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ESTIMATE OF THE SIZE OF THE CONTRIBUTION OF THE ANTHROPOGENIC FLUX DENSITY THAT DRIVES GREEN HOUSE

EFFECT FOR A MODEL DISTRICT

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ABSTRACT

Anthropogenic flux is the primary driver of modern climate change and thus intensifying Greenhouse effect. We have selected a Model city from India's National Smart Cities Mission, the Model city exhibits a unique blend of modern tech-driven infrastructure and traditional natural elements. Since a Model city has a robust Telecommunication backbone running e-governance, Digital Administration, Smart urban management and smart citizen services, the Flux Density contributed by the Telecomm services and Public Works that drives the Model District and Public Works Department Q_{PW} are calculated along with other major factors for Anthropogenic Flux that are prevalent in other regions. viz., Q_V , Q_B , Q_M, Q_T , Q_{PW} , Q_V is vehicular flux density, Q_B stands for Building Flux density density that combines electric and gas flux density, Q_M stands for metabolic flux density, Q_T stands for Telecom services infrasevices flux density and Public Works Department Q_{PW} .

IndexTerms *Anthropogenic Flux density, Greenhouse effect, Global Warming, Model City, National Smart Cities Mission,Model District, Telecommunication, Smart Urban Management, Digital Administration, Public Works, Vehicular Flux density, Building Flux density, Electric Flux density, Gas Flux density, Metabolic Flux density, Telecommunication Flux density, , climate changes, environmental policies, Atmosphere, Fuels,Deforestation, Water Treatment, Waste Management, Road building, landfills, Natural recycling, environmental sustainability, Economic Survey, connectivity, Sun's energy, i-r and u-v frequency absorption, optical/visible frequency- direct and indirect heating, Base Temperature, Layer cooling, BMR(Basal Metabolic Rate),Exercise, weight loss, Resting energy, Thinking, Burning calories, Thermoregulation, physiological functions, Radiation, convection, conduction, evaporation, Thermal balance, Brunt Vatsala frequency, Taylor-Goldstein eqn., Atmospheric Thermodynamic eqn., Poynting's theorem, Beer-Lambert's Law, AGW(Acoustic Gravity Waves), troposphere, stratosphere, thermosphere, tropopause, solar flux constant, vehicle Fuel, Fuel density, Net Heat of combustion, Fuel economy, Fuel emission factor, STP(Sewage Treatment Plant), Anaerobic decomposition, 4G/5G cell Towers, small cells,Distributed Antenna system(DA)S, wi-fi router, smartphone pieces, Base stations, DAS headend/central hub. , Greenhouse gases-* CO_2, CH_4, N_2O, O_3, *water vapor,*

I. Introduction

The **Greenhouse effect** is the natural process where atmospheric gases (like $CO_2$and methane) trap the Earth's outgoing heat, keeping the planet habitable.[4][6][11] The **Anthropogenic flux** is the extra surge of these gases added by human activities (e.g., burning fossil fuels, deforestation), which traps excessive heat and causes global warming. [83][84]

Understanding the precise scale and velocity of the anthropogenic flux is critical because it removes the guesswork from fighting climate change. Without accurate measurement of human-driven gas flows, it is impossible to design effective environmental policies, set realistic corporate targets, or predict future global warming. It Proves Accountability and Source Attribution. It Validates Climate Policies and Technologies. Scientists use flux data to calculate the absolute maximum amount of greenhouse gases humanity can emit before crossing dangerous warming thresholds. Measuring the flux distinguishes between natural planetary emissions (like volcanic eruptions or decomposing forests) and human actions. It pinpoints exactly which industries (e.g., concrete production, aviation) and nations are releasing the most gases, creating a transparent baseline for international climate negotiations. [11][86][82]

II. Anthropogenic flux

Anthropogenic flux is the rapid, human-driven flow of greenhouse gases into the atmosphere that disrupts Earth's natural climate balance. It is caused or produced by human activity. **Flux is** the rate of transfer of matter (in this case, carbon and other gases) from one reservoir to another over a specific time.[83][84][85][86][87]

- For millennia, Earth maintained a balanced cycle. Forests and oceans absorbed (sinks) roughly the same amount of carbon that volcanoes, decaying plants, and respiration released (sources), which is termed as Natural Flux.[86]
- Humans bypass this cycle. By burning fossil fuels, we extract carbon stored underground for millions of years and inject it directly into the atmosphere. This creates a massive, one-way surplus that natural sinks cannot clean up fast enough. This is termed as Anthropogenic Flux.[83][84]

Main Sources of the Influx[85][87]

- Fossil Fuel Combustion: Burning coal, oil, and gas for electricity, manufacturing, and transport.
- Deforestation: Cutting and burning forests, which releases stored carbon and destroys a vital natural sink.
- Industrial Agriculture: Massive releases of methane from livestock and nitrous oxide from chemical fertilizers.

The term anthropogenic flux includes vehicle, electric, gas, and human metabolic fluxes because anthropogenic simply means "originating from human activity."

In environmental science and urban metabolism studies, scientists track *every* pathway through which human presence alters the natural flow of matter and energy. Each of these specific fluxes represents a distinct human-driven system that injects gases, heat, or materials into the environment.[82]

1. Vehicle Flux (Transportation)[32][[83][84]

The movement and burning of petroleum-based fuels by cars, trucks, planes, and ships.It is a direct human-engineered flow. It extracts fossil carbon from the earth and injects millions of tons of tailpipe emissions nitrogen oxides, and particulate matter) directly into the lower atmosphere daily.

2. Electric Flux (Power Generation))[32][[83][84]

The flow of electricity generated by human power plants to power homes, cities, and industries. While electricity itself isn't a gas, generating it is the largest global source of anthropogenic greenhouse gas flux. Burning coal and natural gas at power stations creates a massive upward flux of emissions into the atmosphere.

3. Gas Flux (Heating and Industry))[32][[83][84]

The extraction, distribution, and burning of natural gas (methane) for residential heating, cooking, and industrial manufacturing. It introduces two distinct anthropogenic flows. First, the combustion process releases CO_2. Second, drilling and pipeline leaks cause a direct flux of unburned methane CH_4into the air, which is a highly potent greenhouse gas.

4. Metabolic Flux due to Human Activity (Biological Impact)[13][12][

The flow of carbon, nitrogen, and energy resulting from the digestion, respiration, and waste production of humans and their managed livestock. While breathing is a natural biological process, the *scale* of it is entirely anthropogenic. Humans have altered the biosphere to support over 8 billion people and billions of farmed animals (like cattle). The massive flux of carbon dioxide from human respiration, combined with the immense methane flux from livestock digestion and manure, is a direct consequence of human agricultural systems.

5. **Telecommunication Flux necessary for a Model City**

For a Model city included in a Model District, Telecommunication energy and public works must be included in anthropogenic flux calculations because they represent massive, hidden drivers of modern human resource consumption and environmental alteration. Leaving them out creates a massive blind spot, as both sectors require immense energy budgets and directly alter the Earth's physical landscape.[88]

5.1. Telecommunication Energy: The Invisible Influx

While digital actions feel weightless, the infrastructure powering them requires a massive, continuous flux of electricity and generates significant waste heat. [32][87]

- Data Center Proliferation: Cloud computing, AI processing, and streaming rely on massive data centers globally. These facilities consume immense amounts of electricity, converting it directly into anthropogenic heat flux (AHF) that warms the local atmosphere.
- Network Infrastructure: Billions of cellular towers, routing stations, and fiber-optic networks must remain powered 24/7. Turning on and maintaining this connectivity contributes up to 15% of global carbon emissions indirectly across industries, making its tracking vital for accurate carbon accounting.
- Device Lifecycle: The manufacturing, constant charging, and rapid disposal (e-waste) of billions of smartphones and smart devices represent a major human-engineered material flow.

6. Public Works: The Physical Infrastructure Flux

Public works—including water treatment, waste management, road building, and civil engineering—represent the literal "metabolism" of a city. They dictate how resources enter an area and how waste is ejected.[66][72][73]

- Embodied Carbon in Concrete & Asphalt: Constructing roads, bridges, and public buildings relies heavily on concrete and steel. Cement production alone is responsible for roughly 8% of global anthropogenic CO_2emissions due to the chemical processes and extreme heat required.[80]
- Water and Wastewater Treatment: Moving and purifying billions of gallons of clean water, alongside running massive wastewater treatment plants, requires intensive electrical energy. Furthermore, sewage treatment processes directly release methane $CH_4$and nitrous oxide N_2O into the air during organic decomposition
- Municipal Waste Management**:** Public works departments manage landfills. The collection, transport, and decomposition of city trash generate a massive, localized flux of methane gas

  [76][78][74][75]

- **7. The Big Picture**

By breaking anthropogenic flux down into these specific categories {(vehicles, electricity, gas, metabolism), along with Flux from Telecomm infrastructure and services and Public Works}, scientists can pinpoint exactly which human systems are overloading the planet's natural recycling capabilities.[32]

III. Parameters satisfied by the Selected Model city in the Model district

A **model city[49][6]** is an urban center intentionally designed or developed to serve as an ideal standard. It acts as a prototype for modern living, demonstrating cutting-edge solutions in sustainability, technology, and quality of life with the goal of inspiring and guiding the development of other cities worldwide. Model cities are typically structured around the following core characteristics: (i)Environmental Sustainability (ii) Smart Technology (iii) Walkability & Transit (iv) Mixed-Use Zoning(v) High Quality of Life.

Compare specific examples of model/smart cities (like Songdo in South Korea, Masdar in the UAE, or the 20-minute neighborhood plan in Melbourne).

This model city , has rapidly transitioned from a heavy industrial hub into a self-sustaining metropolitan smart city. Selected under India's National Smart Cities Mission,exhibits a unique blend of modern tech-driven infrastructure and traditional natural elements.[52][47] This city has the following charachteristics that makes it an ideal Model city.

