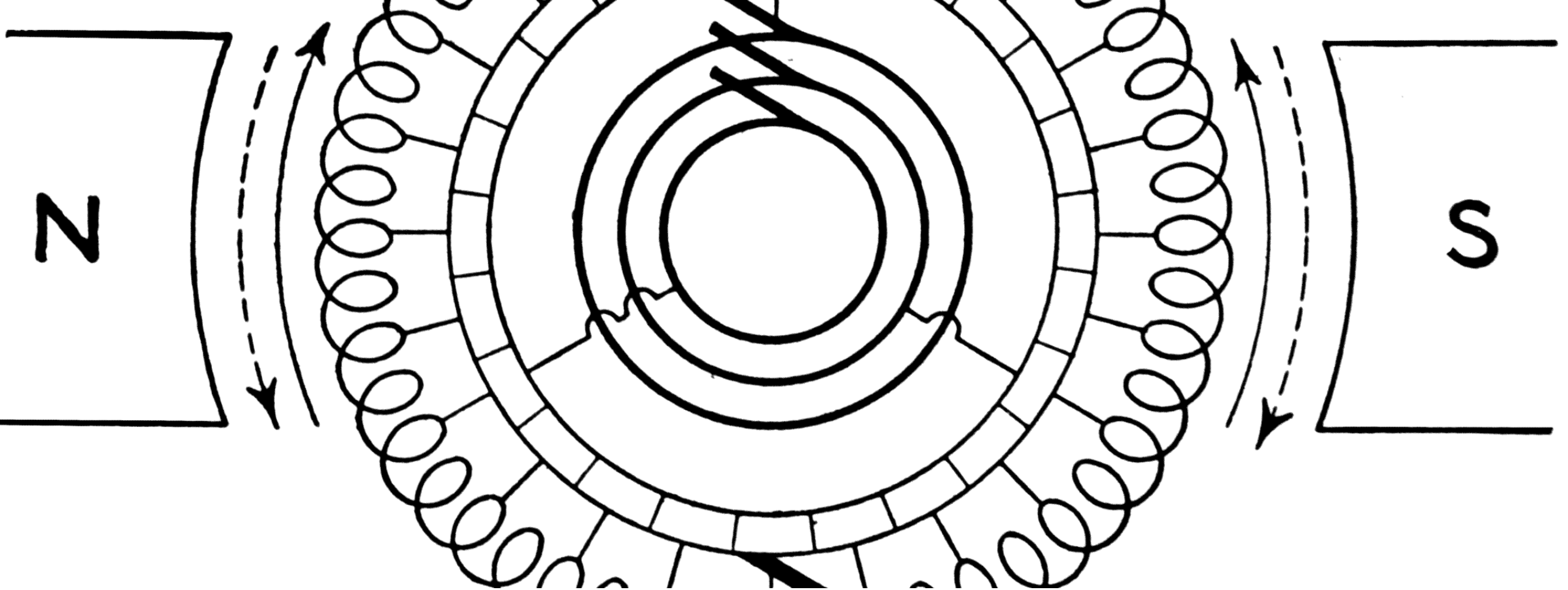


TECNOLOGIAS PARA SISTEMAS DE ENERGIA ESPACIAIS

Nuno Borges Carvalho

BIBLIOGRAFIA

Material das aulas disponível no **elearning.ua.pt**

Electricidade Aplicada para Engenheiros/L. Bessuov/2000 (3/e)

Electricité Théorique et Appliquée/K. Küpfmüller/1959

Introdução à Física/J. Dias de Deus *et al.*/2000 (2/e)

Lectures on Physics/R. P. Feynman/1963

Cálculo Vectorial/Bento de Jesus Caraça/1947

HISTORY

Class 1

HISTORY

- Electricity science goes back to 600BC, when Greeks saw that a rubbed piece of amber will attract a bit of straw
- Study of magnetism goes back to the observation that certain naturally occurring stones attract iron
- The two concepts were separate until 1820 with Hans Christian Oersted explained the connection between them…an electric current in a wire will affect a compass needle

Hans Christian Oersted

WILLIAM GILBERT

William Gilbert called the property of attracting particles after being rubbed *"electricus" in 1600.*

De Magnete was a treatise of electricity and magnetism, noting a long list of elements that could be electrified.

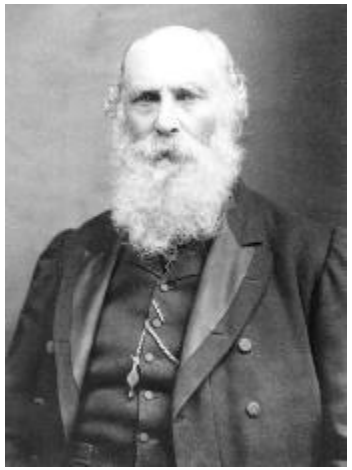
Gilbert invented the versorium, a device that detected statically-charged bodies

Versorium

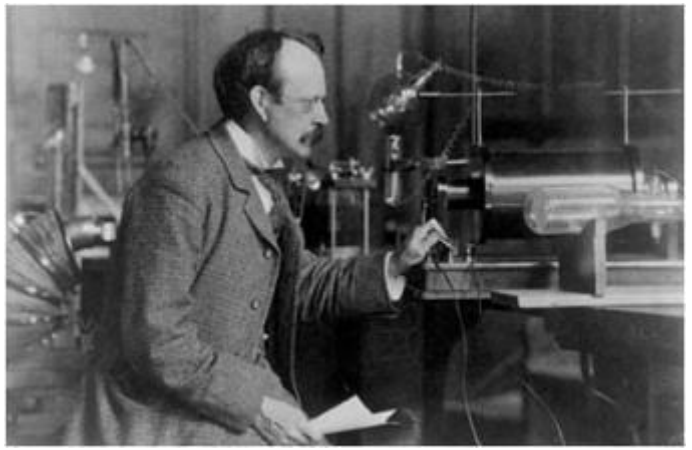
William Gilbert

JOHNSTONE STONEY AND J.J. THOMSON

- In 1891 Johnstone Stoney observe the effect of electric charge and proposed to name it "**electron.**"
- around end of the 1800's J.J. Thomson discovered the particle which carried that charge, the name "electron" was applied to it. He won the Nobel Prize in 1906 for his discovery.



