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Comprehensive study the potential of green roof system

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Abstract

Green roofs have been recognized since ancient times in hot and cold climates . It is a passive cooling technique that reduce incoming solar radiation inside of the building and can manage higher cooling in summer and lower heating load in winter . Green roof has adopted as a specialized roofing system as a sustainable technology .It can reduce indoor temperature by approximate 42 % and heat flux 40 % to 50 % as compared to without green roof .Due to its specific quality 1/100 th to 1/10 th of total amount energy can be saved annually . Due to rapid economical growth many countries increasing urbanisation so the green area is continuously decreasing . A liveable city should have 25 % greeneries of entire area .Vegetation is an important element for succesful performance of green roofs . Green roofs play significant role in energy saving ,enriching the biodiversity ,purifying the air pollutants , delaying the storm peak drainage system, improvement of water runoff quality , filter the particulate matter from air ,to reduce urban heat islands ,generate aesthetic skyscrapers ,decrease the air pollutions ,increase sound insulations, reducing traffic , balance the wildlife habitat provision ,increase the drought tolerant ,solar radiation tolerant and life time of roofs .There is relationship between performance of green roof and gross domestic product (GDP) .Green roofs can utilised grey water of the building for irrigation . The albedo rang 0.7 to .85 is recorded due to green roofing . Green roofs can reduce the need of air conditioning in summer season.To sustain the pleasant living conditions of environment in urban area there should be the balance between green area and concrete built up area.

Keywords: Green roof ; passive cooling; Albedo; leaf area index; gross domestic product; Thermal comfort ; Growing medium

1. INTRODUCTION

It is documented that approximately 40 % of worldwide energy is associated with the buildings maintenance and building construction so building segment is associated very large quantity of energy consumption worldwide .So there is very high energy saving potential in building sector .Buildings segment are also associated 33 % of green house gas emission globally .Due to the very high amount of energy consumption and greenhouse gas ambition we have to require a sustainable and energy friendly approach in building sector [14]**.** There are so many sustainable approaches and environment friendly technologies have been introduced in this category green roofs are identified as an important energy efficient technology for buildings [8]. Nowadays in Germany more than 10% of the houses have green roofs [kohler,et al 2006]. Green roofs become widely popular in France, Switzerland, United Kingdom, Austria, Norway. This paper represents comprehensive study of energy saving potential and environmental benefits of green roofs [1]. The acceptance of green roof is a going on since 1960 [24]. Green roof is a passive cooling technique that stops incoming solar radiation in side of the building [2].Green roofs are also named as roof garden ,roof top greenery ,living roofs ,eco-roofs ,bio-roofs and roof garden [4-8]. There are three types of green roofs; extensive green roof, intensive green roof and semi-intensive green roof [1-24]. All the different types of green roofs require different depths of growing mediums and different types of vegetations [Banting et al.,2006] .Some important characteristics features of extensive green roof plants - (1) They are short in height and mat formatting (2) Their roots are shallow (3) Their leaves able to store water (4) they grow fast [Maclvor and Lundholm,2011].To establish extensive roof we do not desire extra structure support. These roofs are least economic, very low maintenance cost and establish in short time [22] .There are four types of plants which have these characteristics (1) Moss Sedum plants (2) Sedum moss herbaceous plants (3) Sedum herbaceous grass plants (4) Grass herbaceous plants.These types of plants require 2 cm to 20 cm depth of thin growing medium [Banting et al.,2005] .Another four types of plants like grass herbaceous plants, wild shrubs coppices ,shrubs and coppices are require deeper growing medium 12cm to 100 cm these types of plants are suitable for semi intensive green roofs .These roof require high capital cost in establish and maintenance [22].The vegetations of intensive green roofs can be medium and large size shrubs canopies small trees this kind of vegetation require deeper growing medium 15 cm to 200 cm [Banting et al.,2005]. Due to tall height of plants and trees deep growing medium this types of intensive green roof require large capital cost in establish,maintenance, building structure ,fertilising weeding and watering [22] . In various types of green roofs extensive roof are least expensive, lowest weight and minimal maintenance required and easy to install .Their vegetation require minimal irrigation [1]. Green roofs provide large significant role in economic benefits ,energy saving ,improving thermal comfort inside the building, enriching the biodiversity ,purifying the air pollutants ,improve the quality of storm water, increase the thermal insulation, delaying the storm peak drainage system,

