

# Natural Gas in the Context of Russia's Energy System

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**Abstract:** This article examines Russia's natural gas consumption in the context of stationary energy use, particularly the close linkage between electricity and heat supply. This interdependence will largely determine the prospect of domestic demand and will restrict the extent of adjustment. The author also investigates the constraints on gas production, exports, and imports.

**Keywords:** electric power, gas consumption, gas production, Gazprom, heat supply, UES (RAO-UES)

In Russia, as elsewhere, energy is used not in an abstract fashion but in concrete geographic space and, except in mobile machines, in a locationally concentrated manner. It is also consumed in a concrete world of existing equipment and specific technological applications. Energy production is similarly specific and particular, both in its various primary forms (raw fuels and hydro- and nuclear power) and in its location. However, the different primary forms in which energy is produced are not uniformly transportable nor uniformly applicable, efficient, or environmentally acceptable in the diverse technological processes. Energy demand, and the transport-delivery infrastructure to satisfy it, is, therefore, subject to pronounced inertia. The ghost of geography, which burdened the Soviet energy system in its last decade, also haunts that system in Russia today. In the 1980s, 65–70 percent of all fuels used in the European regions (the Urals included) of the USSR had to be shipped from Siberia and Central Asia; in today's Russia, also with three-fourths of the population in its European parts and the Urals, the share is significantly larger.

The enormous spatial discrepancy between consumption and production that characterized the energy complex of the late Soviet era, specifically the oil and gas sector, remains. Indeed, its significance has increased because a much larger share of oil and gas output is exported today, and these exports account for a greater portion of Russia's economy than ever before. Roughly one-half of the oil and one-third of the natural gas were exported in recent years, overwhelmingly through Black Sea and Baltic ports and pipelines to Europe. The sharp rise in prices and the increased volumes, at least until the middle of the present

decade, lifted the contribution of energy exports (nearly all of it oil and gas) to approximately 23 percent of Russia's GDP in the first seven months of 2006.<sup>1</sup> To plug the huge domestic deficit in European Russia and fill export pipelines and tankers, Moscow still depends on its West Siberian province and a pipeline system largely developed in Soviet times. Russian oil companies did increase production, construct and expand tanker terminal capacity, and build a few hundred kilometers of pipeline. The anemic growth in the gas sector, however, is due entirely to independent producers who work on small fields and to oil companies, both of which extract mostly fat gas—that is, gas high in heavier hydrocarbon molecules that need to be removed before interregional pipeline transport. Gazprom, the Russian gas monopoly, continues to live off its Soviet inheritance.<sup>2</sup> Although Gazprom's reserves have grown, much less has been done to access and prepare them for production and tap them with new pipelines.

Geographic and structural rigidities in the consumption pattern will therefore circumscribe the scope of change, possibly for a generation. The population and settlement structure on the one hand and the sectoral-technological structure of consumption on the other set severe limits on feasible shifts. Within these limits, adjustments, conservation, and substitution in a market economy will proceed to the extent that price signals convey correct information. Political exigencies, however, circumscribe such adjustments everywhere, at least in the short term. This is doubly true in Russia, still a very distorted market economy, in which the oil and gas sector fueled the recent boom in personal consumption and which faces momentous parliamentary and presidential elections in 2007 and 2008.<sup>3</sup>

This article focuses on natural gas, but in the context of boiler and furnace fuel use as a whole, particularly electric power generation. In 2005, Russia's aggregate fuel-energy consumption (including primary electricity—that is, hydro, nuclear, and geothermal power) amounted to 29.5 quads or 7,423,500 million kilocalories, roughly 30 percent of the U.S. total. Boiler and furnace use plus primary electricity are essentially equivalent to stationary consumption and in that year composed 76 percent of Russia's aggregate energy demand.<sup>4</sup>

This article first analyzes the consumption sphere, especially the electric power, household, and municipal sectors, which, when combined, accounted for some two-thirds of natural gas used domestically in 2005.<sup>5</sup> In the next ten to fifteen years these sectors will be the most technologically constrained to alter demand. In particular, the intertwining of the natural gas and electricity industries is a special feature of the Russian energy system. This symbiosis is critically important for the prospect of gas supply, energy conservation in stationary uses, social and environmental issues, and regional equity. This intertwining relationship cannot be altered significantly within the stated period. Equally important in the next ten years, the electric power sector and the household consumer are least likely to be fully exposed to the shock of price signals, but at the same time would not be entirely capable of responding to them. Following this section I examine constraints on natural gas supply to the Russian economy, a subject drawing extensive media coverage recently.

### **Natural Gas in the Boiler-furnace Fuel Balance and the Role of Electric Power Stations**

In recent decades, the transformation of mineral fuels into electricity, high-temperature heat, and steam has been the most striking technological trend in stationary use of energy the world over. Direct combustion of fuels in end-use installations has declined while

shares of precisely controllable electricity in industrial furnaces and electrochemical processes have sharply increased. This trend, together with the rising global supply of natural gas—which burns more cleanly and with higher efficiency in end-use equipment—more than compensated for thermodynamic losses associated with converting fuels to electric power. In addition, natural gas contributes to the economy both as fuel and as feedstock for a range of chemical products, being essentially the only feedstock for ammonia, the base for nitrogenous fertilizers, methanol, and similar products. It creates higher value-added as feedstock than as fuel, and as fuel it produces far greater economic and environmental benefit for households and municipal use than in industry.

In Russia today the contribution of natural gas in the aggregate fuel mix and, in particular, power generation is much larger than in most countries. The gas and power industries have their problems and prospects crucially intertwined to a far greater extent than elsewhere. Yet these two industries are joined, like Siamese twins, in an uneasy relationship by colossal supply-demand linkages that are critical for the economy and society. This also means that shifts in subsidies, price changes, and the implementation of investment strategies in one of these industries will ripple through the other—but to different degrees and at different rates across Russia's vast geographic space.

Natural gas and electric power industries have much in common. For both energy forms, a robust, interconnected system increases stability, reliability, and, all things being equal, reduces unit cost. For electric power supply, such systemwide operation also reduces the share of reserve capacity, essential given the nonstorability of electricity, which must contend with fluctuating demand. On the consumption side, the difficulty of switching suppliers has long made these industries natural monopolies, which deregulation has only recently been trying to eliminate and with only qualified success.<sup>6</sup> In addition, gas and electricity each represent both intermediate and final demand in an economy, with varying opportunity costs between the two and within the intermediate sector.

In Russia, however, the two industries share not only these similarities, but their problems are also so intertwined that no resolution is feasible in isolation. In both industries, the longer outlook requires technological remedies along the whole chain from supplier to consumer. For the short and medium terms, price increases and reforms must be faced. The latter, however, will introduce critical tensions between the two industries that will impact the coherence of the whole system. Price increases will not, and almost certainly cannot, be uniform either for the wide range of intermediate users or the final consumer. Institutional and enterprise trade-offs will be the subject of bargaining and direct and indirect pressures. Russian industry's competitiveness is strongly tied to the level of energy prices, particularly those for gas and electricity. With 3,000 m<sup>3</sup> of gas consumed per \$1 of GDP produced, Russia's economy has perhaps the highest gas intensity in the world today.<sup>7</sup> This, however, is largely due to wasteful use and the depressed share of high-value products in Russia's GDP.<sup>8</sup> Gazprom has acquired partial ownership of industries in the metallurgical, chemical, and petrochemical sectors and in regional power systems—the partial acquisition of Mosenergo being the most important.<sup>9</sup> All these will militate against the uniform treatment of consumers with respect to price reforms. Finally, the prospect of the gas and power sectors and the evolution of their relationship ultimately rest on decisions made or not made today and in the recent past. Inertia is built into both sectors because both are extremely capital intensive, with long lead times for project development.

In 2003, more than a quarter (approximately 26.5 percent) of all fuel that Russia consumed in stationary equipment on a heat value basis was supplied to electric power plants. Three features of that system constrain Russia's energy prospects: a) the low conversion efficiency of the country's power stations (only 36 percent), with only a small, declining fraction of the waste offset by economies of cogeneration,<sup>10</sup> b) the high share of natural gas in thermal stations in general, and c) its geographic pattern. Thermal power plants consume far more gas than any other fuel, of course, making the low conversion efficiency doubly poignant because gas represents a highly effective heat source. In Russia as a whole, gas composed more than 70 percent of the fuel mix of thermal stations, and gas produced approximately 48 percent of all power in 2005. The share of all electricity generated by gas, however, rises to 80 percent in European Russia, where three-fourths of the population live.<sup>11</sup>

Until recently, the thermodynamic efficiency of power plants burning natural gas could not be much higher than those of the most advanced coal-fired ones. Combined-cycle technology has changed that. Today, up to 58 percent conversion efficiencies can be achieved, some 20 percent better than those in modern coal-burning power plants. Most power units put on line in the United States and Western Europe in the 1990s and the early years of this decade were combined-cycle units. (Recent pessimism on reserves and price escalation will most likely restrain the growth of gas-burning power generation in the United States and Europe once those under construction are put on line.) In Russia, however, even gas-fired plants reach a mere 38 percent efficiency. Shifting all such stations to combined-cycle technology would save as much as 30 billion m<sup>3</sup>, or 27 percent of all gas that electricity generation consumed in 2005. While reconstruction is capital intensive and takes time, such investment should be greatly accelerated. Yet United Energy System (UES) plans for no more than half such stations to work on combined-cycle, even by 2015.<sup>12</sup>

