SECTION I
The History of the Photovoltaic Effect

Of course there is the immediate question of what Aristarchus invented, and Vitruvius explains that he invented a sundial in the shape of a hemispherical bowl with a pointer to cast shadows placed in the middle of the bowl.[21]

Stonehenge War Memorial
Maryhill, Washington[22]

"Why in the Sam Hill did he build this?"

The sun cast its rays of import upon the earth long before the first utterings of human civilization. Daily, I am ever amazed by the simplicity of the sun's dominion over every aspect of life on Earth from the gravitational pull that holds the earth in orbit to the sunlight that brings us the day.

Photo taken by David Backman, July 25, 1999

The use of amber begins with the dawn of civilization. The discovery of beads in the royal tombs at Mycenae and various places throughout Sardinia and the territory of ancient Etruria, proves that trade in it existed in prehistoric times; while the identity in chemical construction of the amber ornaments of Mycenae and the Baltic amber from the Tertiary formation of the Prussian Samland, the coasts of southern Sweden and northern Russian provinces, indicates the far distant source from which the resin was anciently derived.[23]

The first known observation of electricity was the magnetism found in *amber.* It was around 600 BC when the Greeks found that by rubbing an 'electron' or hard fossilized resin today known as *amber* against a fur cloth, it would attract particles of straw. Stones and metals that when burnished, have a golden glow were called children of the sun "Elector" –reflecting that radiance. The magnetism of amber is used on spindles of spinning wheels.

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[21] *Aristarchus of Samos [Born 310 BC died 230 BC]*, JJ O'Connor and E F Robertson, JOC/EFR April 1999 School of Mathematics and Statistics, University of St. Andrews, Scotland URL: http://www-history.mcs.st-andrews.ac.uk/history/Mathematicians/Aristarchus.html

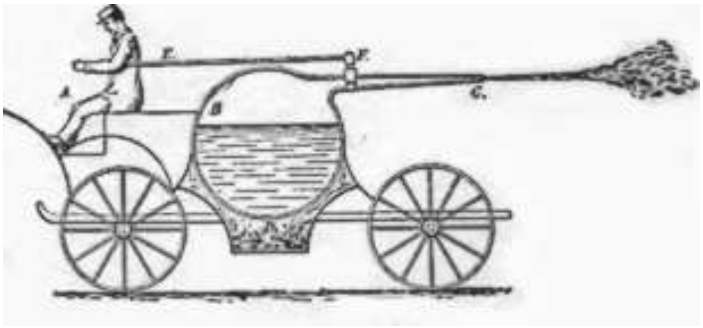
[22] *Stonehenge War Memorial near the Sam Hill Museum, West through NorthWest, with Wes, A Run to the Pacific Through Oregon and Washington,* July 1999 http://www.notduck.com/westrek/oregon99.html

[23] *History of Electricity, The Intellectual Rise in Electricity, from Antiquity to the Days of Benjamin Franklin,* by William Benjamin Park, John Wiley and Sons, 1898 pages 15 and 16

Love's Complaint

Who would of his course be sure,
When the clouds the sky obscure,
He an iron needle must
In the corkwood firmly thrust.
Lest the iron virtue lack
Rub it with the lodestone black,
In a cup with flowing brim,
Let the cork on water swim.
When at length the tremor ends,
Note the way the needle tends;
Though its place no eye can see –
There the polar star will be.[24] William the Norman Clerk, 1329

This Medieval poem is apparently the first attempt to account for the north and south pointing of the compass needle. The poem claims the needle points to the Pole star because it was rubbed by the lodestone, and therefore received virtue from the stone. It explains the virtue of the stone comes from the Pole star itself for why else would the needle point to that star in preference to any other object in the universe. The poem represents an important scientific stride forward, however it is most important because it demonstrates significant progress in deductive reasoning. It seeks to explain a natural phenomenon by natural causes not by supernatural forces or an appeal to faith, or by the exercise of dialectic ingenuity but with *" . . . straight rectilinear thought"* at a time when minds ran in small circles.



STEAM CAR DEVISED BY SIR ISAAC NEWTON 1680

We will get to be able to construct machines with which we will be able to impel great boats with higher speeds than all a trimming of rowers, and with which only a pilot who governs the boat will be needed; we will impel vehicles with incredible speeds, without the aid of any animal and we will construct machines that, by means of wings, will allow us to fly in the air, like birds.[25]

[24] Ibid 23 *Love's Complaint*, William the Clerk, *History of Electricity*, Chapter Six, page 151

[25] XIII century. Roger Bacon, an English Franciscan monk, *History of the automobile, the first steam machines that replaced the horse vehicles,* The Old Times, 2003 http://www.austral.addr.com/old_cars/

 ISBN 0-9741412 -9-1

From the beginning of time, humanity has depended upon the sun and its by-products for heat and light. For over 12,000 years, we have relied upon many indirect sources translating the sun's energy via the mysteries of the *flame*. Generally those sources include candle tallow from vegetable and animal fat, animal and human waste, biomass oil from plants, and most significantly fossil fuels including coal, oil and gas. Other sources include uranium. We have also used the wind and water in the form of steam or hydro to generate electricity. An important consideration I would like consumers to embrace is the lack of a natural evolution in electricity generation technologies the past century despite the vast evolution of a variety of electronic conveniences. The evolution of electronics emerged from a solid foundation of observation of phenomena, experimentation and the discovery and use of nature's mysteries over the last two millenniums.

In 1900, only 3% of Americans had electricity in their homes. 99% of it was generated by coal. *Electricity* has transformed civilization in many ways over the last century. The tremendous *vacuum of energy commerce* created in the 20th Century is unlike any phenomena heretofore faced in the history of human civilization. It is destined to expand worldwide in the 21st Century. The more we use what we learn, the wider our vista of potential seems to widen. Only in the last half century, have the mysteries of solid-state electronics and semiconductors been readied for commercial use allowing us to rely upon the direct light of the sun to generate electricity.

The ElectriCity® series shares with you, the consumer, an overview of the history of scientific discovery related to electricity and magnetism with an introduction into the arena of public hearings within energy agency proceedings. The reason that I include my experience in policy management is that my profession is that of a design consultant in architecture with special training in restoration of buildings and solar architecture or building-integrated photovoltaics [BI-PV]. My participation in energy agency proceedings was initiated by and grounded in the need for consumer education and protection. Consensus rules the rulemaking.

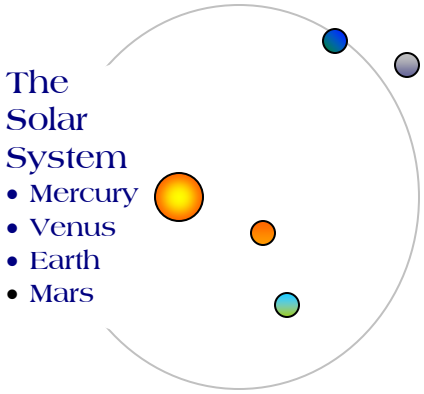
I seek to reveal to consumers the significance of the new accessibility in energy agency proceedings that for most of the last century were costly, inaccessible and dominated by energy cartels, utilities and government. Today, consumers have an unprecedented opportunity to observe and officially intervene in administrative proceedings via the Internet from the comforts of home. In modern society, with increasing dependency on electricity for security, health and communications every person has an interest in, a right and really a responsibility to know how their electricity is generated and delivered to their homes and offices. As consumers we need to know how to officially intervene in the administrative process, regularly.

This book does not seek to convince you of anything, but to inform you. One is never sure how the sharing of their experiences and knowledge may influence the world. However, the potential of what may occur in my not sharing compelled me to inform consumers of what I know on the subject.

In his discourse on perception Aristotle discuses the need to take account of the difference between the *Potential* and the *Actual.* While Aristotle did not directly discuss electricity, he discussed forces upon things and upon the psyche. The forces of commerce and intellect that he pondered are far more influential in the energy industry, today, than the technical science of electronic phenomena. Humanity has not yet digested the actual or the potential of what we have technologically discovered in the last century.

This book begins with a mini history to provide you with a summary of the origins of scientific discovery and thought regarding electricity. When I read through the following summaries of the evolution of scientific thought, one thing I found most interesting is that the elements of electricity were named after the scientists whose names dominate electronic science. Most of the truths they shared have existed since the beginning of time, as we know it. The scientists were honored because they explained their discoveries in a practical manner, which evolved our understanding of nature and ourselves.

The massive *vacuum of energy commerce* is like a huge vessel almost as large as the earth itself. In the 21st century it will most certainly become larger than the earth in scope. The computer industry and the Internet have proven the matter in which the *vacuum of modern commerce* can transform human existence, overnight for better or worse. Understanding the forces dominating the energy industry can only assist humanity and consumers in making wiser choices with less violence, crime, war and natural disaster throughout this century and beyond. So, relax and enjoy this book and let me know what I have overlooked.



