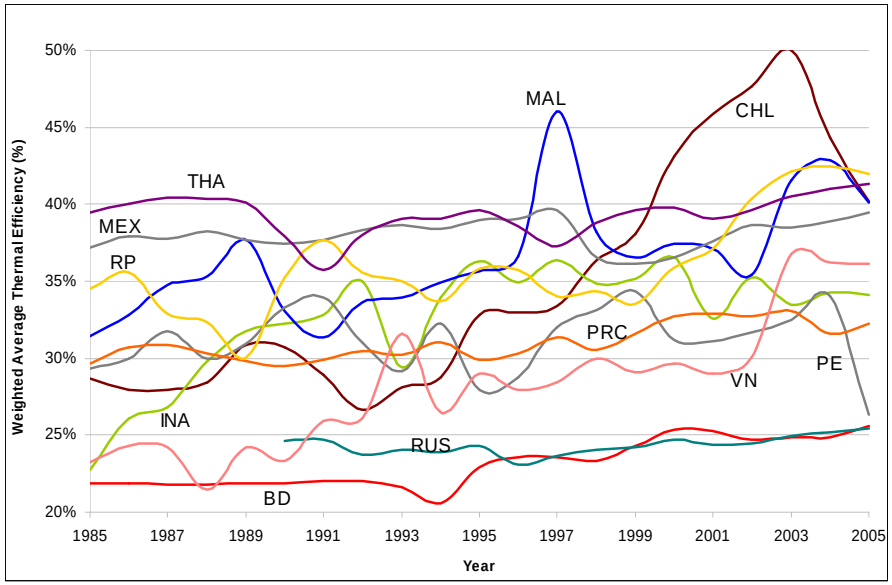
Weighted average fossil fuel thermal efficiency

Developed economies



Developing economies



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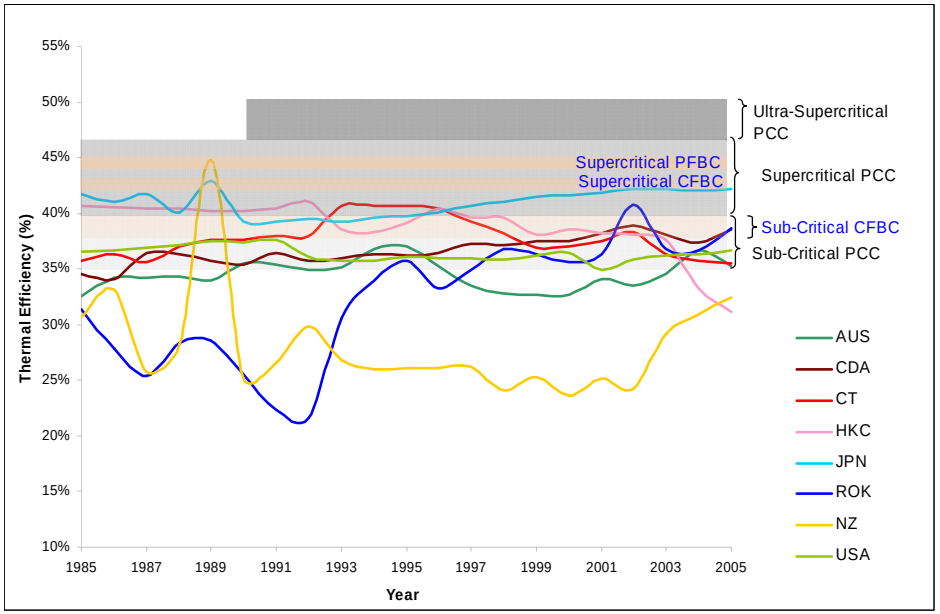
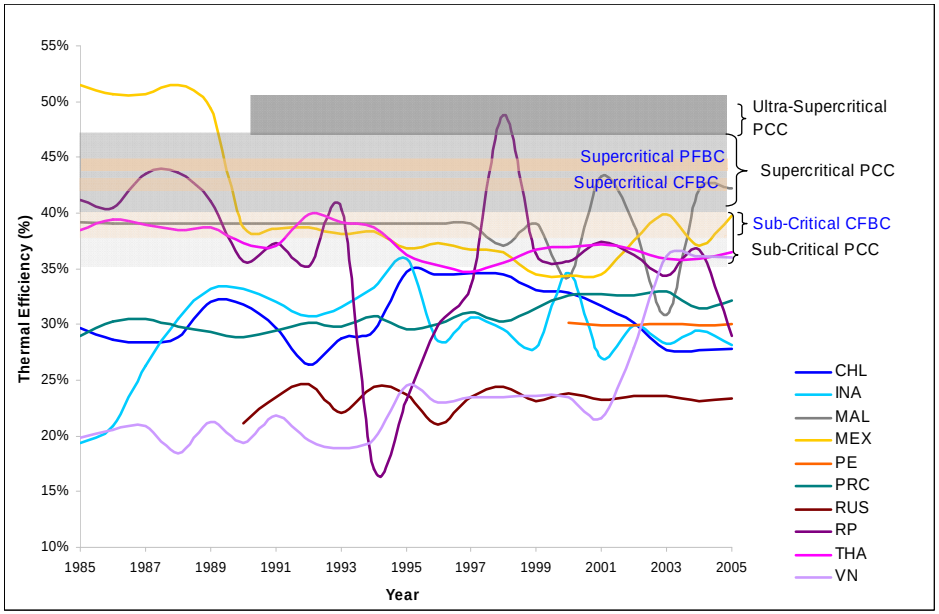
Averaged thermal efficiency of coal-fired power generation