### **Fuel Substitution, Conservation, and Price Policy**

Fuel substitution for gas is a more complex issue. It is also more economically and ecologically questionable. Fuel oil (mazut) can be readily used in most power plants, but until the gas price is completely deregulated it will cost far more. Economic rationality also calls for the gradual increase in the depth of oil refining (hence a reduced share of mazut), while the probable peaking of oil output hardly makes this a viable choice. This leaves substitution by coal-fired and nuclear power generation as an option, both of which fall far short of providing a solution in the next fifteen or more years. Presently, only twenty power stations, all in European Russia and originally planned for coal, could reconvert back to that fuel at a reasonable cost. Switching back would allegedly free 27 billion m<sup>3</sup> of natural gas but would demand the mining and delivery of some 40 million tons of extra coal.<sup>13</sup> UES's plan to raise coal use within four years by almost as much (from 121 million tons to 159 million in 2010) is unrealistic. Only the Kuzbas could provide such quantity after considerable lead time and investment, and current railways capacity cannot handle that extra freight. In the longer term, however, such expansion for coal-fired power plants should be realized. Gazprom already owns more than one-tenth of UES's shares, which are expected to be used for the expansion of coal-fired capacity in West and East Siberia. Recently, Gazprom acquired a controlling share in the Siberian coal company SUEK, which produces three-tenths of Russia's steam coal and also owns shares in large local power plants.<sup>14</sup>

Unlike much of the world, however, Russia cannot make coal the mainstay of its power generation even in two or three decades. In most of the developed world, and in China and India, coal is the dominant fuel in power generation, reaching from 75 to 80 percent in the United States, Australia, China, and India and more than 90 percent in South Africa and Poland. In all these countries, however, large accessible coal fields lie either fairly close to major consuming centers or near deep-water ports that can import the fuel cheaply by huge ocean-going colliers. (And one should not ignore the staggering health and environmental cost of coal in these countries, especially China.) Kuzbas coal, deep in Siberia, lies 2000 km east of the Urals and 2,800–3,500 km east of the major cities along the Volga river.<sup>15</sup>

With surplus hydropower just to the east, there is no regional power deficit. Despite serious pollution, the construction of modern coal-fired power stations and transmitting electricity to the Urals and European Russia could still make sense if the technical and economic problems of extra high voltage (EHV) transmission over such distances are solved. The Soviet regime worked on these tasks for many years and they have been pursued in North America as well. Yet nowhere in the world has EHV transmission been able to conquer such distances.

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UES management seems intent to continue with a gas-generating strategy west of the Urals, but realizes that maintaining previous growth rates for gas is impossible. Coal’s contribution to electric power generation is envisaged to increase from 27 percent at the end of 2006 to 37 percent by 2016, with a corresponding decrease in the share of gas. However, specialists doubt that financial resources and physical inputs for such substitution can be marshaled within a decade.<sup>16</sup> Most of the increase in coal’s contribution, if such plans materialize, should occur east of the Volga river, while gas would have to continue its overwhelming dominance in thermal stations west of that river. Given the huge scope for combined-cycle gas technology, not yet used in 2000<sup>17</sup> and now with only a handful of units on line and projected, some experts consider this not only ecologically but economically the most rational path. In addition, significant volumes of gas burned in power stations are lost through the leaky pipeline and distribution system, much of which could be saved through a systematic reconstruction program. However, all this would take time and will not eliminate the looming energy crunch in stationary energy use within the coming decade.<sup>18</sup> In the near and medium term, hope for substitution by nuclear power is also delusional, given long lead times, high unit costs of construction, and the fact that nuclear plants can substitute exclusively for power generation and not for plants supplying both heat and power for municipalities and industry. Bold plans to launch ten new nuclear reactors by 2015 in the most economically dynamic areas (the Moscow region, elsewhere in European Russia, the Urals, and the Far East) seem far too ambitious.<sup>19</sup> At any rate, however, a 1,000 MW nuclear station can replace not much more than 2 billion m<sup>3</sup> of natural gas per year, if turbines are on a combined-cycle regime, and 3–4 billion m<sup>3</sup> if they are not.

Gazprom is determined to limit gas supply to UES and press for the expansion of exports. Significantly, it estimates that gas needs for power stations in 2010 will be almost one-tenth lower than Anatoly Chubais, UES's chief, and German Gref, minister of Economic Development and Trade predict (168 billion m<sup>3</sup> versus 186 billion m<sup>3</sup>, respectively). Prime Minister Mikhail Fradkov said in early March that this large gap "should be eliminated by determining regional electricity needs *jointly* with regional governors and presidential envoys to the seven federal districts" (emphasis added).<sup>20</sup> Gazprom's ambitious export plans, the increasingly conspicuous role of energy in foreign policy, and the billions of dollars in damages the gas monopoly would have to pay for contract violations all put domestic consumers at a disadvantage against those in Western and central Europe. The newly independent states will be even more vulnerable. Still, the large discrepancy suggests significant conflict ahead. Putin has taken Gazprom's side as far as current export priorities are concerned, pressing for the greater use of coal and nuclear power, with the presidential staff allegedly working on a new strategy to meet the power industry's fuel needs.<sup>21</sup> Even a decade into the future, however, this is chimerical beyond the reconstruction of the twenty power stations originally built for both fuels.

Electricity consumption in Russia is growing much faster than anticipated. Demand in 2006 increased by more than 4.2 percent, spurred especially by the construction boom extending into, and partly counteracting, the effect of the unusually mild winter.<sup>22</sup> Moreover, among the sixteen regions where supplies are most strained are the economic engines of the country, such as Tyumen Oblast, the Moscow and St. Petersburg urban regions, and others along the Volga River and in the Urals. Power demand in the vital Tyumen energy system, for example, surged by almost 9 percent in 2006, in Chelyabinsk Oblast by 7 percent.<sup>23</sup> At a time of peak demand, a 6–7 percent deficit is forecast as early as 2010, but in the Ural Region and west of it in European Russia the deficit could be significantly more.<sup>24</sup> As noted, power generation in all metropolitan regions west of the Urals relies overwhelmingly on Gazprom's pipeline system, while in Tyumen Oblast associated gas from oil wells, produced by oil companies, is also significant. Clearly, the extent that demand management and conservation succeed in the uneasy, symbiotic relationship between UES and Gazprom will determine the seriousness of the looming energy shortage.<sup>25</sup>

Because the potential for conservation is immense, the degree that power sector reform and price liberalization will provide solutions is critical. An Italian energy expert cogently observed recently that private investment and price liberalization alone will not be the answer. "[C]apital-intensive power systems can only offer profitable returns over mid-to long-term. . . . Energy-efficiency measures . . . have to be coordinated in different sectors of the economy. These initiatives are therefore best approached institutionally and not left to market mechanisms alone." In particular, such measures require cooperation between producers and consumers (of intermediate and final demand) over an extended period. Such coordination is proving itself in Western Europe, with power companies providing funds for electricity savings and tariffs linked to power reduction over a specific time frame.<sup>26</sup> In Russia, institutional coordination should first of all mean such an endeavor between Gazprom and UES, and between each and the final consuming sectors concerning a) a coordinated rise in prices and b) investment to increase the efficiency of use.

The upsurge in prices is underway, but existing consumers will be provided protection and suffer only fairly modest hikes for the rest of this decade. Prices for new incremental users, however, are unregulated and by 2010 all industrial gas consumers should pay more

than \$100 per 1000 m<sup>3</sup> (compared with \$44 in 2006).<sup>27</sup> As for electricity, the average industrial consumer in October 2006 was still charged only the equivalent of 3.5 cents per kWh (90.84 kopeks), and the urban population half again that much.<sup>28</sup> Similarly, with natural gas, it will take until 2011 before a step-by-step increase in the share of unregulated prices will encompass the entire power market. According to UES, tariff increases for electric power have so far proven insufficient to balance the rising price of gas, and profits for the power monopoly in 2005 were down 43 percent.<sup>29</sup> Gazprom aims to command a number of wholesale generating companies for the acknowledged purpose of “optimization” in that sector. By a new agreement it will also control three-tenths of Russia’s coal output, overwhelmingly in Siberia and the Far East.<sup>30</sup> Given that electricity use is far easier to meter than the use of heat, inelasticity in power consumption may compensate with higher revenues.

In a recent forum, the changes anticipated on the domestic gas and electric power market generated anxiety and controversy among Russian experts. In fact, the argument is not unlike that which has raged about deregulation in the West and has no doubt been influenced by the Enron debacle. On the one hand, rising and, in five years, fully unregulated prices could spur modernization, investment in conservation, expanding supplies from independent producers and heightened interests even by Gazprom in the domestic market. Others, on the other hand, point to the risk of price liberalization under conditions of virtual monopoly. Where is the guarantee that prices will not be set arbitrarily and that increased revenues will be spent on developing new reserves in an increasingly extreme environment? Competitive markets evolve only in a situation of surplus; yet, for a number of years at least, constraints on supplies are far more likely, especially with new restrictions on foreign capital and Gazprom’s continued control of pipeline access. Independent producers, still with only one-tenth of aggregate extraction, may be far more dynamic but confront great risks from surging transport fees, which they cannot influence. Energy-intensive consumers (steel and heavy chemicals, among others) fear for their exports because of the expected hikes in gas prices, at least in the near term. Investment in modernization and energy saving to improve competitiveness will need to be substantial but will yield dividends only later. Sheltering industry through tax cuts and subsidies, on the other hand, will unavoidably shift the burden, directly and through inflation, to the population at large.<sup>31</sup>

For the power sector, by far the largest and most wasteful gas consumer, the critical window for radical reforms and liberalization seems to have closed. Because obsolescence in that sector reached 60 percent by 2005, it now ranks as one of the most dangerous of all industries, according to Vladimir Milov. Given that perilous state and the present wave of centralization, the essential need today is to secure sufficient state investment for modernization in the hope of relaunching reforms later. If the sector stagnates, starved of capital, improvement will be even less likely.<sup>32</sup> It also seems that conflict and subsequent coordination between the gas and power monopolies are unavoidable. A long-term compact, according to which Gazprom would supply fuel to the power monopoly until the end of this decade, is reportedly under negotiation, with the basic principles of an agreement already set up.<sup>33</sup> However, as of the end of June 2007, such an accord has not been reached. Indeed, *Finansovye izvertiya* quotes Chubais, CEO of the power monopoly, as saying, “During the nine years of my work at UES, my eyes have seen not one [set of] gas balance from Gazprom.” Nor, apparently, had Fradkov, who “unexpectedly” supported Chubais at an important meeting of the government commission concerning the development program for East Siberia and the Far East.<sup>34</sup>

