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Uruguay Energy Supply Options

Assessing the Market for Natural Gas in Uruguay - Executive Summary

Prepared for the Government of Uruguay
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INTRODUCTION

Uruguay is in the midst of making critical decisions affecting the design of its future energy supply system. Momentum for change is expected to come from several directions, including recent and foreseeable upgrades and modifications to energy conversion facilities, the importation of natural gas from Argentina, the possibility for a stronger interconnection of regional electricity systems, the country's membership in MERCOSUR, and the potential for energy sector reforms by the Government of Uruguay.

The objective of this study is to analyze the effects of several fuel diversification strategies on Uruguay's energy supply system. The analysis pays special attention to fuel substitution trends due to potential imports of natural gas via a gas pipeline from Argentina and increasing electricity ties with neighboring countries. The Government of Uruguay has contracted with Argonne National Laboratory (ANL) to study several energy development scenarios with the support of several Uruguayan institutions. Specifically, ANL was asked to conduct a detailed energy supply and demand analysis, develop energy demand projections based on an analysis of past energy demand patterns with support from local institutions, evaluate the effects of potential natural gas imports and electricity exchanges, and determine the market penetration of natural gas under various scenarios.

ANALYTICAL METHODOLOGY

Future fossil and non-fossil energy flows in Uruguay from energy extraction through end use are projected by the BALANCE Module of the ENergy and Power Evaluation Program (ENPEP). BALANCE is a generalized equilibrium model that consists of a system of simultaneous nonlinear relationships that specify the transformation of energy quantities and energy prices through the various stages of energy production, processing, and use. The basic assumptions in the equilibrium approach are that the energy sector consists of autonomous energy producers and consumers that carry out production and consumption activities while pursuing individual objectives. BALANCE is not an optimization model; rather, it simulates and describes energy market choices that are made by producers and consumers.

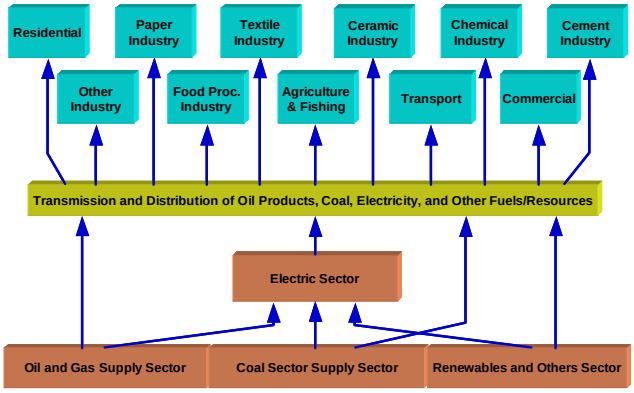

Figure 1: Uruguay General Energy Supply and Demand Network

For this study, the BALANCE Module utilizes an energy network that was constructed to simulate the interactions among energy supply and demand sectors as shown in Figure 1 (a more detailed network representation is given in the full report). The network design is more detailed for the residential, industrial, and transportation sectors because they are expected to be most affected by imported natural gas and electricity. Also, these three sectors accounted for more than 86% of Uruguay's final energy demand in 1993.

ENERGY SECTOR DEVELOPMENT SCENARIOS

Using a variety of major scenario design components and options, local experts defined six alternative energy sector development strategies for analysis under this study as presented in Table 1. Scenario 1 represents the Base Case or the so-called Reference Case. Under this scenario, Uruguay continues its current energy policies and strategies, and no significant changes are expected with regard to energy imports and exports. A natural gas pipeline will not be developed, and electricity exchanges with Argentina and Brazil will remain at low levels.

Under Scenario 2, Uruguay will import natural gas through a new natural gas pipeline. Scenario 3 assumes an open electricity market with Argentina in addition to the natural gas imports. Under Scenario 4, the electric system integration with Argentina is supplemented by an increased transmission capacity with Brazil. However, natural gas is assumed to be unavailable in this case. Scenario 5 explores the

Scenario Option	Reference	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Base Year	1993					
Study Period	21 years					
Macroeconomic Forecast	Medium (1.9% GDP growth per year)					
Demand Forecast	Moderate Growth					
Electric Hydropower Condition	Average over all years of the study period					Low during 1997-2001, average after
Natural Gas Import and Storage	No natural gas pipeline	Natural gas pipeline to Montevideo, no storage		No natural gas pipeline	Natural gas pipeline to Montevideo, no storage	No natural gas pipeline
Electricity Interconnection with Brazil	Current conditions (incl. 70 MW in 1998)			Current conditions plus 300 MW starting in 2002		Current conditions (incl. 70 MW)
Electricity Energy and Resource Agreement with Argentina	Emergency purchases only		Open market (electricity exchanges limited by transmission capacity only)			Emergency purchases only

Table 1: Summary Description of Energy Sector Development Scenarios

benefits of an integrated electric system with Argentina, stronger electrical interconnections with Brazil, and natural gas imports from Argentina. Scenario 6 is identical to the Reference Case except for the period of 1997 to 2001 when much less hydro resources are assumed to be available.

MACROECONOMIC FORECASTS AND ENERGY DEMAND PROJECTIONS

A local team of experts projected that the total population will grow at an average annual rate of 0.53% over the period 1993-2013. However, the rural population is expected to slowly decrease over time as people move to urban areas. The team also developed two GDP growth scenarios with the average annual GDP growth rate for the period 1996-2013 estimated to be 1.9% and 2.9%, respectively. Only the lower growth rate was used in the energy demand forecast. Sectoral growth rates were also developed to reflect structural changes in the economy. In addition, the local experts developed a set of equations that show the relationship between macroeconomic variables and demand growth rates for final and useful energy. The team also determined relevant income elasticities and autonomous growth rates using approaches that vary by economic sector. Table 2 presents the projected growth in energy demand by sector (absolute growth and average growth rate). The table aggregates demands over a variety of end uses, such as process steam, direct heat, cooking, lighting, motive power, vehicle-km traveled, etc.