improvement of water runoff quality ,mitigation floods in certain reasons , filter the particulate matter from air ,habitat creation to reduce urban heat islands ,generate aesthetic skyscrapers ,decrease the air pollutions ,increase sound insulations, reducing traffic noise ,reducing carbon dioxide , re-oxygenating the air, removing the airborne toxins, recycling nutrients ,rain water management ,balance the wildlife habitat provision in urban area, drought tolerant ,solar radiation tolerant and increase the life time of roof [1,2,5,11,12]. Green roofs contribute befits of energy saving in both summer and winter seasons [8].Green roof can reflect 20%, absorb 60% for photosynthesis process and 20% of solar radiation transmitted to growing medium [8]. A habitable urban area should have minimum 25% of green area. Trees shading can reduce annual energy for cooling 10- 50% and peak electricity use up to 23% and temperature difference 3-4 ^{0}C lower than hot outside temperature [21].

There are various common assumption about green roofs are--(a) foliage of plants and density of substrate are homogeneous (b) heat flux of sun transmit vertical (c) plants are healthy (d) roof are fully covered by plants .

Classification of green roof and their main attributes

Attributes	Extensive roof	Intensive roof
Growing thickness	<200mm	>200mm
Weight	60-150kg/m^2	>300 kg/m^2
Height of plants	low	high
Installation	easy	complex
Watering	not require or low	watering required
Cost	low	high [22]
Maintenance	low	high [14]

[2]

2. BACKGROUND OF GREEN ROOFS

There are various types of ancient green roofs have been recognized in different countries to take the benefits of climatic conditions .In early history we found that Babylon's hanging garden (green roof) have been established in fifth centuries .The ziggurats of ancient Mesopotamia had planting of shrubs and trees on the terrace in 600 BC . In the period of Roman architecture the Villa of Mysteries in Pompeii which had an elevated terrace garden [14].A roof garden has also identified in Roman-Byzantine Caesarea period. In early 11th century the roof garden was established on Nasir Khusraw building in city Fustat in medieval Egyptian period. The Hanging garden of Babylon was one of seven wonder of ancient Hellenic culture .Green roofs also have implemented in vernacular architecture in Norway .In 20th century the Swiss architect Le Corbusier who introduce terrace garden in their five points of architecture . Around the same period of time in American architects introduced garden roof as an integral part in organic architecture [14].

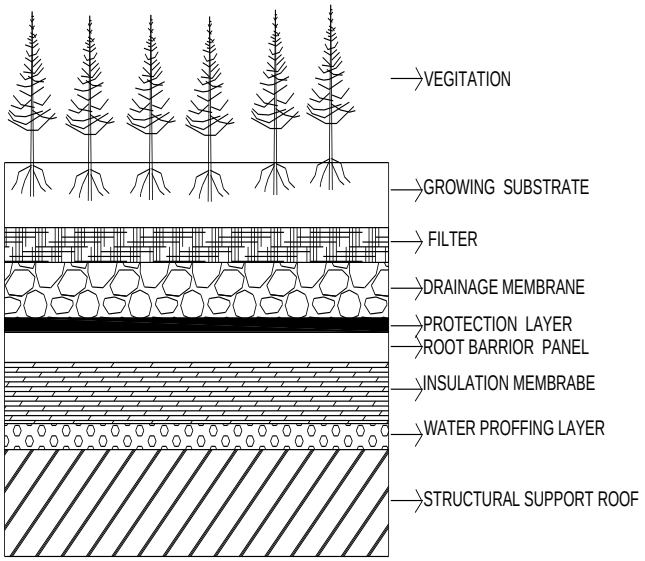
Nowadays Germany is a leader in implementation of green roofs [1]. In 1970 the modern type of green roofs was introduced designed and developed in Germany .At same time green roofs became popular in France, Switzerland and north America .Japan has implemented green roof to reduce the effect of urban heat island [14]. Most of the early information of development and design of green roofs was written in German language which is not available.Germany is increasing green roof approximately 1.5 million square per meter per year [22]. In Germany more than 10% buildings have green roofs [1].In the first phase 1% of green roofs were implemented end of 19th century and at the large scale implementation is done in from 1983-1996 (Kohlar ,2006) .In Britain green garden is used in built up area so any can provide garden on the roof of the building [1].Nowadays some of the country like America ,Australia ,Japan , Singapore and Canada are applying green roofs very intensively .In the Basel city 15% of the green roofs have been established .In Toronto city according to by- laws for the new construction of more than 2000 square meter the implementation of green roof 20-60% of the roof is compulsory . Up till 2005 approximately 2 acres green roofs have been established in Portland and Hong Kong city .Research and development work of green roofs has started in various countries. USA has published 34 % of total research journals. European Union and Asian countries contribute 33 % and 20 % respectively [22].