Efficiency improvements in the heat supply and distribution are especially urgent. In 2000–1, UES, the electric power monopoly, overwhelmingly provided the largest, if declining, share of heat to the urban economy not used for industrial purposes from gas-fueled power plants and boilers. (That is, they furnished almost one-third of all heat supplied by public utilities, although not by individual boilers and stoves).<sup>35</sup> Market strategies, however, will find such a technologically interconnected system particularly difficult to tackle. At the beginning of this decade, less than one-tenth of the apartments were equipped with meters and regulation devices, while residential and public buildings accounted for two-thirds of all heat loss. Since the early 1990s, wealthier customers have been switching off district heating, leaving the system with decreasing economies and severe payment collection problems.<sup>36</sup> A mere 0.15 percent of the rapidly aging heat distribution network is annually replaced, compared with the minimum 4 percent needed.<sup>37</sup> And given the increasing insolvency of district heating systems losing their more affluent customers, it remains a huge burden for state and municipal authorities, with minimal attraction for the private sector or foreign capital. This, of course, means that in smaller cities with fairly low heat loads, putative savings from monitoring may never cover the installation, maintenance, and service cost of metering devices and activities. And by extension, this will apply to larger cities, too, once enough customers opt out of central heating in their districts. Very little research has been done about consumer behavior concerning heat consumption and tariffs. It is safe to say, however, that monitoring and, as far as possible, optimizing steam and hot water distribution through tens of thousands of multistory Soviet-era buildings will take years, costing many billions, as it did in former East Germany. Such technologies, however, are available and well proven elsewhere and should be vigorously pursued both through institutional coordination and price incentives. Electricity conservation through more efficient lighting can be accomplished far more quickly and easily, but can save only a small portion of energy wasted.

Rising gas prices have also affected other industries already, particularly the chemical and metal industries, each accounting for approximately 7 percent of Gazprom's domestic deliveries (some 43 billion m<sup>3</sup> combined). In the former, the cost of gas composes 40–80 percent of total cost today; in the latter, 8–14 percent.<sup>38</sup> A large segment of the chemical industry will clearly suffer. Almost two-fifths of ammonia production in Russia was under Gazprom's control in the early part of this decade, ensuring finances for modernization and uninterrupted gas deliveries. The rest of that industry, however, has "neither finances for modernization, nor feedstock due to very limited quotas and [beyond quotas] much higher prices for the gas," according to one specialist.<sup>39</sup>

### **Export versus Domestic Demand and Prospects for Gas Supply**

The Russian gas industry is at a critical junction. Before domestic and export prices at the border equalize, with due incorporation of transport costs, conflict between demand priorities is inevitable. Until 2020, Gazprom allegedly has contracts for exporting a cumulative volume of 2.2 (according to another source, 2.5) trillion m<sup>3</sup> worth more than \$250 billion. Long-term export contracts are "for certain to be extended," according to Viktor Khristenko, minister of Industry and Energy.<sup>40</sup> At the same time, rapid GDP growth and the rising income of the urban population resulted in increasing domestic demand for both electricity and gas, and constraints on energy supplies will impede economic growth,

according to experts. The five years from 2000 through 2004 saw Russian gas consumption increase 18 percent (a 2.8 percent annual growth), and a gas demand–GDP elasticity of 0.7 percent. By 2010, with current trends holding, Russia may not fulfill even the current gas contracts in their entirety, and much larger deficits could follow. Domestic shortages would curtail the expansion of GDP below 5 percent. Other sources see an even greater imbalance, with the specter already on Russia's doorstep.<sup>41</sup>

With all gas prices free to float by 2011, Gazprom, in theory, should be indifferent as to whether it sells abroad or domestically, once transport costs are accounted for. In reality, however, the export market will still carry extra benefits absent on the domestic one, even in the purely economic sphere. As Milov notes, Gazprom can immediately securitize its long-term contracts and the income expected from them, underpinning loans and guaranteeing the monopoly's financial system. This is extremely attractive and may never exist domestically.<sup>42</sup> As noted, the giant German and French importers have already extended their contracts until 2030 and Italy's Eni until 2035. At any rate, the home market is a captive one for Gazprom. It can trade "above limit" (*sverkhlimitnyi*) gas at much higher prices at whatever the domestic consumers can bear. Only two-thirds of all gas for UES was to be within such price limits by the fall of 2006, but Gazprom would not release even the more expensive balance to electric power stations. And the monopoly can, and allegedly does, manipulate prices even on the gas exchange by tinkering with the volume it is willing to transport for independent producers.<sup>43</sup>

A number of recent studies by European and Russian research institutes, the International Energy Agency (IEA), and UBS AG, Europe's second-largest bank, all foreshadow a future shortfall.<sup>44</sup> According to the IEA, as early as 2015, nearly 200 billion m<sup>3</sup> of extra gas will be needed from newly developed deposits, assuming no additional Central Asian imports. 2010–20 will see output declines in old reserves almost evenly matching demand for new gas in yet-to-be-opened fields within Gazprom's domain. Jonathan Stern computed similar declines for 2004–20, showing accelerating decreases for most major deposits.<sup>45</sup> We also know that water incursion, and consequent loss of producible reserves, has become a serious problem, leading to the loss of 15–20 percent of extractable reserves throughout Russia. In the critical fields of Northwest Siberia, such loss amounts to five years of cumulative extraction at the current level.<sup>46</sup> The IEA lists a range of uncertainties, such as timely investment in extraction at new fields and in transportation and distribution efficiency, the likely contribution by independent producers, and the volume of available Central Asian gas. Most of these would have to be positively resolved to avoid a shortfall.<sup>47</sup>

Two additional issues add to the uncertainties of estimating the current volume of domestic consumption and, still more, projecting Russian gas demand. One is the internal use of gas (mostly at oil fields) produced but not sold, escaping reliable statistics about consumption. For example, in 2005 non-Gazprom producers extracted 94 billion m<sup>3</sup> of gas (49 billion of them by oil companies) but sold 20 billion m<sup>3</sup> less.<sup>48</sup> The second is the existence of four unconnected nodes in East Siberia and the Far East.<sup>49</sup> They are minor markets with major but very difficult reserves nearby, such as the Sakhalin-1 and 2 offshore deposits and the giant Kovykta gas field, until this year in majority foreign ownership. The Kremlin's political objectives via Gazprom clearly will determine future extraction in these regions, an issue briefly discussed later. It seems most of the difference in various estimates of Russia's aggregate gas consumption in the middle of the present decade, ranging from 400 billion m<sup>3</sup> to 445 billion m<sup>3</sup>, can be attributed to these uncertainties.<sup>50</sup>

By 2005, the balance of domestic gas demand and supply availability in Russia was already very tight. The rapid economic expansion of the decade has stoked increases in Russia's gas consumption. As noted, consumption grew at an annual rate of 2.8 percent from January 2000 through 2004, then jumped still more in the harsh winter of 2005–6. In 2005, Gazprom sold 307 billion m<sup>3</sup> to Russian consumers while independent gas producers and oil companies sold 74 billion m<sup>3</sup>. If we add the 206 billion exported to all markets and Stern's 2004 figure of 52 billion for pipeline losses and compressor-station use, the numbers add up to match Russia's aggregate production of 640 billion m<sup>3</sup> in 2005.<sup>51</sup> Such growth in domestic demand cannot be maintained, and it is surprising that the monopoly would undertake an ambitious regional and rural gasification program this decade. That program is to expand the distribution network to reach 62 percent of the population as opposed to the present 54 percent. With close to \$1 billion already spent and almost as much earmarked for 2007, seven million citizens in fifty-three regions are affected.<sup>52</sup> No economic justification can be given for that project, which, however, illustrates Gazprom's social and political role and its fusion with Russia's "commanding heights." After all, 2007 and 2008 are election years.

The marked increase in domestic gas consumption, "is a major factor haunting the Kremlin," in the words of Roman Kupchinsky. Domestic demand jumped 17 billion m<sup>3</sup> between January 2004 and December 2005, then by as much as 27 billion during 2006 according to BP's latest Statistical Review of World Energy.<sup>53</sup> Such growth would raise domestic consumption to nearly 500 billion m<sup>3</sup> by the end of this decade and much more afterward, if pipeline use and losses are included. Exports, which beyond the CIS remain a priority for Gazprom and critical for Europe, would come on top of that. Although such increases in domestic demand cannot be maintained, Industry and Energy Minister Khristenko predicts that a volume of aggregate consumption reaching 470 billion m<sup>3</sup> by 2010 and 495 billion five years later "will be satisfied in full."<sup>54</sup> Because Gazprom's own production remains stagnant,<sup>55</sup> independent gas firms, oil companies, and imports from Central Asia must provide nearly all growth.

