INTRODUCTION
During the recent decades, a new wave of reforms aiming to promoting participation of private sector in state activities has appeared over the world. Requirements such as expansion of capacities, systems preservation reinforcement and witnessing relatively successful experiences by several countries over the private sector participation were of the highly important reasons encouraging many developing countries to follow above stated reforms.

During the recent two decades, Iranian authorities have tried to grant economic activities and service rendering units to private sectors. With regard to such movement in the Islamic Republic of Iran, it was arranged that Ministry of Energy to grant distribution company to private sectors. Such restructuring created the new management of the distribution companies with the real influence on the development strategy of the company. Improvement of power supply continuity to customers is nowadays the main task to be dealt with by power distribution companies. The choice of proper ways to resolve this problem depends on numerous conditions defining the investment possibilities of distribution companies, the exigencies and expectations of customers, in according to the comprehensive master plan.

The authors of the present article focusing this critical notion have conducted this research upon realistic approach plus implementation of comprehensive plan using island method for distribution companies (specifically urban areas) and also have made studies and investigation on verification of design, completion and exploitation of unused spaces for electricity power distribution substations as a mean for implementation of comprehensive planning.

THE DISTRIBUTION NETWORK IN TREC
TREC is the largest power regional company in Iran and its duty is to supply required power of the capital. The data statistics indicated on table 1 shows wide activity of the said company.

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>% (out of whole country)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor stations(20/.4Kv)</td>
<td>Each</td>
<td>8035</td>
<td>36</td>
</tr>
<tr>
<td>Outdoor station (20/.4Kv)</td>
<td>Each</td>
<td>24628</td>
<td>9</td>
</tr>
<tr>
<td>Underground lines(20Kv)</td>
<td>Km</td>
<td>5058</td>
<td>51</td>
</tr>
<tr>
<td>Overhead lines(20Kv)</td>
<td>Km</td>
<td>153291</td>
<td>6</td>
</tr>
<tr>
<td>Underground lines(400v)</td>
<td>Km</td>
<td>10757</td>
<td>43</td>
</tr>
<tr>
<td>Overhead lines(400v)</td>
<td>Km</td>
<td>21513</td>
<td>11</td>
</tr>
<tr>
<td>Customers</td>
<td>Each</td>
<td>4571709</td>
<td>25</td>
</tr>
</tbody>
</table>

Table 1: data of distribution network in TREC

On the other hand, some other parameters such as wearing of the network system, political and social sensitivity, high accumulation of population, increase of system load, high immigration of people from other cities to Tehran, lack of specified and planned urban development, have caused multiple problems and difficulties in distribution system. Basic changes were made in Tehran Electric organization structure, in 1992 by separating Tehran power distribution from Tehran Regional Electric and according seven distribution companies as private companies were established. Each of these companies, with regard to related territory and available network, were divided into several operational regions.

CUSTOMER EXPECTATIONS, MASTER FACTOR FOR PLANNING
In order to have a sound decision-making, the mangers of electrical industry need to have knowledge and an acquaintance of their customers' satisfaction. Customers' views evaluation helps them to recognize their weak and strong points in order to overcome them and perform a better planning.

To determine the goals that must be reached, it is important to understand what customers expect and the analysis of expectations must be made on the basis of customer requests, by inquiries or surveys, or in a more personalized way according to the type of customer.

This issue was tested under assessment over both house and trade centers customers of electricity over Tehran city in terms of quantity and quality of diverse dimensions of electricity supply services to whom.

Increasing demand from customers are under special attention by them regarding promotion of electricity quality and issues like energy interruption of any cause whether in unwanted or planned forms.

These are stipulate in light of studying and recognizing effective factors on subscriber's satisfaction and determining their priorities as well as short term and medium term programs within a comprehensive and practical plan plus enjoying topology system of the network.

THE NETWORK TOPOLOGY AND COMPREHENSIVE MASTER PLAN AS A NECESSITY FACTOR
Throughout the world, present networks are simply the result of years of lying of structures one on top of the other as needs have increased. In addition a network ages and is constantly in need of maintenance and renovation work to retain its performance level and to avoid incidents, the sources of “undistributed energy”.

RASOUL KHALILI
Tehran South East Distribution Co. – IRAN
RASOOL_KHALILI@HOTMAIL.COM
So networks, equipment and operation are all evolving and a network’s performance depends above all on its topology. The topology of an electrical network is defined here as all of the principles involved in carrying electrical energy in public distribution (layout, protection and operation). In practice for a distributor, defining a topology means fixing a certain number of physical factors, whilst taking account of criteria dependant on objectives aimed for and technical constraints. Since these factors are closely interrelated, choice of a certain topology is always the result of technico-economic compromises. [1] Nevertheless, it should be considered that entry to systems with a structure more sophisticated than topology network will be feasible when a suitable background and acceptable conditions being available in the network plus framework of efficiency and accountability to customers' expectations with respect to reliability and quality.

