Pathway to Low Carbon City, Delhi

1. INTRODUCTION:

The cornerstone of turning the Indian city a low carbon one, is towards an integrated approach of ecology and the conservation of the natural resources for City Planning. During the Last Century Urban Population of India increased ten folds from 27 million to some 270 million. Cities today are in the centre-stage of environmental pollution, and degradation and loss of bio-diversity. Concentration of intense economic processes and high level of consumption in cities increase their resource demands. Beyond their boundaries, cities affect traditional rural economics and their culture. The main problem with cities today is that they have become centres of mobilisation rather than civilisation. They are nodes of an increasingly intense economic activity, with the volume of travel having reached unprecedented levels in recent years. The urban economic culture has a deep impact on the human mind, which has become too pre-occupied with the pursuit of personal gain. The city of the future, to be sustainable, will have to re-establish the concept of civilisation, with greater dependence on local production for local consumption, with greater concern on the liveability of local environments and with a greater emphasis on creating public spaces for people to enjoy.

Delhi, the fast growing Capital City of India has presently a population of about 17 million persons and is estimated to grow in a 23 million population Mega City by the year 2021. After Independence Delhi had 1.43 million populations by 1951 and has increased to 8.42 million by 1991. According to 2001 Census of India it has reached to 17 million just 100 percentage increase. Ever increasing population with end lasting demand can be sustained with adopting an integrated approach towards ecology and the conservation of the natural resources which should form the basis of city planning and development. Land use, Ecology, energy, water, waste management, sanitation, mobility and information should be the basis of future growth pattern along with price based signals enabled investment and technology choice to make Zero Carbon City. Natural resource saving is the starting point for environmentally responsive planning.

For eco-efficiency ‘factor four’ provides a valuable tool. As a rule of thumb, if a certain level of resource use is defined as a baseline, reduction of use by a factor x (say half) implies a reduction of the load on ecosystem by the same factor. At the same time enhancing the efficiency factor for technology and operation (say twice) gives a ‘Factor -4’ efficiency.

2. NEED OF STUDY:

Delhi today is emerging as one of the largest and most populated cities of the world. Out of a total area of 1483 sq km about 50% has already been urbanised and the rest is under heavy pressure of urbanisation. In spite of the plans for decentralisation and to restrict the growth of the city by development of National capital Region (NCR), the runway growth of Delhi continues. Putting several strain and demands on land, physical infrastructure, transport, ecology and environment, housing and resources Delhi has been evolved for creation of a sustainable physical and social environment for reducing its carbon foot.

Creation of a sustainable physical and social environment for reducing its carbon foot-print is one of the major objectives of planned development. An unprecedented scale and speed of urbanisation in Delhi has resulted in enourmous pressure on the physical environment with a severe adverse impact in terms of pollution, and today Delhi is considered to be among the most polluted cities in world.

3. STRATEGY OF CARBON FOOTPRINT:

In the above stated background the following three fold approach and strategy needs to be adopted:
i). **Land use Efficiency: Development and preservation of open Spaces**, green and landscapes, recreational areas as Form of lanuse.
ii) **Management of Natural Resources** in a manner that would lead to optimisation of use of natural resources, and reduction/abatement of pollution;
ii). **Conservation and Development of resources** and features with a view to enhancing their environmental value.

4. WAY TO CARBON NEUTRAL CITY

A. Landuse Efficiency:

Despite a land locked situation and with such a big concentration of population, it is a liveable city with natural landscape and with very high percentage of landuse under green/open spaces. Out of total area of 1483 sq km in NCT Delhi, about 150 sq km has been proposed as Green Belt at the peripheral area of the city to act as lung space for City, 100 sq km land is in River Zone as Green Space to facilitate ground water recharge and about 90 sq km of Aravali ranges and water bodies with biodiversity parks for enriching the environment and natural flora and fauna in its original style in the city. The built up areas also contain more than 15% area in form of city and neighbourhood level parks allocating about 5 sq km open space per person at city level.

