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INCREASE PRODUCTIVITY IN LOW VOLTAGE NETWORKS WITH HARMONIC REDUCTION IN NONLINEAR LOADS

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Abstract- The increasingly trend of power electronic systems in trade and home appliances as well as harmonic-sensitive loads enhanced the harmonic in transmission and distribution networks. Thus in order to adjusting the model of power consumption and achieving these , some necessary actions should be done to reduce the harmonic which consequently, reduce the foreseen and unforeseen costs in application of electrical energy. Now increasing the level of harmonic and their undesirable effects is considered as one of the major problems in electrification system, therefore on the basis of standard, some restrictions on its level has been applied as coefficient in the dominant harmonic disturbance (THD). Therefore, identification all kinds of Harmonics and optimal methods of remove and reducing them to permissible level are essential. Hence in this study, various references for harmonic production in home uses has been analyzed that if power companies, in order to management and controlling this harmonics, don't consider some principle for communication this kind of subscribers, their enhancement and intensification will cause irreparable damages to network equipments. Based on this, in this article, it's attempted to pay for studying the causes of existing harmonics that are composed of an infinite number of sine wave with different frequencies in nonlinear loads that is considered as the best reasons for saving the consumption of electrical energy. Finally, some practical principles are represented to avoid the losses of consumption in electrical energy and domestic uses and distribution networks of electricity and also improving the quality of electricity and preventing of losses caused by harmonics in the low voltage networks.

Keywords: Consumption Patterns, Non-Linear Load, Low Voltage Networks, Harmonic Elimination, Total Harmonic Distortion.

I. INTRODUCTION

Productivity is a general concept, which its increase as a necessity, for improving the level of life, more prosperity, peace and comfort of people involved into account political, economic , and statesmen, and the [1] term of productivity for the first time, was applied by mathematician and economist, physiocrasy pro-school, "Franco Kene" [21].

Starting the use of productivity in the economic culture referred to two centuries ago. In many areas of the world, especially in industrialized countries, productivity is considered as a mindset and culture [20]. Therefore, increasingly attention during recent decades about circumstances of enhancing competitiveness and profitability through improving the productivity, changed to the most disputable topic in organizations, firms and even big economic agencies.

The term "productivity" for different peoples and organizations has different meanings. According to definition of International labor Organization (ILO), productivity consisted of the portion of output to the one production factors (land, capital, human resource and management). In general concept, productivity is the relationship between the produced products by the productive or service system and an input for the product. Also the Europe Productivity Agency European Productivity Agency (EPA) defines the productivity as the effective amount of use than each one of production factors. Higher productivity means completion and produces more goods with the same amount of references, or achievement more products in terms of volume and quality with the same amount of inputs [17]. As in 1950, the Organization for Economic Cooperation Europe Development "OECD" presented more complete definition of productivity and it is attributed to the "quotient of production inputs" [22].

Productivity is the criteria for performance evaluation and the using procedure of reference for achievement the goals. In the national level, enhancement of productivity will be followed by increasing the competitive power of national economy, increasing the standard of life, improvement of political power, reduction of inflation and higher wages [15]. This important point, especially in public sector organizations which act non- profit, has been remained in more negligence. The fundamental problem for finding the most effective strategy to improve the productivity is the lack of sufficient knowledge in this field and precise and common understanding of the concept of productivity. Revenues will increase with optimal use than data and produce

more suitable output; this process will be accessible only with correct attitude to productivity and its promotion.

Economic growth can be derived from increasing the efficiency of production factors. In other words, for having continual economic growth, either should have plenty of productive references, or use than existing references more effectively. Nowadays what is important in all countries is; having the economic growth through increasing productivity. The main factors for promoting the productivity are humans and the main condition of people's attempt in this relation, is their willing to work in line with physiological and psychological deficiency and absorption of necessary achievement and reduce the costs and waste of references and customer satisfaction and dynamic organization.

Existing the various energy activities is necessary for human life. One of the most important of them is electrical energy that the trend of demands for that in different countries, especially Iran with significant rate is rising. Optimization the consumption of energy, is the most important change that happened in country's economic structure and will be followed by some accomplishments such as industrial growth and enhancement of gross national product with reducing the costs. Electrical energy is one of valuable carriers of energy and one of its advantages, being clean and easy to transport and is one of the strategic goals of each organization's energy sector, energy consumption as suitable and optimum.