3. GREEN ROOF COMPONENTS

According to report of UNI 11235:2007 there are various types of layers composing in the green roofs system [Figure-1].

(1). Structural layer –main function is bearing the load.
(2). Water proofing layer –to protect the roof from filtration of water normally made of PVC or bitumen.
(3). Root barrier layer- to protect building roof from the roots of the plants and trees made of hard plastic.
(4). Protection mat- to protect the root barrier from destroy.
(5). Drainage layer- draining the extra water of the roof.

(6). Moisture retention layer- watering for dry periods.
(7). Filter fabric layer –to protect the layer of substrate.
(8). Growing medium- most commonly soil with fertiliser .
(9). Plant layer- vegetation like -plants, shrubs, trees [26].



Typical section of green roof and its components [Figure1]

3.1 Vegetation

Vegetation is the top layer of green roof system .Efficiency of green roof system is depend upon the foliage height and leaf area index of the plants [14]. Plants can reduce air pollution, energy load on air condensing, carbon dioxide [22].Vegetations decrease the cooling demand in summer and heating demand in winter and increase the thermal comfort inside the building [5].The foliage of vegetations absorb a part of solar radiation for photosynthesis process which is a biochemical characteristic of plants .Foliage of plants act as a shading device decrease the impact of solar radiation [8]. There are some various constructive characteristics for growing of plants are –require less maintenance, require minimal water ,grow fast ,short root, can bear conditions of weather .First Environmental Protection Agency [EPA] in the United State 2012 decided that native plants already established in the local climatic conditions they do not require pesticide ,nutrient condition, irrigation.Native plants have ability to sustain balance in healthy elevating biodiversity by attracting different birds, butterflies and animals [1]. According to many researches for a green roof selection of plants act very important role .It should have solar radiation and drought tolerant. According to Clark and Mac Arthur, 2007 the biodiversity of semi-intensive with native plants is greater than non-native plants. Crassulacean acid metabolism (CAM) plants can survive without irrigation for long periods of time (Van Woerth et. al, 2005). CAM plants can survive approximately 113 days without irrigation (Farrell et al, 2012). Plants can help to the manage temperature in drought tolerance. The temperature reducing effect increase according to plants height like 10cm<15cm (Liu et al, 2012). Sedum plants are more suitable for extensive green roofs because they do not require irrigation their leaves store water have create more ability of transpiration process. [36].Sedum spp plant can survive four months without watering (Durhman et al ,2006).(Terri et al,1986) indicated that sedum rubrotinctum plant can survive two years without water. As well as possible plants should completely cover substrate and it should not expose to direct sun light and air [22].Native plant Portubla grandiglora is suitable for green roofs in wed and dry climatic conditions (Vijayaraghavan and joshi ,2014).Artenia cordifoliaas plant is suitable under hot and [3] dry climatic conditions [Schweitzer and Erell et al 2014].For the better effect of performance of green roofs various types of plants are recommended [37].

3.11 Leaf area index

Leaf area index [LAL] represent area coverage of leaves or the density of foliage in green roofs [14-57].It symbolize the positive outcome in summer conditions. The cooling effect increase due to shading and transpiration process [57]. It depends on height and density of vegetation most commonly its value varies 0.5 to 5.0. Increasing the leaf decrease thus reduce cooling load. The higher value of LAL increases the transpiration rate in green roofs. Raising the value of LAL the temperature of inside building decrease as per table-1 [5]. For the bigger values of LAL the plants of denser foliage should use. It decreases intensity of the solar heat flux in the roof [25-17].The foliage height and density increase the performance of green roofs. It can decrease 74% of energy peak load comparison to typical roofs [17].The LAL value 6 is symbolize as a very valuable for cooling effect .Typical LAL value range is 0-5.0 [57].