Regional Park. The Aravalli Range in the NCT of Delhi comprises of the rocky outcrop stretching from the University in the North to the NCT Border in the South and beyond, and sizeable areas of the same have been designated as the Ridge. This is not a continuum as various intervening stretches have, over a period of time, been brought under urbanisation - for example the Central Ridge area was planned as an integral part of New Delhi, at the time of the development of New Delhi as the Capital in the early part of the twentieth century. The Master Plan of Delhi – 2001 identified the Regional Park into four parts as below:

- Northern Ridge 87 ha.
- Central Ridge 864 ha.
- South Central Ridge 626 ha. (Mehrauli)
- Southern Ridge 6200 ha.

The area of Regional Park is 7777 hectares. Part of this has been notified as Reserve Forest.

Green and Recreational Area: The area under recreational/ green use i.e. 7145 ha is in the form of District Parks, City Parks, Community Parks etc. comprising around 15 % of the total urban land area. In addition to this, a large chunk of green area is provided in the form of Neighbourhood Parks/Tot lots in the gross residential use zones, plantations/greens in large campuses like President's Estate, JNU, IARI, Delhi University, plantations along drains and roadside plantations. In addition to above, two Bio-diversity parks are under development.

In the Urban Extension the green cover is to be provided at the rate of 15 % of the total land, excluding the Ridge Regional Park. Out of this, some area shall be developed in the form of formal parks for the community and the rest shall be developed as woodlands and incidental greens for balancing the environment. This will be in addition to the development of specialized parks like Bio-Diversity Parks, plantation along the roads, drains, riverbank, etc. The norms for City green is as under:

Table: 1: Norms & Standard for City Green

S.No	Planning Category Norms & Standards	Population/Unit (Approx.)	Plot Area (Ha)
1.	City Park	10 lakh	100
2.	District Park	5 lakh	25
3.	Community Park	1 lakh	5
4.	Neighbourhood Park	10000	1.0
5.	Housing Area Park	5000	0.5
6.	Tot lot at Housing Cluster Level	250	0.0125

Source: MPD, 2021

Amusement Park: Amusement Park up to 10 ha may be permitted in District Park. Following development controls shall be applicable:

- Max Ground Coverage- 5 %
- Max. FAR- 7.5
- Max. Height- 8 mt
- Parking- 3 ECS/100 m² of floor area with the stipulation to provide min. parking for 100 cars.

Green Belt: The Plan provides for agricultural land as Green Belt along the border of NCT of Delhi, in synergy with the provisions of Regional Plan 2021 of NCR. The belt extends from the NCTD boundary up to a depth of one peripheral revenue village boundary.

Urban Form: Delhi city is an assemblage of buildings and streets, system of communication and utilities, places of work, transportation, leisure and meeting places. Delhi had a traditional Urban Design which is reflected in the glory of 17th century the Walled City of Shahajahanabad and New Delhi in 1916, the Central Vista was conceived as a landscaped stretch to form continuity between the ridge and the river Yamuna..The boulevard of Chandni Chowk was its commercial centre piece Red Fort and Fateh Puri Mosque as its two ends. The stretch with the Rashtrapati Bhawan and the India Gate at two ends has tremendous visual quality. The Jama Masjid a dominating feature located on hill top was visually linked with Parliament House, Connaught Place in the same axis.To make city with footstep of carbon neutrality several measures have been taken integrity of landuse in urban form.

In Metropolitan Centre and Extension : Connaught Place: Landscape Schemes are prepared to integrate MRTS stations, safe pedestrian walkways, parking areas, recreational and cultural areas, etc.with planting of trees and street furniture. The intermediate public transport such as monorail, battery operated / high capacity buses, sky buses are introduced to increase the mobility within the City Centre. Use of alternative renewable sources of energy is encouraged for new buildings (especially those of commercial or institutional nature), traffic signals, public signages, etc. Encourage the concept of rainwater harvesting and remodeling the storm water drainage to recharge the ground water as per the norms.

In Walled City And Extensions: Conservation approach to retain the overall traditional character of the Walled City. Pedestrian made completely free of vehicular traffic so as to restore the human scale and convenient living, controls considering built to edge typology to enhance environmental state.

In District Centres: The district park adjoining to the district centre proposed in the master plan / zonal plan should be properly integrated with the district centre. The area provided for landscape as part of the district centre should weave through the entire district centre to create a pleasant environment.