Johnstone Stoney



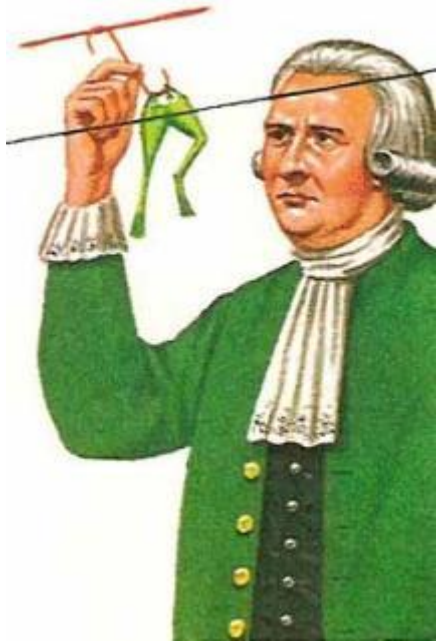
J.J. Thomson

BENJAMIN FRANKLIN

In 1752, Franklin proved that lightning and the spark from amber were one and the same thing.

LUIGI GALVANI AND ALESSANDRO VOLTA

In 1786, Luigi Galvani, an Italian professor of medicine, found that when the leg of a dead frog was touched by a metal knife, the leg twitched violently. Galvani thought that the muscles of the frog must contain electricity.



Luigi Galvani

By 1792, another Italian scientist, Alessandro Volta, disagreed: he realized that the main factors in Galvani's discovery were the two different metals - the steel knife and the tin plate - upon which the frog was lying. Volta showed that when moisture comes between two different metals, electricity is created. This led him to invent the first electric battery, the voltaic pile, which he made from thin sheets of copper and zinc separated by moist pasteboard.

Alessandro Volta

VOLT

Volta actually showed that electricity flow steadily like a current of water instead of discharging itself in a single spark or shock.

Volta showed that electricity could be made to travel from one place to another by wire.

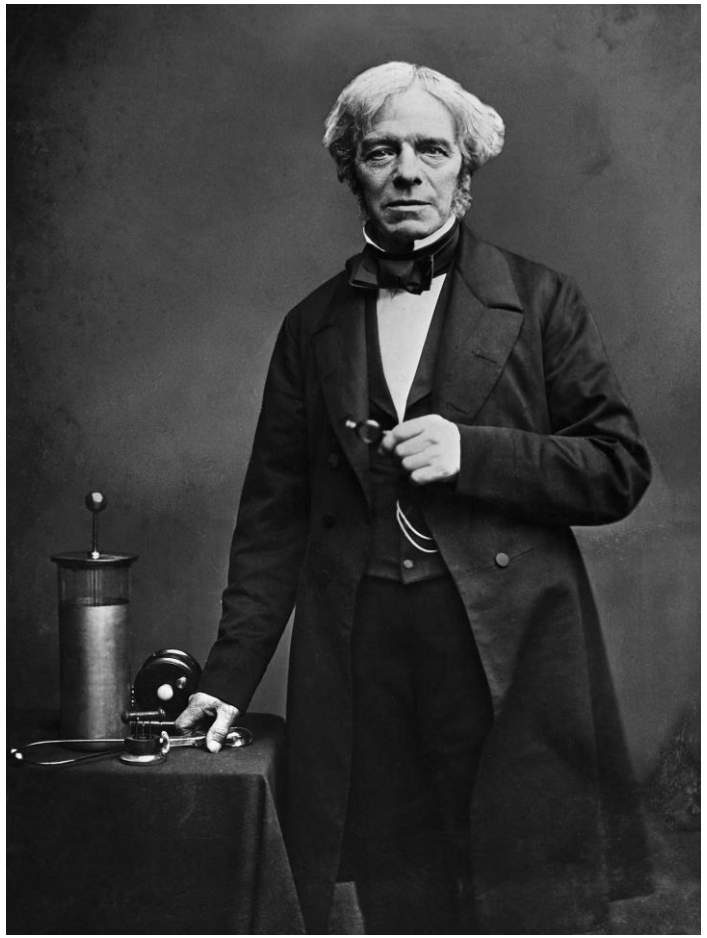
The unit of electrical potential, the **Volt,** is named after him.

MICHAEL FARADAY

Michael Faraday was an English scientist that actually showed a first electrical generator.

Faraday was interested in the invention of the electromagnet.

He found that if electricity could produce magnetism, why couldn't magnetism produce electricity?

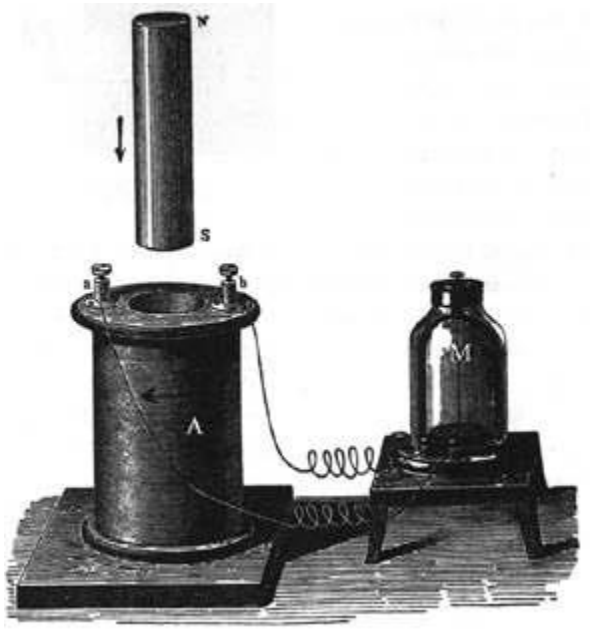


FARADAY

In 1831, Faraday found that Electricity could be produced through magnetism by motion.