ENERGY SUPPLY

As indicated in Figure 2, Uruguay's primary energy supply in the Reference Case continues to be based mainly on crude oil, hydro energy, wood, and some minor amounts of biomass. The only addition is coal, which enters the market in 2011. Primary energy supplies reach 2,907 ktoe by 2013. The share of imported crude oil is expected to increase from 53% in 1991 to 60% in 2011 and then drop to 55% when coal will be used in the electric sector. Wood, biomass, and hydro are projected to decline slightly. Primary energy consumption in 1993 is fairly low due to the shutdown of ANCAP's domestic refinery. The

Year	Residential		Commercial		Industrial		Agr. & Fish.		Transport	
	ktoe[1]	%[2]	ktoe	%	ktoe	%	ktoe	%	10^9 km	%
1993	254	2.5	130	2.5	463	1.3	160	4.2	7.09	1.9%
2013	416		231		597		363		10.30	

[1] Useful energy for residential, industrial, and transport; final energy for commercial and agriculture/fishing.

[2] Average annual growth rate.

Table 2: Summary Results of Energy Demand Forecast

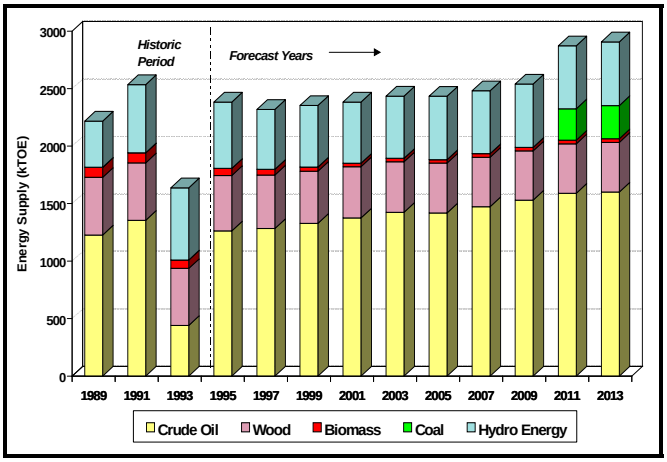

Figure 2: Primary Energy Supply in Reference Case

refinery outage also results in significant imports of refined oil products in 1993. The drop in total supplies at the beginning of the forecast period is connected with a lower hydro generation that is projected to only slowly increase.

Figure 3 shows the change in natural gas imports for the natural gas scenarios (i.e., Scenarios 2, 3, and 5) compared to the Reference Case.[1] Natural gas imports are strongly affected by the projected electric sector capacity expansion plan and resulting dispatch of gas-fired units. In addition, the level of electric system integration with Argentina and Brazil plays a significant role in natural gas demand. With electric integration, electricity exports are expected to increase substantially, driving up the demand for natural gas in the power sector. Natural gas imports in 2013 are forecast to be 832 ktoe (24.9% of primary energy) in Scenario 2, 957 ktoe (27.5%) in Scenario 3, and 1,000 ktoe (28.4%) in Scenario 5. However, the demand for natural gas by all other sectors changes very little as a result of electricity integration.

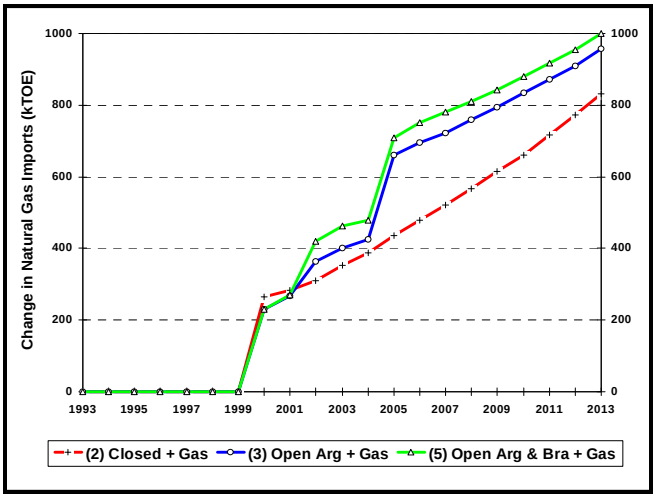

Figure 3: Change in Natural Gas Imports by Scenario Relative to the Reference Case

Changes in crude oil imports are negligible as the production in the domestic refinery is assumed to be primarily driven by the demand for gasoline. Gasoline is not expected to compete with imported natural gas or electricity. Under all scenarios, the domestic refinery is expected to reach its capacity limits by the year 2012. Except for Scenario 6, diesel, fuel oil, and LPG imports are projected to be less than under the Reference Case. By 2013, diesel imports are 351 - 388 ktoe (57 - 63%) lower, fuel oil imports decrease between 67 and 124 ktoe (52 - 95%), and LPG imports are expected to be reduced by 43 - 54 ktoe (80 - 100%). Scenario 6 imports are temporarily higher than in the Reference Case due to the dry hydro period between 1997 and 2001. In 1999, Scenario 6 imports increase by 279% for diesel, 146% for fuel oil, and 59% for LPG over the levels in the Reference Case. Production of fuel wood under the alternative scenarios is also forecast to decline as compared to the Reference Case (except for Scenario 6). The drop in production ranges from 25 to 100 ktoe (i.e., 6 - 23%).

