Florida Department of Education

COURSE DESCRIPTION – GRADE 9 – 12, ADULT

Subject Area: Science
Course Number: 2002540
Course Title: Solar Energy and Other Alternative Resources I
Credit: 1.0

Will meet graduation requirements for Science

A. **Major Concepts/Content.** This is an integrated Honors elective course that provides students opportunities to study, comprehend, and apply concepts related to energy, its various resources, its consumption, and its effect on the Earth's systems. The focus of the course is on solar energy, other renewable resources, and interrelated technologies and applications. Solar heat, solar electricity (photovoltaic and solar thermal), and related technologies are explored and studied throughout the course. Concepts and their applications are addressed through exploratory investigations, short and long-term research projects, design, and construction of products.

The content should include, but not be limited to, the following:

- Unifying concepts, skills, attitude, application, and context of energy
- Energy analysis, conventional and non-conventional energy resources
- Energy, technology, society, and the environment: global energy-related issues and energy for sustainability
- Solar energy related principles and concepts, solar radiation properties and availability
- Thermodynamic laws and solar heat technologies and applications
- Electromagnetic energy as applied in solar electricity, photovoltaic and thermal concepts and principles, application and technologies.

This course shall integrate the Goal 3 Student Performance Standards of the Florida System of School Improvement and Accountability as appropriate to the content and processes of the subject matter.

B. **Special note.** This course shall include laboratory investigations and product design and construction. Experimental activities will require the use of measurements, problem solving, data collection and analysis, laboratory apparatus, safety procedures and experimental procedures.

C. **Course requirements.** The requirements should include, but not be limited to, benchmarks from the Sunshine State Standards that are most relevant to this course.

After successfully completing this course, the student will:

1. **Demonstrate an understanding and apply science processes and inquiry skills to design, conduct appropriate investigations and experiments, collect and analyze data, and form conclusions on energy related topics.**

SC.H.1.4.1 know that investigations are conducted to explore phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories (e.g., design and conduct experiment to test the efficiency of a solar collector using various insulating materials; analyze and compare the data collected with published experimental results).

SC.H.1.4.4 know that scientists in any one-research group tend to see things alike and that therefore scientific teams are expected to seek out the possible sources of bias in the design of their investigations and in their data analysis (e.g., review scientific publications on global warming and climate change, compare the findings in different investigations, communicate the conclusions in a debate; review, analyze, and compare old and recent publications on electric vehicles).

SC.H.2.4.2 know that scientists control conditions in order to obtain evidence, but when that is not possible for practical or ethical reasons, they try to observe a wide range of natural occurrences to discern patterns (e.g., investigate and analyze energy issues and the threat that developing countries may adopt developed countries' fossil-fuels based technologies and discuss the possible consequences on the global environment).

SC.H.3.4.6 know that scientific knowledge is used by those who engage in design and technology to solve practical problems, taking human values and limitations into account (e.g., design and construct a solar collector device, demonstrate how it works and how it could play a part in reducing energy-related concerns, modify the design to fit the availability of materials in a developing country such as Haiti).

2. Demonstrate an understanding of energy-related concepts, forms, conversions, and evaluate efficiency; differentiate between conventional and non-conventional energy resources.

SC.B.1.4.1 understand how knowledge of energy is fundamental to all scientific disciplines (e.g., study and analyze the energy required in meteorological systems that feed the formation of wind, clouds, storms, etc., and the energy required to power a city or a country).

SC.B.1.4.2 understand that there is conservation of mass and energy when matter is transformed (e.g., describe the energy conversions to produce electricity from coal in a power plant; explain how matter and energy are conserved in the process, and compare the efficiency of a traditional power source to a solar thermal power plant).

SC.B.1.4.5 know that each source of energy presents advantages and disadvantages to its use in society (e.g., students investigate the political, economic, and environmental implications that may determine a society's selection of renewable or nonrenewable energy sources).

SC.B.2.4.1 know that the structure of the universe is the result of interactions involving fundamental particles (matter) and basic forces (energy) and that evidence suggests that the universe contains all of the matter and energy that ever existed (e.g., investigate and understand how the total quantity of matter and energy is the same; however, the quality of matter and energy is changing in the universe; explain how the solar

nuclear fusion, where matter is converted into light and heat energy is in essence, increasing the entropy of the sun).

SC.A.2.4.3 know that a number of elements have heavier, unstable nuclei that decay, spontaneously giving off smaller particles and waves that result in small loss of mass and release of large amount of energy (e.g., analyze and solve practical problems using Einstein's famous formula: $E = MC^2$).

SC.C.2.4.1 know that acceleration due to gravitational force is proportional to mass and inversely proportional to the square of the distance between the objects (e.g., compare gravitation potential energy [GPE] and gravitational kinetic energy [GKE]; design and conduct an experiment to observe the exchange of GPE to GKE using a pendulu; calculate explain the difference between GPE and GKE).