B. Management of Natural Resources

Natural Features

The major natural features and eco-systems of Delhi are the river Yamuna, together with a network of streams/drains that empty into the river, and the Aravalli Range. Both of these are in a state of considerable degradation, and it is of vital importance to conserve and rejuvenate these ecosystems. This has regional carrying capacity, therefore, surrounding states also have to contribute towards their conservation and rejuvenation.

Water (Surface and Ground)

(a)The surface water resources in Delhi are basically consisted of the river Yamuna, drains and the lakes/ponds. The ground water in Delhi occurs in confined and semi-confined conditions, with depths varying from 1 m to 10 m below the ground level and in the alluvial terrain, several sandy aquifers occur at different levels upto a depth of 70 m. The conditions of surface water in Delhi are:

- The Yamuna river and the drains are highly polluted; The major source of pollution in the river to the extent of about 80%, is the the discharge of treated and untreated water through the 22 major drains, which flow into the river. Six of these drains viz. the Najafgarh and the Supplementary Drain, the Shahdara Drain, the Drain near Sarita Vihar, the Maharani Bagh Drain, the Barapulla drain and the Sen Nursing Home Drain contribute almost 90 percent of the flow and 80 percent BOD load levels respectively.
- The supply of water for human use is too much in absolute terms, but is characterized by iniquitous distribution in per capita terms in different areas, and significant wastage;. Assuming that 80 percent of the water is converted into waste water, the capacity to treat waste water is grossly deficient; Various options for the re-use of treated waste water must be explored and implemented.
- The actual quantity of waste water treated is much below the installed capacity on account of missing links in sewer connectivity between the generation points and treatment plants and choking/silting of sewer lines, etc. The missing links in sewer connectivity must be covered for its continuity from the generation point to the treatment plant. However, over the years, rapid urbanisation, encroachments on the river banks, over exploitation of natural resources/water, and serious deficiencies and backlog in sanitation and waste water management services, have resulted in the dwindling of water flow in the river and extremely high levels of pollution in the form of BOD and Coliforms, etc. As against the stipulated 3 mg/l, the designated water quality for bathing purposes, the water quality data for 2003-04 suggests that the BOD values range from 1-3 mg/l at Palla, 5.56 mg/l at Nizamuddin and nearly 7 mg/l at Okhla. Similarly, at all locations, except Palla, the total coliform levels are many times higher than the minimum tolerable standards for drinking and bathing purposes. The planned re-use of treated waste water is minuscule.

Measures for Rejuvenation of River Yamuna to conserve Natural Resource

- Minimum flow in river Yamuna to be ensured by Riparian states by releasing adequate water.
- Refurbishment of Trunk Sewerage System. DJB has a network of approx. 130 km. length of trunk sewerage system to convey the collected sewage to different STPs for treatment. Nearly 91 km of sewer lines are in highly dilapidated condition and have been silted to the extent of 50 % to 70 % at different stretches.
- Treatment of the flows in Najafgarh and Shahdara drains.
- Laying of Sewer Lines in the un-sewered areas of Delhi
- Removal of Slum Cluster and Yamuna River Bed
- Treatment of Industrial Effluent
- Re use of Waste water for methane capturing and way to carbon neutrality

(b) Groundwater is one of the major sources for water supply in many parts of the country. Ground water contributes a substantial quantity of water supply in Delhi too. Especially in new development areas, groundwater is largely being used as drinking water resources. The average annual rainfall in Delhi is 611 mm. However, recharge of ground water gets limited due to decreased availability of permeable surfaces owing to urbanisation, and the runoff getting diverted into the sewers or storm water drains that convey the water into the river Yamuna. The annual rainwater harvesting potential has been assessed at 900 billion litres or 2500 million litres per day. If even 25% of this could be harvested it would imply availability of 625 mld, which would be nearly equivalent to the presently estimated deficiency. This is in addition to the potential for roof water harvesting assessed at 27 mld. The existing drainage basins shall have to be made self-sustainable in water management by integrating water-sewerage-drainage systems.

Development of parks and green corridors along the drains should incorporate conservation of ground water and water bodies to recharge the ground water, conservation of water bodies and rainwater shall be essential.

Apart from the above measures, steps would also need to be taken to augment ground recharge from the river and decentralised wastewater treatment system. The creation of 'regulated flood plane reservoirs', for storing the excess monsoon overflow at suitable locations would augment the water retention capacity of the riverbed.