Developed economies

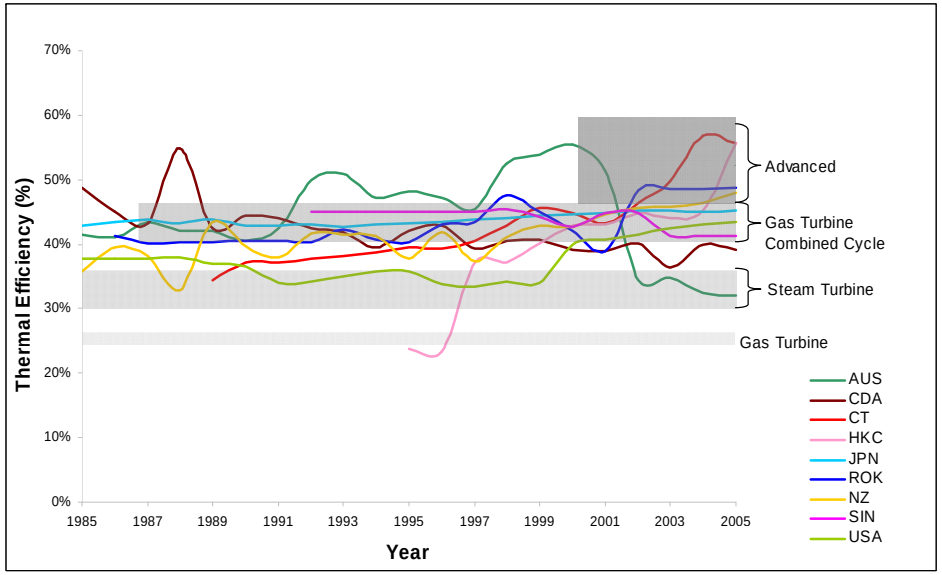


Developing economies

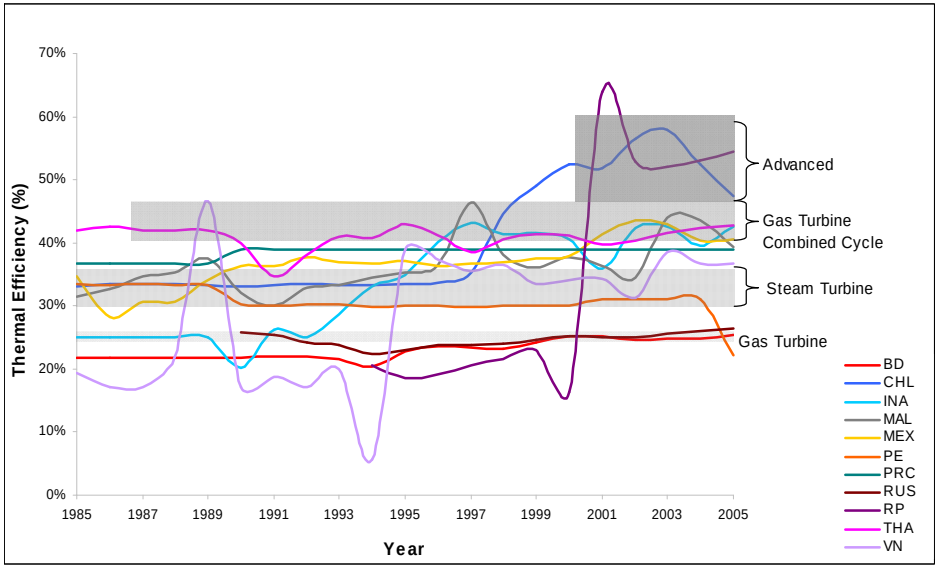


Averaged thermal efficiency of gas-fired power generation

Developed economies



Developing economies



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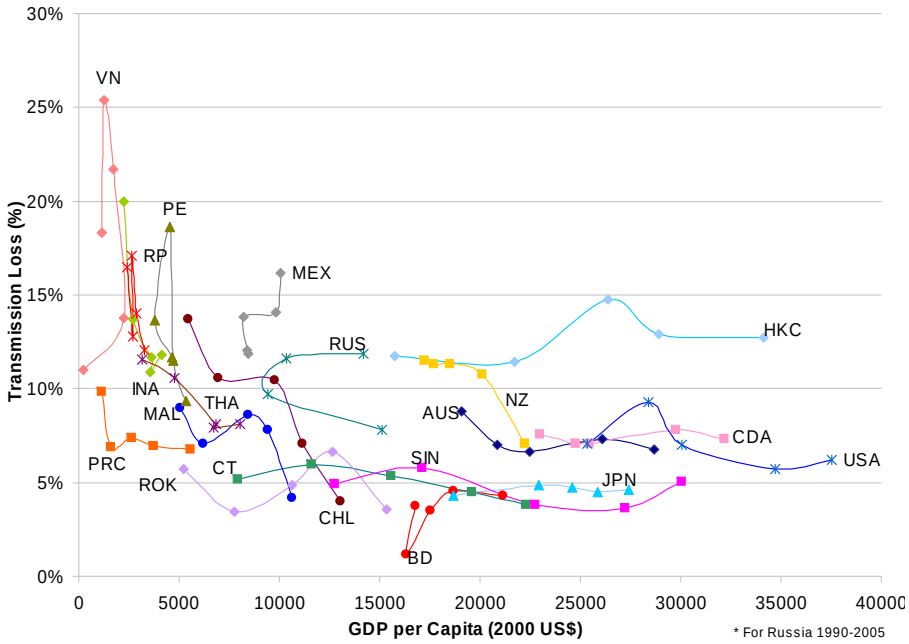
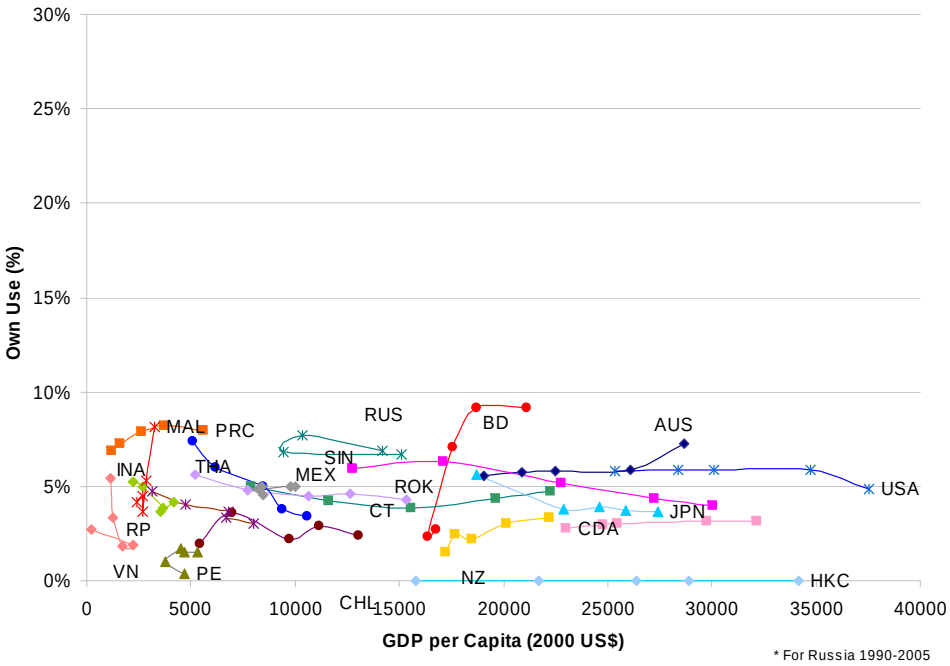
System Losses – T&D Losses and Power Plant Own Use (1985-2005)

Transmission Losses



Power Plant Own Use



(Source) APERC Analysis (2007)

