HOW CAN TURKEY BENEFIT FROM NATURAL GAS FIRED ELECTRICITY GENERATION?

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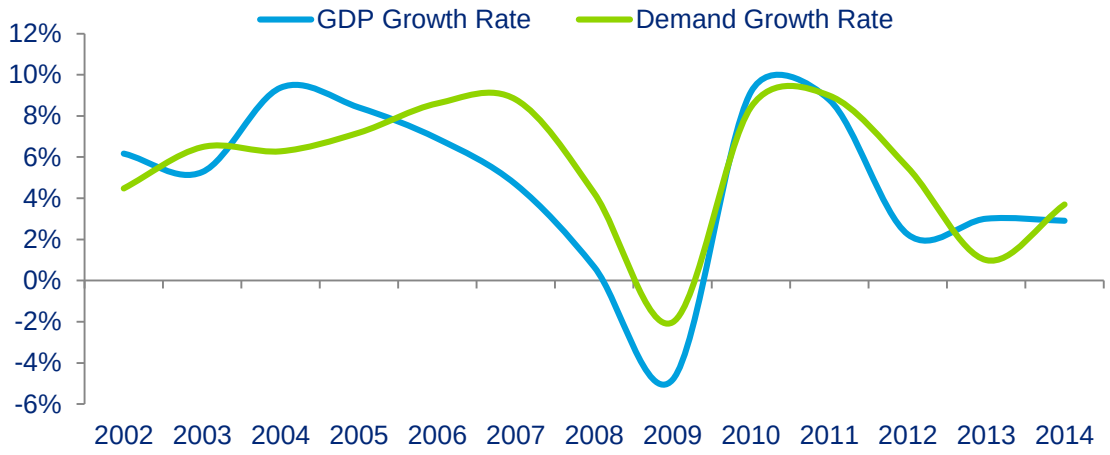
Overview

Turkey has been a focus of attention among investors, academicians and analysts alike, for its steady energy market liberalization pace and growing demand driven by a young, growing, and urbanizing population. Simultaneously with the expansion of electricity networks over the country and robust economical growth, electricity demand has been increasing continuously over the years except economical depression periods.

Figure 1 - GDP & Electricity Demand Growth Rate Comparison

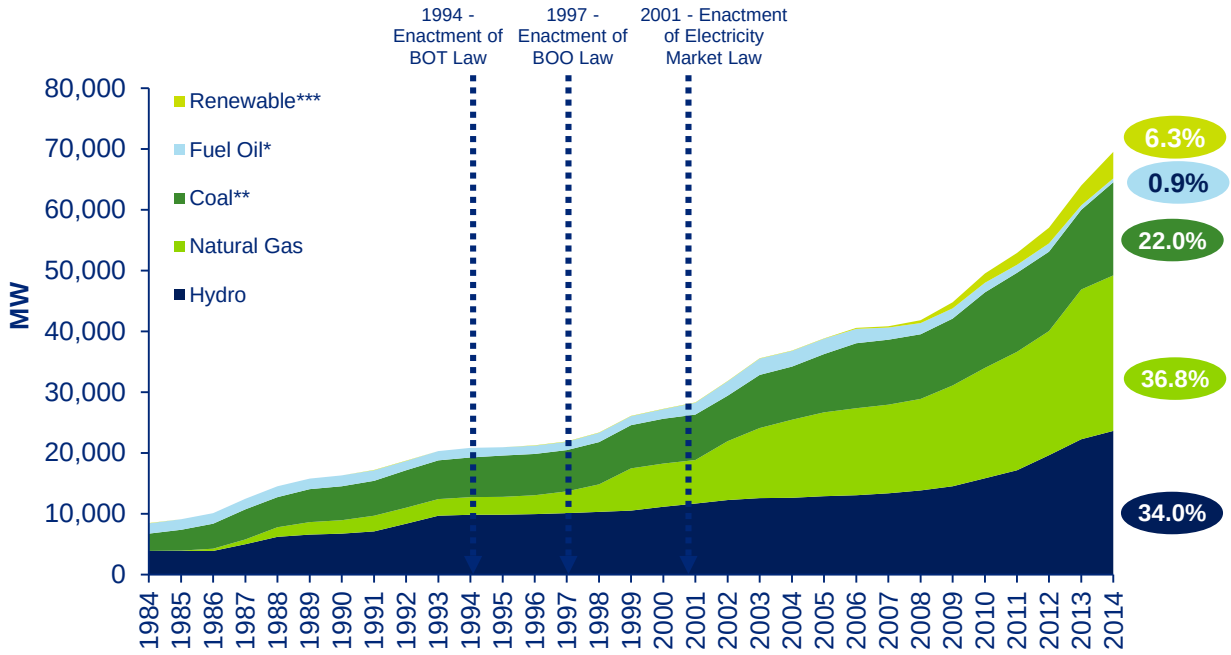


Source: *Turkstat, Economist Intelligence Unit (EIU), TEİAŞ*

Figure 1 clearly exhibits the co-movement of GDP growth rate and electricity demand growth rate. Research by Kapusuzoglu and Karan (2010) explains the long term relationship and causality between GDP and electricity consumption in Turkey.

