DG Research FP-6

PRIMES model analysis for EUSUSTEL project

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ICCS/NTUA

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Overview

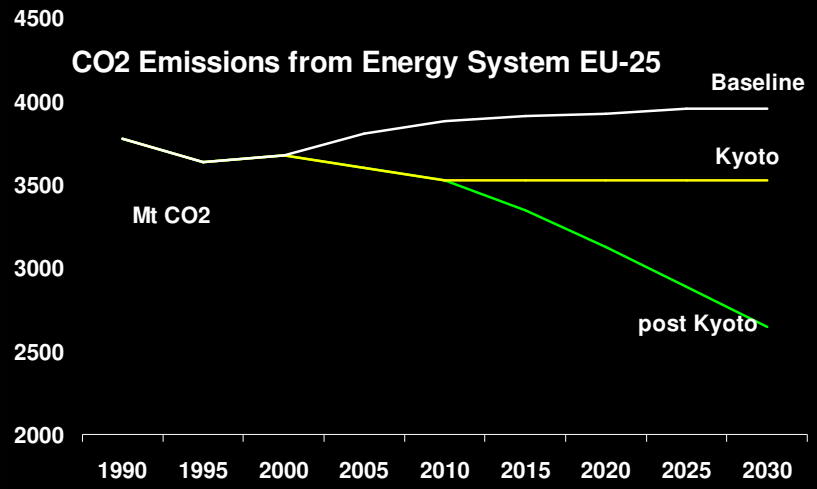
- PRIMES energy system model for each of the EU-30 countries, with inclusion of a detailed electricity sector
- PRIMES performs economic-engineering projections of the energy system up to 2030 with detailed analysis of both demand-side and supply-side and their interactions through explicit markets and prices
- For EUSUSTEL, PRIMES quantified three policy scenarios which are compared against a baseline projection

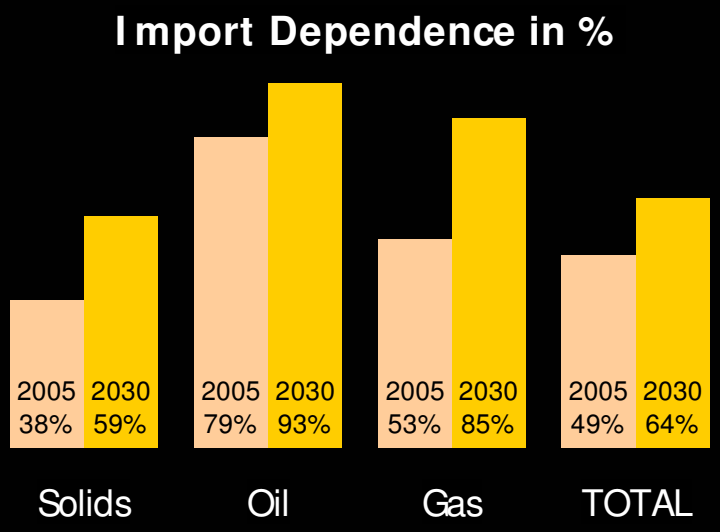
Baseline scenario: assumptions

- Economic growth 2% pa in average
- Oil and gas prices higher than in the past, however increasing slowly
  - Gas to coal competitiveness deteriorated
- No climate change policy, except a weak ETS leading to 5 Euro / t of CO2
- Continuation of support to renewables
- Nuclear phase out in some countries and no extension of life time of existing nuclear plants
- No special care about security of supply
- Technology evolves without any breakthrough

Baseline Scenario: Unsustainable

- The baseline scenario fails in terms of
  - Environmental impacts from energy and mainly carbon dioxide emissions
  - Security of supply as energy dependence of the EU substantially increases
- Nevertheless, the baseline scenario succeeds relatively competitive prices despite high world energy prices





Power Sector under Baseline

- Electricity remains a growing market due to
  - Its high efficiency and comfort in final uses
  - The preference for multiple electric appliances
  - As carrier of high technology in manufacturing and services
- Structure of power generation changes with increasing contribution of renewables (wind) and CHP
- In the medium to long term coal plants are most competitive for base load – gas use still significant
- Nuclear energy develops in few old but also in new MS
- Despite high fuel prices, electricity prices increases are relatively small
- The power sector developments are incompatible with a climate change mitigation strategy

EU-25: Baseline Outlook

Year 2005	Prospects to 2030
✓ 460 million people	✓ Stable
✓ 9,715 billion € GDP	✓ 2.0% per year
✓ 1,744 Mtoe Gross Energy Needs	✓ 0.3% per year
✓ Energy Intensity of GDP	✓ -1.7% per year
✓ 904 Mtoe Imported Energy	✓ 1.4% per year
✓ 3,177 TWh Electricity Generation	✓ 1.3% per year
✓ 726 GW of Power Generation Capacity	✓ 32 GW new Power Plants per year
✓ 3,800 Mt of CO2 Emissions	✓ 0.2% per year

Alternative Scenarios

- Three Goals
  - Serious emissions cap on EU-25: -16% in 2030 from base year 1990 *(no carbon tax, just a cap)*
  - Alleviate security of supply vulnerability
  - Obtain least cost effects on energy costs and prices
- Options as Changes from Baseline
  - Nuclear renaissance: no phase-out, extension of life time, new technology
  - Carbon capture and storage technology
  - Energy Taxes to reduce import dependence

Names of Scenarios

- Baseline → **Baseline**
- Scenario PK → **Post-Kyoto**
  - Climate change -16% in 2030 from 1990
  - Nuclear constrained in some MS as in Baseline
  - CCS available in the long term
  - No additional promotion of renewables and efficiency
- Scenario PKAT → **Post-Kyoto and All Technologies**
  - Climate change -16% in 2030 from 1990
  - Nuclear not constrained except in few small countries
  - No extension of lifetime of Nuclear plants
  - CCS as all future technologies available
  - Promotion of renewables and efficiency as in Baseline
- Scenario LID → **Limited Import Dependence**
  - Climate change – Carbon values as in PK
  - Nuclear constrained as in PK
  - Technologies and their promotion as in PK
  - Energy Taxes on Fossil Fuels as necessary to decrease fossil fuel imports by 10% in 2030 as compared with PK

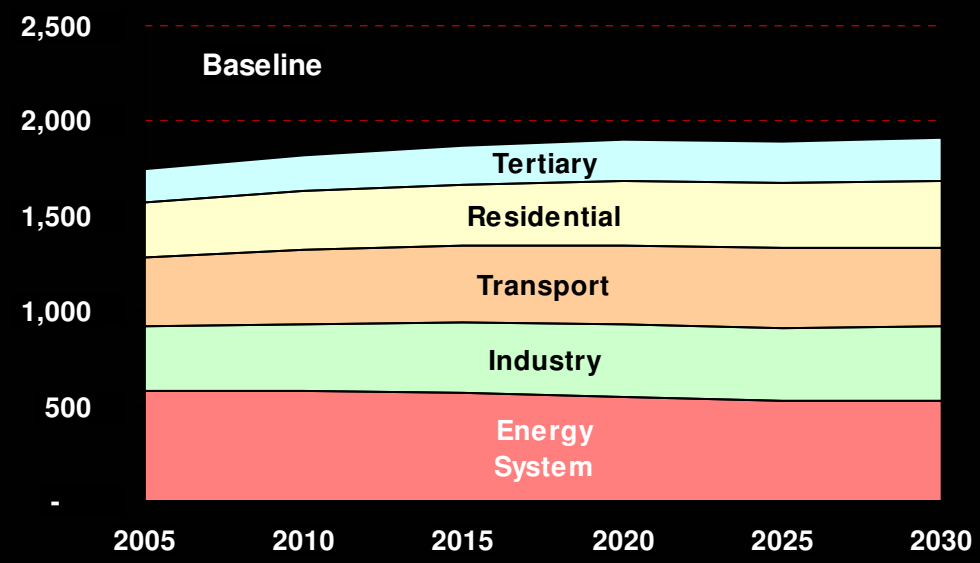
Overview of Scenario performance

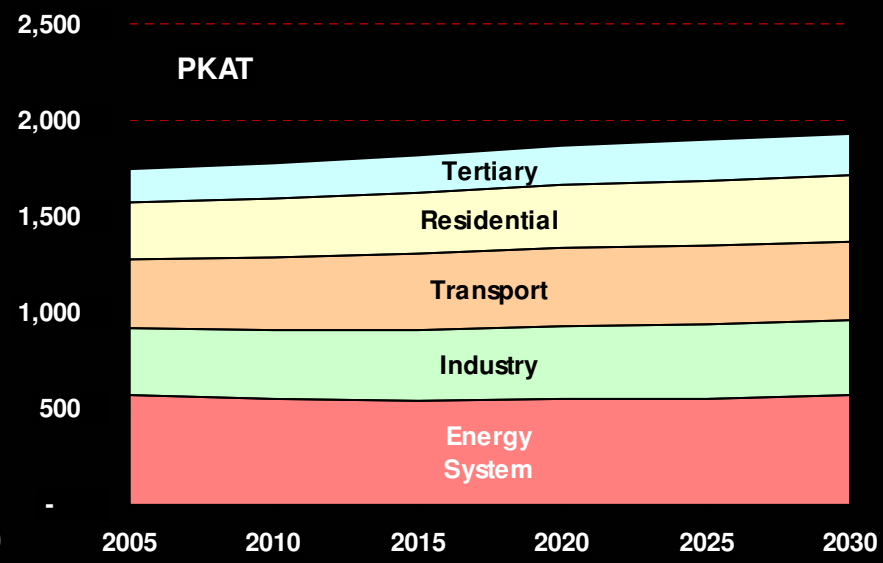
	Baseline	PK	PKAT	LID
Avg Electricity Prices in 2030				
€'05/MWh	94.0	97.1	92.7	107.7
Avg Cost of Energy Services in 2030				
€'05/MWh	91.2	99.5	96.2	110.3
CO2 Emissions in 2030				
Mt of CO2	3,991	3,179	3,172	3,040
% change from 1990	6	- 16	- 16	- 20
Import Dependence in 2030				
%	65.1	63.1	56.9	57.7
% diff. from 2005	14.5	12.4	6.2	7.1
Add. Gas Imports in 2030 from 2005				
Bcm per year	241	276	235	216
Energy Taxes as % of import price	0	0	0	50%
Carbon Value in €'00/MtCO2 in 2030	-	51.5	31.5	51.5