COMPREHENSIVE PLAN OF DISTRIBUTION COMPANIES
Setting comprehensive and integral plans is accounted as one of effective factors regarding establishment of permanent development and also play an essential role as an important contributing parameter in civic management planning. The comprehensive plan of distribution delineates present status of distribution installations, programs and future estimation of the zone of covered by the company over an definite time interval as to electrical energy distribution, satisfactory service providing to the customers within communicated credits and budgeting with consideration of technical economical explanations. Compilation of comprehensive plan is carried out in two forms:

- Logically expansive and integrative such that whole the network and or a zone being covered.
- In confined and island form

About executive operations of the comprehensive plan in progressively expansive levels the followings are necessitated:

- Allocation of a huge volume of financial credits
- Setting a complete coordination between extra-organizational organs acting as guardians for urban services
- Ability to analysis of voluminous and numerous information and data by users and designers

Often by lacking each of above parameters, plan execution is subject to change or stop, resulting uncompressible damage to the executives of the plan.
In island method, initially network of the zone or company is divided into some islands under some criteria including geographical limits and boundaries, highways and wide streets with the minimum crossing networks of MV and LV, and then the scenario of comprehensive plan implementation is executed with respect to customers' expectations and electrical quality in order of priorities.

Finally, by establishing an appropriate bed the setting comprehensive plan and entry to the more complicated topology of distribution will be provided. (fig.1)

Fig.1: critical points and priority with island point of view
In framework of materialization of comprehensive plan in island form and making efficient the available topology in section of MV and LV the following objectives provide basis for the plans under supervision of distribution network technical management:
Achieving of master plan in distribution regions, technical management of distribution networks was considered as an island point of view and for every limits these goals consist of:

- The structural reformation of MV and LV networks. The structural reformation of MV networks so that MV/LV substation is closer to customer's points and decreasing the length of MV and LV networks.
- To decrease load factor on the existing substation and construction new substation with low capacity.
- Networks reformation and optimization, reducing and balancing the LV feeders load and changing and optimizing the MV and LV panels.

One of the most problem in the urban area, with ground distribution network, It is difficult to build substation. Nevertheless the demand of the stable and high quality electric power is increased.
In addition the most important factor of master plan fulfillment in limited area of every distribution regions in order to be closer the consumption points to MV/LV substation and decrease LV&MV networks, is construction the new substation, however because of the problems and difficulties exist in crowded cities such as Tehran, approaching to this goal has been impossible.
DEAD SPACE DESIGN FOR DISTRIBUTION SUBSTATIONS

TREC, in order to promotion of qualitative level of servicing to customers and specialization of distribution methods, has organized some active teamwork committees which members were elected among managers and electrical and construction experts, will may play their duties by presenting appropriate strategies in short term and long term in line of materialization of comprehensive plan of island approach. Of activities of these committees are: designing for use of dead spaces for distribution substations that consequently will lead to development of this policy and approaching MV/LV substations to customers and decreased length of MV & LV networks in line and followed by covering all throughout work zone in urban limits of distribution network.

Compilation of Designing Indices of Dead Space

About designing distribution substations for dead spaces a diverse group of factors contributed in where teamwork of the committees were evaluated and assessed all features effective in this issue:

- Recognition of unused and dead spaces at civic limit areas and coordination with utilities organs
- Reflexibility and maneuver in design with respect to the domestic conditions
- Diminishing required spaces and possibility to erection at special locations
- Removing dilemmas of new plan which had been experienced previously in electricity power distribution substations
- Safety in exploitation and high rate of reliability
- Minimizing risk of environmental and atmospheric affects
- Safety of citizens
- Minimum time of installation or equipment replacement or exchange
- Minimizing environmental effects and making harmony with surrounding periphery and local architectural works
- Lowering erection and maintenance expenses
- Considering utilities organs (water, telecommunications, and gas) in designing electricity power distribution substations.

For optimization of the collection of factors and above indices in line of erection and exploitation of distribution substations at unused spaces like footpath, under streets, margins of highways and squares and parks and inside the public passage and traditional markets, some evaluation and analysis were carried out and finally some plans after they were prepared and monitored during stages of manufacturing, operation and exploitation in pilot distribution companies, were communicated to all distribution companies for fulfillment.

