Scenarios of power demand and supply for Kazakhstan – a view from outside*)

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Climate Change Coordination Centre and Nurdana Foundation
“Energy Safety: Global and National Aspects”
Astana, September 3rd 2008

Overview

- **Kazakhstan and the World:**
  An international comparison
- **Some notes on the present situation**
  of the electricity sector in Kazakhstan
- **Energy and electricity scenarios for Kazakhstan:**
  A top down approach
- **The role of renewable energies**
- **Some conclusions**

Energy consumption and CO_2-emissions – a global challenge

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The data base

- **The figures used for this presentation are mainly based on data by the International Energy Agency (IEA), in particular**
  … Energy Balances of Non-OECD- countries (2008 ed)
  … Energy Statistics of Non-OECD- countries (2008 ed)
  … CO_2 Emissions from Fuel Combustion (2007ed)
- **Energy Information Administration (EIA): Country Analysis Briefs and miscellaneous facts and figures.**
- **Worldbank: World Development Indicators Online (WDI)**
- **World Energy Council (WEC): Electricity in Central Asia, July 2007**
- **TACIS project: Energy system and CO_2 emission scenarios for Kazakhstan prepared with the technical economic MARKAL-MACRO modelling tool, September 2006**
- **BP: Statistical Review of World Energy,. June 2008.**

GDP (PPP), electricity generation and primary energy consumption in Kazakhstan 1990-2007

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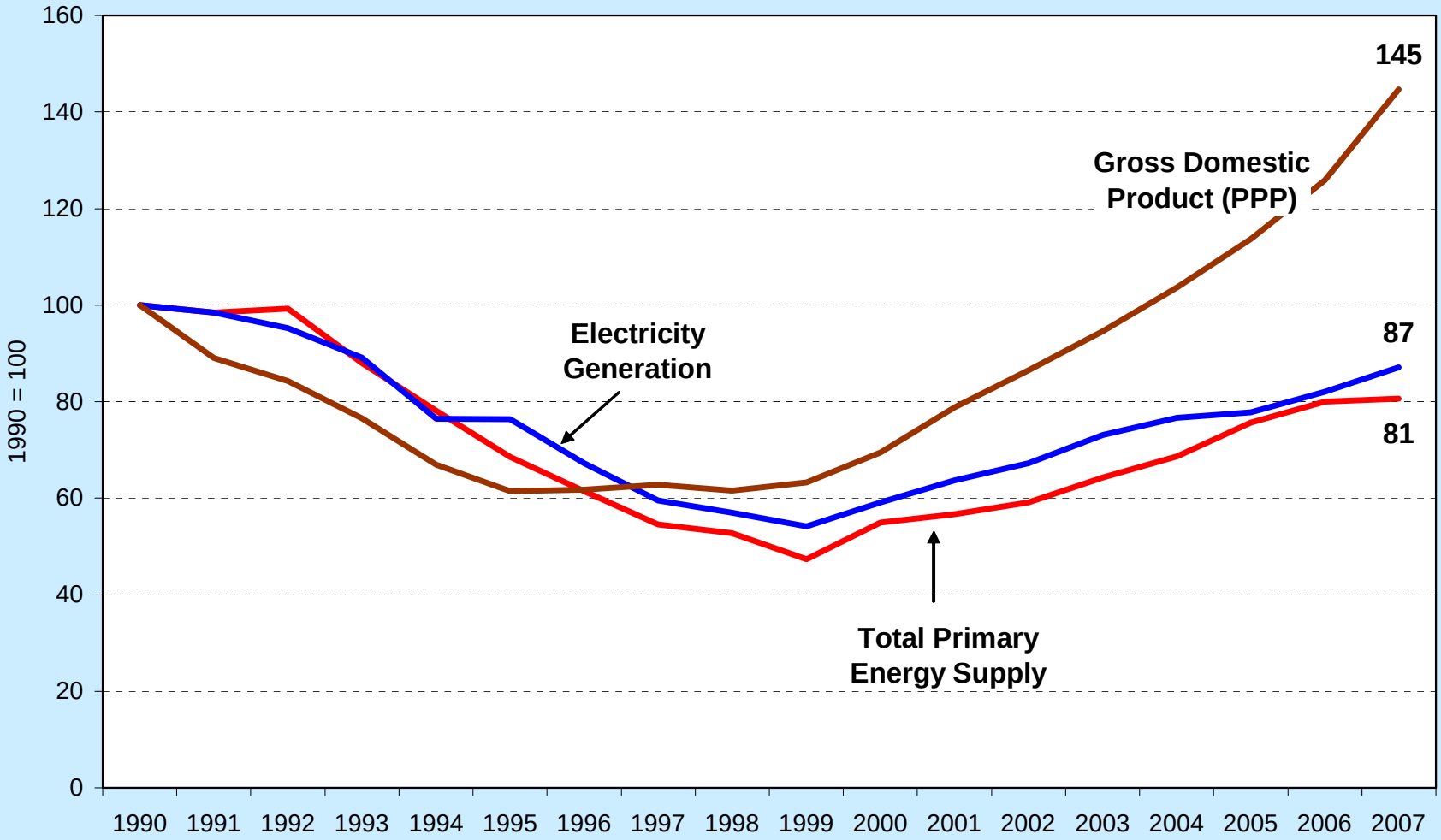

sources: BP Statistical Review of World Energy, June 2008; Worldbank, World Development Indicators.

Energy consumption by sectors and source of energy in Kazakhstan 2006

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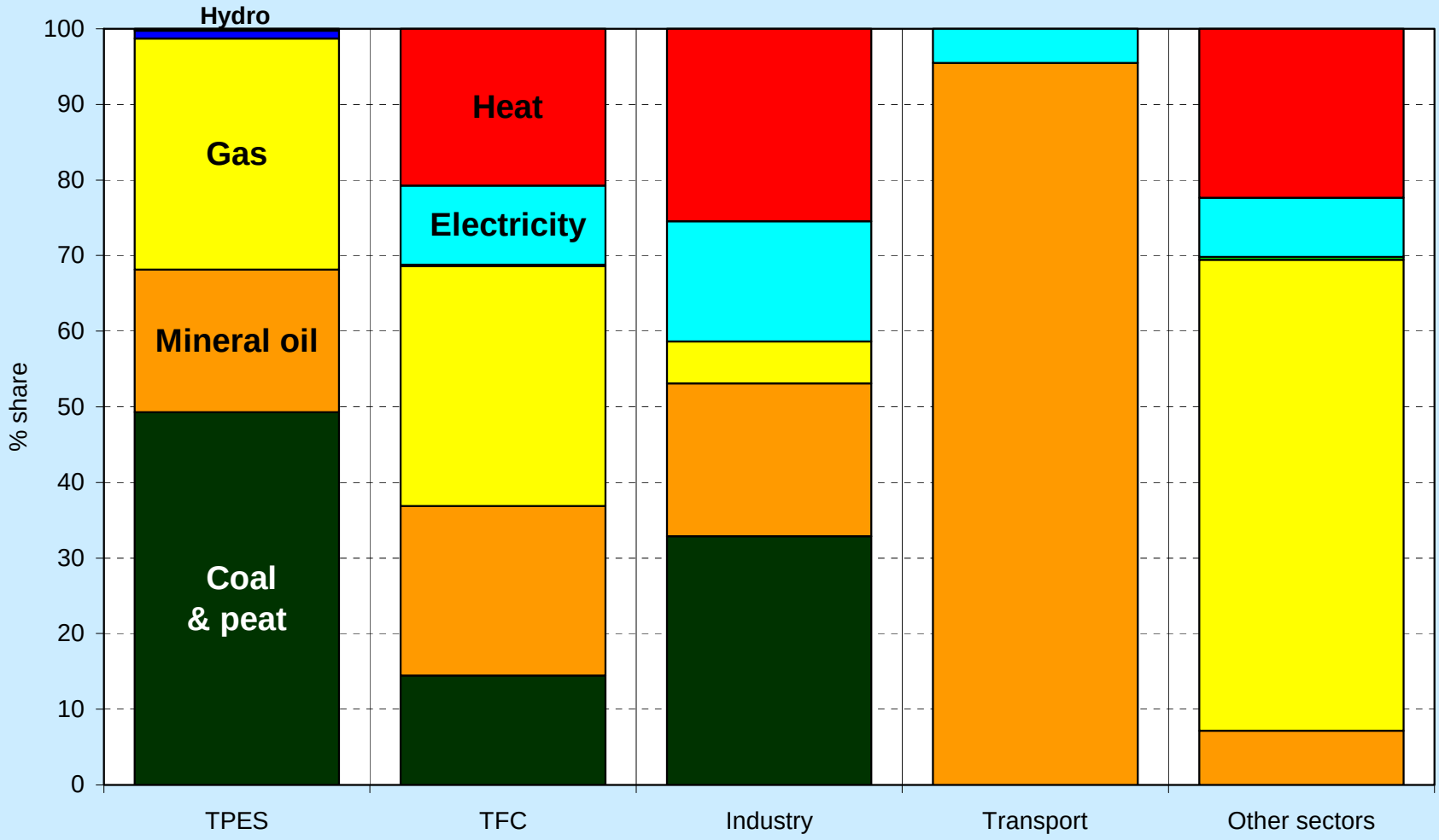

source: IEA, 2008.

