

The background of the slide features a large, faint watermark of the Seal of the State Board of Education of Alaska. The seal is circular and contains the text "BOARD OF EDUCATION" at the top and "ALASKA" at the bottom. In the center, there is a figure of a woman in traditional Alaskan dress holding a spear, and a bear is depicted at the bottom. The seal is surrounded by a decorative border of stars and a rope-like pattern.

Energy and Utilities Industry Sector

Career Pathways

- ◆ Electromechanical Installation and Maintenance
- ◆ Energy and Environmental Technology
- ◆ Public Utilities
- ◆ Residential and Commercial Energy and Utilities



Energy and Utilities Industry Sector

The Energy and Utilities sector is designed to provide a foundation in energy and utilities for all students in California. The pathways emphasize real-world, occupationally relevant experiences of significant scope and depth in Electromechanical Installation and Maintenance, Energy and Environmental Technology, Public Utilities, and Residential and Commercial Energy and Utilities. The standards integrate academic and technical preparation and focus on career awareness, career exploration, and skill preparation in four pathways. The following components are integral to the Energy and Utilities sector pathways: classroom, laboratory, hands-on contextual learning, project- and work-based instruction, internship, community classroom, cooperative career technical education, and leadership development. The Energy and Utilities sector standards prepare students for continued training, postsecondary education, or entry to a career.

FOUNDATION STANDARDS

1.0 Academics

Students understand the academic content required for entry into postsecondary education and employment in the Energy and Utilities sector.

(The standards listed below retain in parentheses the numbering as specified in the mathematics, science, and history–social science content standards adopted by the State Board of Education.)

1.1 Mathematics

Specific applications of Number Sense standards (grade seven):

- (1.1) Read, write, and compare rational numbers in scientific notation (positive and negative powers of 10) with approximate numbers using scientific notation.
- (1.2) Add, subtract, multiply, and divide rational numbers (integers, fractions, and terminating decimals) and take positive rational numbers to whole-number powers.

- (1.3) Convert fractions to decimals and percents and use these representations in estimations, computations, and applications.
- (1.4) Differentiate between rational and irrational numbers.
- (1.5) Know that every rational number is either a terminating or a repeating decimal and be able to convert terminating decimals into reduced fractions.
- (1.6) Calculate the percentage of increases and decreases of a quantity.
- (1.7) Solve problems that involve discounts, markups, commissions, and profit and compute simple and compound interest.

Specific applications of Algebra and Functions standards (grade seven):

- (1.1) Use variables and appropriate operations to write an expression, an equation, an inequality, or a system of equations or inequalities that represents a verbal description (e.g., three less than a number, half as large as area A).
- (3.4) Plot the values of quantities whose ratios are always the same (e.g., cost to the number of an item, feet to inches, circumference to diameter of a circle). Fit a line to the plot and understand that the slope of the line equals the quantities.

Specific applications of Measurement and Geometry standards (grade seven):

- (1.1) Compare weights, capacities, geometric measures, times, and temperatures within and between measurement systems (e.g., miles per hour and feet per second, cubic inches to cubic centimeters).
- (2.4) Relate the changes in measurement with a change of scale to the units used (e.g., square inches, cubic feet) and to conversions between units (1 square foot = 144 square inches or $[1 \text{ ft}^2] = [144 \text{ in}^2]$, 1 cubic inch is approximately 16.38 cubic centimeters or $[1 \text{ in}^3] = [16.38 \text{ cm}^3]$).

Specific applications of Mathematical Reasoning standards (grade seven):

- (2.1) Use estimation to verify the reasonableness of calculated results.
- (2.2) Apply strategies and results from simpler problems to more complex problems.
- (2.3) Estimate unknown quantities graphically and solve for them by using logical reasoning and arithmetic and algebraic techniques.
- (2.4) Make and test conjectures by using both inductive and deductive reasoning.
- (2.5) Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning.
- (2.6) Express the solution clearly and logically by using the appropriate mathematical notation and terms and clear language; support solutions with evidence in both verbal and symbolic work.
- (2.7) Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.
- (2.8) Make precise calculations and check the validity of the results from the context of the problem.
- (3.1) Evaluate the reasonableness of the solution in the context of the original situation.
- (3.2) Note the method of deriving the solution and demonstrate a conceptual understanding of the derivation by solving similar problems.