Table -1

Leaf area index	Decrease temperature
1.5-to 3.5	0 .1 ^{0}C inside of building
0.5 to 2.0	0.3 ^{0}C air temperature [17]
0.5 to 5.0	28.3 ^{0}C to 27.9 ^{0}C inside temperature [57]
3.5 to 5.0	0.1 inside of building [57]

3.12 Evaporation effect

Feng et al (2010) investigated that 58% of incident solar heat on green roofs lost by evapotranspiration in summer and 9.5 % reduce by photosynthesis effect [11]. Lazzarin et al (2010) calculated passive cooling in summer season due to evapotranspiration in the wet condition of green roof, the solar heat loss becomes more than double comparative dry condition on a hospital building China. The dry green roof reduce 60%of of solar heat flux relative to conventional roof so wet green roof can reduce more solar flux through evapotranspiration thus create more passive cooling inside the building in summer season [11].

3.13 Albedo effect

Albedo is an evaluate the reflectance of the surface. There is an adverse relation between albedo effect and surface temperature [1].Gaffin et al (2006) recorded that albedo of green roof range is 0.7 -0.85 and white paint roof is 0.8 on average. If we increase the biomass on green roof albedo will increase. [1].

In green roof plants contribute cooling response by transpiration of water through stomata and direct shading [Balnusa et al.2013]. The various surfaces have diverse albedos. The forest ,lake and oceans have lower albedo value while desert ,sea ice ,snow belong large albedo value [58] .There are some important albedo value shown in the table-2 .

3.14 Green Roof Energy Balance

Thermal performance of green roofs depends on the following process (1) shading (2) insulation (3) evaporation (4) thermal mass. In the evapotranspiration process water loss from soil (evaporation) and transpiration from plants. In the transpiration process water of plant leave surface go in the air by convection .Lost of water balance by a small process in which small pours of leaves allow enter gases and carbon dioxide for photosynthesis such process plant release oxygen and water vapour .Thus plants can balance their transpiration [15].

Table-2

Type of surface	Albedo value
Tall grass	.04 [58]
Medium grass	.05 [58]
Evergreen forest	.03 [58]
Deciduous forest	.03 [58]
Desert	.28 [58]
Snow	.76 [58]

3.2 Growth Substrate

Growth of plants are directly depend on growing substrate thus the good performance of green roof the appropriate substrate is necessary. So the selection of useful substrate is very serious concern [22].Some properties of green roofs are directly concern with growing substrate like solar heat sink, sound insulation, improving urban biodiversity, managing run off quantity of rain water [1].There are some more impressive substitute substrates like (1) Pumice (2) Zeolite (3) Scoria (4) Vermiculite (5) perlite (6) peat [38].(7) Crushed brick[1].The important component of these are low cost ,light weight and made of waste materials [39].A good substrate can prepare by mixing of 30% perlite,20% vermiculate,20% crushed brick,10% sand, and 20% coco peat .These substrate represent good value like low density ,high water holding capacity , air filled porosity high hydraulic conductivity .This type of substrate is appropriate for green roofs [40]. The low cost substrate for green roof can be prepared by using local waste materials [41]. Density of substrate can be reduced up to 9.4 times by using low density inorganic recycled materials. With the saturation condition of coco peat substrate becomes 5.2 times bulky of its original weight [40].The bulk density of biochar 4.1 times of their

original weight in saturation condition [Cao et al,2014].The growth of plants and moisture retaining capacity of substrate can increase if we increase organic matter in substrate [42]. According to German code it is suggested 4-8% for extensive and 6-12% for intensive roofs mixing of organic matter by volume in substrate [43].The substrate with 20% of coco peat can refine 6000 mm of rainfall without any metals [Vijayaraghvan et al 2014].Bio sorbents can be used as substrate. It performs as a fertiliser and soil nutrients [22]. Water holding capacity of substrate is deciding factor for plants in drought conditions. Water holding capacity of substrate can be increase by mixing silicate granules [Farrell et al,2013].Air filled porosity of substrate in extensive roofs should be less than 10% and hydraulic conductivity less than 3600mm/h .Large partials size increase the air filled porosity [43].If we increase organic matter in substrate water holding capacity will be increase. In saturated substrate of green roof transpiration process of plants becomes slow. It is suggested that 10% organic matter is optimum for substrates .The organic matters 0% and more than 25% not recommended for extensive green roofs [29].The alternative recycled materials like cursed red bricks, clay pellets, paper ash pellets, carbon 8 pellets can be used in substrates [30-31].There are various advantages of natural mineral ingredients for green roofs as per table -3.