7 Another question respecting sense-perception is as follows: assuming as is natural, that of two (simultaneous) sensory stimuli the stronger always tends to extrude the weaker (from consciousness), is it conceivable or not that one should be able to discern two objects constantaneously in the same individual time? . . . [15] The above assumption explains why persons do not perceive what is brought before their eyes, if they are at the time deep in thought, or in a fright or listening to some loud noise.[26]

[26] Ibid 21 *Aristotle* [b. 384 B.C.], 367 B.C. student of Plato, 335 founded Lyceum School in Athens, pg 684 http://www-history.mcs.st-andrews.ac.uk/history/Mathematicians/Aristotle.html

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CHAPTER 1
Antiquity to 1970
Magnetism, Electricity and The Photovoltaic Effect

Electricity is electricity no matter how it is generated.

Pythagoras of Samos[27] [569 BC to 475 BC] *'Semicircle'* School; Pythagorean Society ~ *identified the brain as the locus of the soul*

". . . at its deepest level, reality is mathematical in nature"

(i) The sum of angles of a triangle is equal to two right angles. …polygon with n sides has sum of interior angles 2n - 4 right angles and sum of exterior angles equal to four right angles.

(ii) The theorem of Pythagoras - for a right-angled triangle the square on the hypotenuse is equal to the sum of the squares on the other two sides.

(iii) Constructing figures of a given area and geometrical algebra. For example they solved equations such as $a\,(a - x) = x^2$ by geometrical means.

(iv) The discovery of irrationals . . . given his belief all things are numbers it would be a natural task to prove the hypotenuse of an isosceles right-angled triangle had a numeric length.

(v) The five regular solids. It is thought that Pythagoras himself knew how to construct the first three but it is unlikely that he would have known how to construct the other two.

(vi) In astronomy Pythagoras taught that the Earth was a sphere at the centre of the Universe. He recognized the orbit of the Moon was inclined to the equator of the Earth and he was first to realize Venus as an evening star was Venus as a morning star.

Plato[28] [427 BC to 327 BC] *Phaedo, Republic*

. . . that the reality which scientific thought is seeking must be expressible in mathematical terms, mathematics being the most precise and definite kind of thinking of which we are capable. The significance of this idea for the development of science from the first beginnings to the present day has been immense.

Aristotle[29] [384 BC to 322 BC] *Physica, Analytica posteriora*

In 367 BC Aristotle, at the age of seventeen, became a student at Plato's Academy. Aristotle, more than any other thinker, determined the orientation and the content of Western intellectual history. He was the author of a philosophical and scientific system that through the centuries became the support and vehicle for both medieval Christian and Islamic scholastic thought: until the end of the 17th century, Western culture was Aristotelian.

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[27] Ibid 21, *Pythagoras of Samos,* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Pythagoras.html

[28] Ibid 21, *Plato,* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Plato.html

[29] Ibid 21, *Aristotle,* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Aristotle.html

Euclid of Alexandria[30] (325 BC to 265 BC) *Elements*

Thirteen books demonstrate numerous geometrical theories. *Non-Euclidian geometries* refuted his famous fifth, or parallel, postulate, which states that one and only one line can be drawn through a point parallel to a given line.

Aristarchus of Samos[31] (310 BC to 230 BC) proposed sun-centered universe

> *His hypotheses are that the fixed stars and the sun remain unmoved, that the earth revolves about the sun on the circumference of a circle, the sun lying in the middle of the orbit, and that the sphere of fixed stars, situated about the same centre as the sun, is so great that the circle in which he supposes the earth to revolve bears such a proportion to the distance of the fixed stars as the centre of the sphere bears to its surface.*

Archimedes of Syracuse[32] Sicily (287 BC to 212 BC) *Sandreckoner.* His father Phidias was an astronomer. He estimated distances to heavenly bodies.

Michelagnolo Lodovico di Lionardo Buonarroti Simoni[33] (1475 to 1564) A Master of the portrayal of passive light in painting, sculpture and architecture.

Nicolaus Copernicus[34] (1473 to 1543) *Little Commentary, De revolutionibus orbium coelestium*. His writings established sun as center of solar system.

1. There is no one centre in the universe.
2. The Earth's centre is not the centre of the universe.
3. The centre of the universe is near the sun.
4. The distance from the Earth to the sun is imperceptible compared with distance to stars.
5. The rotation of the Earth accounts for the apparent daily rotation of the stars.
6. Apparent annual cycle of movements of the sun caused by Earth revolving round it.
7. Apparent retrograde motion of planets caused by motion of Earth from which one observes.

Galileo Galilei[35] (1564 to 1642) *Starry Messenger* May 1610, *Dialogue* 1632

The astronomical discoveries he made with his telescopes from 1609 were described in his book *Starry Messenger* published in Venice May 1610. This work caused a sensation. Galileo claimed to have seen mountains on the Moon, to have proven the Milky Way was made up of tiny stars, and to have seen four small bodies orbiting Jupiter, which he named *'the Medicean stars'*.

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[30] Ibid 21, *Euclid of Alexandria,* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Euclid.html

[31] Ibid 21, *Aristarchus of Samos,* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Aristarchus.html

[32] Ibid 21, *Archimedes of Syracuse,* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Archimedes.html

[33] *Michelangelo: A dominant force in Florence and Rome*, by Nicolas Pioch, March 2003, Web Museum, Paris http://www.ibiblio.org/wm/paint/auth/michelangelo/

[34] Ibid 21, *Nicolous Copernicus,* www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Copernicus.html

[35] Ibid 21, *Galileo Galilei,* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Galileo.html

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1600 Dr. William Gilbert[36] (1544 to 1603) The Galileo of Magnetism, ~gilbert, Gi, GB a unit of magnetomotive force equal to 0.7958 ampere-turns

'De Magneta, Magneticisque Corporibus, et de Magno magnete tellure; Physiologia nova, plurimis et argumentis et experimentis demonstrata'

The strange effects of amber remained a mystery for over 2000 years, Gilbert called the natural magnetism of amber its 'verticity'. He is attributed with having first recorded the word 'Electric' in his report written for Queen Elizabeth on the theory of magnetism.[37] Gilbert's experiments led to the development of electric technology the next 350 years. He was the first in history to have an element of electricity named after them. He reiterated the plea of Roger Bacon for more intensive research.[38]

> *In book VI, Gilbert marshaled evidence that magnetism was the motive force of the Earth's Copernicus motions. He may have been inspired by the thirteenth century writer Petrus Perigrinus, who claimed that a spherical magnet suspended from its pole rotated every twenty-four hours.*

René Descartes[39] (1596 to 1650) *Rules for the Direction of the Mind* 1619, *Discourse on the Method* 1637, *Meditations on First Philosophy*; *In Which the Existence of God and the Distinction Between Mind and Body are Demonstrated* 1640. He inspired new levels of human self-awareness.

Otto von Guericke[40] (1602 to 1686) he built the first electric generator 1663

Sir Isaac Newton[41] (1643 to 1727) *Principia, Opticks,* spectrum of light 1670

Every scientist since Aristotle had believed white light was a basic single entity, but the chromatic aberration in a telescope lens convinced Newton otherwise. When he passed a thin beam of sunlight through a glass prism he found that white light is really a mixture or spectrum of many different hues. He revealed the foundations of quantum mechanics with his theory that light rays consist of the motion of small particles rather than waves. Variations of color in light particles were later found to represent different frequency and intensity of light rays. This well-established fact today provides a basis for calculating the output of photovoltaic generators at different times of the day.

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[36] *Cambridge Scientific Minds,* edited by Peter Harmon and Simon Mitton, Cambridge University Press, 2002, quote on page 13 http://assets.cambridge.org/0521781000/sample/0521781000WS.pdf

[37] *De Magnete, Magneticisque Corporibus, et de Magno MagneteTellure; Physiologia Nova, Pluribus et Argumentes et Experimentis Demonstrata,* Dr. William Gilbert, 1600

[38] *Bibliographical History of Electricity and Magnetism,* by Paul Fleury Mottelay, Phd. 1922, Charles Griffin & Company Ltd., pages 82 to 97

[39] *René Descartes*, by Douglas Burnham and James Fieser, The Internet Encyclopedia of Philosophy, 2004 http://www.utm.edu/research/iep/d/descarte.htm#Religion,%20Science%20and%20Scepticism

[40] *Otto Von Guericke,* Corrosion Doctors, 2004, http://www.corrosion-doctors.org/Biographies/GuerickeBio.htm

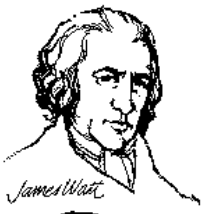
[41] Ibid 21, *Sir Isaac Newton*, http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Newton.html

