You may incorporate this data into your website. You may also supplement it with data on climate change from your own research.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**COMPUTING AND CLIMATE CHANGE**

The use of computers has led to both positive and negative impacts on the climate change of our planet. Computers can help make some processes more efficient and save energy while the use and manufacture of computers contributes to the increased use of energy which leads to global warming. This website helps you to look at the positives and negatives of computing and climate change.

**Climate change**

Climate change, one of the most important trends that scientists look at, is the increasing average temperature of the Earth, called global warming.

Global warming leads to other changes in the Earth’s climate, eg stronger hurricanes, melting glaciers, and the loss of wildlife habitats. When air temperatures rise, the oceans absorb more heat from the atmosphere and become warmer. Warmer oceans, in turn, can cause stronger storms.

**Greenhouse gases**

For more than 100 years, people have been burning large amounts of fossil fuel ― coal, oil, and natural gas ― to power their homes, factories, and vehicles. This releases carbon dioxide (CO2), a heat-trapping gas, into the atmosphere.

Greenhouse gases trap heat in the atmosphere, which makes the Earth warmer.

**Carbon dioxide**

Carbon dioxide (CO2) is the most important greenhouse gas. Burning fossil fuels releases the CO2 stored millions of years ago. CO2 is probably the most important of the greenhouse gases as it accounts for the largest proportion of the 'trace gases' and is currently responsible for 60 per cent of the 'enhanced greenhouse effect'.

**Methane**

The importance of methane in the greenhouse effect is its warming effect. Even though it occurs in lower concentrations than CO2, it produces 21 times as much warming as CO2. Methane accounts for 20 per cent of the 'enhanced greenhouse effect'.

Methane is generated naturally by bacteria that break down organic matter, it is found in the guts of termites and other animals and in natural gas deposits.

Methane remains in the atmosphere for 11–12 years — less time than most other greenhouse gases.

**Water vapour**

Water vapour is the biggest contributor to the 'natural greenhouse effect' and varies the most in the atmosphere. As the planet gets warmer, more water evaporates from the Earth's surface and becomes vapour in the atmosphere. Water vapour is a greenhouse gas, so more water vapour in the atmosphere leads to even more warming.

**NF3**

Nitrogen trifluoride, NF3, a binary compound of nitrogen and fluorine, is a colourless, toxic, non-flammable, corrosive gas shipped in cylinders at high pressure. NF3 is a greenhouse gas, with a global warming potential (GWP) 17,200 times greater than that of CO2 when compared over a 100-year period. NF3 is used as a chamber cleaning gas in the manufacture of semiconductors, flat panel displays and other electronic devices. When released into the atmosphere it has a powerful and long lasting warming effect.

**Computers’ negative impact on climate change**

Computers, printers, mobile phones and the widgets that accompany them account for the emission of about two per cent of the estimated total of emissions from human activity. And that is the same as the aviation industry's contribution. 25 per cent of the emissions in question are generated by the manufacture of computers. The rest come from their use.

**Manufacture**

Producing computers uses up lots of energy. This adds to climate change because fossil fuels are burned to create the energy.

70 per cent of the energy a typical laptop will consume during its lifespan is used in manufacturing the computer: 227–270 kilograms (or 500–594 pounds) of CO2 are emitted in manufacturing a laptop computer.

**Nitrogen trifluoride (NF3)**

Nitrogen trifluoride (NF3), a binary compound of nitrogen and fluorine, is a colourless, toxic, non-flammable, corrosive gas shipped in cylinders at high pressure. NF3 is a greenhouse gas, with a global warming potential (GWP) 17,200 times greater than that of CO2 when compared over a 100-year period. NF3 is used as a chamber cleaning gas in the manufacture of semiconductors, flat panel displays and other electronic devices. When released into the atmosphere it has a powerful and long-lasting warming effect.

**Use of electricity**

A typical desktop computer uses about 65–250 watts. Add another 15–70 watts for an LCD monitor. A typical cable modem uses 7 watts, a router: 4.5 watts.

Most laptop computers use about 15–60 watts, far less than desktops.

|  |
| --- |
| Computers |
| Desktop computer | |
| Onscreen saver | |
| Sleep/standby | |
| Laptop computer | |

**Server farms**

By far the biggest use of energy by computers is made by the server farms that power the internet.

‘Server farms’ is the term used to describe the vast arrays of servers used by large internet-based companies like Google and Amazon.

Server farms contain thousands of servers and use a lot of energy to power them and to cool them. One 50,000 square foot data centre uses about 5 megawatts, enough to power 5,000. This level of energy consumption is just by the servers themselves. The cooling systems use as much energy as the plants!