ELECTRICITY GENERATION

Under the Reference Case, domestic electricity demand is projected to grow at an annual average rate of 2.5% — from 486 ktoe in 1993 to 796 ktoe in 2013 (see Figure 4). With the exception of Scenario 4, alternative scenarios show a slightly lower electricity demand than the Reference Case, i.e., 10 - 27 ktoe or 1.3 - 3.3% lower. Scenario 4 with no natural gas but full electric integration has lower electricity prices that result in a demand level by 2013, which is approximately 100 ktoe or 12.6% above the Reference Case.

Since no new hydropower plants are expected to be built in the future, fossil-fuel-fired units will have to be used more often in order to satisfy the growing

[1] Note that the change relative to the Reference Case in this document is calculated as follows: Results of Alternative Scenario ***minus*** Results of Reference Case.

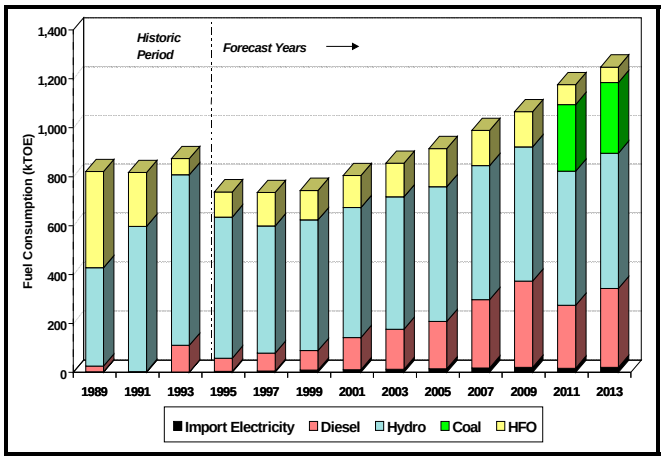

Figure 4: Energy Supplies for Electric Power Sector under Reference Case

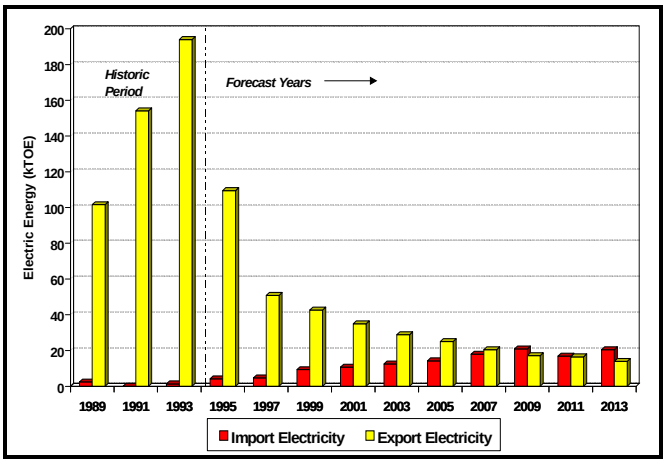

Figure 5: Reference Case Electricity Exports and Imports

demand for electricity. As shown in Figure 4, energy consumption in fossil-fired power stations under the Reference Case is projected to increase from 176 ktoe in 1993 to 675 ktoe in 2013. Diesel shows the largest increase. Coal-fired units are projected to come on line in 2011 displacing some of the diesel and fuel oil-fired generation. Under this case, Uruguay is forecast to move from being a net exporter (net exports of 193 ktoe in 1993) to becoming a net importer of electricity by the year 2008 (net imports of 6 ktoe in 2013) as shown in Figure 5.

When natural gas becomes available in the year 2000 under Scenarios 2, 3, and 5, it displaces diesel and heavy fuel oil, as well as coal after 2010. By 2013, it is projected that natural gas becomes the predominantly consumed fuel with approximately 422 ktoe (Scenario 2) to 593 ktoe (Scenario 5) while diesel and fuel oil decrease substantially. For example, the change in fuel consumption by energy type under Scenario 2 relative to the Reference Case is shown in Figure 6 (positive values represent natural gas consumption; negative values represent the quantities of displaced electric sector fuels).

Although the domestic electricity demand is projected to be lower under all natural gas scenarios, total electricity production in Uruguay is expected to be higher because of a forecast increase in exports to Argentina. Exports range from 19 ktoe (Scenario 2) to 170 ktoe (Scenario 5) above the Reference Case. Imports are slightly lower in Scenario 2 than under the Reference Case, whereas in the other natural gas scenarios, electricity imports are significantly higher than in the Reference Case. Table 3 summarizes the electric sector projections for the year 2013 as a function of scenario.

Full integration with Argentina and Brazil without natural gas (Scenario 4) will result in large imports of electricity (net imports of 330 ktoe) and lower domestic thermal generation compared with the Reference Case. Integration will allow Uruguay to minimize operating its expensive fuel oil and diesel-fired units. Electricity imports also replace the coal-fired units constructed under the Reference Case.

Scenario 6 is characterized by a low hydropower period from 1997 to 2001. This leads to a higher generation level of Uruguay's diesel and fuel oil-fired units during these years. In addition, electricity imports increase substantially while electricity exports drop, leading to a noticeable rise in average system generation cost and end use electricity prices.