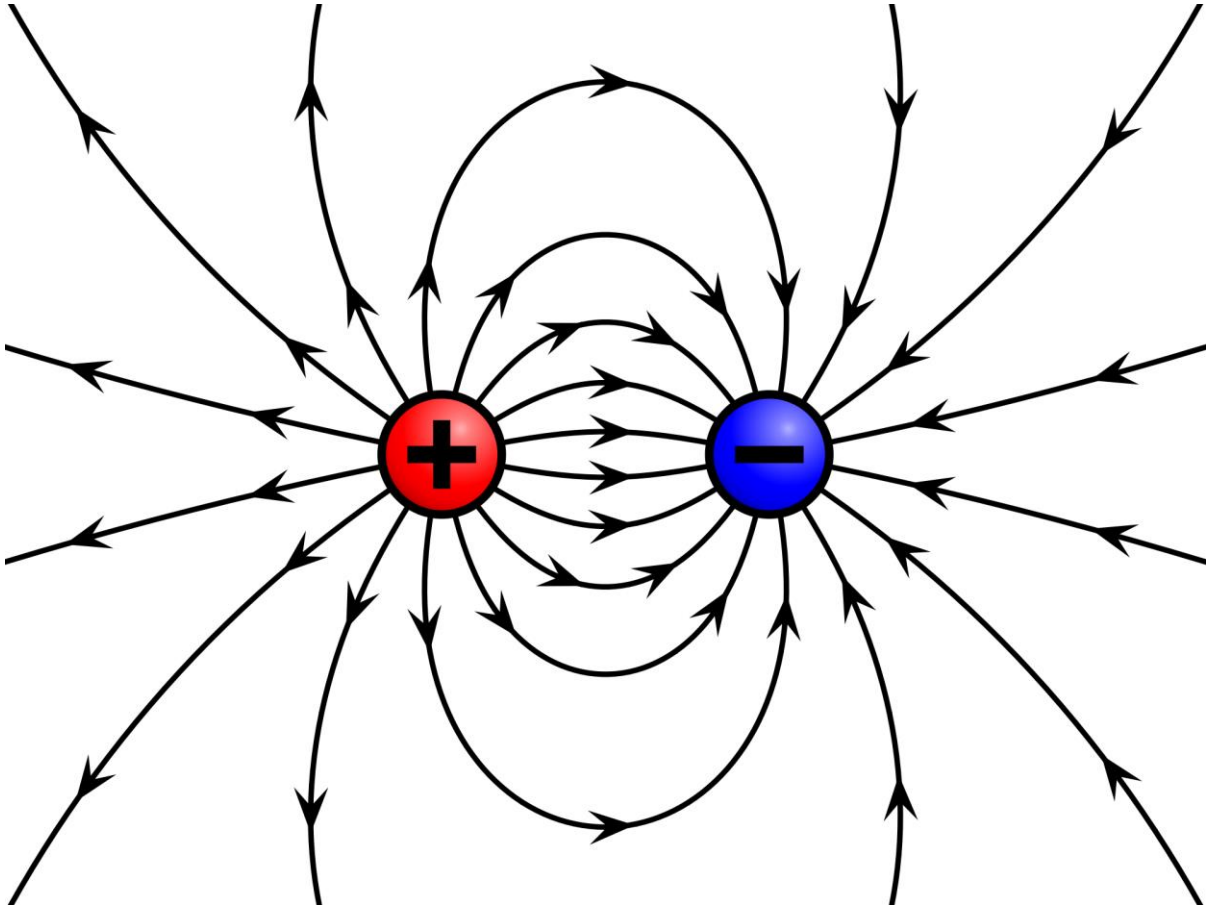
He discovered that when a magnet was moved inside a coil of copper wire, a tiny electric current flows through the wire.

He discovered the first method of generating electricity by means of motion in a magnetic field.



FARADAY

At that time electric field was also discovered, by discovering that it generates an electrical force.



ANDRE MARIE AMPERE

Andre Marie Ampere, a French mathematician who devoted himself to the study of electricity and magnetism, was the first to explain the electro-dynamic theory.

The use of his name, Ampere, for the unit of electric current is a demonstration of his work in this field.

OHM

George Simon Ohm, a German mathematician and physicist, in 1827 published, "The Galvanic Circuit Investigated Mathematically".

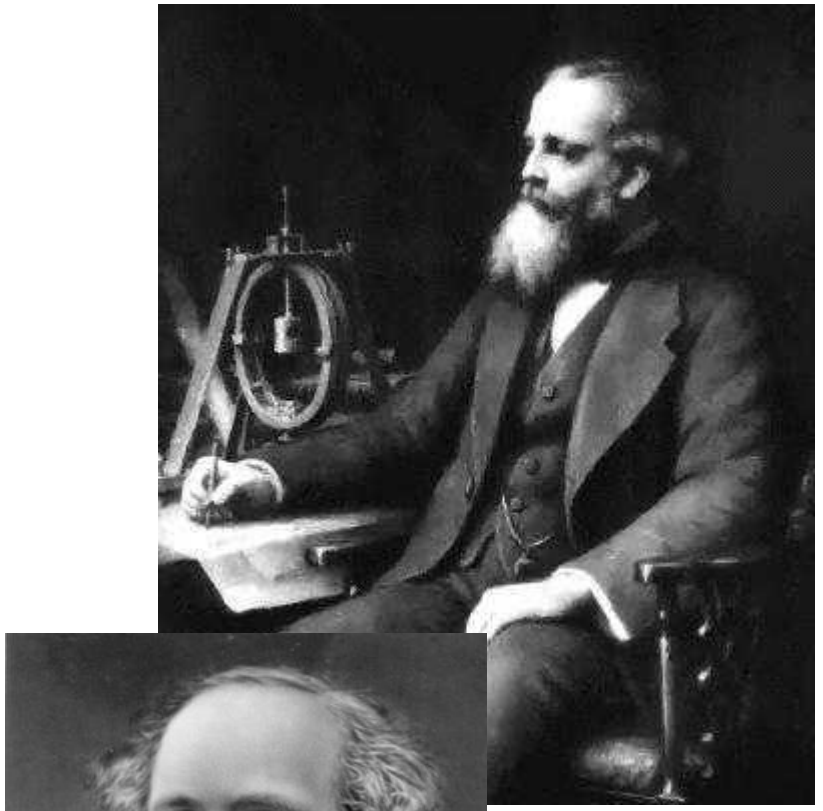
His name has been given to the unit of electrical resistance.

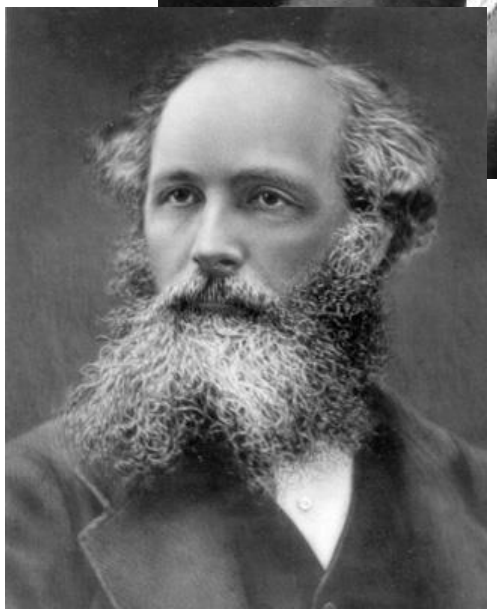
Voltage = Current x Resistance

JAMES CLERK MAXWELL

James Clerk Maxwell is the known father of the laws of electromagnetism in the form we know them today: Maxwell's Equations (1873)