(i)Smart City & Digital Infrastructure (ii) Multi-Modal Transport & High Connectivity (iii) "City of Lakes" & Environmental Focus (iv) Transition to Mixed-Use & Mall Culture (v) Community-Centric & Inclusive Urban Spaces[50][42][43][44]

Evaluation as a model city requires balancing its rapid advancements under the National Smart Cities Mission with the real-world infrastructure challenges its citizens face daily. [54] In this paper, we have considered a model city after going through the List of Smart cities that have been selected under Smart City Mission for the country, India. On an objective scale, this city would score a **7.5 out of 10** as a model city, according to **Economic Survey.[51]** The strong points that gives the city a high ranking are (i) National Recognition (ii) Massive Transit Integration (iii) Nature-Urban Balance (iv) Self-Sustaining Mixed Zoning.[48]

The integration of neighbouring cities alongside creates a powerful blueprint for a model district, scoring an impressive **8.0 out of 10** on a regional scale.[54]

Instead of functioning as isolated towns, these neighboring municipalities act as a interconnected urban cluster. They pool complementary strengths—ranging from massive industrial manufacturing to affordable housing—to form a self-sustaining regional ecosystem.[46]

The district cities collectively makes the case for a model district. (i) The Regional Specialization Architecture (ii) Multi-Tier Housing and Living Standards (iii) Mass Regional Connectivity.[53]

IV. The Greenhouse effect and Global Warming

1. The Greenhouse effect

- The greenhouse effect[5] is a natural, life-sustaining process where atmospheric gases trap the Sun's heat. Global warming is the unnatural acceleration of this process, driven by human activities like burning fossil fuels and deforestation, which drastically increases these gas levels and causes Earth's average temperatures to rise.
- Fossil fuels – coal, oil and gas – are by far the largest contributor to global climate change, accounting for around 68 per cent of global greenhouse gas emissions and nearly 90 per cent of all carbon dioxide emissions. Carbon emitted from greenhouse gases accounts for 95% is the main culprit for increasing global Mean Temperature.[11][82][4][6]
- As greenhouse gas emissions blanket the Earth, they trap the sun's heat. Because of this, the planet is warming up and the climate is changing. The world is now warming faster than at any point in recorded history. Warmer temperatures over time are changing weather patterns and disrupting the usual balance of nature. This poses many risks to human beings and all other forms of life on Earth. This would cause irreversible damage on earth's natural geography leading to food and water scarcity and extreme weather conditions. Global Warming had a rate of $0.87℃/decade$ (1850-90) and $0.91℃/decade$ (2006-2015). This rate would breach the $2℃$ threshold by 2040. International community recognises Global Warming as an impending catastrophe that causes irreversible damage to environment and threaten life on earth. [11][4][6][86]
- The Sun's energy passes through Earth's atmosphere and warms the surface. The Earth absorbs this energy and radiates it back outward as thermal heat (infrared radiation). Atmospheric Greenhouse Gases (GHGs)—like water vapor, carbon dioxide $CO_2$and methane (CH_4)—act like a blanket. They absorb this escaping heat and re-radiate it in all directions, keeping the planet roughly 33℃ warmer than it would be without an atmosphere.[87]

2. What Causes Global Warming?

While the greenhouse effect is entirely natural, human activities are supercharging it, creating what is known as the enhanced greenhouse effect.[82]

- Burning Fossil Fuels: Power plants, vehicles, and factories emit immense amounts of CO_2through coal, oil, and gas combustion.
- Deforestation: Cutting down trees diminishes the planet's natural ability to absorb and remove $CO_2$from the air.
- Agriculture & Livestock: Intensive farming practices and livestock release large amounts of methane and nitrous oxide.

3. Key Differences at a Glance:

Greenhouse effect is a natural planetary function [1].It regulates temperature and makes Earth habitable. Natural water vapor and trace gases are the primary driver of the Greenhouse effect. Global Warming is an unnatural, man-made enhancement. It causes destructive climate imbalances. Excess CO_2, methane, and human emissions are the primary drivers of Global Warming effect.[87][10][85]

4. Why It Matters

When too much heat gets trapped, it disrupts the Earth's delicate climate system. Consequences include melting polar ice, rising sea levels, and a drastic increase in extreme weather events like heatwaves, droughts, and floods.[86]

Sunlight is the fundamental energy source that heats our planet, but it does not cause the *increase* in global temperatures.

Here is the vital scientific distinction between heating the Earth and warming the Earth:

4.4.1. The Sun sets the Base Temperature [90] [96]

- Sunlight works like engine continuously pours energy into the Earth system. Without an atmosphere, that energy would bounce right back into space, leaving Earth at a freezing -18 ℃(0°F). The natural greenhouse effect keeps the planet at a comfortable baseline of average 15℃ (59 °F) .

4.4.2. Greenhouse Gases Cause the Extra Warming[85][87][10]

- The Blanket: Sunlight passes straight through greenhouse gases to heat the Earth's surface.
- The Trap: The heated surface radiates that energy back out as infrared heat.
- The Multiplier: Greenhouse gases block this outgoing heat, trapping it in the atmosphere.
- The Modern Issue: Adding more human-made greenhouse gases is like adding a thicker blanket. The Sun's energy output remains the same, but less heat can escape.

4.4.3. How We Know the Sun Isn't Causing Modern Warming

- Layer Cooling: If increased sunlight were driving global warming, the entire atmosphere would heat up. Instead, data shows the lower atmosphere (troposphere) is warming, while the upper atmosphere (stratosphere) is cooling because heat is trapped below. [8] [7] [45] [9][96][31]

Night vs. Day: Earth's nights are warming faster than its days. If the Sun were driving the warming, days would heat up faster.

4.4 Anthropogenic activity

Anthropogenic activity (human actions) is responsible for over 100% of the observed global warming since the mid-19th century. Human-driven greenhouse gases are the primary cause of this warming, while changes in solar flux have played a negligible role. [28] [1]Human lifestyle also adds a small amount to the global warming by exchanging physiological heat to the surroundings.

The breakdown of how these factors influence global climate is clear:

4.4.1. Anthropogenic Activity & Greenhouse Gases (>100% of warming)

- The Role of Humans: Human activities (like burning fossil fuels, deforestation, and agriculture) are estimated to have caused between 95% and 134 % of the observed warming. [4][1]
- The Role of Greenhouse Gases: Greenhouse gases (GHGs) such as Carbon Dioxide (CO_2), Methane (CH_4), and Nitrous Oxide (N_2O) trap heat that would otherwise escape into space,

  as Carbon Dioxide (CO_2) alone accounts for the vast majority (roughly 64 %) of this human- induced warming effect. [7][45][10]
- Why >100%? Human activities drive all of the current warming. This exceeds 100% because natural factors like solar cycles would have otherwise induced a slight cooling effect over the past 50 years, slightly offsetting the warming humans have caused. [6][1]

4.5 . Solar Flux (Negligible impact on modern warming)

- Solar Variations: Solar flux—or the amount of energy emitted by the sun—does change over time, but only by a tiny fraction of a percent (e.g., about 0.1% over an 11-year sunspot cycle). [90]
- The Data: Satellite measurements tracking the sun's energy since 1978 show no net increase in the sun's output. Solar variations and volcanic activity combined are estimated to have contributed less than $\pm1\%$ to total warming since 1850, rendering it statistically insignificant in modern temperature trends. [90][13]

V. Human Metabolism

5.1 [Work,Energy, Power]

- The human body converts energy stored in food into work, thermal energy, and/or chemical energy that is stored in fatty tissue.[25]
- The *rate* at which the body uses food energy to sustain life and to do different activities is called the metabolic rate, and the corresponding rate when at rest is called the basal metabolic rate (BMR)[25]
- The energy included in the basal metabolic rate is divided among various systems in the body, with the largest fraction going to the liver and spleen, and the brain coming next.[25]
- About 75% of food calories are used to sustain basic body functions included in the basal metabolic rate.[25]
- The energy consumption of people during various activities can be determined by measuring their oxygen use, because the digestive process is basically one of oxidizing food. [25]

- All bodily functions, from thinking to lifting weights, require energy. The many small muscle actions accompanying all quiet activity, from sleeping to head scratching, ultimately become thermal energy, as do less visible muscle actions by the heart, lungs, and digestive tract. [25]

- **5.2 Energy Conversion in Humans**

Our own bodies, like all living organisms, are energy conversion machines. Conservation of energy implies that the chemical e nergy stored in food is converted into work, thermal energy, and/or stored as chemical energy in fatty tissue. The fraction going into each form depends both on how much we eat and on our level of physical activity. If we eat more than is needed to do work and stay warm, the remainder goes into body fat.[25]

- 5.3 Power of Doing Useful Work
- Work done by a person is sometimes called *useful work*,[25]which is *work done on the outside world*, such as lifting weights. Useful work requires a force exerted through a distance on the outside world, and so it excludes internal work, such as that done by the heart when pumping blood. Useful work does include that done in climbing stairs or accelerating to a full run, because these are accomplished by exerting forces on the outside world. Forces exerted by the body are nonconservative, so that they can change the mechanical energy (KE + PE) of the system worked upon, and this is often the goal. A baseball player throwing a ball, for example, increases both the ball’s kinetic and potential energy.
- If a person needs more energy than they consume, such as when doing vigorous work, the body must draw upon the chemical energy stored in fat. So exercise can be helpful in losing fat.[25]
- Energy consumption is directly proportional to oxygen consumption because the digestive process is basically one of oxidizing food. We can measure the energy people use during various activities by measuring their oxygen use. Approximately 20 kJ of energy are produced for each liter of oxygen consumed, independent of the type of food.[25]

5.4 Exercise, weight loss, Resting Energy

Regular exercise increases the amount of energy you burn while you are exercising. But it also boosts your resting energy expenditure — the rate at which you burn calories when the workout is over and you are resting. Resting energy expenditure remains elevated as long as you exercise at least three days a week on a regular basis.[98]

Because resting energy expenditure accounts for 60% to 75% of the calories you burn each day, any increase in resting energy expenditure is extremely important to your weight-loss effort. The kinds of vigorous activity that can stimulate your metabolism include walking briskly for two miles or riding a bike uphill. Even small, incremental amounts of energy expenditure, like standing up instead of sitting down, can add up..[98]

But because exercise raises resting energy expenditure, people continue to burn calories at a relatively high rate.[98]

5.5 Thinking burn calories

A good-sized chunk—roughly 8% to 15%—goes toward digesting the stuff you swallow, while a much larger portion is required to power your organs and keep you alive and functioning. And no part of you demands more energy than your brain.[22]

Energy travels to the brain via blood vessels in the form of glucose, which is transported across the blood-brain barrier and used to produce adenosine triphosphate (ATP), the main currency of chemical energy within cells. [23]

In 2012, British neuroscientist David Attwell and colleagues measured oxygen consumption in slices of rat brains.

