How to calculate watts per square meter

 The Sun --> Always there; lots of Energy What Makes the Sun Shine? Nuclear Fusion; something we may learn how to do later on the Earth and thus solve our Energy Problem. How many photons (energy) reach the surface of the Earth on Average? The main components in this diagram are the following: Short wavelength (optical wavelengths) radiation from the Sun reaches the top of the atmosphere. Clouds reflect 17% back into space. If the earth gets more cloudy, as some climate models predict, more radiation will be reflected back and less will reach the surface 8% is scattered backwards by air molecules: 6% is actually directly reflected off the surface back into space So the total reflectivity of the earth is 31%. This is technically known as an Albedo . Note that during Ice Ages, the Albedo of the earth increases as more of its surface is reflective. This, of course, exacerbates the problem. What Happens to the 69% of the incoming radiation that doesn't get reflected back: 19% gets absorbed directly by dust, ozone and water vapor in the upper atmosphere. This region is called the stratosphere and its heated by this absorbed radiation. Loss of stratospheric ozone is causing the stratosphere to cool with time. 4% gets absorbed by clouds located in the troposphere. This is the lower part of the earth's atmosphere where weather happens. The remaining 47% of the sunlight that is incident on top of the earth's atmosphere reaches the surface. This is not a real significant energy loss. Cliff Notes Summary How much energy from the sun reaches the surface of the Earth on Average? Note that we measure energy in units of Watt-hours. A watt is not a unit of energy, it is a measure of power. ENERGY = POWER x TIME 1 Kilowatt Hour = 1KWH = 1000 watts used in one hour = 10 100 watt light bulbs left on for an hour Incident Solar Energy on the ground: Average over the entire earth = 164 Watts per square meter over a 24 hour day 8 hour summer day, 40 degree latitude 600 Watts per sq. meter So over this 8 hour day one receives: 8 hours x 600 watts per sq. m = 4800 watt-hours per sq. m which equals 4.8 kilowatt hours per sq. m This is equivalent to 0.13 gallons of gasoline For 1000 square feet of horizontal area (typical roof area) this is equivalent to 12 gallons of gas or about 450 KWH But to go from energy received to energy generated requires conversion of solar energy into other forms (heat, electricity) at some reduced level of efficiency. Efficiency of PV Cells Demo We will talk more about PV cells in detail later. For now the only point to retain is that they are quite low in efficieny! Collection of Solar Energy Amount of captured solar energy depends critically on orientation of collector with respect to the angle of the Sun. Under optimum conditions, one can achieve fluxes as high as 1000 Watts per sq. meter In the Winter, for a location at 40 degrees latitude, the sun is lower in the sky and the average flux received is about 300 Watts per sq. meter A typical household Winter energy use is around 3000 KWHs per month or roughly 100 KWH per day. Assume our roof top area is 100 square meters (about 1100 square feet). In the winter on a sunny day at this latitude (40o) the roof will receive about 6 hours of illumination. So energy generated over this 6 hour period is: 300 watts per square meter x 100 square meters x 6 hours = 180 KWH (per day) more than you need. But remember the efficiency problem: 5% efficiency 9 KWH per day 10% efficiency 18 KWH per day 20% efficiency 36 KWH per day At best, this represents 1/3 of the typical daily Winter energy usage and it assumes the sun shines on the rooftop for 6 hours that day. With sensible energy conservation and insulation and south facing windows, its possible to lower your daily use of energy by about a factor of 2. In this case, if solar shingles become 20% efficient, then they can provide 50-75 % of your energy needs Another example calculation for Solar Energy which shows that relative inefficiency can be compensated for with collecting area. A site in Eastern Oregon receives 600 watts per square meter of solar radiation in July. Asuume that the solar panels are 10% efficient and that the are illuminated for 8 hours. How many square meters would be required to generate 5000 KWH or electricity each square meter gives you 600 x.1 = 60 watts in 8 hours you would gt 8x60 = 480 watt-hours or about .5 KWH per square meter you want 5000 KWH you therefore need 5000/.5 = 10,000 square meters of collecting area Add your questions or comments about this particular lecture Previous Lecture Next Lecture Course Page Most of the world uses the metric system to calculate length, weight and volume, notably with the exception of the United States. As a result, there are many situations that might arise where a person may need to calculate the price of a square meter to square