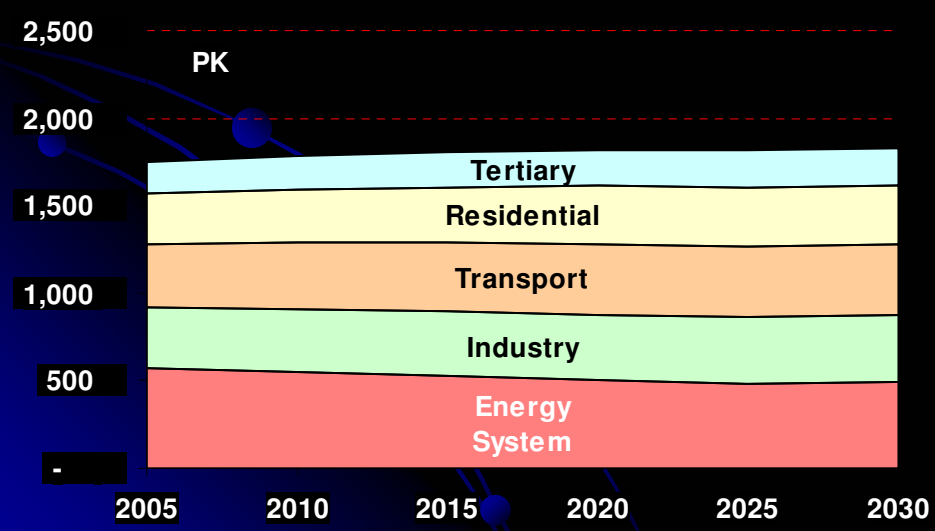
Overview of scenario results

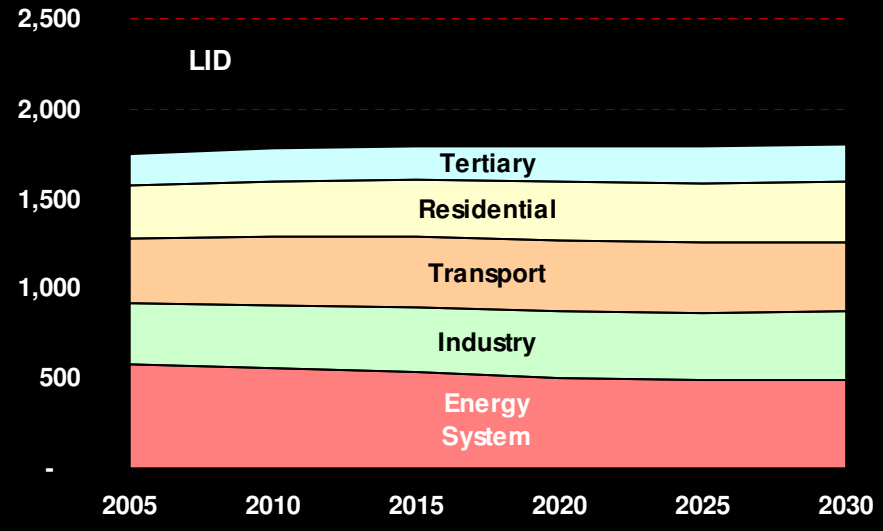
2030	Baseline	PK	PKAT	LID
Nuclear Investment up to 2030 (GW)	70.9	80.6	175.0	81.3
Nuclear Plants with Extension of life time (GW)	-	-	-	-
New Plants with CCS Capacity (GW)	-	56.8	7.3	40.6
Load factor of gross electric capacities (%)	45.4	41.6	43.8	40.9
Share of Electricity (%)	24.2	24.8	24.8	25.3
Gross Inl. Cons./ GDP (2005= 100)	66.0	63.3	66.9	62.2
Efficiency of thermal electricity production (%)	47.5	49.8	48.2	48.9
CHP indicator (% of electricity from CHP)	24.4	24.7	24.5	24.8
Non fossil fuels in electricity generation (%)	46.3	55.0	67.1	57.2
CO2 Emissions per MWh	0.32	0.17	0.15	0.18

Final Energy Demand by Sector (Mtoe)