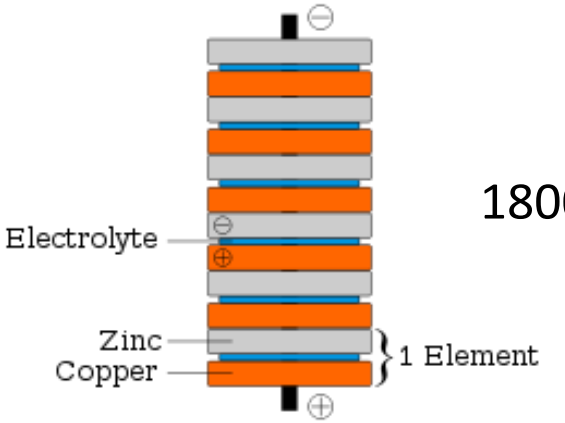
Maxwell's Equations are to electromagnetism what Newton's Laws are to gravity





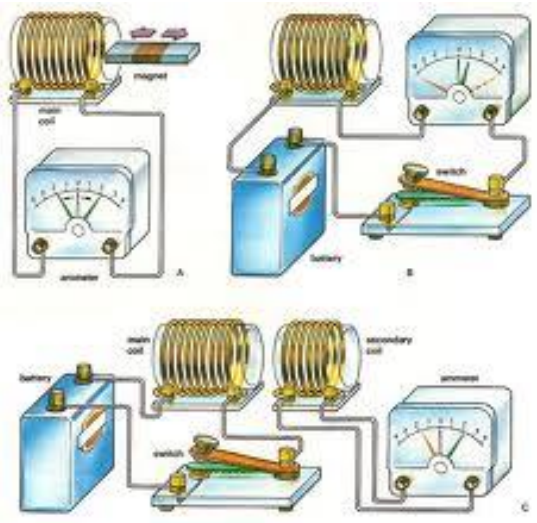
James Clerk Maxwell

HISTORY



Voltaic pile

1800 – voltaic pile developed by Alessandro Volta, a precursor to the **battery**



Circuits containing inductors

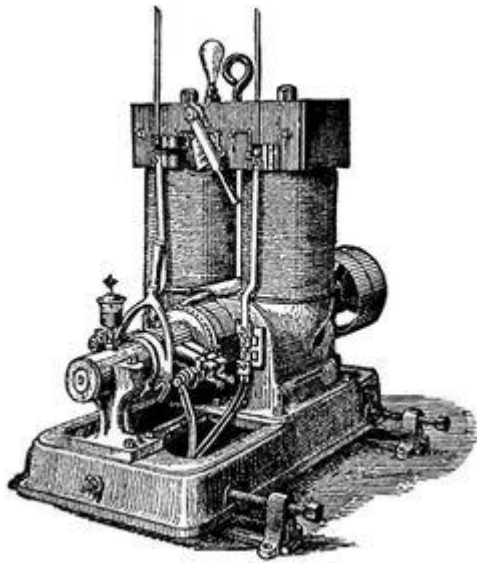
1831 – Michael Faraday discovers **electromagnetic induction**

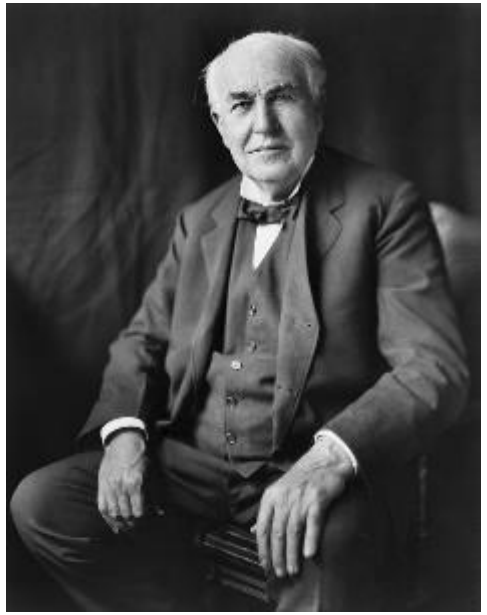
$$\nabla \cdot \mathbf{D} = \rho$$
$$\nabla \cdot \mathbf{B} = 0$$
$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$
$$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}$$

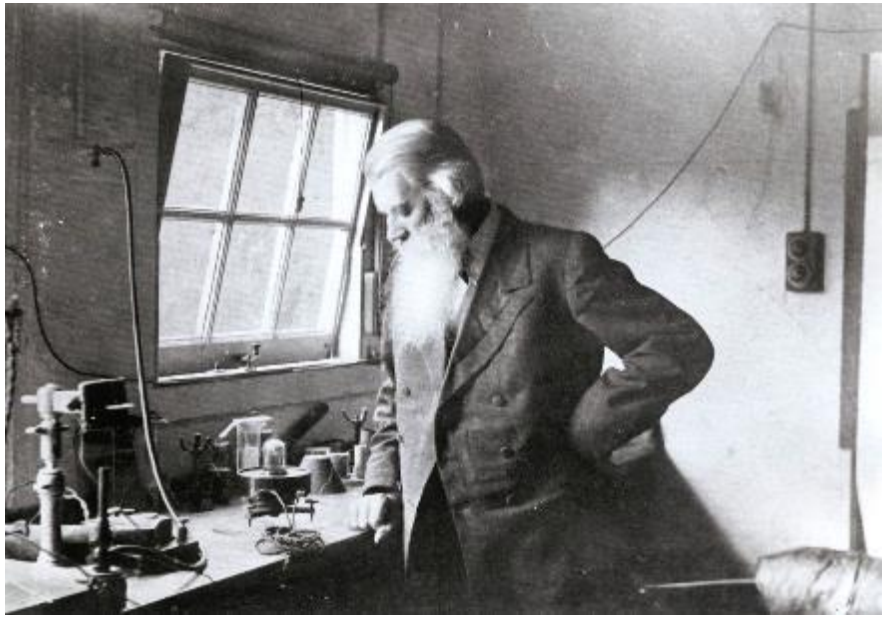
Maxwell's equations

1873 – *Electricity and Magnetism* published by James Maxwell, describing a **theory for electromagnetism**