They determined that while 25 percent of energy needs are used for housekeeping activities, like maintenance of cell walls, the bulk 75 percent is used for information processing, such as computing and transmitting neural signals.[23]

We can’t measure brain energy consumption in humans in this way, but we can follow the oxygen, as increased brain activity requires more oxygen.

So, in a nutshell, research tells us mental activity is indeed related to increased energy consumption. Still, the increase is minimal, region-specific and often offset by energy decreases in other areas.[23]

This makes sense, however, given that our brain is always on and therefore always has energy needs. Even in moments, we might casually consider idle-mind states, we still process vast amounts of information.

First, there is the ever-present sensory input: we typically don’t spend our day in a dark floatation tank.[23]

Second, our mental activity, even in a seemingly task-less state, will bounce from us reminiscing about past events and planning our future.

Last, there are our emotions, which, even when subtle (such as feelings of serenity or uncertainty), are the products of brain activity and therefore come with an ongoing energy cost.[23]

In most cases, short periods of additional mental effort require a little more brainpower than usual, but not much more. Brainpower[30]

Although the average adult human brain weighs about 1.4 kilograms weight, it demands 20 percent of our resting metabolic rate (RMR)—the total amount of energy our bodies expend in one very lazy day of no activity. RMR varies from person to person depending on age, gender, size and health. If we assume an average resting metabolic rate of 1,300 calories, then the brain consumes 260 of those calories just to keep things in order.[30] That's 10.8 calories every hour or 0.18 calories each minute. (For comparison's sake, see). [98][99]With a little math, we can convert that number into a measure of power:[30]

—Resting metabolic rate: 1300 kilocalories, or kcal, the kind used in nutrition
—1,300 kcal over 24 hours = 54.16 kcal per hour = 15.04 gram calories per second
—15.04 gram calories/sec = 62.93 joules/sec = about 63 watts
—20 percent of 63 watts = 12.6 watts

Energy travels to the brain via blood vessels in the form of glucose, which is transported across the blood-brain barrier and used to produce adenosine triphosphate (ATP), the main currency of chemical energy within cells [30]

While the brain represents just 2% of a person's total body weight, it accounts for 20% of the body's energy use, Raichle's research has found.[22]

That means during a typical day, a person uses about 320 calories just to think.[22]

Raichle says you're out of luck. While the brain burns a lot of energy, any changes in brain activity and energy use during a tough mental task are minute: "maybe a 5% change against the backdrop of all brain activity," he says.[22]

The bulk of your brain's energy consumption is put toward sustaining your alertness, monitoring your environment for important information, and managing other "intrinsic" activities.[22]

McNay agrees that our brains don't expend a whole lot more energy during tough tasks than during simple ones. A person doing cognitively challenging work for eight hours would burn about 100 more calories than a person watching TV or daydreaming for the same amount of time, he estimates. "If you were doing something really demanding that uses multiple senses—something like learning to play an instrument—that might get as high as **200 [calories**]," he says. "But we're talking eight hours of learning a new instrument."[22],

A study suggests that even mildly stressful intellectual challenges change our emotional states and behaviors, even if they do not profoundly alter brain metabolism.[30] Students who exercised their brains helped themselves to around 200 more calories than students who relaxed.[30]

Global Warming has a huge impact on human health, functions and activities that impact the human-centred design and operatives of economy, industry and society. Labourers, farmers, outdoor sports, military personnels are affected the most because of their outdoor work.[12]

5.6 Thermoregulation and Global Warming

There is general agreement that performing physical work in hot environment would shift the mix of metabolic fuel to lower fat and higher carbohydrate utilization.[38][89] Metabolic heat production is more than 10 fold during inore intense physical exertion overwhelms heat dissipation mechanism and promote heat storage in body. Thermoregulatory system exhibits some degree of thermoplasticity that is capable of semi-permanent adaptation to heat through the process of heat acclimitization. The ability to sense, respond and adapt to external environment threats is one of the key attributes that supported the evolution of life.[89] The innate property of a limited extent of thermoplasticity forms the underlying physiological functions that allow humans to explore live, socialize and labour under extremes of environmental temperatures. Although primitive, the thermoregulatory system continues to play vital roles in supporting human life and daily functions in present time.

5.7 How the Caloric Energy Enters the Environment

- Metabolic Heat: The body burns calories to stay alive and move.[89]

The body converts the energy (measured in calories/kilocalories) from food through metabolism. This energy is then transferred into the surrounding environment in four primary ways: [89]

- Radiation: The body emits infrared thermal radiation—just like an incandescent light bulb. This processed energy continuously radiates outward from your skin
- Conduction & Convection: Heat transfers directly from your skin to the cooler air surrounding you, which then moves away. : Body heat directly warms the air and objects you touch.
- Evaporation: Your body releases moisture (sweat), and as it turns from liquid to vapor, it absorbs heat and carries it away from the body into the air. Sweating transfers body heat into water vapor, warming the air when it condenses.

- Exhalation: You breathe out warm air and warm water vapor into the room.

5.8 Does it Heat or Cool the Environment?

Because a person's core body temperature is typically around 98.6 °F (37°C) they are warmer than the standard ambient temperature.[89] Therefore, a person always acts as a

heat source, heating the environment around them.

The Impact on Your Surroundings

- Net Warming: A living person acts like a small space heater.
- The Heating Effect: An average resting human generates roughly 100 watts of thermal power—about the same as a standard incandescent light bulb.[38] When exercising or doing heavy physical labor, this output can easily jump to 300 to 400 watts. This raises the ambient temperature of confined or crowded spaces.
- The Cooling Effect (Local): While humans heat their immediate surroundings, the evaporative process (sweating) actually consumes thermal energy. The conversion of sweat to water vapor extracts heat from the skin's surface, cooling the *human* down while adding humidity and and warm vapor to the environment. [12] [89]

5.9 Formula for a proper Thermal Balance.[12][89][38]

For a proper thermal balance, heat exchanged between the skin and environment through conduction, convection and radiation is bidirectional and down the Temperature- gradient with the above means of heat exchange. But heat transfer from skin to environment is unidirectional . Metabolic heat production adds heat to the body.[38] The eqn.

Heat storage = $+M \pm Ra \pm Cv \pm Cd - E$ (1)

M = Metabolic heat production

Ra = Radiative heat exchange

Cv = Conductive heat exchange

Cd = Convective heat exchange

E = Evaporative heat exchange

A person's calories enter the environment primarily as heat, which warms the surroundings.

Multiple people in an enclosed space will rapidly raise the room temperature.

5.10 Various Formulaes for Urban Modeling of Anthropogenic Flux

In regional climate and urban modeling, the total heat released by human activities into the atmosphere is called the Anthropogenic Heat Flux (Q_F).

When isolating the exact heat contribution of a biological population using population statistics, the foundational equation breaks down calories consumed into watts of regional heat flux per unit area **(**Watts/m^2**).**

5.10.1 The Regional Human Metabolic Heat Flux Formula

To find the specific metabolic heat flux (Q_M) added by a population over a regional area, climate models use the following formula: [29]

Where: $Q_M = \frac{P.C.4184}{A.86400}$ (2)

- Q_M = Human metabolic heat flux (Watts/m^2)
- P = Total regional population (from population statistics).
- C = Average daily per-capita caloric intake (dietary calories or kcal/day per person).
- A = Total regional land area (m^2).
- 4184 = The conversion factor from dietary calories (kcal) to Joules (J).

- 86400 = The number of seconds in a day (converts Joules per day to Joules per second, which equals **Watts**).

5.10.2 Alternative Formula Using Population Density[29]

If you already know the regional population density (D, measured in people/m^2), the formula simplifies directly to:

Q_M = D.C. 0.0484 (3)

(Note: 0.0484 is the rounded constant resulting from ($\frac{4184}{86400}$)

5.10.3 **The Broader Context:** Total Regional Heat Flux (QF) [32][[34] [32]

In actual regional climate calculations, human metabolism is just one component. The total anthropogenic heat flux (QF) is calculated as the sum of three major human-driven sources: [32][34][14], and are described in short in Table 1.

$Q_F = Q_M + Q_V + Q_B$ (4)

Table-1: . The total anthropogenic heat flux (QF) is calculated as the sum of three major human-driven sources: Q_M, (Human Metabolic Flux), Q_V (vehicular Flux) and Q_B (Building Flux) in broader context. [32]

Term	**Source Component**	**Definition**
Q_M	**Metabolic Heat**	Heat directly radiated from human bodies (calculated using the calorie formula above).
Q_V	**Vehicular Heat**	Heat exhausted by transportation, fossil fuel combustion, and traffic.
Q_B	**Building/Industrial Heat**	Heat leaked from air conditioning units, electricity use, and manufacturing.