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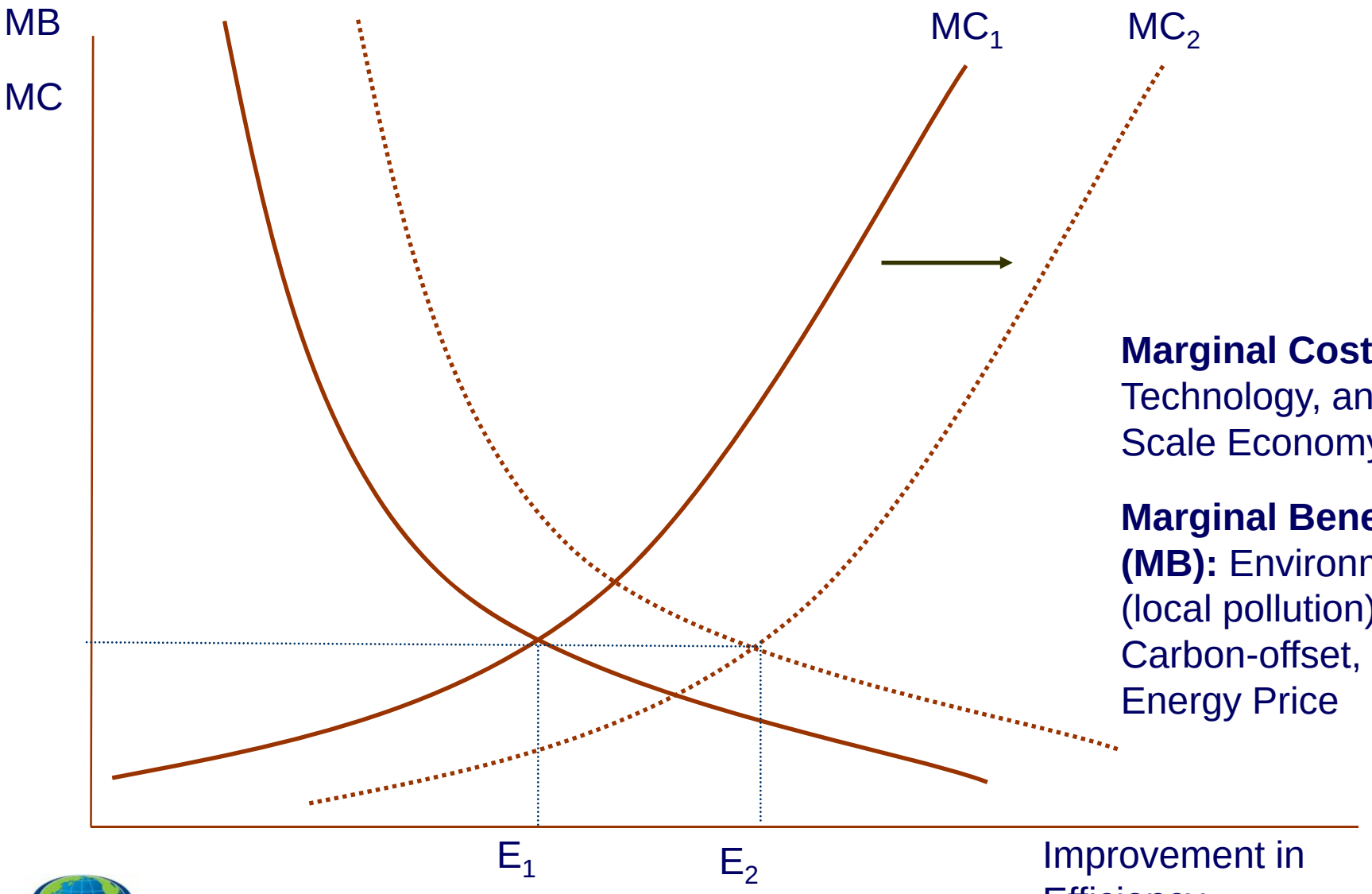
Economics of Energy Efficiency Improvement



Marginal Cost (MC): Technology, and Scale Economy

Marginal Benefit (MB): Environment (local pollution), Carbon-offset, and Energy Price

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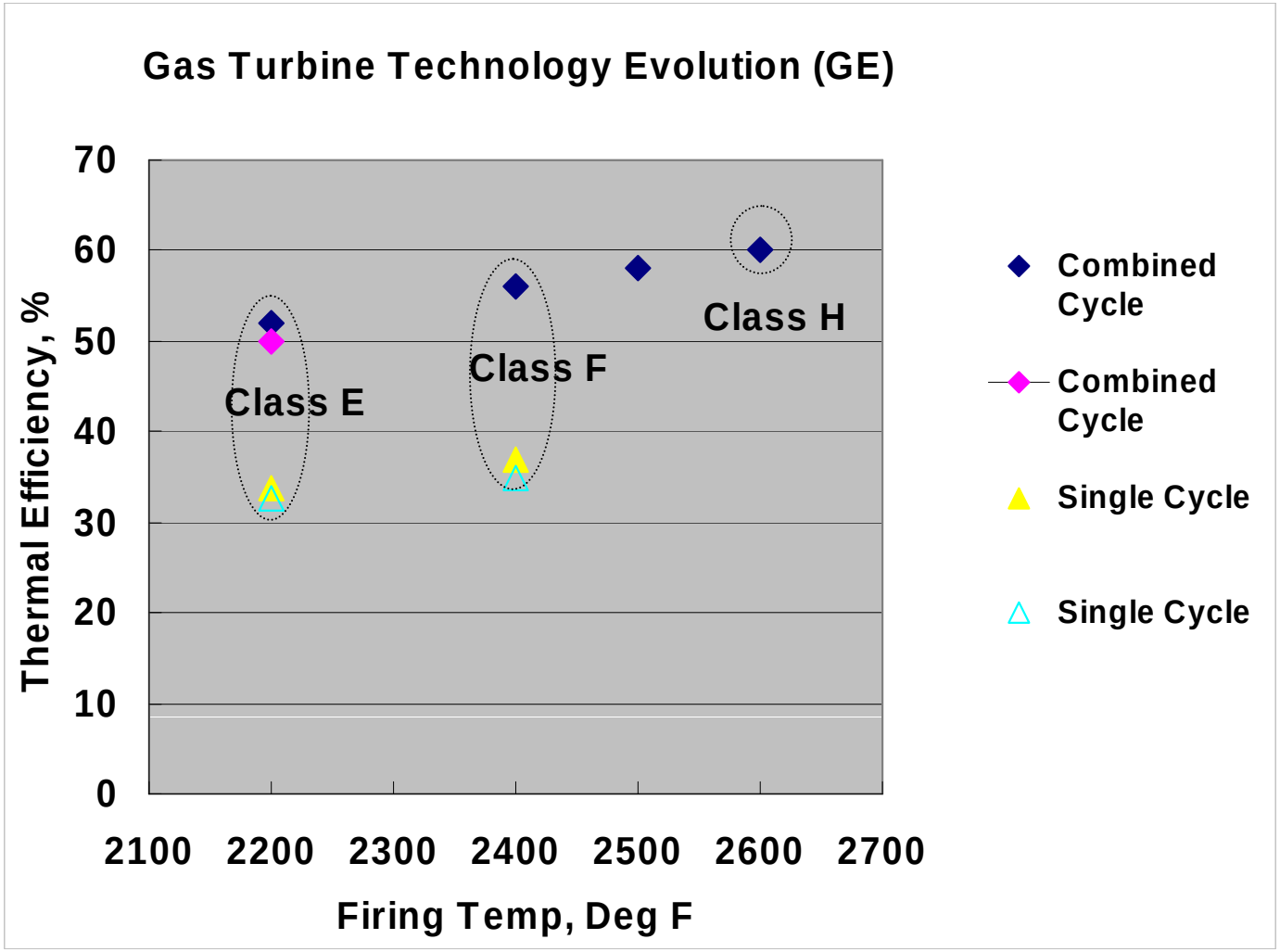
Performance Characteristics of Power Generation Technologies