Table-3
Influence of natural mineral ingredients

Materials	advantages
Sand	- Rapid growth for plant [31]
	- Increase water retaining capacity [29]
Clay	- Increase water retaining of substrate
Gravel	-Improve drainage [29]
Pumice	-porous light weight [31]

pH rang of substrates 7 to 9 are appropriate in acid rain region [31].

3.3 Filter layer

The filter layer is provided to separate drainage layer from growing medium in green roofs. In regular practice geo textile fabric is used as filter layer [44].This fabric has high tensile strength also act as root barrier layer for vegetations .There are large number pores allow the extra water pass through drainage layer [22].The fabric can absorb 1.5 litre water per square feet area. This feature increases the water holding capacity of green roofs. [Wong and Jem et al, 2014].Thicker fabric can retain 300% more water [22].

3.4 Drainage layer

The main function of drainage layer is to balance water and air, improve thermal properties, remove the extra water in green roof so the performance of green roof depends on good quality drainage layer [45].Vijayraghwan et al ,(2012) recommended clay pebble of 5-15 mm size drainage layer for green roofs, Perez et al,(2012) recommended rubber cramps as a drainage layer, Vijayraghwan and joshi et al,(2014) suggested Bio Reme Gre drain cell as drainage layer which can retain 2 litter water per square meter .

3.5 Water proofing layer

The main function of water proofing layer is to protect roof structural direct contact from water . For a successful working of green roof water proofing membrane act as a key role. There are many choice suggested like single ply sheet, modified bitumen sheet, thermo plastic sheet, hard plastic and sheet, copper metal sheet [22].

4. BENEFITS OF GREEN ROOF

Green roofs play an important role in energy saving it can save up to 10-15% of annual energy [14].It can play in important role improvement the elevating the biodiversity in urban concrete area [1].Vegetation of roofs attract bird animals. [20].

4.1 Energy Saving Potential

Green roofs are capable to decrease the temperature inside of building in summer and increase temperature in winter thus reduces the building energy consumption [12]. It has higher value of insulation comparative to other conventional insulation of roof. In the hot climatic conditions green roofs decrease temperature inside of building due to shading of plants, substrates and other layers decrease solar radiations [14].It can reduce the building energy consumption up to 2-48% with the reduction of indoor temperature 4k [56].If the density of vegetation increase than

cooling demand can be decrease up to 60% [Olivieri et al,2013]. Performance of green roofs can increase with the increase the density of plants [Sailor et al ,2011].In summer condition bare black roof temperature can reach up to 80 ^{0}C whereas same conditions for green roofs temperature recorded 27 ^{0}C [52]. It is recorded that albedo of green roof value range 0.7-0.8 whereas bitumen, tar ,gravel roof rang 0.1-0.2 [11].Lue and Minor et al (2005) indicated that solar heat gain decrease up to 70-90% in summer condition and heat loss up to 10-30% in winter condition. The energy saving performance of green roofs depend on U-values of various layers of system [Niachou et al, 2001].Wons and Chen et al ,(2007) investigated that surface temperature reduce 18 ^{0}C after applying green roofs in Singapore. Heat storage of extensive green roof was 75% lower, temperature reduction 38 ^{0}C and solar heat reduction 51-63% comparative to conventional roof in hot and dry climate condition in India [12].M.Zinzi et al,(2012) investigated green roof can reduce energy consumption by 14% [23].There are several performance of green roofs regarding cooling load shown in table-4.