foot or vice versa. While price per square foot is most commonly used to calculate the cost of land, this calculation can also be used for manufacturing, flooring, dressmaking and many other situations where items are sold by the square foot or meter. A square meter is a space that is one meter wide and one meter long. The cost per square meter is determined by dividing the total cost of a property or product by the total number of square meters in the property or product. For example, if a piece of fabric was 20 meters and it cost $200, the cost per square meter would be $10. To use a real estate example, if an available business property was 1,000 square meters and the monthly lease was $5,000, the monthly lease fee per square meter would be $5. If you are an American comparing prices on products, some of which are sold in the U.S. and some of which are sold by international companies, you may need to convert square meters to feet so the prices can be compared properly. Alternatively, if you are familiar with what properties cost in America and want to get an idea of how much more expensive property is to rent in another country, you may want to convert the price per square meter to square foot. The easiest way to do this conversion is to use a cost per square meter calculator. These can be found online with a quick web search. If you prefer to do the math yourself, though, the first thing you should know is that while there are around 3.2 feet in a meter, you cannot simply divide the cost per square meter by 3.2 to get the cost per square foot. That's because once you turn a measurement from a straight line into a square area of space, you have to square the difference between meters and feet as well. In other words, there are approximately 10.76 (3.2 squared) feet in a square meter. In order to convert the price of a square meter to a foot, then, you need to divide the cost per square meter by 10.76. So, if an apartment for rent in Europe was $50 per square meter, the total cost per square foot would be about $4.65 ($50 divided by 10.76). The process of calculating the price per square meter based on price per square foot is pretty much the same as it is for converting the price per square meter into square foot. The only difference is that rather than dividing the total price by 10.76, you will need to multiply it by this number. For example, imagine you are comparing the prices of carpets, and you find three sold by the square meter that cost $19, $25 and $28, and you want to compare them to one you found that is sold by the square foot at $3. You would need to multiply the cost of the fourth carpet by 10.76 in order to discover that the total cost per square meter for this carpet would be $32.28. While the carpet sold by the square foot might sound cheap before your calculation, it actually costs more than any of the other options. The traditional method for specifying power density using a single figure such as watts per square meter (or foot) is an unfortunate practice that often leads to confusion as well as a waste of energy and money. The following bullets can summarize the problems… What is included in the area calculation, or how it relates to the number of IT racks or devices is not defined. What's included in the power calculation is not defined. There's no information about the variation in power amongst the IT racks; is it a peak number? An average over area? An average over time? Or something else??? It's not at all clear how this number is used for data centers that have changing growth plans or are built out over time in a modular fashion. When important performance characteristics are left undefined in this way, considerable confusion during the specification, design, and commissioning processes will likely result – and the Facility Ops team won't have a clear understanding of the data center's capabilities once operational. And beyond just confusion and the mistakes that might potentially result, an inaccurate or poor specification can lead to waste and inefficiencies. If you specify too HIGH of a density (compared to the eventual reality in the data center), your first costs and operating expenses are needlessly increased as you will end up having more infrastructure capacity and fixed losses to pay for than needed. And if you specify too LOW of a density, then performance becomes unpredictable with various overloads and overheating problems occurring. So it is important that power density be specified properly using an approach that defines all the necessary parameters and which accounts for the reality of dynamic power variations – that occurs in both time and place. White paper 155, "Calculating Space and Power Density Requirements for Data Centers" written by Schneider Electric Chief Innovation Officer, Neil Rasmussen, describes a better approach that addresses the four bullets above. The method he developed