	Past Practice (Pulverized coal plant)	Modern Plant (Pulverized coal super critical with FGD and SCR)	Modern Plant (IGCC)	Future Plant (IGCC with zero emissions technologies)	Natural Gas Combined Cycle
SO2 (mg/Mm3)	1500-7500	150	10 or less	0	0
Nox (mg/Mm3)	500-1000	100	50 or less	50 or less	50 or less
Particulates(mg/Mm3)	200-350	50	10 or less	0	0
Thermal Efficiency (%)	25-35	37-44	45	43	55
CO2 (g/kWh)	900-1300	770-880	750	Near zero	350
Current Capital Costs ($/kW)	500-700	900-1200	1200-1500	1500 <	600

(Source) World Bank (2003), "Technology Assessment of Clean Coal Technologies for China: Electric Power Production" and "Financing Clean Coal Technologies in China"

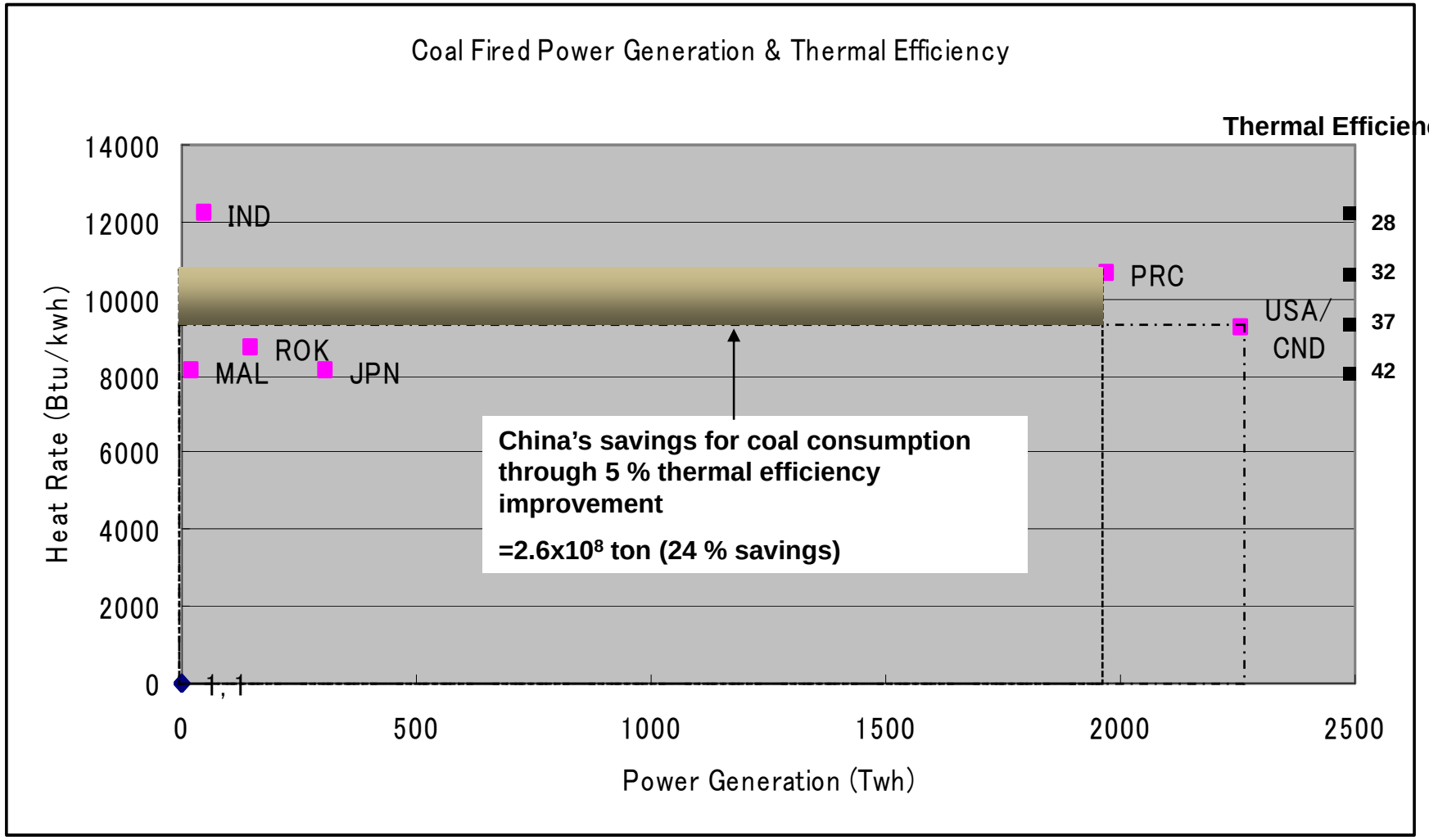
Technology Roadmap – Natural Gas

Higher firing temperature enables higher thermal efficiency



(Source) GE Homepage (2007)

APEC Coal Fired Power Generation & Fuel Consumption 2005 – Potential for Energy Efficiency Improvement



(Source) APERC Analysis (2007)

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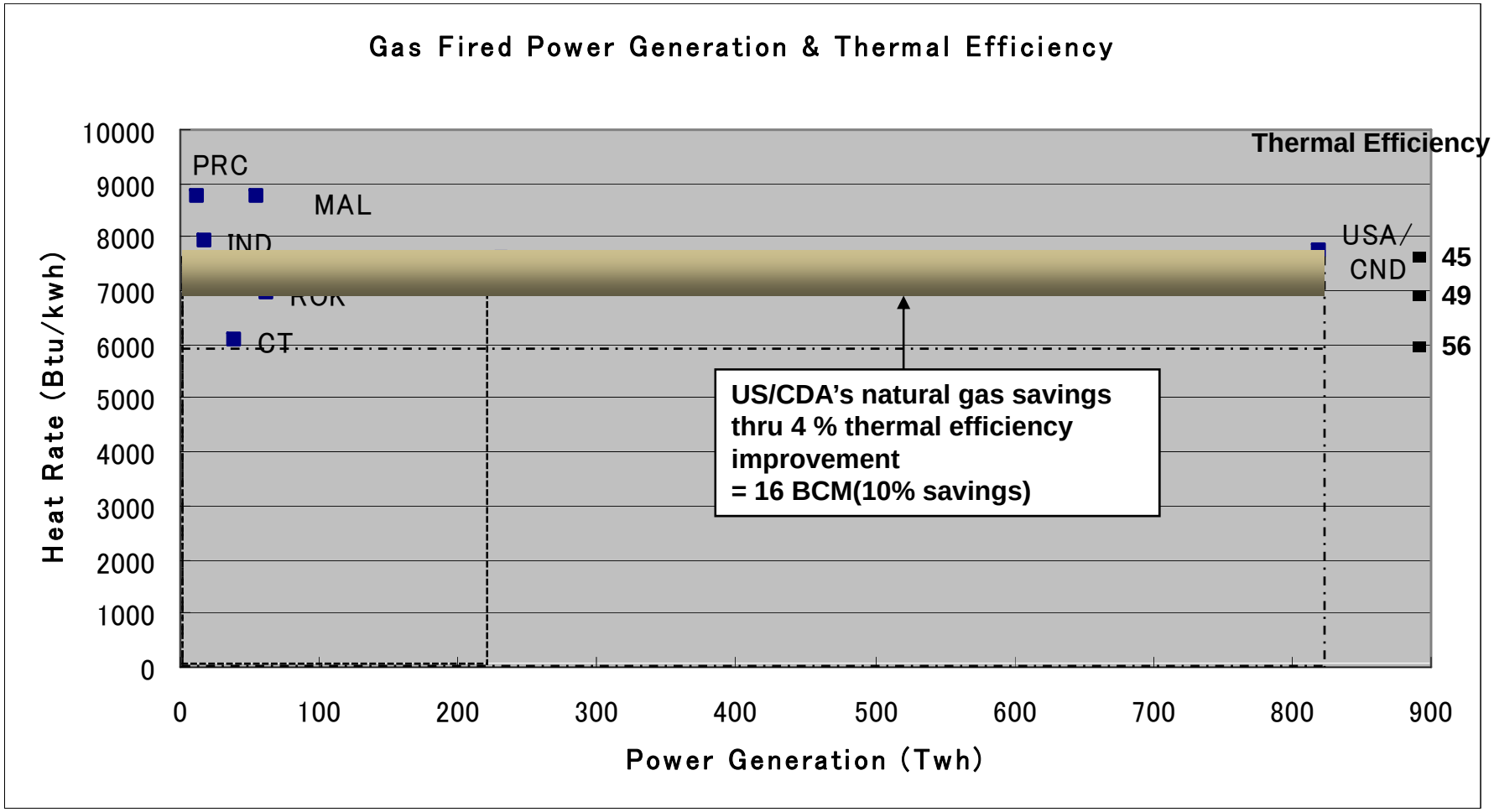
APEC Gas Fired Power Generation & Fuel Consumption 2005 – Potential for Energy Efficiency Improvement