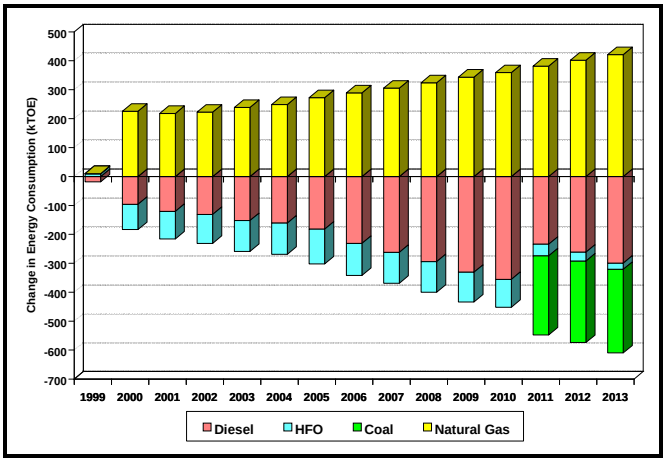

Figure 6: Scenario 2 Change in Electric Sector Fuel Consumption Relative to Reference Case

Power Sector Results	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Fuel oil consumption	63	42	14	24	19	60
Diesel consumption	323	23	0	3	0	309
Coal consumption	289	0	0	0	0	276
Gas consumption	0	422	550	0	593	0
Hydro generation	553	548	561	556	558	553
Electricity exports	14	33	104	127	184	14
Electricity imports	20	13	63	457	131	20
Average generation cost (US$/mmbtu)	14.87	8.73	8.07	8.42	8.08	14.75 (24.17 in 1999)

Table 3: Summary of Electric Power Sector Results in 2013 (ktoe)

FINAL ENERGY CONSUMPTION UNDER REFERENCE CASE

Figure 7 and Figure 8 together with Table 4 provide the projected final energy consumption levels under the Reference Case by sector and by fuel type. While the market share of city gas is expected to remain constant, biomass and wood/charcoal decrease their penetration rates. Only electricity and oil products are projected to increase their shares. Sectoral shifts in energy consumption follow more or less macroeconomic assumptions; that is, the commercial and agriculture/fishing sectors expand while the industrial sector decreases its consumption share. The residential share is forecast to drop slightly because of a predicted shift from wood to more efficient energy forms (mostly electricity) to meet growing end use demands. The energy consumption share in the transportation sector is expected to remain almost constant due to average demand growth rates, little projected fuel substitutions, and insignificant changes in energy conversion efficiencies.

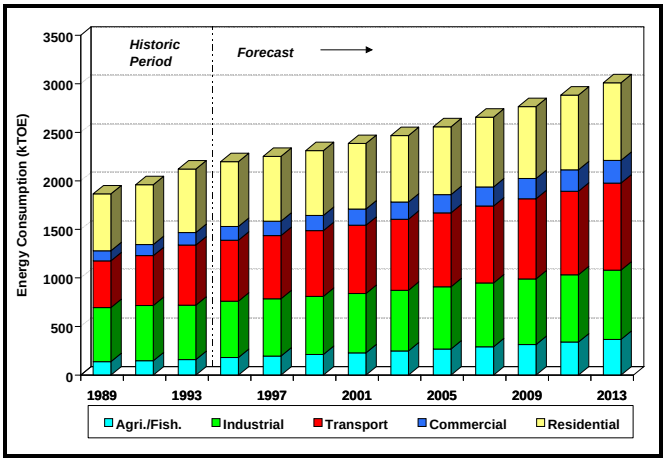

Figure 7: Reference Case Final Energy Consumption by Sector

Consumption by Fuel	City Gas	Biomass	Wood/ Charcoal	Electricity	Oil Products
1993 consumption (ktoe)	11	68	487	393	1168
2013 consumption (ktoe)	15	32	427	668	1868
Market share (%) 1993 to 2013	0.5 ⇔ 0.5	3.2 ⇩ 1.1	22.9 ⇩ 14.2	18.5 ⇧ 22.2	54.9 ⇧ 62.1
Average growth rate (%/year)	1.6	-3.7	-0.7	2.7	2.4
Consumption by Sector	**Residential**	**Commercial**	**Industrial**	**Transport**	**Agr. & Fish**
1993 consumption (ktoe)	654	129	559	620	159
2013 consumption (ktoe)	799	234	714	896	367
Consumption share (%) 1993 to 2013	30.8 ⇩ 26.6	6.1 ⇧ 7.8	26.4 ⇩ 23.7	29.2 ⇔ 29.8	7.5 ⇧ 12.2
Average growth rate (%/year)	1.0	3.0	1.2	1.9	4.2

Table 4: Summary Results of Final Energy Consumption under Reference Case

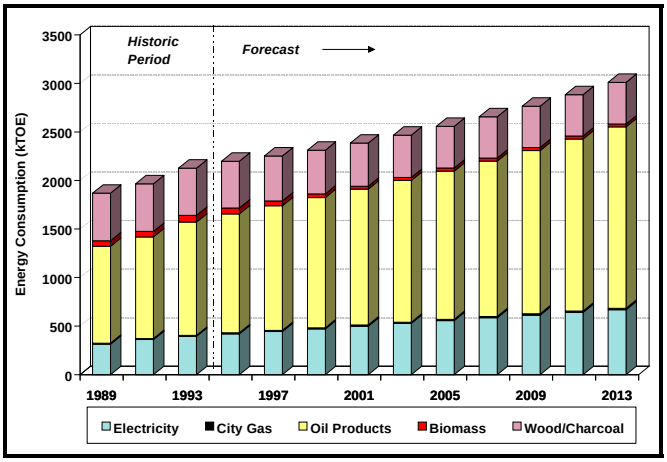

Figure 8: Reference Case Final Energy Consumption by Fuel

FINAL ENERGY CONSUMPTION UNDER ALTERNATIVE SCENARIOS

Final energy consumption by fuel type under most alternative scenarios differs significantly from the Reference Case due to expected fuel substitution trends in the end use sectors. Under Scenarios 2, 3, and 5, natural gas is forecast to displace oil products, wood/charcoal, and to a much smaller degree electricity. In Scenario 4, the electric sector benefits from the integration with Argentina and Brazil and the absence of natural gas competition. Lower electricity prices under this scenario drive up electricity demand by 82 ktoe or 12.2% above the Reference Case levels in 2013. Predicted changes in 2013 under Scenario 6 are relatively minor as the electricity demands rebound after the assumed dry hydrological period in 1997-2001. Table 5 summarizes the forecast final energy consumption levels by fuel type under all alternative scenarios.