THOMAS EDISON AND JOSEPH SWAN



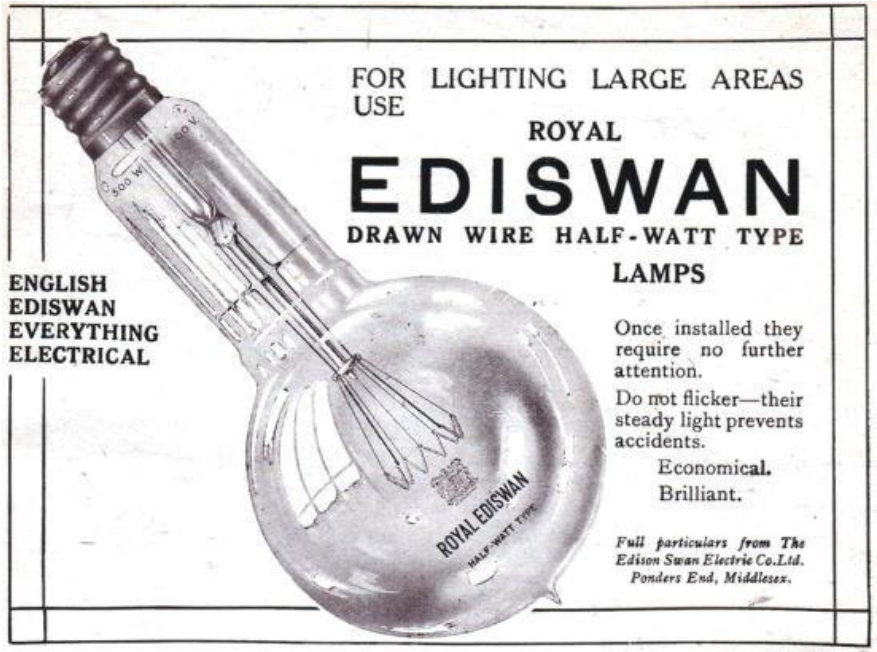




Thomas Edison built the first practical DC (Direct Current) generator.

In 1878 Joseph Swan and Edison invented the incandescent filament lamp.

THOMAS EDISON AND JOSEPH SWAN



WESTINGHOUSE AND TESLA

Nikola Tesla patent a motor for generating alternating current.

Westinghouse join Tesla in building the first AC current generator which has significant advantages over DC generation.

Tesla is known due to the use of his name as a measurement for magnetic fields.

Westinghouse

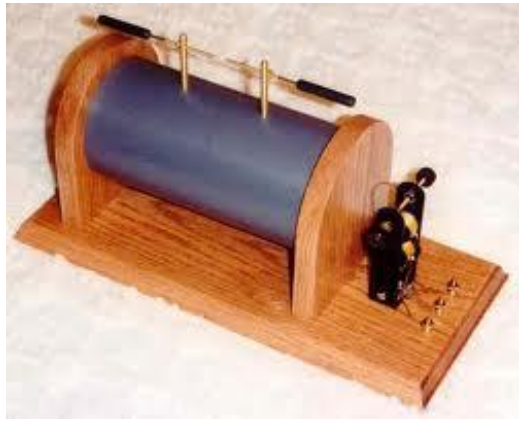
Nikola Tesla

JAMES WATT

Edison work join Watt's steam engine and create a true revolution.

Watts name was given to the electric unit of power, the Watt.

HISTORY

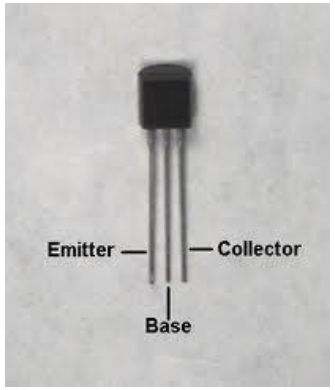


Spark-gap transmitter

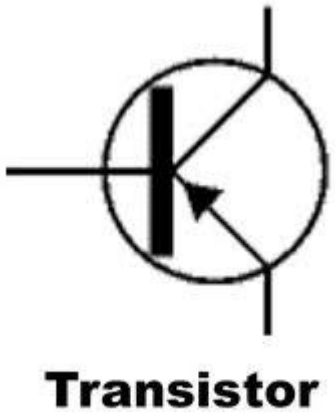
1888 – Heinrich Hertz transmits and receives **radio signals**