Correlation between GDP (PPP) per capita and TPES per GDP(PPP) in 152 Countries

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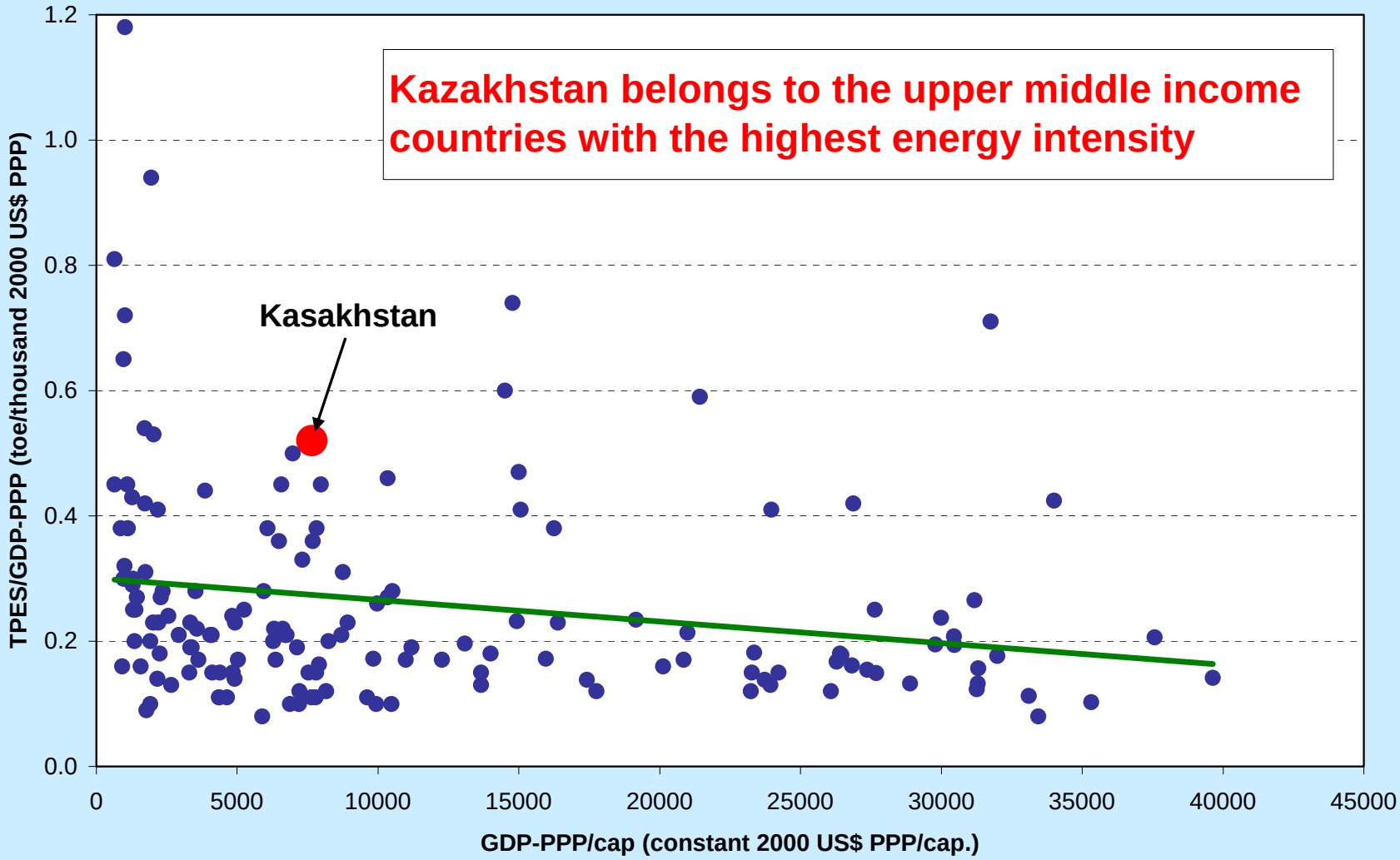

Energy intensity in countries with an energy consumption > 3 toe/cap (2006)

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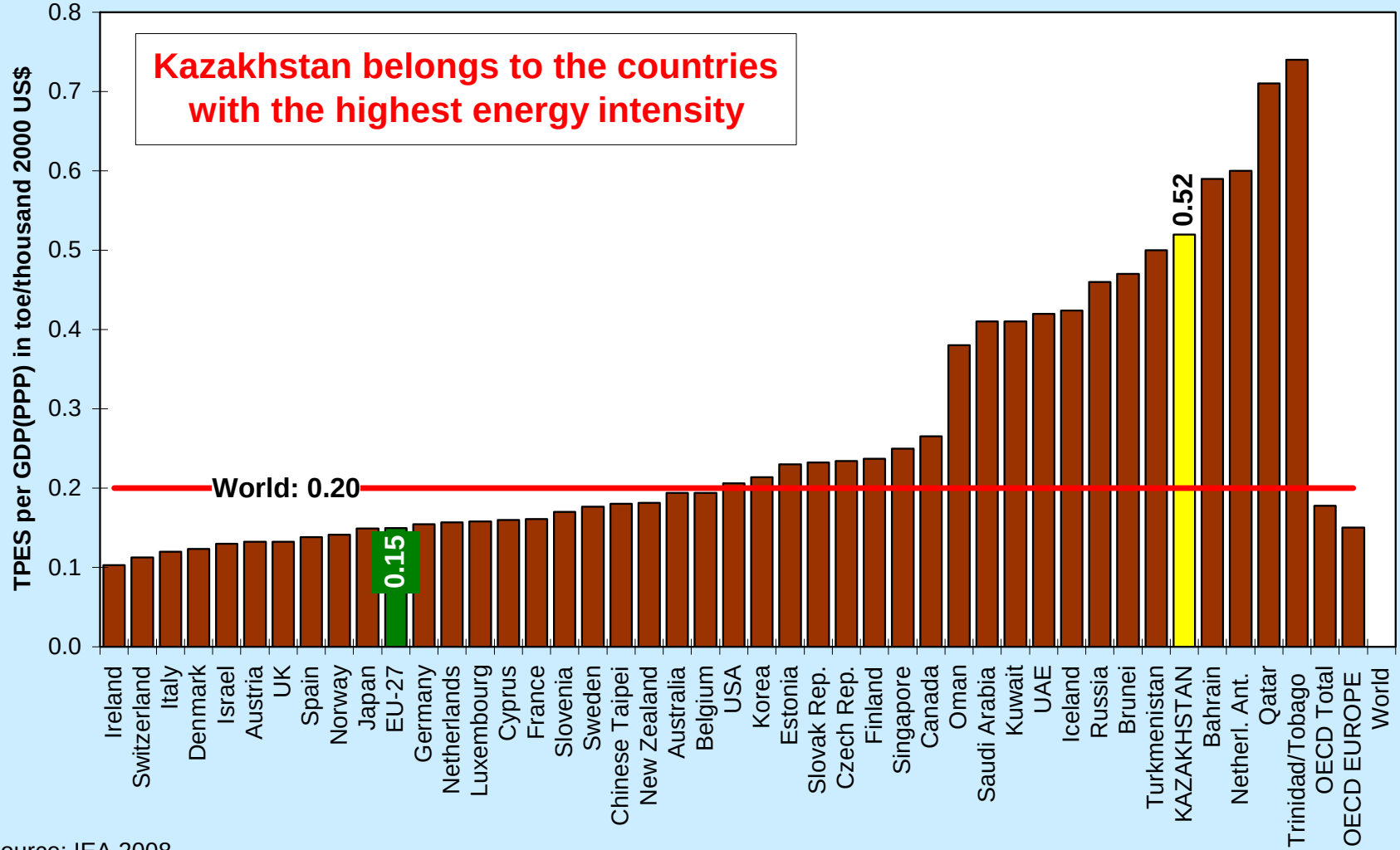

source: IEA,2008.