Total final energy consumption by sector varies only slightly among all six scenarios. Changes in the commercial and agriculture/fishing sectors are negligible because they were modeled at a less detailed level. The transport sector also varies insignificantly from the Reference Case, as compressed natural gas penetration rates under Scenarios 2, 3, and 5 are projected to be minimal with little to no effect on sectoral energy consumption. Differences relative to the Reference Case, though not very substantial, can be observed in the residential and industrial sectors. These sectors are projected to experience noticeable shifts in their fuel and technology mix affecting to some extent the average sectoral energy conversion efficiencies. Compared to the Reference Case, this results in variations of -6.4% (Scenario 2) to +0.8% (Scenario 4) in total residential final energy consumption and -1.0% (Scenario 4) to +1.1% (Scenario 6) in total industrial final energy consumption.

NATURAL GAS CONSUMPTION AND FUEL SUBSTITUTION

Total natural gas consumption in 2013 is forecast to be between 769 and 936 ktoe. As Figure 9 shows for Scenario 2, during the first years after natural gas becomes available, almost all of it is consumed by the

Gas Consumption	Scenario 2		Scenario 3		Scenario 4		Scenario 5		Scenario 6	
	ktoe	%	ktoe	%	ktoe	%	ktoe	%	ktoe	%
2013 Consumption in ktoe and % Market Share										
City/Natural Gas	348	11.5	345	11.4	12	0.4	345	11.4	15	0.5
Biomass	31	1.0	31	1.0	31	1.1	31	1.0	32	1.1
Wood/Charcoal	334	11.1	330	11.0	404	13.7	330	11.0	430	14.2
Electricity	647	21.4	656	21.8	750	25.4	657	21.8	659	21.8
Oil Products	1661	55.0	1650	54.8	1750	59.4	1650	54.8	1885	62.4
Change from Reference Case in ktoe and %										
City/Natural Gas	+333	+2236	+330	+2212	-3	-17.6	+330	+2211	0	+1.9
Biomass	-1	neg.[1]	-1	neg.	-1	neg.	-1	neg.	0	neg.
Wood/Charcoal	-93	-21.8	-97	-22.6	-23	-5.4	-97	-22.6	+3	+0.7
Electricity	-21	-3.2	-12	-1.7	+82	+12.2	-11	-1.7	-9	-1.3
Oil Products	-207	-11.1	-218	-11.7	-113	-6.1	-218	-11.7	+17	+0.9

[1] neg. = negligible

Table 5: Final Energy Consumption in 2013 by Fuel Type under Alternative Scenarios

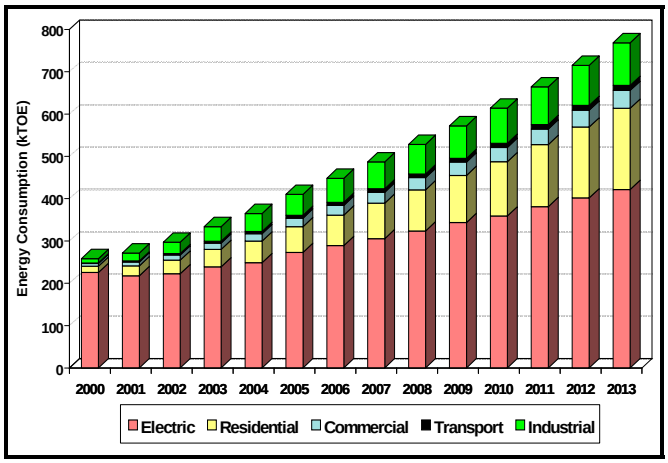

Figure 9: Scenario 2 Natural Gas Consumption by Sector

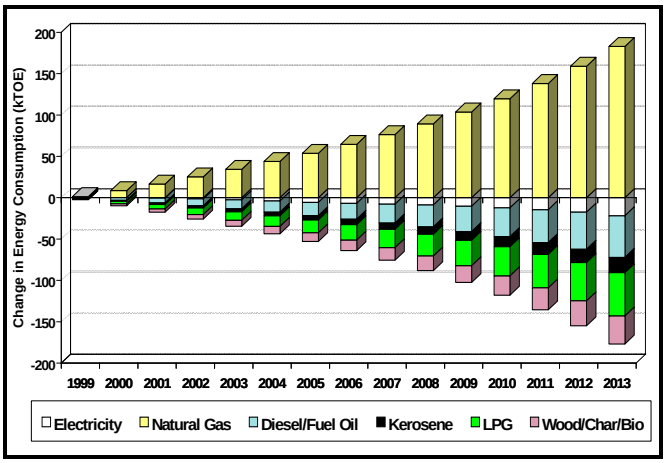

Figure 10: Scenario 2 Change in Residential Final Energy Consumption Relative to Reference Case

electric utility sector. Over time, natural gas penetrates other economic sectors as well. But as presented in Table 6, the majority of the gas (i.e., between 55% and 63%) will still be consumed by the power sector by the end of the forecast period. The residential sector is projected to be the second largest consumer of natural gas, followed by the industrial and commercial sectors. Natural gas consumption in the transportation sector is expected to be small.