In order to keep up with this climbing electricity demand, before 2000s, Turkey used to invest for electricity supply sources through public enterprises or specific concessions. Over the years, with the efforts for vertical unbundling and competition enhancement measures, heavy dominance of public enterprises easened considerably and private sector investments were both encouraged and incentivizes through market mechanisms to take part in the supply side. In such an environment, private sector investors made their investment decisions (primary source selection, technology, procurement channels etc.) based on their prospective cost and benefit expectations. Investment decisions of investors collectively shaped the primary resource composition of electricity generation fleet. Figure 2 summarizes the development of supply according to primary sources:

Figure 2 - Development of Installed Capacity in Turkey 1984 – 2014



Source: *TEİAŞ, Deloitte Analysis*

** Includes Diesel,Asphaltit and Naphta firing power plants*

*** Includes all kinds of local and imported coal firing power plants*

**** Includes Wind, Geothermal and Waste and other renewable power plants*

Involvement of private sector in electricity generation starts with Build Operate Transfer (BOT) Law in 1994 and continued with Build Own Operate (BOO) Law in 1997. Akdeniz, Çağlar and Güllü (2002) also underlines the strategy of government for attracting private capital in their study. Enactment of Electricity Market Law in 2001 can be considered as the official beginning of the liberalization process that lead to establishment of indispensible market mechanisms. As a result of these liberalization steps, it can be observed that installed capacity has been agressively increasing ever since. It is worth to note that especially the installed capacity of natural gas fired power plants climbed up to 9 times of 1994 levels, which indicates that investment decisions of private investors tended towards natural gas fired power plants.

As of end of 2014, natural gas fired power plants constitute 37% of the total installed capacity and their generation dominates the market by 49% [1]. This situation raises question marks related to overdependence of the system to natural gas. However, in this study it will be propounded that if managed wisely, considering the current conditions of Turkey, benefits of gas fired power plants can be seized.

1) Management of Contractual Obligations

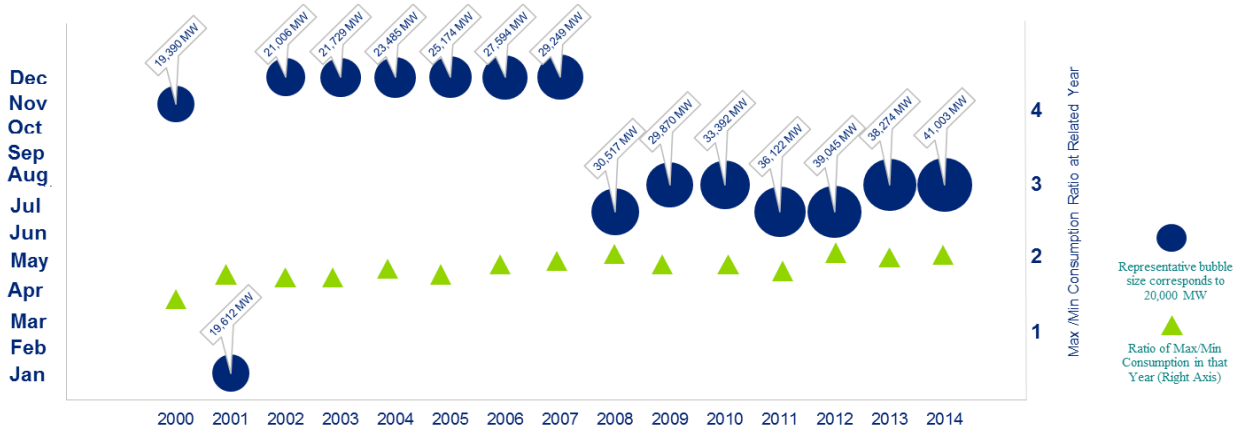
Besides the natural gas fired power plants, natural gas is intensely diffused into residential and industrial sector over the years. While there were only 6 cities supplied natural gas at the beginning of the decade, by the end of 2014, 74 cities are supplied with natural gas and the investments for the remaining 7 cities are ongoing. Such a growth in residential sector, whose natural gas consumption exhibits large seasonaly behaviour (winter-summer total residential consumption difference is nearly 8 times according to İGDAŞ which is the gas distribution company of Istanbul region with over 3.5 million subscribers (Ekiz, 2014)), comes with corresponding problems of management of contractual off-take obligations in the import contracts with source countries. Simply put, an off-take obligation is a buyers contractual commitment to the amount of purchase, payment for which would be made regardless of the purchase is made or not. For natural gas import contracts, such amounts are usually defined per annum, but considering the

[1] *It should be noted that electricity from gas fired power plants was exceptionally high in 2014 due to hydrological draught experienced over the past years.*

technical capacity of the pipelines, certain levels of purchases have to be maintained monthly in order to meet yearly goals. Goncu, Karahan and Kuzubas (2013) underlines the large deviations of demand between seasons and propose a stochastic model to forecast the seasonality behavior of natural gas demand. Many academicians are working on this issue because of the cruciality of demand forecasting for network management as well.