Correlation between GDP (PPP) per capita and Electricity Consumption per GDP(PPP)

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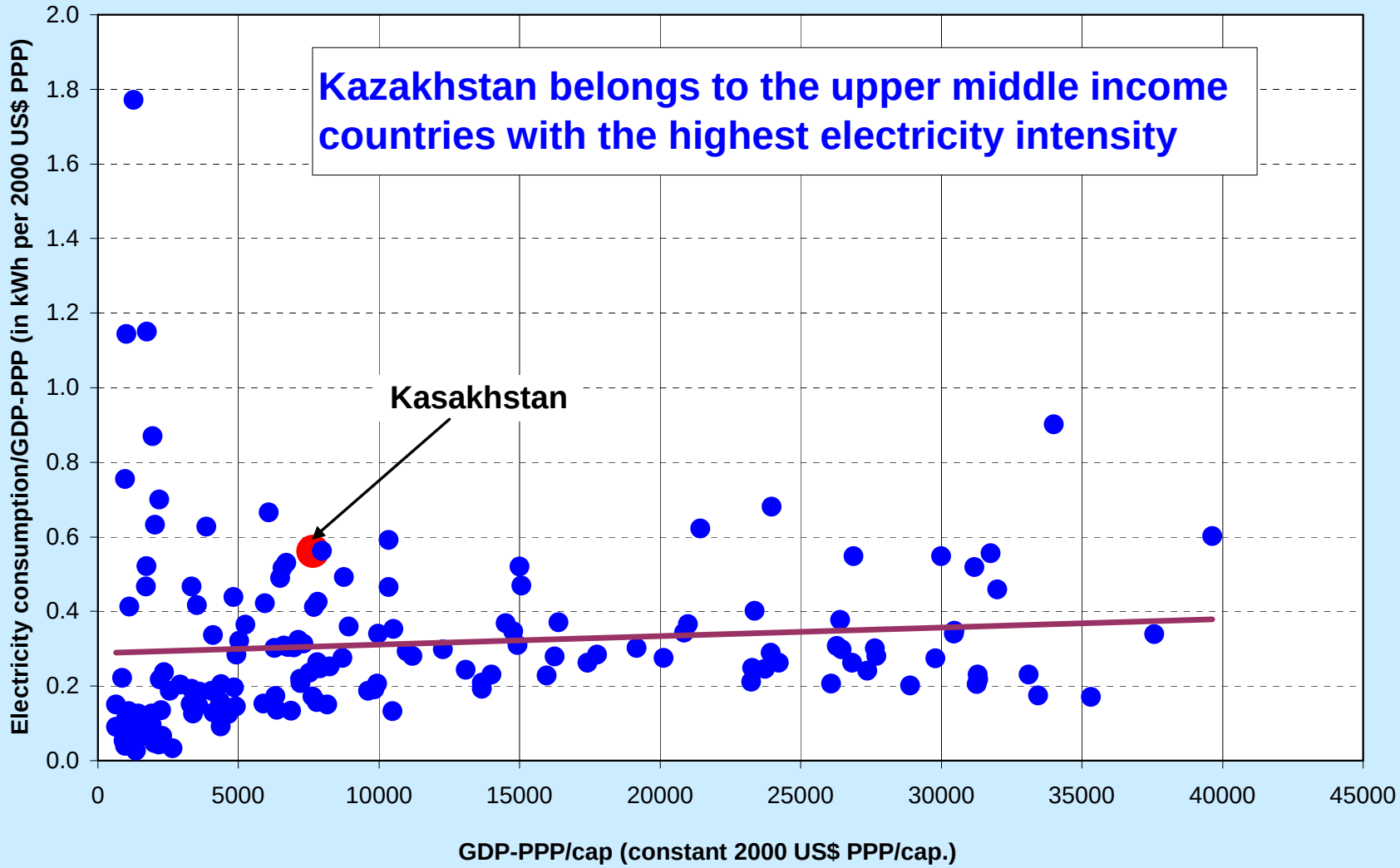

Electricity intensity in countries with an electricity consumption > 4000 kWh/cap (2006)

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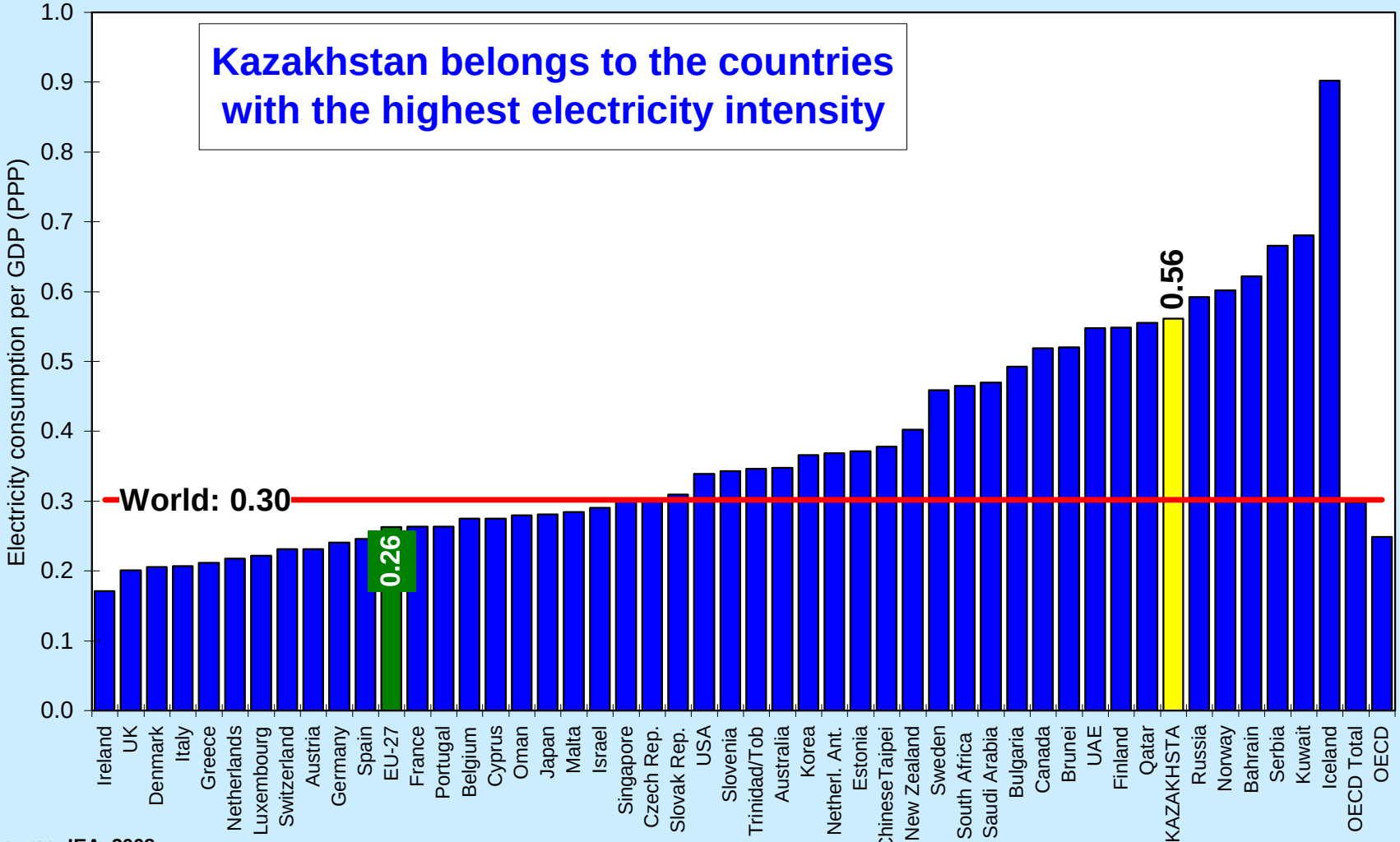

source: IEA, 2008.