Therefore, for more and better recognition of productivity and its increasing in energy-producer organizations, such as electrical energy, precise examination and exploration and some appropriate scientific, pertaining to research studies are required, so in one side, for achievement the better indicators and criteria for evaluation the productivity and the effective factors for its increase and in the other hand, calculation and examination the level of productivity effect on the performance of these organizations and circumstances of reducing the loses and waste to show the strategy and necessary practical solutions for increasing the productivity.

II. THE STATEMENT OF PROBLEM

It is more than three decades that the major consumer countries of energy carriers, quit serious and planned have pursued the activities to reduce losses due to consumption of energy carriers and fuel optimization policies. But unfortunately, energy consumption in different parts of the country's economy in the past years has had a growing trend. Statistics show that during 1994 to 2001 final energy consumption with the average growth equal with% 4.1 per year has increased. According to latest statistics, some undergraduate estimates at this moment between 25 to 30 percent of the total Gross Domestic Product (GDP) of without any efficiency waste or dissipation, rolling out of national wealth as waste, even conservative estimates evaluate the figure of Iran's GDP as the figure of mentioned lesions as the international price between 30 to 40 billion dollars based on purchasing equality power. This figure is comparable with the total number of non-oil exports in 1997 and Iran's 22.5 billion dollars total non-oil exports of oil in 1996 .According to the International Monetary Fund, Iran is the second country in terms of energy subsidies with payments figure of 37 billion dollars. Per capita consumption of energy per person in Iran is five times the per capita consumption in a country similar to Indonesia with 225 million people, 2 times of China with one billion and 300 million people and four times of India with one billion and 122 million people. Due to the increasing energy consumption in the world, the need for more extraction of energy resources is inevitable. But among the various Energy carriers use, one of the highest growth of waste is in electrical energy consumption which Iran is the nineteenth of electricity consumer in the world and annually, government considered 4 billion dollars subsidies for electricity [9].

Based on studies and statistics, if the total losses in the distribution of the country's electricity transmission network was 7601 million kW hours, this amount can, from the total rate of production allocated 13.9% to itself, that this high percentage of losses, can causes loses over 600 billion Rials in the year to electricity industry. If we compared this condition of country with other countries we see that the year 1981 electricity distribution network losses of 15.4% Japan, 5.8% South Korea, 6.7% France 9% and 20.5% India, respectively, but these statistics in 1986 12.6% Iran, 5.7% Japan, 6.5% South Korea, 8% France, 24.09% Pakistan, 4% Germany, 8.2% China and 21% India [25].

These losses can be due to loads such as light bulbs with energy-efficient electronic ballast without the filter, incandescent, refrigerator and television.... However, non-linear loads in the home uses, such as videos, satellites and laser printers can only have much influence on the THD value of about 75% to 100%. Thus, for promoting and improving the quality of electricity and reduce destructive phenomena such as "harmonic" we should reduce the loses rate in the networks and with applying the introduced trade tools on nonlinear loads route of a network, can reduce harmonic voltage to the network side to about zero percent for the consumer and the harmonic of current in loan side to network side to about 5 percent. In other words, using these tools can have an efficient influence on reducing the power coefficient of network by harmonics and created reactive power [12].

Yet, in this study because of existing the harmonics which consist of unlimited sine wave outcome with different frequencies in the nonlinear load, which are considered as the best saving agents in electrical energy, were discussed. Also with offering practical strategies to prevent losses in electrical energy in consumption and domestic distribution networks has been tried to improve the quality of electricity and prevent losses caused by the harmonics so in this way, promote the rate of productivity in the Low Voltage Network.