(Source) APERC Analysis (2007)

Cost and Benefit of Power Generation Efficiency Improvement – A Case Study of Turbine Retrofitting in China

Project Description

- Retrofitting turbines of two units in the Pucheng coal-fired power plant in Shaanxi Province, China
- Capacity and commissioning date
  - Unit 1 (330 MW): March 1996
  - Unit 2 (330 MW): December 1997
- Thermal efficiency
  - Current: 34.5%
  - New: 38.4%
- Turbine Manufacture
  - Current Turbine: General Turbine (Romania)
  - New Turbine: Dongfong Turbine (China)

Project Assessment

- Approximately 10% reduction of CO2, NOx, and SOx emissions
- Capital investment for turbine
  - 29.57 million USD
    - ➢ 7.6 million USD/1% improvement of thermal efficiency
- Net revenue increase from reduced coal consumption
  - 4.428 million USD/year
- Project life
  - 30 years
- Expenses
  - No O&M costs assumed (as it is reflected in the baseline case)
- IRR
  - 8.1%

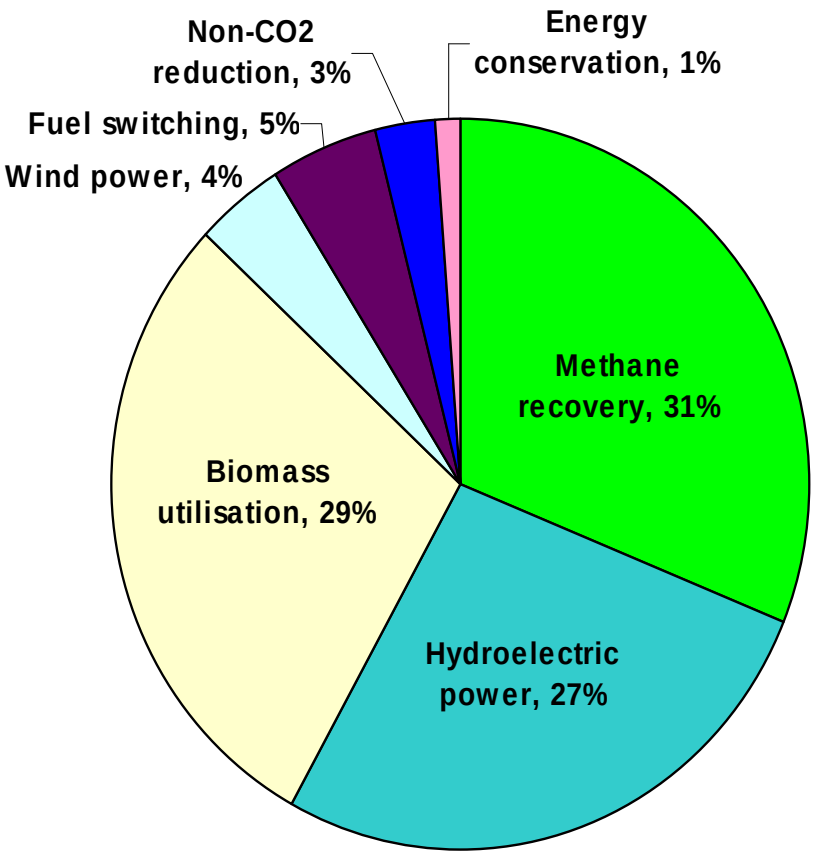
(Source) Mitsubishi Research Institute (2006), CDM Project Design Document Form

Barriers for Technology/Know-how Transfer for Power Generation

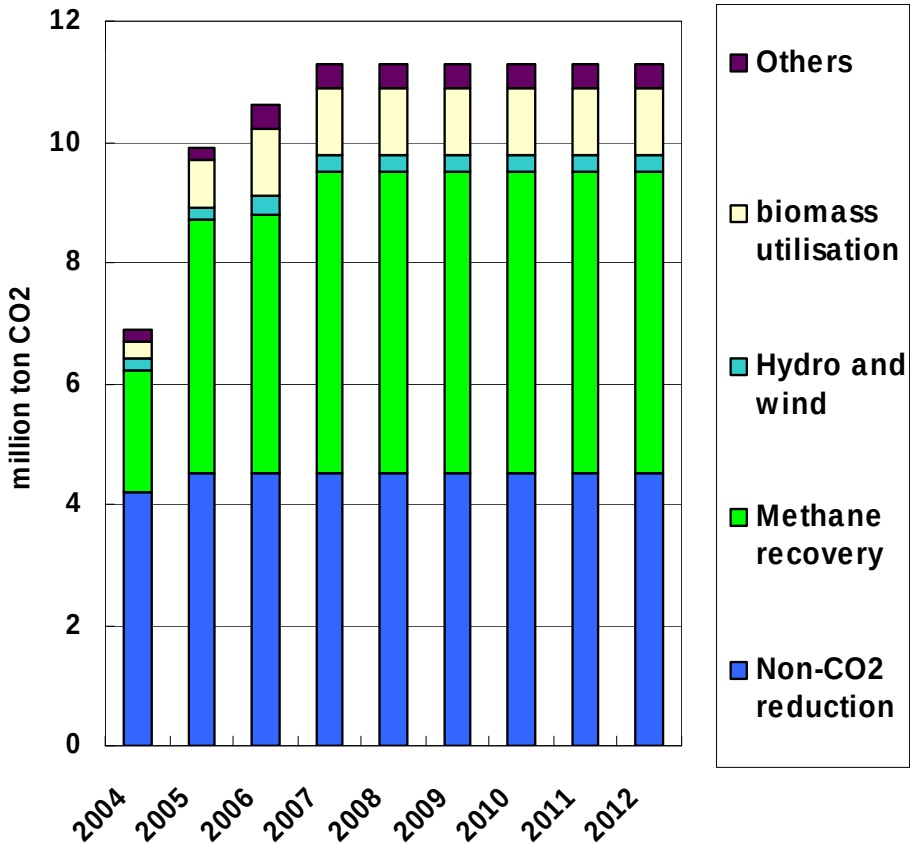
- **Economic barriers**
  - High transaction costs
  - Lack of full cost pricing
  - Low rate of return
- **Lack of local infrastructure**
- **Lack of understanding of local needs**
- **Institutional limitations**
- **Inadequate environmental codes and standards**