Intensity of CO_2 emissions by countries and regions in 2005

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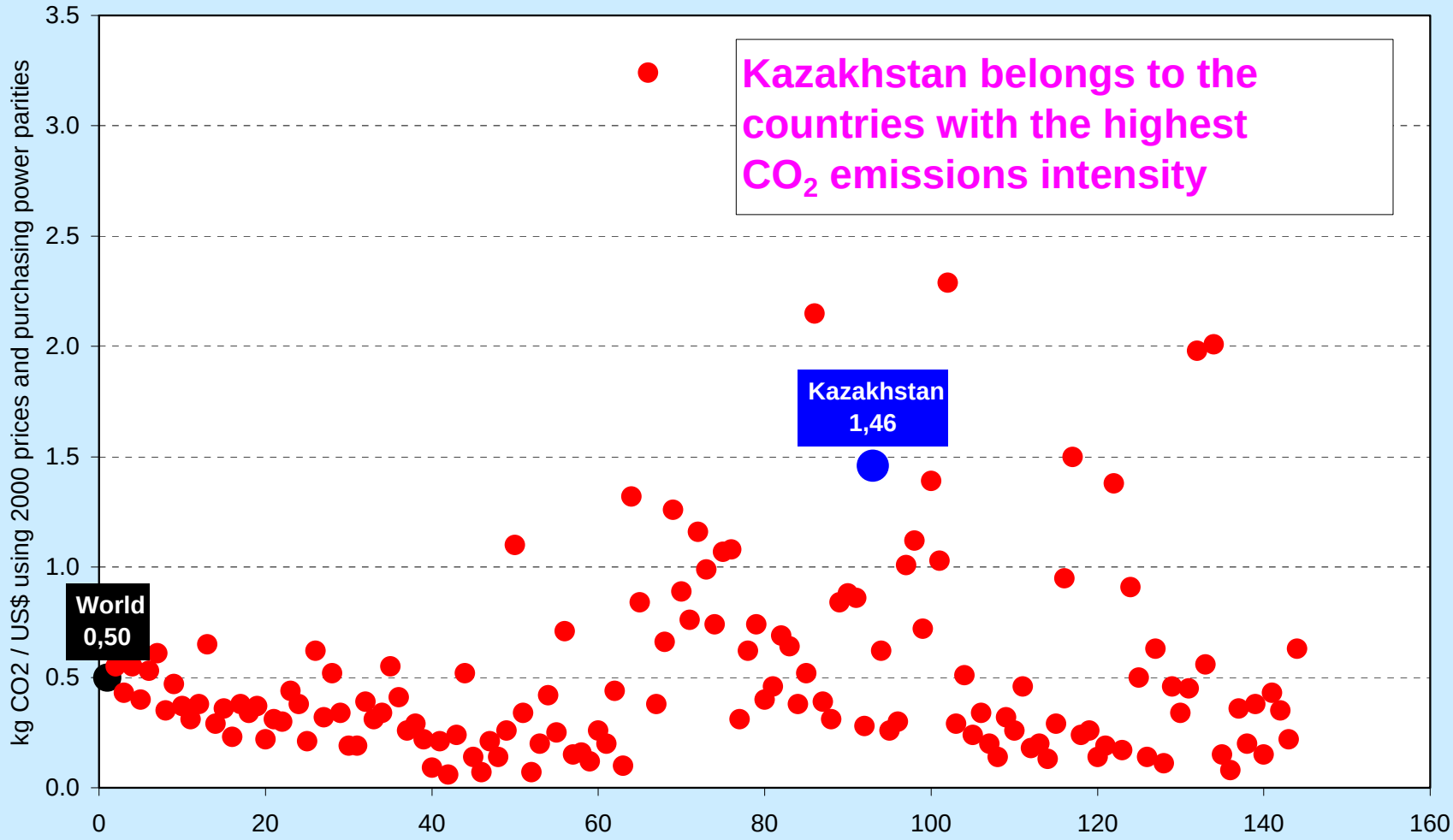

Quelle: IEA, 2007.

CO_2 emissions per capita in countries/regions with emissions > 100 Mt of CO_2 in 2005

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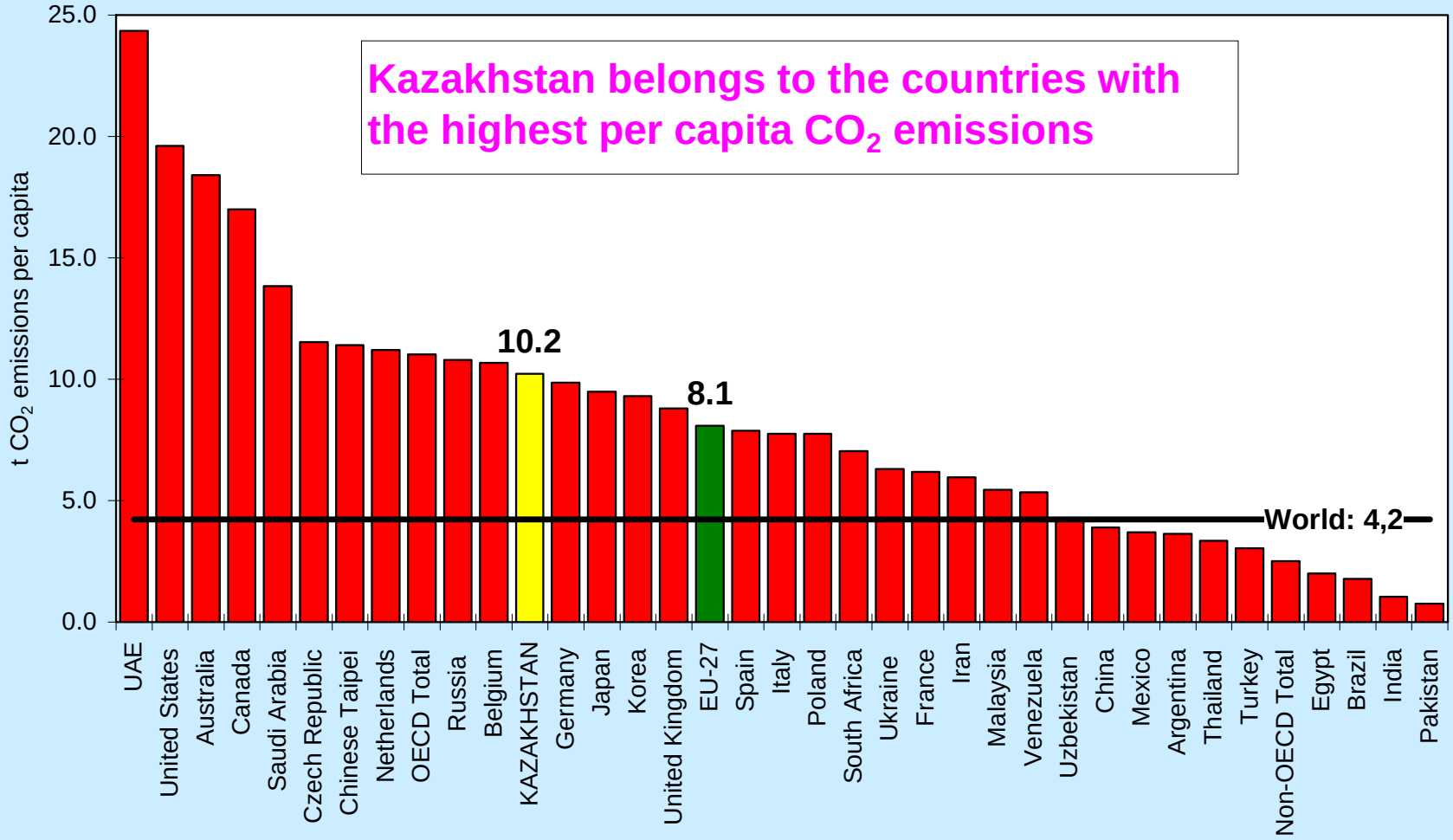

source: IEA, 2007.

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Some observations concerning the thermal power plants (TACIS project)

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Most of the thermal power plants are old and use obsolete technology and low quality fuel. The facilities of the sector include 448 water heating and power boilers, of which 247 are heated by coal dust. From the seventies to the mid-eighties, practically all power stations were equipped with ash traps whose efficiency reached 96-97 per cent.

By the end of the eighties, however, a programme was launched to build the devices necessary to minimize harmful emissions were introduced in all power plants, but their low efficiency (15-30 per cent) did not enable the pollution problems to be overcome. The bulk of the installed thermal power capacity has been in operation for more than 25 years and requires considerable investment in clean combustion and gas-emission control technologies.

Obstacles to further investments in the electricity sector

Non-payment of electricity bills, an inadequate collection system, and a lack of market-based transportation tariffs are all obstacles to further large-scale investment in Kazakhstan's transmission and distribution sector. Although the government plans to further privatize the grid, the likely success of these utilities' privatization remains questionable.

Kazakhstan incurs large electricity losses during transmission and distribution over its 285,000 miles of distribution lines. According to Kazakh Minister of Energy and Natural Resources Vladimir Shkolnik, an average of 15 percent of the electricity generated in Kazakhstan is lost before it reaches consumers due to the widespread deterioration of Kazakhstan's power infrastructure.