III. IMPROVING THE PRODUCTIVITY RESULTING FROM THE IMPLEMENTATION OF DEMAND SIDE MANAGEMENT

The implement of Consumption management in demand side, especially in the Iran's main industries and trade sectors, one of the methods to improve the energy productivity is to reduce peak load with the network so the network drive to increase storage capacity can prevent from building new power plants [19]. Although the Ministry of Energy primarily is responsible for providing the consuming electrical energy in society, but it should be noted that in applying electrical energy consumption management should move forward as we made that productivity don't have any conflict and confrontation with other areas in the country. Therefore, before applying the management of electrical energy consumption a great attention should pay to productivity of energy [6]. Having a wise and prudent management of consumption, which Supreme Leader emphasized it, is also one of the basic necessities of this matter [11].

Also, using equipment with higher productivity can considerably save in energy consumption. In recent years in industrialized countries mandatory legislation standards for imposing the standards of construction on structures and on the other hand, the enhancement of energy prices and natural and gradual penetration of new technologies in the manufacturing of goods, has been caused a considerable saving in energy consumption. So for American during 1993 to 2000, this has been led to saving in energy consumption up to %8.5.

Comparing the GDP with a production capacity of electrical energy in more than 100 countries in the world shows that there is a direct relationship between amount of electrical energy and welfare of society [6]. Obviously, Iran compared to developed countries has the more potential for saving. The reason of this is using older technology in country's equipments. Researches show that in most of domestic and trade equipments, designs are not based on modern technology but also because of the lack of mandatory standards, the consumer of electrical energy in Iran is not used for optimum powers. Although the observance of standards and prevention of loss factors such as harmonic and by construction designers, because of specific economic and cultural issues in Iran they need more time. However, the electricity industry officials with joint meetings of the Ministry of Industries and Standard Office lead and force manufacturers towards higher standards [19]. Because the main goal of consumption and production management programs, were not necessarily reducing consumption, hence the main problem is increasing the productivity [6].

IV. THE REASON OF NON-LINEAR LOADS' INFLUENCE ON ELECTRIC ENERGY LOSSES

Harmonics in the 1930's were diagnosed, when the main topic of harmonic effect was in synchronous and induction machines, communication wires and power capacitors. Sometimes ago the reaction of manufacturers against the harmonics was, constructing the equipments to tolerate more harmonics and reducing the reciprocal influences [5] But in the late 1970's during the repeated studies in power systems in order to prevention of losses, electricity network company engineers achieved significant outcomes and represented disappointing predictions of power systems fate if using this equipments. That was non-linear harmonic elements that growing use of nonlinear elements in power systems, such as commissioning (drivers set the speed) and power electronic converters, the amount of harmonic current and voltage wave form significantly increased [24] and so far a lot of efforts in this field have been developed and with invention of different methods and applying them achieved good results [25].

Existing of non-linear loads from transformation system of alternative current to direct current, are used for better control and saving energy, or in other words, nonlinear element is the element that its current is not appropriate with applied voltage and the multi percentage enhancement of voltage may cause the double current and the wave of current, take another form. Generally, non-linear equipment cause production of harmonic currents and harmonic voltage on impedance of network. These harmonic currents with the same frequency caused by various sources add to together like vector and create some destructive effects such as overlapping in phone lines and remote control circuits [24].

On the other hand according to the results of electricity Researches Secretariat of Power Technology Center, existing harmonics in voltage and current signals can affect on protection relays and measuring equipments. This effect is dependent on their internal structure the disorder caused by the existing of harmonics in protective relays occurs like false function or function that both can interface the network utilization with problem, in addition to creating technical problems, it also can followed by some economic consequences. Generally, electric power which because of the harmonics has poor quality can remain undesirable effects in wide range from system to generate electricity to consumers, such as the above stated cases. Also, the existence of harmonic loads that identified the need to use equipments or devices that produce harmonic potential problems seems to be necessary and have capability in order to correction or prevention and improve the quality of electrical energy [18].

V. THE RESOURCES FOR HARMONIC PRODUCTION

Emergence of the semiconductor factor and nonlinear elements such as diode, Thyristor, rectifier bridges and ... and frequent use than them in power networks has created a new factor in the harmonic system. Application of these elements can be seen in following equipments and systems.

Convertors: consisted of rectifier bridges which provided reactive power or non-sine currents from the source and large reduction of power coefficient of distribution network are the result of low output of electricity [2].

Lighting: discharge and fluorescent lamps are current harmonic sources often in such harmonics is reached 3 to 25% in the main harmonic.

