Physics to Generate Electricity and Regulate it – A Review

***Dr.Shivaraj Gadigeppa Gurikar. Asst Professor of Physics. Govt First Grade College, Yelburga.**

Abstract

This paper seeks to study Electric power generation and regulation by various means, electricity is the rate, per unit time, at which electrical energy is transferred by an electric circuit. The SI unit of power is the watt, one joule per second. Electricity is essential for modern life, yet almost one billion people live without access to it. Challenges such as climate change, pollution and environmental destruction require that we change the way we generate electricity. Over the past century, the main energy sources used for generating electricity have been fossil fuels, hydroelectricity and, since the 1950s, nuclear energy. Despite the strong growth of renewables over the last few decades, fossil-based fuels remain dominant worldwide. Their use for electricity generation continues to increase in both absolute and relative terms: in 2014, fossil fuels generated 64.5% of worldwide electricity, compared with 61.9% in 1990. Access to reliable electricity is vital for human wellbeing. Currently one in seven people in the world has no access to electricity. As such, electricity demand will continue to rise. At the same time, greenhouse gas emissions must decrease drastically if we are to mitigate climate change, and we must switch to cleaner sources of energy to reduce air pollution. This will likely require large increases of all low-carbon energy sources, of which nuclear is an important part. In order to achieve a sustainable world, all sectors of the economy will need to be decarbonised, including transport, heat and industry. Electricity provides the means to utilise low-carbon energy sources, and so widespread electrification is seen as a key tool for decarbonising sectors traditionally powered by fossil fuels. As the end uses for electricity grow, and as the benefits of electricity are extended to all people, demand will grow significantly.

Fossil fuel power plants burn coal or oil to create heat which is in turn used to generate steam to drive turbines which generate electricity. In gas plants hot gases drive a turbine to generate electricity, whereas a combined cycle gas turbine (CCGT) plant also uses a steam generator to increase the amount of electricity produced. In 2014, fossil fuels generated 64.5% of electricity worldwide. These plants generate electricity reliably over long periods of time, and are generally cheap to build. However, burning carbon-based fuels produces large amounts of carbon dioxide, which drives climate change. These plants also produce other pollutants, such as oxides of sulphur and nitrogen, which cause acid rain. The burning of fossil fuels for energy causes considerable numbers of deaths due to air pollution. For instance, it is estimated that in China alone 670,000 people die prematurely - every year due to the use of coal.

Key words: feminism, interrogation, Kashmir, women writing, regional, religious

Introduction

Fossil fuel plants require very large quantities of coal, oil or gas. In many cases these fuels need to be transported over long distances, which can result in potential supply issues. The price of the fuels has historically been volatile, and can rise sharply at times of shortages or geopolitical instability, which can result in unstable generation costs and higher consumer prices. Hydroelectric power Most large hydroelectric power plants generate electricity by storing water in vast reservoirs behind dams. Water from the reservoirs flows through turbines to generate electricity. Hydroelectric dams can generate large amounts of low-carbon electricity, but the number of sites suitable for new, large-scale dams is limited. Hydroelectric power can also be produced by run-of-river plants but most of the rivers that are suitable for this have already been developed.In 2014, hydropower accounted for 16% of worldwide electricity generation. The flooding of reservoirs behind dams and slowing the flow of the river system below the dam can also have a serious impact on the environment and local populations. For instance, during the construction of the world's largest hydroelectric dam – the Three Gorges Dam in China – some 1.3 million people were displaced. In terms of the number of deaths from accidents, hydroelectric power is the most deadly energy source.

The accident with the highest death toll was the collapse in 1975 of the Banqiao Dam in China's Henan province, which resulted in 171,000 direct and indirect fatalities according to official estimates. Nuclear power Nuclear power reactors use the heat produced from splitting atoms to generate steam to drive a turbine. No greenhouse gases are produced in the fission process, and only very small amounts are produced across the whole nuclear life- cycle. Nuclear power is an environmentally-friendly form of electricity generation, and does not contribute to air pollution. In 2014, nuclear power generated 10.5% of the world's electricity. Nuclear power plants, like fossil-fuelled power plants, are very reliable, and can run for many months without interruption, providing large amounts of clean electricity, regardless of the time of day, the weather or the season. Nuclear fuel can be used in a reactor for several years, thanks to the immense amount of energy contained in uranium.