The most urgent development challenges in Kazakhstan (% of responses); source World Bank

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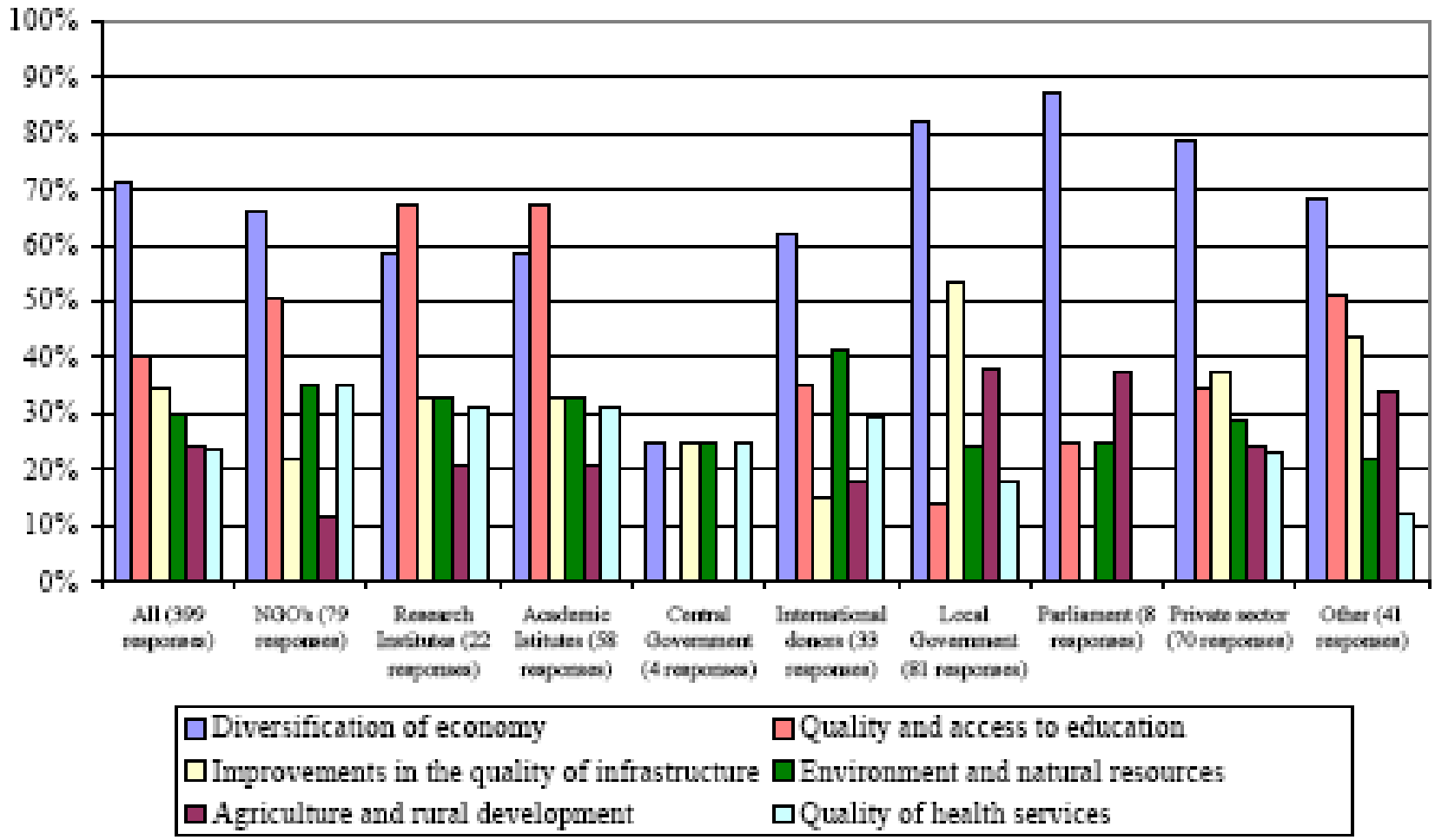

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The problems of forecasting future developments …..

Demand is very hard to predict in the region, since consumption levels are not necessarily a reliable indicator. The problems with improper metering, theft, distribution loss, non-payment, and widespread rural non-connectivity skew demand figures so much that it is difficult for project proposals to offer much investment security.

Normal factors such as past consumption, population growth, or current tariff levels are not as useful, since each fluctuates fairly rapidly over a short period of time. As a result, growth forecasts typically have a very large range of values. It is difficult to reconcile the security of large investments with such imprecise and potentially unreliable indicators.
(WEC, 2007)

… BUT WE WILL TRY IT WITH THE HELP OF SCENARIOS

Key strategies for meeting the increasing energy and electricity demand

Apart from the indispensable modernisation of the existing power plants the improvement of the energy and electricity efficiency on the supply and demand side as well as the enforced expansion use of renewable energies must be the key pillars for an economically and environmentally sound electricity system. This will contribute to modernize and diversify the basis of Kazakhstan's economy.

Two scenarios are described (with common demographic and overall economic assumptions):

1. **The Reference scenario is characterised as a more or less business-as-usual- scenario (BAU scenario). This means neither significant changes in the patterns of energy supply and demand nor extensively changed policies and measures. In principle it is prolongation of perceivable trends.**

2. **The Efficiency scenario is characterised by the ambition to improve energy and electricity efficiency in a way that Kazakhstan catch up with the efficiencies in the EU-27. It is assumed that in Kazakhstan the respective figures for 1990 in the EU-27 will be realized by 2020, and the EU-27 figures for 2006 by 2030.**

Key assumptions for the Reference and Efficiency Scenario for Kazakhstan 2020 and 2030

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		2000	2006	2020	2030	changes in %/a			
						2000-2006	2006-2020	2020-2030	2006-2030
Population[1)]	million	14.9	15.3	16.7	17.1	0.4	0.6	0.2	0.5
GDP (PPP)	billion 2000$	64.7	117.1	302	426	10.4	7.0	3.5	5.5
GDP (PPP)/capita	2000$/cap.	4342	7654	18056	24847	9.9	6.3	3.2	5.0
		Reference scenario							
Energy intensity (TPES/GDP)	toe/thousand 2000 US$ PPP	0.65	0.52	0.32	0.27	-3.6	-3.5	-1.5	-2.7
Electricity consumption[2)]/GDP	kWh per 2000 US$ PPP	0.73	0.56	0.38	0.36	-4.3	-2.8	-0.5	-1.8
Net imports of electricity	TWh	3.02	0.84	0.00	0.00	-19.3	xxx	xxx	xxx
		Efficiency scenario							
Energy intensity (TPES/GDP)	toe/thousand 2000 US$ PPP	0.65	0.52	0.19	0.15	-3.6	-7.0	-2.3	-5.1
Electricity consumption[2)]/GDP	kWh per 2000 US$ PPP	0.73	0.56	0.29	0.26	-4.3	-4.7	-0.9	-3.1
Net imports of electricity	TWh	3.02	0.84	0.00	0.00	-19.3	xxx	xxx	xxx

1) Data for 2020 and 2030 according to UN: World Population Prospects: The 2006 Revision.-
2) Domestic supply without distribution losses.- 3) Domestic supply including domestic losses.

sources: IEA, 2008; UN; WEC; TACIS project, 2006.

Key results of the Reference and Efficiency Scenario for Kazakhstan 2020 and 2030

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		2000	2006	2020	2030	changes in %/a			
						2000-2006	2006-2020	2020-2030	2006-2030
		Reference scenario							
Total primary energy supply (TPES)	Mtoe	42.2	61.4	96.2	116.6	6.5	3.3	1.9	2.7
TPES per capita	toe/cap.	2.83	4.01	5.75	6.80	6.0	2.6	1.7	2.2
Total Electricity consumption[2)]	TWh	47.2	65.7	113.9	152.7	5.7	4.0	3.0	3.6
Total Electricity consumption[3)]	TWh	54.3	72.5	125.1	166.9	4.9	4.0	2.9	3.5
Electricity consumption[2)]/population	kWh per capita	3169	4293	6808	8911	5.2	3.3	2.7	3.1
Electricity consumption[3)]/population		3647	4738	7481	9738	4.5	3.3	2.7	3.0
Electricity production[4)]	TWh	51.3	71.7	125.1	166.9	5.7	4.1	2.9	3.6
Distribution losses	TWh	7.2	6.8	11.3	14.2	-0.9	3.7	2.3	3.1
		Efficiency scenario							
Total primary energy supply (TPES)	Mtoe	42.2	61.4	57.4	63.9	6.5	-0.5	1.1	0.2
TPES per capita	toe/cap.	2.83	4.01	3.43	3.73	6.0	-1.1	0.8	-0.3
Total Electricity consumption[2)]	TWh	47.2	65.7	86.57	112.01	5.7	2.0	2.6	2.2
Total Electricity consumption[3)]	TWh	54.3	72.5	95.13	122.41	4.9	2.0	2.6	2.2
Electricity consumption[2)]/population	kWh per capita	3169	4293	5177	6534	5.2	1.3	2.4	1.8
Electricity consumption[3)]/population		3647	4738	5689	7141	4.5	1.3	2.3	1.7
Electricity production[4)]	TWh	51.3	71.7	95.1	122.4	5.7	2.0	2.6	2.3
Distribution losses	TWh	7.2	6.8	8.6	10.4	-0.9	1.7	2.0	1.8

1) Data for 2020 and 2030 according to UN: World Population Prospects: The 2006 Revision.-
2) Domestic supply without distribution losses.- 3) Domestic supply including domestic losses.
sources: IEA, 2008; UN; WEC; TACIS project, 2006.