CDM Projects under Validation

Project Types

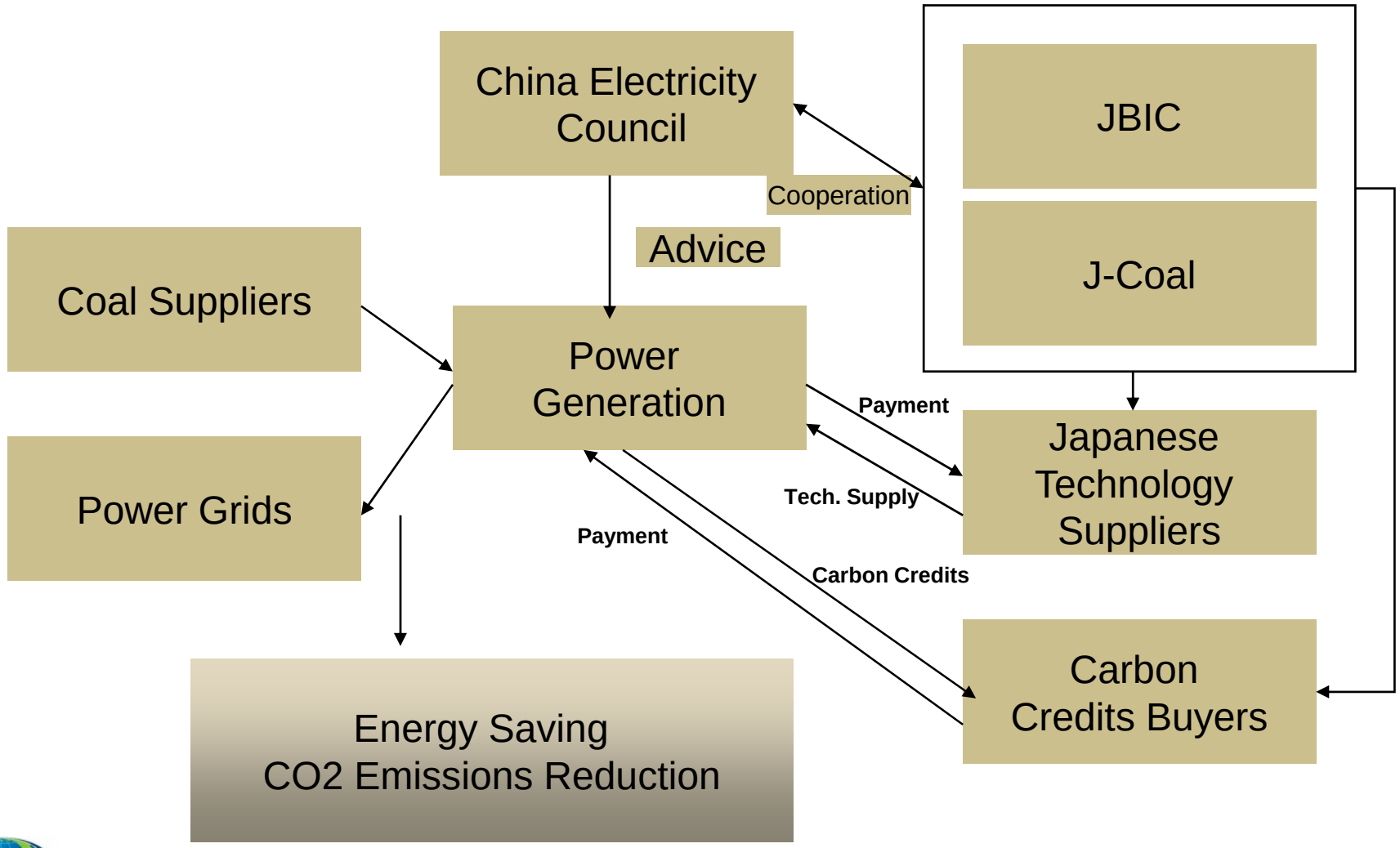


Emissions Reduction Potential



Source: Fujitomi (2005), "Current Situation of the CDM", April 2005

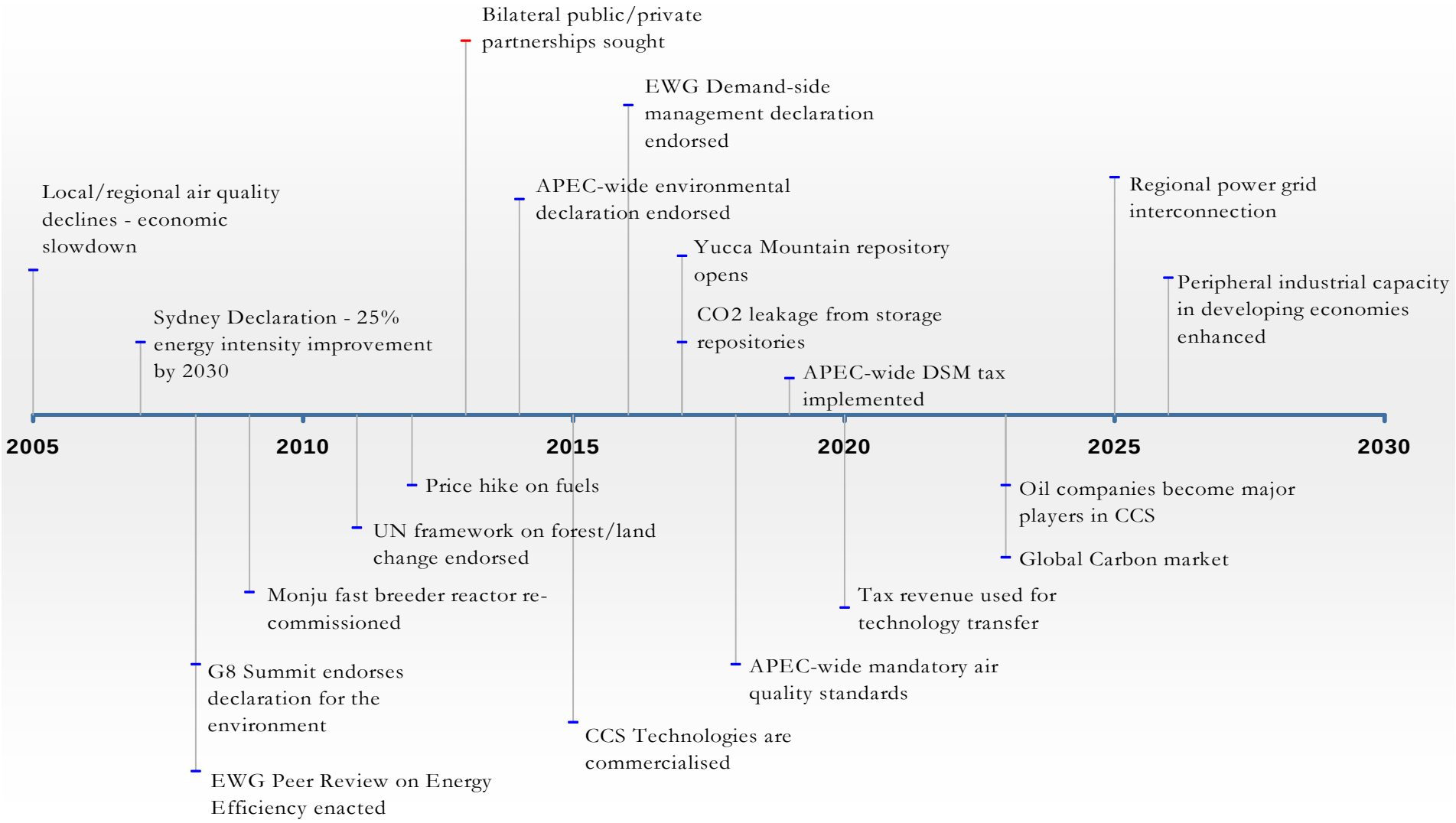
JBIC's Proposed Financial Support for Renovation of Coal-fired Power Generation in China