SC.C.2.4.4 know that the forces that hold the nucleus of an atom together are much stronger than electromagnetic force and that this is the reason for the great amount of energy released from the nuclear reactions in the sun and other stars (e.g., investigate nuclear fission and the amount of energy generated per unit mass and compare it to energy generated by fossil fuels or biomass per unit mass; investigate the energy released by nuclear fusion and compare it to nuclear fission).

SC.D.1.4.2 know that the solid crust of Earth consists of slow moving, separate plates that float on a denser, molten layer of Earth and that these plates interact with each other, changing the Earth's surface in many ways (e.g., investigate how the heat of volcanic activities, hot springs, and geysers is harnessed to generate electricity in geothermal power).

SC.G.2.4.1 know that layers of energy-rich organic materials have been gradually turned into great coal beds and oil pools (fossil fuels) by the pressure of the overlying earth and that humans burn fossil fuels to release the stored energy as heat, carbon dioxide, and other polluting gases (e.g., conduct research to investigate the availability, production, and consumption of fossil fuels in the world; analyze the main energy resources used in the US; assess the amount of fossil fuels used per person in the US; calculate individual carbon dioxide quotient and determine ways to reduce it).

3. Demonstrate an understanding and explain the global nature of the interaction between energy and the Earth's ecosystems. Investigate the ever-increasing energy consumption due to continuous population growth and thriving technology. Discuss energy issues related to social, economic, and environmental concerns. Suggest ways to apply energy for sustainability.

SC.D.1.4.3 know that changes in the Earth's climate, geological activity, and life forms may be traced and compared (e.g., research and debate the history of warming of the Earth, and discuss if the global warming we are experiencing now is a natural cycle or that humans' activities have affected the climate by the release of an enormous amount of greenhouse gases).

SC.D.2.4.1 understand the interconnectedness of the systems on Earth and the quality of life (e.g., investigate deforestation, air, water, and land

pollution, and their effect on deteriorating the ecosystems and their inhabitants).

SC.G.2.4.2 know that changes in a component of an ecosystem will have unpredictable effects on the entire system, but that the components of the system tend to react in a way that will restore the ecosystem to its original condition (e.g., conduct a study to investigate the environmental impact of a local or regional fossil fuel, nuclear, or hydropower power plants).

SC.H.1.4.6 understand that in the short run, new ideas that do not mesh well with mainstream ideas in science often encounter vigorous criticism and that in the long run, theories are judged by how they fit with other theories, the range of observations, and how effective they are in predicting findings (e.g., investigate public and governmental budget and support for research and development of conventional fuels versus renewable resources; conduct research on the importance of public education and awareness of the environmental problems related to energy consumption, and discuss how education in this area would increase the pressure on political and economic forces that might lead to a shift in policies and allocation of funds for research and development of techniques to solve problems).

SC.H.3.4.2 know that technological problems often create a demand for new scientific knowledge and that new technologies make it possible for scientists to extend their research in a way that advances science (e.g. investigate environmental problems, such as pollution, resource depletions, ecosystem degradation; explain how these problems have motivated scientists to develop cleaner and more efficient technologies to alleviate, slow down, and even solve some of the problems).

4. Demonstrate understanding of solar energy related principles and concepts; explain solar radiation properties and their conversion into useful and clean energy sources.

SC.A. 2.4.4 know that nuclear energy is released when small and light atoms are fused into heavier ones (e.g., discuss the sun as a giant nuclear fusion plant, a source for the ultimate energy which supports all life on earth, supplying heat and light; calculate the approximate efficiency of solar radiation that reaches the surface of Earth).

SC.D.1.4.1 know how climatic patterns on Earth result from the interplay of many factors (e.g., learn how solar radiation reaching the earth is affected by many factors such as Earth's topography, its rotation on its axis, the transfer of heat energy where the atmosphere interfaces with lands and oceans, and wind and ocean currents; analyze the insolation in various regions of the US and the possible application of solar energy technologies).

SC.E.1.4.1 understand the relationships between events on Earth and the movements of the Earth, its Moon, the other planets, and the Sun (e.g., examine the extraterrestrial solar constant which does not change; compare it to the availability and intermittence of solar radiation, or insolation, received by the Earth's surface and affected by Earth's tilt, its rotation around its axis and its revolution around the sun; discuss how solar technology could be profitable in spite of the intermittence of radiation).

SC.H.1.4.2 know that from time to time, major shifts occur in the scientific view of how the world works, but that more often, the changes that take place in the body of scientific knowledge are small modifications of prior knowledge (e.g., conduct a chronological study of the science and technology that were established by the ancient Greeks and Romans in order to harness solar heat. Identify the various modifications that were developed in order to improve the efficiency of solar technology).