- (3.3) Develop generalizations of the results obtained and the strategies used and apply them to new problem situations.

Specific applications of Algebra I standards (grades eight through twelve):

- (1.1) Students use properties of numbers to demonstrate whether assertions are true or false.
- (5.0) Students solve multistep problems, including word problems, involving linear equations and linear inequalities in one variable and provide justification for each step.
- (8.0) Students understand the concepts of parallel lines and perpendicular lines and how those slopes are related. Students are able to find the equation of a line perpendicular to a given line that passes through a given point.
- (12.0) Students simplify fractions with polynomials in the numerator and denominator by factoring both and reducing them to the lowest terms.
- (15.0) Students apply algebraic techniques to solve rate problems, work problems, and percent mixture problems.
- (24.1) Students explain the difference between inductive and deductive reasoning and identify and provide examples of each.

Specific applications of Geometry standards (grades eight through twelve):

- (11.0) Students determine how changes in dimensions affect the perimeter, area, and volume of common geometric figures and solids.

Specific applications of Algebra II standards (grades eight through twelve):

- (6.0) Students add, subtract, multiply, and divide complex numbers.

1.2 Science

Specific applications of Physics standards (grades nine through twelve):

- (3.a) Students know heat flow and work are two forms of energy transfer between systems.
- (3.g) Students know how to solve problems involving heat flow, work, and efficiency in a heat engine and know that all real engines lose some heat to their surroundings.
- (5.a) Students know how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.
- (5.b) Students know how to solve problems involving Ohm's law.

Specific applications of Investigation and Experimentation standards (grades nine through twelve):

- (1.a) Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.

1.3 History–Social Science

Specific applications of United States History and Geography: Continuity and Change in the Twentieth Century standards (grade eleven):

- (11.5) Students analyze the major political, social, economic, technological, and cultural developments of the 1920s.
- (11.5.7) Discuss the rise of mass production techniques, the growth of cities, the impact of new technologies (e.g., the automobile, electricity), and the resulting prosperity and effect on the American landscape.
- (11.7) Students analyze America’s participation in World War II.
- (11.7.6) Describe major developments in aviation, weaponry, communication, and medicine and the war’s impact on the location of American industry and use of resources.
- (11.8) Students analyze the economic boom and social transformation of post-World War II America.
- (11.8.7) Describe the effects on society and the economy of technological developments since 1945, including the computer revolution, changes in communication, advances in medicine, and improvements in agricultural technology.
- (11.11) Students analyze the major social problems and domestic policy issues in contemporary American society.
- (11.11.3) Describe the changing roles of women in society as reflected in the entry of more women into the labor force and the changing family structure.

2.0 Communications

Students understand the principles of effective oral, written, and multimedia communication in a variety of formats and contexts.

(The standards listed below retain in parentheses the numbering as specified in the English–language arts content standards adopted by the State Board of Education.)

2.1 Reading

Specific applications of Reading Comprehension standards (grades nine and ten):

- (2.1) Analyze the structure and format of functional workplace documents, including the graphics and headers, and explain how authors use the features to achieve their purposes.
- (2.6) Demonstrate use of sophisticated learning tools by following technical directions (e.g., those found with graphic calculators and specialized software programs and in access guides to World Wide Web sites on the Internet).

Specific applications of Reading Comprehension standards (grades eleven and twelve):

- (2.3) Verify and clarify facts presented in other types of expository texts by using a variety of consumer, workplace, and public documents.