Benjamin Franklin[42] (1705 to 1790) Father of Electricity, Kite Experiment 1752

Make a small Cross of two light strips of Cedar, the Arms so long as to reach to the four Corners of a large thin Silk Handkerchief when extended; tie the Corners of the Handkerchief to the Extremities of the Cross, so you have the Body of a Kite; which being properly accommodated with a Tail, Loop and String, will rise in the Air, like those made of Paper; but this being of Silk is fitter to bear the Wet and Wind of a Thunder Gust without tearing. To the Top of the upright Stick of the Cross is to be fixed a very sharp pointed Wire, rising a Foot or more above the Wood. To the End of the Twine, next to the Hand, is to be tied a silk Ribbon, and where the Twine and the silk join, a Key may be fastened. This Kite is to be raised when a Thunder Gust appears to be coming on, and the Person who holds the String must stand within a Door, or Window, or under some Cover, so that the Silk Ribbon may not be wet; and Care must be taken that the Silk Ribbon may not touch the Frame of the Door or Window. As soon as any of the Thunder Clouds come over the Kite, the pointed Wire will draw the Electric Fire from them, and the Kite, with all the Twine will be electrified, and the loose Filaments of the Twine will stand out every Way, and be attracted by an approaching Finger. And when the Rain has wet the Kite and Twine, so that it can conduct the Electric Fire freely, you will find it stream out plentifully from the Key on the Approach of your Knuckle. At this Key the Phial may be charged; and from Electric Fire thus obtained, Spirits may be kindled, and all the other Electric Experiments be performed, which are usually done by the Help of a rubbed Glass Globe or Tube; and thereby the Sameness *of the Electric Matter with that of Lightning completely demonstrated.*

!!!Note from Stephen Tubbs: Don't try to repeat this kite experiment!
It is very dangerous and it was a miracle that Franklin survived!!! 1752

James Watt[43] (1736 to 1819) ~ watt = electric unit of power



During the five years from 1761-66 Watt had worked out all the principles and invented all that was essential in the details for realizing the most perfect steam engines of the present day. When Edison's generator was coupled with Watt's steam engine and Nicola Tesla's perfection of *alternating current*, large-scale electricity generation became a practical proposition.

Horace de Saussure-Benedict[44] (1740 to 1799) flat plate solar collector 1767

John Playfair[45] (1748 to 1819) *'On the Arithmetic of Impossible Quantities', Philosophical Transactions*, 1779

"... a greater taste for purely analytical investigation than shown by any of the British mathematicians of that age."

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[42] *The Kite Experiment,* by Benjamin Franklin, The Pennsylvania Gazette, October 19, 1752

[43] *James Watt* by Andrew Carnegie, New York, Doubleday Page & Company May 1905, reprinted by Siddarth Sharma and Rahul Singh Baswan, The Steam Engine Library, 1996 http://www.history.rochester.edu/steam/carnegie/
James Watt by Andrew Carnegie, 1905, The Great Idea Finder, http://www.ideafinder.com/history/inventors/watt.htm

[44] *History of Solar Cells Timeline,* Charles E. Brown Middle School, Newton, Maine, 2004
http://www.newton.mec.edu/brown/te/HOT/STUDENTS/SALL/timeline.html
Celebrities in Switzerland: *Horace-Bénédict de Saussure*, 2004
http://switzerland.isyours.com/e/celebrities/bios/233.html

[45] Ibid 21, *John Playfair,* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Playfair.html

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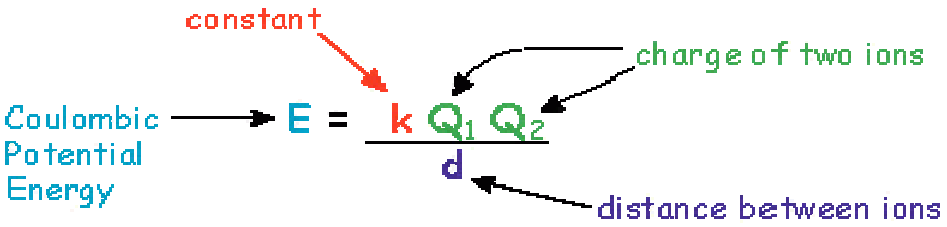
Charles Augustus de Coulomb[46] (1736 to 1806)~coulomb, symbol C is the SI unit of electric charge carried by a current of one ampere flowing for 1 second. A coulomb is about *6.24x10^{18}* times the charge of an electron.

One of the most important measuring devices of the century was invented about 1784 when Coulomb discovered that like charges repel and opposite charges attract. Coulomb is credited with having established the *science of friction*. In 1779, he published an important investigation on the laws of friction *'Théorie des machines simples, en ayant égard au frottement de leurs parties et à la roideur des cordages'.* The electric force between charges may be calculated using Coulomb's Law. The charge of an electron is the constant 6.24x10^{-19}C. Two point charges q_1 and q_2 are a distance r apart. The force between them acts on a line joining the two charges and is equal to: Fe = K q_1 and rq_2 / r^2. K is the constant that depends on the units used. Coulomb's Law is an example of Newton's 3rd Law of force where the force falls off quad-radically much like gravity. The primary difference in the formula is that r is squared in Coulomb's Law.



Luigi Galvani[47] (1737 to 1798)~galvanize = to administer an electric shock

In 1786, Luigi Galvani, was an Italian professor of anatomy and medicine at the University of Bologna. During the year of 1780, while dissecting a dead frog on a table near an electrical machine that was being used for electrical experiments, he noted a spark. While at the same time, a scalpel was held with its point at a nerve center, the legs of the frog contracted. Galvani thought that the muscles of the frog must contain electricity.

Johann Wilhelm Ritter[48] (1776 to 1810) discovered ultraviolet rays

Ritter perfected process of electrolysis discovered by Nicholson and Carlisle. He then developed the idea of a series of metals from which the relative electrical pressures produced by various pairs when immersed in a salt or acid solution could be determined. Volta conceived the same idea at a later date, and the series came to be known as Volta's *electromotive series.*

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[46] Ibid 21, *Charles Augustin de Coulomb,* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Coulomb.html
http://encyclopedia.thefreedictionary.com/Charles%20Augustin%20de%20Coulomb

[47] *Luigi Galvani*, IEEE Virtual Museum 2004, http://www.ieee-virtual-museum.org/collection/people.php?id=1234675&lid=1

[48] *Adventures in Cybersound* by Dr. Russell Naughton, 2000, http://www.acmi.net.au/AIC/RITTER_BIO.html
http://www.geocities.com/bioelectrochemistry/ritter.htm

Count Alessandro Giuseppe Antonia Anastasio Volta[49] [1745 to 1827]
volt = the unit of electrical potential Watts = Amps x Volts

By 1792 another Italian scientist, Alessandro Volta, disagreed with Galvani. 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 laying. 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. In this way, electricity flowed 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, thereby making an important contribution to the science of electricity.

André Marie Ampére[50] [1775 to 1836] ~ amp = unit of electric current
'Recueil d'Observations . . .' Paris 1822, *'Précis de la Théorie . . .'* and *'Théorie des Phénomènes Electro Dynamiques'*

Ampére was a French mathematician who devoted himself to the study of *electricity* and *magnetism*. He was the first to explain the *electro-dynamic theory*. His greatest achievement was his discovery and explanation of the forces between two wires carrying electric currents. A permanent memorial to Ampére is the use of his name for the unit of electric current. In 1820, he delivered lectures at the French Academy describing the relationship between the direction of current flow and the deflection of a magnetic needle. He showed that parallel conductors carrying currents in the same direction attracted each other, and conductors carrying currents in the opposite direction were mutually repelled. He developed the *astatic needle,* which neutralizes the effects of the earth's magnetism.

Hans Christian Øersted[51] [1777 to 1851] *'Experimenta circa effectun conflictus electrici in acum magneticam'*

In 1819, he discovered that electric current in a voltaic battery would affect the needle of a compass, and that a large magnet would alter the course of electric current. On July 21, 1820 he published his great discovery.

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[49] *Alessandro Volta, Fascinating Facts About the Man that Invented the Battery*, The Great Idea Finder, 2004 http://www.ideafinder.com/history/inventors/volta.htm

[50] Ibid 21, ***André Marie Ampére***, http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Ampere.html

[51] *Selected scientific works by Hans Christian Ørsted*, Translated and edited by Karen Jelved, Andrew D. Jackson, and Ole Knudsen, and with an introduction by Andrew D. Wilson. Princeton University Press, 1998 http://chem.ch.huji.ac.il/~eugeniik/history/oersted.htm

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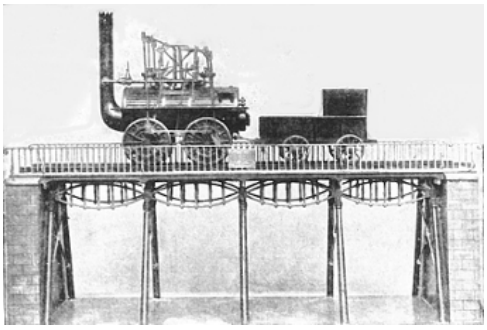
Sir Humphrey Davy [1778 to 1829][52] *'An Account of Some Galvanic Combinations Formed by the Arrangement of Single Metallic Plates and Fluids, Analogous to the New Galvanic Apparatus of Volta'*

He was one of the most brilliant scientists of his age. In his first lecture before the Royal Institution on April 25, 1801 he discussed the history of *galvanism*. Batteries at that time were subject to a defect called *polarization.* Davy had proven the chemical nature of the *voltaic cell* and other experimenters had succeeded in decomposing water. Therein, he developed a great interest in the chemical action of *voltaic current*. Berzelius of Gotland, Sweden published a number of related papers on electrochemical research from 1802 to 1806. On November 20, 1806, Davy delivered his first Bakerian Chemical lecture before the Royal Society entitled, *"On Agencies of Electricity,"* and thereby provided the basis for *ionization theory.* In 1810, Davy for the first time exhibited the carbon electric arc using a battery as the source of electricity.