SC.H.1.4.5 understand that new ideas are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from an unexpected findings, and usually grow slowly from many contributors (e.g., study the history of photo electricity and photovoltaic technology, which have evolved for more than fifty years).

5. Demonstrate understanding of the thermodynamic laws and their multiple applications in solar thermal technologies; design, build and test the effectiveness of a solar heat collector.

SC.A.1.4.3 know that a change from one phase of matter to another involves a gain or loss of energy (e.g., design and carry out experiments to investigate and calculate the efficiency of a solar collector, such as a solar distiller, food dehydrator, solar cooker, or solar water heater).

SC.B.1.4.3 know that temperature is a measure of the average translational kinetic energy of motion of the molecules in an object (e.g., after constructing a solar collector, modify and improve the heat retention and the internal temperature increase; relate the heat and temperature to the shape, size, and materials used to build the collector).

SC.B.1.4.6 know that the first law of thermodynamics relates the transfer of energy to the work done and the heat transferred (e.g., investigate the thermo-siphoning of water in a passive solar heating and cooling system; test a solar heat concentrator to weld metal or to steam a fluid, that could be converted to mechanical energy).

SC.B.1.4.7 know that the total amount of usable energy always decreases, even though the total amount of energy is conserved in any transfer (e.g., investigate energy conversion efficiency and entropy; conduct a debate on entropy and present some solutions to slow it down, such as conservation and increasing efficiency).

SC.H.3.4.5 know that the value of a technology may differ for different people and at different times (e.g., compare the ancient Greek and Roman advanced passive-solar architecture building that was built in harmony with the surrounding environment and to the current architecture that relies on artificial indoor environment for heating and cooling).

6. Demonstrate understanding of principles, concepts, and laws of electrical energy and apply them to solar electricity technologies: photovoltaic and solar thermal.

SC.A.1.4.2 know that the vast diversity of the properties of materials is primarily due to variations in the forces that hold molecules together (e.g. understand how the crystal lattice of silicon in various photovoltaic cells determines the efficiency of the conductivity of the released electrons as they are struck by photons; use various chemicals to prepare crystals, compare the crystals formed under a magnifier glass).

SC.A.1.4.5 know that connections (bonds) form between substances when outer-shell electrons are either transferred or shared between their atoms, changing the properties of substances (e.g., explain how doping silicon

	with phosphorous and boron in a proportion of one part per million, changes the conductivity property of silicon, allowing enough electrons to generate an electric current when the solar cell is exposed to light; design an experiment to test the power output efficiency of the three types of silicon-based solar cells).
SC. A.2.4.1	know that the number and configuration of electrons will equal the number of protons in an electrically neutral atom and when an atom gains or loses electrons, the charge is unbalanced (e.g., investigate various battery technologies; construct a battery using various electrolytes).
SC.A.2.4.5	know that elements are arranged into groups and families based on similarities in electron structure and that their physical and chemical properties can be predicted (e.g. study the various semiconductor elements and compare their properties as related to photo-electricity).
SC.B.1.4.4	know that as electrical charges oscillate, they create time-varying electric and magnetic fields that propagate away from the source as an electromagnetic wave (e.g., design experiments to measure the energy generated by a solar module under various intensities of solar radiation: effect of shade, tilt angle, color of glazing, etc.).
SC.C.2.4.5	know that most observable forces can be traced to electric forces acting between atoms and molecules (e.g., design an experiment to investigate electrostatic electricity; determine how the force between charged particles is affected by changing the distance between them).
SC.C.2.4.2	know that electrical forces exist between any two charged objects (e.g., investigate the electrolytes of a battery; design an experiment to test solar electrolysis of water or other organic compounds to produce hydrogen, which could be harnessed to generate electrical energy).
SC.H.1.4.3	understand that no matter how well one theory fits observations, a new theory might fit them as well or better, or might fit a wider range of observations, because in science, the testing, revising, and occasional discarding of theories, new and old, never ends and leads to an increasingly better understanding of how things work in the world, but not to absolute truth (e.g. understand how the investigation of solar electricity theory and application, and the study of the various evolving technologies to generate electricity from the sun, did not stop in spite of insufficient funding for research and development).
SC.H.1.4.7	understand the importance of a sense of responsibility, a commitment to peer review, truthful reporting of the methods and outcomes of investigations, and making the public aware of the findings (e.g., when running an experiment, students understand that the experimental results are not the goal of the learning; the thinking process, the sharing, the discussion, and finding ways for performance improvement are the goals of experimentation).
SC.H.3.4.4	know that funds for science research come from federal government agencies, industry, and private foundations and that this funding often influences the area of discovery (e.g., conduct an investigation to compare federal funding for solar and renewable energy research and development to that of fossil fuels and nuclear energy).