In order to understand the behavior of seasonal gas demand, the reflection of gas market on electricity market should be evaluated as well. Analysis of peak electricity demand indicates that Turkish Electricty Market demonstrated a transformation in recent years towards summer peaks from winter peaks as visualized in Figure 3:

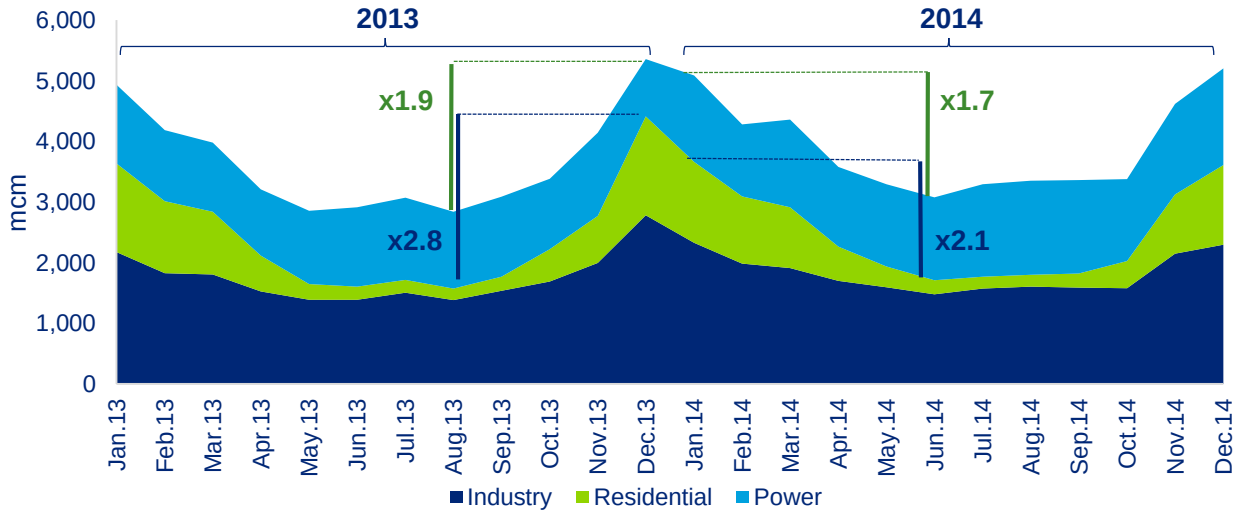
Figure 3 - Months of Years when Instantaneous Peak Demand Realized 2000-2014



Source: *TEİAŞ, Deloitte Analysis*

Climbing air condition uses in summer periods paved the way for such a transition which gave a wider role for natural gas fired power plants because of the combined effect of lowest utilization of run of river type hydroelectric power plants, water rationing at storage type power plants, and lower wind power generation in summer periods. As a result, natural gas consumption of power plants tend to rise in the summer times when the total gas demand is at very low levels for other uses across the country. Figure 4 summarizes the impact of natural gas fired power plants on the seasonality effect.

Figure 4 - Monthly Natural Gas Consumption by Sector 2013-2014



Source: *MENR, Deloitte Analysis*

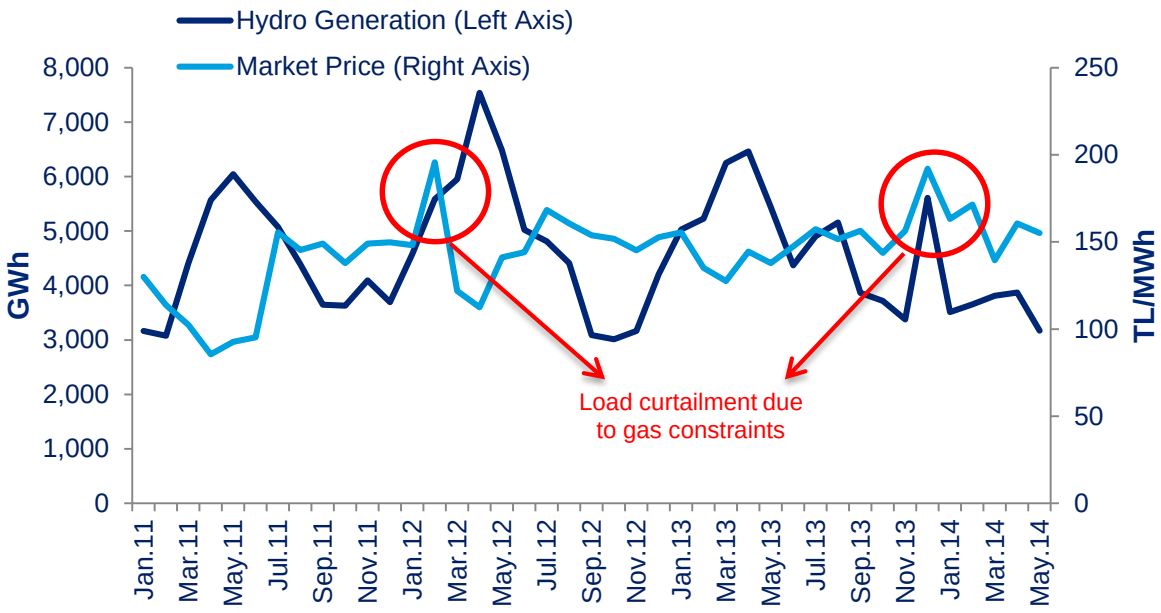
Although the largest portion of the natural gas consumption of industrial sector is base load in every season, heating requirement in winter periods has a direct impact on residential and industrial sector consumption. The differences between monthly maximum and minimum aggregated consumptions of industrial and residential sectors are observed as 2.8 and 2.1 times in 2013 and 2014 respectively. However, as the additional gas consumption of natural gas fired power plants in summer periods are taken into account, maximum and minimum consumption difference drops to 1.9 and 1.7 levels which easens the management of contractual obligations by offsetting the large summer/winter gas consumption differences. As the distribution network development of Turkey is taken into account, with the rapid penetration of residential, larger demand gap in the natural gas consumption is expected to be observed.