Implemented plans in this section are:

- Underground substation (equipped with compact installations - work performance zone width, minimum of 5 meter)
- Tunneling underground substation (work performance zone width, minimum of 3 meter)
- Compact kiosk Substation
- Compact Platform Substation
- Compact Out Substation

Expansion of Underground Spaces as a Solution for Affording Better Servicing to Customers.

Experiences of using underground spaces for erection of distributing substations has been occurred many year ago regarding limits of cities including Tehran but due to primary designing dilemmas and fail to be considered influencing indices on plan has led to appearing some difficulties in service providing and during exploitation to customers in practice (specially safety problems). By the same reason, authorities of distributing affairs working in plan and exploitation units of distributing companies are not so much intended to or interested in assessment of solutions derived for solving problem faced to erection of underground substations and do not consider them as a solution for this dilemma encountered with the electricity distribution in civic limits.

By compilation of distributing substation design indices and taking into account these indices for underground substations it is hopped that some of expectations of designers and beneficiary distribution companies in some extent being satisfied.

Method of work and establishment of new underground substations are in operation with notice to local conditions and limitation of public passes.

Underground Substation (Equipped with compact installation)

Method of performance of drilling and excavation is in cut and open fashion. At footpath or street excavation is carried out in dimensions of 6.5x4x4 and then with preserving stability and inhibition of soil, sub base work and erection of primary brick wall and pipe laying for passing input and output cables and very high quality insulation for prevention of water or humidity penetration being performed. Armaturing, molding and concrete pouring are carried out step by step. Designing of concrete coverage of the ceiling in form of arch and lateral walls in vertical form, with considering the depth of electricity power distribution substation from bed of street, footpath, park spaces, and so on are carried out and then loading is completed. Total dimensions of the substation are 6x3.9x4 and those of location of installations are 4x3.9x4 and those of location of passing installations and equipment and personnel (entrance corridor) are 2x3.9x4.

A door separates installation space from entrance corridor, preventing entering inside dust and substation internal space pollution, leading to increased safety coefficient. Also trafficking of personnel and equipment are made easy producing convenience for personnel and tranquility despite this point that facilities exist in underground. (fig.2) Due to insufficiency of inner space of substation, diversity of design in terms of arrangement of equipment (LAYOUT) enjoys diversity.
Ventilation system in vertical position having two canals for input and output air. MV panels of compact SF6 type and transformer power of 800 or 1000 KVA and LV panels equipped with automatic switch, 1600 A, placed inside the substation.

Underground Tunneling Substation

Tehran Center Distributing Co. has designed and implemented one typical tunneling substation. The plan executive method, N.A.T.M. (NEW AUSTRIAN TUNNELING METHOD) description is that from footpath, the place entering to the underground substation, a vertical drilling with height of 7.5m with preserving stability and inhibition of soil has been done, then drilling operations of tunnel is commenced toward under street, where some pre-designed frames prevented creep age, and after making a temporary ceiling drilling operations being completed and then subtraction commenced that in where a layer of humidity insulation for drainage and one layer of PVC for insulation are applied and in continuation of operations armaturing and molding and concrete pouring are done step by step. Building of the related substation is done according to the plans delivered featuring inner dimensions 3.4x3.20 with a surface area of 10.88 sqm of which 4.59 sqm are allotted to the entrance space to the installation, stairs for access of personnel to the substation and location in where air drain canal and output and input cables installed, and 6.29 sqm will be the useful space of the substation in where a MV panels and one 630 or 800 KVA transformer is installed. (fig.3)

Structure of the substation is of reinforced concrete and structural design of each substation depends on its own environmental and loading conditions, and principal executive plans for structure will be performed after soil mechanics testing. In this point all traffic and seismic loading are applied, in addition to ordinary loading. Meanwhile, ventilating system having two channels and two vans and one hood in where air enter from one channel and exits via hood installed over transformer through another channel. [2] Advantages for utilizing underground spaces for electricity power distribution substations had caused popularity of them and they are delineated in table 2.