2.2 Writing

Specific applications of Writing Strategies standards (grades nine and ten):

- (1.3) Use clear research questions and suitable research methods (e.g., library, electronic media, personal interview) to elicit and present evidence from primary and secondary sources.
- (1.4) Develop the main ideas within the body of the composition through supporting evidence (e.g., scenarios, commonly held beliefs, hypotheses, definitions).
- (1.5) Synthesize information from multiple sources and identify complexities and discrepancies in the information and the different perspectives found in each medium (e.g., almanacs, microfiche, news sources, in-depth field studies, speeches, journals, technical documents).
- (1.8) Design and publish documents by using advanced publishing software and graphic programs.

Specific applications of Writing Strategies and Applications standards (grades eleven and twelve):

- (1.8) Integrate databases, graphics, and spreadsheets into word-processed documents.
- (2.5) Write job applications and résumés:
 - a. Provide clear and purposeful information and address the intended audience appropriately.
 - b. Use varied levels, patterns, and types of language to achieve intended effects and aid comprehension.
 - c. Modify the tone to fit the purpose and audience.
 - d. Follow the conventional style for that type of document (e.g., résumé, memorandum) and use page formats, fonts, and spacing that contribute to the readability and impact of the document.
- (2.6) Deliver multimedia presentations:
 - a. Combine text, images, and sound and draw information from many sources (e.g., television broadcasts, videos, films, newspapers, magazines, CD-ROMs, the Internet, electronic media-generated images).
 - b. Select an appropriate medium for each element of the presentation.
 - c. Use the selected media skillfully, editing appropriately and monitoring for quality.
 - d. Test the audience's response and revise the presentation accordingly.

2.3 Written and Oral English Conventions

Specific applications of English Language Conventions standards (grades nine and ten):

- (1.4) Produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization.

2.4 *Listening and Speaking*

Specific applications of Listening and Speaking Strategies and Applications standards (grades eleven and twelve):

- (1.8) Use effective and interesting language, including:
 - a. Informal expressions for effect
 - b. Standard American English for clarity
 - c. Technical language for specificity
- (2.4) Deliver multimedia presentations:
 - a. Combine text, images, and sound by incorporating information from a wide range of media, including films, newspapers, magazines, CD-ROMs, online information, television, videos, and electronic media-generated images.
 - b. Select an appropriate medium for each element of the presentation.
 - c. Use the selected media skillfully, editing appropriately and monitoring for quality.
 - d. Test the audience's response and revise the presentation accordingly.

2.5 *Multimedia*

Understand the importance of technical and computer-aided design and drawing technologies essential to the language of the energy and utilities industry, including reading, interpreting, and creating drawings, sketches, and schematics using energy and utilities industry conventions and standards; interpreting and understanding detailed information provided from available technical documents, both print and electronic, and from experienced people; and using computers, calculators, multimedia equipment, and other devices in a variety of applications.

3.0 **Career Planning and Management**

Students understand how to make effective decisions, use career information, and manage personal career plans:

- 3.1 Know the personal qualifications, interests, aptitudes, knowledge, and skills necessary to succeed in careers.
- 3.2 Understand the scope of career opportunities and know the requirements for education, training, and licensure.
- 3.3 Develop a career plan that is designed to reflect career interests, pathways, and postsecondary options.
- 3.4 Understand the role and function of professional organizations, industry associations, and organized labor in a productive society.
- 3.5 Understand the past, present, and future trends that affect careers, such as technological developments and societal trends, and the resulting need for lifelong learning.
- 3.6 Know important strategies for self-promotion in the hiring process, such as job applications, résumé writing, interviewing skills, and preparation of a portfolio.