While Q_V and Q_B generally dominate dense urban areas, Q_M becomes highly significant in exceptionally crowded environments like public transit hubs, sports stadiums, or heavily congested pedestrian zones.

This involves tracking physical fuel combustion and electrical energy consumption across a specific regional area (A).

5.10.4 Calculating vehicular heat flux[14][29][34] [32]

Vehicular heat flux accounts for all the thermal energy wasted by internal combustion engines (gasoline/diesel) and electric vehicles

$$Q_V = \frac{\sum N_i.L_i.EF_i}{A.t} \tag{5}$$

$$N_i = \ number\ of\ vehicles\ of\ a\ specific\ class.$$

$$L_i = \ average\ distance\ traveling\ by\ vehicle\ class\ i\ within\ a\ region.$$

$EF_i =$ energy emission factors/m

A = Total regional Area

T = Time period (usually 86,400 sec for a day).

$$EF_i = \frac{Net\ Heat\ of\ combustion\left(\frac{J}{Kg}\right) x\ Fuel\ Density\left(\frac{Kg}{L}\right)}{Fuel\ Economy\left(\frac{m}{L}\right)} \tag{6}$$

5.10.5 Calculating Building Heat Flux (Q_B) [34][32] [29]

Building Heat Flux encompasses all energy used for HVAC systems, water heating, appliances and lightning. Ultimately 100% of electricity and gas consumed inside a building degrades into heat that leaks into the external environment.

$$Q_B = \frac{E_{elec} + E_{gas}}{A.t} \tag{7}$$

$$E_{elec} = Total\ electricity\ required\ consumption\ over\ a\ period\ of\ time(Joules)$$

$$E_{gas} = Total\ regional\ natural\ gas\ or\ heating\ oil\ burned.$$

A = Total regional Area.(m^2)

T = Time in seconds

5.10.6 Building Heat during summer [34][32] [29]

$$Q_{HVAC\ Heat\ dump} = electric\ energy\ used\ x\ (1 + \frac{1}{COP}) \tag{8}$$

AC unit absorbs heat from intense and dumps it outside alongside the mechanical heat of compressor, it's true environment dump uses equivalent COP.

5.10.7 Combining All The Vectors Into One Model

We will layer metabolic calories Q_M, vehicles Q_V,, and buildings Q_B, together, a typical high-density city energy balance will reveal the thermal landscape.[29] In this paper, we have considered a model city and the adjoining Model District areas, which is High -Tech and totally inter-connected, we have also made an attempt to calculate Telecommunication Flux density Q_T, also along with Public Works Department Q_{PW},, which also has to be tip-toed along with the regular Developmental and Maintenance work of PWD, going on in the Model District.

VI. Key Mathematical Mechanics for Solar Flux: [45][7a] [3] [7b]

6.1 Brunt-Väisälä Frequency

Solar flux acts as the primary energy driver (forcing mechanism) that generates the fluid conditions modeled by the Brunt-Väisälä Frequency and Taylor-Goldstein equations. **: [13][7] [3] [45]** Solar radiation creates the temperature layers and buoyancy frequencies that make acoustic-gravity waves possible

Solar Flux Drives the Brunt-Väisälä Frequency N^2. The transverse atmospheric gravity waves mentioned earlier depend entirely on the stability of the atmosphere, quantified by the Brunt-Väisälä frequency squared:

$$N^2 = \frac{g}{\theta}\frac{\partial\theta}{\partial z} \quad (9)$$

The potential temperature gradient $\frac{\partial\theta}{\partial z}$ is established because solar flux differentially heats the Earth's surface and atmosphere. For example, solar UV flux is absorbed by the ozone layer, heating the stratosphere from above and creating a highly stable layer where $N^2$is large. This stability allows transverse gravity waves to oscillate.

6.2 The Taylor-Goldstein equation

The Taylor-Goldstein equation relies heavily on horizontal wind velocity U and wind shear U''. Global wind profiles are driven entirely by unequal solar flux absorption between the equator and the poles.[9] This differential solar heating creates the pressure gradients that generate the jet streams and wind shears that input into the Taylor-Goldstein equation.

$$\frac{\partial^2\hat{\omega}}{\partial z^2} + [\frac{N^2}{(U-c)^2} - \frac{1}{(U-c)}\frac{d^2U}{dz^2} - k^2]\hat{\omega} = 0 \quad (10)$$

Mode Conversion[8][96]

Solar Flux Powers Ionospheric Mode Conversion. **T**he plasma wave conversion in the upper atmosphere require a high concentration of free electrons and ions. Extreme Ultraviolet (EUV) and X-ray solar flux ionize the upper atmosphere, creating the ionosphere. Without this solar flux, there would be no plasma medium to convert longitudinal mechanical waves into transverse electromagnetic radio waves.

6.3 Atmospheric Thermodynamic Energy equation

To bridge the gap between solar radiation and atmospheric fluid mechan ics, scientists insert a solar radiative heating term Q_{solar} directly into the Atmospheric Thermodynamic Energy equation where:

$$\frac{\partial T}{\partial z} + u.\nabla T + \frac{RB}{c_P} w = \frac{Q_{solar}}{\rho c_P} \quad (11)$$

Q_{solar} = The solar flux absorbed per unit volume (calculated using the Beer-Lambert Law mentioned earlier). ρ, c_P = Air density and specific heat capacity. u, w = Fluid velocity vectors.

6.4 Poynting vector

The Poynting vector ($\vec{S} = \vec{E} \ x\ \vec{H}$) describes the directional power flux density of an electromagnetic wave.[8a][8b] For solar flux incident on Earth, its time-averaged magnitude $< S >$ represents solar irradiance (measured in W/m^2.At the Top of the Atmosphere (TOA**)**, $< S >$ equals the Solar Constant **(**1361 W/m^2).As this energy moves downward, atmospheric layers filter out specific wavelengths through absorption and scattering, systematically reducing the Poynting vector's magnitude. As solar radiation propagates downward,

Poynting's theorem dictates that the decrease in field energy ($\nabla.S$) is converted into thermal or chemical energy within each layer. *The Table 2 below gives specific details of the various atmospheric layers with their Elevation range, Core spectral interactions along with the Poynting Flux range.[52]*

*Table-2: The Table gives specific details of the various atmospheric layers with their Elevation range, Core spectral interactions along with the Poynting Flux range. [10] *Values assume solar rays are perpendicular to the surface (Air Mass 0 to Air Mass 1 conditions).*

Atmospheric Layer[11]	Elevation Range	Core Spectral Interactions	Remaining Poynting Flux Range (<S>)

Thermosphere & Exosphere	Above 85 km	Extreme UV (EUV) & X-rays cleanly ionize sparse gases O_2 ,N_2	~ 1361 W/m^2 (Loses < 1 % total energy, but highly energetic wavelengths)
Mesosphere	50 km – 85 km	Minor UV absorption; mostly transparent to visible spectra.	~1350 W/m^2
Stratosphere	12 km – 50 km	Intense UV-B andUV-C absorption via the ozone-oxygen cycle.	~1300 W/m^2 (Loses ~3 – 5% of total solar power)
Troposphere	Surface – 12 km	Heavy scattering by clouds/aerosols; near-IR absorption by water vapor (H_2O) and CO_2 .	~ 1000 W/m^2 (Clear sky global maximum at noon)

1. **6.5 Attenuation** due to Beer-Lambert Law[81]calculates how much solar flux enters a layer of air. That absorbed solar energy changes the local temperature T . That temperature change alters the buoyancy and sound speed C_s, which finally dictates how Acoustic-Gravity Waves propagate and convert.[94][2]

According to Beer-Lambert Law, The Poynting vector magnitude decays exponentially as it penetrates downward through the varying density profile of the atmosphere:[91]

$$(< S > = < S_{TOA} > \; e^{-\tau(z)} \tag{12}$$

Where $\tau(z)$ is the optical depth of the atmospheric column down to altitude , combining Rayleigh scattering, Mie scattering, and molecular absorption cross-sections.

6.6 Local Energy Dissipation

According to Poynting's Theorem, [52]the power lost per unit volume (W_{loss}) from the electromagnetic wave inside an atmospheric layer is equal to the negative divergence of the Poynting vector:

$$-\nabla.\vec{S} = \frac{\partial u_{em}}{\partial t} + \vec{J}.\vec{E} \tag{13}$$

In the context of the neutral steady-state atmosphere, $\frac{\partial u_{em}}{\partial t} = 0$, meaning the lost Poynting flux directly translates to work done on atmospheric particles ($\vec{J}.\vec{E}$)warming the layer via molecular rotation, vibration, or ionization. [2]

6.7 Conditions for which Poynting vector drops to zero

The magnitude of the incoming solar Poynting vector at sea level drops exactly to zero when there is no direct or diffuse solar electromagnetic radiation reaching the surface.

This condition occurs under several distinct physical and astronomical scenarios [52]

1. Astronomical Conditions due to total absence of Incident solar light viz., Local Night (True Midnight), Polar Night, Total Solar Eclipse (Totality Path).

2. Extreme Atmospheric Conditions (Infinite Optical Depth)

Mathematically, according to the Beer-Lambert law $(< S > = < S_{TOA} > \; e^{-\tau(z)}$

the Poynting vector reaches zero when the atmospheric optical depth (τ) approaches infinity. In practice, this happens during catastrophic atmospheric blocking events viz., hyper-dense volcanic ash plumes, severe dust storms (Haboobs), nuclear winter / asteroid impact scenarios.

3. Instrumental and Computational Filters[31]

Wavelength-Specific Zeros**:** If you isolate specific spectral bands, the solar flux is zero at sea level even at high noon.