Natural gas consumption with the use of power plants flatten the gas consumption pattern and facilitates the monthly contractual quantity (MCQ) management. This phenomenon is very important in the contractual negotiations of MCQs with the source country. Especially, as the restricted gas storage opportunities and opportunity cost of storing the gas for a long time are taken into account, flatter gas consumption pattern brings valuable contractual flexibility for the system.

2) Optimization of Hydro Sources

Constituting 34% of total installed capacity as of end of 2014, hydro sources are invaluable for Turkey. By covering approximately one-third of the total installed capacity, impact of hydroelectric power plants on electricity market is very significant.

Figure 5 - Monthly Hydro Generation vs. Electricity Price Average Development



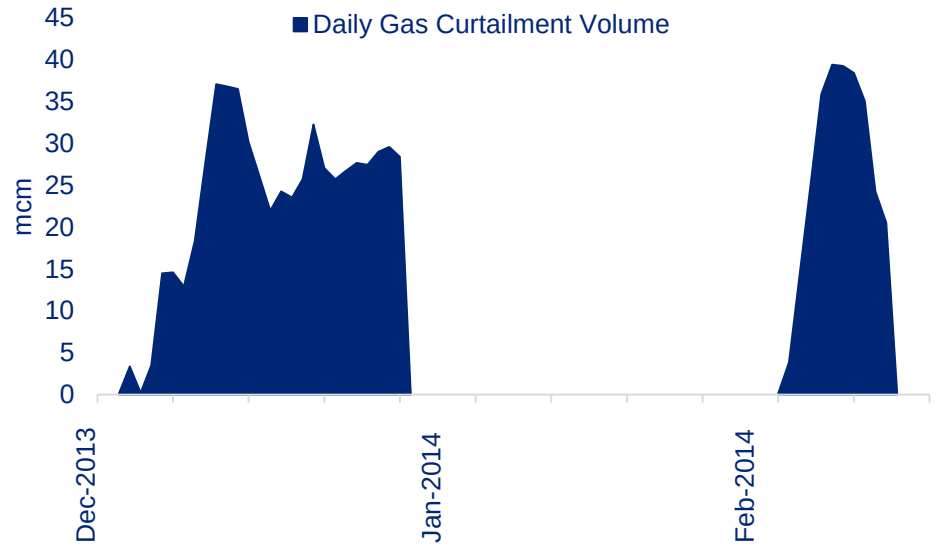
Source: *TEİAŞ, Deloitte Analysis*

Figure 5 exhibits the reverse movement of hydro generation and electricity prices. Especially in spring months, vast hydro generation drives electricity prices down. In the late of fall months and winter periods, hydro generation drops and electricity prices climb. An exception to this reverse movement is the cold weather conditions when natural gas curtailments are observed on natural gas fired power plants. In order to compensate the absence of natural gas fired power plants, in curtailment periods hydroelectric generation increases.
The main advantage of hydroelectricity power is the low marginal cost generation but moreover, by collecting water in their reservoirs, dam types seize the generation flexibility, and thus act as some sort of energy storage facility. However, opportunity costs of hydroelectric power plants should also be kept in view. To clarify, if the water in the reservoir is spent now, it cannot be used in the future and opportunity of selling for higher price is missed and especially, in dry years, water in the reservoirs become much more crucial for such arbitration. Hydro plant operators calculate the value of collected water in reservoirs and optimize their generating profile considering the results of

these optimization as well as other constraints related to their facilities. Hydro generation is always tried to be shifted to the highest electricity price hours. Such an operation is called "peaking"; peak prices (or peak demand) is met with shifting generation from lower priced hours (lower demand). The results for the system can be simplified as a least cost optimization in the general sense. If the hydro power plants do not seize the maximum benefit, it turns into a sub-optimal result since the invaluable water sources are misspent and overall cost reduction in peak hours is not realized. In a well functioning market, this results in significant peaks in prices and overall price volatility.