Table -4
Impact of green roof in summer conditions

Reference	reduce of cooling load	temperature reduction
Sfakianaki et al, 2009	11%	0 .6 ^{0}C
Santamouris et al,2007	6-19%	12-87%

4.11 Thermal mass U value

According to UK building policy roof the upper limit U-value of residential buildings should 0.25 w/m^2 [53].After 1965 rules set upper limit 1.42 w/m^2 , after 1976 upper limits was 0.6 w/m^2 ,after 1985 upper limit was 0.35 w/m^2 .Nowadays there are large numbers of buildings in UK which have lower U-value of 0.25 w/m^2. [54]. Alcarzar and Bass et al (2005) determined that increasing the mixture contents in substrate the u-value also increase. The U-value of sedum is 2.15 w/m^2 which is very low comparative to other plants [23].A Niachou et al, (2001) investigated that U-value of non-insulated roof rang is 7.76 -18.18 w/m^2 where as green roofs rang 1.73-1.99 w/m^2 .Thus these represent reduction of solar heat flux in green roof is very high. Another study indicates that rang of U-value for non-insulated roof is .74 w/m^2 -0.8 w/m^2 whereas green roof rang is 0.55-0.59 w/m^2 [23].

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4.2 Storm water management

Green roofs can retain the rainwater and delay the peak flow and it reduces the flooding in urban area [22]. Decrease of storm water runoff is a most significant environmental component of green roofs [14] . The substrate of green roofs have water holding capacity and runoff dynamics [Banting et al,2005].The water holding capacity varied 40% to 60% of rainfall in extensive green roofs with various types of plants [1].Green roofs can retain all small amount and less than 10mm rainfalls. Its water retaining capacity depends on the intensity of rainfall. The water retaining capacity varied 86% to 26% if rain fall is 12mm [Simmons et al, 2008].If the intensity of rainfall is less than 4.3 mm/h thus the runoff rate of green roof will be 2.4 mm/h [De Nardo et al, 2005].The only roof and substrate can retain 50.4% but at the same time roof substrate and plants [green roof] can retain 60.6% of rainfall [Van Woert et al ,2005]. The evaporation and transpiration process will start in retained water of green roofs. Its water retains potential increase with increase the thickness of substrate [22]. Extensive green roofs can keep average 65.7% of water holding capacity [Speak et al,2012].Water holding capacity can be raise with increase the height of plants, diameter and root biomass [22].Green roofs with sedum plants can retain 40% of rain water [Berghage et al,2007].

4.3 Water quality improvement

Green roofs act as a filter of pollutions of rain water and produce good quality of storm excess water, plants and substrates both absorb dust and airborne particulates. Substrate act as filter for nutrients and metals from rainwater. Green roofs act as a sink for high concentration of ions in rainwater [22].Van Seters et al (2009) indicated that storm runoff of most pollutants extensive green roof was lower than conventional roof. If green roofs established in 20% buildings of Washington DC thus they can store 958 million litre of rain water in every year [Deutsch et al, 2005].

4.4 Urban Heat Island Effect

Due to rapid urban growth in developing countries pollutions, urban heat islands are increasing very fast. Green roofs can reduce these concerns. The albedo of green roofs varies .7 to .85 is higher than the albedo value (.1 to.2) of tar bitumen and gravel roof [14].The estimate increase of 4k atmospheric temperature in next 80 years in Manchester these problem can be solved using 10% of green roofs [Gill et al, 2007].The surrounding temperature can be decrease up to 0.3 ^{0}C to 3.0 ^{0}C after using green roofs at large scale. The performance of Green roofs are most effective in hot and dry climatic conditions [14].Smith and reober et al ,(2011) determined the impact of green roofs in urban heat island, ambient

temperature decrease up to 3k in Chicago, ambient temperature reduce .37 k to.86 k at the height of 2 meter [Savio et al,006] , solar radiation intensity reduce from 900 w/m^2 to 300-400w/m^2 [Takebay Moriyama et al,2007], dry roof reduce 110 w/m^2 ,wet roofs reduce 230 w/m^2 Lazzarin et al ,2005],on average UHI reduce 2 ^{0}C [14]. To increase the albedo and injurious effect of urban heat island the green roof is valuable tools [22-26].The urban heat island increase cooling energy load in the building and urban smog [26].