Transformers: Generally, all equipments which have magnetic core.

VI. TECHNICAL AND ECONOMIC ADVANTAGES OF REDUCING HARMONIC

Electrical energy is one of the valuable carriers and some of its benefits are being clean and easy to transport. But since the presence of loss factors such as harmonics can cause strategic goals' deviation of each organization's energy sector in optimum and appropriate consumption of energy [4]. It is possible in a brief summing up, express the reduction benefits of harmonics, like: the reduction of electrical equipment's waste, and power supply network, releasing the capacity of network such as electric motors and transformers, increase equipment longevity and reducing losses due to reduced temperature, reduce the likelihood of parallel and series resonant network.

Increasing efficiency of electric motors, reducing the error of relays performance (controlling and protecting equipments of the network due to the effects of harmonics), reducing error reading machines and meter measurement error and thus as a result , reduce the amounts received from subscribers [24]. Thus, optimization of energy consumption, was independent of the price of consuming energy and with applying innovative methods in the framework of governmental laws and regulations, trying to impose changes in the organization [14].

VII. NEED TO ASSESS THE QUALITY OF LOW VOLTAGE ELECTRICITY NETWORK

Growing Equipment enhancement and harmonic generator in domestic and trade subscribers, such as low consumption lamps with electronic ballasts without filter, personal computers, laser printers, fax machines, telephone systems, stereo, radio, television, and motor controller, control frequency, battery charging ups and any equipment that have nutrition switching source are also the buying of consumers from undesired systems other than the standard lower price that offered by downscale manufacturers offer been caused harmonics flow in the low voltage network and adverse effects on the mentioned network.

Using nonlinear elements connected to the network in recent years caused production of harmonic and unbalanced current and waveforms of voltage in production and distribution systems [13]. That according to standard, the values of harmonics should not exceed the rate which is determined, so both the consumption and Producers are required to observe some standards so that if the amount of harmonics injected to the network on behalf of consumers beyond the limit, they must take action to resolve it, otherwise they will receive fines.

Table 1. Harmonic characters base on standards

Voltage	Voltage THD%
Up to 20 KV	5%
20 KV up to 132 KV	2.5%
Over 132 KV	1.5%

Based on accomplished researches, in a medium family simultaneous use than 3 low consumption lamps with electrical ballast, without filter, four string lamps, refrigerator and TV, the amount of THD current is measured as 18%, and in a medium family simultaneous use than 3 low consumption with electric ballast without filter, 2 string lamps, refrigerator, TV set and computer, and studied sound systems, the amount of THD current is measured equal to 33.4%.

Considering that the commercial subscribers can have some of these consumers, and then we can predict the same values for those subscribers. Except for above loads, non-linear loads can be used for other purposes, including home video, satellite and laser printers that have the current THD value of about 75% to 100%.

The following results measured THD values for one and two subscribers with replacement of string bulbs instead of energy-efficient lamps with electronic ballasts without filter and personal computers is shown.

Table 1 shows the results of measurements in case of replacement of non-linear loads and shows a normal use Tables 2 and 3 the results of joint measurements for two common purposes in case of replacement of non-linear consumption.

Table 2. The results measured in residential units before and after replacement

Description	Before replacement	After replacement
Supply voltage (V)	228	229
Flow (A)	4.58	2.96
Active power (KW)	1.0	0.73
P.F.	0.97	0.93
Flow THD	18	23.6
Voltage THD	1.8	1.8

Table 3. description of appliances used in Residential units

	Explanation electrical equipment in residential units	Power consumption (KW)
1	A second refrigerator device	0.60
2	Freezer	0.30
3	Toaster	0.65
4	TV	0.20
5	Audio device	0.20
6	Washing machine (no element)	0.30
7	Number 4, 100 Watt lamp string	0.40
8	10 number 60 Watt lamp string	0.60
9	A number of fluorescent lamp 40 watt	0.04

Table 4. Results of measurements in two residential units before and after Replacement

Description	Before replacement	After replacement
Supply voltage (V)	230	230
Flow (A)	9.04	10.37
Active power (KW)	1.2	2.25
P.F.	0.97	0.96
Flow THD	12.1	18.4
Voltage THD	1.90	1.80

According to Tables 2 and 3 can be deduced that the THD value by adding a few non-linear loads uses shows approximately 25% increasing and Table 4 indicated a 20% increase in amount of THD. Therefore with considering that only low lamps and computers added to the above subscribers, we will be witness of increasing the value of THD about 20%. With increasing the above loads, the possibility of increasing the amount of THD much more than above-mentioned indicates the importance of the study of non-linear loads statement in low subscribers including domestic and commercial [5, 7].