Reference and Efficiency Scenario for Kazakhstan 2020 and 2030: Total primary energy intensity

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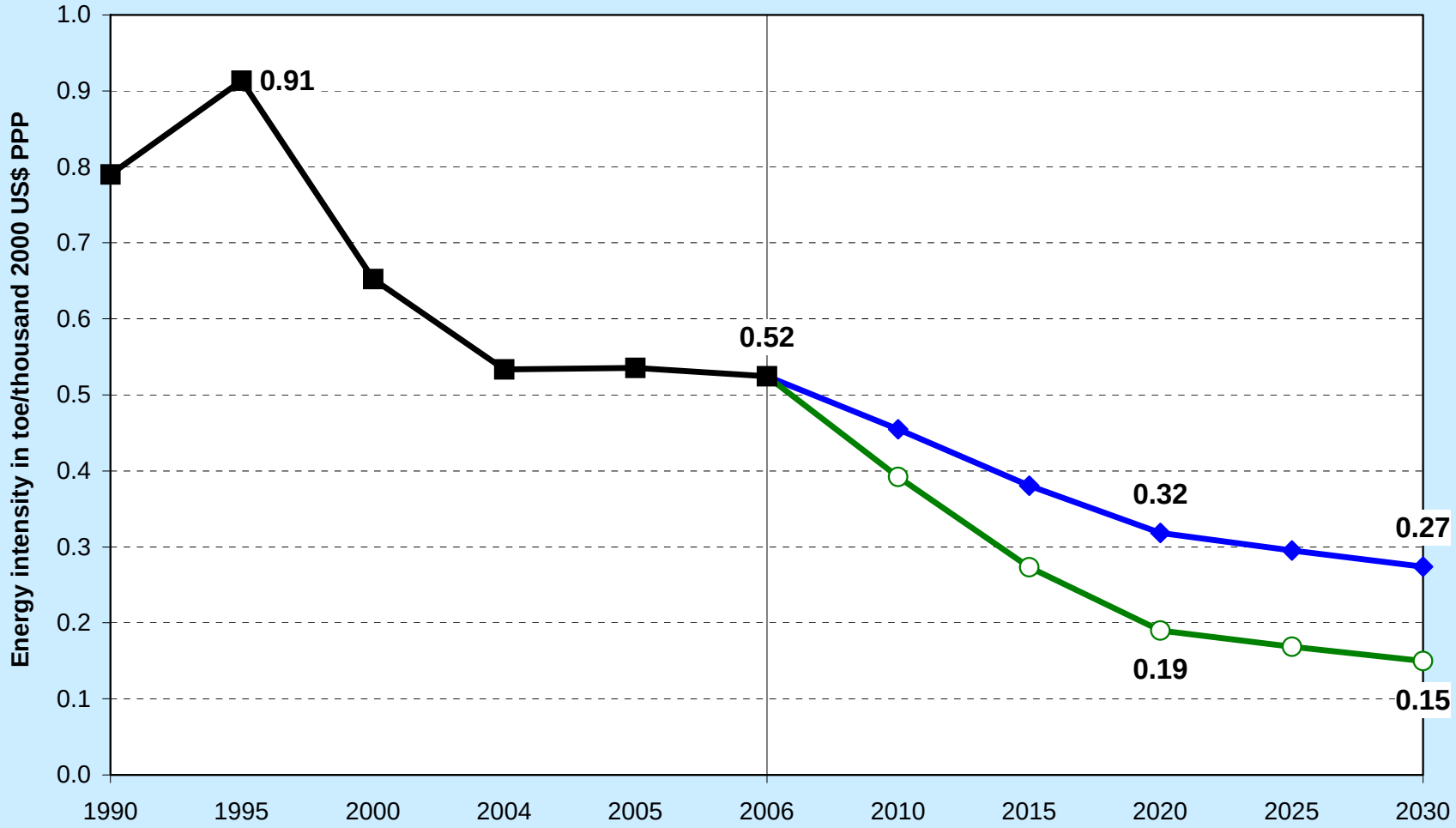

sources: IEA, 2008; author's estimate.

Reference and Efficiency Scenario for Kazakhstan 2020 and 2030: Total primary energy supply (TPES)

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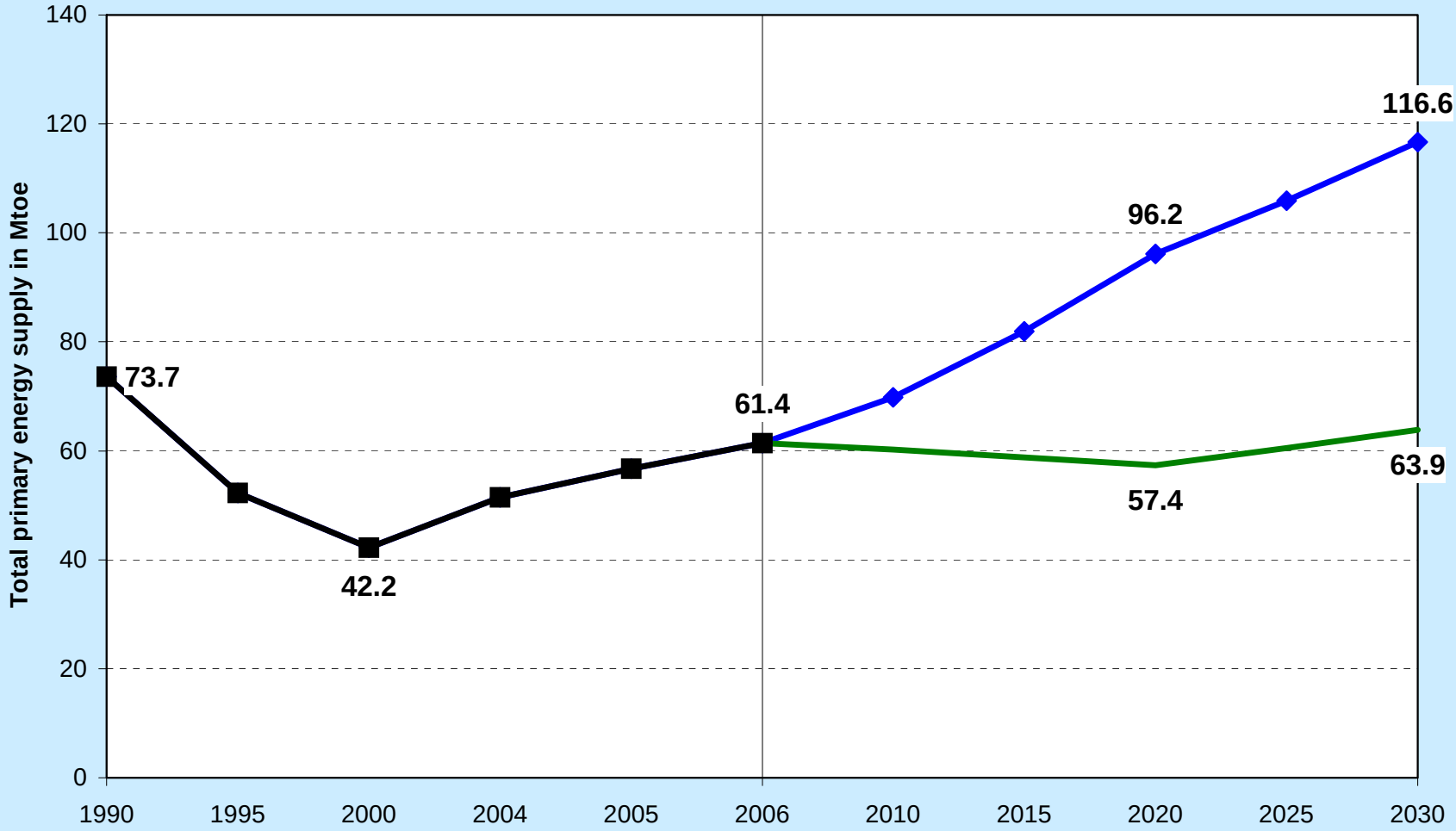

sources: IEA, 2008; author's estimate.