I believe that I can do something for you", were the modest words whereupon Sir Humphrey Davy finished the interview, and seven weeks later, he announced that his experiments and tests had been still more lucky than hoped. The result was the discovery of the coal miner's Davy safety lamp.

The Locomotion, built by Stephenson in 1825, Here it is going over the first railroad bridge[53]

. . . The work of the miner has been and will always be a hard fight against the danger. The death is constantly on his side. He can be poisoned by carbon monoxide , carbonic acid , or carbonaceous hydrogen called marsh gas , or by the products that infest a mine after the explosion; he can be squashed by the collapses of the ceilings and walls of the mines, because always the weight of the undermined Earth tends to sink whatever is on the head of the miner, and to obstruct the underground galleries by pressures in all directions.

William Thomson[54] [1824 to 1907] knighted 1866, raised to peerage in 1892 [Baron Kelvin of Largs] in recognition of his work in engineering and physics. Kelvin symbol K is absolute zero temperature where no further energy may be extracted. K = Absolute Zero; K = −459.67 °F and K = − 237 °C

He was foremost among the small group of British scientists who helped to lay the foundations of modern physics. His contributions to science include

[52] Ibid 38, *Davy Humphrey*, Bibliographical History of Electricity and Magnetism, pgs 339 to 350

[53] *History of Transportation/Coal,* The Olden Times, 2003 http://www.austral.addr.com/old_trains/english.htm

[54] Ibid 21, *William Thomson [Lord Kelvin],* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Thomson.html
What is Absolute Zero? Lansing State Journal, January 29, 1992, http://www.pa.msu.edu/~sciencet/ask_st/012992.html

a major role in the development of the second law of thermodynamics, the absolute temperature scale (measured in *kelvins*), the dynamical theory of heat; the mathematical analysis of electricity and magnetism, including basic ideas of electromagnetic theory of light. He brought precision and order into electrical science, and linked its principles to chemistry and physics.

Jean-Charles de Borda[55] (1733 to 1799)

> *Borda made good use of the differential calculus and of experimental methods to unify areas of physics. He also developed a series of trigonometric tables in conjunction with his surveying techniques. He* [*also*] *calculated the coefficient of fluid contraction from an orifice. Borda's use of the principle of conservation of* [*energy*] *was important as a precursor of Lazare* Carnot's *work in mechanics.*

J[öns] J[akob] Berzelius[56] (1779 to 1848) electrochemical properties of selenium; Secretary of Royal Academy of Sciences in Stockholm (1818–48)

> *Electrochemistry has many applications beyond the university laboratory and provided the start of many corporations. These twelve achievers all investigated the connection between chemistry and electricity. The field began as a theoretical exploration of fundamental forces at work in the universe; it is now a cornerstone of industry, technology, and medicine.*

His interest in compounds led to his discovery of a number of new elements, including cerium, selenium, and thorium. Using his experimental results, he determined the atomic weights of known elements.

> *When selenium is rapidly cooled from a fused condition it is a non-conductor. In this, its "vitreous " form, it is of a dark brown color, almost black by reflected light, having an exceedingly brilliant surface. In thin films it is transparent, and appears of a beautiful ruby red by transmitted light. The chemical properties of this new element were found to resemble those of tellurium in such a remarkable degree that Berzelius gave to the substance the name of "selenium" from the Greek word selhum, the moon, ("tellurium," as is we'll known, being derived from tellus, the earth). Although tellurium and selenium are alike in many respects, they differ in their electrical properties ; tellurium being a good conductor of electricity, and selenium, as Berzelius showed, a non-conductor.*

George Simon Ohm[57] (1787 to 1854) ~ohm=current flowing via conductors In 1827, Ohm published the results of his study *"The Galvanic Circuit Investigated Mathematically"* which first presented the law that now bears his name. In present day international symbols, this law reads $I = V/R$, where I is the current V is the electromotive force or voltage and R is the *resistance.* He was awarded the Copley Medal in 1841. His name Ohm has been given to the *unit of electrical resistance*.

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[55] Ibid 21, *Jean-Charles de Borda,* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Borda.html

[56] *Jon Jakob Berzelius*, Chemical Achievers, The Chemical Heritage Foundation
http://www.chemheritage.org/EducationalServices/chemach/eei/eei.html2000
http://nautilus.fis.uc.pt/st2.5/scenes-e/biog/b0008.html

[57] Ibid 21, *George Simon Ohm,* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Ohm.html

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Karl Friedrich Gauss[58] (1777 to 1855) ~ gaussian =units in magnetic formula

This was one of the principal authors of electric and magnetic units. Gauss developed a system of magnetic units in 1832, using the millimeter, milligram, and second as the units of length, mass, and time. Gaussian refers to the changes in units to make the magnetic formula more uniform. Lorentz named it after Gauss. The primary element left out was 4π.

Samuel F.B. Morse[59] (1791 to 1872) invented and sent first telegraph1844

Michael Faraday[60] (1791 to 1867) ~ evolved the practical use of electricity

In 1821, through experiments in magnetism and electricity he discovered that a conductor carrying a current would rotate about a magnetic pole and that a magnetized needle would rotate about a wire carrying an electric current. If electricity could produce magnetism, why couldn't magnetism produce electricity? In 1831, Faraday found the solution. He demonstrated that *electricity could be produced through magnetism by motion thus inventing the world's first electrical generator.* He discovered that when a magnet was moved inside a coil of copper wire, a tiny electric current flows through the wire. Faraday was the first to speak of a *molecule of electricity*.

> ***Faraday discovered the two laws of electrochemistry: The amount of chemical change or decomposition is exactly proportional to the quantity of electricity that passes in solution; and the amounts of different substances deposited or dissolved by the same quantity of electricity are proportional to their chemical equivalent weights. In 1833 he and William Whewell worked out a new nomenclature for electrochemical phenomena based on Greek words which is more or less still in use today—"ion," "electrode," and so on.***

George Johnstone Stoney[61] (1826 to 1911) atom of electricity an *'electron'*

Stoney was one of a group of Irish scientists who made significant contributions to the study of spectra, that is the light of various colours emitted or absorbed by different substances. Stoney's most important scientific work was the conception and calculation of the magnitude of the atom or particle of electricity, for which he coined the term "electron".

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[58] Ibid 21, *Karl Fredrich Gauss,* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Gauss.html

[59] *Samuel F.B. Morris,* by Tyler Anbinder, A Reader's Companion to American History, Houghton Mifflin, 2001 http://college.hmco.com/history/readerscomp/rcah/html/ah_061700_morsesamuelf.htm

[60] *Michael Faraday*, *The Human Face of Chemical Science*, by Mary Ellen Bowden and Mark Michalovic, Chemical Achievers, The Chemical Heritage Foundation 2000, http://www.chemheritage.org/EducationalServices/chemach/eei/mf.html

[61] *George Johnstone Stoney*, Aug 2004, http://www.universityscience.ie/pages/scientists/sci_georgestoney.htm

THE PHOTOVOLTAIC EFFECT

Alexandre-Edmund Becquerel[62] (1820 to 1891) discovered and noted the Photovoltaic Effect in 1839 as was recorded in his paper, *'On electron effects under the influence of solar radiation.'* Comptes Rendues 9, 56'.

By the light of whale oil and candles this French physicist immersed two electrodes of the same material in an electrolyte bath. He found that when he laid one of them in the sunlight there was a difference of potential between them of about 0.1 volt. This recorded observation represents the discovery of the *Photovoltaic Effect.*

His son Antoine Henri Becquerel (1852 to 1908) *father of radioactivity* and received the Nobel Prize. His father was Antoine César Bequerel (1788 to1878) Fellow of the Royal Society and inventor of an electrolytic method.