VIII. BUSINESS TOOLS AVAILABLE IN MARKETS FOR USING IN THE NETWORK CONTAINING NONLINEAR LOADS

A. Triangle Stars Transformers

The harmonics which produced by nonlinear loads can create dangerous thermal and heating problems in the standard distributing transformers. Even if the power of load be much lower than its nominal value, the harmonics can cause excessive heat and damage to transformers, all two- armature transformers in terms of electric are separated and its primary and secondary couple with each other by magnetic fields.

Except in autotransformers, their primary and secondary windings are joined with each other electrically. Transformer Y-Δ will remain a lot of reducing effects in zero sequence of harmonic currents during the transition from primary to secondary because the connecting of triangle in primary side caused a reduction in harmonic currents and side of line a small amount of harmonic will be visible.

Figures 1 and 2 that created of practical tests, respectively shows the voltage and current waves in a primary and secondary of a triangle-star transformer.

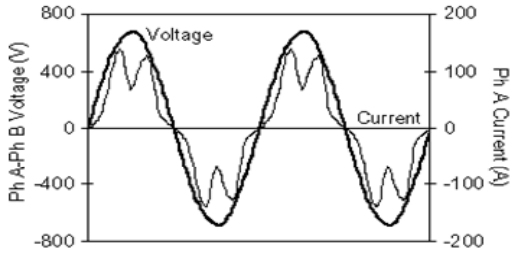

Figure 1. The waves of voltage phase-phase and phase A current in primary side of the of star-triangle connection transformer

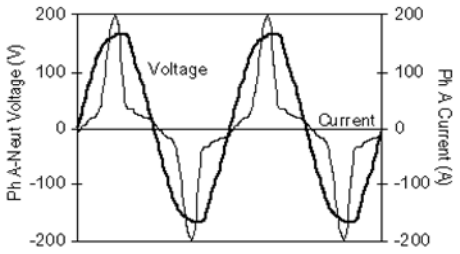

Figure 2. The waves of voltage phase-earth and phase A current in the secondary side of star-triangle connection transformer

As you can see the amount of THD current harmonics reduced about 50% from the secondary to the primary (in line side) because the third harmonic amplitude of current that in side of load is about 51.8% of main amplitude of current, will be reduced about 4.8% of main dominant in side of line. The other harmonics, including the ninth and the fifteenth and twenty first, and so on in the secondary side show a reduction below the 1% of current main amplitude in primary (line). It is more recommended that for improving the quality of power in the primary side, the neutral point in load side (star connection) to be connected to earth since the reduction of harmonic's percentage occur in desirable condition. Table 5 values shows the amplitude reduction of third to fifteenth harmonic range and also the value of THD which has been made by the installation of above tool to a nonlinear three-phase load [5].

Table 5. Numerical values of the harmonic amplitude reduction in the connection of triangle-star transformer to a non-linear load

Harmonic	Phase A Current Spectrum		Phase B Current Spectrum		Phase C Current Spectrum	
	X_{fmr} Pri	X_{fmr} Sec	X_{fmr} Pri	X_{fmr} Sec	X_{fmr} Pri	X_{fmr} Sec
THD	30.1	63.5	26.2	40.4	33.7	44.1
3rd	**4.8**	**51.8**	**3.2**	**32.9**	**2.3**	**37.6**
5th	26.6	32.4	24.0	20.9	30.6	20.4
7th	12.4	14.8	9.1	9.0	12.7	8.9
9th	**0.4**	**6.0**	**0.4**	**4.1**	**0.0**	**4.5**
11th	3.3	4.5	3.2	2.8	3.9	2.6
13th	2.6	3.1	1.8	1.8	2.5	1.7
15th	**0.5**	**1.7**	**0.0**	**1.3**	**0.4**	**1.5**

B. The Promoter of Line Active Power

Figure 3 shows a promoter of active power line circuit (APLC).