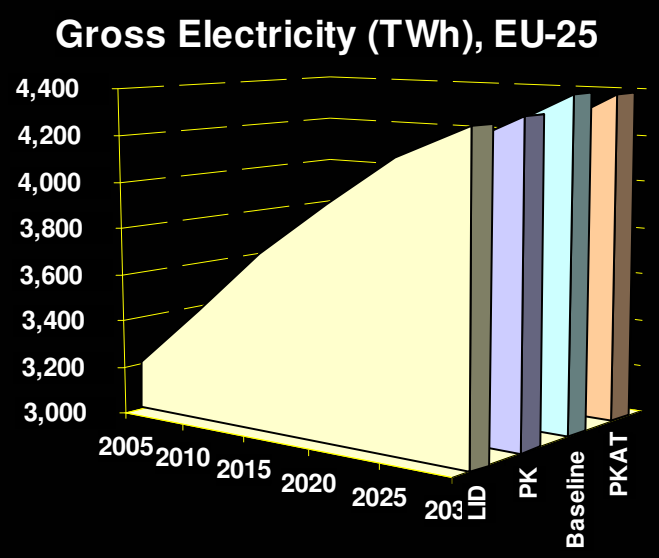


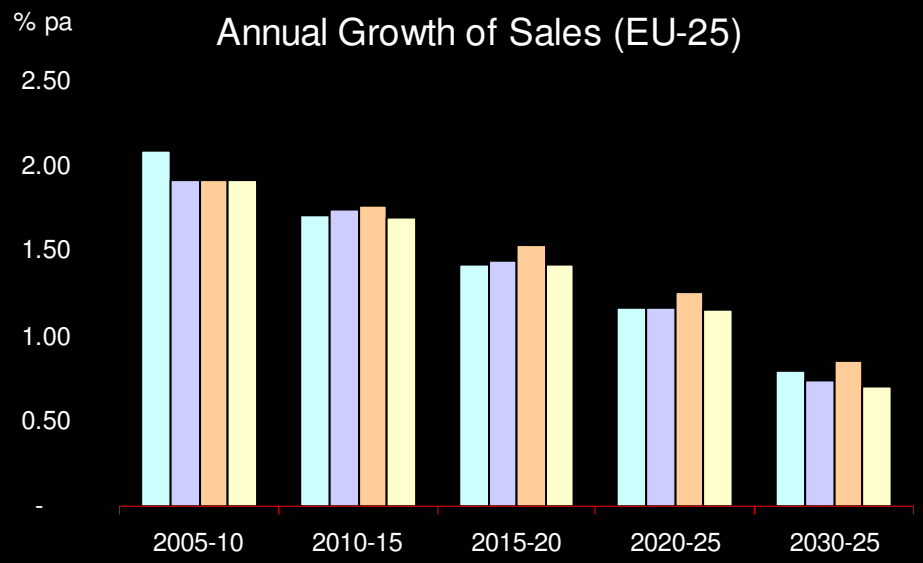


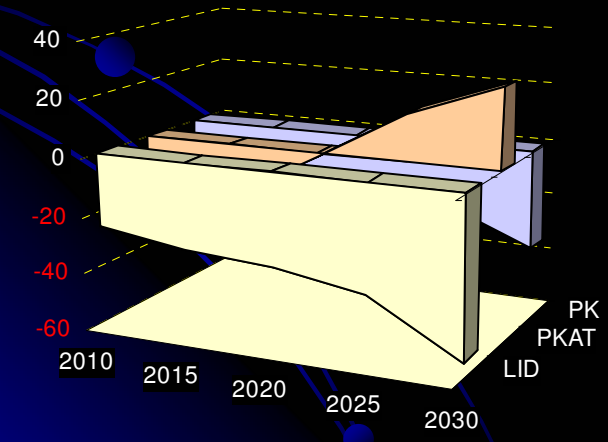


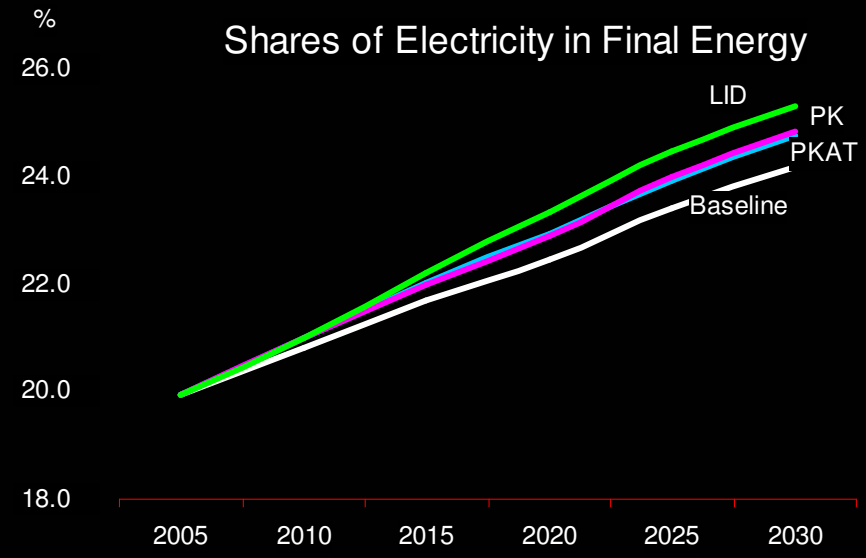


PRIMES Model – Electricity Sales

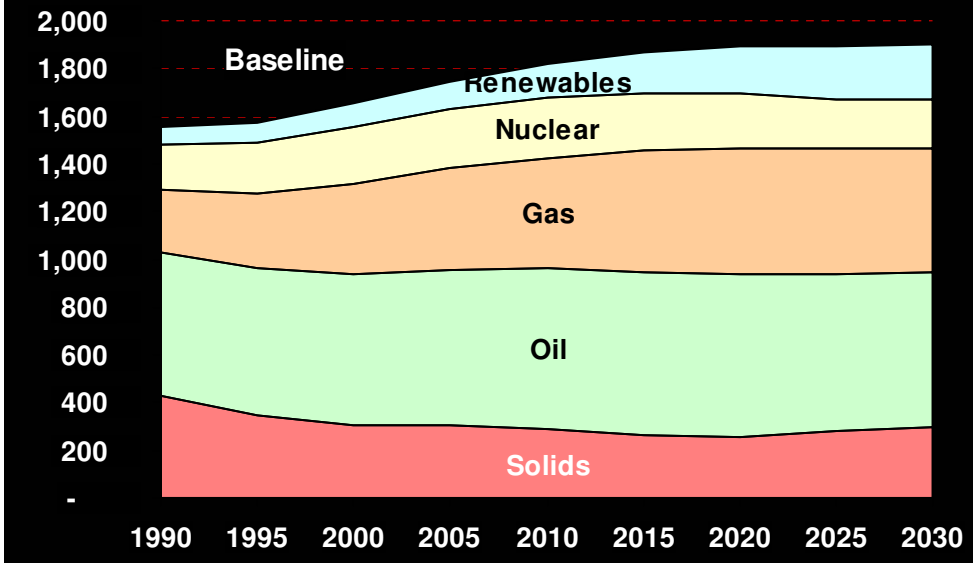


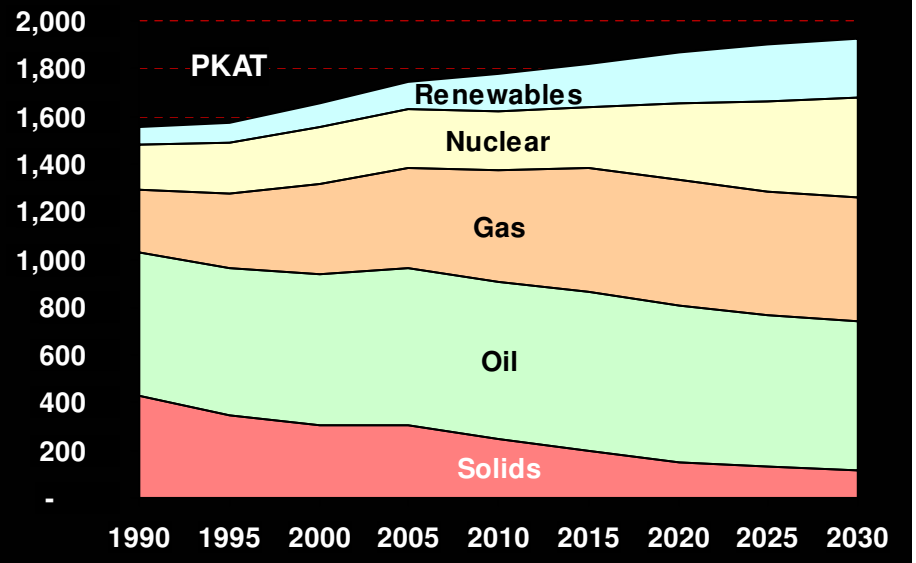


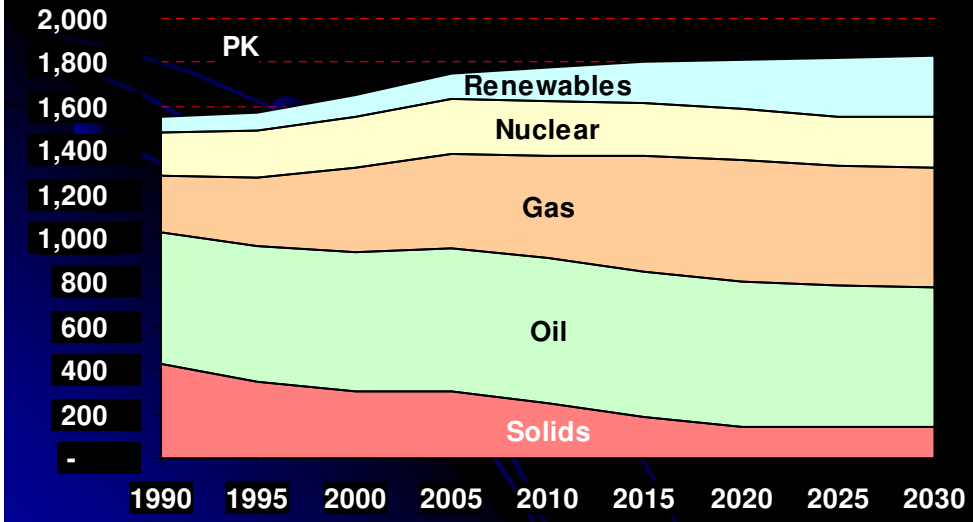


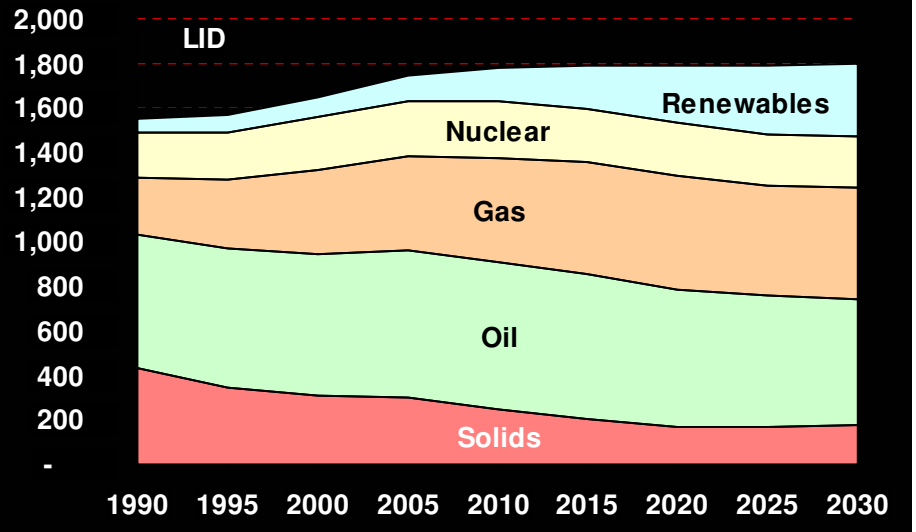


Total Primary Energy Needs (Mtoe)