### **Independent Producers**

Independent producers form a very diverse group with little shared interest and only a few dominant players. In 2006 independent gas firms and oil companies extracted 105 billion m<sup>3</sup>, roughly evenly divided between gas and oil companies. As noted, non-Gazprom producers extract mainly fat gas (rich in heavier hydrocarbon molecules), which cannot be transported long distances unless processed. As a result, only about 80 percent of that gas was sold at middecade, the rest used in-house, mostly by oil companies. Yet even Novatek, the largest independent gas company, produced fewer than five percent of Russia's aggregate gas output, and Gazprom continues to acquire assets from smaller firms.<sup>56</sup> While Novatek can now process fat gas in its own plant, smaller companies depend entirely on Gazprom's facilities. Without exception, independents and oil companies must use Gazprom's pipelines for interregional transport and, according to Milov, the monopolist now charges tolling fees that are beginning to approach European levels.<sup>57</sup> It is doubtful that non-Gazprom producers could furnish nearly half of all (domestic) deliveries by 2010, up from fewer than 30 percent today, as Khristenko asserted last November.<sup>58</sup>

Oil companies have their own interests, with gas output and utilization mostly subordinated to their plans to extract the far more transportable liquids. Increasingly, tight elec-

tricity supplies and transmission bottlenecks have forced petroleum producers to generate much of their own power from associated (oil well) gases. (Massive outages during the harsh winter of 2005–6 resulted in the shutdown of many wells in West Siberia). Surgutneftegas already produces a quarter of its electricity in-house, with Lukoil and TNK-BP producing smaller shares. Interim construction of small and midsize generating capacity is underway throughout Tyumen Oblast and the Urals region.<sup>59</sup> Gas flaring, as elsewhere in the world, clearly wastes a huge part of this resource, in addition to contributing significantly to the emission of greenhouse gases. Russia qualifies for carbon finance through the Kyoto mechanism, in addition to the market value of flared gas. However, relatively low flow rates, distances to major consumption centers, and the uncertainty of future tolling fees by Gazprom act as disincentives to major investment by oil firms to reduce that wastage. More associated gas will no doubt be consumed as in-house power-station fuel by oil companies, given the persistent electricity shortage. This could ease the pressure on natural gas for electricity generation, but only in certain regions. At the same time, the aging of existing oil fields and the unrelenting growth of power demand on the arctic and Siberian resource frontier will counteract such economies.

### **Uncertainty and Equivocation**

Gazprom's latest document projects \$343–\$420 billion in investment needs by 2030. Yet for 2007 the monopoly actually lowered previously planned increases in its capital outlays, given its recent expensive purchases (Sakhalin Energy, Beltransgas, Mosenergo), heavy debt burden, and last winter's reduced revenues because of the uncommonly warm weather.<sup>60</sup> Yet the warm weather cannot explain the officially given 11 billion m<sup>3</sup> (23.5 percent) export cutback to Europe and its worth of \$2.6 billion in the first quarter of 2007. Gazprom is silent on the matter, but the "take or pay" contracts imply that importers have already paid and would not have abandoned such a volume. Instead, they would be injecting it into underground storage, if they have not already done so.<sup>61</sup> Regardless of what explains last winter's discrepancy, all evidence points to strained supplies in the forthcoming years. In fact, before he was fired (resigned) over another internal issue, Gazprom's former deputy head openly conceded that the monopoly cannot meet export and domestic demands simultaneously, as supplies from the Yamal Peninsula will not reach consumers until 2012–13 at the earliest.<sup>62</sup>

More recently, complete uncertainty has crept into official pronouncements. Gazprom's deputy chairman, Alexander Ananikov, declared that the monopoly by 2020 may produce not the planned 590 billion m<sup>3</sup>, but as much as 670 billion m<sup>3</sup>. (So it also "may not"? asks a reporter sarcastically.<sup>63</sup>) Still wilder claims by the governor of Yamal District about the region's output reaching 730 billion m<sup>3</sup> by that same date (2020) must be dismissed as pure chimera. Given the depletion rate of current fields, such a volume would demand at least 250 billion m<sup>3</sup> of new capacity, with respective transport expansion, more than half of it on the Yamal Peninsula itself. Another hint of the indeterminacy of Gazprom's long-term plans is surmised from a reference to its latest document, "General Scheme of Development," which allegedly examines eighteen scenarios until 2030. But equal ambiguity characterizes the monopoly's plans for the near term.<sup>64</sup>

As with extraction, Gazprom has not prepared for the rising need. Through 2000–6, it targeted less than one-tenth of its capital outlays for increasing pipeline capacity and most of it went to expand exports near Russia's western borders.<sup>65</sup> It has neglected the development

of smaller deposits south of the Yamal Peninsula. From 2000–6, it invested one-fifth of its aggregate outlays into developing new production. In the same period it has spent more on acquisitions and non-gas-related business than on developing new reserves, and so far in 2007 it continues with such investment policy.<sup>66</sup> It has also limited the use of its facilities by independent producers. On the other hand, the postponement of the Yamal Peninsula itself for more than a decade was, on the whole, justified, given the enormous difficulties, capital requirement, and long lead time. It is doubtful that gas from the peninsula could have yielded profit even at prices expected in 2010.<sup>67</sup>

Beyond the latter part of the 2010 decade, only one thing is clear. The accelerating decline of Gazprom's supergiant fields near the Ob estuary means that new supplies from the Yamal Peninsula, when they arrive, will merely compensate for depletion. Also, without that gas, Russia can only fill half of the Baltic undersea pipeline capacity.<sup>68</sup> Construction startup on the seabed of this highly controversial pipeline has been postponed, most likely until 2009, for environmental reasons and inadequate information provided to the affected states, shortages of steel pipes, and financial delays. Studies and negotiations are underway concerning significant changes on four sections on the sea floor. Even the overland section on Russian soil is behind schedule.<sup>69</sup> In this light, speculations about the underlying reasons for Gazprom's changed plans for the colossal Shtokman offshore field from liquefaction to eventual pipeline shipment on the mainland may also have some credibility. If in the next fifteen to twenty years the reserves available to satisfy both domestic and export demands are indeed constrained, assigning all of Shtokman's production to the pipeline for Western Europe in its first two stages is plausible. Gazprom's deputy head asserts that Shtokman will be open by 2013, with the first volume flowing into pipes a year later, to the doubts of most experts. Frederic Hauge, chief of Norway's Bellona Foundation, believes the field will not be on line before 2035.<sup>70</sup>

Shtokman will face unprecedented technical challenges such as fast-moving icebergs, ice flows, and an uneven sea floor for pipelines. In addition, the almost 600 km distance from the mainland means that natural pressure will not bring the gas to shore. Undersea compressor stations must be constructed on special platforms.<sup>71</sup> While Gazprom intends to subcontract for Western technology, it is certain that no gas from here will surface for a long time. Because Gazprom cannot develop both megaprojects (the Yamal Peninsula and Shtokman) simultaneously, even with substantial Western subcontracting, it will likely give the onshore Bovanenko field on the peninsula priority. Meanwhile, even with more substantial contribution by independent producers and domestic market prices (which will surely curb consumption), a gas deficit from the end of the present decade is unavoidable. Economies from this year's unusually mild winter will not be repeated each year.

### **Gas from Central Asia**

In the last two decades of the Soviet era, European Russia and Ukraine, and other western republics, became heavily dependent on massive oil and gas flows from Tyumen Oblast (northwest Siberia) and from Central Asia. Given the more forbidding location of gas reserves and much greater transport constraints on this fuel than on oil, the Tyumen gas deposits were tapped a decade later than the region's oil fields. Each year, through most of the 1970s, Uzbek and Turkmen fields piped more gas to the Urals and European regions of the USSR than did the fields of Siberia. They remained critical suppliers until the end of the Soviet era. The disintegration of the Soviet Union and the collapse of much of its

military-industrial complex and energy-intensive industries created a gas bubble. In the first post-Soviet decade, therefore, Russia had no need for Central Asian gas. Gazprom blocked Turkmen gas exports to the European market, directing the flows exclusively to Ukraine and the Caucasus. The gas surplus enabled the Kremlin to foil attempts by Turkmen dictator Saparmurat Niyazov to raise prices and easily weather his drastic cuts in supplies for several years.

All this changed in the present decade. The resurgent and highly energy-intensive Russian economy, growing consumer demand, and increased exports all combined to swiftly augment the need for more gas. Because reserves in Siberian deposits were not being replaced, Central Asian gas rapidly assumed critical importance for the Kremlin. So did more complex reserves in Kazakhstan. At their tripartite summit on May 12, 2007, Putin signed a "framework agreement" with Turkmenistan's new president and with Uzbek President Islam Karimov. They concurred that Russia would restore and enlarge the worn-out Central Asia–European Russia trunkline system plus a smaller pipeline along the Caspian shore, which would be further expanded much later. By 2010, the system would transmit a full 100 billion m<sup>3</sup>, with another 20 billion m<sup>3</sup> transmission capacity added in the second half of the 2010s.<sup>72</sup> A framework agreement, however, is not a formal contract. Recent reports indicate serious difficulties ahead, with no guarantee that such a treaty will be signed in September 2007 as intended, although the contract for current deliveries will expire at the end of 2009.<sup>73</sup> Whatever the outcome of these negotiations, it is doubtful Moscow can count on 100 billion m<sup>3</sup> from Turkmenistan. No independent outside confirmation exists today about the size and condition of that country's gas reserves, nor of the technical state of the Turkmen gas industry. Mystery shrouds an allegedly massive, but complex, discovery at South Yolán, where China's CNPC holds drilling, but no production, rights.<sup>74</sup> Ashgabat and Beijing continue negotiations, began by recently deceased president Niyazov, though the Chinese government is unlikely to agree to the \$100 per 1,000 m<sup>3</sup> price that the Turkmen leadership seems to have in mind.<sup>75</sup>

Moscow seems to find the new Turkmen president, Gurbanguly Berdymukhammedov, no easier to deal with than his predecessor. It is true that, for the forthcoming decade at least, and probably longer, Central Asian countries will find market diversification even more difficult than Russia. Their pipeline connections lead toward that country and through it to other former Soviet states. On the other hand, political control over the population is far greater than in Russia, and in the largest gas producer, Turkmenistan, the population is not only isolated but small. This should give the Turkmen government as much leverage over Moscow as the latter has over Ashgabat.