The power from one kilogram of uranium is about the same as 1 tonne of coal. As a result, a correspondingly small amount of waste is generated. On average, a reactor supplying a person's electricity needs for a year creates about 500 grams of waste – it would fit inside a soda can. Just 5 grams of this amount is used nuclear fuel – the equivalent of a sheet of paper. There are several management strategies available for the used fuel, such as direct disposal or recycling in reactors to generate more low-carbon electricity.Renewables, such as wind, solar and small-scale hydro, produce electricity with low amounts of greenhouse gas emissions across their entire life-cycle. In 2014, wind and solar generated 4.4% and 1.3%, respectively, of the world's electricity.

Objective:

This paper intends to explore generation/regulation of electric power is usually produced by electric generators, but can also be supplied by sources such as electric batteries. Also its supply to businesses and homes (as domestic mains electricity) by the electric power industry through an electric power grid.

Electricity generation/ regulation the modern necessity

Electricity generation from wind turbines varies with the wind speed, and if the wind is too weak or too strong no electricity is produced at all. The output of solar panels is reliant on the strength of the sunshine, which depends on a number of different factors, such as the time of day and the amount of cloud cover (as well as the amount of dust on the panels). Another problem is that there might not be enough space or public willingness to accommodate the vast number of turbines or panels required to produce enough electricity. This is due to the fact that energy from the wind or the sun is diffuse, meaning that very significant amounts of land are required in order to generate a significant quantity of electricity. Because electricity cannot be easily stored, renewables have to be backed up by other forms of electricity generation. The largest batteries cannot operate for days, let alone the weeks that would be required to back up renewables in order to ensure the supply of round-the-clock electricity. In order to ensure a steady supply of electricity, gas plants are increasingly providing backup services to renewables electricity. Natural gas plants emit large amounts of carbon dioxide during operation, and significant amounts of methane are often released during the extraction and transport of gas, both of which contribute to climate change.

A biomass plant operates in a very similar way to gas- and coal-fired power plants. Instead of burning gas or coal, the plant is fuelled by different forms of biomass (such as purpose-grown trees, wood chips, domestic waste, or 'biogas'). In 2014, biomass generated 2.3% of the world's electricity.Biomass production can require a lot of energy, both in terms of production of biomass itself and in terms of transport. Due to this, the energy required can be greater than the energy value in the final fuel, and the greenhouse gas emissions can be as high, or even greater, than those from equivalent fossil fuels. Additionally, it can take more than 100 years for the emitted carbon dioxide to be absorbed, which leads to a short-term emissions increase.

Other environmental impacts related to land use and ecological sustainability can be considerable. Additionally, as with coal, the use of biomass can contribute to air pollution, and thus has negative health impacts for populations local to biomass plants.Electricity is growing in importance. If we are to address climate change and reduce air pollution, we will need to increase the use of all low-carbon energy sources, of which nuclear is an important part. To meet the growing demand for sustainable energy, World Nuclear Association has introduced the Harmony programme, which sets a target for nuclear power to provide at least 25% of electricity before 2050. This would mean that nuclear generation would have to triple globally by then. In order to drastically reduce the levels of fossil fuels, nuclear and renewables need to work together to secure a reliable, affordable and clean future energy supply. The World Nuclear Association's Silent Giant white paper provides further information on the need for nuclear in a clean energy system.

What is electricity?

Everybody uses it, almost without thinking, but how many of us can actually define what it is?

Electricity is the energy generated by the movements of electrons (negative charge) and positrons (positive charge) within conductive materials.

Opposites attract. Positive and negative charges come together, creating two types of energy: Static electricity (generated by friction) and dynamic electricity (known as a current).

Where does electricity come from?

Electricity's journey to your plug is very long, but occurs at astonishing speed. It is not magic; it is not science fiction. It is a step-by-step process which explains many of the doubts that arise with regard to the electricity sector:

Generation: electricity is produced in plants capable of drawing electrical energy from primary energy sources. These primary energies may be renewable (wind, solar power, tidal power, etc.) or non-renewable (coal, natural gas, oil, etc.). The companies which (fully or partly) own the various power plants sell the energy generated to companies which supply it commercially.

Transmission: once the energy has been processed and turned into electricity, it is sent through overhead or underground wires from the plants to substations. There, transformers ensure sufficient electrical voltage. Substations tend to be above ground near to power plants, or on the outskirts of cities, though if they are not too large, they may also be within the actual city, inside a building.