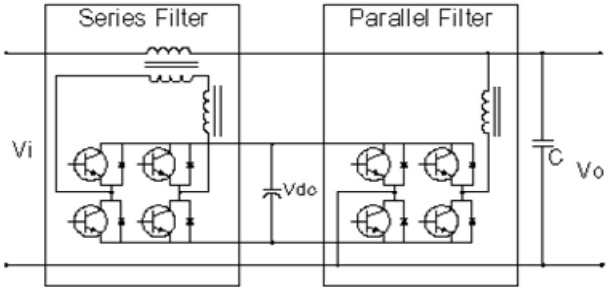

Figure 3. Block diagram of the circuit promoting active power line (APLC)

The above tools of harmonic elimination tested for a phase one time and for three-phase 3 times, and following results according to (4) and (5) are derived. Explanation that the three-phase load of APLC like star-star will be closed from the source toward the load.

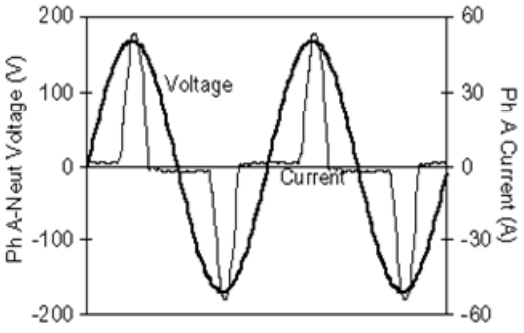

Figure 4. Wave voltage phase - phase earth and the A side load

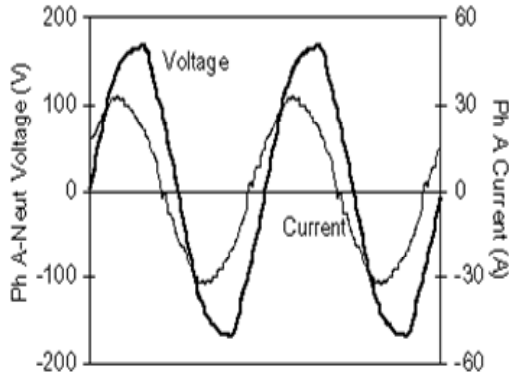

Figure 5. Wave voltage phase - phase A in the earth and the network side

It is noted that APLC decreases the current THD value from the side line from a value of 118.4% to 6.3%. Thus convert an APLC voltage network with a value of THD almost 2.7% to a voltage THD almost 0% for consumers. With installing the above filter on the path of a nonlinear three-phase load, some good practical results are derived in accordance with the information of table (6) such as reduce the amount of current amplitude and the coefficient of CREST [5].

Table 6. Numerical values of the reduction of harmonic amplitude and THD value in connection of APLC tools to a non-linear load

Harmonic						
3rd	81.4	0.8	-99%	679.8	2.38	-65%
5th	54.4	3.5	-94%	37.7	20.2	-46%
7th	26.8	0.7	-97%	37.3	12.6	-66%
9th	6.3	1.2	-81%	10.2	32.8	222%
11th	4.8	1.5	-69%	23.5	4.6	-80%
13th	6.5	0.9	-86%	21.4	8.1	-62%
15th	3.5	0.6	-83%	16.8	20.3	21%
17th	1.6	1.2	-25%	10.6	6.7	-37%
19th	2.2	1.1	-50%	5.4	5.3	-2%
21st	1.7	0.8	-53%	11.8	11.4	-3%

C. Combination of Magnetic Field Control Ferorezonans

Figure 6 shows block diagram of a magnetic field component commercial Ferorezonans. The effects of installation the above tool in the path of harmonic loads and nonlinear such as Figures 7 and 8 and Table 7 is obtained and presented. The reduced THD value by above tools was about 90% from load to primary side (line).

