

Lesson Exemplars for Photovoltaic Systems Installation

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Lesson Exemplar for Photovoltaic Systems Installation

Grade 11 – Term 2

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LESSON EXEMPLAR			
Learning Area	PHOTOVOLTAIC SYSTEMS INSTALLATION	Grade Level	11
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I. OBJECTIVES	
A. Content Standard	The learners demonstrate an understanding of the concepts and principles of Photovoltaic (Solar Energy) Systems Installation.
B. Performance Standard	The learners perform photovoltaic (solar energy) systems installation with safety precautions.
C. Learning Competencies	Perform inspection of PV components, materials and measuring instruments compliance.
II. REFERENCES and MATERIALS	<p>References:</p> <ul style="list-style-type: none"> Philippine Electrical Code (PEC) Part 1, Article 6.90 – Solar Photovoltaic (PV) Systems International Electrotechnical Commission (IEC) 61215: Terrestrial photovoltaic (PV) modules – Design qualification and type approval Underwriters Laboratories (UL) 1703: Standard for Flat-Plate Photovoltaic Modules and Panels Department of Education. (2020). K to 12 Basic Education Curriculum: Senior High School – Photovoltaic Systems Installation. Manila: DepEd. <p>Materials:</p> <ul style="list-style-type: none"> Laptop and Projector/TV Actual PV module, inverter, charge controller, mounting structure, and DC/AC disconnect switches Sample product labels (or high-resolution images of labels from different manufacturers) Digital multimeter Inspection checklist template (printed) Safety gloves, safety glasses, and insulated tools Markers and Manila paper for group activity
III. CONTENT	Components and materials standards (IEC, UL, PEC)
IV. OBJECTIVES	<p>At the end of the lesson, learners should be able to:</p> <ol style="list-style-type: none"> Identify key PV components and the acronyms of major standards organizations (IEC, UL, and PEC).

	<ul style="list-style-type: none"> 2. Explain the role of IEC, UL, and PEC standards in ensuring PV system safety and compliance. 3. Inspect PV components using a checklist to verify physical condition and required certification labels. 4. Evaluate PV component labels for compliance with PEC and international standards. 	
V. PROCEDURES		ANNOTATIONS
A. Activating Prior Knowledge	1. Activating Prior Knowledge “One Word, One Purpose” <p>Teacher says: “Good morning, class! Before we start, let's have a quick review. Last quarter, we discussed the basic components of a PV system. On a piece of paper, I want you to list down at least three main components and write one word that describes the purpose of each. For example, 'Solar Panel: Energy.' You have 3 minutes.”</p> <p>After 3 minutes, the teacher asks a few students to share their answers, guiding the class to confirm the main components: PV Module (Energy Source), Inverter (Conversion), Charge Controller (Regulation), and Battery (Storage).</p>	<p>This activity serves as a diagnostic assessment to ensure students have the foundational knowledge of what the components are before moving to how to inspect them. The use of a quick write activates prior schema and sets the stage for the lesson's focus on standards.</p>
	2. Establishing the Purpose of the Lesson <p>Teacher says: “Excellent recall. Now, imagine you are a newly hired PV system installer. You are given a brand-new solar panel to install on a client’s roof. How do you know if this panel is safe to install? How do you know if it will perform as promised and won't start a fire? You can't just trust the brand name. You need proof. Today, we will learn how to look for that proof by inspecting PV components for compliance with international and local safety and performance standards. This is your first step in becoming a</p>	

	certified, professional PV installer who protects clients and ensures system reliability.”	
B. Instituting New Knowledge	<p>1. Presenting Examples</p> <p>“Logo & Symbol Scavenger Hunt”</p> <p>Teacher says: “Before we dive deep, let's look at what we're inspecting. I'm going to pass around a real PV module and a sample inverter. As you examine them, I want you to focus on the labels at the back of the module and the side of the inverter. Don't read the technical numbers yet. Instead, look for any logos, symbols, or acronyms you recognize. Can anyone spot a logo or a set of letters that looks official or like a certification mark?”</p> <p>The teacher facilitates a brief discussion, encouraging students to point out markings like "UL," "IEC," "TÜV," "PEC," and CE logos, even if they don't know what they mean.</p> <p>2. Discussing New Concept</p> <p>Teacher says: “Great observations! All those logos and acronyms are the 'fingerprints' of compliance. Let's decode what they mean and why they are on your inspection checklist. I will be using this presentation. Please take notes in your activity notebook.”</p> <p>The teacher then presents a detailed lecture using a slide deck or whiteboard, covering the following:</p> <p>Slide 1: The "Why" of Standards</p> <p>- "Standards are not just bureaucratic hurdles. They are the</p>	<p>This activity uses concrete, tangible objects to make abstract concepts like "standards" visible and real. By asking students to search for and identify markings, the teacher piques their curiosity and creates a "mystery" that the upcoming discussion will solve. It moves the learning from abstract to concrete.</p>