In the electric sector, natural gas is forecast to provide between 40% and 46% of its resource requirements (including hydro and imports). The overall market share of natural gas in the residential sector reaches around 24% by 2013. More than half of the residential gas will be used for space heating. The analysis accounts for the fact that natural gas will not be available in all of Uruguay. In regions where natural gas is expected to be available, penetration rates are forecast to be much higher. By 2013, it is projected that in natural-gas-connected regions, it will provide about 83% of final energy used for water heating, almost 80% for cooking, and more than 75% for space heating. Although natural gas displaces some electricity demand in areas where it is available, overall electricity demand does not change significantly. The reduction in electricity demand in regions connected to the natural gas distribution system is offset by increases in the demand for electricity in areas that are not connected. Electricity demand in these regions increases because of projected lower prices relative to the Reference Case (see Table 3).

Typically, residential natural gas replaces renewable fuels, refined oil products, LPG, and electricity. In general, fossil fuels like diesel, LPG, and kerosene, which are consumed the most by the residential sector, are projected to have the largest reduction in consumption. Wood consumption also decreases, but by a lesser extent, because large amounts of wood are used in regions that will not be connected to the gas distribution system. Figure 10 gives the market shifts in the residential sector for Scenario 2. These substitution trends are very similar in other natural gas scenarios.

Sector	Scenario 2			Scenario 3			Scenario 5		
	Ktoe	% of all gas	% market share	ktoe	% of all gas	% market share	ktoe	% of all gas	% market share
Residential	192	25.0	24.2	189	21.1	24.0	189	20.2	24.0
Commercial	42	5.5	18.4	42	4.7	18.2	42	4.5	18.2
Industrial	101	13.1	14.2	101	11.3	14.2	101	10.7	14.2
Transport	12	1.5	1.3	12	1.3	1.3	12	1.3	1.3
Electric	422	54.8	40.3	550	61.6	46.3	593	63.3	45.6
TOTAL	769	100	na	894	100	na	936	100	na

Table 6: Natural Gas Consumption in 2013 by Sector under Alternative Scenarios

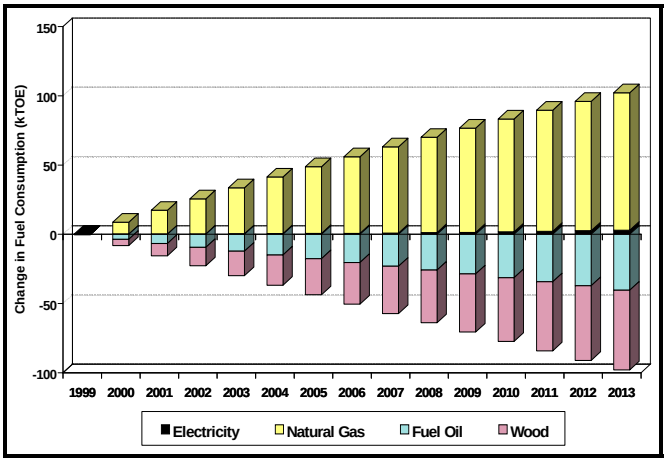

Figure 11: Scenario 2 Change in Industrial Final Energy Consumption Relative to Reference Case

Natural gas penetration in the industrial sector reaches 101 ktoe in 2013 with a market share of 14.2%, making it the third largest gas consumer. The sector is projected to switch mostly from wood and fuel oil to natural gas as displayed in Figure 11. Changes in other types of energy are small. Overall gas penetration levels are relatively low because not all industries are expected to have access to it.

Market behavior varies substantially among different industrial subsectors and across the different end use types (steam, heat, on-site electricity generation). As Table 7 shows, gas penetration for steam and heat production is generally much higher than for on-site electricity generation. In the chemical industry, for example, natural gas supplies about 29% of final energy for steam generation and about 27% for heat production. The textile and food industries also show fairly high penetration rates for steam generation (i.e., 24% and 20%), whereas the ceramics industry has a relatively high share (i.e., 22%) of natural gas for the production of direct heat. The combined others sector accounts for about 41% of total industrial gas consumption and shows a high market share of gas especially in steam generation. Only the paper industry shows a noticeable gas share for electricity generation.

END USE ENERGY PRICES

Energy end use prices that vary across alternative scenarios include electricity and city/natural gas. For example, Figure 12 shows that for the residential sector, electricity tariffs are projected to be highest under the Reference Case and the Dry Reference Case. The lowest tariffs are forecast for Scenario 5 with electric integration with Argentina and Brazil combined with natural gas imports. Tariffs in Scenarios 2, 3, and 4 are forecast to be slightly above levels projected under Scenario 5.

The projected cost of city gas/natural gas is significantly lower under scenarios where natural gas is available. In the absence of natural gas, the residential city gas tariff is projected to be approximately US$36 per mmbtu in 2013. Under natural gas scenarios, this tariff drops to US$10 per mmbtu, which is comparable to Argentina's tariff (Figure 13).