Distribution: from the substations, electricity is distributed to the homes in the surrounding area. As a consumer, you cannot choose your electricity distributor; it is determined by where you live. That company is responsible for ensuring electricity reaches your home properly, and takes care of repairs when needed. It is also the company which owns your electricity meter, and sends readings from it to your commercial energy supplier.

Commercialisation: what you certainly can choose is your commercial energy supplier. It is the supplier who sends you the bill: the supplier buys the energy from the generation companies, and sells it to you. Commercial suppliers are the ones who offer various rates and offers, although in Spain, there is a free market (you pay under the terms of your contract, as happens with your mobile bill) and a regulated market (what you pay is set by a system designed by the Government).

"The company which delivers the electricity to your home is not the same as the one you get your bills from."

Types of electricity plant

As we said earlier, in order to generate electricity, we need to release the energy contained in primary materials. How do we do this? It depends entirely on the type of electricity plant we are talking about:

Conventional cycle thermo-electric plants (coal, diesel oil and natural gas): energy is liberated by burning coal, natural gas or diesel oil. As they burn, they are used to heat a tank of water. That water transforms into steam, which is used to drive a turbine. It is this movement which generates electricity, by means of an alternator, which turns the mechanical energy into electrical energy. Finally, the steam passes through a condenser, turning back into liquid water, and starting the cycle anew.

Combined-cycle thermo-electric plants (coal, diesel oil and natural gas): these plants work in a very similar way to conventional-cycle ones. Like these, they have a turbine which is driven by steam from heated water. However, they also have another turbine, driven by air drawn in from outside and heated by the same fossil fuels. The major advantages of combined-cycle over conventional-cycle plants is that they are more efficient, more flexible (they can work at full capacity or at "half throttle" as required) and more ecologically friendly (producing less emissions into the atmosphere).

Nuclear power plants: the heat released by nuclear fission in a reactor is used to heat large quantities of high-pressure water. The resulting steam produces electricity as it passes through a turbine connected to a generator. The fuel used tends to be uranium.

Geothermal power plants: the system is similar to the previous ones (water is heated to create steam which drives a turbine), but in this case, we use the natural heat within the planet through pipelines in the subsoil.

Biomass plants: in this case, heat is generated by burning organic material, be it plant matter or any kind of waste (animal, industrial, agricultural and urban waste products).

Hydro-electric plants: these plants do not require heat, as these are the evolved version of the windmills of old. What they do use is a significant water drop to move a hydraulic turbine. They are typically built in barrages and reservoirs.

Wind farms: in this case, it is the wind which drives a turbine to obtain electricity.

Solar power farms: there are two types. Las Thermo-solar installations use the heat from the sun to heat water and use the steam to drive a turbine. Photovoltaic installations transform solar energy directly into electricity, using photovoltaic cells.

Tidal power plants: the movement of water caused by high and low tides drives a turbine, which produces electricity by means of a generator.Wave power plants: similar to the previous technology, but using the force of waves instead of tides.

The major difference between renewable and non-renewable stems from the primary energy being used to generate electricity. Do we need to replace the so-called “fuel”, or is it no longer necessary, because nature provides it for free?

At present, the most commonplace power plants use non-renewable energies: that is, they use primary energy which must be extracted from the ground (coal, natural gas, uranium, etc.). However, the future looks much more renewable. “Electricity is considered renewable if we do not need to replace the fuel that is used to generate it.”

How is wind power produced?

Wind power is difficult to explain briefly, but we’ll give it a go: the force of the wind on three-bladed wind turbines creates mechanical energy, which is transferred to a series of copper wires, where it is turned into (yes) electrical energy.

More specifically, wind is turned into electricity by the so-called aerogenerators or wind turbines, which have an electrical generator on board, alongside their control system and grid connection system. “Spain, along with Denmark and the Netherlands, is one of the countries with the highest rates of wind power in the world.” Thinking clearly about it, though, we seem to have jumped the gun a little, forgetting about a crucial question: where does the wind come from? It is something so utterly everyday that we never stop to think where it comes from. Wind is caused by the effects of the sun on our planet. Between 1% and 2% of solar radiation absorbed by the planet becomes wind energy. This is due to the fact that the earth’s crust releases a large portion of solar energy into the air, causing the air to warm up, become less dense, expand and rise. At the same time, the cooler, denser air – sitting over seas, rivers and oceans – comes sweeping in to fill the gap left by the warm air.