At another level, a strategy for the conservation/development of the Yamuna River Bed area needs to be developed and implemented in a systematic manner. This issue is sensitive both in terms of the environment and public perceptions. Any such strategy will need to take into account the cycle of flood occurrences and flood zones, the ground water recharge potentials and requirements, potential for reclamation derived from the foregoing considerations, designation and delineation of appropriate land uses and aesthetics of the River Front which should be more fully integrated with the city and made more accessible- physically, functionally and visually.

Environmental study of the existing major drains should be conducted before their covering.

To increase sub-surface soil water through seepage of rain water, porous paving tiles should be used in the pavements and soft parking areas. all the new bridges/flyovers must have the provision for rain water harvesting. Water bodies, having a minimum size of surface area of 1 ha., shall be preserved by the concerned authorities. Further efforts shall be made at the local level to retain smaller water bodies.

AIR:
Various initiatives and measures taken over the past few years, like introduction of CNG and EURO II norms etc., the air quality in the city, in terms of pollution levels, has continued to be a matter of concern, and has been responsible for a number of respiratory diseases, heart ailments, eye irritation, asthma, etc. The three main sources of air pollution in Delhi are vehicular emission (around 70 percent) industrial emissions (around 20 percent) with a major element of this coming from the three thermal power plants, and from other sources such as diesel generator sets and domestic cooking, burning of biomass, etc.

Apart from the issue of pollution on account of industries, the major area of planning and intervention would relate to transportation planning. With the phenomenal growth in the number of vehicles, almost 8-10 times in the last two decades in absolute terms, the most significant aspect in the context of congestion and pollution, relates to the growth in personalised transport as compared to the availability of public transport. It has been estimated that buses, which constitute barely 1.2 percent of the total number of vehicles, cater to around 60 percent of the total transport load, while personal vehicles –cars and

scooters, though almost 93 percent of the total number of vehicles, cater to around only 30 percent of the travel demand. Such a huge share of private vehicles in Delhi, while serving a relatively limited purpose in terms of the transportation modal split, obviously creates tremendous pressure on road space, parking, and pollution directly and through congestion. Public transportation planning must, therefore, drive the future policy. So far public transport is largely seen as the transport mode for the not so well off and poorer sections of the community, who cannot afford to own/use personal transport. An important element of policy would now also have to aim to make public transport a mode for personal vehicle owners and users through a mix of incentives and disincentives. Apart from aspects like frequency, inter-modal integration, a possible single ticketing system, use of parking policy as a means to influence vehicle use, etc., the quality of public transport, particularly buses, would need to be significantly upgraded, inter-alia, keeping the element of clean transport in view. Another issue which has been raised in the context of vehicular congestion and pollution relates to the policy of mixed land use.

The Metro Rail system has a big footstep for reducing carbon footprint. The Metro Rail system has provided a big relief to the city and placed it on higher demand for providing relief to the 100% metro with adequate feeder system. Use of CNG on public transport has experienced a journey of reducing Carbon emission. It is further paving way for utilization in private vehicles. Bus Rapid Transit is meant to be a high quality public transport system, oriented to the user that offers fast, comfortable and low cost urban carbon mobility. The overall green cover in this zone should be enhanced and protected

MRTS Corridor: In prior master plans, city structure was thought in terms of hierarchies with CBD, District Center and Community Centres in descending order of importance. But with due course of development and introduction of MRTS, need is felt to connect these scattered districts with more imaginable components. These components with enhanced built up areas and activities form a network by which the experience of various district and commercial centres becomes a part of continued experience.

The other elements which would need carefully thought out policy measures would relate to the operation of existing Power plants to significantly reduce the pollution arising from them, and industries, both in terms of pollution control in designated industrial areas, and relocation of non-conforming industries.

As per the Government of India Notification, it is mandatory for all construction agencies to use Fly Ash bricks or tiles or clay fly ash bricks along with pond ash in the construction of roads/flyovers embankments and reclamation of low-lying areas. To control the ambient air quality of Delhi, it may be made mandatory that all commercial vehicles (like trucks and tempos) are converted into CNG. All Thermal Power plants located in Delhi should be gradually converted to gas based plants.