Industry	Steam		Heat		Electricity/Other		Total
	ktoe	Market Share (%)	ktoe	Market Share (%)	ktoe	Market Share (%)	ktoe
Cement	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ceramic	0.1	8.3	5.5	21.9	0.0	0.0	5.6
Chemical	4.0	28.9	0.3	26.6	0.0	0.0	4.3
Food	24.5	19.8	6.8	20.2	0.0	0.0	31.3
Paper	3.2	6.7	0.0	0.0	1.1	8.4	4.3
Textile	13.1	23.7	0.0	0.0	1.0	1.6	14.0
Subtotal	44.8	--	12.5	--	2.0	--	59.5
Combined/Others	27.6	51.2	13.1	15.8	0.8	2.8	41.5
Total Industry	72.4	--	25.6	--	2.8	--	100.9

Table 7: Industrial Natural Gas Consumption in 2013 by Subsector and Energy Use

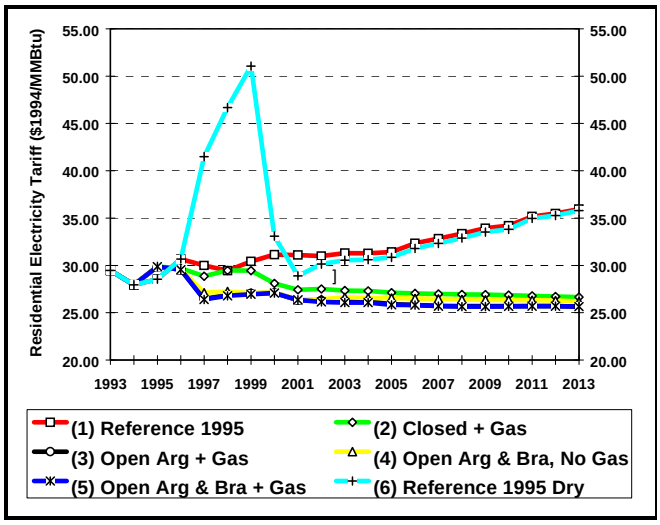

Figure 12: Projected Residential Electricity Prices by Scenario

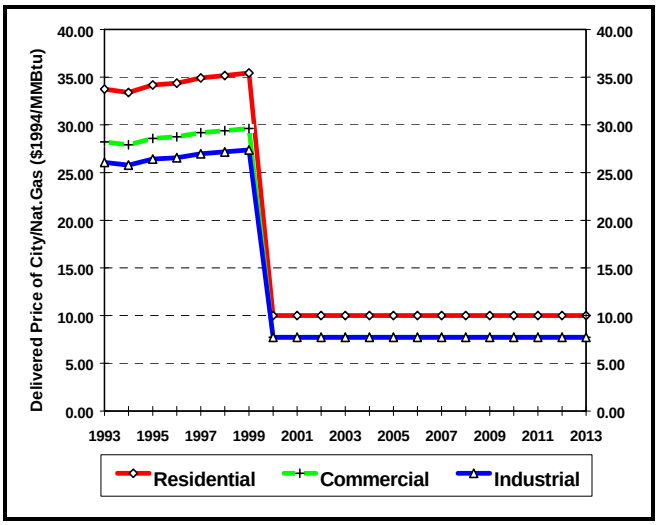

Figure 13: Projected Delivered Cost of Natural Gas under Natural Gas Scenarios

NET ENERGY IMPORT BILL

The net energy import bill is shown in Table 8. Scenario 5 has the lowest net import bill with US$1.81 billion, while Scenario 6 has the highest with US$2.36 billion. Differences in the net oil import bill can be attributed to variations in import levels of refined oil products, e.g., Scenario 6 with its substantially increased oil product imports during the dry hydro period. Natural gas imports range from US$117 million (Scenario 2) to US$152 million (Scenario 5). Uruguay's net electricity balance (imports minus exports) shows export revenues between US$41 million (Scenario 4) and US$233 million (Scenario 5). It should be noted that most exports of electricity are in the early forecast period. Thus, they are given a higher weight in the net present value calculations. Under Scenario 4, Uruguay is projected to import significant amounts of electricity in the later parts of the study period, leading to much lower discounted net revenues. Under Scenario 5, Uruguay uses imported natural gas to export more electricity, resulting in much higher export revenues.

ECONOMIC COST OF DELIVERED ENERGY

The study also examines the effect on the net economic cost of delivered energy across Scenarios 1 to 5. The total net economic cost includes (1) fuel supply cost, (2) transport and distribution cost, (3) energy conversion cost, (4) additional capital investments, and (5) exports (subtracted from total). Taxes and subsidies are excluded from the analysis. Due to the limited information available, the absolute values are considered less reliable and the focus should be on the differences compared to the Reference Case. As shown in Table 9, it is estimated that Scenarios 2 to 5

Import Resource	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Crude Oil, Oil Products	2,272	1,970	2,025	1,952	1,894	2,471
Coal	19	0	0	0	0	18
Natural Gas	0	117	142	0	152	0
Electricity[2]	-195	-213	-210	-41	-233	-133
Total	2,096	1,874	1,957	1,912	1,813	2,357

[1] Net present value @ 12% discount rate.
[2] Negative numbers indicate net export revenues.

Table 8: Net Energy Import Bill by Scenario in million US$1994 (Net Present Value)[1]

Total Supply & Distribution	Net Present Value (NPV) - Absolute				
Cost	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Fuel Supply Cost	2,770	2,538	2,530	2,670	2,589
Transport & Distribution Cost	3,006	2,918	2,911	2,966	2,911
Energy Conversion Cost	521	517	523	516	516
Additional Capital Cost	769	872	413	298	413
Exports (subtracted from total)	228	252	322	454	478
Total NPV	6,838	6,592	6,055	5,996	5,951
Total Supply & Distribution	**Net Present Value (NPV) - Difference Compared to Reference Case**				
Cost	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Fuel Supply Cost	na	-232	-240	-100	-181
Transport & Distribution Cost	na	-89	-96	-40	-95
Energy Conversion Cost	na	-4	2	-5	-5
Additional Capital Cost	na	103	-355	-471	-355
Exports (subtracted from total)	na	24	94	226	250
Total NPV	na	-246	-783	-843	-887

Table 9: Economic Cost of Delivered Energy in million US$1994 (Net Present Value)

all have a total net present value of less than the Reference Case. The cost reductions range from a net present value of US$246 million for Scenario 2 to US$887 million for Scenario 5.