4.5 Air Pollution Removal

High levels of air pollutions are very hazardous to health (Mayer et al, 2007) [32].According to report of the American Lung Association -2007 in America 3700 people died due to increase of ozone levels in air. According to report of World Health Organisation -2007 approximately one million died in every year due to urban air pollution in developing countries. Green roofs can reduce the air pollution through microclimatic effects and dry deposition process .The high surface area of the foliage, branches and stems act as sink of air pollutants (Beckett et al,1998). Modifying the microclimates plants remove environmental pollution .Due to shading of plants reduce ambient temperature thus reduce electricity load on air conditioning (Heisler et al, 1986). According to researches the trees share important role to the reduction of air pollution in urban area (Nowak et al,2006). The United States Environmental Protection Agency 2004 reported the policy to reduce air pollution trees planted in urban area reducing 711000 metric tons pollution annually in USA .In urban area 40-50% of air pollution can be removed by using green roofs (Dunnett and Kingsburey et al,2004).In Toronto 109 hectare of green roofs are removing 7.87 metric tons of air pollutions per year (Currie and Bass et al,2005). Deutsch et al ,2005 indicated that 58 metric tons of air pollutions can be removed if all the roofs replace as green roofs in Washington DC .Corrie et al ,2005 describe that decrease of NO_2 806.48 to 2767.86 metric tons after covering 20% applying the green roofs in Chicago. Tan and Sia et al,2005 estimated that pollutions of particulate matter and acid gaseous after installation green roofs the levels of pollution reduced 37% and 6% respectively in 4000 square meter area in the Singapore. The annual removal rate of air pollutions in Chicago city per canopy cover of plants are shown in table-5. Due to phytoextraction process vegetations of green roofs absorb metals ions like Fe, Cr, Ni, Zn,Cd, Pb,Na, Ca,Mg,Al from pollute rain water [22].Yang et al,(2008) investigated that air pollution reduction rate 85kg ha^{-1} was obtained by using green roofs in Chicago [31]. Green roofs are natural sink for nitrogen, lead and zinc [1].

Table -5
Annual discharge rate of air pollutions per canopy of plant (gm^{-2} $yr^{-1)}$ in Chicago 2006-2007

Type of plants	SO_2	NO_2	PM_{10}	O_3
Small grass	.65	2.33	1.12	4.49
Herbaceous plants	.83	2.94	1.52	5.81

4.6 Ecological preservation

Green roofs play a crucial role in increase urban ecological conservation and appreciate the biodiversity. It can establish urban gardens [14].Green roofs are like cool passages in urban area [Kim et al, 2004].The main elements of green roofs which contribute in urban biodiversity are plants growing mediums, vegetations, increasing organic matter from leaves and biological activities [1].

4.7 Noise Reduction

Green roofs can reduce noise pollution in urban area originating from transportation system [55].It can reduce noise reduction up to 10 to 20 dB .It investigated that extensive green roofs can reduce noise pollutions up to 10-20 cm and intensive green roofs up to more than 20 cm [22].Green roofs and its substrates absorb more noise pollutions comparative to hard surface of roof (Botteldooren et al 2009).Due to spaces in between the particles of substrate noise waves absorbed in it (Van Renterghem and botteldooren et al 2009). Increasing the depth of substrate 15-20cm the noise pollutions can be decrease up to 10dB [14]. Green roofs can play an impressive role near air port area, dance urban area, heavy transportation area, and industrial area. Green roofs can increase the transmission loss 5-13 dB at low and mid frequencies [32]. Noise of an urban street determined appreciable lower with green roofs [Young et al 2010] [14].

4.8 Carbon Dioxide Reduction

Green roofs are an important tool for decrease carbon dioxide in atmosphere. These are natural sink for carbon dioxide [32]. Sailor et al (2008) investigated 1.1 kilometre square of green roofs can reduce 3640263 kg of carbon dioxide per year.

5. PARAMETER OF WEATHER ON GREEN ROOFS

There are some climatic uncontrollable variables which effect the performance of green roofs these shown in table-6.The most common metrological parameters are likes- solar radiation ,relative humidity, soil moisture and wind velocity [Jim and peng et al.2012].