**Saving energy**

There are many ways in which computers can help cut down on our use of energy. Computers are steadily improving the amount of energy that they use with the smaller computers producing less CO2 than larger desktop computers.

Computer Power used kg Co2/year

|  |  |  |
| --- | --- | --- |
| Apple Mac mini (MD387) 2.5Ghz Intel Core i5, 4GB RAM | Sleep: 1.2372W Idle: 10.2648W Off: 0.26028W | 20.45 kgCO2 |
| Acer Veriton N281G 1.8GHz Intel Atom PC | Sleep: 0.95W Idle: 18.81W Off: 0.48W | 37.17 kgCO2 |
| Apple MacBook Air (MC966) 13.3 inch 1.7GHz Intel Core i5 Laptop | Sleep: 0.97W Idle: 4.28W Off: 0.17W | 7.04 kgCO2 |
| HP Pavilion DM1 1.3 GHz Intel Laptop | Sleep: 0.8W Idle: 9.57W Off: 0.7W | 15.99 kgCO2 |

**Low power processors**

Processors are becoming greener, with each generation employing smaller transistors that require less power. Using multiple processors, or ‘cores’, on the same chip also reduces energy consumption as collectively they require less cooling. Intel’s 4th generation processors, Haswell, or the 4th Generation Core Processor can go as low as 6 watts, measured by system design power (SDP).

**Using intelligent software**

Intelligent software can be used to manage energy consumption by the servers. It monitors server usage to see if it can turn down or turn off components, reduce processor speed or shut down memory modules.

**Using virtualisation**

Server virtualisation is the masking of server resources, including the number and identity of individual physical servers, processors, and operating systems, from server users. The server administrator uses a software application to divide one physical server into multiple isolated virtual environments. The virtual environments are called virtual private servers

Storage virtualisation is the pooling of physical storage from multiple network storage devices into what appears to be a single storage device that is managed from a central console. Storage virtualisation is commonly used in a storage area network ([SAN](http://searchstorage.techtarget.com/definition/storage-area-network-SAN)).

**Green energy**

***Google cuts down its carbon based energy use*** — Google has been taking measures to eliminate its carbon footprint by utilising renewable energy sources such as wind. In fact, Google has invested in a wind farm superhighway (transmission network) involving an undersea cable located off the east coast of the United States. The wind power potential there could produce 6,000 megawatts of energy, enough electricity to power approximately two million homes.

**Computers’ positive impact on climate change**

Computers can be used to reduce emissions produced by other industries, up to 7.8 billion tonnes by 2020, or five times ICT's own footprint. Computers can make industries more efficient and less wasteful of power and fuel.

**Using computer models to analyse climate change**

The Community Earth System Model (CESM) will be one of the primary climate models used for the next assessment by the Intergovernmental Panel on Climate Change (IPCC).

The CESM is one of about a dozen climate models worldwide that can be used to simulate the many components of Earth’s climate system, including the oceans, atmosphere, sea ice, and land cover. The CESM and its predecessors are unique among these models in that they were developed by a broad community of scientists. The model is freely available to researchers worldwide.

Scientists rely on computer models to better understand Earth’s climate system because they cannot conduct large-scale experiments on the atmosphere itself. Climate models, like weather models, rely on a three-dimensional mesh that reaches high into the atmosphere and into the oceans. At regularly spaced intervals, or grid points, the models use laws of physics to compute atmospheric and environmental variables, simulating the exchanges among gases, particles, and energy across the atmosphere

**Low power processors**

Processors are becoming greener, with each generation employing smaller transistors that require less power. Using multiple processors, or ‘cores’, on the same chip also reduces energy consumption as collectively they require less cooling. Intel’s 4th generation processors, Haswell, or the 4th Generation Core Processor can go as low as 6 watts, measured by system design power (SDP).

**Using ICT to reduce emissions**

Perhaps the best-known of these enabling effects is to replace face-to-face meetings, which involve air or car travel, with videoconferencing. Reducing transport emissions using technologies such as videoconferencing and teleworking could save a potential 140m and 220m tonnes of CO2 by the year 2020.

Using computers to improve logistics (for example, by planning the routes of delivery vehicles more efficiently) could save 1.5 billion tonnes.

Using data networking inside a ‘smart’ electrical grid to manage demand and reduce unnecessary energy consumption could save 2 billion tonnes;

Computer-enabled ‘smart buildings’, in which lighting and ventilation systems turn themselves off if nobody is around, could save 1.7 billion tonnes.