C. Conservation and Development of Resources

Water Conservation and Development Practices

Delhi depends largely on river Yamuna and partially on river Ganga for its share of raw water. For sustainable development of Delhi, it is essential to ensure adequate supply of water in terms of reliability, quality and quantity. However, Delhi has an average water availability of 225 lpcd, the distribution of the same is not uniform. Some areas get 24 hrs water supply, whereas some get hardly 1-2 hr water in a day. The minimum water supply @ 270 lpcd will have to be ensured for the projected population. The water requirement has to be made from river water allocation and ranney wells in Yamuna flood plains. The supply crucially depends on the progress of the proposed dams in adjoining States, Satluj Yamuna link canal and Sharda Yamuna link canal. Further it will also depend upon the conveyance

system, which should be in place before the release of allocated water to Delhi. However to some extent localised ground water extraction and its supply after treatment to prescribed level of quality may also be required to meet up the demands. In addition, promotion of recycled wastewater based on techno economic feasibility is also to be done by the concerned agencies for water augmentation. To improve the water supply in accordance with the projected requirement upto the year 2021 Inter-State river water allocation is required to be worked out. All measures are to be taken to reduce unaccounted flow of water (UFW) and production losses at existing water treatment plants. The drainage basins shall be made self-sustainable in water management by integrating water-sewerage-drainage systems. It is imperative to not only initiate new projects and upgrade present infrastructure, but also to promote water conservation through an integrated and a community driven model, comprising of complimentary short term and long term measures as given below:

(1) Towns/cities have so far been planned by their respective authorities for their individual needs. There has been total lack of regional approach for sustainable use of available water and its conveyance from areas of plenty to scarcity. The raw water augmentation should not be territory specific but it should be on regional basis irrespective of State boundaries.
(2) Recycling of treated wastewater with separate lines for potable water and recycled water. For this, dual pipeline system has to be introduced in a phased manner in all the areas.
(3) Ground water recharging through rain water harvesting, conserving water bodies and controlling groundwater extraction:
(4) Groundwater extraction is to be controlled through registering boreholes and recharging according to test yields. Ground water management is to be enforced by concerned agency.
(5)Focused planning and action will be required to be taken to prepare and implement rain water as roof water harvesting schemes both with the aim of optimizing water use and ground water recharge. For this suitable mandatory provision is to be made for planning and construction of various schemes.

Energy Efficiency:
The concept of energy efficiency should begin with the idea of Zero-fossil Energy Development (ZED) which envisages an urban form and design of passive building envelope that reduce the demand for power to the point where it becomes economically viable to use energy from renewable resources. This involves a holistic approach combining the issues and actions at various levels of planning, design, construction and maintenance leading to a sustainable and energy efficient regime. The city geometry, restructuring and zoning with self-contained neighbourhoods could minimise the need to travel and substantial saving of recurring energy/ fuel consumption. Integrated mass transport system, traffic and transit operation and management, better tele-communications, promoting bicycles and NMV transport, is another major area of energy efficient habitat. The introduction of energy audit and design of energy efficient buildings by site planning, heights, form, construction and materials and reducing energy demand by passive micro-climatic design approach, intelligent energy controls, heat recovery, landscape, opening design, furnishings, etc., arethe critical considerations. The key to future is a cybernetic form of sustainable energy, which integrates symbosis, recycling and energy chains.

Load management techniques and energy accounting should be adopted. Schemes to minimise power thefts/ losses by improved metering arrangements should be enforced.

Non-conventional energy sources like recovering energy from sewerage, solar energy, etc. should be used for street lighting, lighting at public spaces, open areas, traffic signals, hoardings, etc.

To supplement part of the estimated growing power requirement, non-conventional sources/solar energy and other actions proposed are as follows:

- . Solar energy should be encouraged for all units with floor area of more than 300 sqm.

- Compulsory Solar Panels for public advertising, lighting in open areas, public utilities, streets, etc.
- As alternate mandatory arrangement during power cuts to replace generators/inverters etc.
- Adoption of Load Management Technique.
- Tariff restructuring and improved metering arrangement to minimize power thefts/losses.
- Interim solutions of single point connection in unauthorized colonies and jhuggies.
- Private Sector Participation in different stages of Power generation, transmission and distribution.
- Incentivising energy savings and use of energy efficient gadgets.
- Public awareness, capacity building and training.