Wind is simply the movement of air. Masses of air which move from areas of high atmospheric pressure to areas of low pressure move at speeds proportional to the pressure differences between the two areas (the greater the difference, the more powerfully the wind blows).

To transform sunlight into energy, metal semi-conductor sheets are needed: these are called photovoltaic cells.

These cells have one or more layers of a semi-conductive material, and are covered by transparent glass which allows solar radiation in and helps minimise heat losses.

The solar panels that can be seen on the rooftops of many houses are made up of these photovoltaic cells. Whilst they may seem costly to install, data show that they pay for themselves in the long run, offering savings of around 30% on electrical consumption; in the longer term (25 years), this represents and a saving of between €20,000 and €30,000! Another of their advantages is that they do not require much maintenance.

The sun’s rays are made up of photons which strike the panel’s photovoltaic cells, generating an electrical field between them and, hence, an electrical circuit. The more intense the light, the greater the flow of electricity.

The photovoltaic cells convert sunlight into direct current (DC) electricity, with an intensity ranging between 380 and 800 volts. To improve the result, an inverter is used to turn that energy into alternating current(AC), which is the form of energy we use in our homes.

Finally, this alternating current passes through a meter that quantifies it and supplies it to the general electrical grid.

“Photovoltaic solar is on course to become the cheapest source of electricity in the world.”

Hydroelectric energy

A study by NASA states that the origin of life may be found in the electricity generated naturally on the sea floor some 4,000 million years ago. Water and movement are a source of life and, thus, also a source of energy.

Our ancestors knew this and used the currents in rivers to move large mills. More sophisticated versions of these water mills are used in hydro-electric power plants. A dam blocks a river with a concrete wall, flooding the area around the plant and creating an artificial lake. The retained water harbours enormous potential energy.

Water is one of the strongest and most powerful forces of nature. That torrent can be converted into kinetic energy (the energy of a body in motion). Under the force of gravity, the water travels downward through a series of large pipes called penstocks. This makes the blades of the turbines spin quickly.

The turbines supply mechanical energy to the plant's electric generators. A transformer increases the electric power and transmits it to the power grid, which then supplies power to your TV or washing machine.

Tidal energy

A lesser-known variant of hydroelectric energy in tidal energy.

This system utilises the vertical movement of seawater, which is caused by the gravitational force of the moon and sun on the sea. The ebb and flow of the tides generates tidal power.

At present, there are three different types of tidal power plants:

Tidal barrages: built at river mouths, tidal barrages are quite similar to hydropower plants. They harness the potential energy generated by the difference in height between high and low tides. Although they produce large amounts of energy, these facilities are quite costly to build and maintain.

Tidal stream generators: the tidal flows drive a series of axial turbines, similar to wind turbines, which generate mechanical energy. This is the simplest and most economical method, with the lowest impact on nature. As no dam needs to be built, it does not alter the ecosystem in the sea.

Dynamic tidal power: this method is merely theoretical, as it has never yet been successfully applied. It would combine the two methods described above. To do this, dams would be built off the coast and further out to sea creating a T-shaped structure that, on one side, would retain the force of the high tides and, on the other, the energy of the low tides.

Tidal energy stems from the movement of water caused by the high/low tide cycle.

Geothermal energy

Moving out of the water and onto dry land, let us know look at geothermal energy, a system which uses the heat stored inside the earth, in hot rocks and/or hot springs.

The thermal energy contained under our feet is tremendous. By simply digging to a depth of some 10 metres, we find temperatures of around 17°C year-r due to the thermal inertia of the soil.

To harness this energy, geothermal heat pumps are used to extract heat from the earth or release heat into it, depending on whether the goal is to heat or cool the air, or to heat water.

One of the most precise methods is to inject liquid water deep into the earth to raise its temperature; the water is turned to steam and returns to the plant carrying a great deal of energy, ready to be transformed into electricity.

- This energy can be used for different purposes depending on the characteristics of the source:
- Resources at high temperatures (over 150°C) are used to generate light.
- Below 100°C they are used to supply electricity to heating/air conditioning systems.
- At very low temperatures (less than 30°C) they are used directly for heating water.