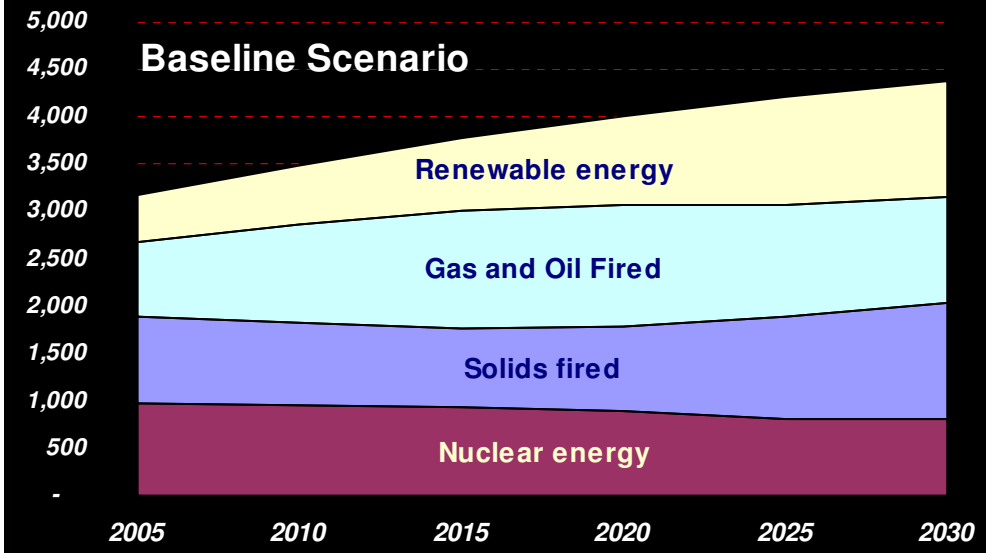


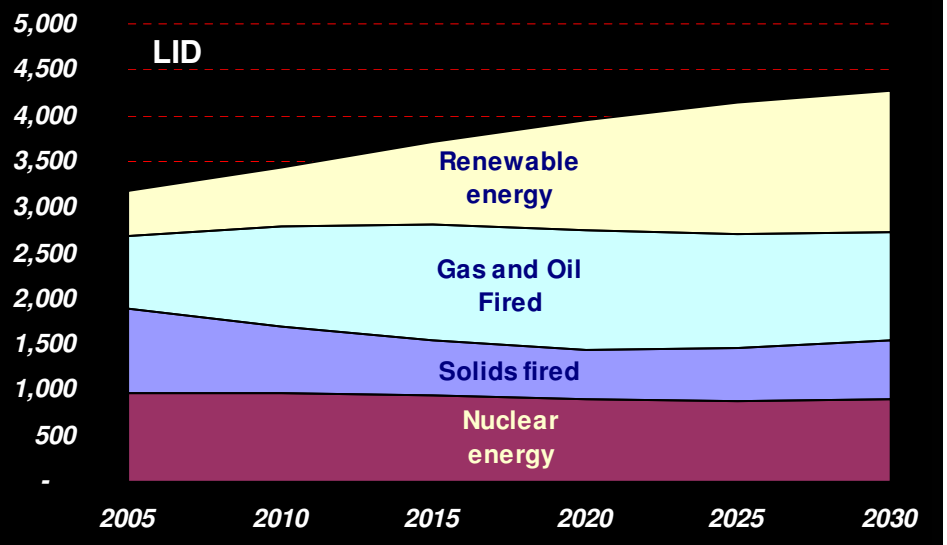


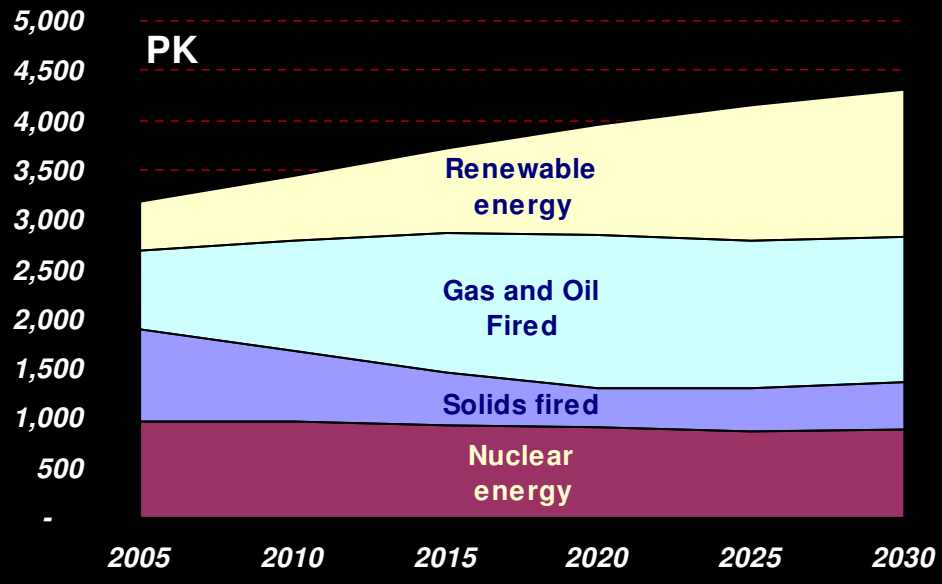


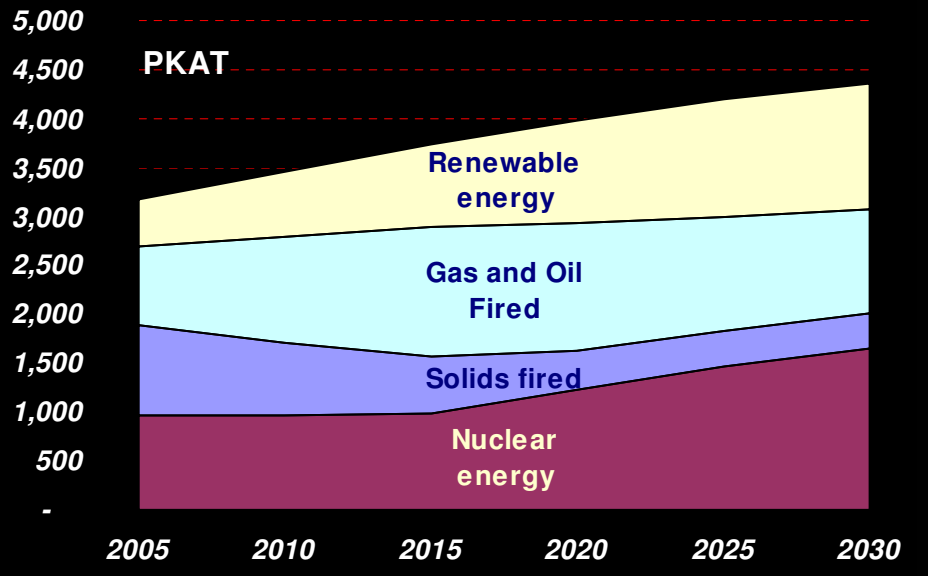


PRIMES – Power Generation (TWh)