### **The Far East**

Until now, Gazprom was absent from East Siberia and the Far East. Gas reserves and the isolated pipelines were under company and regional ownerships. But this has changed. Gazprom forced its way to majority ownership in the huge Kovykta field (until this year, chiefly the property of TNK-BP) and the Sakhalin-2 integrated offshore oil-gas and liquefaction project, probably the largest of its kind in the world. And most recently, the Russian government and Gazprom are pushing to prevent ExxonMobil, a consortium leader for the Sakhalin-1 complex, from selling gas to China via a pipeline to the mainland across the Tatar Strait. Russia's gas monopoly wants that gas for Far Eastern consumers, whose need in the four southern regions exceeds 15 billion m<sup>3</sup>. "Like it or not," claims the deputy

minister for Industry and Energy, we have “. . . a law. . . . [T]here exists only one window [i.e., Gazprom] for export.” That law is supposed to exempt the few product-sharing agreements, but the latter have been under assault recently, as the Kremlin consolidates its control over Russia's energy sector.<sup>76</sup>

Gazprom's objectives and posture regarding the two Sakhalin projects may now be different. After gaining a majority (51 percent) share in the nearly completed Sakhalin-2 project, with its giant liquefaction plant, the monopoly will most likely focus on acquiring expertise in liquefied natural gas (LNG) technology and will not block further cooperation with its foreign partners. So far it has no experience with gas liquefaction and transport, which are the fastest-growing aspects of the global gas industry. Gazprom appears keen to acquire expertise here for the future. Pipeline transport and supply are another matter. They have always been part of the monopoly's profile and means of exercising control. But they also have been a socioeconomic obligation and an economic burden. Even today, with rising domestic prices, Gazprom makes most of its profits on export sales, and the household market continues to be subsidized.

### Conclusion

Transport and environmental constraints have played critical roles in energy development everywhere, but particularly in Russia. As the frontiers of fuel production expand into the high Arctic and East Siberia, this will be even more true. Such a move multiplies capital, technology demand, and the lead time for projects, making timely supply responses to demand increasingly difficult. This applies with particular force to natural gas, which is far more costly to transport than crude oil and is burdened with locked-in rigidities between fields and consuming centers that make supply diversification infeasible except over the long-term. The extensive, multifaceted transport infrastructure that ships West Siberian energy westward, particularly the giant gas trunkline system (but also oil pipelines and ports), has locked Russia and Europe into mutual dependency. Even regarding the largest importers, however, this interdependence is asymmetrical. Sudden disruptions can expose consumers to immediate vulnerability, which rebounds on the supplier, politically and economically, only with a time lag. Yet market diversification overall will be no less difficult for Moscow than supply diversification for Europe. It cannot happen for at least a decade.

In contrast to past disinterest, Gazprom has now elbowed itself into reserves and major projects in Russia's Pacific half. It is eager to move into Eastern markets, especially through the acquisition of LNG technology. This, however, is music for the more distant future. Presently, Duma and presidential elections loom and immediate political-social issues take precedent. The ongoing program of regional gasification and the expansion of the gas network to more settlements and neglected regions testify to that. Over the next decade or so, any notion of diverting any more than a tiny fraction of Russia's energy exports toward the Pacific Basin is a mirage.

Meanwhile, Gazprom's monopolistic control and its failure to prepare new supplies from smaller fields around the Ob estuary will result in a supply crunch in forthcoming years. On the other hand, neither the available technology nor prices until the end of this decade would have justified aggressive investment on the environmentally superfragile Yamal Peninsula, let alone Shtokman, the offshore giant in the Barents Sea. Nor are the necessary volumes of Central Asian gas guaranteed in time, especially from Turkmeni-

stan. The technical state of the gas industry and the pipeline system east of the Caspian is in poor shape and the full size of reserves has never been verified by outside observers. Recent pronouncements by Russian spokesmen concerning supplies, exports, and domestic demand suggest major uncertainties. At the same time, downstream within Russia structural rigidities of the consumption pattern will circumscribe the extent consumers can respond to price rises in the short term. As this article outlines, the intertwining of the gas and electric power industries in the European parts of the country has a particularly strong influence on stationary energy demand. Price increases in the two monopolies will have to be coordinated, increasing the economic and political impact. It seems also certain that higher prices and supply constraints will impact CIS consumers even more than those in Russia.

### NOTES

1. From the official Web site of the Ministry of Economic Development and Trade, a value of \$117.25 billion for aggregate energy export was calculated for January through July 2006 as the weighted average of exports to the far abroad and the CIS from their respective shares. See Ministerstvo Ekonomiki Razvitiya i Torgovlya Rossiyskoi Federatsii, "O Tekushchey Situatsii v Ekonomike Rossiyskoy Federatsii, v yanvare–yule 2006," Vneshneekonomicheskie svyazi, <http://www.economy.gov.ru> (accessed August 23, 2007). The GDP estimate of \$504 billion (at the official exchange rate) for the seven-month January through July period was taken as seven-twelfths of the IMF forecast for all of 2006. See [www.econstats.com/weo/C132V019.htm](http://www.econstats.com/weo/C132V019.htm) (accessed July 12, 2007) Compared with 2000–1, I computed an average of 17 percent a few years ago from a Web site of this ministry, which has since disappeared. A ministry official also stated that the oil sector alone contributed almost one-third to overall economic growth in the first half of 2006, when oil prices were increasing. That share for oil varied between nearly 18 percent and 20 percent from 2001 through 2004 and increased to 30 percent in 2002; see Shinichiro Tabata, "Observations on the Influence of High Oil Prices on Russia's GDP Growth," *Eurasian Geography and Economics* 47, no. 1 (2006): 102.

2. For example, almost 90,000 km of gas trunkline consisting of forty- to fifty-six-inch pipes (and another 60,000 km from twenty-eight- to forty-inch pipes) was laid during the final fifteen years of the USSR, and most of the large-capacity compressor stations also were installed after 1970. The twenty-one-string forty- to fifty-six-inch pipeline bridge from the Yamburg and Urengoi fields alone constitutes the largest energy flow in the world today aside from that which passes through the Strait of Hormuz.

3. Shinichiro Tabata concludes his latest research on what underpins Russia's recent economic expansion with these words: "There has been little *direct* influence of high oil prices on GDP growth in Russia. . . . [T]he increase in oil export revenues prompted a considerable increase in personal consumption, nearly half of which was traced to imports. We can therefore characterize the Russian economic boom as *personal consumption-led growth fueled by oil and gas exports*" (emphasis added); see Tabata, "Observations on the Influence of High Oil Prices," 110–11.

4. A quad (quadrillion Btu) is equivalent to one trillion cubic feet of natural gas, 170 million barrels of oil, or 45 million tons of quality coal. U.S. consumption in the same year amounted to 98.2 quads. For Russia, I allocated all mazut consumption to boiler and furnace fuels and all diesel products to mobile uses. In each case a very small but unknown amount should be counted in the opposite category. Data from [http://www.eia.doe.gov/emeu/world/country/cntry\\_RS.html](http://www.eia.doe.gov/emeu/world/country/cntry_RS.html) (accessed August 15, 2007).

5. Y. Yarigin, "Implementation of Modern Approaches to Reconstruction and Recovery of Gas Distribution Systems: Russian Experience," Paper presented at the 23rd World Gas Congress, Amsterdam, 2006, <http://www.igu.org/html/wgc2006/pdf/paper/add10800.pdf> (accessed July 12, 2007).

6. As Paul Krugman writes, "[T]o make competition possible, a deregulated electric power industry needs considerable more transmission capacity than one based on regulated monopolies."

"The Road to Ruin," *New York Times*, August 19, 2003, 21. See also Paul Krugman, "Another Friday Outrage," *New York Times*, September 2, 2003, 23. Much the same goes for natural gas. It is significant, and generally ignored by proponents of deregulation, that both the electric power and the natural gas industries have only a very marginal presence on the futures' market, following the disastrous experiment in California and less than stellar ones elsewhere. It should also be noted that the push for deregulation and liberalization in the EU has led to increasing demand for gas, hence growing dependence on imports—a consequence that only recently seems to have been recognized by proponents of liberalization of the electricity market. "Deregulation and competition rules put the burden of funding investment on financial markets instead of the public purse . . . [making] financial costs higher than for public utilities. . . . The increase in financial costs favours technologies with lower initial investment costs—that is gas." Jerome Guillet, "Liberal Markets Create an Addiction to Gas," *Financial Times*, February 1, 2007.

7. Natalya Porokhova, "Illyuzii i realii gazozameshcheniya," *Neft i kapital*, August 8, 2006, [http://www.oilcapital.ru/analytics/2006/08/081215\\_95567.shtml](http://www.oilcapital.ru/analytics/2006/08/081215_95567.shtml) (accessed July 10, 2007).

8. In addition, the freeing of more transportable crude oil for export through gas substitution has been an economically rational choice. As to coal, location and environmental costs drastically limit the utility of this fuel.

9. "Gazprom stal vladeltsem 49.899% obyknovennyky aktsii 'Mosenergo,'" RIATEKH News, August 19, 2007, <http://www.riatec.ru/shownews.php?id=41585&RiatecSess=902058a5e841b2872e75852d3836ce2b> (accessed August 16, 2007); "Mosenergo Stake Takes Gazprom Closer to Becoming Gas/Energy Corp.," ITAR-TASS Weekly News, October 3, 2006, <http://dlib.eastview.com/searchresults/article.jsp?art=0&id=10135391> (accessed July 10, 2007).