6.7.3.1 Infrared (IR) Frequencies: The Primary Atmospheric Heater

Infrared radiation is responsible for the vast majority of direct atmospheric heating, primarily in the **troposphere** (lower atmosphere). Instead of altering electrons, IR photons match the natural vibrational and rotational frequencies of asymmetric gas molecules.[7][45][10][13]

- Frequencies**:** 3 x10^{11} Hz to 4 x10^{14} Hz (Wavelengths: 700 nm to 1 mm).

- Key Absorbers: Water Vapor , Carbon Dioxide , Methane and Nitrous Oxide
- The Mechanism:
    - For near-ir (solar), incoming near-IR from the Sun is absorbed directly by water vaporin the lower troposphere, contributing to minor daytime warming.
    - For thermal/far-ir (terrestrial), the earth's surface absorbs shortwave sunlight and re-radiates it as longwave thermal ir. Greenhouse gases absorb these specific frequencies, causing the molecules to bend, stretch, and vibrate.
    - For the heat transfer, These energized molecules collide with surrounding Nitrogen and Oxygen molecules, converting the quantum vibrational energy into kinetic energy (sensible heat).

6.7.3.2. Ultraviolet (UV) Frequencies: The Stratospheric Heater.[7][45][10][13]

Ultraviolet radiation transfers heat to the upper atmosphere through **photodissociation**—using high-energy photons to break chemical bonds.

- Frequencies: 7.5 x 10^{14} Hz to 3 x 10^{16} Hz (Wavelengths: 10 nm to 400 nm).
- Key Absorbers: Ozone (O_3) and Molecular Oxygen (O_2).
- The Mechanism (Ozone-Oxygen Cycle):
    - For UV-C (100 to 280 nm): Absorbed by O_2 in the upper stratosphere, breaking it into individual oxygen atoms.
    - UV-B (280 to 350 nm): Absorbed by O_3 in the mid-stratosphere, breaking ozone into O_2 + O .
    - Heat Transfer: The excess energy from these broken chemical bonds is released as kinetic energy when the fragments fly apart and slam into surrounding air molecules. This specific UV absorption is the sole reason temperature *increases* with altitude in the stratosphere.

6.7.3.3. Optical / Visible Frequencies: Indirect Heating. .[7][45][10][13]

The atmosphere is mostly transparent to visible light. Visible light does not directly transfer significant heat to clean air, but it heats the atmosphere indirectly.

- Frequencies: 4 x 10^{14} Hz to 7.5 x 10^{14} Hz (Wavelengths: 400 nm to 700 nm).
- Key Absorbers: Aerosols, dust, soot (black carbon), and cloud droplets.
- The Mechanism:
    - Direct Aerosol Heating: Solid particulates suspended in the air (like wildfire smoke or pollution) physically absorb visible light photons, warm up, and conduct that heat to the surrounding air.
    - The Surface Loop (Main Driver): Visible light passes cleanly through the air to strike Earth's surface. The surface absorbs this optical energy, warms up, and converts it into thermal infrared frequencies, which are then trapped by the atmosphere.

The Heat generation in various atmospheric layers due to Physical action on sunlight in the specific spectral band and the Primary Frequency Range is summarized in Table 3.[31][13]

Table-3: Summary of the Heat generation in various atmospheric layers due to Physical action on sunlight in the specific spectral band and the Primary Frequency Range.[31]

Spectral Band	Primary Frequency Range	Atmospheric Layer Heated	Physical Action
Ultraviolet (UV)	750-30000THz	Stratosphere &Thermosphere	Breaking molecular bonds (Photodissociation)
Visible / Optical	400-750 THz	Troposphere (Indirectly)	Surface absorption and aerosol capture
Infrared (IR)	0.3-400 THz	Troposphere(Lower atmosphere)	Molecular vibration and rotation

6.8 Baseline Solar Flux (Irradiance) at Sea Level

While the total solar irradiance outside the Earth's atmosphere (the solar constant) is roughly 1361W/sq.m, atmospheric absorption and scattering reduce the peak solar flux reaching sea level on a perfectly clear day to approximately 1,000 W/sq.m. . This baseline value serves as the global standard for testing photovoltaic systems. [96]

VII. Calculations of various Anthropogenic Factors

7.1 **Calculation of Vehicular Flux density**

The Table 4 shows Vehicle Fuel given along with Fuel Density (Kg/Litre) and Net Heat of Combustion(Kg/Litre). [27] Table-5 shows various vehicular Entry Timing and the class of Road Motorable for the class of vehicle[35][37] The data concerning various vehicles in the Model City and the adjoining district region and the corresponding Fuels are available in the References [40][41][37][[33][27][15] [17][[18][20][19][[36][35][21][26]

The Table-6 shows the calculation of Vehicular Heat Flux Q_V(W/m^2) using Formula eqn. 5 and eqn. 6 for vehicular Flux [32]. The vehicular Flux comes out to be 3.84632 W/m^2.

Table-4: Vehicle Fuel given along with Fuel Density (Kg/Litre) and Net Heat of Combustion(Kg/Litre)[27] (Note: We havel taken the minimum Fuel density and minimum heat of combustion to calculate Energy Emission Factor E_{F_i} from here in Table -6)

Fuel	Fuel density Kg/Litre	Net Heat of combustion M J/kg
Diesel	0.82-0.845	42.5-43
CNG	0.18-0.2	47-50
Petrol(gasoline)	0.72-0.77	43-44
LPG	0.51-0.54	46.1-46.5

Table-5: Table showing various vehicular Entry Timing and the class of Road Motorable for the class of vehicle[35][37]

Length of Roadways → / Vehicles and their Open Hours ↓	Rural Roads 2493 Km	Major Roads 1850 Km	State Highway 1195 Km	National Highway 226 Km
Passenger car(24 hrs. Entry)	Y	Y	Y	Y
Bus(13 hrs. Entry)	N	Y	Y	Y(13 hrs only)
Two-wheeler(24 hrs. Entry)	Y	Y	Y	Y
Auto-rickshaw(24 hrs. Entry)	Y	Y	Y	N
Truck (13 hrs. Entry)	N	Y	Y	Y
Car (24 hrs. Entry)	Y	Y	Y	Y

*Table-6: Table showing calculation of Vehicular Heat Flux Q_V (W/m^2) using Formula eqn. 5 on vehicular Flux [32]. The data concerning various vehicles and the corresponding Fuel are available on the given sites. [(Note: We have considered the minimum Fuel economy to calculate Energy Emission Factor E_{F_i}) **[40][41][37][[33] [27]**[**15] [17][[18][** 20][19]**[** [36][35][21][26]*

Vehicle Class	N_i Number of vehicles of i[th] Class	L_i Average distance Travelled by vehicle of i[th] class (Km)	Vehicle Fuel	% N_i Percentage of i[th] class vehicle	Fuel Economy (Km/L)for petrol Diesel (Km/Kg) for L.PG.,CNG	Energy emission factor E_{F_i} (MJ/Km) or (KJ/m) {EV units -KWHr/ 100Km}	Vehicular Heat Flux density Q_V W/m^2	TotalHeat Flux density W/m^2
Passenger car	25,000	5,764	Diesel	18	16-20	2.203	0.03347	=3.84632 W/m^2
			CNG(0.5)	78	18-25	0.47		
			Petrol	2	12-16	2.58		
			LPG(1.87)	2	10-12	2.35		
Bus	18,000	3,271	Diesel	60	3.5-5.5	10.074	0.30222	
			CNG(0.5)	38	2.8-4	48.021		
			EV	2	-------	15-22		
Two-wheeler	37,75,942	5,764	Petrol	96.5	45-65	0.688	(1.666)	
			EV	3.5	15-22	0.671		
Auto-rickshaw	289493	5,538	CNG(0.5)	98	25-32	0.338	(0.06467)	
			Petrol	1	22-26	1.407		
			LPG(1.87)	0.5	20-24	1.175		
			EV	0.5	-------	15-22		
Truck	48,000	3,271	Diesel	97	2.5-4.5	13.94	0.45073	
			CNG(0.5)	3	2.5-3.5	3.38		
Car	10,93,982	5,674	Diesel	15	18-24	1.95	1.32923	
			CNG(0.5)	16	20-28	0.42		
			petrol	65	14-20	2.21		
			LPG(1.87)	2	11-14	2.13		
			EV	2	-------	15-22		

7.2 **Calculation of Building Flux density-** (Electricity and Gas Flux density)

For the calculation of Building Flux[32] composed of (Electricity and Gas Flux), we use eqn. 7 below.

Total Annual Electricity Demand ~ 16,500 GWh ~ 16,500 MU~ 1883.56 MW

Total Electric Flux density = $\frac{Electric\ energy\ consumed}{surface\ area\ of\ district} = \frac{1883.56}{4214}$ = 0.4469 W/m^2

Total Annual CNG Gas Demand ~ 73,000 MT

Heat of Combustion of CNG = 47 M J/kg

Fuel Density = 0.18 Kg/L

One Tonne of CNG = 5,555 L

Total Heat Energy of CNG =(Heat of combustion x Fuel Density) x Annual CNG demand

=47x 0.18) x 73000 X (5,555 x 10^6) = 6,17,580 = 3.4306 x 10^{15} MJ/ year = 108.7836MW

Total Annual LPG Gas Demand ~ 20,500 MT

Heat of Combustion of LPG = 46.1 M J/kg

Fuel Density = 0.5 Kg/L

One Tonne of LPG = 1960 L

Total Heat Energy of LPG =(Heat of combustion x Fuel Density) x Annual LPG demand

= (46.1x 0.5) x 20,500 x(1960 x 10^6) = 0.9261x 10^{15} MJ/year = 29.3664 MW

Total Gas Flux density = CNG Heat Energy + LPG Heat Energy—

Total Gas Flux density = $\frac{\text{CNG Heat Energy + LPG Heat Energy}}{surface\ area\ of\ district} = \frac{108.7836M+29.3664M}{4214\ sq.Km}$

Q_G= =0.03278W/m^2

Q_B = QE + QCNG + QLPG)/A.t [35]

Q_B = (16500GWH + 3.4306 x 10^{15} MJ/year + = 0.9261x 10^{15} MJ/year)/4214 sq.Km

Q_B = (1883.56 MW + 1 08.7836 MW + 29.3664 MW)/4214 sq.Km = 2021.71 MW/4214 sq.Km =

=).47968 Watt/m^2 = $Q_E + Q_G$ = 0.4469 Watt/m^2 + 0.03278 Watt/m^2

Total Gas Flux density= 0.03278W/m^2 and Total Electric Flux density = 0.4469 W/m^2

Building Heat Flux density= 0.47968 Watt/m^2

During summers, we use the electric flux formula, eqn.no. 7,

The COP of an air-conditioning system ranges from 3 to 5. We use the value of Total Annual Electricity Demand = 1883.56 MW and surface area of district = 4214 sq.Km

During summer season, as the demand electricity is huge, we use the eqn. 8 for calculating $Q_{HVACheatdump}$ instead of Q_E.