has four main features; The unit of physical space in the density specification is the IT cabinet, NOT floor area. Floor area is determined during the design as an output of the process using per cabinet power and other factors. The specification is hierarchical and modular, so that different rooms and zones can have different density requirements. The specification comprehends that IT cabinets within data centers have different power requirements, and that these requirements may not be well-defined in advance. The specification comprehends that IT equipment cabinets may have power require-ments that vary with time. What really makes this white paper a practical one, is that it contains an embedded spreadsheet that makes it easy for you to use this new specification for your next data center project. We encourage you all to check it out and would welcome any feedback. Thanks! Tags: APC, design, high density, modular data center, Modularity, Neil Rasmussen, Patrick Donovan, Racks, watts, Whitepaper \$\begingroup\$ Want to improve this question? Add details and clarify the problem by editing this post. Closed last year. I am from a computer science background, I need some help with some electrical engineering problem. Electricity consumption for a home in the last 56 days is 7561 kWh. There are two floors. The combined area is 300 square meters. Can I use this information to get watts per m^2 for this house? \$\endgroup\$ 6 What are the restrictions relating to Artificial Lighting and Power for Buildings? It's important to know the regulations of the Commercial Building(s) you're managing. Non-Residential incorporates Classes 3 and 5 through to 9 and for the Common Areas of Class 2 Buildings. Section J of the Australian Building Codes Board (ABCB) outlines the National Construction Code (NCC) requirements for Artificial Lighting & Power and Building Classes. For those of you who aren't familiar with Section J, it assesses the compliance of the energy efficiency measures in the Artificial Lighting and Power Design and must be adhered to in all buildings. The Lighting Calculator for Property Managers… As a Property Manager, you can be faced with the difficult task of making sure each building complies with strict regulations. Prolux Electrical Contractors can assist in identifying lighting and power requirements and can provide you with valuable solutions. Furthermore, the Lighting Calculator has been designed by the ABCB to assist in developing a better understanding of lighting energy efficiency parameters. To put in simply, it helps you to identify the wattage per square metre for each room, to work out the Illumination Power Density for areas outlined, while taking into consideration all variable factors. Illumination Power Density is the total power that would be consumed by lights in any given space, this includes lamps, ballasts (device to limit the amount of current in an electric circuit), current regulators and control devices (lighting timer, motion detectors or dimming devices) other than those that are plugged directly into a socket outlet for intermittent use, such as floor standing lamps, desk lamps or work station lamps, divided by the floor area of the space. Multiple Lighting Systems refers to the Illumination Power Load when multiple lighting systems serve the same space. Download the NCC Lighting Calculator Just a few properties Prolux Electrical Contractors have serviced, in and around Melbourne's CBD… Building Classes: Class 1a – Detached, Terrace, Townhouse or Villa Class 1b – Guesthouse Class 2 – Two or more Sole Occupancy Units Class 3 – Accommodation or Residence in Public Building Class 4 – Only Dwelling in Class 5,6,7,8 or 9 Building Class 5 – Office Building Class 6 – Shop Building Class 7a – Car Park Class 7b – Warehouse – Storage or Display Class 8 – Laboratory or Building used for production Class 9a – Health Care Building Class 9b – Public Assembly Building Class 9c – Aged Care Building Class 10a – Sheds and Garages Class 10b – Non-Habitable Structure The statue is in a main square of Birmingham, England, in the center of the industrial country of England, the birthplace of the industrial revolution. James Watt measured the power that can be exerted by a standard horse, the horsepower. His contributions to science and technology are recognized in the unit of power (the watt) in SI, the International System of Units. 1 watt = 1 joule per second = 1 newton meter per second = 1 kg m2 s-3. The "watt per square meter" is the SI unit for radiative and other energy fluxes in geophysics. The "solar constant", the solar irradiance at the mean earth-sun distance is approximately 1370 W m-2. The global and annual average solar irradiance at the top of the earth's atmosphere is one-fourth of the solar constant or about 343 W m-2. Why? This page was last updated 1999-10-21. Return toStephen E. Schwartz Home Page.