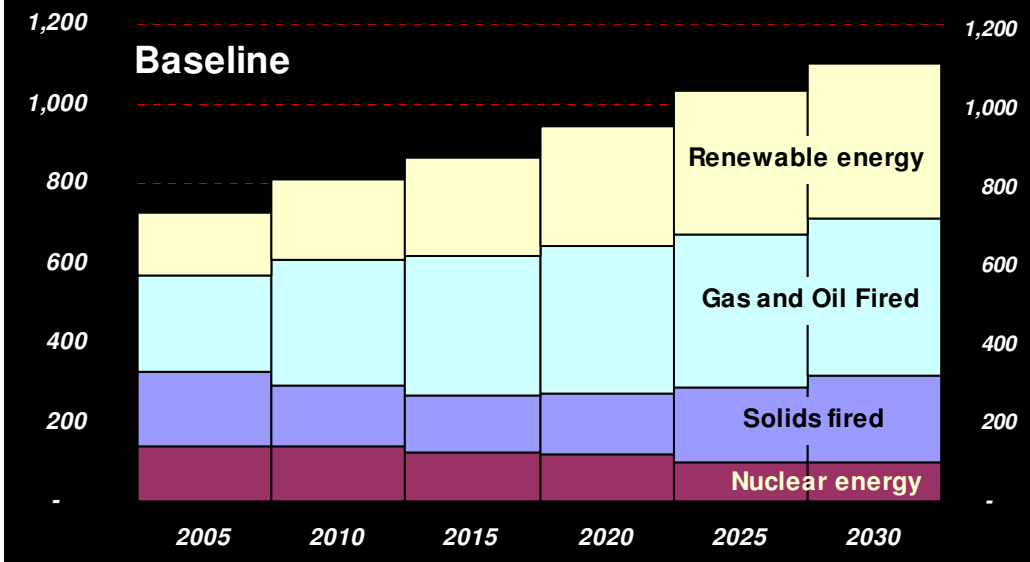


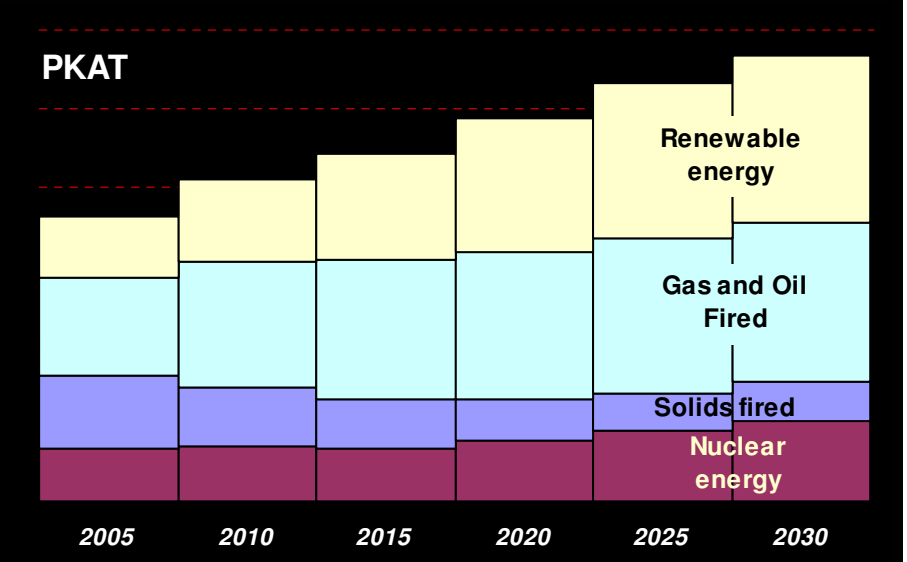


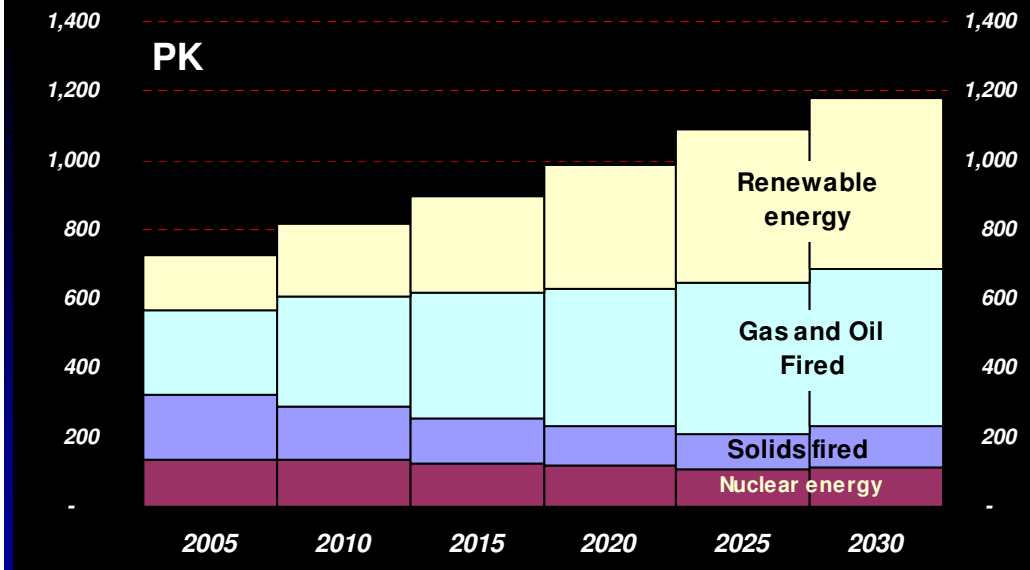


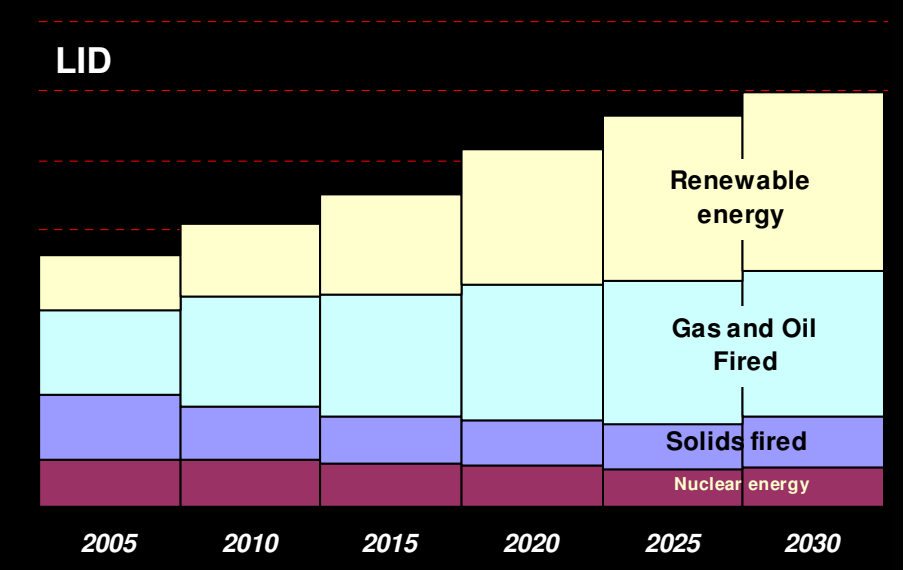


PRIMES – Power Capacities (GW)