Z3 computer

1941 – Konrad Zuse introduces the first ever **programmable computer**



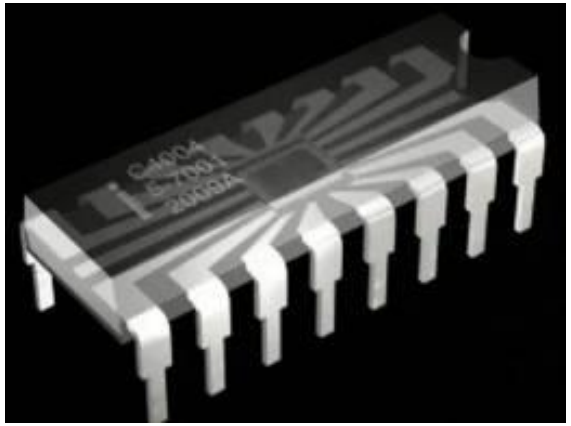
Transistor

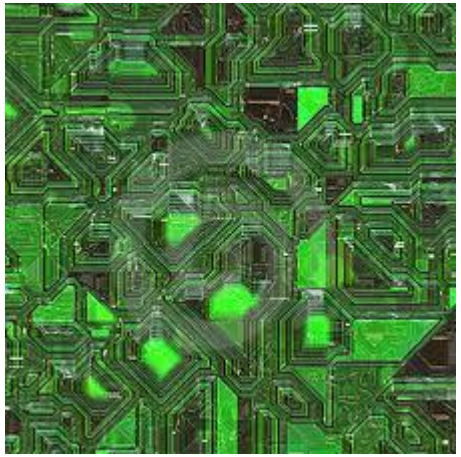


1947 – invention of **transistor**

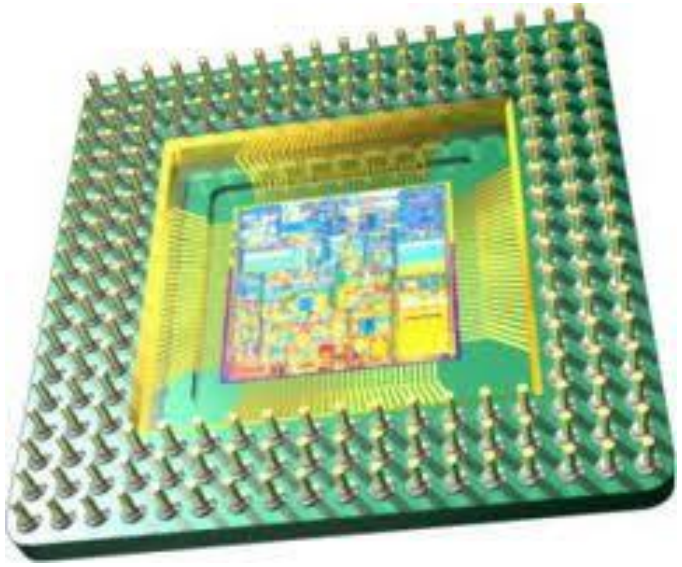
HISTORY

1958 – **integrated circuit** developed by Jack Kilby





Integrated circuits



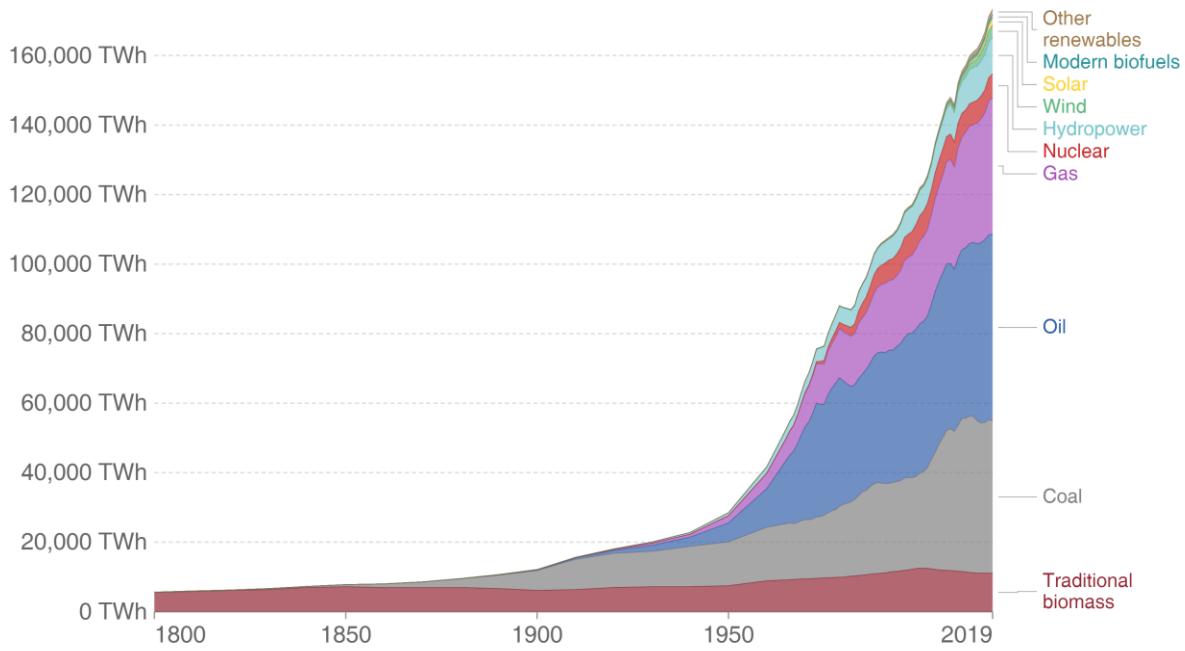
Microprocessor

1968 – first **microprocessor** is developed

Global primary energy consumption by source

Primary energy is calculated based on the 'substitution method' which takes account of the inefficiencies in fossil fuel production by converting non-fossil energy into the energy inputs required if they had the same conversion losses as fossil fuels.

Our World in Data



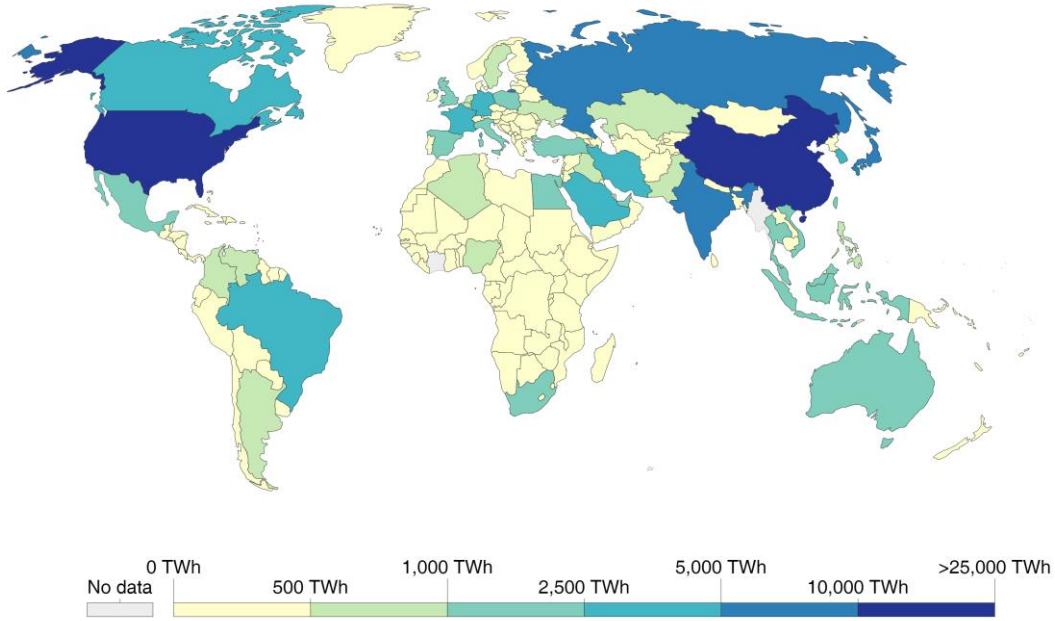
Source: Vaclav Smil (2017) & BP Statistical Review of World Energy

OurWorldInData.org/energy • CC BY

Primary energy consumption

Primary energy consumption is measured in terawatt-hours (TWh).