As per Asian Development Bank's report (1997) potential in saving due to better overall efficiency in domestic sector is about 20% by adopting following measures:

- Replacement of low efficiency incandescent lamp with high efficiency fluorescent tubes (CFLs) without compromising with the lumens output.
- Similarly for refrigerators, which account for 30% of total electricity consumed, measures like
- increased thickness of foam insulation, use of high coefficient compressors increased evaporator surfaces, use of tighter door seals and through technical improvements can reduce consumption from 540 KWH/year to 300 KWH/year (for a 165 litre refrigerator).
- Incandescent bulbs, neon tubes and fluorescent lamps are giving way to light-emitting microchips that work longer, use less power and allow the use of light in new ways. The chips, known as light emitting diodes, or LEDs have huge performance advantages in many mundane tasks (such as traffic lights). These consume 80 per cent less electricity than the bulbs and have longer life. Moreover, they have the safety advantage of gradually fading instead of burning out. This eventually results in huge savings in terms of energy and maintenance costs.

Solid Waste Management

The problem of solid waste management in Delhi is assuming serious proportions due to increasing population, urbanisation, changing lifestyles and consumption patterns. The garbage from unauthorized developments, slums, JJ settlements, etc is not collected which further adds to the environmental degradation. The projected average garbage generation upto the year 2021 is at 0.68 kg per capita per day and total quantum of solid waste is 15750 tons/day.

Management of solid waste involves waste generation, segregation and storage; waste collection; waste transfer/ transportation; treatment, recycle, reuse, recovery; and disposal. For effective waste management, its segregation at the community and neighbourhood level is imperative. The waste shall be segregated and collected, in separate chambers. For this, involvement of rag pickers is to be encouraged. The municipal biodegradable and recyclable waste, which is segregated at the source, decentralised treatment at neighbourhood level may be adopted, while for non-biodegradable, centralised treatment may be followed.

The other type of specialised waste includes biomedical waste; hazardous waste from industries; construction debris and fly ash; meat processing centre etc. Disposal of bio-medical waste is to be as per bio-medical waste rules and hazardous waste requires special handling according to hazardous waste handling rules. Proper dumping, recycling and reuse of construction debris and fly ash have to be linked. Meat processing centre waste is to be recycled for chicken feed etc. Considering the nature of solid waste and the economic aspects of its disposal, major part of solid waste especially non bio-degradable has to be disposed off in sanitary landfills. Recycling should be preferred than disposing off the waste in sanitary landfill sites' wherever possible. The segregation of solid waste should start at the

point of generation of the waste. It should be collected in two separate bags of green and black colour.

The clean, litter free public spaces add to the pleasant built environment. Thus the design, location and maintenance of public amenities such as public toilets, garbage bins, bus stops, etc. determine the quality of public spaces.

The involvement of RWAs and Rag pickers association will reduce the quantum of waste drastically. And it will also result in the reduction of area required for landfill sites. Further, some more viable alternatives to landfills are vermiculture, fossilisation, composting etc. Waste Minimisation Circles (WMCs) should be constituted and made effective. Implementation and monitoring & Bio-Medical Wastes (Handling & Management) Rules, 1998, for hospitals, nursing homes, and clinics should be taken up. The filled up sites may be reused for plantation or as recreational area. The proposed sites for sanitary landfill and compost plants are to be finalised by the MCD. This shall also include buffer zone of 'no development' around landfill sites. Keeping in view the fact that finding new sanitary landfill sites in Delhi is becoming extremely difficult, there is no option, but to resort to alternative and decentralised methods of waste treatment, reduction, recycle and use, which include composting. Pilot projects in this regard have been taken up by the MCD with the consultants. vermiculture, fossilisation and composting. Pilot projects in this regard have been taken up by the MCD with consultants.

4 types of wastes: Solid waste, Hazardous Waste, E- Waste, Bio Medical Waste are included under Clean Development Mechanism (CDM) for accounting Carbon Credits.

5. CONCLUSION

Management of logistics in green building complexes provides an opportunity to use water and sewage, renewable solar energy for saving energy and gaseous emissions in climate as much as saving pollution of Yamuna River. Beyond this, general awareness induced by this is a compound dividend.