Oil products demand to decline in Croatia

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REVIEW

Majority of big thermal power plants in Croatia, including a number of industrial and public cogenerations, use heavy fuel oil for firing their steam boilers.[2] Among them, the most important thermal power plants started their operation thirty or more years ago (TE Sisak, TE Urinj – Rijeka and other) and they are still predominant electricity producers, in addition to hydro plants and the nuclear power plant. Majority of them will stop their operation during the next ten years. They will be replaced with new thermal and cogeneration plants which will mainly use natural gas as a fuel.

At the same time, the two fuel refineries will decrease production of heavy fuel oil after upgrading of processing units, and in the later stage, this production will almost stop or stop entirely. This will happen after completion of the conversion process by which heavy hydrocarbons will be converted into medium (diesel fuel) or light hydrocarbons (gasolines, LPG or refinery gases). Fuel oil consumption for refineries' own needs will also be replaced with natural gas.

The timing of decreased fuel oil production, or its stopping, should be harmonized with the timing of shutdown of thermal power plants which are the largest consumers of fuel oil, in order to avoid big fuel oil surpluses, or shortages. Also, it will be necessary to ensure supply and transport of natural gas for new power and heat producers. Increased natural gas demand will be met mainly from imports.

It is important to slowdown and eventually stop increase of diesel fuel consumption, the import of which is rather high and costly.

During the last several years the first wind power plants were put into operation in Croatia. As a renewable energy source, they will help in decreasing electricity import, which is now very high. Reconstruction of large hydro plants and construction of new plants will also decrease electricity import.

Key words: oil refining, diesel fuel, natural gas

Introduction

The majority of large thermal plants use heavy fuel oil for production of electricity, steam and heat.[2] A number of smaller plants have already switched to natural gas. The biggest changes will take place in the next ten years with expected shutdown of the biggest plants using fuel oil or coal.[13] Instead of them, new gas fired power plants will be built. In the forthcoming years a series of problems will have to be resolved: problems related to higher natural gas import requirements (financial capabilities of potential investors and buyers of natural gas, their status, rights and liabilities, supply routes, gas pipeline network, gas prices etc). First, it would be essential to establish clearly who in Croatia is responsible for the supply of natural gas to current and future consumers, what means are available to such entity responsible for gas supply, and with whose support it can accomplish its assignment. In case of crude oil, the situation is more favourable thanks to JANAF oil pipeline construction (put in operation in 1979) and its subsequent reconstructions. The most recent upgrading will enable reversible transport of crude from Sisak to Omišalj, so that Russian oil could be transported by pipeline to the terminal in Omišalj, while before only seaborne transport was possible.

In order to enhance environmental protection and increase output of higher value refinery products, the refineries are building new units that will process heavy hydrocarbons and convert them into medium and light hydrocarbons which will be desulfurized by means of hydrogen. The first new units have already been put into operation and some other will be constructed in the next five years. INA should resolve all remaining open issues regarding new processing units rather quickly.

1. Fuels consumption in Croatia

The fastest increase of fuel oil consumption in Croatia was recorded in the 1970s when the three biggest thermal power plants were put into operation (TE Sisak A - 210 MW in 1971, TE Sisak B - 210 MW in 1976, and TE Urinj, close to Rijeka, 320 MW in 1978), all fired by fuel oil. By the end of that decade the construction of power plants fired by fuel oil was banned. Although this ban is not in force any more, such thermal plants were mainly abandoned. New thermal and cogeneration plants use natural gas (TE-TO Zagreb) or coal (Plomin).

In 1987 total heavy fuel oil consumption in Croatia was 1 215 kt. In the 1990s it recorded further increase (1995 – 1 425 kt, 1996 – 1 365 kt, 1997 – 1 484 kt and 1999 – 1 593 kt)[2] as a result of several smaller public and industrial plants put into operation which used mainly fuel oil. In the last decade of the 20th century fuel oil consumption was about 1.5 Mt/y, in recent years it is below 1 Mt/y as some plants switched to natural gas.