Our World in Data



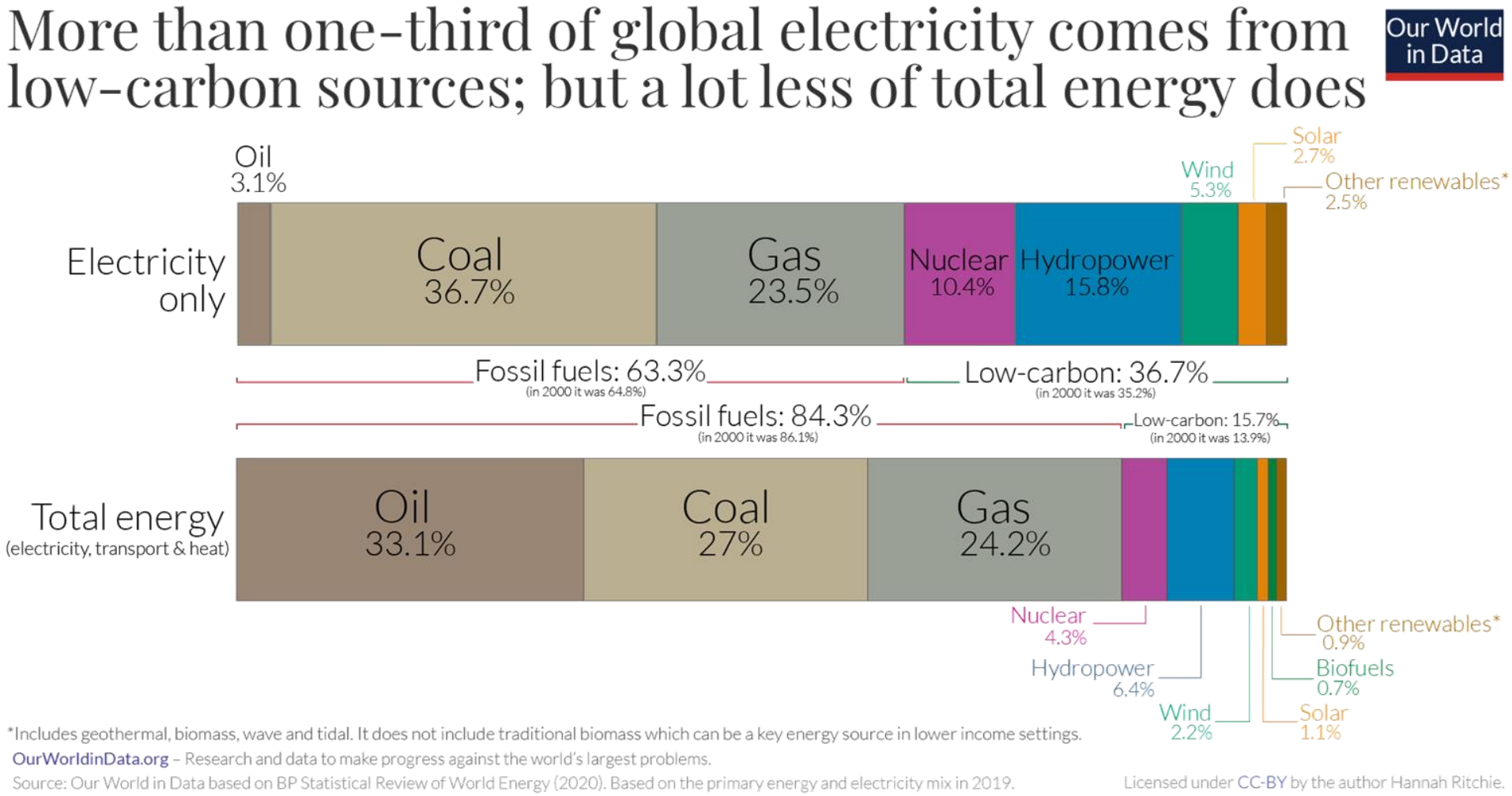
Source: BP Statistical Review of Global Energy

OurWorldInData.org/energy • CC BY

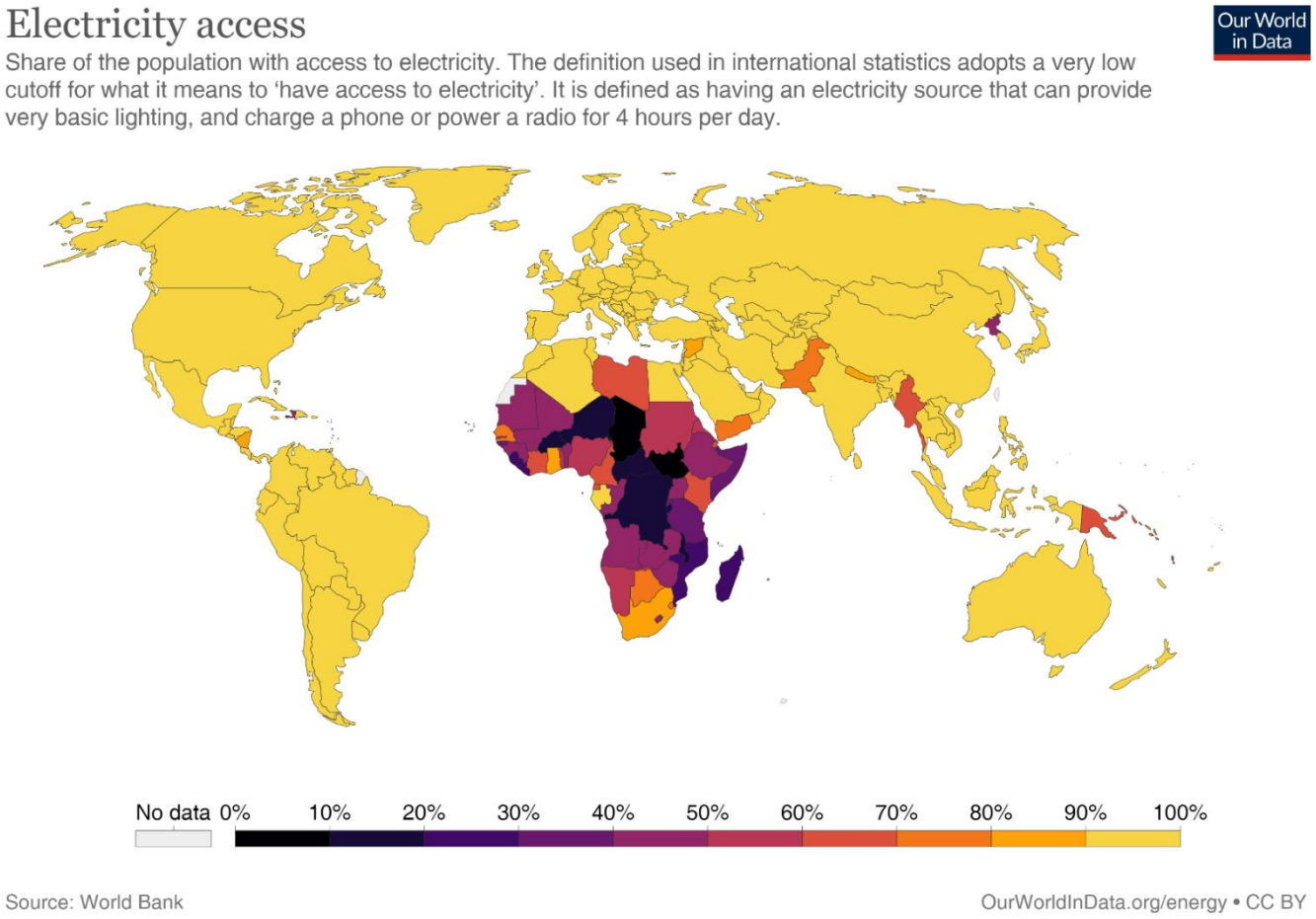
Note: Data includes only commercially-traded fuels (coal, oil, gas), nuclear and modern renewables. It does not include traditional biomass.