In Turkey, in winter periods, when residential natural gas consumption climbs as a result of heating requirements, gas consumption priority is given to residential consumers by the transmission system operator. Natural gas fired power plants rank after the industrial consumer according to the priority list of tranmission system operator. Figure 6 summarizes the situation visually:

Figure 6 - Indicative Daily Gas Curtailments from Power Plants & Industrial Consumers in Gas Shortage Periods



Source: *Turkey International Underground Gas Storage Conference 2014 – Presentation of Zafer Demircan, General Manager of General Directorate of Energy Affairs*

This means that in case of natural gas shortage, gas fired power plants remain idle and availability of the overall system drops. In order to overcome this situation and satisfy the increasing electricity demand of the system, hydro sources are potently utilized. Reflection of such a situation on the electricity market is observed as relatively suppressed electricity prices compared to the situation of filling the deficit amount of electricity from costly liquid fuels such as diesel and fuel oil. In summary, as the reservoirs can be sustained for winter periods by the optimization of hydro electric power plants and natural gas fired power plants, gas can be directed to residential use in winter periods without any electricity short-coming problem. This means, existence of natural gas fired power plants lessens the burden on hydroelectric power plants over the year and creates them flexiblity for utilizing at the most required periods.

3) Ancillary Services and Saving Hydro Resources

As it can be observed from Figure 2 that hydroelectric installed capacity has always been a strategic and crucial source for Turkey. In 1980s, nearly 50% of the installed capacity was composed of hydro sources. Kömürcü and Akpınar (2010) underlines the importance of State Hydraulic Works (DSİ) and their impact for the development of hydro sources in those years. According to the master plans prepared in 1960s by State Hydraulic Works, and Electricity Works Study Administration (EİE, now obsolete) planning of hydroelectric power plants were made according to the maximum total generation goal from the plants. However, as the paradigm changed in the developed electricity markets, the role of hydroelectric power plants were transformed into peaking with their maximum dispatch goals in peak demand hours instead of total maximum generation. The design approach of hydro power plants are crucial for

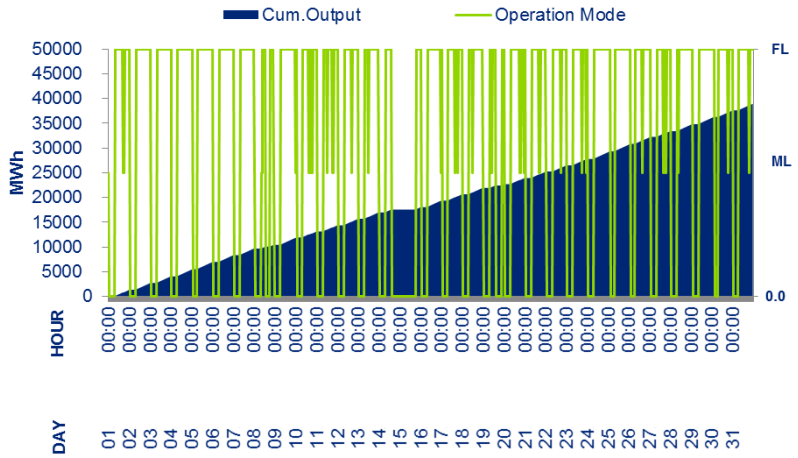
the utilization of these sources. Hosseini, Rahimpoor and Forouzbakhsh (2005) points out the importance of optimal installed capacity for the hydro power plants. The reflection of this paradigm change on Turkish Electricity Market has recently been started to be observed among privately designed facilities and investments of the market players are being shaped according to peaking goals; however, the prevalence of this approach takes time and impacts are expected to be observed in the medium to long term.

Furthermore, Turkey is aspiring to add more lignite fired power generation plants to its system through tax incentives and other support mechanisms as Topuz, Günaydın and Adıgüzel (2014) expressed. Being baseload operating plants, such additional lignite capacity leaves room for gas fired plants that offer flexility.

On the other hand, ancilliary services are highly important for the system security and system operator maintains the stability of the system through the orders given to the ancilliary services capable power plants. Since there are not many power plants which are capable to keep secondary frequency reserve, large hydro sources are utilized for ancilliary services and valuable hydro sources, which are scarce and have ability to suppress the electricity prices with their competitive advantages, are reserved for other purposes.

As an alternative, natural gas fired power plants, especially the new technology, are tailor made for peaking with their technical capabilities; namely, quick ramp up/down durations, hot/warm/cold startup flexibilities, compatibility with primary and secondary frequency control equipment and similar, provide significant assistance in fulfilling peak demand, supporting balancing power market as well as provision of ancillary services. This flexibility is hard to be satisfied from base load power plants. Figure 7 is a sample from a study conducted by Deloitte and exhibits indicative operating regime simulation of a new technology CCGT under the predicted hourly electricity prices:

Figure 7 - Operating Regime Simulation of a CCGT



Source: *Deloitte Analysis*

Deloitte OpReg Model is an in-house developed mixed integer linear programming model for the simulation of optimal operating regime of power plants under the given predicted electricity prices. With the aim of profit maximization, operation decisions of power plants are simulated by taking their technical characteristics into account. The main indication is that base load power plants do not demonstrate short interval on/off flexibility due to their relatively low marginal costs and high flexibility costs in contrast to natural gas fired power plants. This instantaneous response opportunities of natural gas fired power plants can provide significant benefits, if managed diligently and wisely within the overall generation system.