10. Russian thermal plants required, on the average, 2,366 kcal or 9,388 Btu (338 grams of standard fuel [black coal equivalent in my source]) to generate 1 kWh of electricity in 2003. One-hundred percent conversion efficiency would equal 3,415 Btu. See OAO Promgaz, *Gas to Power: Russia*, 2006, <http://www.wgc2006.nl/files/sprb/Gas%20to%20Power%20Russia.pdf> (accessed July 10, 2007). At this average efficiency, the 569,718 million kWh generated required 26.5 percent of all the calories consumed by stationary equipment in 2003. See [http://www.eia.doe.gov/emeu/world/country/cntry\\_RS.html](http://www.eia.doe.gov/emeu/world/country/cntry_RS.html) (accessed August 15, 2007). OAO Promgaz's *Gas to Power: Russia* report attributed 610,000 million kWh to thermal plants in 2004. See also Fedor Chayka, "Mikhail Fradkov, Ob osvoyenie dalnevostochnykh nedr," *Finansovye izvertiya*, June 19, 2007.

11. Porokhova, "Illyuzii i realii gazozameshcheniya." Electric power stations (Porokhova apparently refers only to those connected to the grid) used 110 billion m<sup>3</sup> in 2005. Nikolai Gorelov and Aleksei Grivach, "Kto sogreyet v kholoda," *Vremaya novostei*, September 20, 2006, <http://www.vremya.ru/2006/171/8/161381.html> (accessed July 10, 2007). The gas burned to produce electricity in any generator (including generators belonging to enterprises, institutions, and so on) totaled roughly 170 billion m<sup>3</sup>—that is, 46 percent of that which reached domestic customers, according to an October 2005 report; see Igor Bashmakov, *Energeticheskaya effektivnost v Rossii i perspektivy eksporta rossiyskoi gaza*, Tsentri po effektivnomu izpolzovaniyu energii, <http://www.cenef.ru/info/books/GasExportsProspects.pdf> (accessed July 10, 2007). In 2005, supply shortages reduced this total by at least 11 m<sup>3</sup>. Igor Tomberg, "Export Interest above All?" RIA Novosti, September 26, 2006, <http://en.rian.ru/analysis/20060926/54287406.html> (accessed August 10, 2007).

12. Porokhova, "Illyuzii i realii gazozameshcheniya."

13. In 2005, 59 million of the 79.6 million tons exported went to Europe and the Near East, the great bulk of it from the Kuzbas. Earlier in this decade, the Kuzbas also supplied 14.5 million tons to enterprises in European Russia; see review of "Russian Coal Export Deliveries and Coal Imports to Russia in 2005," <http://www.rosugol.ru/eng/index.html>, and Economic Commission for Europe, *The Coal Industry in the Russian Federation*, March 4, 2004, figure 4, <http://www.unece.org/ie/se/pdfs/coal6e1e.pdf> (accessed July 10, 2007). All Kuzbas mines are also subject to particularly high methane gas, the explosion of which accounted for 40 percent of all deaths in the collieries in the past five years, including the most recent one in a modern mine; see "Vse shakhty Kuzbassa opasny po bzryvam I ugolnoy pyli," *Neft i kapital*, March 28, 2007, [http://www.oilcapital.ru/news/2007/03/280924\\_107017.shtml](http://www.oilcapital.ru/news/2007/03/280924_107017.shtml) (accessed August 14, 2007).

14. Sergey Pravosudov, "RAO navsegda," *Neft i kapital*, March 29, 2007, [http://www.oilcapital.ru/analytics/2007/03/291124\\_107101.shtml](http://www.oilcapital.ru/analytics/2007/03/291124_107101.shtml) (accessed July 10, 2007); Ivan Rubanov, Dmitry Sivakov, and Andrey Vinkov, "Privatizatsiya energobalansa strany," *Ekspert*, February 2007, [http://expert.ru/printissues/expert/2007/07/privatizaciya\\_energobalansa\\_strany/](http://expert.ru/printissues/expert/2007/07/privatizaciya_energobalansa_strany/) (accessed August 15, 2007).

15. Even in the United States, long overland hauls of cheap, surface-mined coal from eastern Wyoming very rarely exceed 2000 km, and development of both the mines and transport facilities started decades ago, following the 1973 energy crisis.

16. Porokhova, "Illyuzii i realii gazozameshcheniya"; Pravosudov, "RAO navsegda."

17. B. G. Saneev, A. V. Lagerev, V. N. Khanaeva, A. V. Tchemezov, "Outlook of Russia's Power Industry Development in the 21st Century and Greenhouse Gas Emissions," Power Engineering Society General Meeting, Institute of Electrical and Electronics Engineers, Volume 4 (July 2003): 13–17.

18. Raising efficiency to 50 percent in every gas-fired unit is clearly impossible (it would produce an economy of more than 50 billion m<sup>3</sup>) but should be aggressively pursued in UES plants. Combined with the savings produced by cutting pipeline leakage in half, 60–65 million m<sup>3</sup> could be available. See Alexander Golub et al., "Economic Growth, Fuel Mix and Air Quality in Russia," Environmental Defense, 2003, [http://www.environmentaldefense.org/documents/2878\\_fuel-mix\\_05\\_view.pdf](http://www.environmentaldefense.org/documents/2878_fuel-mix_05_view.pdf) (accessed July 10, 2007); and Igor Babanin and Vladimir Chuprov, "Sokrashchenie potrebleniya prirodnogo gaza i perspektivy elektroenergetiki . . .," *RELGA: Gazeta soyuza zhurnalystov*, October 24, 2006, <http://www.relga.ru/Environ/WebObjects/tgu-www.woa/wa/Main?textid=1138&level1=main&level2=articles> (accessed July 10, 2007).

19. Judith Perera, "Power Market Developments; Russian Future Map," *Nuclear Engineering International*, January 18, 2007.

20. Anatoly Medetsky, "Cabinet Disagrees on Gas Production," *Moscow Times*, March 5, 2007, 7.

21. Y. Grishovets and N. Grob, "Kremlin Activates Coal," *Kommersant*, September 19, 2006.

22. Vladislav Dolgov, "Spasibo teploi zime," *Nezavisimaya gazeta*, January 18, 2007.

23. A. Kilichev, "Chubais peredumal," *Novaya izvestiya*, September 19, 2006, 1; V. Korchagina, "Electricity Grid Facing Acute Crisis," *Moscow Times*, August 22, 2006, 7; Ludmila Kolbina, "Naleyte uspkoinu," *Ekspert Ural*, no. 27, July 16, 2007, [http://www.expert.ru/printissues/ural/2007/27/upravlenie\\_energetikoy](http://www.expert.ru/printissues/ural/2007/27/upravlenie_energetikoy) (accessed August 14, 2007).

24. See "Narastayushchie moshnosti," *Ekspert reytingovoe agenstvo*, for the looming power deficit in major regions. UES accounted for approximately 90 percent of the nearly 217 GW-generating capacity in Russia in the middle of this decade. See <http://www.raexpert.ru/researches/energy/teploenergetic/2/> (accessed March 10, 2007). Similarly, the deputy economic development minister predicts "considerable shortages" by 2010 in the same regions ITAR-TASS Weekly News, September 12, 2006, <http://dlib.eastview.com/searchresults/article.jsp?art=213&id=10028987> (accessed July 10, 2007).

25. Mild winters, such as the past one, do not translate into correspondingly large financial savings for power plants. With limits on gas supplies enforced, they have to stock up on much more expensive fuel oil, the quality of which declines in costly storage. The warm winter of 2006–7 proved almost as unhelpful for power plants as the previous one, which was extremely severe. See Aleksey Kamensky, "Tayushchie Dengi," *Vedomosti/Smart Money*, January 29, 2007, <http://www.smoney.ru/article.shtml?2007/01/29/2126> (accessed July 10, 2007).

26. Gianguido Piani, "UES Reform Needs Kremlin," *St. Petersburg Times*, October 3, 2006.

27. Anatoly Medetsky, "Higher Electricity, Gas Prices Approved," *Moscow Times*, December 1, 2006; E. Grishkovets, N. Grip, and D. Butrin, "Gazprom Pushes for a Hike in Domestic Gas Prices," *Kommersant*, November 1, 2006.

28. Minpromenergo, Rossiya, "O Tekushchei situatsii razvitiya promyshlennogo proizvodstva" (January–October 2006), <http://www.minprom.gov.ru/ministry/dep/eapp/stat/7> (accessed July 10, 2007).

29. Valeria Korchagina, "Electricity Grid Facing Acute Crisis," 7.

30. Gorelov and Grivach, "Kto sogreet v kholoda"; Ivan Rubanov, Dmitry Sivakov, and Andrey Vinkov, "Privatizatsiya energobalansa strany," *Ekspert*, February 19, 2007, [http://www.expert.ru/printissues/expert/2007/07/privatizaciya\\_energobalansa\\_strany/](http://www.expert.ru/printissues/expert/2007/07/privatizaciya_energobalansa_strany/) (accessed July 16, 2007).

31. Podshivka, "Rynok gaza: reforma ili rost tsen?" *Neftegazovaya vertical*, no. 1 (January 2007), <http://www.ngv.ru/article.aspx?articleID=20572> (accessed July 10, 2007).

32. Vladimir Milov, "My tak i ne smogli liberalizovat elektroenergetiku" Interview Internet saytu Rossiyskogo soyuza promyshlennikov, August 28, 2006, <http://milov.info/articles.php?yes&id=261> (accessed July 10, 2007).

33. "Gazprom i RAO EES soglasovali basovye printsipy zakliucheniya dolgosrochnykh dogovorov," *Neft i kapital*, March 7, 2007, [http://www.oilcapital.ru/news/2007/03/070928\\_106149.shtml](http://www.oilcapital.ru/news/2007/03/070928_106149.shtml) (accessed July 10, 2007).