4.0 Technology

Students know how to use contemporary and emerging technological resources in diverse and changing personal, community, and workplace environments:

- 4.1 Understand past, present, and future technological advances as they relate to a chosen pathway.
- 4.2 Understand the use of technological resources to gain access to, manipulate, and produce information, products, and services.
- 4.3 Understand the influence of current and emerging technology on selected segments of the economy.
- 4.4 Use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphic calculators) to perform tests, collect data, analyze relationships, and display data.
- 4.5 Understand the process of delivering a multimedia presentation.
- 4.6 Understand the effects of financial, technical, and economic trends on the energy and environmental technology industry.

5.0 Problem Solving and Critical Thinking

Students understand how to create alternative solutions by using critical and creative thinking skills, such as logical reasoning, analytical thinking, and problem-solving techniques:

- 5.1 Apply appropriate problem-solving strategies and critical thinking skills to work-related issues and tasks.
- 5.2 Understand the systematic problem-solving models that incorporate input, process, outcome, and feedback components.
- 5.3 Use critical thinking skills to make informed decisions and solve problems.
- 5.4 Understand the role of troubleshooting, research and development, invention, and experimentation in problem solving.
- 5.5 Know how to develop an energy and utilities sector product to given design parameters by using industry-specific materials, tools, equipment, and systems that meet end-use goals.

6.0 Health and Safety

Students understand health and safety policies, procedures, regulations, and practices, including the use of equipment and handling of hazardous materials:

- 6.1 Know the policies, procedures, and regulations regarding health and safety in the workplace, including employers' and employees' responsibilities.
- 6.2 Understand critical elements of health and safety practices related to storing, cleaning, and maintaining tools, equipment, and supplies.
- 6.3 Maintain safe and healthful working conditions and environments.
- 6.4 Use tools and machines safely and appropriately.

- 6.5 Understand the role and fundamental responsibilities of governmental safety agencies.
- 6.6 Know how to perform cardiopulmonary resuscitation (CPR) and basic first aid.

7.0 Responsibility and Flexibility

Students know the behaviors associated with the demonstration of responsibility and flexibility in personal, workplace, and community settings:

- 7.1 Understand the qualities and behaviors that constitute a positive and professional work demeanor.
- 7.2 Understand the importance of accountability and responsibility in fulfilling personal, community, and workplace roles.
- 7.3 Understand the need to adapt to varied roles and responsibilities.
- 7.4 Understand that individual actions can affect the larger community.
- 7.5 Understand the personal and time-management skills needed in a variety of workplace situations.
- 7.6 Understand the role of careful planning in producing desired results and accomplishing change.

8.0 Ethics and Legal Responsibilities

Students understand professional, ethical, and legal behavior consistent with applicable laws, regulations, and organizational norms:

- 8.1 Know the major local, district, state, and federal regulatory agencies and entities that affect the industry and how they enforce laws and regulations.
- 8.2 Understand the concept and application of ethical and legal behavior consistent with workplace standards.
- 8.3 Understand the role of personal integrity and ethical behavior in the workplace, including environmental awareness and responsibilities.

9.0 Leadership and Teamwork

Students understand effective leadership styles, key concepts of group dynamics, team and individual decision making, the benefits of workforce diversity, and conflict resolution:

- 9.1 Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace settings.
- 9.2 Understand the ways in which preprofessional associations, such as SkillsUSA, and competitive career development activities enhance academic skills, promote career choices, and contribute to employability.
- 9.3 Understand how to organize and structure work individually and in teams for effective performance and the attainment of goals.
- 9.4 Know multiple approaches to conflict resolution and their appropriateness for a variety of situations in the workplace.

- 9.5 Understand how to interact with others in ways that demonstrate respect for individual and cultural differences and for the attitudes and feelings of others.
- 9.6 Understand how to organize, conduct, and participate in meetings.