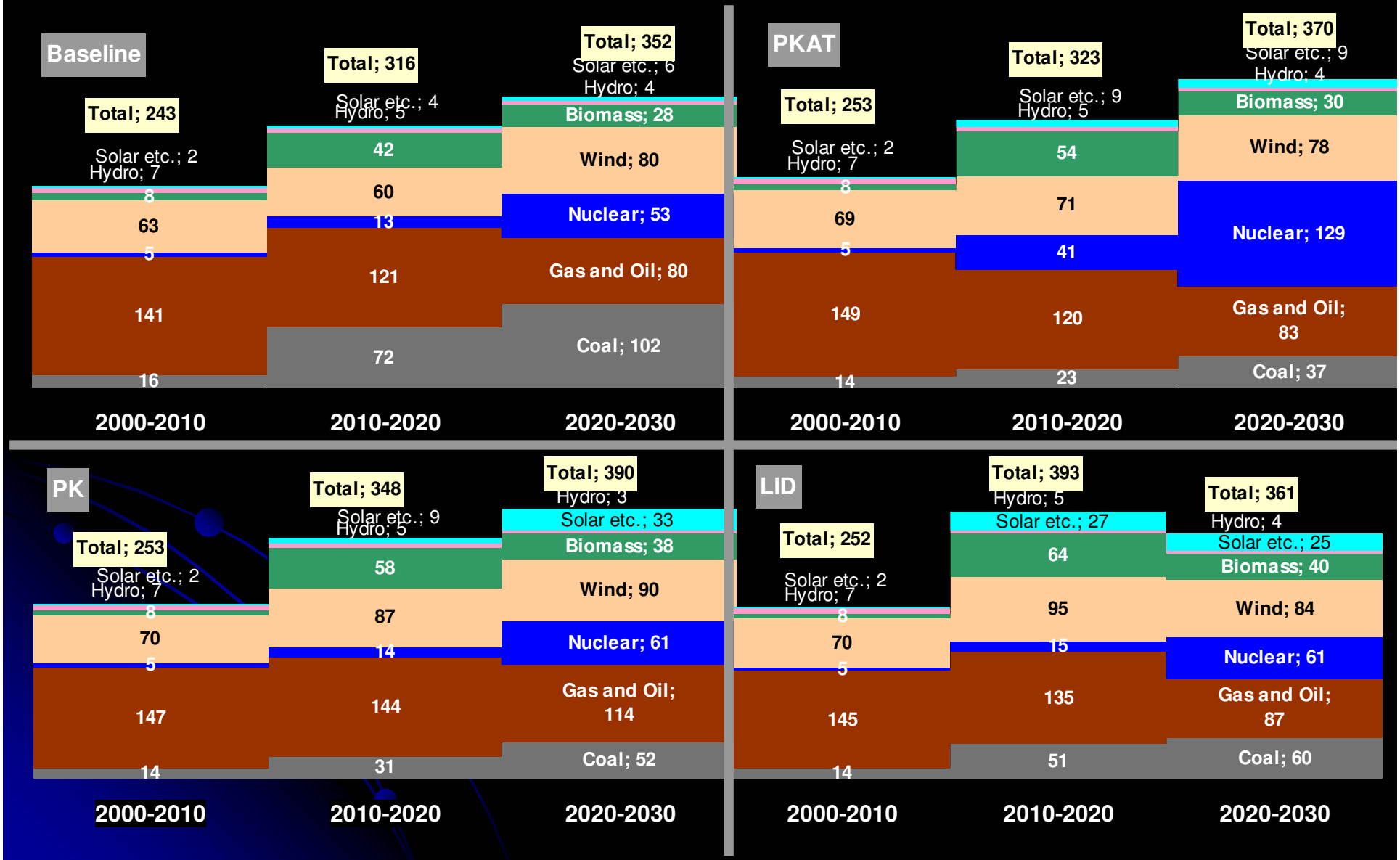








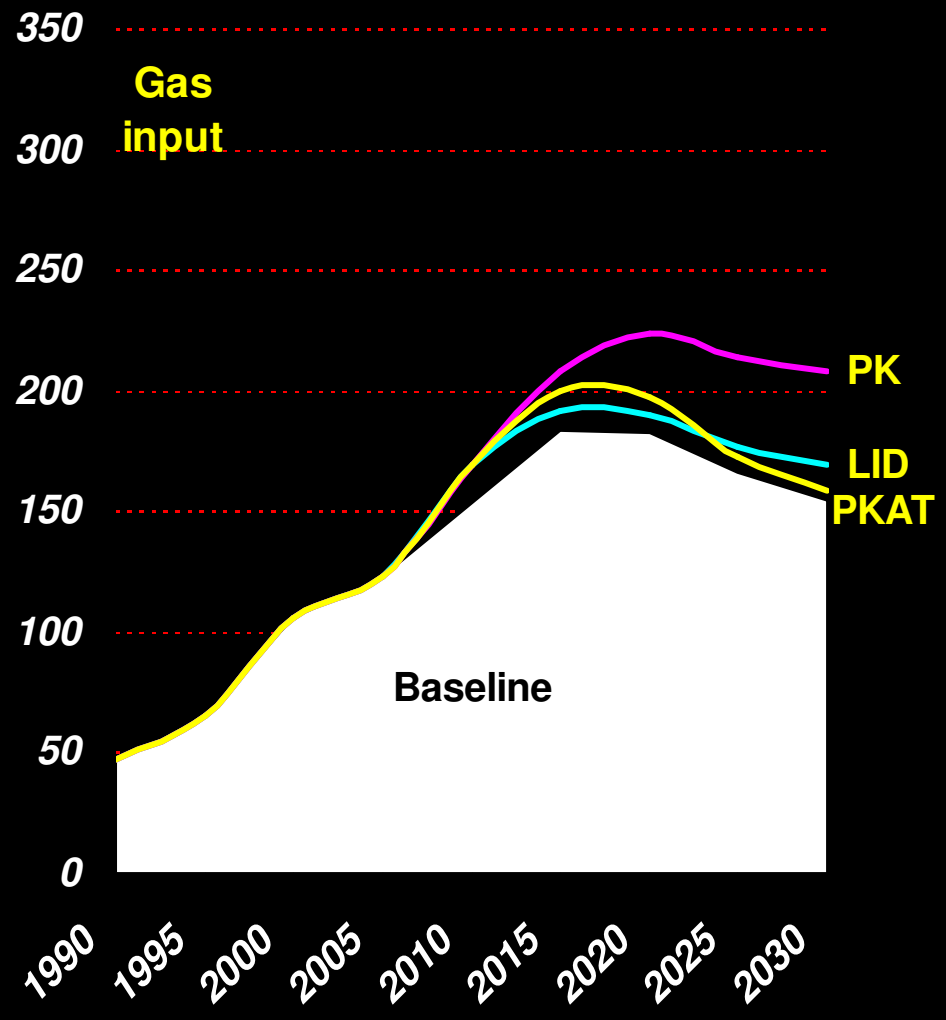
Power capacity expansion (GW)