4) Motivating Renewable Investments and Network Integration of Renewables

As explained before, natural gas consumption is highly correlated with temperature and thus, as temperature drops demand volatility increases. Particularly Turkey, as a country which neither has adequate local gas production

capabilities nor storage facilities to balance demand, cannot adjust the production to match demand and have to manage this situation with the contractual flexibilities obtained from source countries.

In integrated liberal natural gas and electricity markets, requirement for risk management tools and portfolio optimization arise and quick response must be given to the changes in market conditions. Such a requirement for flexibility highlights the necessity of seasonal natural gas pricing so that supply and demand dynamics determine the price of gas in a competitive environment based on the scarcity and abundance of natural gas. From the economic point of view, since price of a commodity is seen as the information for consumers and producers incentivizing to increase/decrease supply and demand, such valuation differences for natural gas create investment signals for investors. In natural gas markets the signals correspond to investments for storage facilities, LNG terminals etc. while in electricity market, via price determining natural gas fired power plants, motivate base load power plants, renewable sources, and even pump storage facilities.

Especially, the integration of renewable energy sources; namely, solar and wind power plants, is lively debated on various channels. Although it is known that they are advantageous in terms of local source utilization and environmental friendliness, their direct dependency to weather conditions creates difficulty for network integration. To clarify, the instaneous changes in solar radiation or wind blow lead to load changes on the grid and these are to be corrected with the instructions of the transmission system operator in order to secure quality of the electricity. As Clingendael International Energy Programme's 2014 report related to coordination mechanisms of renewables "Reflections on Coordination Mechanism" clearly points out although variable renewable electricity (solar and wind) is very advantageous in terms of carbon emissions but "poor dispatchability" of these technologies distorts the system reliability and quality, which is a public good that everyone benefits from. At this point, with their quick response capabilities, natural gas fired power plants can take role and reinforce the system security via ancillary services channels or balancing market means.

Clingendael International Energy Programme's 2014 report prepared for Dutch Ministry of Infrastructure and Environment (Transition? What Transition?) indicates support of renewable energy and system balancing via fossil fuel fired plants, especially natural gas fired power plants, is witnessed in many European countries through their renewable energy transition since the electricity storage technologies are not developed enough . Aggressive development of renewable energy shifts the natural gas fired power plants out of the merit order and make them hard to conduct their operations. As a matter of fact, many natural gas fired power plants are either decommissioned or kept at standby with capacity payments in such an environment . Since these power plants are very important for system balancing, capacity payment models aiming to cover the fixed costs of power plants are emerging. The first "Capacity Payment" mechanism was experienced in the UK at the end of 2014. For 2018/2019 period, 49 GW of capacity is granted and 45% of this capacity is awarded to CCGTs. This situation underlines the fact that existence of natural gas fired power plants are important for the system security and absence of them in the market pushes the authorities to find ways to include them in the generation mix.

Deloitte utilizes a sophiticated hydro-thermal optimization and scheduling model, Stochastic Dual Dynamic Programming (SDDP) developed by PSR for electricity market modelling and long-run electricity price forecasting studies and uses its in-house developed linear programming based natural gas market model which represents characteristics of Turkish Natural Gas Market, including seasonality from climatic factors. The simulation studies conducted via SDDP specifically for Turkey exhibit that with in case of the continuation of expected sound electricity demand development, even renewable boom scenario happens and significantly high amount of wind/solar power plants are commissioned, still natural gas fired power plants are going to be the price determinant in most of the hours.This actually means that adequate number of natural gas fired power plants will still exist and they are expected to continue investment signals creation. Nevertheless, it should be underlined that initiation of liberal natural gas markets is defined by 2018 into the Deloitte Turkey Natural Gas Market Model. In other words, only existence of a liberal natural gas market is expected to support such a scenario.

Considering all, it can be claimed that natural gas fired power plants are both investment motivating by creating investment signals with relatively higher electricity prices and system security enhancing via their short start-ups durations and ancillary service capabilities. Most importantly, they support the presence of renewable generation with their backing up abilities. However, the most important issue for benefiting from these advantages lies in the existence of liberal gas markets and seasonal pricing of gas with supply and demand equilibrium. In case of the presence of such markets, the balance between desired renewable energy development and system security issues are determined by the

hands of "market forces". Otherwise, if the natural gas prices do not reflect the real cost of the commodity, it indicates that market failures exist and investment signals are distorted. As a result of such distortion, overreliance on natural gas incurs and no playground orginates for renewable development.