According to date of itsr construction, the first block - TE Sisak A will be out of operation in 2013.[13] At the same time fuel oil production in the Sisak refinery should be decreased. This will be achieved with the start up of new heavy gas oil hydrocracking (HC) plant, which will decrease heavy fuel oil production and increase the production of lighter products, especially diesel fuel. It is very important that this start up and shut down take place simultaneously because TE and refinery are divided only

by fence and connected by pipes. Otherwise, the refinery should deliver fuel oil to other customers by rail, or TE Sisak should have fuel oil transported by rail with huge offloading problems. Similar situation is at the TE Urinj and the Rijeka refinery.

According to date of its construction, the second block – TE Sisak B should stop operation between 2017 and 2019. At the latest by that time the old coking plant in Sisak (in operation since 1967 when processing capacity was 1.5 Mt/y) should be replaced with a new one of higher capacity and state-of-the-art technology.[14]

The shut down of TE Urinj is foreseen in 2020. It is questionable whether it will be possible for the plant to continue its operation so long because of pollution problems. The unit for processing heavy residue in the Rijeka refinery should be constructed earlier (by 2015) but then the thermal plant TE Urinj should start importing fuel oil. Already in 2010 a new gasoil hydrocracking (HC) unit will decrease fuel oil production (the conversion is 45%) and the production of medium and light products will increase.

Table 1 contains the data for the largest or particularly interesting consumers.

The lower fuel oil consumption in thermal power plants is the result of natural gas use during summer months in line with technical possibilities of their steam boilers, but also lower electricity production and higher import of electricity. It is not easy to understand why export of fuel oil increased, import decreased, in the situation when thermal power plants had rather low capacity utilisation. Obviously, shortage of feedstock was not the problem. In recent time import of electrical energy was unacceptably high (Table 4).

In a number of public and industrial heating plants (including those in both refineries and petrochemical industry) upgrading plans foresee switch to natural gas. A very good example is the construction material industry where gas fired plants outnumbered those using fuel oil.

As a result of significant decline of heavy fuel oil consumption, but also extra light fuel oil, the total oil products consumption is likely to decline in the next decade in Croatia. It is expected that we shall see slowdown in growth of motor fuels consumption (processed from crude oil) as a result of higher biofuels use (biodiesel and bioethanol) as motor fuel components and wider use of compressed natural gas (CNG).[12] As GDP will eventually grow, energy demand will also grow but not at the same pace thanks to higher energy efficiency which must be improved.

After start up of the new heavy gasoil hydrocracking plant (HC)[5] in the Rijeka refinery, at current capacity of (3 Mt/y), the fuel oil production will decrease, but diesel fuel production will increase by 303 kt/y, and at the same time production of gasoline and lighter products will also be higher. If the refinery operated at full capacity (4.5 Mt/y) diesel fuel production would increase by 505 kt/y compared with former production when the mentioned unit was not in operation.

It is a very positive fact that the domestic production of natural gas is permanently growing, but unfortunately this growth will stop in the near future. Namely, the production from the fields in the northern Croatia is declining after many years of exploitation.

Part of production from the North Adriatic gas fields is being exported pursuant to production sharing agreement signed with the joint venture partner.

Gas consumption for energy transformations is expected to grow in the next decade. In some years it will have sharp rise as several new public and industrial gas fired plants will be put into operation, including the refineries. Natural gas consumption in household segment will also grow as new households are connected to the grid. The network of trunk pipelines is being extended to cover the unserved areas (eg. Lika, Dalmatia and western Istria) and new distribution network is extended in already served areas. In response to fast growing gas con-

Table 1. Fuel oil consumption (kt/y)

Year	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total consumption	1 505	999	1 122	1 172	1 354	919	964	977	995	810
Refineries	82	46	48	57	52	66	71	58	82	33
Thermal plants	654	283	398	408	559	252	284	311	424	332
Public cogeneration	208	109	115	93	166	114	162	156	102	125
Public heating	36	37	39	36	38	39	39	34	27	20
Indust.cogen	261	256	247	261	273	250	255	262	214	187
Industrial heating	53	49	43	48	42	36	38	43	39	29
Const.material industry	78	137	160	168	130	59	53	17	27	18

Source: El Hrvoje Požar[2]

Table 2. Fuel oil import and export (kt/y)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Import	226	43	47	138	331	325	214	85	118	97	73
Export	201	61	192	73	86	4	305	234	225	215	176

Table 3. Production, import and consumption of natural gas (M m³/y)