(Source) J-Coal (2007)

Scenario Analysis – Technology and Market Road Map

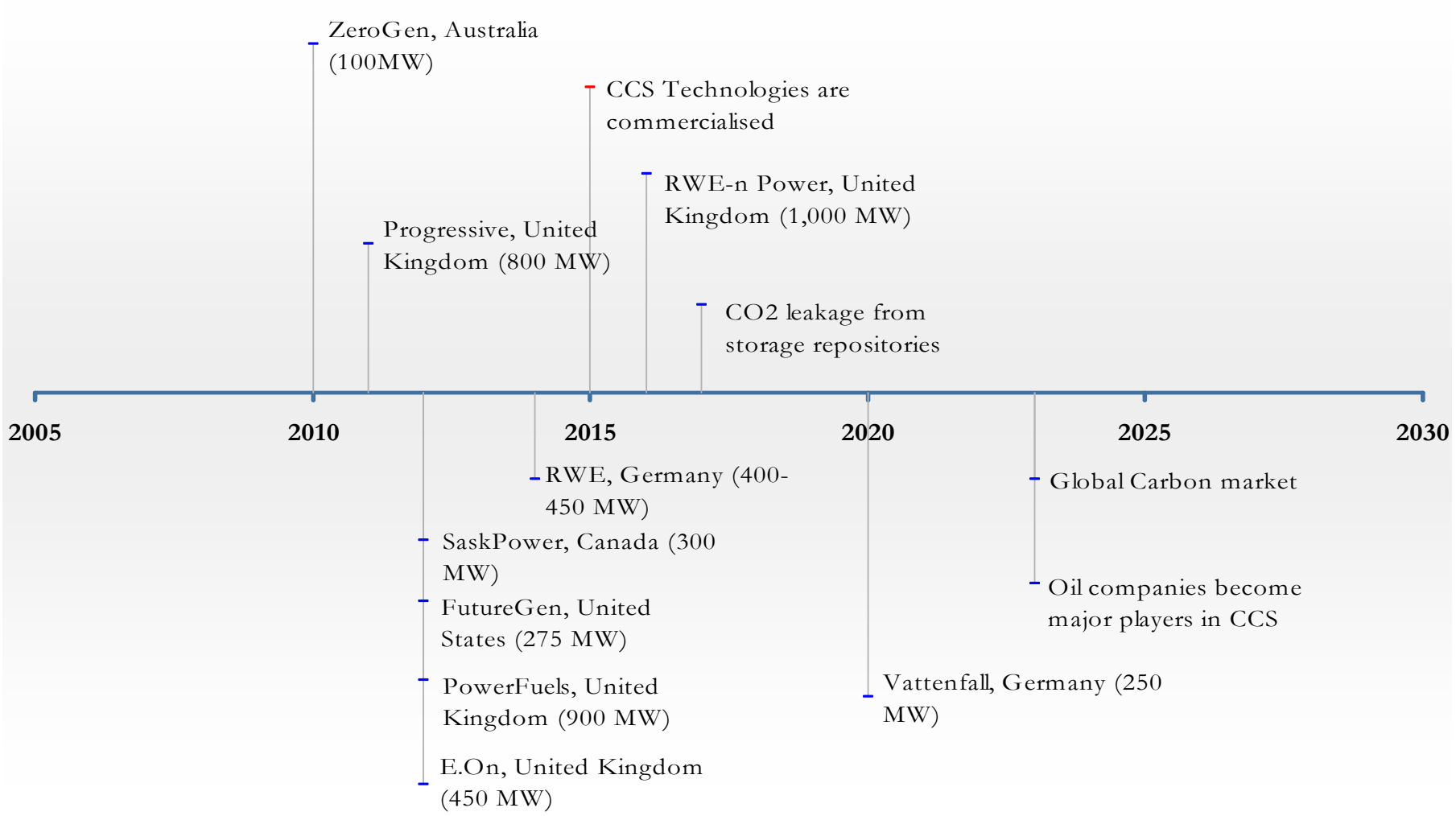
Efficiency and Enviro-centric Combination Scenario



(Source) APERC Analysis (2007)