10.0 Technical Knowledge and Skills

Students understand the essential knowledge and skills common to all pathways in the Energy and Utilities sector:

- 10.1 Select, use, adjust, and maintain tools, equipment, systems, and products common to the school energy and utilities instructional program in a safe, effective, and appropriate manner.
- 10.2 Know the common energy and power technologies.
- 10.3 Know the sources and systems of power and energy.
- 10.4 Know the energy resources currently in use or under research.
- 10.5 Know the basic theory of energy conversion processes and energy transmission systems and know their common applications.
- 10.6 Know the fundamentals of energy extraction processes and conserving and storing systems.
- 10.7 Use service resources, including print and electronic retrieval systems, to diagnose and solve technical problems.
- 10.8 Know the essential elements of a clearance and tagging program.
- 10.9 Understand the basic principles and proper selection and use of equipment designed for working in confined spaces and equipment designed for working at heights in a safe and appropriate manner.
- 10.10 Interpret material safety data sheets and locate information on hazardous materials.
- 10.11 Understand the fundamentals of lubricants and lubrication.
- 10.12 Understand the basic principles associated with the use of fasteners and the skills required in good bolting practices.
- 10.13 Understand the need to participate in sector-related professional improvement activities, SkillsUSA, other career technical education leadership and skill associations, and related career pathway specializations.
- 10.14 Comprehend complex details and specifications from both technical documentation and presentations.
- 10.15 Understand the need and process to obtain and maintain industry-standard, technical certifications and affiliations with professional organizations, including the American Gas Association and the Institute of Electrical and Electronic Engineers, Incorporated.

11.0 Demonstration and Application

Students demonstrate and apply the concepts contained in the foundation and pathway standards.

PATHWAY STANDARDS

A. Electromechanical Installation and Maintenance Pathway

The Electromechanical Installation and Maintenance Pathway prepares students for employment or advanced training in a variety of electromechanical installation and maintenance industries.

A1.0 Students understand the advantages and disadvantages of energy resources currently in use or under research that influence or will influence electromechanical installation and maintenance industry systems and processes:

- A1.1 Know the new and emerging energy resources in the industry.
 - A1.2 Know the advantages and disadvantages of energy resources used in the industry and the effects of those resources on the environment.
 - A1.3 Know the theory of basic plant electrical components.
 - A1.4 Know the fundamentals of cycles (including vapor and combined power, cogeneration, and Brayton and Rankin cycles) as they relate to energy resources used in the industry.
 - A1.5 Understand the operational fundamentals of basic industrial plants as they relate to energy resources used in the industry.
-

A2.0 Students understand energy conversion processes and energy transmission systems used in the electromechanical installation and maintenance industry:

- A2.1 Know the basic physical and chemical terms, characteristics, and concepts related to process and systems operations and maintenance.
 - A2.2 Know the fundamentals of control systems and circuitry.
 - A2.3 Use a variety of rigging techniques in appropriate situations.
 - A2.4 Know the fundamentals of shaft couplings and shaft alignment.
 - A2.5 Know the fundamentals of basic electrical supply components.
 - A2.6 Understand basic process measurement systems.
-

A3.0 Students understand energy extraction processes, energy conservation systems, and energy storing in the electromechanical installation and maintenance industry:

- A3.1 Know the practical operation of energy extraction processes, energy conservation systems, and energy.
- A3.2 Know the application of energy extraction processes, energy conservation systems, and energy storing methods in the industry as they relate to human needs.
- A3.3 Know the fundamentals of material characteristics, alloys, and testing.
- A3.4 Know the basic extraction, conservation, and storing applications of oxidation-reduction reactions and thermodynamics.
- A3.5 Know the basic principles of hydraulic, pneumatic, and electrical power.

A4.0 Students understand specific career preparation and planning requirements for employment in the electromechanical installation and maintenance industry and how these requirements apply to all students planning to enter and advance in the industry:

- A4.1 Interpret scaled plant, circuit, and process drawings; perform calculations; and use resultant details to plan and produce components and systems that meet industry standards.
- A4.2 Know the processes used in controlling work scheduling and completion.
- A4.3 Understand a process used in controlling parts and equipment.
- A4.4 Understand the fundamentals of metallurgy and fluidics, including grain structure, hardness, flow control, and metering.