	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
Production	1 570	1 659	2 010	2 120	2 190	2 198	2 283	2 714	2 892	2 729
Import	1 104	1 108	1 083	1 084	1 139	1 054	1 134	1 127	1 055	1 227
Export	0	0	246	362	342	348	447	896	752	696
Total consumption	2 644	2 705	2 834	2 902	2 884	3 010	2 910	2 878	3 307	3 206
Transformation	887	962	1 056	1 202	1 047	1207	988	1 033	1 414	1 227
Thermal power plant	177	156	167	319	100	130	36	118	301	151
Public cogen	281	363	431	455	521	581	479	459	573	540
Industrial cogeneration	184	188	189	204	198	288	286	271	329	341
Households	495	497	562	549	633	630	688	652	623	683

Source: El Hrvoje Požar[2]

sumption it is necessary to create conditions for contracting at least one additional, reliable, gas import route, make timely decisions on appropriate solutions and then construct necessary facilities. It is important, and quite urgent, to make realistic review of possibilities for linking of Croatia's gas system to new gas supply routes and see what preconditions are to be met for the realization of such connection.

2. Production and consumption of electricity in Croatia

The average annual electricity consumption per capita Croatia exceeded four thousand kWh in 2005. In Europe, the highest electricity consumption in 2008 was recorded in Iceland with 38 635 kWh per capita[2], while in Norway it was 27 MWh. In the majority of European countries the electricity consumption ranged between 5 and 9 MWh per capita, the average in EU 27 was close to 7 MWh. In 2008 Croatia was on the top among 4th ranked group of European countries according to electricity consumption. Lower electricity consumption per capita had Bulgaria, Poland, Latvia, Lithuania, Turkey etc. It is very important that along with the rise in electricity consumption, Croatia had lower losses in transmission and distribution. In 2003 the mentioned losses were 2 543 GWh, and in 2008 only 1 706 GWh. Thanks to this trend, in the observed period there was a significant improvement of energy intensity in total electricity consumption (average gross electricity consumption per unit of gross domestic product), but unfortunately the net consumption intensity has not been decreased and fluctuates slightly above or below 2%.

The electricity consumption has steady growth, while production falls in the recent years, consequently, the electricity import is unacceptably high (especially from 2005 onwards). This cannot be changed quickly. A number of power plants are old and new construction takes time. The nuclear power plant Krško had high capacity utilisation rate: in 2008 it was 97.68%. The capacity utilisation of other thermal plants was only 37.82% in 2009,

Table 4. Production and consumption of electricity (Gwh/y)

	1998	2000	2002	2003	2004	2005	2006	2007	2008
Total production	10 897	10 702	12 286	12 669	13 321	12 459	12 430	12 245	12 326
Thermal pow.pl	3 959	3270	4 085	5 130	3 613	3628	3 936	5181	4 414
Public cogen.pl	927	980	1 328	2 022	2 121	1 877	1 875	2 116	2 086
Industr.co.plant	546	560	541	582	535	510	476	513	460
Import	3 783	4 386	3 927	4 479	5 298	8 746	8 313	7 812	8 164
Total consumpt	14 252	14 702	15 807	16 566	16 987	17 572	18 052	18 606	18 903

Table 5. Share of electricity generated by thermal plants in total electricity production (%)

1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
49.85	46.15	44.94	45.91	48.46	61.04	47.05	48.25	50.58	63.78	56.47

Table 6. Share of imported electricity in total consumption (%)

1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
26.54	20.24	29.83	24.42	24.84	27.03	31.19	49.77	46.05	41.99	43.19

which is a poor result. The only exception is TE Plomin (50% foreign share) which had capacity utilisation of 89.8%.

In the forthcoming decade the old power plants will have to be replaced with new ones. Until new capacity is installed, electricity import will remain high. Some increase in electricity generation will be achieved with putting into operation several wind power plants, however it will not have a significant impact as the capacity of individual wind plant is relatively low in comparison with large thermal or hydro power plants. By 2020 a wind power share in domestic electricity production could reach ten percent. However, it is essential to improve the transmission system capacity. According to forecasts, by 2020 wind power could rise to 1 200 MW and current acceptance capability of the transmission system is only 360 MW (according to one rather pessimistic calculation). Currently EU countries have wind power capacity of 83 000 MW10 while Croatia has only 90 MW. By 2020 the EU countries plan to increase wind power capacity to 230 000 MW. If a nuclear plant is to be built in Croatia in order to provide additional power generation, it will not be completed by the mid 2020s.