Reference and Efficiency Scenario for Kazakhstan 2020 and 2030: Electricity intensity

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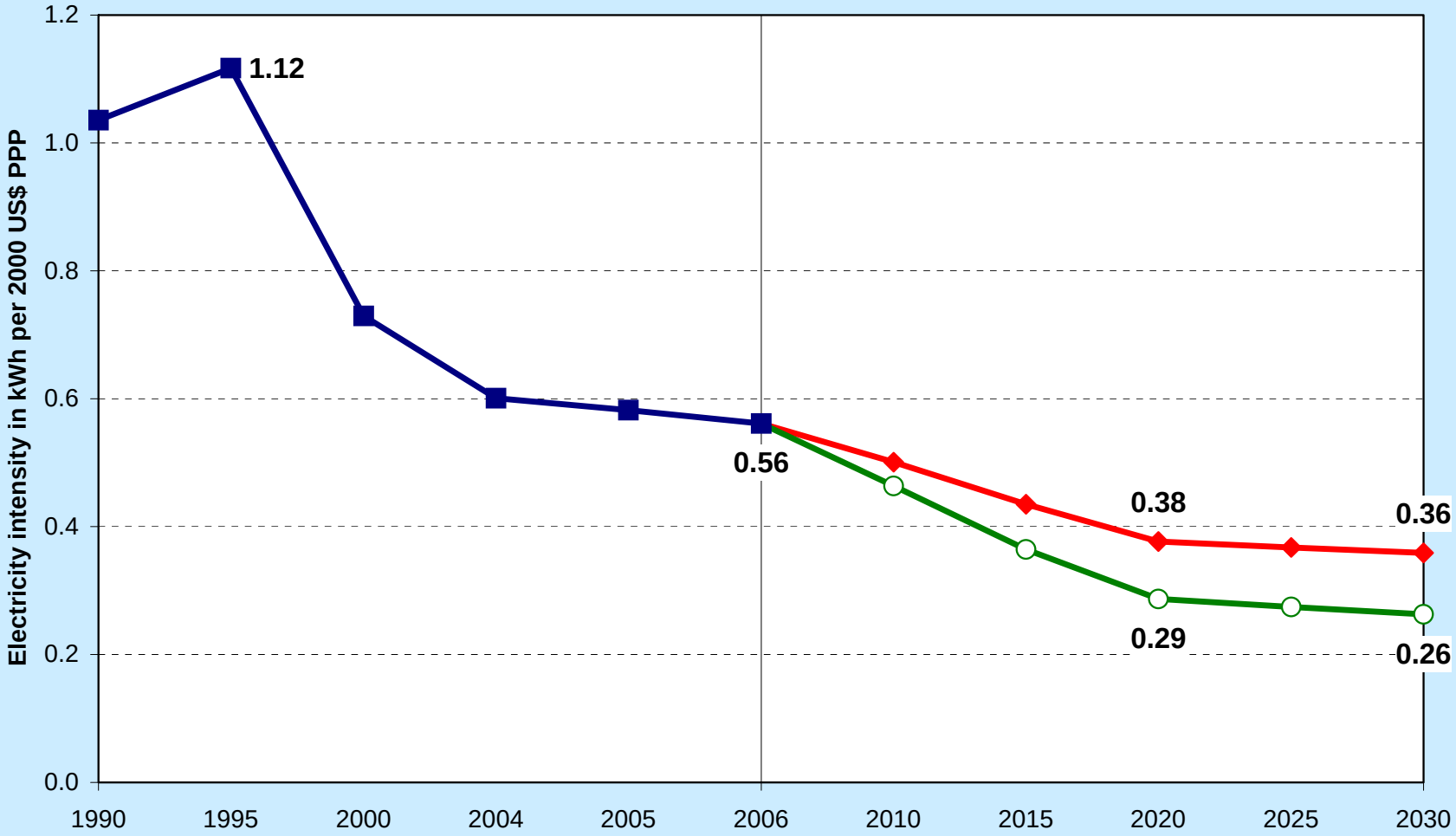

sources: IEA, 2008; author's estimate.

Reference and Efficiency Scenario for Kazakhstan 2020 and 2030: Total electricity consumption

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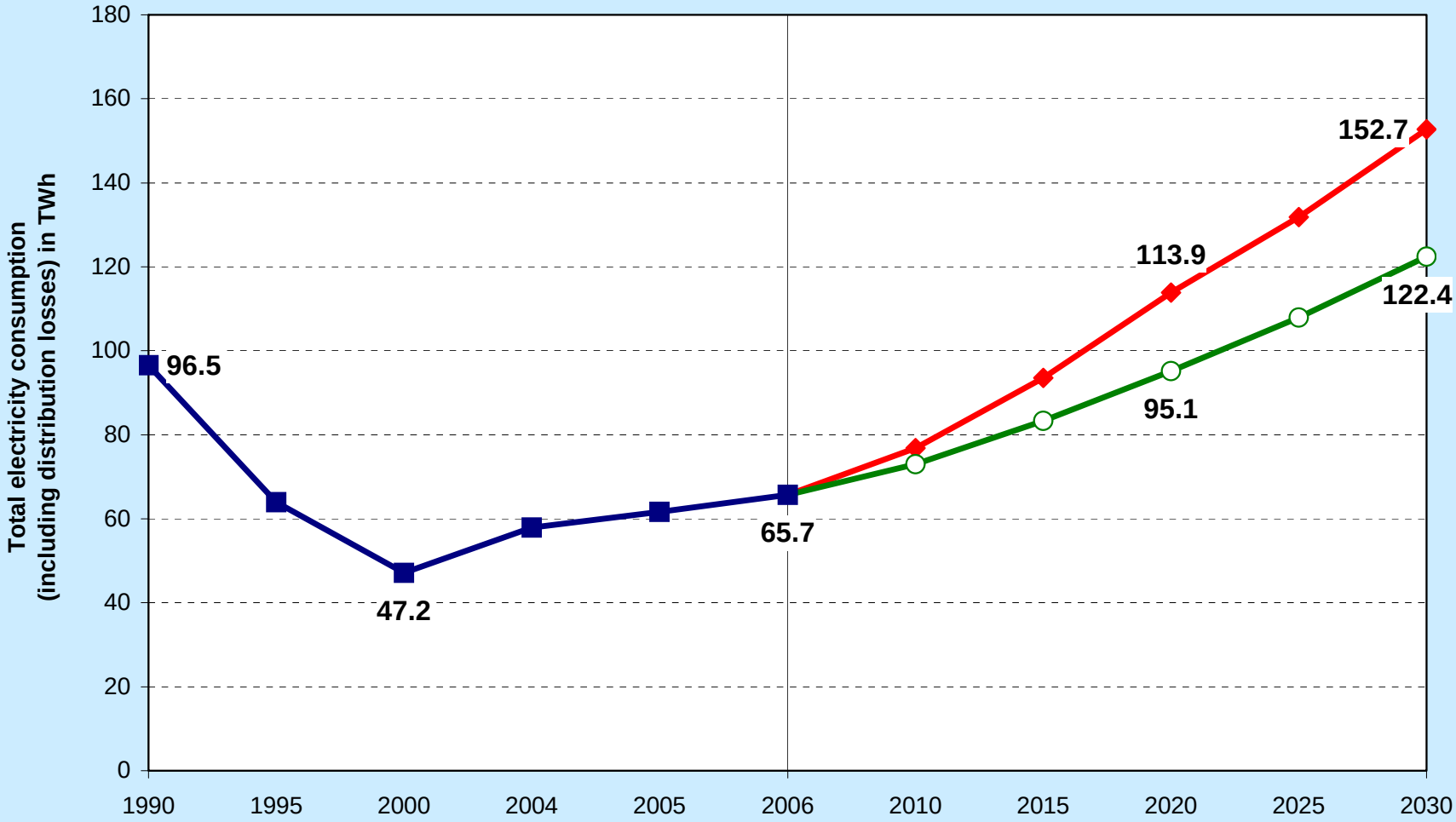

sources: IEA; 2008; author's estimate.

An intermediate result

Considering the electricity generating capacity there is a huge need of modernization of the existing power plants and as well as to install new capacities.

But there is a large uncertainty over the range of the necessary capacities. Still there seem to be no clear structures allowing a serious projection of what will be the future electricity demand and supply in Kazakhstan. This widely depends on the expected economic growth and the foreseeable progress of improving the efficiency of electricity generation and use.

Regarding the minor efficiency in energy and electricity use compared with most of other countries there seem to exist large potentials in Kazakhstan to limit the growth of energy/electricity consumption and of the future generation capacities.