	<p>rulebook for safety and reliability. They ensure that the solar panel on your roof won't:</p> <ul style="list-style-type: none"> - Start a fire (due to poor insulation or overheating). - Electrocute the installer or homeowner. - Fail prematurely (lose efficiency after a few months). - Damage other components like the inverter or battery. - When we inspect for compliance, we are verifying that a component has passed rigorous tests to prevent these failures." <p>Slide 2: IEC (International Electrotechnical Commission)</p> <ul style="list-style-type: none"> - "What is it? A global, non-profit organization that develops international standards for all electrical, electronic, and related technologies. It is not a testing lab itself. - Key Standard: For PV modules, IEC 61215 is the 'gold standard.' It tests for durability—things like mechanical load (hail, wind), damp heat, and temperature cycling. A module that passes IEC 61215 is certified to withstand environmental stress. - What to look for during inspection: The label should state IEC 61215 or IEC 61730 (for safety). Its presence means the module is internationally recognized as safe and durable." <p>Slide 3: UL (Underwriters Laboratories)</p> <ul style="list-style-type: none"> - "What is it? A global safety science company based in the USA. They test products for fire, shock, and other safety hazards. While it's an American standard, it's widely accepted globally and is often required by insurance companies and local building codes, including in the Philippines. - Key Standard: For PV modules, UL 1703 focuses on fire safety and electrical shock hazards. - What to look for during inspection: The label will have a UL logo (a circled UL). Its presence is a key indicator of 	<p>This is the core content delivery. The lecture is structured to be a direct, ready-to-use script for the teacher. It moves from explaining the "why" (purpose of standards) to the specifics of each standard (IEC, UL, PEC) and finally ties it together into a practical inspection framework. The use of slide titles and clear subheadings makes the information digestible for</p>
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	<p>product safety, especially for fire prevention. The PEC often references UL standards."</p> <p>Slide 4: PEC (Philippine Electrical Code)</p> <ul style="list-style-type: none"> - "What is it? The PEC is the law. It is the set of rules and regulations that govern all electrical installations in the Philippines, including PV systems. It is based on the US National Electrical Code (NEC) but adapted for the Philippine context. - Key Section: Article 6.90 is dedicated to Solar Photovoltaic Systems. It dictates everything from conductor sizing to overcurrent protection and disconnecting means. - What to look for during inspection: The PEC itself is not a sticker on a component. Instead, the PEC <i>mandates</i> that components must be listed and labeled by a recognized testing laboratory (like UL or TÜV). So, when you see a UL or IEC mark, you are checking for compliance with PEC Article 6.90. An inspector's job is to ensure the installation follows PEC rules and that components are certified by a lab." <p>Slide 5: The Inspection Checklist</p> <ul style="list-style-type: none"> - "Now, let's put this into practice. Your inspection checklist will have two key parts: <ol style="list-style-type: none"> 1. Physical Inspection: Look for cracks, corrosion, water ingress, or loose parts. 2. Labeling & Documentation Inspection: Verify the presence of the marks we just discussed. - Example Checklist Items: <ul style="list-style-type: none"> - [] PV Module label is legible and permanently affixed. - [] PV Module label shows IEC 61215 and/or UL 1703 certification. - [] Inverter label shows UL 1741 (the standard for inverters, converters, controllers, and interconnection system equipment). 	<p>students. The teacher directly connects the PEC to the UL/IEC marks, showing how the different standards interrelate.</p>
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	<p>- [] All components are listed by a recognized testing laboratory (e.g., UL, TÜV, CSA)."</p> <p>3. Developing Mastery</p> <p>Teacher says: "Let's see if you can apply what you just learned. In your groups of four, you will receive a 'Component Inspection Card.' Each card has a picture of a label from a PV component. Your task is to analyze the label and answer the questions on the card. You have 10 minutes."</p> <p>Sample Cards:</p> <ul style="list-style-type: none"> - Card 1 (Compliant PV Module): Image of a label clearly showing "IEC 61215," "UL 1703," and a TÜV logo. Questions: "Is this module compliant with international standards? Which ones? Would the PEC likely accept this?" - Card 2 (Non-Compliant Inverter): Image of a label with only a generic "CE" mark (which is a self-declaration, not a third-party certification like UL) and no mention of UL 1741. Questions: "What certifications are missing? Is it safe to install this inverter in a Philippine residential system? Why or why not?" - Card 3 (Damaged Module): Image of a module with a physical crack and a faded, partially torn label. Questions: "What are the two types of inspection failures here? Why is a legible label just as important as a physical one?" <p>After the group work, the teacher calls on groups to share their findings, clarifying any misconceptions.</p>	<p>This activity moves students from passive listening to active application. By analyzing sample labels and scenarios, students develop the critical skill of interpreting certification marks. The activity also reinforces that "compliance" involves both physical condition and proper documentation. The use of a "non-compliant" card forces students to practice the skill of identifying problems, a core part of the inspection process.</p>
C. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application</p> <p>Teacher says: "Now, it's time for a simulated site inspection. I have set up three stations: Station A (PV Module), Station B (Inverter), and Station C (DC Disconnect Switch). At each station, there is a real component with some of them intentionally 'faulty.' Using the 'PV Component Inspection</p>	<p>This activity directly simulates the performance standard: "perform PV components inspection with safety precautions." It provides a hands-on, authentic application of the</p>