In addition to high investments in new power plants it will be necessary to invest in transmission network improvement and in transformation stations, in order to provide adequate infrastructure capacity capable to accept additional electricity, especially in some regions. The main shortfall of our power grid is its low regulation capability.

The huge future investments should be protected from non-commercial risks. In order to select the best projects it is necessary establish fairly in advance and for a longer time, tax and custom fee policy in gas business, mineral extraction royalty policy, energy prices and other issues. Natural gas prices were capped in Croatia for a long period, then increased several times in the last two years by relatively high percentage. Such policy has disturbing and discouraging effect firstly on gas producers, and then on consumers and potential investors in new plants which should use natural gas. Croatian Energy Regulatory Agency has allowed further gas prices increase even during the time when salaries and pensions are frozen, which is not acceptable. The announcement of new possible gas price increase is not justified.

3. Refining and oil products consumption in Croatia

During a long period the two fuels refineries in Croatia processed between 5 and 5.5 Mt of crude per year. Consumption of derivatives fluctuates, but in general it has a growing trend. Import of derivatives grew considerably, because until recently our refineries were not able to produce higher volumes of fuels according to effective European standards. After the start up of new processing plants in the refineries in Sisak and Rijeka (HDS FCC gasoline and PSA-2 at Sisak refinery in 2009, and light gasoline isomerization at Sisak and heavy gas oil hydrocracking - HC with HDS plant and hydrogen plant in the Rijeka refinery) the situation is much better. Higher production of motor gasoline and diesel fuel according to Euro 5 standard in the future will significantly decrease and even stop the need for import of these fuels.[5]

Rather high export of fuels to regional and international markets was not very lucrative because we exported products that did not comply with European standards, so the achieved export prices were relatively low. With new refining units in full operation there will be no need for export of lower value products. Nevertheless, our refineries production volumes in the future will depend on possibility and profitability of derivatives export.1 Oil products demand in Croatia (particularly fuel oil, but other derivatives as well) will decline in the forthcoming years when some large thermal plants will be shutdown and when biofuel components will be introduced.

LPG (propane – butane) is the only refined product which is mainly exported. In 1998 LPG production was 289.6 kt and export 169.1 kt; in 2003 production was 380.4 kt and export 264.2 kt, while in 2007 production was 372.4 kt, and export 198.8 kt.

Table 7. Refining, import, export and consumption of derivatives (kt/y)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Refining	5 345	5 711	5 480	5 094	5 250	5 525	5 498	5 313	5 031	5 469	4 650
Import of derivatives	696	471	227	492	1 212	1 307	1 313	1 519	1 637	1 729	2 081
Export of derivatives	1 772	1 817	1 699	1 642	1 627	1 726	2 055	1 869	1 852	2 020	1 736
Consumption	4 355	4 483	4 016	4 102	4 462	5 166	4 630	4 797	4 852	5 078	4 673

Source: El Hrvoje Požar[2]

Table 8. Consumption of light and medium oil products (kt/y)

	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
LPG	117	102	116	117	123	135	138	163	173	191
Gasoline	737	784	754	759	757	724	710	711	725	696
Diesel fuel	772	864	925	996	1 146	1 222	1 312	1 426	1 544	1 557
Ext.light f.o	435	480	480	492	526	497	467	395	333	307

Table 9. Motor gasoline consumption per segment (kt/y)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Road transport	717	760	764	735	745	741	710	694	695	708	678
Agriculture	12	13	12	11	8	8	7	8	8	8	9
Construction industry	9	8	8	8	5	7	7	7	7	8	8

Table 10. Diesel fuel consumption per segment (kt/y)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Road transport	458	528	533	576	658	785	858	927	1 023	1 127	1 080
Water transport	25	26	26	26	28	29	29	32	33	34	40
Public transport	26	26	25	25	25	26	27	28	26	26	27
Agriculture	172	149	187	202	190	189	183	183	189	190	200
Construction ind.	59	51	66	68	67	89	96	111	124	134	149

Source: El Hrvoje Požar[2]

By the end of the last century, annual consumption of virgin naphtha was about 70 kt (virgine naphta cracker at DIOKI in Zagreb), but this plant is out of operation now (due to its age). Currently, virgin naphtha export ranges from 150 – 200 kt. It is not realistic to expect a construction of a big naphtha cracker in Croatia which could use about 1 Mt/y of virgin naphtha, but it is more likely that an ethane cracker is constructed to cover our needs for ethylene and other light olefins.