A5.0 Students understand procedures and processes as they occur in an electromechanical installation and maintenance project:

- A5.1 Interpret written and oral maintenance and job specifications to plan and produce components, systems, and services that meet both customer needs and industry standards.
- A5.2 Estimate the materials to be used from the blueprints for projects and services.
- A5.3 Plan a sequence of events in a project.
- A5.4 Construct projects accurately from blueprints and specifications.
- A5.5 Solve common project problems by using construction codes, technical manuals, and building standards.
- A5.6 Understand the importance of and procedure for maintaining accurate records of the progress of a project.

B. Energy and Environmental Technology Pathway

The Energy and Environmental Technology Pathway prepares students for employment or advanced training in a variety of energy and environmental industries.

B1.0 Students understand energy resources and the effects of these resources and systems on the environment:

- B1.1 Know how to classify various conventional energy resources by type: depletable, nondepletable, renewable, and nonrenewable.
 - B1.2 Know the new and emerging energy resources.
 - B1.3 Understand the advantages and disadvantages of energy resources in terms of the effects on the environment.
-

B2.0 Students understand the environmental implications of energy conversion processes and energy transmission systems:

- B2.1 Know energy conversion processes and energy transmission systems as they relate to activities across the environment.
 - B2.2 Know the basic terms, characteristics, and concepts of physical and chemical processes related to components and systems operations and maintenance in energy conversion and transmission systems.
 - B2.3 Know the basic gas, electrical, and electronic terms, units, definitions, and concepts in energy conversion and transmission systems.
 - B2.4 Know the influences of three different energy conversion processes and energy transmission systems.
 - B2.5 Understand the basic principles of energy systems: chemical, hydraulic, pneumatic, electrical, nuclear, solar, wind, and geothermal.
 - B2.6 Understand basic energy production systems and components, including the main components and system flow-paths in energy conversion and transmission systems.
-

B3.0 Students understand the applications and environmental effects of energy extraction processes, energy conservation systems, and energy storing systems:

- B3.1 Know the common energy extraction processes, energy conservation systems, and energy storage systems.
- B3.2 Understand the environmental implications of energy conservation principles related to energy extraction processes, conservation systems, and storage systems.
- B3.3 Understand the pragmatic applications of energy extraction processes, energy conservation systems, and energy storing methods.

B4.0 Students understand and apply specific career preparation and planning requirements for employment in the environmental technology industry and understand how these requirements apply across all standards for students planning to successfully enter and advance in the industry:

- B4.1 Know the practical and theoretical applications of voltage, amperage, and resistance in electrical circuits and systems.
- B4.2 Know fault analysis and the steps that lead to fault analysis.
- B4.3 Interpret circuit, plant, process, and systems drawings and diagrams.
- B4.4 Understand oil and gas exploration, extraction, distillation, and distribution processes and systems.
- B4.5 Understand the essential elements of a chemical-control program.
- B4.6 Understand the principles of an auditable calibration program in an energy or utilities context.

C. Public Utilities Pathway

The Public Utilities Pathway prepares students for employment or advanced training in a variety of opportunities in the public utilities industry.

C1.0 Students understand the advantages and disadvantages of energy resources in use or under research that influence or will influence the public utilities industry:

- C1.1 Know the new and emerging energy resources used in the public utilities industry.
 - C1.2 Understand the advantages and disadvantages of energy resources used in the public utilities industry.
 - C1.3 Understand the effects of energy resource and conservation systems on the environment.
-

C2.0 Students understand the energy conversion processes and energy transmission systems used in the public utilities industry:

