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ERASMUS-EDU-2024-CB-VET Strengthening work force potential in the renewable-energy sector REnForce
Project ID: 101183074

MODULE 1:

Solar energy essentials and VET context

Consolidated by: VICTORIA/RISEBA
Reviewed by: RUEA

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National priorities in renewable energy and VET reform:

1) Renewable energy in Armenia:

30 % electricty in Armenia are from renewable sources. And only 7% in energy mix.

Discussion: Is that enaugh for the future?

2) Key national strategies - including the Energy Sector Development Program and the Strategy for Skills Development (2040)

target is to reach at least 15% renewable energy share in the national mix by 2030.

Discussion: Is that even enaugh? And does Armenia have enaugh own labor sources for these plans?

One of the major policy shifts is the integration of work-based learning (WBL) and capstone projects into technical programs.

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And how about future?

Electric cars
12,000 km ÷ 100 km × 17.5 kWh = 2,100 kWh per vehicle per year
500,000 vehicles × 2,100 kWh = 1,050,000,000 kWh = 1.05 TWh annually

Current Production in Armenia: ~7.7-11 TWh annually, where additional Need: ~1.0-1.2 TWh

Annual electricity needs in Armenia:
10-11 TWh year 2024 (each year needs increse up to 3%)

Discussion about electricity needs in future in Armenia and global..

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Labour market demand and qualification pathways in Armenia

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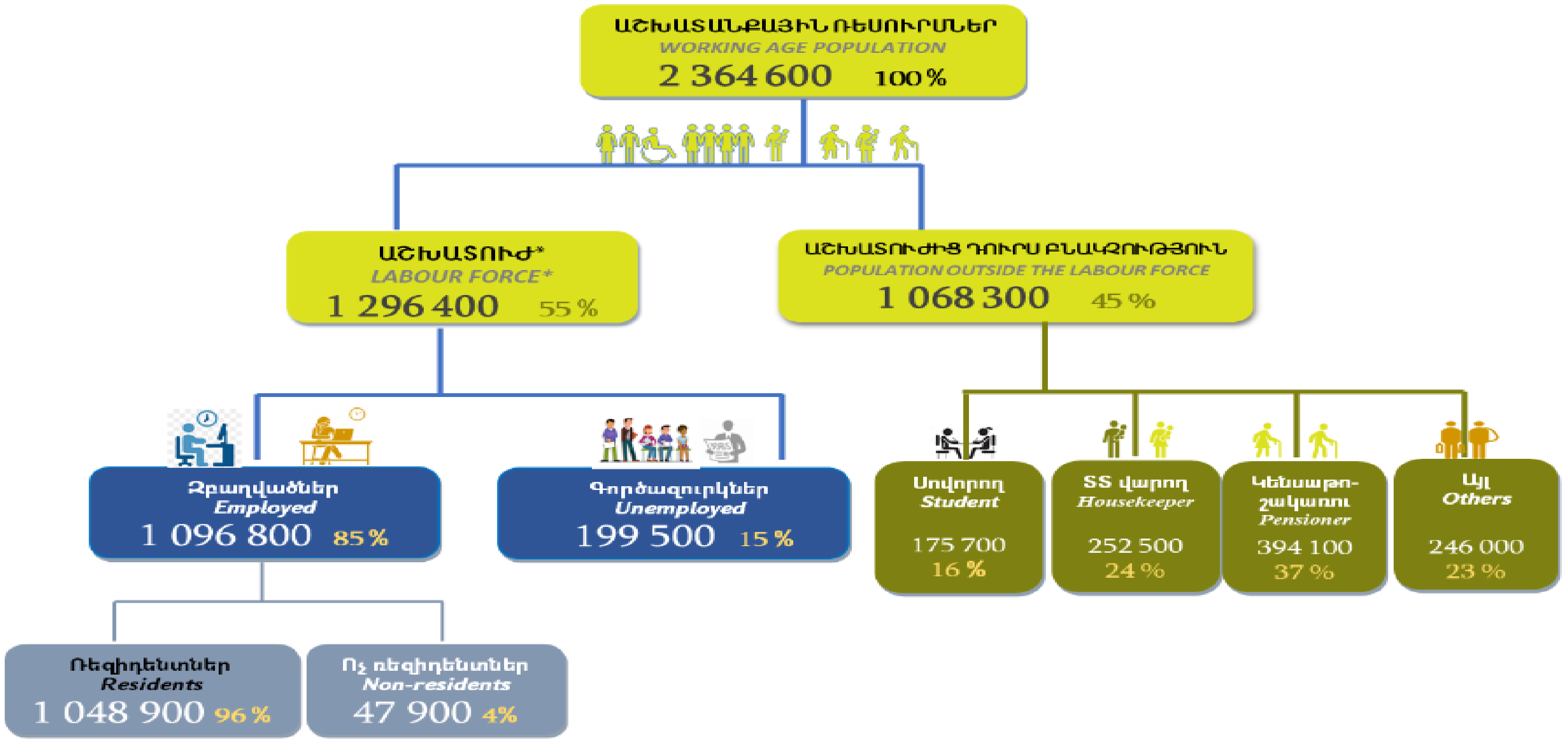
Labour market demand and qualification pathways in Armenia