WORLD ENERGY

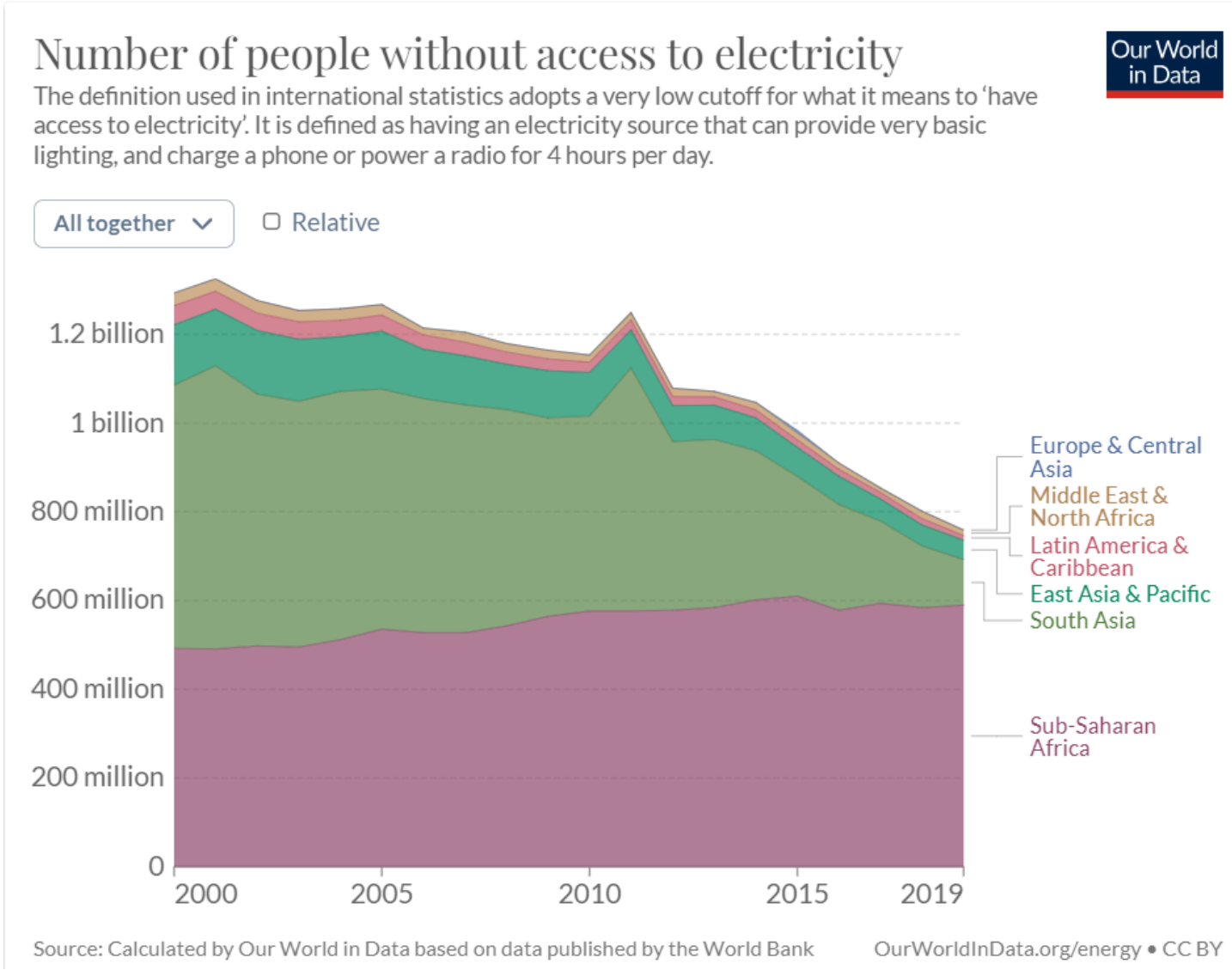
WORLD ELECTRICITY



WORLD ELECTRICITY



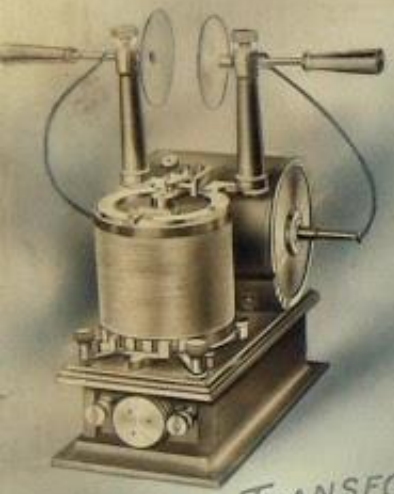
WORLD ELECTRICITY



SOLAR/WIND FARMS OF EARTH

Intermittent energy
Day and Season
based

Image: Sungrow



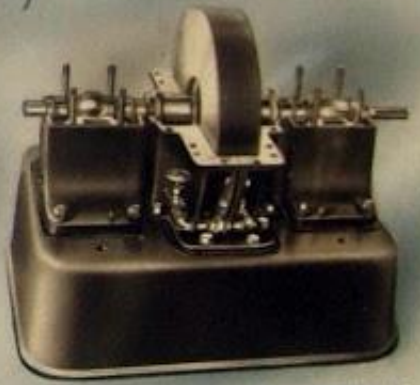
OSCILLATION TRANSFORMER

INDUCTION MOTOR

12,000000 V. 800 A. Dec. 18, 1899.

WORLD WIRELESS TELEPHONE TRANSMITTER

TELAUTOMATON



STEAM & GAS TURBINE

TESLA COMPANY, INC.

TELEPHONE
9090 BRYANT

8 West 40th St.
NEW YORK