



## ANALYSIS

# Cooperation benefits of Caspian countries in their energy sector development



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## ABSTRACT

This paper studies the development possibilities of the energy systems of four Central Asia and Caspian countries. It explores options that improve their domestic energy efficiencies and increase their export of fossil energy commodities. Using the MARKAL-TIMES modelling tool, it represents their energy system with a bottom-up partial economic equilibrium growth model. With the help of scenario analyses, it evaluates the direct economic advantage of improving the domestic energy efficiencies. Furthermore it calculates the direct economic advantage of cooperation. It finds out that a new/different geo-economic attitude brings USD billions of annual economic benefits, particularly if the countries aim to differentiate their export routes, increase the amount of export and contribute to climate change mitigation.

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## 1. Introduction

### 1.1. Energy in Central Asia

Azerbaijan, Kazakhstan, Turkmenistan and Uzbekistan – Central Asian Caspian countries, CAC – are endowed with abundant energy resources. In particular Uzbekistan (UZB) and Turkmenistan (TKM) are rich in natural gas, Azerbaijan (AZJ) oil, Kazakhstan (KZK) oil, coal and uranium. In 2009, the overall production of the area was around 145 million tonnes (Mt) of crude oil against a consumption of 35.3 Mt, and around 150 billion cubic meters (Bcm) of natural gas against a consumption of 100 Bcm (Table 1).

About 110 Million tonnes oil equivalent (Mtoe) and 40 Mtoe of natural gas were exported in 2009, mainly to, or through, the Russian Federation. If the present status is extrapolated to the future, CAC countries will not be able to take full advantage of their energy resources, which could be compatible with a large increase of both domestic consumption and exports. Taking full advantage of their future

energy rents would increase the GDP of the CAC countries and their economic development prospects much more than at present [1].

The full exploitation of the overall production capacity would make the Area a “key player” in the fossil fuels export for the next few decades. This calls for the urgent need of investments and the agreement on a joint energy export-strategy towards external markets as well as among the Caspian countries themselves. As stated in a special report [2] by the National Bureau of Asian Research “What we have yet to see is cooperation among the different players in Central Asia pipelines in pursuit of convergent objectives, as opposed to competition for divergent interests.”

This study aims to assess quantitatively the direct economic benefits of cooperation among CAC countries, under different development and policy assumptions. The evaluation is carried out with the help of an energy model of the four countries and the CAC area. The TIMES-CAC-4R model is built with the aim of:

- representing the structure and the mid-long-term development of the four domestic energy systems at the maximum level of detail made possible by the available information, with hundreds of existing and new energy technologies; the models should indicate the optimal mix of energy resources, the optimal level of investments in new infrastructures, the desirable level of energy efficiency in supply and demand, etc.;

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**Table 1**  
Azerbaijan, Kazakhstan, Turkmenistan and Uzbekistan: energy resources and indicators.

Indicators	References	AZJ	KZK	TKM	UZB	Sum	China + India	World
Population (million, 2011)	[7]	9.1	16.6	5.1	29.3	60	2586	6958
Population density (cap/sqkm) (d)		111	6	11	69	–	144/411	13.5
GDP/capita, 2011 (\$'2005ppp/cap)	[7]	8.9	11.6	8.3	2.9	6.7	5.4	10.1
Oil rents (+) (% GDP) (€)	[1]	34–62	26–37	16–41	3–10	–	–	–
Natural gas rents (+) (% GDP) (€)	[1]	3–12	2–8 (ˆ)	22–85	15–91	–	–	–
Energy consumption, 2011 (toe/cap)	[7]	1.4	4.7	4.8	1.6	2.7	1.3	1.9
CO2 emissions, 2011 (tco2/cap)	[7]	2.9	14	12	3.8	7.2	3.8	4.5
Crude oil (%)								
Ultimate recoverable resources (Billion of bbl)	[8–10]	15	71	19	3	108	57	3000
Reserves (Billion of bbl)	[8–12]	7	35 (*)	0.6 (a)	0.6	43 (*)	35	1480
Domestic consumption (2009, million of bbl/a)	[13]	70.8	118	60.0	21.6	270	3770	30,950
Net export (2009, million of bbl/a)	[13]	317	449	14.4	–	780	–	0
Natural gas								
Ultimate recoverable resources (Tcm)	[8–10]	4.5	7.2	11.8c	3.4	26.9	9.4	425
Reserves (Tcm)	[8–10]	>0.85	>3.5	>7.4 b	>1.8	>13.5	3.1	180
Domestic consumption (2009, in Bcm/a)	[13]	10.4	20.3	18.0	43.8	92.5	120	3114
Net export (2009, in Bcm/a)	[13]	5.8	6.9	19.1	12.7	44.5	–	0