<table>
<thead>
<tr>
<th>Primary Expenses</th>
<th>Saving expenses in land purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Saving in design in special conditions</td>
</tr>
<tr>
<td></td>
<td>Application of materials attained from drilling</td>
</tr>
<tr>
<td>Operational Expenses</td>
<td>Relatively stable conditions of Temperature, humidity in underground area</td>
</tr>
<tr>
<td>Design Expenses</td>
<td>Freedom of designer for work in all principal directions due to lack of limitation</td>
</tr>
<tr>
<td>Architecture</td>
<td>It is no necessity for designing due to lack of appearance of installation</td>
</tr>
<tr>
<td>Safety</td>
<td>High security against robbery - Immunity against natural hazards (storm, etc.) Immunity against access of fire-lack of transmission of sound from underground atmosphere to the outside</td>
</tr>
<tr>
<td>Structure (new design)</td>
<td>Isolation of installation establishment place from entrance corridor (for personnel)</td>
</tr>
<tr>
<td></td>
<td>Facilities in outside or inside transportation of facilities and user personnel</td>
</tr>
<tr>
<td></td>
<td>Feasibility for transfer of installations of other servicing companies like gas, water and suitable ventilation</td>
</tr>
</tbody>
</table>

Table (2): Advantages of underground spaces for erection of distributing substations.

Compact Kiosk Substation:

Taken into account problems such as suitable land limitation in heavy loading centers, ever more compacting substation equipment and using public spaces for erection of required substations have necessitated design and manufacturing compact kiosk substations. Tehran South Eastern Distribution Company for the first time has erected a typical above named substations at civic crowded regions. The notion should be pointed out in designing compact kiosk substations is accordance and harmony of these substations in terms of dimensions and apparent shape with their surrounding environs. (fig.4) Of the most important advantages of such substations we can address the followings:

- Feasibility to be installed in open space
- Very low size of volume: 3x2 sqm in dimensions
- Abeyance of safety under very high protection degree IP54
- Portability and very fast and easily installed
- Capability to be painted in harmony with civic atmosphere
• Equipment with three compartments (MV switchgear, transformer and LV distribution board)

Fig 4: compact kiosk substation

Platform Substation
In certain city points due to concentrated texture and crowdness as well as low passage width and presence of numerous obstacles, erection of substation construction under usual methods are not possible. A new recent substation under title of platform substation has been erected in one of areas of Tehran Bazaar by Central Electricity Power Distribution Company which indicates one solution for dilemmas addressed here.
This substation has erected in 2.05x1.6x4 in dimensions in 3 storeyed. Interior space dimensions are 1.7x1.40 and one window with 0.50x0.50 in dimension for transit of cables are considered there. Depth of canal equals 1.00 m, and a transformer with maximum power of 500 KVA has been installed at the 3rd storeyed. (fig.5a)
A MV switch protection using as equipment installed in adjacent operate substation which is responsible for feeding the platform substation in common branch fashion.
Substation include one 500 KVA transformer and LV panel.

Compact Out Substation:
Due to rising land purchase expenses and also substation building erection and utilization of unusefull spaces (DEAD SPACE) for purpose of substation erection, distributing companies attempted to diminish constructional dimensions of the substation, and therefore we witness some substations of very small dimensions have been designed and executed by Tehran North Eastern Distribution Company, concerning feasibility to suitable arrangement of equipment. (fig.5b)
Dimensions of the substation are 3.45x1.85x3 and its building are made of skeletal structure plus interlocking tile, and entrance door designed such a way that it is opened completely and facilitates operations on equipment. Covers of walls and ceiling is done such that follows civic furniture.
Equipment installed in the substation include one set of 500 KVA transformer, one MV compact panels plus one 800A LV panels board equipped with 3 output sliding vertical fuses.

Fig 5

DISTRIBUTION SUBSTATION OVER CIVIC FLOOD CHANNEL (STUDY PHASE)
Because city of Tehran situated at the Alborz mountain range slope and due to its extent it includes numerous canals and open flood channels at throughout the city utilized for conduction of river water input to the city as well as transfer of superficial waters, hence suitable use exploitation of space over these flood path for erection of compact kiosk substations are in process of study and design at Tehran South Eastern Distribution Company. (fig.6)
It is clear that in case of utilization of these spaces we can able to, in addition to eliminate distribution problems, implement an appropriate design in line of optimization of the city landscape beauty.

Fig 6: substation over civic channel (study phase)

CONCLUSIONS
The discussion on load density increase for urban areas and “necessity for erection of distribution substations in these areas-in which problems of required space and land as well as high price of land are faced-is considered as a subject fallen beyond a merely prospective category and has turned into a up-to-date problem an dilemma to which majority of distribution companies are faced. On the other hand the most important tool for materialization of the issue of shortening length of LV and MV distribution networks is erection of electricity power distribution substations.
The experience with the distribution substation in dead spaces gained up to now proved to produce the expected realist so as we can witness improvements which is the limitation of black out hours of distribution networks and satisfaction of customers.
Dead space design has been based on a broad system approach that has covered all aspects, in clouding satisfaction of both designers and operation teams of Distribution Company, in order to reach the optimum compromise in terms of economy, efficiency reliability.

REFERENCES