34. Chayka, "Mikhail Fradkov, Ob osvoyenie dalnevostochnykh neutr."

35. Unified Energy System, *Annual Report, 2006*, <http://www.rao-ees.ru/en/invest/reporting/reports/report2006/> (accessed July 10, 2007); Igor Bashmakov, "District Heating Capacity and Demand in Russia: Policy Approaches for Improvement," IEA/OECD DH Conference, Prague, February 23–24, 2004, [http://www.iea.org/Textbase/work/2004/dh/bashmakov\\_doc.pdf](http://www.iea.org/Textbase/work/2004/dh/bashmakov_doc.pdf) (accessed August 15, 2007).

36. Over-centralization and UES's inflexible heat pricing policy from cogenerating plants resulted in a 35 percent decline in heat production by such plants between 1990 and 2001. See Bashmakov, *District Heating Capacity and Demand in Russia*.

37. Vladimir Milov, "Energy Efficiency Challenges in Russia in the Policy Context," prepared for the World Bank, <http://www.energypolicy.ru/eanalit.php?id=1002271> (accessed August 14, 2007).

38. Natalya Grib and Alexander Gudkov, "Gazprom Gets a Tariff Boost," *Kommersant*, September 28, 2006.

39. Olga Ashpina, "Gas Sector," *The Chemical Journal*, no. 6 (2005): 19, [http://www.tcj.ru/en/2005/5/gas\\_sector.pdf](http://www.tcj.ru/en/2005/5/gas_sector.pdf) (accessed July 10, 2007).

40. Igor Tomberg, "Export Interest above All," RIA Novosti, September 26, 2006, <http://en.rian.ru/analysis/20060926.html> (accessed July 10, 2007). Kristenko's statement is from Andrei Urban, "Electricity, Gas Liberalization Not to Alter Gazprom's Plans," ITAR-TASS Daily, November 30, 2006, <http://dlib.eastview.com/sources/article.jsp?art=89&id=10459967> (accessed August 14, 2007). The two largest German importers that participate in the construction of the undersea Baltic pipeline (E.ON and BASF) extended their contracts with Gazprom into the 2030s, fearing serious shortages. So did Gaz de France and ENI (Italy), in exchange for Gazprom's entry into the French and Italian retail market. See Michael Fredholm, "Gazprom in Crisis," Conflict Studies Research Center, October 2006, [http://www.defac.ac.uk/colleges/csrc/document-listings/russian/06\(48\)MF.pdf](http://www.defac.ac.uk/colleges/csrc/document-listings/russian/06(48)MF.pdf) (accessed July 10, 2007), 11–13; and Judy Dempsey, "Russian Company to Sell Natural Gas Directly to French Consumers," *International Herald Tribune*, December 19, 2006.

41. Igor Bashmakov, "The Crosses of Economic Growth," *Current Digest of the Post-Soviet Press* 58, no. 27 (2006); and Bulat Nigmatulin and Aleksei Gromov, "Gazovyi disbalans," *Neft i kapital*, May 19, 2006, [http://www.oilcapital.ru/analytics/2006/05/191644\\_91523.shtml](http://www.oilcapital.ru/analytics/2006/05/191644_91523.shtml) (accessed August 14, 2007). For Bashmakov, see also <http://www.cenef.ru/info/books/GasExportsProspects.pdf>. A minimum of nine new generating units soon to come on line may experience fuel shortages, which could last for a decade. See Fedor Chayka, "'Gazovaya pauza' ili 'Vtoraya ugol'naya volna?'" *Finansovye izvestiya*, December 12, 2006; and Simon Shuster, "Electricity Producers Cry Foul at Gas Prices," *Moscow Times*, February 20, 2007, 5.

42. Vladimir Milov, "Kompleksnyi analiz problem rossiyskoi gazovoi otrasli," Prezentatsiya (chast vtoraya), Institute of Energy Policy, Moscow, <http://www.energypolicy.ru/pv.php?id=1002390> (accessed August 15, 2007); "Iz otvetov V. Milova na voprosy," *Vystuplenie*, August 8, 2006, <http://www.energypolicy.ru/pv.php?id=1002390> (accessed August 15, 2007).

43. Gorelov and Grivach, "Kto sogreyet v kholoda"; Shuster, "Electricity Producers Cry Foul at Gas Prices."

44. See IEA, *Optimizing Russian Natural Gas*; Michael Fredholm, "Gazprom in Crisis," Conflict Studies Research Center, Russian Series, Defence Academy of the United Kingdom (London, October 2006); Conclusion of studies by Institute of Energy Policy, Moscow, such as that in note 66; Vladimir Milov et al., "Russia's Energy Policy, 1992–2005," *Eurasian Geography and Economics* 47, no. 3 (2006): 303–6.

45. International Energy Agency, *Optimizing Russian Natural Gas. Reform and Climate Policy*, Paris (2006), 34, figure 2; Jonathan Stern, *The Future of Russian Gas and Gazprom* (Oxford: Oxford Institute of Energy Studies, 2005), 7, 32, tables 1–4 and 1–10.

46. In Tyumen Oblast, the principal gas-producing region, such lost reserves exceed 2,500 trillion m<sup>3</sup>. "Obvodnenie mestorozhdeniy—korennoy vopros sovremennosti rossiyskoy neftegazovoy otrasli," *Neft i kapital*, May 24, 2007, [http://www.oilcapital.ru/technologies/2007/05/021042\\_108687.shtml](http://www.oilcapital.ru/technologies/2007/05/021042_108687.shtml) (accessed July 16, 2007).

47. International Energy Agency, *Optimizing Russian Natural Gas*, 35.

48. Ibid., 33; Alexander Gas and Oil Connection, "Introduction," *Independent Gas Producers in Russia*, March 2006, <http://www.gasandoil.com/goc/marketintelligence/rpi/russian-independent.htm> (accessed July 11, 2007).

49. These are the Norilsk node near the mouth of the Yenisy, central Yakutia, the Irkutsk area, Sakhalin, and Maritime Kray (connected by a pipeline) in the Far East.

50. See Vladimir Milov, Leonard L. Coburn, and Igor Danchenko, "Russia's Energy Policy, 1992–2005," *Eurasian Geography and Economics* 47, no. 3 (2006): 305, table 3; International Energy Agency, *Optimizing Russian Natural Gas*, 36; and Stern, *The Future of Russian Gas and Gazprom*, table 1-3, 6, for 2004. Roland Götz's figure of 445 billion m<sup>3</sup> for 2005, derived as a residue, seems to include all these nodes and is on the high end. Roland Götz, "Russian Gas and Alternatives for Europe," German Institute of International and Security Affairs Working Paper, June 2006, [http://www.swp-berlin.org/common/get\\_document.php?asset\\_id=3070](http://www.swp-berlin.org/common/get_document.php?asset_id=3070) (accessed August 20, 2007).

51. From Gazprom's Web site. See <http://www.gazprom.ru/articles/article20152.shtml>; <http://www.gazprom.ru/articles/article20015.shtml> (accessed August 14, 2007); Alexander Gas and Oil Connection, "Introduction," *Independent Gas Producers in Russia; Rossiyskiy Statisticheskiy Yezhegodnik. 2006* (Moscow: Rosstat, 2006), 389, 732. (One ton uslovnogo topliva = 836 m<sup>3</sup> of natural gas.) Stern, *The Future of Russian Gas and Gazprom*, 6, table 1–3. Stern's table also includes 10.4 billion m<sup>3</sup> for linepack (increase in the volume of gas in the pipeline), which I ignore here.

52. "Gazprom vydelit 20.2 mlrd rub. Na stroitelstvo novykh obyektoy gazifikatsii v 2007 g.," *Neft i kapital*, June 19, 2007, [http://www.oilcapital.ru/news/2007/06/19199244\\_.shtml](http://www.oilcapital.ru/news/2007/06/19199244_.shtml) (accessed August 15, 2007). The expansion involves 655 settlements and a number of regions in Siberia and elsewhere.

53. Roman Kupchinsky, "Energy: Is Gazprom's Investment Drive Feasible?" Radio Free Europe/Radio Liberty, July 9, 2007, [http://www.rferl.org/features/features\\_Article.aspx?m=07&y=2007&id=704F501B-D3A0-4198-AC11-AC395F9719CE](http://www.rferl.org/features/features_Article.aspx?m=07&y=2007&id=704F501B-D3A0-4198-AC11-AC395F9719CE) (accessed August 15, 2007) and BP Statistical Review of World Energy, June 2007, [http://www.bp.com/liveassets/bp\\_internet/globalbp/globalbp\\_uk\\_english/reports\\_and\\_publications/statistical\\_energy\\_review\\_2007/STAGING/local\\_assets/downloads/pdf/statistical\\_review\\_of\\_world\\_energy\\_full\\_report\\_2007.pdf](http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2007/STAGING/local_assets/downloads/pdf/statistical_review_of_world_energy_full_report_2007.pdf) (accessed August 15, 2007).

54. Khristenko also claims that gas pipeline capacity by middecade will also grow by 52 percent, an assertion that strains credibility. ITAR-TASS, "Russia to increase annual gas output to 742–754 bcm by 2015—minister," October 9, 2006, <http://dlib.eastview.com/sources/article.jsp?id=10162323> (accessed July 11, 2007).

55. Last year Gazprom increased production by a mere one billion m<sup>3</sup>. The same minute growth is expected in 2007. The 177.5 billion m<sup>3</sup> of capacity expansion during the past five years merely counterbalanced declines in older reservoirs. See Mikhail Krutikhin, "Dobycha gaza: stabilizatsiya ili stagnatsiya?" *RusEnergy*, June 20, 2007, <http://rusenergy.com/companies/a20070620.htm> (accessed July 11, 2007).