5) Management of Commercial Contracts

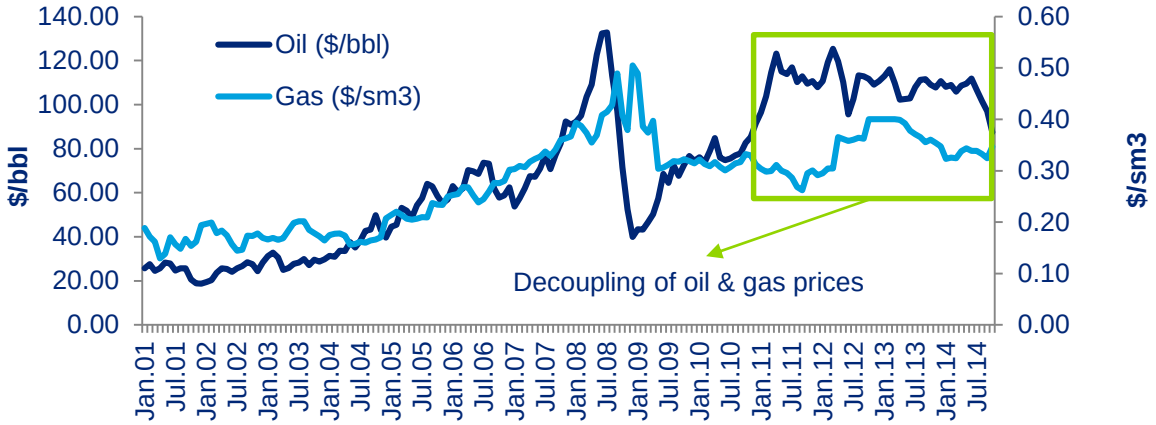
Turkey's geographical position as a transit destination between gas producer countries; namely, Russia, Iran, Azerbaijan, Iraq and East Mediterranean, and a large gas consuming node; namely, Europe. With its continuously climbing demand, Turkey is an important customer for natural gas producing countries. Despite being a large natural gas consumer, local gas production opportunities of Turkey is very limited and therefore, 99% of the natural gas is supplied via pipelines from Russia, Iran, Azerbaijan; via LNG from Nigeria, Algeria and spot (various countries such as Qatar, UK, Norway etc.). This roboust demand can be used for stronger bargaining power and reduce gas procurement costs with better commerical management of contracts.

Figure 8 - Indicative Map of Natural Gas Supply & Demand Nodes

Source: *IEA, EU Energy Regulators*

Turkey demonstrates the only one of its kind characteristics in the natural gas market. In order to take liberalization steps, state incumbent BOTAŞ released its 10 bcma volume West Line Russian contracts to private sector players and such a contract release approach is not observed in European experience; instead volume release approach is followed. Although some steps were taken for liberalization of the import part of the value chain, still BOTAŞ dominates the market with its long term contracts with source countries. With its vertically integrated structure, the actions taken by BOTAŞ determines the market dynamics; namely, pricing behavior, cross subsidization of residential sector, market penetration etc.

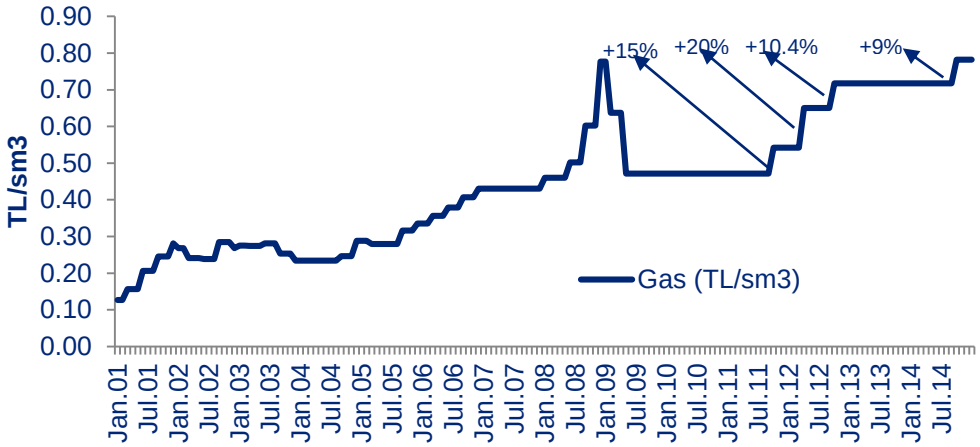
Figure 9 - Development of Brent Oil Prices and BOTAŞ Tariff (in USD)



Source: *EIA, BOTAŞ, Deloitte Analysis*

Figure 9 above visualizes the decoupling of oil and gas prices over the years. Although cost based pricing approach was followed until the end of 2010, by 2011 this approach was left and pricing strategy changed. Figure 10 below visualizes that before 2010 prices were being adjusted according to changes in the costs but then the situation turned into a political decision:

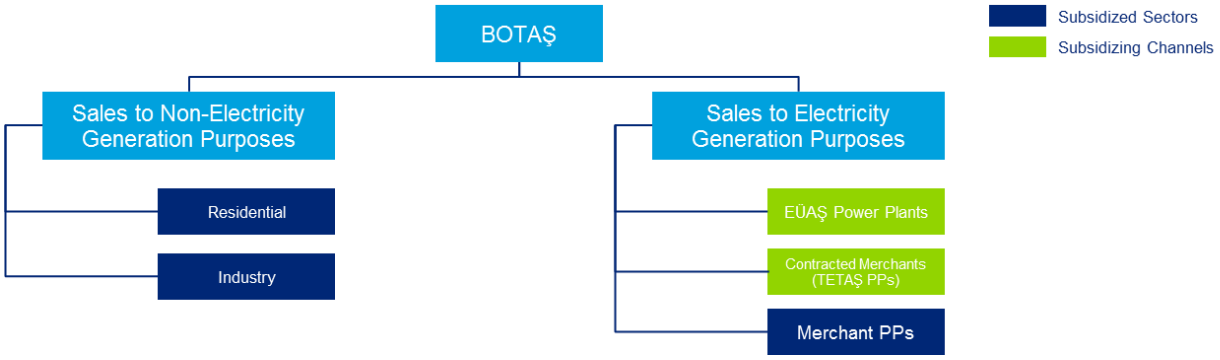
Figure 10 - Historical Development of BOTAŞ Tariff (in TL)