Conclusion

Electricity is all around us--powering technology like our cell phones, computers, lights, soldering irons, and air conditioners. It's tough to escape it in our modern world. Even when you try to escape electricity, it's still at work throughout nature, from the lightning in a thunderstorm to the synapses inside our body. But what exactly *is* electricity? This is a very complicated question, and as you dig deeper and ask more questions, there really is not a definitive answer, only abstract representations of how electricity interacts with our surroundings. Electricity is a natural phenomenon that occurs throughout nature and takes many different forms. In this tutorial we'll focus on current electricity: the stuff that powers our electronic gadgets. Our goal is to understand how electricity flows from a power source through wires, lighting up LEDs, spinning motors, and powering our communication devices.

Electricity is briefly defined as the flow of electric charge, but there's so much behind that simple statement. Where do the charges come from? How do we move them? Where do they move to? How does an electric charge cause mechanical motion or make things light up? So many questions! To begin to explain what electricity is we need to zoom way in, beyond the matter and molecules, to the atoms that make up everything we interact with in life.

References

1. Csiszar, I, Korner, J. Information Theory: Coding Theorems for Discrete Memoryless Systems Akademiai Kiado: 2nd edition, 1997. ISBN 963-05-7440-3
2. van Hove, Leon (1958). "Von Neumann's contributions to quantum mechanics" (PDF). Bulletin of the American Mathematical Society. 64 (3): Part 2:95–99. doi:10.1090/s0002-9904-1958-10206-2.
3. A New Kind of Science Note (a) for Quantum phenomena
4. Feynman, Richard. "The Feynman Lectures on Physics III 21-4". California Institute of Technology. Retrieved 2014-11-24. " .it was long believed that the wave function of the Schrödinger equation would never have a macroscopic representation analogous to the macroscopic representation of the amplitude for photons. On the other hand, it is now realized that the phenomena of superconductivity presents us with just this situation.
5. Richard Packard (2006) "Berkeley Experiments on Superfluid Macroscopic Quantum Effects" Archived November 25, 2014, at the Wayback Machine accessdate=2014-11-24
6. "Quantum – Definition and More from the Free Merriam-Webster Dictionary". Merriam-webster.com. Retrieved 2012-08-18.

7. Thall, Edwin. "Thall's History of Quantum Mechanics". Florida Community College at Jacksonville. Archived from the original on October 7, 2009. Retrieved May 23, 2009.
8. "ysfine.com". Retrieved 11 September 2014.
9. "Quantum Mechanics". geocities.com. 2009-10-26. Archived from the original on 2009-10-26. Retrieved 2014-06-13.
10. P.A.M. Dirac, The Principles of Quantum Mechanics, Clarendon Press, Oxford, 1930.
11. D. Hilbert Lectures on Quantum Theory, 1915–1927
12. J. von Neumann, Mathematische Grundlagen der Quantenmechanik, Springer, Berlin, 1932 (English translation: Mathematical Foundations of Quantum Mechanics, Princeton University Press, 1955).
13. H.Weyl "The Theory of Groups and Quantum Mechanics", 1931 (original title: "Gruppentheorie und Quantenmechanik").
14. Dirac, P.A.M. (1958). The Principles of Quantum Mechanics, 4th edition, Oxford University Press, Oxford, p. ix: "For this reason I have chosen the symbolic method, introducing the representatives later merely as an aid to practical calculation."
15. Greiner, Walter; Müller, Berndt (1994). Quantum Mechanics Symmetries, Second edition. Springer-Verlag. p. 52. ISBN 978-3-540-58080-5., Chapter 1, p. 52
16. "Heisenberg – Quantum Mechanics, 1925–1927: The Uncertainty Relations". Aip.org. Retrieved 2012-08-18.
17. Greenstein, George; Zajonc, Arthur (2006). The Quantum Challenge: Modern Research on the Foundations of Quantum Mechanics, Second edition. Jones and Bartlett Publishers, Inc. p. 215. ISBN 978-0-7637-2470-2., Chapter 8, p. 215
18. Lodha, Suresh K.; Faaland, Nikolai M.; et al. (2002). "Visualization of Uncertain Particle Movement (Proceeding Computer Graphics and Imaging)" (PDF). Actapress.com. Archived (PDF) from the original on 2014-08-01. Retrieved 2014-08-01.
19. Hirshleifer, Jack (2001). The Dark Side of the Force: Economic Foundations of Conflict Theory. Cambridge University Press. p. 265. ISBN 978-0-521-80412-7., Chapter, p.
20. "dict.cc dictionary :: eigen :: German-English translation". dict.cc. Retrieved 11 September 2014.
21. "Topics: Wave-Function Collapse". Phy.olemiss.edu. 2012-07-27. Archived from the original on 2014-02-28. Retrieved 2012-08-18.
22. "Collapse of the wave-function". Farside.ph.utexas.edu. Retrieved 2012-08-18.
23. Weinberg, Steven (2010). Dreams Of A Final Theory: The Search for The Fundamental Laws of Nature. Random House. p. 82. ISBN 978-1-4070-6396-6. Extract of page 82
24. Michael Trott. "Time-Evolution of a Wavepacket in a Square Well – Wolfram Demonstrations Project". Demonstrations.wolfram.com. Retrieved 2010-10-15.
25. Michael Trott. "Time Evolution of a Wavepacket In a Square Well". Demonstrations.wolfram.com. Retrieved 2010-10-15.