$Q_{HVACheatdump}$ = 1883.56 (1 + $\frac{1}{5}$) =1883.56 x 1.2 = 2260.272 = Total Electric Flux density = $\frac{Electric\ energy\ consumed}{surface\ area\ of\ district}$ = $\frac{2260.272}{4214}$ = 0.5363 W/m^2

7.3 Calculation of Flux density due to Public Works- (Road Building)

Extensive construction of highways has a major impact on the landscape and its structure.[66][32] They can also influence local climate and heat fluxes in the surrounding area. After the removal of vegetation due to highway construction, the amount of solar radiation energy used for plant evapotranspiration (latent heat flux) decreases, bringing about an increase in landscape surface temperature, changing the local climate and increasing surface run-off. Construction of a four-lane highway can influence the heat balance of the landscape surface as far as 90 m in the perpendicular direction from the highway axis, i.e. up to 75 m perpendicular from its edge. During a summer day, the decrease in evapotranspired water can reach up to 43.7 m^3 per highway kilometre. This means a reduced cooling effect, expressed as the decrease in latent heat flux , by an average of 29.7 MWh per day per highway kilometre and its surroundings.[66]

7.3 Calculation of Flux density due to Public Works- **Road-Building works and**

Wastewater & Sewage Treatment Plants and Landfill sites:

7.3.1 Calculation of Flux-density of Heat during Road-Building works:

Total Length of the 4- Lane Roads according to Road Building Projects running presently under PWD = 120.12555 = Km stretch of 4-Lane roads.[35][32]

Total Latent Heat energy Flux due to Road building = 29.7 MWh per day per km of 4-Lane highway.

Therefore Total Latent Heat Energy Flux due to 120.1255 Km road = 29.7 x 120.125 = 3567.7125 MWh

This extra Heat = 3567.7125 is spread over regional Area of 4214 sq.Km

This extra Heat = 0.8466 Wh/Day = 0.03275W/sq.m = **35.275 mW/sq.m**

7.3.2 Wastewater & Sewage Treatment Plants and Landfill sites:

7.3.2.1 Wastewater & Sewage Treatment Plants

District operates dozens of major municipal treatment facilities alongside hundreds of localized private, industrial, and commercial plants. Because the District is vast—spanning multiple municipal corporations, the infrastructure is divided between solid waste and wastewater treatment. The Municipality manages 8 large-scale Sewage Treatment Plants. It operates several major municipal Sewage Treatment Plant facilities. There are over 350+ private, residential, and corporate decentralized STPs.[67][68][71]

The city operates 1 wood waste briquetting plant and 1 flower waste manure plant. The Municipality manages heavy industrial and hazardous chemical waste processing for the region. A massive 1,000-tonne-capacity Waste-to-Energy plant is under development to consolidate municipal solid waste processing. [74][75][67][68][71]

- At 450 kWh per MLD, a plant consumes about 1.62GJ of energy per day per MLD.[72][73]
- Divided over 24 hours, this equals a continuous thermal dissipation of roughly 18.75 kW per MLD.
- For a Mid-Sized Plant (50 MLD): Dissipates approx. 937 kW (~0.93 MW) of continuous low-grade thermal heat into the surrounding air and discharged water.
- For a Large Plant (STP - 120 MLD): Dissipates approx. 2.25 MW of continuous heat.
- Across the District, municipal and private infrastructure processes an estimated 650
- to 750 Million Litres per Day (MLD) of liquid waste and sewage.

Note: Wastewater also holds massive latent thermal energy from domestic use (showers, washing). Most of this heat does not dissipate into the air; it remains trapped in the water molecules and is discharged directly into the creek.[79]

7.3.2.2 Landfill sites

Every single tonne of raw, unsegregated municipal trash generates roughly 21.5 kg of pure methane gas over its decay lifecycle.;[76],[78] Across the district's 3,500 daily tonnes, this translates to a continuous generation flux of ~75,250 kg (75.25 metric tonnes) of pure methane every day, The Potential Heat Generation: Methane has a Lower Heating Value (LHV) of 50 Megajoules per kilogram (MJ/kg).[72]

The Math: 75,250 Kg x 50 MJ/Kg = 37,62,500 MJ

The Continuous Power Equivalence: If this daily methane flux were captured and combusted cleanly for heat or energy (using bio-methanation tech like the Municipal Corporation's upcoming initiatives), it releases a continuous thermal heat output of ~43.55 Megawatts (MW). [72]

For municipal installations like the Sewage Treatment Plant (STP), the mechanical heat from blowers, aeration pumps, and biological oxidation splits heavily toward the water. To the Atmospheric Air (~10% to 15%): Only a minor fraction escapes into the local air. This happens via surface evaporation across active, open-air aeration tanks.[74][75]

During the actual collection, compaction, and active decomposition phase on the ground, the heat generated directly by the micro-organisms is comparatively low but highly localized.[72] The Thermal Blanket Effect: The 75.25 tonnes of methane released daily over the region exerts an atmospheric warming impact equivalent to releasing over 6,400 tonnes of CO_2 every single day into the local airspace, significantly compounding the urban heat island effect. Radiative heat does not refer to combustion, but rather to the solar infrared energy trapped in the local troposphere by the escaped gas. Over a 20-year timescale, methane has a Global Warming Potential (GWP) 86 times higher than CO_2 .[76][78]

7.3.2.3 Solid Waste Treatment & Dumping Ecosystems

For open dumpsites, composting facilities, or future Waste-to-Energy incinerators (like the **thermal plants**), the thermodynamic distribution reverses because there is no massive aquatic discharge pipe.

[69],[70],[71],[77]

- To the Atmospheric Air (~90% to 95%): Solid waste thermal systems dump nearly all of their excess heat directly into the local sky.[79]
    - Anaerobic decomposition by methanogenic bacteria is an exothermic biological reaction, but it is highly inefficient at releasing direct physical heat. It releases roughly 0.75 Megajoules (MJ) of direct thermal energy per kilogram of methane produced.The resulting Total Daily Thermal Energy: 56,437.5 MJ per day. The continuous Power output:comes out to be ~653 Kilowatts (kW)[72]

- The Trapped Thermal Energy: The localized accumulation of this daily flux over the urban corridor shifts the local energy balance, trapping roughly 1.2 to 1.5 Watts of continuous thermal energy per square meter W/sq.m directly over and downwind of the primary waste zones.[72]
- Unlike STPs, a Waste-to-Energy plant must actively reject this massive excess heat via cooling towers (evaporative dissipation into the atmosphere) and through hot flue gas stacks[.72] [74][75][
- This trapped energy prevents the city's asphalt and concrete from cooling down at night. It adds a persistent 0.5°C to 1.5°C micro-climatic spike to the local Urban Heat Island (UHI) effect directly above the district.[80]
- The total physical footprint of major municipal landfill sites and large-scale solid waste processing plants across the District covers roughly 180 to 220 acres (approx. 72 to 89 hectares) of land. 180 acres is exactly equal to 0.7284 square kilometres (sq. km)[69][70].[76][78]

7.3.2.4 Calculation of Flux density due to Public Works-

Wastewater & Sewage Treatment Plants and Landfill sites:

The Table 7 below works out the calculation of flux due to public works for the Wastewater & Sewage teatment plants and landfill sites by classifying and calculating waste sewage broadly as solid and liquid waste. The entry

in the last column, cfor Heat FluxDensity, W/m^2 is obtained by dividing the entry in the previous column, of Total Heat dissipation by the surface area of the region, (4,214 Km^2),to get the value of Heat Flux Density 9.44098

W/m^2.

Table-7: Total Heat Flux density for the Wastewater & Sewage Treatment Plants and Landfill sites: calculated for the Model District region using the most Recent Data [72][73][76][78][79]] (Note: We have considered the minimum % heat absorbed in air and not the upper Limit value for the calculation of Total Heat Dissipation)

Type of waste	Daily Amount of waste collection	Potential Heat Generation	Daily Heat Generation	%Heat absorbed in air	Heat Dissipation	Total Heat dissipation	Heat FluxDensity W/m^2
Liquid waste	650 to 750 MLD/	18.75KW/MLD	12.1875 KW	10% to 15%	1.21875 KW	39.19641 MW+ 0.00121875 MW =39.78429875 MW	9.44098 W/m^2
Solid waste	75,250 Kg	50MJ/Kg	43.55 MW	90% to 95%	39.1952 MW		
Solid waste (Anaerobic decomposition)	75,250 Kg	0.75 MJ	653.2 KW	90% to 95%	587.88 KW		

7.4 Calculation of the Human Metabolic Flux density

7.4.1 Calculation of the Human Metabolic Flux density- BaseLine Energy

(Not to be considered for Heat Flux calculation)))

Energy consumption for the activities like sleeping (83 watts), sitting at rest (120 watts), standing relaxed (125 watts), walking(280 watts), cycling (400 watts), climbing stairs (685 watts) [25]

The Brain's Baseline: The brain accounts for about 20% of the body's resting energy consumption (roughly 260 to 320 calories a day) to maintain vital automatic functions, even when you are doing absolutely nothing.[22]

Here let's use eqn. 2 to calculate Human Metabolic Flux for Baseline energy.