Source: *BOTAŞ, Deloitte Analysis*

Using its dominant position, instead of cost based pricing, BOTAŞ applies cross subsidies to industrial and residential consumers by applying higher natural gas prices for contracted merchant TETAŞ Power Plants (Build Operate (BO) / Build Operate Transfer (BOT)) and EÜAŞ power plants. Figure 11 exhibits the cross subsidy approach:

Figure 11 - Sales Channels of BOTAŞ and Cross Subsidization Mechanism



Source: *Deloitte Analysis*

In order to pave the way for liberal gas markets, unbundling of BOTAŞ has been discussed for a long time. However, as the market paradigm changes with the EÜAŞ power plant privatizations and conclusion of contracted merchant agreements, it is expected that dominance of BOTAŞ will be reduced on pricing.

From a macro point of view, better contract management stems from the reflection of supply and demand dynamics in the liberal markets. As the steps for liberalization of natural gas market are taken, the flexibility and width required in market can be obtained through integration of gas fired power generation facilities in a demand response mechanism that incorporates power and gas markets. Gas fired power plants participation in a natural gas demand response mechanism can act as a balancing factor in a market with limited storage and significant natural gas passing through. Also development of liberal gas markets in Turkey oils the wheels for integration with European natural gas markets. In such a case, geographical position of Turkey can become much prominent in the region. Turkey is eligible to welcome new gas supplies from various sources around, then satisfy the internal demand and export gas with competitive price levels to Europe. As Ozturk, Yuksel and Ozek (2011) study asserts, Turkey is spending effort to become a part of the link between Europe and gas sources around. There are many significant areas in the countenance of Turkey to benefit from contractual management if behaved and treated strategically. Nonentheless, as the current conditions are concerned, the prevalent environment is not appropriate to realize these aims in the near future.

Results & Conclusion

With its developing economy and population, Turkey is classified within the emerging markets and correspondingly, energy demand of Turkey has been increasing soundly. Not only in electricity, but also in natural gas consumption demand is rapidly growing and Turkey is trying to catching up this paradigm change with the steps towards liberalization and private sector involvement has been tried to be encouraged.
Natural gas is widely used in industry, residential sectors and electricity generation. As the historical development is analyzed, share of electricity generation from natural gas is continuously increasing and this situation raises the questions of over dependency to natural gas. Overdependency for a foreign originated source is a highly crucial issue for Turkey and this should be closely analyzed. Because with the climbed dependency, absence of gas would hurt the economy deeply. However, if managed wisely, natural gas can create flexibility for the system and its advantages can be benefited from.

Natural gas demand patterns analzyed exhibit that the demand characteristics of different segments help managing the annual and monthly contracted quantities. Existence of natural gas fired power plants contribute positively for the contractual management of natural gas according to the current market conditions. Also, valuable hydro resources can be better managed with the utilization of natural gas and a cost effective electricity generation mix can be created as a result. Technical characteristics of natural gas fired power plants are appropriate for fulfilling the peak demand and providing ancillary services requirements of the system. From electricity markets perspective, natural gas fired power plants are price determining ones in the merit order and enhance investment signals. With the liberalization steps taken

so far in the electricity market, investment cycles paved the way for the realization of large and efficient natural gas fired power plant projects and there are some projects upcoming. If the natural gas markets are also liberalized, the investment signals created are expected to both motivate renewable energy generating facilities and complement their shortcomings stemming from natural factors. Morover, Turkey can turn its geographical location and significant consumption volume into advantage via better contract management and push procurement costs down. At first, liberalization of the market and then, integration of natural gas market with European network are expected to contribute positively for better contract management.

This study just reminds that if managed wisely, considering the current conditions of Turkey, benefits of gas fired power plants can be seized and does not overrule the renewable expansion; on the contrary, paves the way for development. While European utilies and authorities are seeking ways to keep the natural gas fired power plants alive and include them in the energy mix, having newly commissioned high efficiency natural gas fired power plants in Turkey is very advantageous. Foreign energy dependency is something that needs to be managed and Turkey needs highly efficient market mechanisms, robust energy diplomacy and contract management tools to cope with its energy problems. Natural gas fired power plants corresponds to large share of the market but can serve for better market structure if cleverely utilized. Compared to Europe, where power generation investments are rare or stagnant, Turkey is advantageous with its developing supply stake; however, the regulatory and market environment should be shaped to enhance this advancement.

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