26. Mathews, Piravonu Mathews; Venkatesan, K. (1976). A Textbook of Quantum Mechanics. Tata McGraw-Hill. p. 36. ISBN 978-0-07-096510-2., Chapter 2, p. 36
27. "Wave Functions and the Schrödinger Equation" (PDF). Retrieved 2010-10-15.[dead link]
28. Rechenberg, Helmut (1987). "Erwin Schrödinger and the creation of wave mechanics" (PDF). Acta Physica Polonica B. 19 (8): 683–695. Retrieved 13 June 2014.
29. Nancy Thorndike Greenspan, "The End of the Certain World: The Life and Science of Max Born" (Basic Books, 2005), pp. 124–128, 285–826.
30. "Archived copy" (PDF). Archived from the original (PDF) on 2011-07-19. Retrieved 2009-06-04.
31. "The Nobel Prize in Physics 1979". Nobel Foundation. Retrieved 2010-02-16.
32. Carl M. Bender; Daniel W. Hook; Karta Kooner (2009-12-31). "Complex Elliptic Pendulum". arXiv:1001.0131 [hep-th].
33. See, for example, Precision tests of QED. The relativistic refinement of quantum mechanics known as quantum electrodynamics (QED) has been shown to agree with experiment to within 1 part in 108 for some atomic properties.
34. Tipler, Paul; Llewellyn, Ralph (2008). Modern Physics (5 ed.). W.H. Freeman and Company. pp. 160–161. ISBN 978-0-7167-7550-8.
35. Ehrenfest, P. (1927). "Bemerkung über die angenäherte Gültigkeit der klassischen Mechanik innerhalb der Quantenmechanik". Zeitschrift für Physik. 45 (7–8): 455–457. Bibcode:1927ZPhy .45 455E. doi:10.1007/BF01329203.
36. Smith, Henrik (1991). Introduction to Quantum Mechanics. World Scientific Pub Co Inc. pp. 108–109. ISBN 978-9810204754.
37. Einstein, A.; Podolsky, B.; Rosen, N. (1935). "Can quantum-mechanical description of physical reality be considered complete?". Phys. Rev. 47 (10): 777. Bibcode:1935PhRv .47 777E. doi:10.1103/physrev.47.777.
38. N.P. Landsman (June 13, 2005). "Between classical and quantum" (PDF). Retrieved 2012-08-19. Handbook of the Philosophy of Science Vol. 2: Philosophy of Physics (eds. John Earman & Jeremy Butterfield).
39. (see macroscopic quantum phenomena, Bose–Einstein condensate, and Quantum machine)
40. "Atomic Properties". Academic.brooklyn.cuny.edu. Retrieved 2012-08-18.
41. http://assets.cambridge.org/97805218/29526/excerpt/9780521829526_excerpt.pdf
42. Bryce DeWitt, R. Neill Graham, eds., 1973. The Many-Worlds Interpretation of Quantum Mechanics, Princeton Series in Physics, Princeton University Press. ISBN 0-691-08131-X
43. Dirac, P.A.M. (1930). The Principles of Quantum Mechanics. ISBN 978-0-19-852011-5. The beginning chapters make up a very clear and comprehensible introduction.