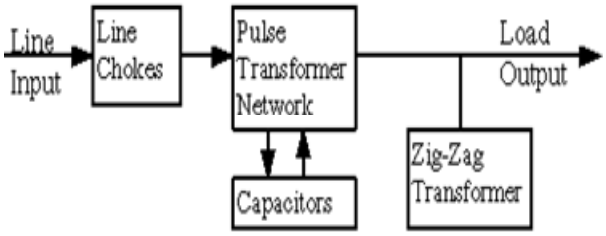

Figure 6. Forums blogs photo diagram of the magnetic field component

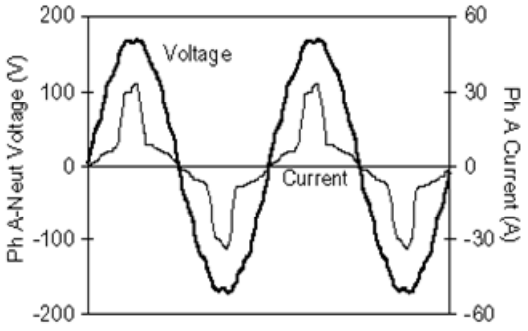

Figure 7. The waves of phase-earth voltage and the phase A in load side

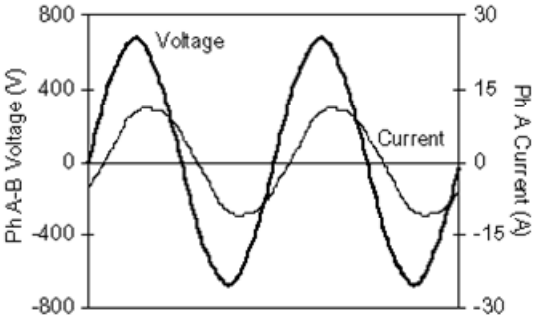

Figure 8. The waves of phase-phase voltage and phase A currents in network side

Table 7. The nominal conclusions of harmonic reduction with control tools of combining the Ferorezonanse magnetic field

Harmonic	Ph A Current Spectrum		Ph B Current Spectrum		Ph C Current Spectrum	
	FMS Line	FMS Load	FMS Line	FMS Load	FMS Line	FMS Load
THD	3.6	63.7	4.0	83.8	3.9	65.0
3rd	2.1	50.1	2.1	66.1	2.2	50.9
5th	2.8	33.7	3.4	43.9	3.1	35.3
7th	0.4	14.4	0.3	18.7	0.3	14.4
9th	0.0	3.0	0.0	4.3	0.0	0.8
11th	0.9	8.6	0.9	10.5	0.9	7.8
13th	0.0	8.4	0.0	11.9	0.0	8.7
15th	0.0	5.7	0.0	8.8	0.0	5.8
17th	0.0	1.4	0.0	3.1	0.0	1.0
19th	0.0	1.1	0.0	0.7	0.0	1.4
21st	0.0	2.1	0.0	2.1	0.0	2.0

With attention to practical outcomes using above tools has been recommended. In order to reduction or elimination of harmonics with considering the network conditions, one of above-mentioned tools must be used. For instance, it is recommended for computer sites, using the third one, also it is suggested for highly sensitive loads use than triangle-star connection with neutral linking to earth [5].

IX. IDENTIFICATION OF LOSES FACTORS AND THE NECESSARY ACTIONS FOR QUALITATIVE PROMOTION OF NETWORK

The most important causes of loses might be such as: unauthorized power, lack of serious management on load, dominance of mastery culture in the distribution network, lack of harmony between supply and demand and ... after its identification; the actions that cause the release of lines capacity and production must be noted. Such as the use of transformers with equal transformation ratio and equal transes' characteristics, or finding deep electrical points and etc in that region, installation small capacitors 5 to 20 KVAR at the end of low pressure lines with high voltage loses.

Above mentioned methods require little investment in terms of equipment, and mainly is depend on human forces , with accomplishment of above instructions, we would have 2 or 3 percent reduction of loses, which in term of power, at least is equivalent with 500 Mega Watt realizing of lines and production. In the next step, long term actions must be considered, which most important of them, are as follows:

The prediction of load density:

(1) Mapping the present condition of medium and weak pressure network.
(2) Promotion the quality of products from the energy consumption's view point.
(3) Replacement of electrical energy consumption with other electrical energies.
(4) Establishment of a regular method and work flow census.
(5) Preparation and approval of distribution system philosophy.
(6) The promotion of staff's scientific level of power distribution.
(7) Completion of engineering and applied standards of power distribution networks.
(8) Promotion the power coefficient level of domestic and commercial consumptions with respect to the high percentage of commercial and domestic consumption in Iran, and low coefficient of power in such consumptions would be a considerable figure.
(9) The adequate procurement of currency and Rial credit.
(10) The management of load and consumption.