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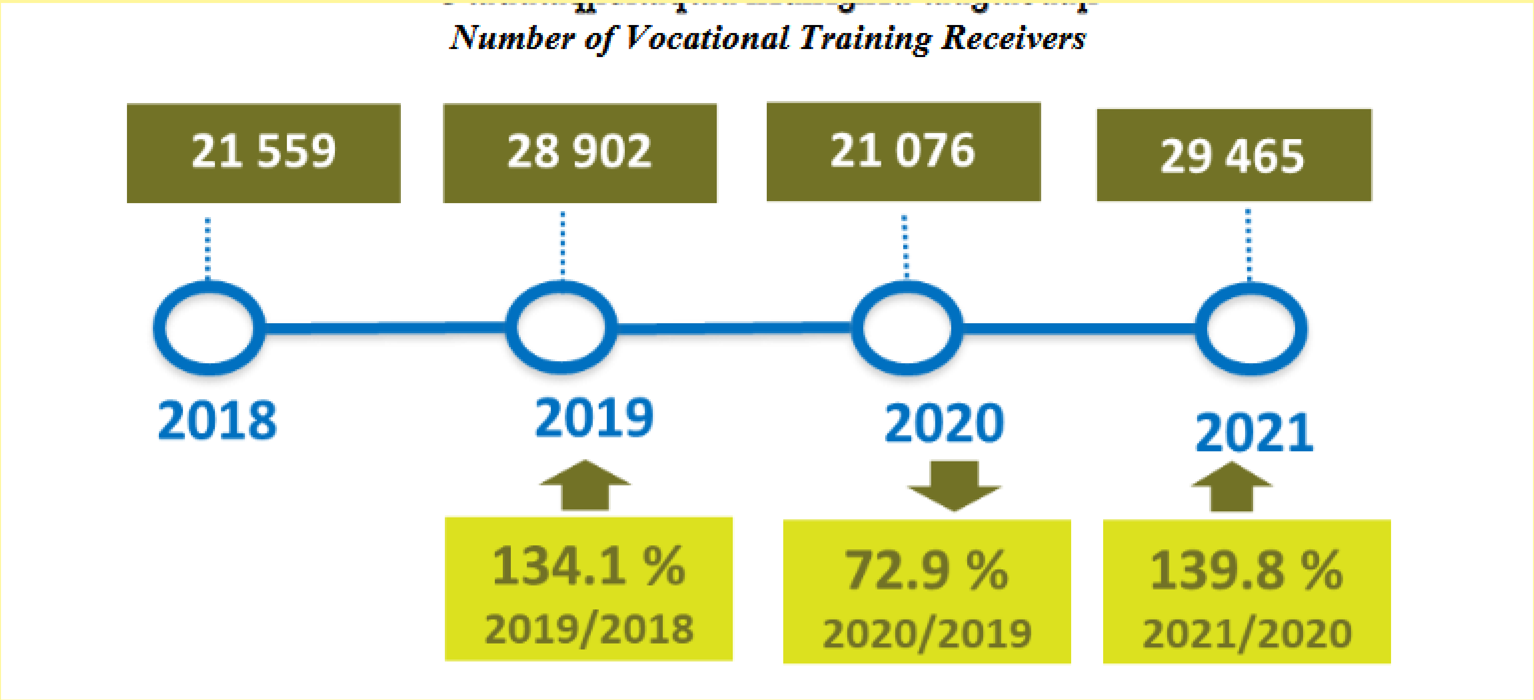