56. Non-Gazprom producers extracted 96 billion m<sup>3</sup> from January through November; I extrapolate approximately 105 billion m<sup>3</sup> for the whole year. "Dobycha gaza v Rossii v yanvare–noyabre," *Neft i kapital*, December 4, 2006, [http://www.oilcapital.ru/news/2006/12/041553\\_101938.shtml](http://www.oilcapital.ru/news/2006/12/041553_101938.shtml) (accessed August 15, 2007). Seventy-four billion m<sup>3</sup> was sold in 2005, as given by Alexander Gas and Oil Connection, "Independent Gas Producers in Russia." Novatek, the largest producer, contributed 28.7 billion m<sup>3</sup> that year. See the company's Web site: [http://www.novatek.ru/eng/our\\_business/production](http://www.novatek.ru/eng/our_business/production) (accessed July 11, 2007).

57. Now Gazprom wants another 20–25 percent increase in transport tariffs, while internal gas prices, as of November 2006, were still one-fifth of European levels. Vladimir Milov, "Gaz Rossii: realnye i mnimye problemy," *Neftegazovaya vertikal*, no. 15 (2006), <http://www.energypolicy.ru/news.php?id=1002476> (accessed July 11, 2007). So far, the mostly fat-gas-producing independents have only bad choices. They must toll through Gazprom's processing facilities, paying high fees to take title of the gas liquids and dry gas. Then they must rail the liquids out to sell them to domestic

petrochemical plants and refineries or inject them into Transneft oil pipelines and sell them as crude oil at a lower price. Communication between the author and Matthew Sagers, Cambridge Energy Research Associates.

58. "Independent Producers' Gas Supply Share to Reach 50 pct by 2010," ITAR-TASS Daily, November 11, 2006, <http://dlib.eastview.com/sources/article.jsp?id=10459941> (accessed July 11, 2007). Novatek plans 30 billion m<sup>3</sup> for 2007 (as compared with 28.7 billion in 2006, or a 4.4 percent growth) but projects 45 billion m<sup>3</sup> by 2010, which would require an annual 14.5 percent increase. "Neftyanaya kompaniya 'Novatek' prognoziruuet rost obyemov dobychi v 2007 g. lish na 4.4%," *Neft i kapital*, February 2, 2007, [http://www.oilcapital.ru/news/2007/02/021735\\_104798.shtml](http://www.oilcapital.ru/news/2007/02/021735_104798.shtml) (accessed July 11, 2007).

59. "Twenty five percent of electric power demand of Surgutneftegas are covered by in-house power generation," press release, Capital Link, October 11, 2006, <http://www.capitallinkrussia.com/press/companies/50010239/42409.html> (accessed August 18, 2007); Lyudmila Kolbina, "Oni poshli na sever," *Ekspert Ural*, nos. 1–2, January 22, 2007, [http://www.expert.ru/printissues/ural/2007/01/uralskaya\\_energetika/](http://www.expert.ru/printissues/ural/2007/01/uralskaya_energetika/) (accessed July 11, 2007).

60. Sergey Veresemsky, "Gazpromu neobkhodimo \$343–\$420 milliard investitsii," *Neft i kapital*, April 16, 2007, [http://www.oilcapital.ru/news/2007/04/161044\\_107882.shtml](http://www.oilcapital.ru/news/2007/04/161044_107882.shtml) (accessed July 11, 2007); Georgiy Borinkov, "Gazprom srezal investitsii," *Vsglyad delovaya gazeta*, June 1, 2007, <http://www.vz.ru/economy/2007/6/1/85597.html> (accessed July 11, 2007); Caterin Belton, "Gazprom Approves 11% Capex Cut," *Financial Times*, June 11, 2007.

61. Sergey Veresemsky, Editorial, *Neft i kapital*, June 1, 2007, [http://www.oilcapital.ru/edition/nik/archives/nik\\_2006/nik\\_05\\_2007/108850/public/108853.shtml](http://www.oilcapital.ru/edition/nik/archives/nik_2006/nik_05_2007/108850/public/108853.shtml) (accessed August 15, 2007).

62. "Gazprom Owns up to Gas Shortfall," *Vedomosti* quoted by RIA Novosti, April 21, 2006, <http://en.rian.ru/analysis/20060421/46808586.html> (accessed July 12, 2007).

63. Aleksander Grivach, "Narashchivanie muskolov," *Neft i kapital*, June 15, 2007.

64. *Ibid.*; Yuri Nevelov, "Dobycha gas v YANAO k 2020 g. uvelichitya do 730 mlrd kub m v god," *Neft i kapital*, February 23, 2007; and Yuri Nevelov, "Gazpromu neobkhodimo \$343–\$420 milliard investitsiy," *Neft i kapital*, April 16, 2007, [http://www.oilcapital.ru/news/2007/04/161044\\_107882.shtml](http://www.oilcapital.ru/news/2007/04/161044_107882.shtml) (accessed August 15, 2007).

65. Milov, "Gaz Rossii: realnye i mnimye problemy," Institute of Energy Policy, November 1, 2006, <http://www.energypolicy.ru/pres.php?id=1002471> (accessed July 11, 2007).

66. Upstream development received \$12.5 billion versus \$30.6 billion for unrelated investment, with an additional \$17.9 billion spent on acquisitions. Vladimir Milov, "Kompleksnyi analiz problem rossiyskoi gazovoi otryasli," Institute of Energy Policy, August 8, 2006, <http://www.energypolicy.ru/pv.php?id=1002389> (accessed July 12, 2007); Vladimir Milov, "Rossiyskiy gazovyi sektor: khronika proizvodstvennoy degradatsii," Institute of Energy Policy, April 20, 2007, <http://www.energypolicy.ru/files/milov%20Apr20-2007.ppt> (accessed August 17, 2007); and "Puti realizatsii potentsiala rosta gazodobychi nezavisimymi proizvoditelyami gaza Rossii," Institute of Energy Policy, June 2007, <http://www.energypolicy.ru/analit.php?id=1002561> (accessed August 17, 2007).

67. The unprecedented difficulties of the Yamal Peninsula were summarized in the words of one geologist: "[Y]amal is a piece of something unknown frozen together over millions of years, and it is unclear how it will be possible to build or produce anything there." Quoted by Vasily Zubkov, "Why Russia Has a Gas Shortage," *Novosti*, November 17, 2006, <http://en.rian.ru/analysis/20061117/55747646.html> (accessed August 15, 2007). When they come on stream, these fields, in the words of Jonathan Stern of the Oxford Institute of Energy, "will need a completely different tax regime from other upstream gas." Stern, *The Future of Russian Gas and Gazprom*, 16.

68. A. M. Samsam Bakhtiari, "The 'Shtokman' Saga," <http://www.sfu.ca/~asamsamb/sb.htm> (accessed July 11, 2007).

69. Vladimir Socor, "Resistance Growing to the Baltic Seabed Pipeline Project," and "Questions Multiply on the Baltic Seabed Pipeline Project's Viability," *Eurasia Daily Monitor*, April 23, 2007; and "Nord Stream izuchit vozmozhnosti optimizatsii marshruta," *Neft i kapital*, April 10, 2007, [http://www.oilcapital.ru/news/2007/04/101221\\_107656.shtml](http://www.oilcapital.ru/news/2007/04/101221_107656.shtml) (accessed July 11, 2007).

70. Upstream Online, <http://www.upstreamonline.com/live/article131366.ece> (accessed July 11, 2007) and BarentsObserver, July 3, 2007, <http://barentsobserver.com/index.php?id=523243&cat=>

16149&xforceredir=1&noredir=1 (accessed July 11, 2007).

71. Bakhtiari, "The 'Shtokman' Saga." All gas from Shtokman's first- and second-stage development would be funneled through the Baltic pipeline for Western Europe. Igor Tomberg, "Shtokman Ticket Getting More Expensive," RIA Novosti, October 12, 2006, <http://www.bilkent.edu.tr/~crs/shtokmanticket.htm> (accessed July 11, 2007). Norway has experienced almost a year delay with its Snow White field in the Barents Sea. Yet the field is located less than one-third as far as Shtokman from the shore and will not require such a pressure boost.

72. Vladimir Socor, "Russia Surging Farther Ahead in Race of Central Asian Gas," *Eurasia Daily Monitor*, May 16, 2007.

73. "Prikaspisky Pipeline: Temporary Delay or Fundamental Problem?" Eurasianet.org, June 26, 2006, <http://www.eurasianet.org/departments/insight/articles/eav062607.shtml> (accessed August 15, 2007).

74. Most recently, an additional reservoir from 4,500 meters of depth was discovered at this complex field. However, its alleged 7 billion m<sup>3</sup> reserves, which would exceed the remaining reserves of any single Russian deposits today, remain in doubt. "Na mestorozhdenii Yuzhnyi Yolotan' v Turkmenistane obnaruzhen novyi pritok gaza," *Neft i kapital*, May 4, 2007, [http://www.oilcapital.ru/news/2007/05/041302\\_108796.shtml](http://www.oilcapital.ru/news/2007/05/041302_108796.shtml) (accessed July 11, 2007); and "CNPC Awarded US\$152mn Turkmen Gas Deal," *Oil and Gas Insight*, November 2006, <http://www.oilandgasinsight.com/file/40478/cnpc-awarded-us152mn-turkmen-gas-deal.html> (accessed August 20, 2007). No further details are available, but the deal marks a strengthening in the relationship between China and Turkmenistan.

75. Viktoriya Panfilova, "Gaz dlya vsego mira," *Nezavisimaya gazeta*, July 16, 2007, [http://www.ng.ru/cis/2007-07-16/7\\_gaz.html](http://www.ng.ru/cis/2007-07-16/7_gaz.html) (accessed July 18, 2007).

76. Yelena Yashkina, "Gazovaya lovushka," *Rossiyskaya gazeta*, from RIATEK News, June 20, 2007, <http://www.riatek.ru/shownews.php?id=40695> (accessed July 11, 2007); Anatoly Medetsky, "Gazprom Seeks to Bar Exxon's Gas Export," *Moscow Times*, June 20, 2007, 7.