After economic recovery the consumption of motor gasoline will resume the level it reached in the last ten years. Higher increase of motor gasoline consumption, but it cannot be realized quickly, would be achieved if excise tax on motor gasoline was aligned with diesel fuel excise tax. Currently, gasoline excise tax is by 1.11 kuna higher than on diesel fuel (higher excise tax plus VAT on excise difference), which is completely unjustified.

While gasoline consumption stagnates, consumption of diesel fuel recorded sharp growth, with the exception of 2008 when financial and economic crises began. However, this is only a temporary change which is not likely to last (probably next two years). Therefore it is important to undertake appropriate measures for durable solution. One of them is alignment of excise taxes for both fuels.[15]

In 2007 the diesel fuel consumption was double the consumption in 1998, while in road transport this consumption increased by 146%. It is a good thing that in the recent years Croatia constructed a modern network of good motorways. However, it also has a disadvantage: excessive share of road transport in total transport of passengers and goods. The road transport is much more energy intensive than rail transport, or sea and river transport. Developed countries take this fact in serious consideration. Such a fast growth of diesel fuel consumption is harmful for our economy and it has to be slowed down by introducing equal excise tax as imposed on Euro standard gasoline. Other countries use the level of excise taxes on various products and their relationships as a tool for balancing state budget revenues and for mitigating fluctuations of retail prices, hence, they protect their citizens and fuel buyers. The responsible Croatian authorities should consider this serious problem, find appropriate solutions and convince law makers to enact necessary measures.

Of course, it is necessary to modernize Croatian railway transport facilities (both tracks and trains), but also navigable waterways need to be improved. However, these are longterm and costly solutions. Future lowland railroad from Rijeka to Zagreb should overtake millions of tonnes of freight from and to northern Croatia, but also Hungary and other neighbouring countries, and assume part of road transport. Only then (probably in the 2020s) will the consumption of diesel fuel normalize. Faster solution can be achieved by better organization and faster passage of freight trains from Slovenia to Greece and Turkey, which has already initiated and should have favourable impact on road transport in northern Croatia. Unacceptably fast growth of middle distillates consumption is slightly refrained by lower consumption of extra light heating oil which is gradually replaced by natural gas. Growth of total consumption of motor fuels from fossil fuels can be slowed down by introduction of biofuels, but the effects might be lower than expected. It is more likely that the use of CNG will grow faster than expected and reach 6% share in total consumption before 2020.[12] Lower consumption of extra light heating oil and gradual abandonment of heavy fuel oil, as well as introducing of biofuels or non-fossil fuels will certainly decrease consumption of oil products in Croatia.

Conclusions

1. By 2020 almost all thermal power plants, heating plants and boiler houses which are fired by fuel oil will be out of operation; therefore it is necessary to build on time new power and heat generation plants, but also to increase transformation and transmission capacities.
2. The new or revamped thermal power plants will mainly use natural gas as a fuel, and only few of them

coal. It will be necessary to ensure timely import of sufficient volumes of natural gas. It is important to find proper solutions already this year so as to be able to realize increased import at latest by 2013.

3. In the next decade wind power is expected to reach 10% share in total power generation. It is important to remove all barriers that slowdown construction of planned wind farms. Hydro power potentials have been utilised to rather high degree and there are no other potential sites for construction of large new hydro power plants. The share of hydro power in total power generation will decrease in the near future if only smaller hydro plants are built.
4. The refineries in Rijeka and Sisak should construct and put into operation new plants for conversion of heavy hydrocarbons into middle and light distillates and units for recovery of sulphur from all derivatives. The consumption of oil products in Croatia will decline as a result of decreased and eventual abandoning of heavy fuel production, introduction of biofuels or their components and greater use of CNG as a fuel.
5. Bringing of motor gasoline and diesel fuel excise taxes on equal level (Euro grade of both fuels) should help balancing production and consumption of these fuels (the ideal consumption ratio is 1 : 1.6).[15] Change of excise tax level in case of significant change of derivatives prices in international market should be used as a tool for protection of state budget revenues when derivatives prices are very low, or for protection of consumes when prices are very high.

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