Table-6

Variables	Effects on green roofs
Solar radiation	High radiation raise the temperature more solar radiation can sustain by cooling through evapotranspiration process .
Relative humidity	Higher relative humidity induces lower temperature [20].
Soil moisture	In raining season it becomes 0.45 m^3/m^3 which has negative correlation with solar radiation [20].
Wind speed	Higher wind speed reduce solar heat flux and temperature [20]

6. POLICIES FOR GREEN ROOFS WORLD WIDE

There are many policies formed for environment responsive green roofs in world wide. In the Tokyo city according to bylaws minimum 20% green roofs are required for private buildings whose area more than 1000 square metre and for public buildings area more than 250 square metre [33] if any is not following the rule have to pay 2000 USD as a penalty per year [22] . Germany is establishing 13.5 million m^2 green roofs every year [34].In Portland city 70% of roofs are in progressive to covered with green roofs the extra bonus floor area ratio is provided for green roof covering [35].In the Nashville city for the implication or green roofs citizen are getting discount of sever fee $ 10 for every square feet of green roofs [15].In the New York city for the establishing green roofs more than 50% of roofs the citizen will get discount of tax benefits up to $ 100000 for one year .In Washington city for the providing green the citizen will get refund $ 5 per square feet [14].Singapore has planned to establish 50 hectares green roofs till 2030 [24].Some study shows that `there is positive relation relationship between the gross domestic product (GDP) and quantity of green roofs [26].According to Dhaka South City Corporation citizen will get 10% tax rebate to establish green roofs on the building [21].According to bylaws in France after march 2015 every new commercial buildings must have to fractional covered with green roofs or solar panels [26]. There is proposal to establish 1000000 m^2 till 2030 [International green roof association-2015].

7. COMPULSION OF GREEN ROOFS

Clark et al (2006) investigated that green roofs payback its cost within 11 years. Its establish cost is 27% more than conventional roof cost [Niu et al ,2010].Pari et al,(2012) indicate that extensive roofs have 40 years life time. It is required extra structural strength in building. The plastic material in filter layer raise some problems [22].Some of agencies investigated as per table-7 the establish and maintenance of cost of green roofs. The maintenance and establish cost of green roof is high [Peck and Callaghan et al 1999].It increases the construction cost [Nagan et al 2004].The Carte and Keelar et al ,(2008) investigated that extensive green roofs are 10-14% more expensive than a traditional roofs over sixty year of lime time [51].The weight of saturated extensive roofs varies 49 to 98 kg/m^2 [11].

8. FUTURISTIC GREEN ROOFS

Combination of green roofs and photovoltaic contribute benefits of green roofs as well as benefits of electrical yield [46].It improve the performance of photovoltaic (PV) cell by 1.29-3.33% [Chemisana and Lamnatoe et al, 2014]. PV panel create shadow on green roof thus decrease sun radiation flux and increase the evaporation rate [22] .Grey water of building have to consume in watering of green roof [47]. Approximate 65-95% of grey water in formed form domestic waste water [48].Grey water of kitchen has nutrients so it can act as fertilisers for green roofs [49]. Green roof acts as a filter for grey water [50].

Table-7
Establish and maintenance cost of green roofs per square meter -

Establish cost	Maintenance cost	References
10-270 $	8-11 $ (Per year)	Environmental Protection Agency -2009 USA
90-130 $	1-6 $ (Per year)	Architectural Service Department-2006 Hong Kong
50-800$ (Local material)	1-6 $ (Per year)	Architectural Service Depart.ment-2006 Hong Kong
60 -100 £	-	The Green Roof Centre-2006
65 £	-	Driver Jonas Deloitte Document 2009 [11]

9. CONCLUSION

Green roofs have been popular from ancient periods due to its properties like reduce intensity of solar heat flux, effects of urban heat island, air pollutions, energy use in cooling in summer. It also reduces heating energy building load in winter thus this is a sustainable tool to reduce building energy. It creates balance greenery in urban area and enhances biodiversity. So overall green roofs have great potential in building energy saving and appreciate the biodiversity in urban area.

Extensive roofs are more suitable because they do not require extra structural strength in building .These are light in weight and do not require maintenance or it has very low value. The potential of green roofs depend on the appropriate selection of plants and its substrate according to climatic conditions.

Green roofs are natural sink for carbon dioxide, air pollutants and pollution of rain water .These keep balance in fauna and flora in urban area.

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