James Clerk Maxwell[63] (1831 to 1879) *Electricity and Magnetism* 1873; *On A Dynamical Theory of Electromagnetic Field* 1865

Maxwell is generally regarded as one of the world's greatest physicists. His research combined the fields of electricity and magnetism and introduced the concept of the *electro-magnetic field.* He rejected the idea that electricity exerted a *"pull"* across empty space. His experiments led the way for wireless telegraphy and telephony. Maxwell showed that electric phenomena display mathematical relations corresponding to the phenomena of light. His belief that light, heat and electric waves are similar in nature led to the discovery of radiation and the development of the *photovoltaic effect.* His theories are set out in four partial differential equations known as Maxwell's equations.

Heinrich Rudolf Hertz[64] (1857 to 1894) ~ hertz = electromagnetic wave Hertz became interested in Clerk Maxwell's theories, and succeeded in producing electromagnetic waves, later called Hertzian or radio waves.

Willoughby Smith[65] (1828 to 1891) *Effect of Light on Selenium during the passage of an Electric Current*, Nature, 20 February 1873; *Selenium: its electrical qualities, and the effect of light thereon. Being a paper, etc.* Hayman Bros. & Lilly, s.l., S.d., (London, 1877 or 1878 ?) , 21 p.

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[62] E.Becquerel, *Comptes Renduces 6* (1839) 561 The History of PV, PV Power Resource Site, Photovoltaics: Sustainable Power for the World, by Mark Fitzgerald, 2003, www.pvpower.com, site@pvpower.com

[63] Ibid 21, *James Clerk Maxwell,* http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Maxwell.html

[64] *Heinrich Rudolph Hertz,* http://encarta.msn.com/encyclopedia_761568022/Hertz_Heinrich_Rudolf.html, Microsoft® Encarta® Online Encyclopedia 2004 Microsoft Encarta, 2004

[65] *Willoughby Smith,* History of Television, January 2003, *http://histv2.free.fr/selenium/smith.htm*

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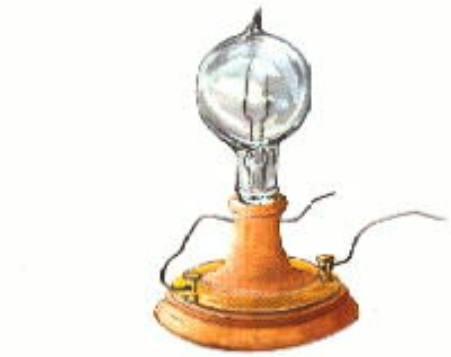
Smith found that small rods of selenium became better conductors of electricity when exposed to light. He first discussed the photoconductivity of selenium, which was used to build the first *photovoltaic cells*.

Thomas Alva Edison[66] (1847 to 1931) patented 1,093 inventions, earning him a title of "The Wizard of Menlo Park." In 1869 he received his first patent for the Stock Ticker. In 1877, Thomas Edison began work on the incandescent lamp in his laboratory in Menlo Park, New Jersey. Edison experimented with carbon then with platinum, with metallic alloys, and then returned to carbon. Several patents were granted to him on the metal filament lamps. 1878 he worked on the phonograph and in summer, he went on an expedition to Wyoming to view an eclipse of the sun. October 21, 1879, he made a lamp with a carbonized thread filament that burned for forty-five hours before it failed. He applied for a patent on November 4, 1879, that was granted Jan. 27, 1880.



electric light bulb

phonograph

kinetoscope

Edison was not only a great inventor, but also an excellent businessman and an organizer. On October 17, 1878, *The Edison Electric Light Company* was organized with a capital of $300,000 backed by stockholders and directors from New York financiers. Sunday, December 21, 1879, the *New York Herald* printed a full-page describing the plant. Gas company stocks fell rapidly. Edison Electric Light Company shares were traded up to $5,000. Edison lauded the benefits of *Direct Current* (DC). Upon partnership with Joseph Swan, Edison used his DC generator to provide electricity to light his laboratory and later from the Pearl Street station he illuminated the first New York Street lit by electric lamps, in September 1882. In 1929, Edison and Swan produced the first practical filament lamp.

[66] *The Wizard of Menlo Park Thomas Alva Edison*, Franklin Institute and Museum, Pittsburgh, Pennsylvania 2004, http://sln.fi.edu/franklin/inventor/edison.html

Joseph Wilson Swan[67] (1828 to 1914) invented the first electric light 1860

In 1860, this British scientist invented the *carbon filament incandescent lamp* nearly twenty years before Thomas Edison made a similar discovery in America. In 1878 he produced an all-glass hermetically sealed bulb.

Alexander Graham Bell (1847 to 1922) patented his telephone invention 1876

W(illiam) G(rylls) Adams[68] (1836 to 1915) and student R.E. Day *'The action of light on selenium,'* in Proceedings of the Royal Society, A25, 113, 1878.

> *In 1876, with his student R. E. Day, Adams discovered that illuminating a junction between selenium and platinum also has a photovoltaic effect, though in this case, an EMF is actually produced, not altered. This effect is the basis for the modern solar cell.*

Charles Fritts[69] an American inventor from New York City devised the first functional intentionally made PV device in 1883. He created the first large selenium solar wafers from Se film by coating the semiconductor selenium with an ultra thin, nearly transparent layer of gold. He believed this *photoelectric plate* would compete with Edison's coal fired electricity plants.

Nikola Tesla[70] (1856 to 1943) ~unit of measurement for magnetic fields; AC

"Nature and Nature's laws lay hid in night: God said "Let Tesla be", and all was light."

Handy Magnetic Field/Flux MKS and CGS Conversion Factors

1 gauss (G) = 1 x 10^3 milligauss (mG)	1 milligauss (mG) = 1 x 10^{-7} tesla (T) or 0.1 μT
1 gauss (G) = 1 x 10^{-4} tesla (T)	1 milligauss (mG) = 1/(4 π) A/m
1 A/m = 4π x 10^{-3} oersteds (Oe)	1 tesla (T) = 1 weber (Wb)/m^2

ELF EMF, 60-Hz Wavelength, DC & AC Fields

*Electric power generated in North America is 60-Hz alternating current (AC). This means both the **voltage** and **current** are sinusoidally varying (change polarity twice in each cycle or 120 times every second). The 60-Hz AC line frequency has a monstrous wavelength of 3,100 miles (5,000 km) calculated between cycles using:*

C speed-of-light = (wavelength)(frequency).

Alternating current (AC) electric and magnetic fields fluctuate in space as the sinusoidally varying voltage and current change polarity, whereas DC fields (like the earth's geomagnetic field) remain statically polarized based upon the direction of the current flow (remember the Right Hand Rule).

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[67] *Joseph Wilson Swan; Electric light and actinic light . . . a pioneer*, Tim Pickford-Jones and Timmonet, June 11, 2004, http://www.timmonet.co.uk/html/body_joseph_swan.htm

[68] *William Grylls Adams, professor of natural philosophy, King's College London,* by Navigational Aids for the History of Science, Technology and the Environment, [NAHSTE], University of Edinburgh, 2004 http://www.nahste.ac.uk/isaar/GB_0237_NAHSTE_P0910.html

[69] *Solar Energy Timeline,* Charles E. Brown Middle School, Newton, Massachusetts, December 2004 http://www.newton.mec.edu/Brown/TE/HOT/TIMELINES/SOLAR/solar_timeline.html

[70] *B.A. Behrend, AIEE annual meeting, New York City, May 18, 1917,* Pr itchard School of Digital Electronics, 2004 http://pritchardschool.com/novustesla.html

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Nicola Tesla worked for a brief time with Mr. Edison, but then went his own way. They were rivals regarding *Direct Current* or DC and *Alternating Current* or AC. *AC/DC*[71] is a modern electric band formed a century later. Nikola Tesla's AC electricity won over at the Chicago World's Fair in 1893.

Alternating Current [AC] Power Plant at World's Fair, Chicago in 1893.[72]

> *Quite apart from the lighting plant, the Westinghouse Company showed at the World's Fair a complete polyphase system. A large two-phase induction motor, driven by current from the main generators, acted as the prime mover in driving the exhibit. The exhibit, then, contained a polyphase generator with transformers for raising the voltage for transmission; a short transmission line; transformers for lowering the voltage; the operation of induction motors; a synchronous motor; and a rotary converter, which supplied direct current, which in turn operated a railway motor. In connection with the exhibit were meters and other auxiliary devices of various kinds. The apparatus was in units of fair commercial size and gave to the public a view of a universal power system in which, by polyphase current, power could be transmitted great distances, and then be utilized for various purposes, including the supply of direct current. It showed on a working scale a system upon which Westinghouse and his company had been concentrating their efforts; namely, the alternating-current [AC] and polyphase system. It has been maintained with some plausibility that the most important outcome of the Centennial Exposition of 1876 was that the people of the United States there discovered bread. So it may be maintained with even more plausibility, that the best result of the Columbian Exposition of 1893 was that it removed the last serious doubt of the usefulness to mankind of the polyphase alternating current.*

George Westinghouse[73] [1846 to 1914] perfected first automatic, electric block train signal and supported Nicola Tesla's research

Westinghouse was a famous American inventor and industrialist who purchased and developed Nikola Tesla's patented motor for generating alternating current. Coal was the fuel first used for commercial electricity generation. In 1900 only 3% of Americans had access to electricity for their homes and 90% was generated by coal. In 2004 coal 55%, fossil fuels 70%.