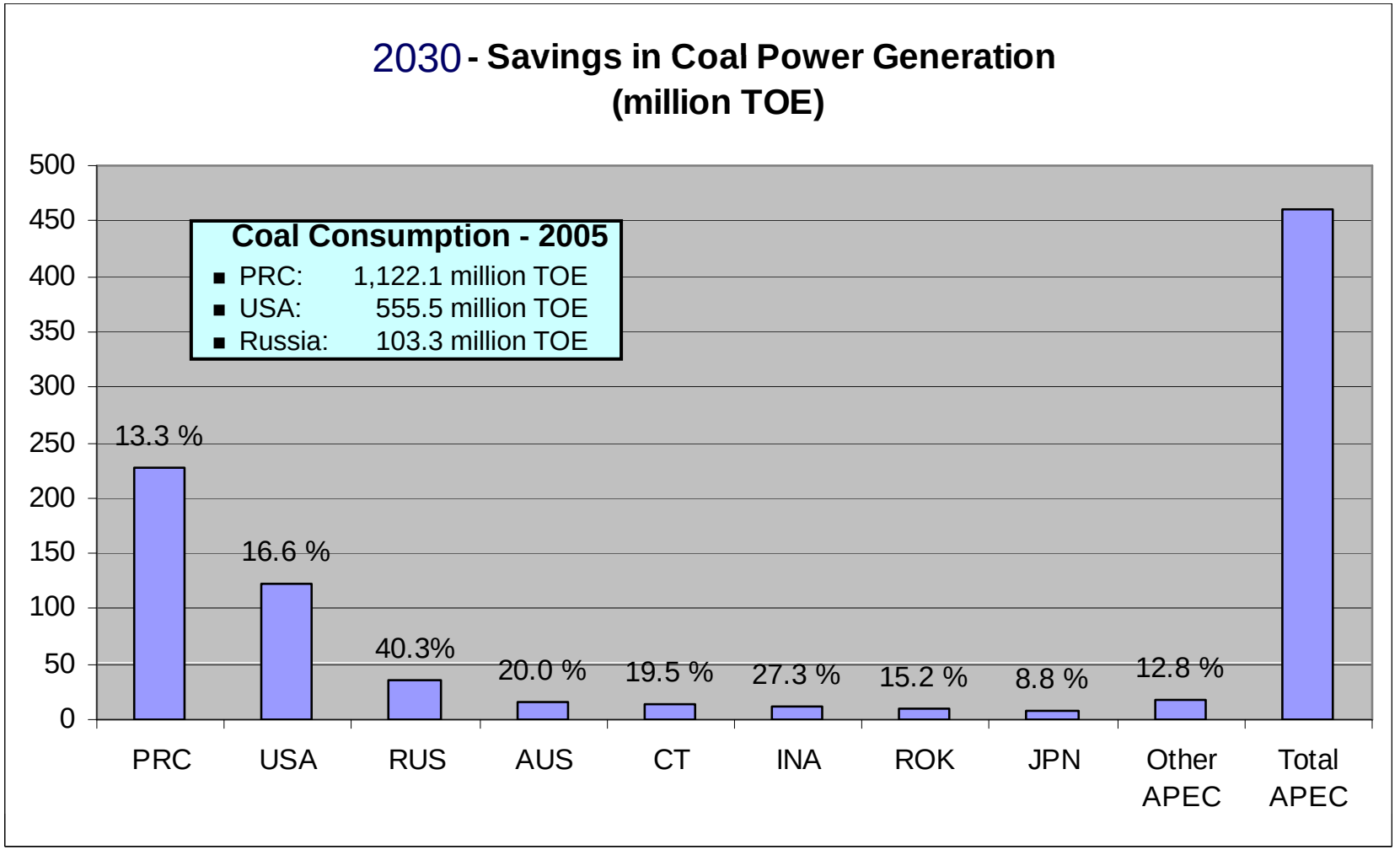
Technology and Market Road Map – The Future of CCS

Carbon Capture and Sequestration (CCS)



(Source) APERC Analysis (2007)

Energy Savings Potential through Thermal Efficiency Improvement



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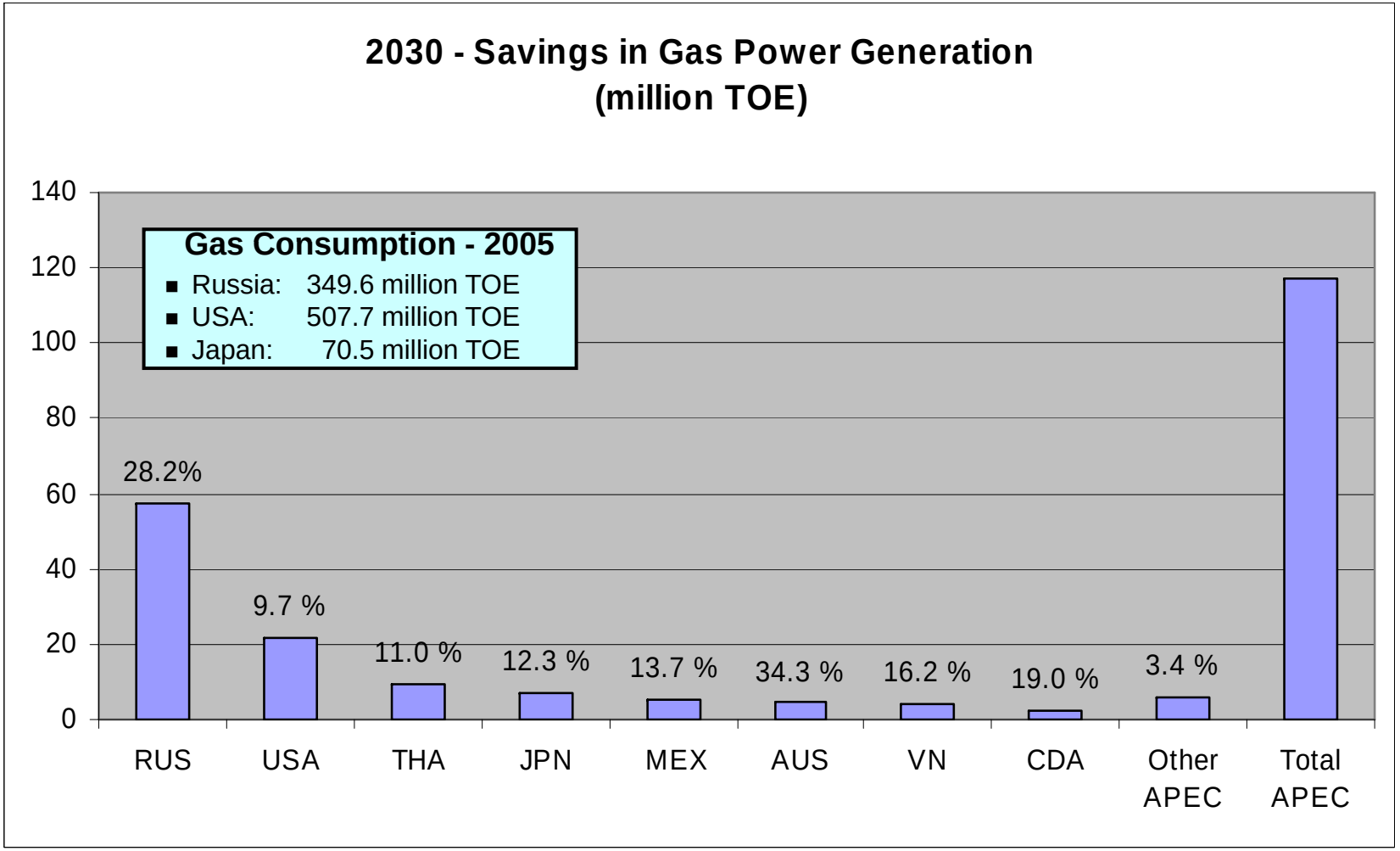

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Tentative Conclusions

- **How to mobilise financial sources is the key for implementing the power sector energy efficiency projects.**
- **Incentives need to be provided to increase project viability.**
  - Carbon price
  - Scale-economy through bundling projects
- **Institutional arrangements are necessary to create framework conducive of financial flows.**
  - ESCOs
  - Government commitment between host and investing economies

Way Forward

- **Fixing all the numbers**
- **Complete the scenario exercise (to be included in the outlook)**
- **Identify economy-specific barriers & policy implications**
- **Extend the study to incorporate the end-use sector (next phase, 2009-2010)**

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