Under Scenario 2, natural gas replaces more expensive imported oil products and reduces the fuel supply cost as well as the transport and distribution cost. Additional capital investments are higher than under the Reference Case due to the expenditures for the natural gas pipeline as well as higher investments in the electric sector in the early years. Though Scenario 2 results in 200 MWe of coal-fired units not being built in 2011, the net effect on the total cost is minimal due to discounting. With electric system integration, electricity exports increase significantly. At the same time, the additional capital investment goes down as less power generating capacity is built, and under Scenario 4 no gas pipeline is constructed.

ENERGY INTENSITY

Uruguay's energy intensity in terms of final energy per GDP is projected to decrease from its 1993 level of 0.143 toe/US$1,000 to as low as 0.133 toe/US$1,000 in 2013 under Scenario 4 (see Figure 14). Note that the slight increase in energy intensity toward the later part of the planning period is related to electricity gradually reaching market saturation expressed in the form of slowly decreasing growth rates. As one of the more efficient final energy carriers, this reduced growth in electricity consumption slowly raises overall energy intensity. In Scenario 4, this saturation is delayed by a few years due to lower electricity prices and an associated larger overall market penetration. Also, a general shift from the industrial sector to the agriculture and service sectors reduces the overall energy intensity.

Final energy consumption per capita increases under all scenarios but shows the lowest increase under Scenario 4 — from 0.674 toe per capita in 1993 to 0.832 toe per capita in 2013. Electricity consumption per capita and per GDP increases in all scenarios and is the highest under Scenario 4 with 0.034 toe/US1,000 and 0.214 toe per capita.

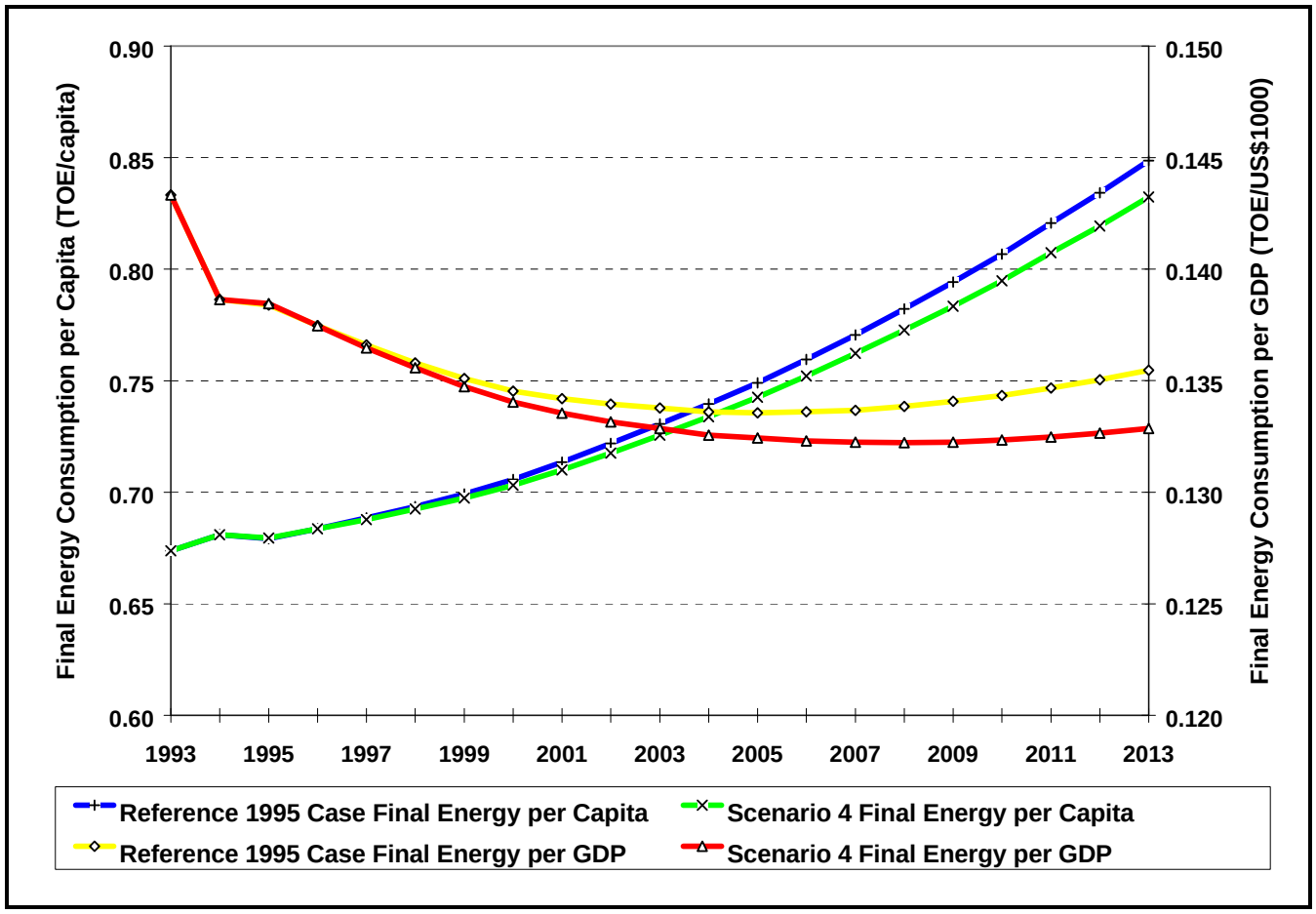

Figure 14: Energy Intensity Reference Case versus Scenario 4

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