J(oseph) J(ohn) Thomson[74] [1856 to 1940] discovered the electron in 1897

As Professor of experimental physics at Cambridge he measured the mass and determined the electric charge of particles in cathode rays. He identified them with the ultimate particles of electricity now known as electrons. Electrons are the basis of *photoelectric cells* or *photovoltaic* electricity.

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[71] *AC/DC Bio*, Electric Shock, AC/DC.net, 2004, http://www.ac-dc.net/

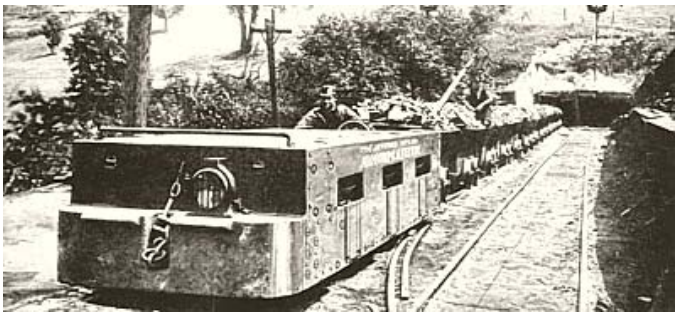
[72] *Nikola Tesla : The Chicago World's Fair,* Adopted from "A Life of George Westinghouse," by Henry G. Prout, 1921., http://www.neuronet.pitt.edu/~bogdan/tesla/chicago.htm

[73] *George Westinghouse*, by Grey Gobel, Wikipedia The Free Encyclopedia, 2004 http://en.wikipedia.org/wiki/George_Westinghouse,

[74] *The Atomic Model and Quantum Mechanics,* Matter and Molecules Timeline of Achievement, Chemical Heritage Foundation, 2004, http://www.chemheritage.org/explore/matter-time7.html

Photo: Jeffrey Manufacturing Co. Train of coal delivery trucks leaving a mine in the direction of breakers. [75]

The enormous coal production towards the 1900's in all active centers of commerce in the world was a completely new thing destined to evolve machinery for Humanity putting speed in the movement of the trains and ships, which accelerated the interchange of the products of all races and climates. The old world did not know anything about soft coal, and it did not, therefore, make practical use of it. About two thousand years ago the British got to know the use of mineral coal, and the Romans learned it from them.



Max Karl Ernest Ludwig Planck [1858 to 1918]
1900 ~ Planck's Constant (h)=quantum of action 6.625 X 10^{-27} erg second

In his study of blackbody radiation he derived a theoretical formula that fit the distribution of radiated energy over all wavelengths for different temperatures. In the derivation of this equation he found it necessary to assume that radiant energy was emitted in very small discrete bundles called *quanta* and that the magnitude of a quantum of energy was *hv,* in which *v* was the frequency of the radiation and *h* was a new universal constant that he called the *quantum of action.*

Guglielmo Marconi[76] [1874 to 1937] wireless medium; radio 1900

Albert Einstein[77] [1879 to 1955] ~ mutual convertibility of matter and energy (photoelectrons) 1923 received Nobel Prize for theories explaining PV effect

In 1905 he presented his treatise explaining the *photovoltaic effect.* A new interest in this simple, pollution-free electricity generation grew slowly over the next half century however the simplicity and beauty of the *photovoltaic effect* were not pursued commercially until fifty years later. Einstein's theory on the mutual convertibility of matter and energy made an important contribution to the theory of photoelectrons. It is expressed by the equation $E = hv = W + \frac{1}{2} mv^2$. *E* equals the product of Planck's constant *h* and the frequency of the photon *v* (the Greek letter nu), which equals the sum of *W;* the work required to free the electron from metal, and its kinetic energy $\frac{1}{2} mv^2$. Here *m* is the mass of the electron and *v* is its speed after being freed

[75] *Old Trains,* The Olden Times, 2003, http://www.austral.addr.com/old_trains/english.htm
[76] *Guglielmo Marconi*, Nobelprize.org, http://nobelprize.org/physics/laureates/1909/marconi-bio.html, from *Nobel Lectures, Physics 1901-1921* Elsevier Publishing Company, Amsterdam 1967
[77] Ibid 21, *Max Karl Ernest Ludwig Planck*, http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Planck.html

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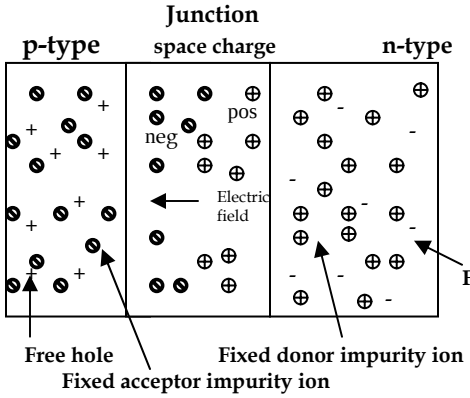
by the photon. The value *v* is determined by one or more methods explained in the source. The *W* is the variable depending on the kind of metal used. The velocity of the photoelectron increases with the energy of the photon. High-frequency photons have greater energies than low-frequency photons, and in order to free electrons from heavier metals ultraviolet light is required. *Adding to the intensity of the light does not change the velocity of the photoelectrons, but increases their number*.

DIFFUSION OF CARRIER[78]



ENERGY OF A PHOTON

A photon is characterised by either a wavelength, denoted by λ, or alternately the energy of the particular photon, denoted by *E*. There is an inverse relationship between the energy of a photon (*E*) and the wavelength of the light (λ) given by the equation:

$$E = \frac{hc}{\lambda}$$

where *h* is Planck's constant and *c* is the speed of light.

Henry Ford[79] (1863 to 1947) built his first automobile in 1896. In 1908 he built prototype for Model T. On May 26, 1927 he watched the fifty millionth Model T roll off the assembly line of his factory in Highland Park, Michigan.

> *Later that year, Ford attended a national meeting of Edison employees. Thomas A. Edison had been Ford's idol for years. But at the meeting, it was Edison who asked to meet the young inventor, after word got around that the obscure engineer from Detroit had actually built an automobile. "Young man, you have the right idea," Edison said. "Keep right at it". Ironically, he was adamant that Ford not waste his time trying to make a car run viably on electricity.*[80]

The advent of mass production is one of the most important events of the 20th century. Demand-site fuel-free electricity generation will be a major transformation of the 21st century. We are not waiting we are trying to figure out how to accomplish this. The consequent *massive vacuum of commerce* evolves technologies as dramatically as it suppresses them. Learning to manage this vacuum of commerce democratically for the good of humanity is one of the most precarious frontiers of the 21st Century. One of my goals is to develop a mathematical formula for this transformation of commerce.

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[78] *Diffusion of Carrier*, PVCDROM, University of New South Wales, Centre for Photovoltaic Engineering, 1998 http://www.pv.unsw.edu.au
The Photovoltaic Junction or Electric Diode,1997, http://www.geocities.com/CapeCanaveral/5161/photo.html

[79] *The Life of Henry Ford*, http://www.hfmgv.org/exhibits/hf/chrono.asp The Henry Ford Museum, 1995-2004 http://www.thehenryford.org/ 2004

[80] *Forbes Greatest Business Stories of All Times*, by Daniel Gross 1996 http://www.wiley.com/legacy/products/subject/business/forbes/ford.html

Electric light, a hundred times more brilliant took over the twentieth century. It extended the hours of sensation and recreation. It made plays and movies visible after sunset. It opened libraries, restaurants, bowling alleys, baseball parks and clubs in the hours of darkness.[81]

Jan Czochralski[82] (1885 to 1953) *Czochralski process of crystalline growth*

" . . . a chemist who discovered the Czochralski process, which is used to grow single crystals and is used in the production of semiconductor wafers."

Wilbur (1867 to 1912) and Orville Wright[83] (1871 to 1948) flew the first plane in 1908. Airlines secured fossil fuel domination of the electricity industry.

Henry Ford (1863 to 1947) In 1913 introduced first moving automobile assembly line at Highland Park. By 1921, Ford dominated 55% of the market. 1926 Henry Ford dedicated his Edison Institute of Technology and Greenfield Village with a celebration of 50 years of the electric light. Gas turbine engines power most airplanes and they are one of the largest sources of electricity, today. After crude oil was introduced to combustion engines, steam trains turned to coal-fired fuels just as Ford introduced mass production in manufacturing.