- C2.1 Understand the application of energy conversion processes and energy transmission systems in the public utilities industry.
 - C2.2 Understand scientific principles (including mechanical, fluid, and thermodynamic) and chemical functions common to energy conversion processes and energy transmission systems.
 - C2.3 Understand the mathematical functions, including measurement scales, tables, and systems, used for safe energy conversion processes and energy transmission systems.
 - C2.4 Understand the basic principles of electricity and electrical power required of safe and economical energy conversion processes and energy transmission systems.
 - C2.5 Understand the basic principles of nuclear and other alternative power energy conversion processes and energy transmission systems used in the public utilities industry.
-

C3.0 Students understand energy extraction processes, energy conservation (e.g., residential) systems, and energy storing in the public utilities industry:

- C3.1 Understand the energy extraction processes, energy conservation systems, and energy storing systems common to the public utilities industry.
- C3.2 Understand the application of energy extraction processes, energy conservation systems, and energy storing methods in the public utilities industry.
- C3.3 Know the various energy extraction processes, energy conservation systems, and energy storing methods used in the public utilities industry.
- C3.4 Understand the basic systems and components found in energy extraction processes, energy conservation systems, and energy storing methods.
- C3.5 Understand the theory and operation of basic electrical and electronic control, measurement, and monitoring components for energy extraction, energy conservation, and storage facilities.

-
- C4.0 *Students understand the effects of financial, technical, and economic trends on the past, current, and future technology in the public utilities industry:*
- C4.1 Understand the effects of financial, technical, and economic trends on the past, present, and future of the public utilities industry.
 - C4.2 Understand the role of the public utilities industry in the local, state, and national community infrastructure.
 - C4.3 Understand the effects of financial, technical, and economic trends on the development of systems and processes in the public utilities industry.
-
- C5.0 *Students understand the career preparation requirements for employment in the public utilities industry and how those requirements apply across all standards:*
- C5.1 Understand the basic pragmatic and theoretical applications of voltage, amperage, resistance, and heat transfer and flow in electrical and electronic circuits and equipment.
 - C5.2 Understand the basic principles of pipelines, conveyors, elevators, and related alternative transport systems used in energy extraction processes, energy conservation systems, and energy storage.
 - C5.3 Understand the concept of and need for maintenance and fault analysis skills and the related need and requirements for maintaining a calibration program in the public utilities industry.
 - C5.4 Understand and interpret circuit, process, and structural drawings, diagrams, and blueprints used in the public utilities industry.
 - C5.5 Understand the fundamentals of metallurgy associated with energy extraction processes, energy conservation systems, and energy storage.
 - C5.6 Understand the basic concepts of heat transfer and flow.
-
- C6.0 *Students understand management procedures and processes as they occur in a public utilities industry project:*
- C6.1 Understand the use of blueprints in job estimation applications, maintenance planning and procedures, and job specification analysis for a public utilities industry project.
 - C6.2 Use scheduling systems to plan sequences of events in public utilities industry projects.
 - C6.3 Construct projects accurately from blueprints and specifications.
 - C6.4 Use construction codes, technical manuals, electronic retrieval systems, and industry standards, such as American Gas Association standards, to solve common problems.
 - C6.5 Understand one system supporting the maintenance of accurate records of the progress of a public utility project.
 - C6.6 Understand the need for the production and use of industry-generated documents, records, and forms and the need for related management skills.

-
- C7.0 *Students understand the variety of building phases, systems, and techniques used in commercial and heavy construction in the public utilities industry:*
- C7.1 Know how to develop building plans and schedules by using processes common to commercial and heavy construction in the public utilities industry.
 - C7.2 Understand the wide variety of tools, equipment, processes, materials, and knowledge and skills associated with the architectural design and development of commercial and heavy construction public utility projects.

D. Residential and Commercial Energy and Utilities Pathway

The Residential and Commercial Energy and Utilities Pathway prepares students for employment or advanced training in a variety of residential and commercial energy and utility industries.