Average calories needed as baseline, as needed in proper nutrition = 1300 Kcal/ Day

1300 Kcal x 0.239 KJ/Day = 310.7 KJ/D

Population of the region = 1.4 crore

Surface Area of Land = 4214 kmsq. [35]

Q_M = Human metabolic heat flux (mind work) (KJ/m^2) = $\frac{1.4 \text{ x } 10^7 \ x \ 310.7}{4214 \ x \ 10^6}$ = 1.0322 KJ/m^2day

Q_{M1} = 11.94 mW/sq.m

This energy will not be considered in the Heat Budget, as this is the minimal energy to keep the baseline just for survival.

7.4.2 Calculation of the Human Metabolic Flux density-(Mind work)

Here let's use eqn. 2 to calculate Human Metabolic Flux for mind work energy.

The Minimal "Thinking" Bump: When you engage in intense mental work (like solving complex equations), the brain's energy usage only increases by about 5% to 10% over its baseline. Doing intellectually challenging work for 8 hours might burn only 100 more calories than simply daydreaming. [22]

A study suggests that even mildly stressful intellectual challenges change our emotional states and behaviors, even if they do not profoundly alter brain metabolism. Students who exercised their brains helped themselves to around 200 more calories than students who relaxed.[30]

Average calories burnt by doing mind work e.g., Thinking and problem solving = 200 Kcal/ Day

200 Kcal x 0.239 KJ/Day = 47.8 KJ/Day

Population of the region = 1.4 crore

Surface Area of Land = 4214 kmsq. [35]

Q_M = Human metabolic heat flux (mind work) (KJ/m^2) = $\frac{1.4 \text{ x } 10^7 \ x \ 47.8}{4214 \ x \ 10^6}$ = 0.158 KJ/m^2day

Q_M = 1.8287 mW/sq.m (Mind Work)

7.4.3 Calculation of the Human Metabolic Flux density-(Physical work)

Massive Muscle Demand: Conversely, large skeletal muscles are far less metabolically efficient than the brain. When you exert your muscles, you are converting metabolic energy into positive mechanical work, which rapidly spikes your oxygen and caloric consumption.

Muscular work demands vastly more energy than intelligent or mind work. While moving your body requires burning thousands of calories to power large muscle groups, intense thinking or mental concentration only increases the brain's base energy usage by a minimal amount. The caloric demand for muscular work (e.g. labour work, running) of >300 calories to 1000 calories per hour (highly dependent on intensity)[100]

RMR varies from person to person depending on age, gender, size and health.[14b] If we assume an average resting metabolic rate of 1,300 calories, then the brain consumes 260 of those calories just to keep things in order. That's 10.8 calories every hour or 0.18 calories each minute. (For comparison's sake. With a little math, we can convert that number into a measure of power[99]

On an average , a person burns 500 calories a day in exercise [22]

Here let's use eqn. 2 to calculate Human Metabolic Flux for doing physical work.

Average calories burnt by an average person by doing physical work = 500 Kcal/ Day

500 Kcal x 0.239 KJ/Day = 119.5 KJ/Day

Population of the region = 1.4 crore

Surface Area of Land = 4214 kmsq. [35]

Q_M = Human metabolic heat flux physical work) (KJ/m^2) = $\frac{1.4 \text{ x } 10^7 \text{ x } 119.5}{4214 \text{ x } 10^6}$ = 0.397 KJ/m^2day

Q_M = 4.594 mW/sq.m (physical work)

Total metabolic Flux density due to physical and mind work will be 4.594 mW + 1.8287 =

6.422 mW/m^2

7.5 Calculation of Flux Density due to Telecomm Infrastructre and Services in the Model District Region

7.5.1 Average number of Macro Cell Towers

There are 15,000 to 20.000 cell towers across the Metropolitan Region, with several thousand physically located within the District to serve its dense residential and commercial areas. [4]

The exact tower count fluctuates as telecom operators continuously upgrade infrastructure and share passive sites.

7.5.2 Average Number of Channels

Rather than "channels," modern telecom networks measure capacity by sectors and concurrent active sessions (bandwidth): [60] [56]

- Standard 4G/5G Tower: Most towers operate with 3 to 6 sectors (directional antennas).

Active Connection

Table-8: Power/Heat Discharged in Watts and BTU by various physical factors for Towers, Distributed Antenna System(DAS) and small cells, Data is available on [60],[56][63][65].

Factor	Power / Heat Discharged
Tower Electronics (Physical Heat)	~3,000 Watts
4G / 5G Signals (RF Waves)	20 to 200 Watts
Peak Traffic Load (Switching/Sectors)	Extra ~300 to 800 Watts
DAS	7,000 BTU to 34,000 BTU
Small cells (physical heat)	100 W to 300 W
Small cells (RF Waves)	5 W to 20 W

Table-9:Table displaying Most Recent Data of the number of 4G/5G Towers, DAS and small cells for the region of the Model District having the Model city.[57][55][64][62][61][63].

4G Tower	5,000
5G Tower	3,500 to 4,000
DAS	1,200 to 2,000
Small cells	15,000 to 25,000

7.5.4 Various Frequency Blocks and Capacity by Sectors

Applying the previous regional baseline of several thousand towers inside District proper, we can model the breakdown based on standard Indian urban network density architectures defined by guidelines.[93] [57][55]

A modern co-located 4G/5G tower in the city utilizes several frequency blocks simultaneously: A single tower location broadcasts across 12 to 20 distinct frequency carrier blocks across different operators. (i)Low-Band (Coverage): 700 MHz, 800 MHz, or 900 MHz (Broad coverage, travels deep into concrete buildings). (ii) Mid-Band (Capacity): 1800 MHz, 2100 MHz, 2300 MHz, and 2500 MHz (Handles heavy day-to-day 4G web traffic). (iii) 5G High/Mid-Band (Speed): 3.3 GHz to 3.6 GHz (C-Band) (The primary driver for massive 5G data speeds) [64] [62] [61]

Capacity by Sectors utilizes(i) Standard Macro Towers: 3 Sectors. (ii) High-Traffic Hubs: 4 to 6 Sectors.(iii) 5G Beamforming. [64]

Total Per Tower: A fully upgraded macro tower in a busy corporate area can sustain 3,000 to 8,000 concurrent active voice and data sessions during evening peak hours.

7.5.5 Small Cells and DAS (The Shadow Network)

Because macro towers cannot easily penetrate dense concrete high-rises or old congested pockets, a massive footprint of smaller nodes is deployed:[63]

Small Cells: Probable count of 15,00 0 to 25,000 units. These low-power base stations are quietly mounted on streetlights, electricity poles, and bus shelters, rises or old congested pockets, a massive footprint of smaller nodes is deployed. A small cell is a compact, self-contained box. It does not have room for loud, heavy air conditioners, so it relies entirely on passive cooling (metal fins that let heat drift away naturally). Because small cells only need to push signals down a street block rather than across a whole neighborhood. A standard 4G/5G outdoor small cell draws between 100 Watts and 300 Watts of electricity. : A small cell typically transmits a total Radiofrequency (RF) power of only 5 Watts to 20 Watts across its antennas.[63]

The Table-8 lists the Power/Heat Discharged in Watts and BTU by various physical factors for Towers, Distributed Antenna System(DAS) and small cells. The Table-9 displays the Most Recent Data of the number of 4G/5G Towers, DAS and small cells for the region of the Model District having the Model city.[63]

7.5.6. A **Distributed Antenna System** (DAS)

A Distributed Antenna System (DAS) breaks down a single large, high-power cell site into a network of dozens of small, low-power antennas spread throughout a building or stadium, the heat it generates is highly fragmented and easily managed.[65]

The individual antennas (called remote units or nodes) mounted on walls or ceilings transmit at very low power levels. A typical indoor DAS antenna transmits between 0.1 Watts to 5 Watts of Radiofrequency (RF) power. For comparison, a household Wi-Fi router transmits around 0.1 to 0.2 Watts, and a smartphone transmits up to 2 Watts.[65] [63]
The real heat from a DAS is concentrated in a single, closed telecom closet or server room called the Headend. This room houses the main base stations, optical master units, and power supplies. Depending on the size of the venue (e.g., a corporate office vs. a massive sports stadium), a central DAS headend consumes between 2 kW and 10 kW of electricity. Nearly all of this energy is converted into 7,000 to 34,000 BTU/hr of physical heat. [65][63]
Because the heat is concentrated inside a building's IT closet rather than being released into the open atmosphere, it requires dedicated climate control: dedicated air conditioning units (CRAC or split AC systems) for the headend room to keep the electronics below 25°C. DAS (Distributed Antenna Systems): Probable count is 1,200 to 2,000 commercial DAS deployments.[65] [63]

7.5.7 . Estimated Number of Wi-Fi Routers: ~1.4 to 1.6 Million

The volume of functional Wi-Fi routers—including home FTTH (Fiber-to-the-Home) setups, commercial office spaces, and portable 4G/5G hotspot routers—is estimated between **1.4 million and 1.6 million units** across the district for the model city considered. [59] [92]