Energy Crisis ca. 1920[84]

Need for oil pioneers ... The pioneering spirit should now lead American capital and American engineering to seek new sources of petroleum supplies in foreign fields for the benefit of the America of tomorrow. Nor can this be done without popular support inspired by general appreciation of oil as our servant, a servant that works 24 hours a day and 7 days a week.[85]

Over the last century civilization has actually become a slave to oil and the fossil fuel market power has become a phenomena with no loyalties. Upon closer scrutiny the political control everyone talks about is revealed to have evolved to a mindless momentum or *vacuum of energy commerce*

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[81] *Pursuing Happiness: American consumers in the Twentieth Century,* Stanley Lebergott, Princeton University Press 1996

[82] *Jan Czochralski,*Wikipedia, free content encyclopedia, *http://www.fact-index.com/j/ja/jan_czochralski.html* 2004

[83] *The Wright Brothers Aëroplane*, by Orville and Wilbur Wright, Century Magazine 1908; website by Steve Wright, 11/24/01, http://www.wam.umd.edu/~stwright/WrBr/Century.html

The Right Brothers A pair of self-taught engineers working in a bicycle shop, they made the world a forever smaller place, by Bill Gates, March 29, 1999 http://www.time.com/time/time100/scientist/profile/wright.html

[84] *But Where Will Americans Get It When America's Wells Cease To Flow,* by George Otis Smith Director of the Geographical Survey 1907 to 1930, 1920

The Energy Crisis Déjà vu All Over Again (Archive), by Blaine Townsend, July 2001, Trillium Asset Mgmt. http://www.trilliuminvest.com/pages/news/news_detail.asp?ArticleID=73&Status=Archive

The U.S. Energy Crisis of 1920 and the search for oil supplies, by Alan L. Olmstead and Paul Rhode, Davis, Calif.: Agricultural History Center, University of California, 1986

[85] *Where the World Gets Its Oil*, National Geographic, February, 1920 http://www.energycrisis.com/history/ng20feb.htm

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perpetuating fossil fuel domination. Another proof of this theory is the fact that while a diversity of electronic appliances have flourished in the last century ways to generate electricity were substantially limited to remote-site fossil fuel, nuclear and large hydro. Mass production of renewable solar electricity devices in the *vacuum of electricity commerce* could evolve positive transformations in energy commerce. This book explores the theory that less than 1% of America's 300 million consumers across the nation could facilitate this massive transformation via the democratic empowerment of consumers in energy agency proceedings. Although the concept may sound simple, the truth is we have not yet figured out how to infuse new technologies with the momentum needed to transform monopoly-dominated industries like electricity commerce. Consultants like Alan Greenspan say the energy industry should not be tampered with insisting *industry dynamics* must be allowed to evolve naturally. We need to consider that the present forces dominating electricity commerce and its unique characteristics have been unnaturally manipulated and that consumers as one of the primary *industry dynamics* have been misused.

Shortly after World War I[86] the first alleged energy shortage was announced. In 1998, I found a little book entitled *The Oil Crisis 1920* at the University of California at Irvine. The book, which could no longer be found for reference, claims the Earth's oil resources would be depleted during the 1920's. In 1943, *'The Oil Crisis, a discussion requested by a gentleman from Massachusetts. An appeal for action'* was published in Independence, Kansas.[87] The Energy Crisis *technique* set out in these books during the first half of the last century appear interestingly similar to media panic coverage of Energy Crisis 2000 and the energy crisis of the 1970's. The *energy crisis technique* is being used to mesmerize and traumatize investors, consumers, decision-makers and taxpayers into panic funding of fossil fuel commerce while diverting attention from the crimes, atrocities and risks involved in furthering remote-site generation with oil, gas and coal deployment. The psychosocial impact of this activity has not been adequately determined. As consumers become educated and more effectively involved in energy agency proceedings, the *energy crisis technique* will surely become less influential resulting in decreased dependency on remote site generation and fossil fuels. Otherwise it may be used to mesmerize civilization to the year 2100 and beyond. Consider the many benefits to humanity to know that as long as the sun shines we will not have another energy crisis due to fuel shortages. We need to hear that *truth* in the news. That is real reliability with the kind of security that makes for a good night's rest.

[86] Hill, Harry H., *The gasoline situation,* Corp.: Universal Oil Products Company; Engineers Club of Philadelphia; United States Bureau of Mines; Universal Oil Products Co., Chicago 1926

[87] Galey, Thomas, M., *The Oil Crisis, a discussion requested by a gentleman from Massachusetts. An appeal for action,* Independence, Kansas 1943

B. Lange, L.O. Gronmdahl & W. Schottky[88] 1930 Discovered photovoltaic properties of cuprous oxide.

America's Answer to the Russian Challenge[89]

. . . in which electric power as a common denominator is requisitioned to throw light on the Russian enigma and the challenge it presents to western civilization . . .

The next quarter century, sound recordings and movies began to challenge the dominance of live theater and performance. Candles were no longer as precious a commodity and community letter writing began to decline because 90% of American homes by 1950 had electricity and telephones. Tesla's AC generation enabled the transmission of large blocks of electrical power using high voltage transformers, which was impossible otherwise. In the first half of the last century, *America's Answer* brought the development of large remote site hydro, nuclear and fossil fuel distribution facilities managed by utilities and rural electric cooperatives. These entities secured the role of remote-site generation during the first half of the 20th century. Large hydro, fossil and nuclear plants became the backbone of modern electricity deployment facilitating the American dream. This romanticized era in American history is idealized in the 1968 song *Wichita Lineman.*[90]

I am a lineman for the county and I drive the main road
Searchin' in the sun for another overload
I hear you singing in the wires I can hear you through the whine
And the Wichita lineman is still on the line . . .

Distributed (DG) or *self-generation* technology was given a minor role in the history of electricity generation, until the energy crisis of the 1970s. Since then, gas turbine co-generation plants and a few commercial solar thermal and PV projects have been more commonly installed on the consumer-side of the grid for many years. But, very few residential photovoltaic systems were actually interconnected to the grid before Energy Crisis 2000.

Alan Greenspan recommends the energy market not be tampered with insisting it must be allowed to evolve via *natural market dynamics.* The truth is historically electricity commerce has been dramatically manipulated and the primary *natural market dynamic* of consumers *unnaturally* misused.

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[88] B. Lang, '*New photovoltaic cell,*' "Z. Phys." 31, 139; W. Schottky, *'New Cuprous oxide photoelectric cells,'* "Z. Phys." 31, 913, 1930, The History of PV by Mark Fitzgerald, 2003 http://www.pvpower.com/pvhistory.html#1839

[89] *America's Answer, to the Russian Challenge in which electric power as a common denominator is requisitioned to throw light on the Russian enigma and challenge its presence to Western Civilization,* by S.E. Sibley, B.S., E.E., Robert, Farallon Press, San Francisco 1931; NOTE: Second World Power Conference Berlin 1930

[90] *Wichita Lineman,* words & music by Jimmy Webb, sung by Glen Campbell, The Musicradio Top 100 Hits of 1968

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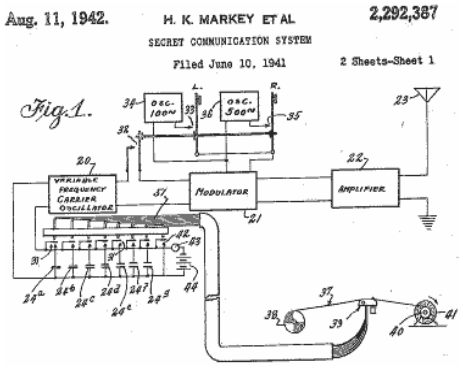
Hedy Lamarr (1913 to 2000) June 10, 1941[91] (Hedwig Kiesler Markey)



Patent No. 2,292,387 was granted for her invention of a secret communication system in an effort to help allies defeat the Germans in World War II. The invention manipulated radio frequencies between transmission and reception to develop an unbreakable code so that top-secret messages could not be intercepted. Few women have applied for and had patents granted throughout history. Ms. Lamarr is a role model for women inventors. Patent law enforcement needs to be improved to protect inventors and assure payment for their inventions from nonpaying opportunists that suppress technologies.

James Chadwick discovered the neutron in 1932. The first atomic bomb was dropped in 1945 after the bombing of Pearl Harbor creating the holocaust that ended the holocaust of World War II. From 1955 to 1964, televisions became commonplace in America. Many families soon owned at least one and often two cars. Grandmother's rural party line evolved to a private phone. Fossil fuels dominated 70% of the electricity industry and 99% plus of the transportation industry throughout the 20th century.

D.M. Chapin, G.S. Fuller and G.L. Pearson introduced photovoltaic light meters at Bell Laboratories in 1954 and achieved 6% efficiency solar cells.

William Cherry of the United States Signal Corps approached Paul Rappaport and Joseph Loferski at RCA Labs in 1956 about developing PV cells for a proposed Earth satellite. 1958 Vanguard I was the first satellite launched with photovoltaic arrays. Thirty years later PV satellites surround the Earth.