	<p>Checklist' you will conduct a real-world inspection. You have 3 minutes per station. Work in your groups. One person can be the recorder, another the inspector. Remember safety first: wear your gloves and glasses, and do not touch any exposed terminals."</p> <p>The teacher circulates among the stations, observing the groups and facilitating by asking questions like, "Did you check for the UL mark? What does the PEC say about this?"</p> <p>2. Making Generalization</p> <p>Teacher says: "Let's step back for a moment. We started by looking at labels and ended by inspecting actual components. Let's summarize. What is the most important reason we inspect PV components for these standards? (Teacher solicits answers)</p> <p>Teacher concludes: "Exactly. We don't just inspect to follow a rule. We inspect to ensure safety and reliability. The IEC, UL, and PEC marks are not just stickers; they are a promise that a component has been tested to withstand real-world conditions and won't endanger life or property. As future PV professionals, you are the guardians of that promise. Your inspection is what separates a professional, safe installation from a potential hazard."</p>	<p>knowledge and skills developed throughout the lesson. The teacher's role shifts to a facilitator and coach, providing guidance and ensuring safety procedures are followed.</p> <p>This activity uses a guided discussion to help students synthesize the lesson's key ideas. The teacher's concluding statement reinforces the ethical and professional responsibility tied to the skill, elevating it from a technical task to a core professional value.</p>
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3. Evaluating Learning

Teacher says: "To check your understanding, please get a ¼ sheet of paper for a short quiz. Write your name and the date."

QUIZ: PV Component Standards and Inspection

Part I: Matching Type (5 points)

Match the standard/acronym in Column A with its correct description in Column B.

COLUMN A	COLUMN B
1. IEC	A. The primary safety standard for PV modules, focusing on fire and shock.
2. UL	B. The governing electrical code in the Philippines.
3. PEC	C. The international standard (e.g., 61215) for testing PV module durability.
4. UL 1703	D. A global safety science company known for testing electrical products.
5. Article 6.90	E. The specific section of the PEC that covers Solar Photovoltaic Systems.

Part II: Identification (5 points)

Write the correct answer on the blank.

6. What two things must an inspector verify during a component inspection, as mentioned in the discussion? (List both)

The quiz serves as a summative assessment of the day's learning objectives. It is designed with both recall (Matching, Part II) and application (questions 8-10) items to assess different levels of understanding, directly aligned with the unpacked objectives.