D1.0 Students understand the advantages and disadvantages of energy resources (e.g., nonrenewable) currently in use or under research that influence or will influence the residential and commercial energy and utilities industry:

- D1.1 Know the new and emerging energy resources used in residential and commercial energy and utilities.
 - D1.2 Know the advantages and disadvantages of energy resources used in residential and commercial industries in terms of their effects on the environment.
 - D1.3 Understand the basic principles of electricity and electrical power, including how electricity is generated and used as a power source.
-

D2.0 Students understand energy conversion processes and energy transmission systems used in residential and commercial industries:

- D2.1 Understand the basic physical and chemical terms, characteristics, and concepts related to process and system operations.
 - D2.2 Use the appropriate electronic instruments to analyze, repair, and measure electric and electronic systems, circuits, and components.
 - D2.3 Understand the basic semiconductor physics and characteristics in circuit applications, including analog circuit basics and various forms of electromotive force.
 - D2.4 Understand the basic integrated circuit design, fabrication, and testing techniques in circuit applications.
 - D2.5 Understand the principles of electrical codes, wiring applications, and circuit and device troubleshooting techniques in circuit fabrications.
 - D2.6 Understand the principles of natural gas codes, distribution applications, and troubleshooting techniques in distribution systems.
-

D3.0 Students understand the role and function of tools and machines in residential and commercial industries:

- D3.1 Know how to select and safely use hand and power tools, equipment, and machines common to residential and commercial energy and utilities systems.
- D3.2 Understand how tools, equipment, and machines may be used to safely measure, test, diagnose, and analyze relationships between voltage, current, resistance, power, gas and fluid pressure, and flow rate.
- D3.3 Know how tools, equipment, and machines may be used to safely measure, test, diagnose, and analyze tuned circuits, sine wave, and resonant and related characteristics of alternating current in alternating current applications.
- D3.4 Understand the consumer concepts (e.g., consumer rights and informed purchasing) that apply to the purchase of industrial products and materials.

- D3.5 Know the fundamental business aspects of the residential and commercial energy and utilities industry.
 - D3.6 Know the basic principles of industry documents, records, and forms associated with the residential and commercial energy and utilities industry.
 - D3.7 Know the importance of the business and consumer relationship and consumer rights concepts associated with the residential and commercial energy and utilities industry products and services.
 - D3.8 Know the essential elements of a quality assurance system.
-

D4.0 Students understand specific career preparation and planning requirements for employment in the residential and commercial energy and utilities industry and how these requirements apply across all standards for students planning to successfully enter and advance in the industry:

- D4.1 Know gas, oil, electric, and electronic component codes and labeling.
 - D4.2 Understand how electricity and electronics are composed of interactive, measurable forces.
 - D4.3 Know the operation and application of circuits for low-voltage control signals.
 - D4.4 Know the principles of electronic communication systems.
 - D4.5 Know basic optoelectronic circuitry; the nature of light, light sources, and light amplification; and the integration of optical systems with electronic systems.
 - D4.6 Know the principles of operation and the applications of transducers, sensors, and electronic and electromechanical controllers.
-

D5.0 Students understand and apply procedures and processes related to a residential and commercial energy and utility project:

- D5.1 Interpret information found in blueprints, maintenance and job specifications, and technical publications.
 - D5.2 Know fabrication processes and how they are used in the industry.
 - D5.3 Estimate needed materials by using blueprints, job specifications, and technical publications.
 - D5.4 Know the process of project planning and maintenance.
 - D5.5 Solve common problems by using technical manuals, electronic retrieval systems, construction codes, and industry standards, such as American Gas Association standards.
 - D5.6 Know the importance of maintaining accurate records of the progress of a project.
-

D6.0 Students understand the value and necessity of practicing occupational safety in the residential and commercial energy and utilities industry:

- D6.1 Know the basic fire hazards in the energy and utilities industry.
- D6.2 Understand the elements of combustion, fire classifications, and fire-fighting equipment and techniques specific to the residential and commercial energy and utilities industry.
- D6.3 Know the basic theory and concepts of electrostatics.