When I was a child in the 1960's, we had one of the first electric washing machines that still had a roller to squeeze water out of the clothes. We had vats of bread and butter pickles settling in the basement and my mother still churned butter. We often visited the family dairy where I would pet the cow that delivered our milk. It was also common to have milk delivered daily to your home. They still do in England. Many more people grew and canned their own food. From the late fifties to the seventies, the use of modern electronic appliances for household chores increased dramatically from electric can openers to electric knives and vacuum sweepers. The radio, phonograph and television were used widely by the close of World War II.

[91] *Hedy Lamarr,* Inventor's Assistance League, *Ecstacy and Me,* Autobiography by Hedy Lamarr, 1966, *American Heritage of Invention & Technology,* Spring 1997, Volume 12/Number 4, http://www.inventions.org/culture/female/lamarr.html

Electric guitars created a new wave of music. The electric typewriter was not invented for nearly twenty years. My first typing job in 1972 was for C.K. Little, Incorporated. I typed their ever-changing flight logs and each one had to be error-free. There was no correction tape or fluid allowed. In less than a decade the unthinkable occurred we evolved through various models of electric typewriters to the birth in the 1980's of the unbelievable mysterious and miraculous big black boxes from Wang that held words animated in space. One could correct entire paragraphs of typing without printing a document. In fact one could save their writing in the black box to print out later. Twenty years later, human dependency on flat gray screens and towers or laptop computers for business, medicine, shopping, personal communication and management activities has been dramatically expanded by the Internet. During the 20th Century, electronics advanced more rapidly than at any other time in the history of humanity. Ironically, the anchor of electronic transformation, the electricity generation and transmission industry, is the one area where new technology has been dramatically suppressed from the market. Efforts for humanity to evolve beyond this dysfunction in commerce have failed.

George Soros[92] is the closest explanation I have found to communicate the scientific basis for this failure. He wrote on the effects of *demand supply* economics and how this method of industry analysis is no longer relevant due to massive industry dynamics that fail to demonstrate the obsolesces of technologies and the demand for new technologies being suppressed by the tremendous *vacuum of modern commerce.* Underlying this dysfunction are outdated undemocratic decision-making techniques and processes. In other words, the methods are not only outdated, but alarm systems of traditional economics are also being over-ridden by erratic decision-making dictated by an impersonal *vacuum of electricity commerce.* This symptom reflects an overburdened system unable to adapt or respond to the need for humane conditions via strategic management. Official consumer intervention may assure electricity commerce evolves innovative peaceful, environmental, humane and economic pathways of deployment in the 21st century.

In 1962, Japan installed a 242-watt peak PV array on a lighthouse. This was the world's largest solar array at that time. Japan formulated the *Project Sunshine* program. Sharp Corporation succeeded in producing the first practical silicon PV modules. In 1964, Nimbus spacecraft was launched with a 470 watt PV array. By 1965, Japan had initiated the *Japanese Scientific Satellite Pro.* Visit these sites for more PV history: www.pvgap.org, http://www.pvpower.com/ and www.geocities.com/Eureka/1905

[92] *The Reflexivity Theory; the Alchemy of Finance, Reading the Mind of the Market*, George Soros, The Theory of Reflexivity April 26, 1994 to MIT Department of Economics World Economy Laboratory Conference Washington, D.C.

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Gas Price Wars and Energy Crisis ca. 1970

In 1970, while the Middle East was at the height of fighting the ongoing war to protect the Western world's access to oil resources, there was another type of gas war going on in the United States. Companies like Standard Oil and Texaco (which was created by government in Texas to compete with Standard Oil) were having *gas price wars.* For my high school driving-around budget, it was *wonderful* to purchase gasoline for 11 cents a gallon in 1970. You might imagine my shock at the price of gasoline in Europe being over $2 gallon. What I didn't realize until Energy Crisis 2000 is that 75% of the price of gasoline in Europe is from government-imposed taxation. By 1973, the second major oil crisis in the history of humanity was going strong. New information and concern about CO2 emissions and global warming awakened during the years of the Energy Crisis of the 1970's. Numerous countries began integrating renewable energy and energy efficiency into energy technology deployment activities.

EARTH DAY 1970[93]

Described by American Heritage Magazine as "one of the most remarkable happenings in the history of democracy . . ."

Denis Hayes left his graduate studies at Harvard's Kennedy School of Government to coordinate the first Earth Day in 1970 - an event often credited with launching the modern American environmental movement. Twenty years later he headed the first International Earth Day, with 200 million participants in 141 countries. Hayes returned in 2000 to serve as chair of the 30th anniversary of Earth Day, and remained as head of Earth Day Network, the group coordinating Earth Day activities worldwide. . . . Former Wisconsin Senator Gaylord Nelson's best known achievement is the founding of Earth Day in 1970.

Earth Day unified national efforts toward environmental protection. A distinguished and influential public servant, Nelson served ten years in the Wisconsin Senate, was twice elected Governor of Wisconsin, and, in 1962, began an 18-year career in the U.S. Senate. Senator Nelson's achievements:

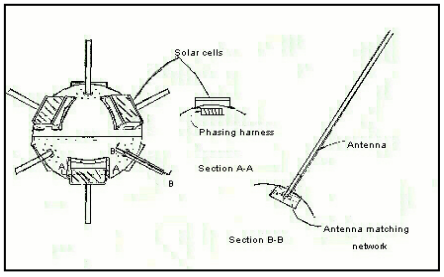
- *Preserve the 2,000-mile Appalachian Trail*
- *Mandate fuel efficiency standards in automobiles*
- *Control strip mining*
- *Ban the use of DDT*
- *Ban the use of 245T (agent orange)*
- *Create the St. Croix Wild and Scenic Riverway*
- *Create the Apostle Islands National Lakeshore"*[94]

[93] *Denis Hayes, Chairman 2003 and Co-founder of Earth Day 1970,* Earth Day Network Pressroom, 2004, http://www.earthday.net/pressroom/hayes.stm

[94] Ibid 94 *Gaylord Nelson Co-Founder of Earth Day 1970,* Earth Day Network Pressroom, 2004

"In 1974, the Sunshine project started as a reaction to the oil crisis. The 8-year long program contributed to cost reduction of PV systems from 23,000 Yen per watt in 1972 to 650 Yen per watt in 1992. From the end of the 1980's the global environmental protection policy considered new energy sources such as photovoltaic energy to be the most "earth-friendly" energy sources."[95]

The Oil Crisis ca. 1970 flew in upon the wings of social revolution and global negotiations gone sour. The rebellion over the Vietnam War was at its height in the 1970's. As a nation, most Americans were feeling rebellious and unsure of the Nation's position in the world. The Vietnam War stimulated the social awareness movement and rock 'n roll rebellion of the 1960s with the spirited new ballads of Elvis Presley and the Beatles. Disneyland developed an exhibit called *The City of the Future* revealing the potential of alternative forms of electricity generation. The Energy Crisis shook American complacency and lack of international awareness as a Nation off the freeways, constructed during the surge of development in the twenty years following World War II, and into lines of cars attempting to buy gas at any price from a few token stations that remained open. The Nation went into shock, and subsequently into action.



There were three operational satellites built but Bell Laboratories built many more copies--they furnished the transistors and invented the solar cells. The total cost was about $125,000 (in 1957-dollars) for all three units. Although the Vanguard 1 satellite must be looked at as a test satellite its technical and scientific results are impressive. Technically its purpose was to test and evaluate solar cells, satellite terminal design and on board instrumentation. All this test objectives met. The solar cells worked so well that its transmitter was active for 7 years. (108 MHz frequency) Well beyond the expected lifetime. The scientific results were also a success.[96]

Within one hundred years, technology had evolved from horse-drawn carriages and reading by candlelight to a rocket that took the first human beings to the moon and telecast it live on television to families who sat in awe watching from the comforts of home. Smog checks and lead-free gasoline became mandatory. However, the lead spent to secure Western access to global fossil fuel resources has continued to be the largest expense in the form of warfare, oppression and genocide in oil rich regions around the world while fraudulent *least cost* debates suppress solar electric building materials commerce. From the 1970s Energy Crisis one pioneering and promising effort began a wave of interest in terrestrial *building-integrated photovoltaics* (BI-PV) leading it into the mainstream market. In 1974, Dr. Joseph Lindmayer, and Dr. Peter Varadi founded the Solarex Corporation. They are considered the *fathers of terrestrial photovoltaics.*

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[95] *A World-wide Overview of Activity in Building-Integrated Photovoltaics,* by Steven Strong pages 26-37, *Building With Photovoltaics* published under the auspices of E.W. ter Horst, PV Program NOVEM Netherlands Agency of Energy and the Environment 1995, pages 27-28

[96] *Vanguard I, World's Oldest Satellite Still In Orbit,* by Tommy Edström Piteå, Sweden 2004 http://home.swipnet.se/~w-52936/index20.htm

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