	<p>7. You are inspecting a PV module label. What specific IEC standard number should you look for that proves it has passed durability tests?</p> <p>8. A client wants to install an inverter with only a "CE" mark. Why is this a red flag for a PEC-compliant installation?</p> <p>9. Besides checking labels, what is another critical part of the physical inspection of a PV module?</p> <p>10. According to the PEC, what is the primary requirement for components regarding their listing and labeling?</p> <p>Answer Key:</p> <ol style="list-style-type: none"> 1. C 2. D 3. B 4. A 5. E 6. Physical condition and Labeling/Documentation 7. IEC 61215 8. The CE mark is a self-declaration, not a third-party certification. The PEC requires components to be listed by a recognized testing laboratory (like UL or TÜV). 9. Check for physical damage such as cracks, corrosion, or water ingress. 10. Components must be listed and labeled by a recognized testing laboratory. <p>4. Additional Activities</p> <p>Remediation: For students who scored below 8 on the quiz, they will be assigned to create a simple 3-column table comparing IEC, UL, and PEC, including their purpose, what they test for, and what to look for during an inspection. They will submit this at the start of the next lesson.</p>	<p>This provides differentiated instruction to cater to varying levels of mastery. Remediation reinforces foundational concepts, while enrichment challenges high-achieving students to delve deeper into specific standards, fostering advanced understanding and research skills.</p>
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	<p>Enrichment: For students who scored 9 or above, their task is to research one specific IEC standard (e.g., IEC 61730 for PV safety) or UL standard (e.g., UL 1741 for inverters) and write a one-paragraph summary explaining what the standard specifically tests for and why it's crucial for the Philippine setting (considering climate, installation practices, etc.). They will share their findings in the next lesson.</p>	
<p>VI. ASSESSMENT</p>	<p>Culminating Performance Task: PV Component Inspection Simulation</p> <ul style="list-style-type: none"> • Objective: To assess the learner's ability to perform a comprehensive inspection of PV components, verifying compliance with IEC, UL, and PEC standards while strictly adhering to safety precautions. • Scenario: You are a PV systems installer conducting a pre-installation inspection for a new residential solar project. Your lead electrician has provided you with three PV components: a PV module, a grid-tied inverter, and a DC disconnect switch. Your task is to conduct a full inspection, documenting your findings on the official inspection report. The client's approval and the system's permit depend on your report's accuracy. • Task: Working individually, you will proceed through three inspection stations. At each station, you will: <ol style="list-style-type: none"> 1. Wear appropriate Personal Protective Equipment (PPE): Safety glasses and gloves. 2. Conduct a Physical Inspection: Visually and physically (where safe) inspect the component for any signs of damage, defects, or improper assembly. 3. Conduct a Labeling & Documentation Inspection: Carefully examine the component's label. Verify the presence of required certification marks (e.g., UL, IEC) and any other relevant information. 4. Complete the Official Inspection Report: Record your observations, findings, and final disposition (PASS/FAIL) on the provided form, citing the specific standard or code (e.g., "FAIL: UL 1703 mark not present, non-compliant with PEC 6.90"). 	

	Scoring Rubric for Performance Task				
	CRITERIA	Excellence (5 points)	Satisfactory (3 points)	Needs Improvement (1 point)	SCORE
	Safety Protocol	Consistently wears appropriate PPE before starting. Demonstrates safe handling of components at all times.	Wears PPE but may handle components slightly unsafely (e.g., poor grip).	Fails to wear PPE or handles components in a clearly unsafe manner.	
	Physical Inspection	Identifies all relevant physical defects (e.g., cracks, corrosion, loose parts) with high accuracy.	Identifies major physical defects but may miss minor or non-obvious ones.	Fails to identify obvious physical defects or misinterprets normal wear as defects.	
	Label Compliance Verification	Correctly identifies all relevant certification marks (IEC, UL, etc.) and links them to their significance (PEC, safety, performance).	Identifies the main certification marks but may miss secondary ones or not fully explain their significance.	Fails to identify or misidentifies key certification marks.	
	Documentation & Report	Report is complete, accurate, and clearly written. Findings are correctly justified with citations to specific standards (e.g., "IEC 61215").	Report is mostly complete but may have minor omissions. Justifications are general (e.g., "no UL mark").	Report is incomplete, inaccurate, or missing. No justifications provided.	

	Final Disposition	Correctly determines PASS/FAIL status for all components based on the evidence and standards.	Correctly determines status for most components but may be indecisive on one.	Incorrectly determines status for a component (e.g., passes a clearly non-compliant part).	
VII. REFLECTION	To be filled out by the teacher after the lesson. <ol style="list-style-type: none"> 1. Were the learners able to correctly identify and explain the importance of IEC, UL, and PEC standards during the inspection activities? 2. Which part of the lesson helped learners most in understanding PV component compliance and safety procedures? 3. What teaching strategies or activities can be improved to enhance learners' skills in conducting PV component inspections? 				
VIII. USE OF	In preparing this Learning Exemplar (LE), the author used Generative AI to assist in structuring and drafting instructional content and assessment items. The author reviewed, edited, and finalized the writing of the content to ensure alignment with curriculum standards and contextual relevance. The author takes full responsibility for the final content of this LE.				