7.5.8 Estimated Number of Smartphones: ~8.8 to 9.2 Million

The overall active smartphone count across the entire Thane district is estimated to sit between 8.8 million and 9.2 million devices. The expanded District has a projected population exceeding 12 million residents. Given that the urban tele-density for the urban conglomerate regularly scales past 130% (accounting for individuals carrying multiple active SIMs or dual-SIM phones)[58] [92]

7.5.9 Formula for the total heat flux Q generated by a group of 4G/5G macro tower[92]

The formula for the total heat flux $Q_{Macro}=$ generated by a group of macro tower for a specific region is:

$$Q_{Macro}=\frac{N\ x\ P}{A} \qquad (14)$$

Where: is the **heat flux** (measured in Watts per square meter, W/m^2

- N is the **total number of towers** in the designated region.
- P is the average **power dissipation per tower** (measured in Watts, (W)
- A is the total **surface area** of the region measured in square meters m^2

7.5.10 Formula for the total heat flux Q generated by a group of small cells node.[92]

The formula for the total heat flux $Q_{small\ cells}$ generated by a group of small cells for a specific region is:

$$Q_{small\ cells}=\frac{N\ x\ P}{A}=\frac{N_{small\ cells} x\ P_{small\ cells}}{A} \qquad (15)$$

Where: is the **heat flux** (measured in Watts per square meter, W/m^2

- $N_{small\ cells}$ is the **total number of small cell low power base stations** in the designated region.
- $P_{small\ cells}$ is the average **power dissipation per base station**(measured in Watts, (W)
- A is the total **surface area** of the region measured in square meters m^2

We can use the above formula eqn. 15 , even for the calculation of heat flux in the case of a distinct no. of smartphone pieces and wi-fi routers.

7.5.11 Formula for the Heat flux Q generated by a group of DAS deployment [92]

The formula for the total heat flux Q generated by a DAS deployment across a specific coverage area is:

$$Q_{DAS}=\frac{P_{headend}+(N_{remote} x\ P_{remote})}{A_{Floor}} \qquad (16)$$

Where: $Q_{DAS}=$ is the heat flux density for a small cell network, (measured in Watts per square meter, W/m^2

To scale the analysis up to a district level, the formula must be modified into an integrated composite formula. Instead of looking at individual nodes, you sum the total thermal power generated by all macro towers, small cells, and DAS networks within that district, and then divide it by the total geographic area of the district.

7.5.12 Formula for the District-level integrated formula for Macro Towers, small cells and DAS: [92]

$$Q_{district}=\frac{\sum P_{Macro}++\sum P_{small\ cells}+\sum_{K} P_{DAS}}{A} \qquad (17)$$

- $Q_{district}$ is the total district-level infrastructure heat flux , W/m^2
- N_{Macro} *and* P_{Macro} are the total count and average power dissipation of **macro towers** in Watts. (W)
- $N_{small\ cells}$ *and* $P_{small\ cells}$ are the total count and average power dissipation of **small cells** in Watts. (W)
- N_{DAS} *and* P_{DAS} are the total count and average power dissipation of **DAS** in Watts. (W)
- the central and remote equipment counts for each specific DAS installation i.
- N_{remote} *and* $N_{headend}$ represent the remote and central equipment counts for each specific DAS installation in K buildings.
- A is the total geographic **surface area** of the region where Macro and small cell equipments and DAS are measured in square meters (m^2)

7.5.13 Calculation for the Flux due to Telecommunication Facilities

Table 10 shows the Total Power dissipation in MW calculated using the eqn. 15, eqn. 16, for DAS and small cell elements Wi-Fi routers and smartphones. Table 11 shows the Total Power dissipation in MW calculated using the eqn. 14, for 4G/5G Towers considering various mechanisms for dissipation elements.

We use eqn. 14, eqn. 15, eqn. 16 and eqn. 17 to sum the fluxes due to Macro-Towers, small cells, DAS , smartphone pieces and wi-fi routers. The Fluxes have been worked out in the Table no.10 and 11.

So total power dissipation resulting in heating of atmosphere in the region is

$Q_T =$ 62.70732 MW + 30.9 MW = 93.60732 MW

Total surface area of the region = 4214 sq.Km.

Heat Flux due to telecommunication facilities is total power dissipation/ Total surface area

$Q_T = \frac{93.60732 MW}{4214\ sq.Km}$ = **22.2134124 mW/sq.m**

Table-10: Total Power dissipation in MW calculated using the eqn. 15, eqn. 16, for DAS and small cell elements Wi-Fi routers and smartphones.Most Recent data is available in [63][65][58][59] (Note: We have considered the minimum no. of cells and min. power dissipation ,for both DAS and small cells, smartphone pieces & wi-fi routers and not the upper Limit value for the calculation of Total Power Dissipation)

Cell Type	Power dissipation	Minimum Power dissipation	Number of cells	Minimum number of cells	Power dissipation	Total Power dissipation (MW)
DAS (RF)	0.1 W to 5 W	0.1 W	1,200-2,000	1,200	{[(0.1W + 5W) + (7,000x0.293)]} =2056.1 W x 1200 } =2.46732MW per DAS Deployment	2.46732M (DAS) + 42.5 M (small cells) = 44.96732M
DAS (housing)	5 W to 20 W	5 W	1,200-2,000	1,200		
DAS (headend room)	7,000 BTU to 34,000 BTU	7,000 BTU x (0.293)	1,200-2,000	1,200		
Small cells-4G (box)	100 W	100 W	15,000-25,000	10,000	10,00,000	
Small cells-5G (box)	300 W	300 W	15,000-25,000	10,000	30,00,000	
Small cells-4G- RF	5 W	5 W	15,000-25,000	10,000	50,000	
Small cells-5G-RF	20 W	20 W	15,000-25,000	10,000	2,00,000	
Wi-fi routers	0.1 W to 0.2 W	0.1 W	1.4 million to 1.6 million	1.4 million	1,40,000	0.14 M(wi-fi) + 17.6 M(smartphone) = 17.74M =62.70732 MW
Smartphone pieces	2 W	2 W	8.8 million to 9.2 million	8.8 million	1,76,00,000	
Total Power dissipation for DAS and 4G/5G cells						62.70732 MW

..

Table-11: Total Power dissipation in MW calculated using the eqn. 14, for 4G/5G Towers considering various mechanisms for dissipation elements. Most Recent Data is available in [57][55][61][63][64].] (Note: We have considered the minimum no. of cell Towers and min. power dissipation and not the upper Limit value for the calculation of Total Power Dissipation)

Different Tower Mechanisms	Minimum Power dissipation	Number of cells	Power Dissipation	Total Power Dissipation MW
Tower Electronics (Physical Heat) 4G	3 KW	5,000	15 M	16.9 MW
4G Signals (RF Waves)	80 W	5,000	4,00,000	
4G Peak Traffic Load (Switching/Sectors)	300 W	5,000	15,00,000	
Tower Electronics (Physical Heat) 5G	3 KW	3,500	1,05,00,000	14MW
5G Signals (RF Waves)	200 W	3,500	7,00,000	
5G Peak Traffic Load (Switching/Sectors)	800 W	3,500	28,00,000	
Total Power dissipation				30.9MW

VII. Calculation of Total Flux density due to all Anthropogenic factors

We add all the values of the anthropogenic factors, , vehiclesQ_V , and buildings Q_B ,metabolic calories Q_M , and Public Works, Q_{PW}, Telecommunication, Q_T worked out in Section VII(7.1, 7.2, 7.3 , 7.4 , 7.5) to get the estimate of the size of Anthropogenic Fliux in Table 12.

Name of the type of Anthropogenic Flux density	Calculated value for the Model District Region (W/m^2)	Total Anthropogenic Flux density W/m^2
Vehicular Flux density	3.84632	13.8308911 Summer value = (13.9202911)
Building Flux density-Electricity	0.4469 Summer value =0.5363	
Building Flux density-Gas	0.03278	
Human Metabolic Flux density-Mind work	0.0018287	
Human Metabolic Flux density-Physical work	0.004594	
Public Works -Road Building-	**0.035275**	
Public Works- for the Wastewater and Sewage teatment plants and landfill sites	9.44098	
Telecommunication Services And Infrastructure	0.0222134124	

Table-12: Total Anthropogenic Flux density (W/m^2) for the Model District Region calculated from it's various component terms.

VIII. Result: The values of anthropogenic heat Flux density were summed by the components, vehicles $flux\ density\ Q_V$, buildings flux density Q_B ($=Q_E$ + Q_G) , Public Works flux density Q_{PW} (= + Q_{PWR} + Q_{PWS}) , $Telecommunication\ flux\ density\ Q_T,$ metabolic calories Q_M, as listed in Table no. 12 and the value of Anthropogenic Flux Density comes out to be to 13.83 W/m^2 for the Model district having the Model cityt. The summers are hot, and results in a heavy consumption of electricity for consumption of HVAC cooling and the Anthropogenic Flux Density revises to 13.92 W/$m^{2.}$.

IX.Conclusion

The paper serves to draw the attention of Global Warming conversation to include the humans and the anthropogenic activities as a part of wider effort to protect the earth from effects of Global Warming . There should be more integrated solution between biologists and technologists so that man and machine can enhance each other. When we layer metabolic calories Q_M , vehiclesQ_V , and buildings Q_B ,Telecommunication infrastructrure and services, Q_T and $Public\ Works\ Department\ , Q_{PW}$ together, the energy balance of the selected high-tech and connectivity along with multi-modal Transport characterising the region of the Model district with the Model city reveals that The Public Works Department controlling the Wastewater & Sewage treatment plants and landfill sites dominate the thermal landscape, followed by vehicles followed by Telecom infra & services, followed by Buildings followed by public Works (Road Building) with human metabolism acting as a minor baseline factor. We can put the standoff amongst the components of anthropogenic flux density as { Q_{PWS}> Q_V > Q_T > Q_B > Q_{PWR} > Q_M }. .

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