Footnotes: (\*) average over the range 30–40 B.bbl found in the literature; (+) as defined in the WB data base, rents are the difference between the value of oil/natural gas production at world prices and total costs of production; (€) 2000–2011 range; (ˆ) coal rents ranged around 3–9% of GDP; (%) Domestic consumption and net export refer only to crude oil; if oil products are added, both values are similar to the values shown in the following tables; (a) plus 1.1 B.bbl of proved plus probable reserves in the Caspian Sea [14]; (b) according to BP, the proven reserves of natural gas in TKM were estimated 24 Tcm at the end of 2011 [11] and 17.5 Tcm at the end of 2012 [12]; (c) according to [15] the ultimate recoverable resources in the Galkinish-Yolotan fields are 26 Tcm, to make a total for TKM of more than 28 Tcm; (d) 144 relates to China, 411 relates to India.

- representing comprehensively the trade infrastructures and the flows level among the 4 CAC countries, in order to understand their optimal level under different development and policy assumptions; and
- more specifically exploring some “predefined size” investment possibilities in oil and gas pipelines.

As far as the authors are aware of, details on consumption by end use service have never been developed, and are not available in the literature. Furthermore, there have been no such models so far for the area and the CAC countries, except Kazakhstan [3].

Previous studies (Bilgin [4], The Regional Environmental Centre for Central Asia (CAREC) [5], and Babali [6]) focussed on the prospects of alternative energy corridors for the Caspian hydrocarbon resources and the possible room for cooperation from a geostrategic point of view and following a “what-if” approach, without any evaluation of the dynamic domestic energy demands and of the costs for the energy sector development. This is the first instance that the Caspian Region energy sector is modelled with detailed representation of both supply and demand sides (bottom-up approach), and with the technological descriptions of the existing mix of plants, demand devices, and industrial chains, in a base year and over 20 years of analysis.

This paper focusses on the potential synergies among the four Caspian nations in a quantitative manner, with a special focus on the development of natural gas and crude oil interregional trades. The second part of Section 1 illustrates the present energy consumption levels of the four countries. Section 2 outlines the main characteristics of methods, models and the scenarios, and Section 3 shows some key results of the analysis.

## 1.2. Energy trade flows and infrastructures

In the Soviet Union period the Caspian region was able to export only to the Russian Federation and through the state-controlled Russian pipelines system, mainly through the Druzhba oil pipeline system and the Soyuz gas pipeline system. After independence in 1991, Azerbaijan and Kazakhstan partly untied from the Russian Federation. They constructed the 1.2 Mbb/d Baku-Tbilisi-Ceyhan pipeline (BTC, from Azerbaijan via Georgia to the Turkish coast) and the Caspian Pipeline

Company’s pipeline (0.7 Mbb/d) from Atyrau in Kazakhstan to Novorossiysk in Russia. The former allows a complete bypass of the Russian territory, the latter of the Russian ownership. In 2009 about 80% of the Kazakh export still passed through the Russian Federation (via Novorossiysk or Samara). Export of Kazakh oil to China started only in 2006, but with relatively small flows due to capacity limitations in Kazakhstan – an additional connecting branch needs completion – and in China – to receive and distribute more oil.

Export of Central Asia’s gas is even more dependent on Russia’s control. About 90% of the total export of the area went through Russia until 2009, mainly via the Central Asia–Centre pipeline system crossing Turkmenistan, Uzbekistan and Kazakhstan (CAC pipeline), with a combined capacity of 40 Bcm/a. Azerbaijan is the only CAC country that can export natural gas independently from the Russian Federation, through Turkey via the Baku-Tbilisi-Erzurum (BTE), up to a maximum volume of 6.5 Bcm/a. Recently the Central Asia – China gas pipeline started bringing Central Asian natural gas to East, highlighting China’s interest for Central Asian energy resources<sup>1</sup>.

## 2. Method: model and scenario analysis

### 2.1. Modelling approach

This scenario analysis uses an integrated 4-region energy model of Azerbaijan, Kazakhstan, Turkmenistan and Uzbekistan, called TIMES-CAC-4R. This bottom up technical-economic partial equilibrium model is built using the TIMES model generator developed by the Energy Technology Systems Analysis Program of the International Energy Agency [16].

The key-components of the single-region national TIMES models are the technologies for the production of primary and secondary commodities (supply side) together with the most representative appliances and devices of the demand sectors. Each model represents separately about 30 demand sectors, as many as shown in the consumption part of the national balances. The main demand drivers, along with the resulting projection of the weighted aggregate demand

<sup>1</sup> Gas from the transit Countries might sum to the amount from Turkmenistan and increase the overall export via the Central Asia–China corridor.

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