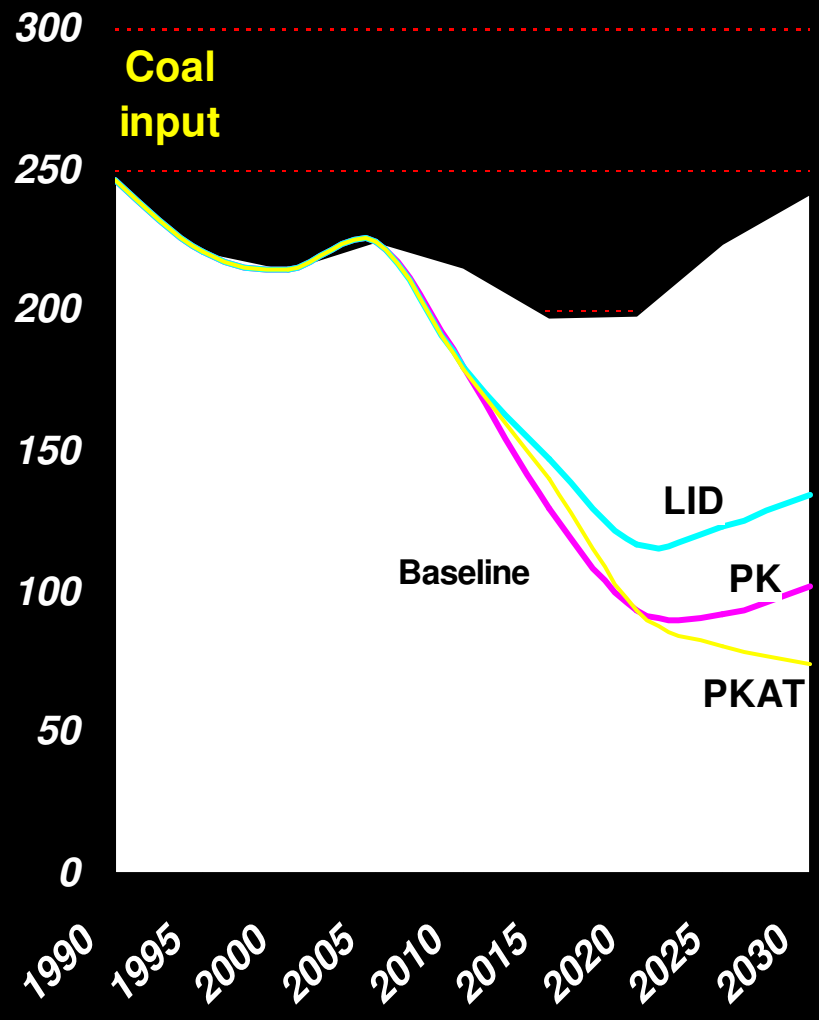


Fuel Consumption in Power

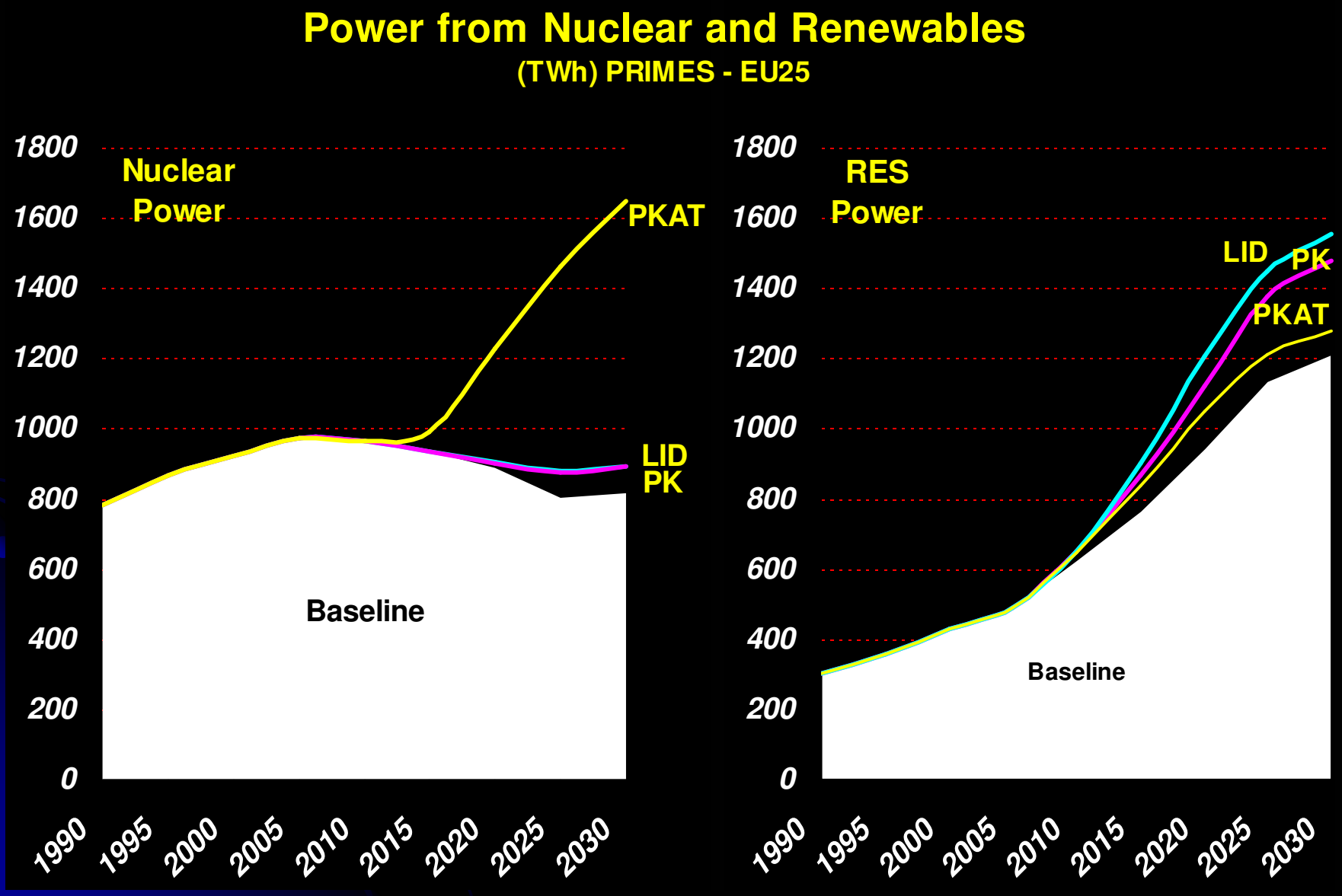
Use of Gas and Coal in Power Generation

(Mtoe) PRIMES - EU25





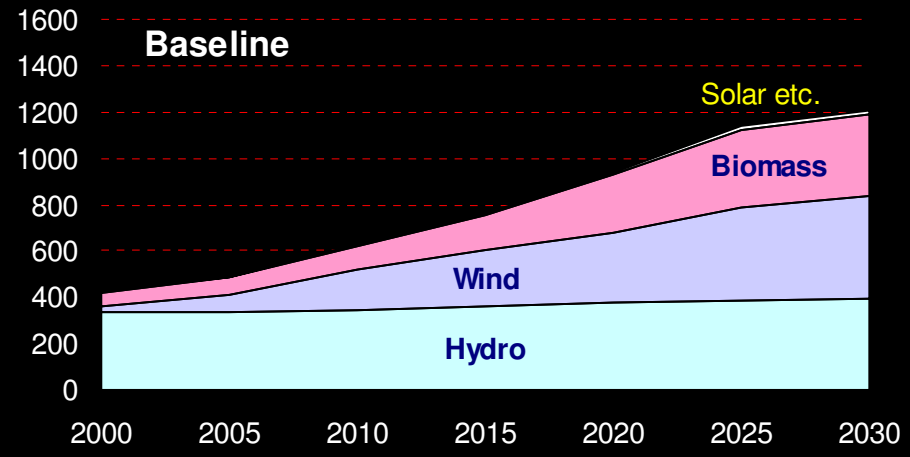
Power from Carbon free sources

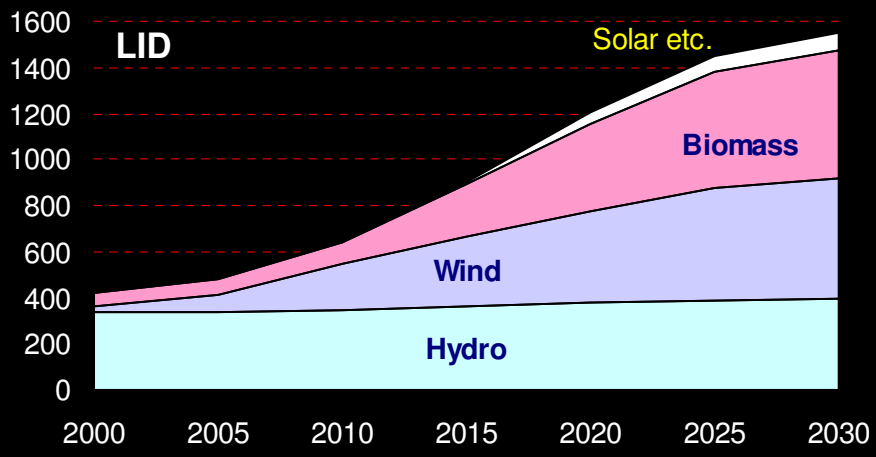


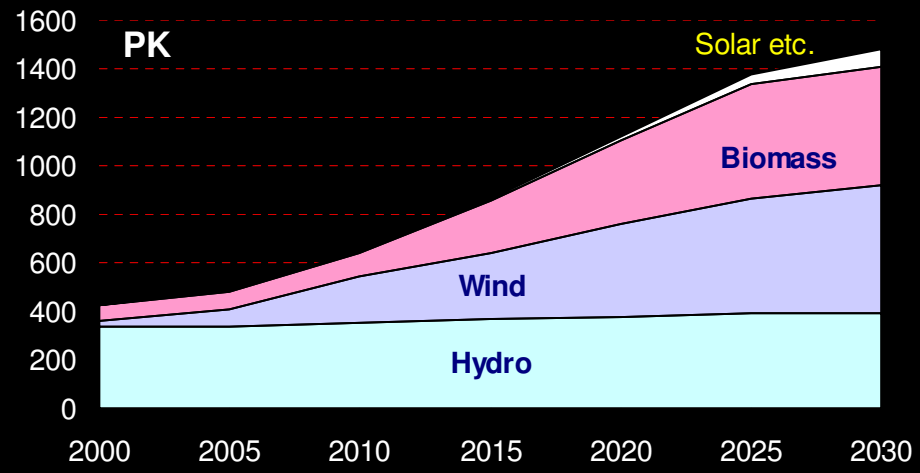
Details about Renewables

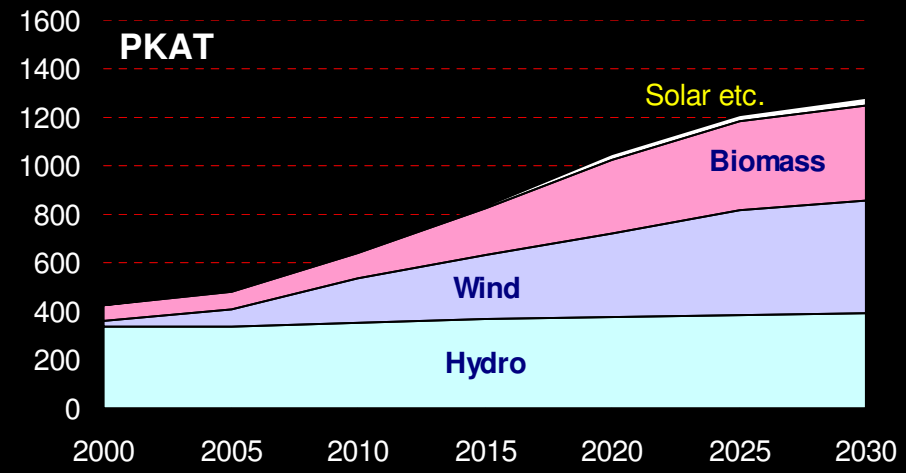
Power from Renewables

(TWh) PRIMES - EU25





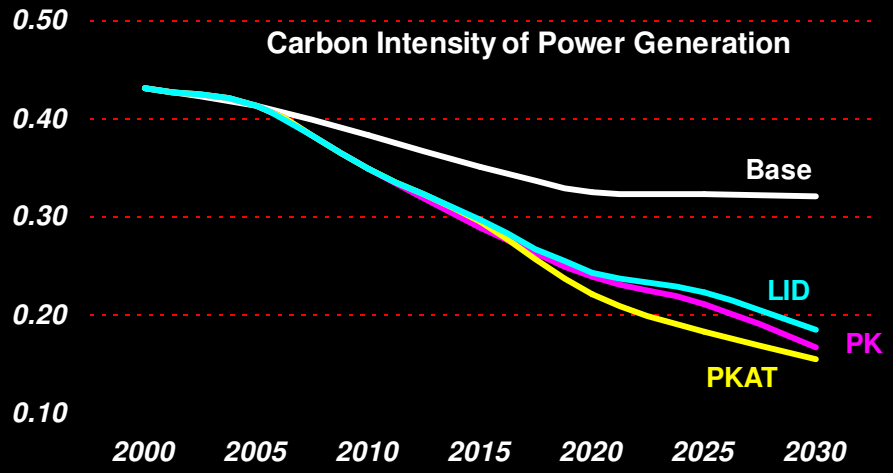


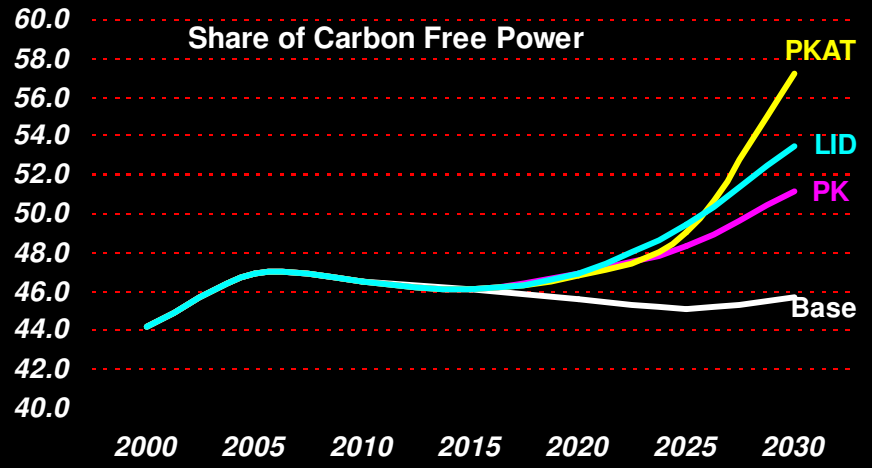


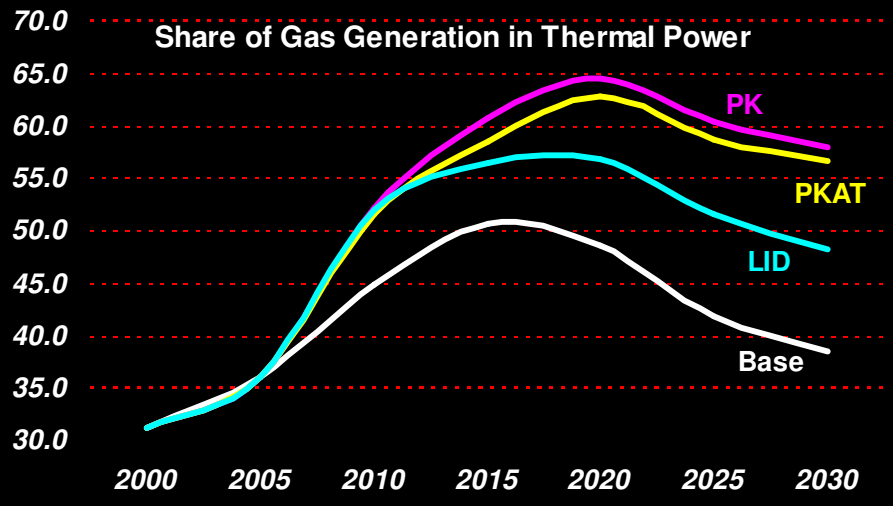
Indicators

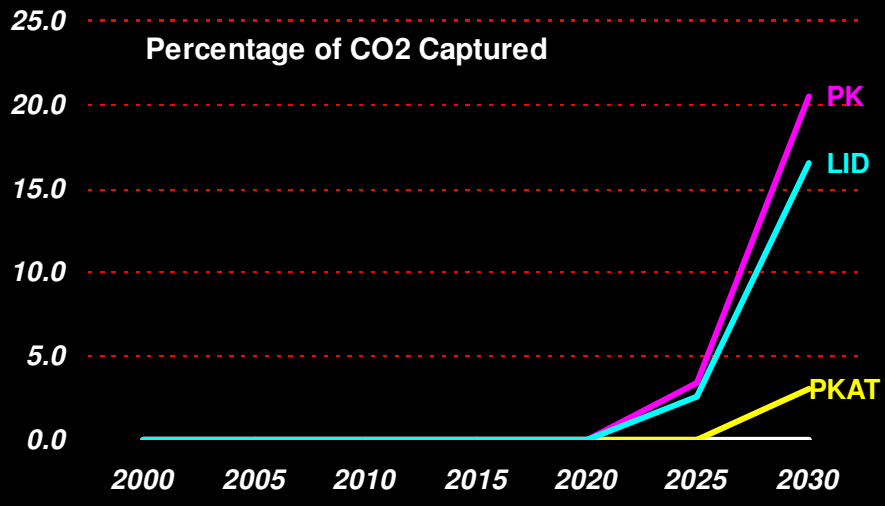
Carbon Indicators for Power Generation

PRIMES - EU25

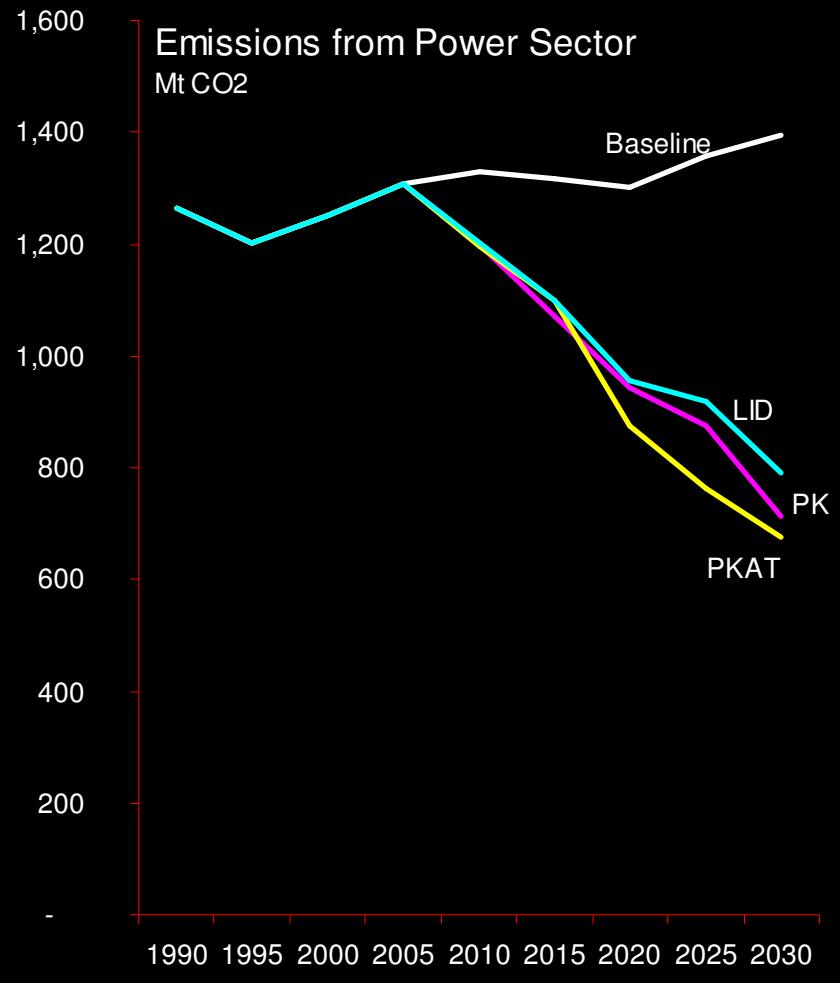






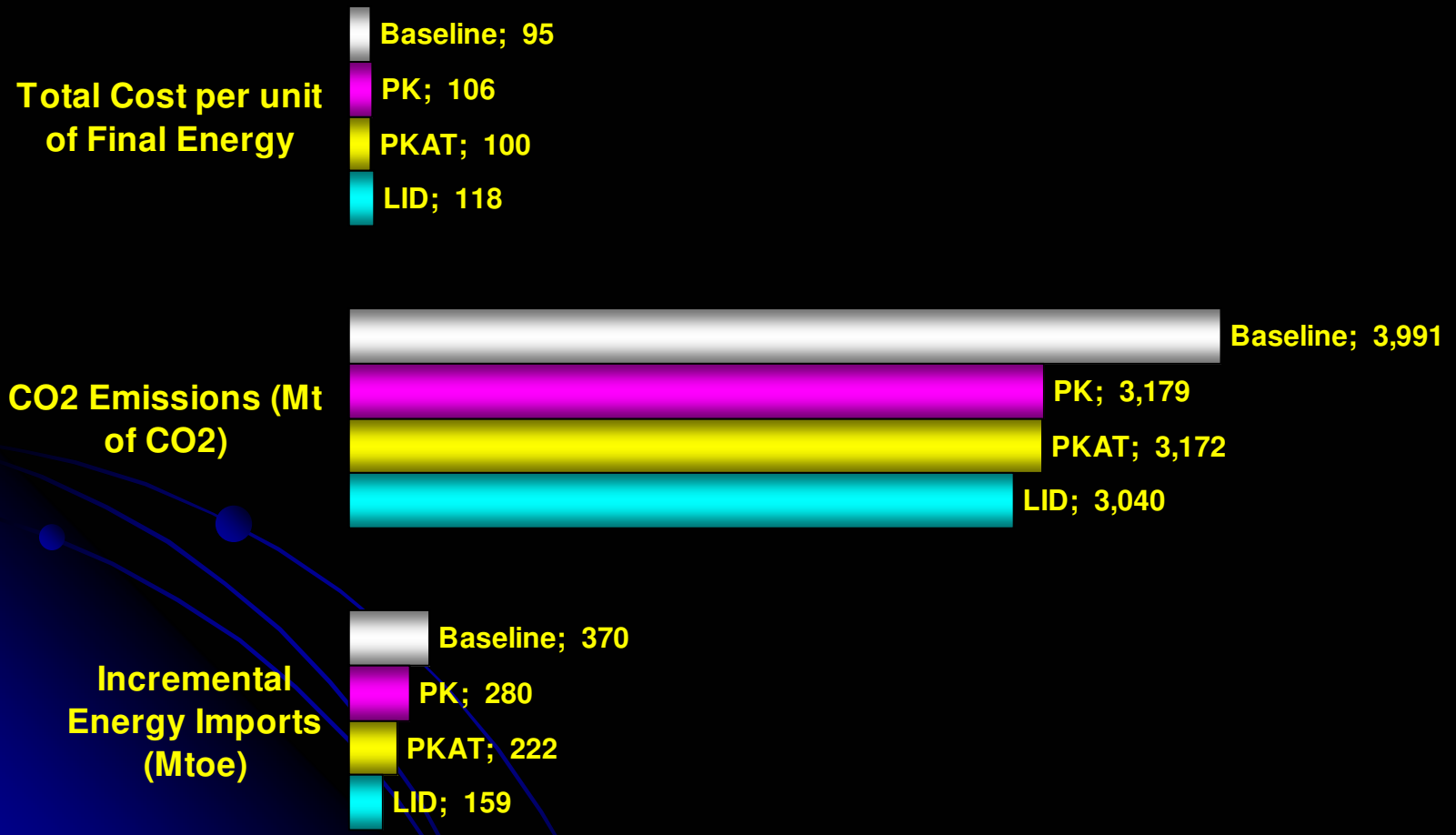


Emission Abatement



Performance

Performance Index (2005=100) in 2030



Concluding Remarks

- The baseline scenario is clearly a non sustainable future in terms of environmental impacts (climate) and security of supply (import dependence)
- The baseline scenario may improve if the nuclear option was freed (no phase out and extension of lifetime) and if efficiency and renewables policies proved more effective

Concluding Remarks

- If climate policy was seriously binding (as -16% of CO2 emissions in 2030 from 1990) then the electricity sector has a great role to play
- Marginal abatement costs are lower in the power sector than in most end-use sectors (beyond certain cheap energy efficiency measures)
- This implies that the overall optimum implies that electricity keeps and even increase its share in the demand-side but also it undertakes a heavy emission reduction program in the supply-side

Concluding Remarks

- Under climate constraints and with current wisdom about technology potential the analysis clearly shows that
  - a balanced portfolio approach in terms of resources and power generation technologies (like in PKAT scenario) is economically superior than any case in which a certain option is excluded or constrained
- Under climate constraints, economic costs increase, but
  - No single option is cost-effective
  - Under portfolio of policies cost-effectiveness improves

Concluding Remarks

- Under climate constraints import dependence is reduced, as a result of
  - Higher energy efficiency
  - Increasing domestic carbon-free resources, such as renewables and nuclear
- Still the EU needs for gas imports seem to increase under climate constraints
- The LID scenario illustrates the imposition of energy taxes to reduce fossil fuel imports (on top of climate policies)
  - LID implies high prices and costs for the consumers
  - LID allows for higher contribution of coal and CCS
  - LID allows for higher renewables
- A combination of PKAT and LID might be an interesting pathway