However, qualitative methods of prediction is used for systems which have no mathematical models or their probable model is complicated and quite non-linear therefore couldn't easily receive to this model by a classical mathematic methods and if it was able to do this, mathematical model would have no more precision or would be expensive.

X. PRACTICAL SUGGESTIONS REQUIRED FOR HARMONIC REDUCTION AND ELIMINATION IN NONLINEAR LOADS OF LOW VOLTAGE NETWORK

(1) Installation of power quality systems in suspected areas for existing non-linear loads to gain awareness of harmonic amplitude and the amount of THD.
(2) Accomplishment of earth system with standard T-N-CS in all subscribers with considering the increasingly rise of modern electronic equipments in subscribers' appliances.
(3) The connection of neutral point of zigzag point of distribution transformers to the earth with a resistance less than 2 ohms and implementation of annual periodic tests measuring aforesaid resistance.
(4) Necessary recommendations for consumers in order to use than standard and quality equipments and electrical systems from electricity companies.
(5) Necessary studies to make balanced loads on the various phases of low pressure network.
(6) Designing Low Voltage networks for nonlinear loads, (Where is required).
(7) Using introduced tools for harmonic elimination or reduction in existing non-linear loads in the network.
(8) Necessary culture making for subscribers in the replacement of linear loads with non-linear loads such as low-consumption lamps with electronic ballasts and harmonic appliances at least to 60 percent of the total load.
(9) Use than resistant transformers factor *K* (consistent with harmonic).

XI. CONCLUSIONS

Optimization of energy consumption, is the most important change that has happened in economic structure of industrial countries and will be followed by dome achievements such as economic growth increasing the national impure production, nowadays, each person of society members should know that in own activities must act for optimum consuming of material resources in addition to lack of attention to standards in domestic and commercial equipment designs such as controlled transistor rectifiers, microprocessor controllers, low-consumption lamps with electronic ballasts without filters, computers, UPSs, the modern electrical equipments with switching power resource can cause harmonic producing loads in subscribers which its consequence will be getting away the defined goals in Iran's 20 years vision document. Since the lack of attention to the electrical system losses by harmonics can cause additional losses and heating electrical induction equipment, additional voltage and additional current in the system due to resonance of system because of voltage harmonics and current in the network, failure to insulation of cables as a result of additional voltage and thus filling the capacity and their warming due to current's harmonics, interference with communications systems and creating errors in meter of consumption measurement and energy production.

Therefore, because of undesirable effects of harmonic in an electrical energy system, the accomplishment of necessary acts for providing secure and sustainable electricity from distribution companies to subscribers is inevitable, therefore for reduction or elimination of harmonics in networks and improving the quality of provided electricity for subscribers, implementation of mentioned recommendations are suitable strategies in this field. As noted in this paper, with installation of defined commercial appliances on a network path nonlinear loads voltage harmonic of the network side can be reduced to about zero percent in the load side and current harmonic of load side to about 5 percent on the network side.

Nevertheless, the increasingly trend of use than harmonic electric appliances and harmonic-sensitive loads, are required the electricity distribution companies to investigate the situation of current and voltage across the various parts of network, including the suspected areas and implementation of necessary actions for the improvement of network stability. Considering the harmonics and conducted a series of necessary measures to reduce them with respect to improve the standard of harmonic producing equipment, we will be able, during 10 years, we will have more than 10% energy consumption savings ,as a result it will cause reducing the predicted and non-predicted expenses in the application of electrical energy. Therefore, in this article, we consider existing potentials in Iran to do proper load management, and some strategies are represented for improving the consumption patterns that cause decreasing the energy and consumption peak. We hope that these strategies, applied in Iran's distribution networks of electricity.

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