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Share of renewable energies in total primary energy supply 2006 in countries > 30 Mtoe TPES

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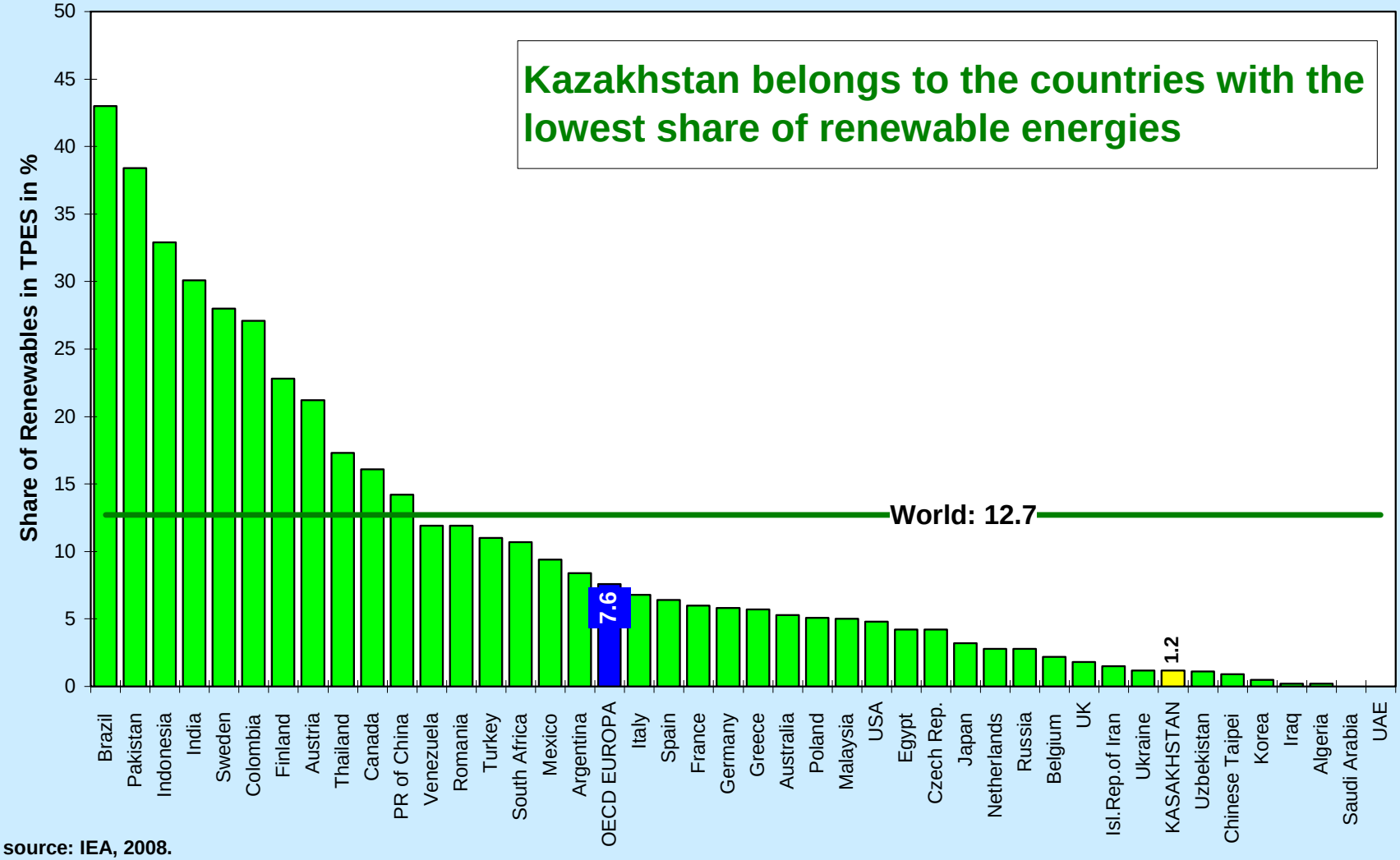

source: IEA, 2008.

The World Energy Council regarding the use of renewable energies in Kazakhstan (1)

- **Apart from modest investment into hydroelectric power, Kazakhstan has not initiated much development of renewable fuel resources.**
- **The renewable energy resource potential in Kazakhstan is significant but was largely neglected in the past in favour of large centrally owned and managed projects. There exist about 5100 remote villages without electricity service; connecting them to the grid would most likely be uneconomic. (Tacis)**
- **The low cost of fossil fuel due to locally abundant supply has discouraged the diversification of energy into renewable fields.**
- **Extraction and use of coal, the fuel source for the vast majority of generating capacity, is not done in an environmentally efficient way**

The World Energy Council regarding the use of renewable energies in Kazakhstan (2)

- **Environmental policy is the most evolved in Kazakhstan, since it has signed the Kyoto Protocol, and has attempted to build a legal environmental framework from Kyoto commitments, and attract foreign investment to assist in this process**
- **To alleviate dependence on fossil fuels, finance long-term debt by lowering fuel costs, reduce environmental impact from coal extraction and combustion, and to work within the legal framework of the Kyoto Protocol, Kazakhstan is exploring renewable energy potential, particularly in wind development, where a UNDP exploratory project is currently underway.**

Potential of renewable energies in Kazakhstan (1) (source: WEC, July 2007; Tacis project))

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- **At present a hydro power capacity of 2,000 MW is installed. The potential capacity is estimated to be ten times higher, i.e. 20,000 MW (WEC, 2007). Mini-hydro (units of less than 10 MW), has a significant potential. Based on existing studies, there are at least 453 potential projects with 1380 MW of total installed capacity and 6315 GWh of mean annual production; the potential capacity grows to 2350 MW if projects below 30 MW are considered.**
- **Kazakhstan has very strong wind potential, largely due to the pervasiveness of wind-intensive areas. The majority of the country's land mass has wind potential of at least 4-5 m/s, with a few coastal areas reaching 6 m/s. The estimated potential amounts to 1,300 TWh (Djungar Gates alone). Additional factors, such as proximity to an existing high-voltage transmission line or to a local market, and good correlation of the wind seasonality with the power demand of the system, make development of this resource attractive.**

Potential of renewable energies in Kazakhstan (2) (source: WEC, July 2007; Tacis-project)

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- **The sheer size of Kazakhstan compared to its Central Asian neighbours gives it a distinct advantage in the development of solar power, since more surface area yields more direct sunlight. The country receives between 2200 and 3000 hours of sunlight per year on average, enough to generate 1300-1800 kWh/m^2/year. Several areas receive the most sunlight in a year. However the expense of the technology has meant that virtually no exploration of integrating it into the fuel mix has been made.**
- **Based on this radiation intensity, Solar Water Heaters (SWH), particularly in remote areas without access to gas pipelines, should be also viable in Kazakhstan. The technology is commercially available and capabilities to undertake local production are good.**

Potential of renewable energies in Kazakhstan (3) (source: WEC, July 2007; Tacis project)

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- **In the ongoing process of searching for new oil deposits and drilling for wells, the thermal water temperature is also analyzed for geothermal electric potential. The potential is fairly strong, and throughout the southeastern region, major geothermal sites have been identified as electricity potential. All the geothermal reservoirs have temperatures in the 80-120 degree Celsius range, with some reaching even higher to 170 degrees. Together, they have the potential for 4300 thermal MW, roughly 1,400 electric MW.**
- **Kazakhstan has only moderate biofuel potential largely due to the large area of desert covering the country's landmass, which yields little biomass. Significant biofuel prospects come from straw. If 20 % of the annual harvest of cereal straw could be commandeered for biofuel, it could produce 2.5 million toe, i.e. 4 % of the present TPES.**

Conclusions (I)

- **Kazakhstan strongly depends on its fossil resources. In particular, in the electricity sector**
- **Under the conditions of a reference scenario Kasakhstan will face a strong increase of primary energy consumption and the electricity consumption.**
- **It needs an effective policy, which provides the necessary framework requirements and implements appropriate instruments for the different agents in economy and society to improve the energy efficiency and enlarge the use of renewable energies.**
- **And it should be a widely common understanding that policy should make use of the market forces as much as possible, and therefore to use mainly market based instruments.**

Conclusions (II)

- There are sufficient technical and other options available to improve the energy efficiency and enlarge the use of renewable energies.
- To use all the given options it is necessary to change the energy and environmental policies significantly
- Appropriate policies and measures seem to be available for immediate implementation
- First of all we need a common understanding regarding the problems to be solved, the targets which should be followed and the policies which has to be implemented.
- A successful policy needs the acceptance of the people and their willingness to follow the way for a sustainable development.

This has to be considered

Finding opportunities is not the problem in this region; any or all of the technical or organizational projects … require substantial investment, not only from IFIs but from private sources as well.

The problem in Central Asia has never been finding destination projects; the problem has been mitigating the unusually high strategic and geopolitical risks.

World Energy Council, Juli 2007.

Thank you for listening

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