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Labour market demand and qualification pathways in Armenia

Growth Drivers

The consistent high growth rates (ranging from 8.9% to 12% CAGR across different reports) indicate several key trends:

1. **Skills Gap Response**: Growing demand for skilled workers in emerging technologies
2. **Digital Transformation**: Need for workers trained in new digital skills
3. **Industry 4.0**: Manufacturing and technological advancement requiring specialized training
4. **Government Investment**: Increased public and private investment in workforce development
5. **Career Flexibility**: Growing recognition of vocational training as viable career path

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Labour market demand and qualification pathways in Armenia

What happens when the number of graduates from the same study programs increases?

Type of mismatch
Overqualification
Underqualification
Overskilling
Underskilling
Horizontal mismatch
Skill shortages
Skill gaps
Skill obsolescence

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Labour market demand and qualification pathways in Armenia

Scale of displacement: The World Economic Forum estimates that AI and robotics will displace 85 million jobs by 2025 Gaper Nexford, while automation will handle 34% of tasks 48 Jobs AI Will Replace by ... across various industries. However, this represents job transformation rather than total elimination.

Jobs most at risk include:

- **Repetitive, rule-based roles:** Data entry, basic manufacturing, routine administrative tasks
- **Retail positions:** 65% of retail jobs could be automated by 2025 How Will Artificial Intellige...
- **Manufacturing:** MIT research shows AI will replace 2 million manufacturing workers by 2025 AI Job Displacement 2025: ...
- **Financial services:** Especially data-processing roles
- **Some analytical roles:** Basic accounting, telemarketing, certain teaching positions

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Labour market demand and qualification pathways in Armenia

Jobs likely to remain human-dominated include those requiring:

- Creative problem-solving and innovation
- Complex interpersonal skills and empathy
- Strategic thinking and leadership
- Skilled trades requiring physical dexterity
- Healthcare roles involving patient care
- Education roles requiring emotional intelligence

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Labour market demand and qualification pathways in Armenia

Discussion:

Can solar station installers and engineers be replaced by robots in the future, and is this type of professional education long-term?

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Legal framework, standards and compliance in solar energy

•**The Law on Energy** (2001) – establishes the legal foundation for energy production, transmission, distribution, and consumption in Armenia.
•**The Law on Renewable Energy and Energy Efficiency** (2004) – outlines Armenia's commitment to supporting renewable energy projects and sets the legal conditions for their development.
•**The Energy Security Concept** (2013) – identifies solar energy as a strategic priority and encourages diversification of energy sources.

Together, these documents form the legislative foundation for Armenia's renewable energy sector. They define key terms, identify responsible authorities (such as the Public Services Regulatory Commission), and establish the rules for licensing, tariffs, and grid connection for renewable energy systems.

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Legal framework, standards and compliance in solar energy

Key standards include:
IEC 61215: Design qualification and type approval
IEC 61730: Safety qualification requirements
UL 1703: Flat-plate photovoltaic modules and panels
ISO 9001: Quality management systems

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Legal framework, standards and compliance in solar energy

The specific example of a solar energy plant in Maharashtra with a corporate office in Haryana perfectly illustrates how multi-jurisdictional regulatory framework creates compliance nightmares for renewable energy companies.

Breakdown of the 799 Regulatory Obligations

The 799 obligations are distributed as follows: labour (244), secretarial (238), industry-specific (106), finance and taxation (84), environment health and safety (58), commercial (38), and general legal obligations (31)

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Legal framework, standards and compliance in solar energy

For most small-scale systems (residential and commercial), licensing is not required beyond notifying the grid operator and obtaining basic approvals. However, for larger systems - especially those exceeding 150 kW or feeding electricity directly into the grid - project developers must go through:

Environmental review procedures (if required);
Application for construction permits;
Licensing procedures regulated by the Public Services Regulatory Commission (check);
Notification of the Ministry of Territorial Administration and Infrastructure.

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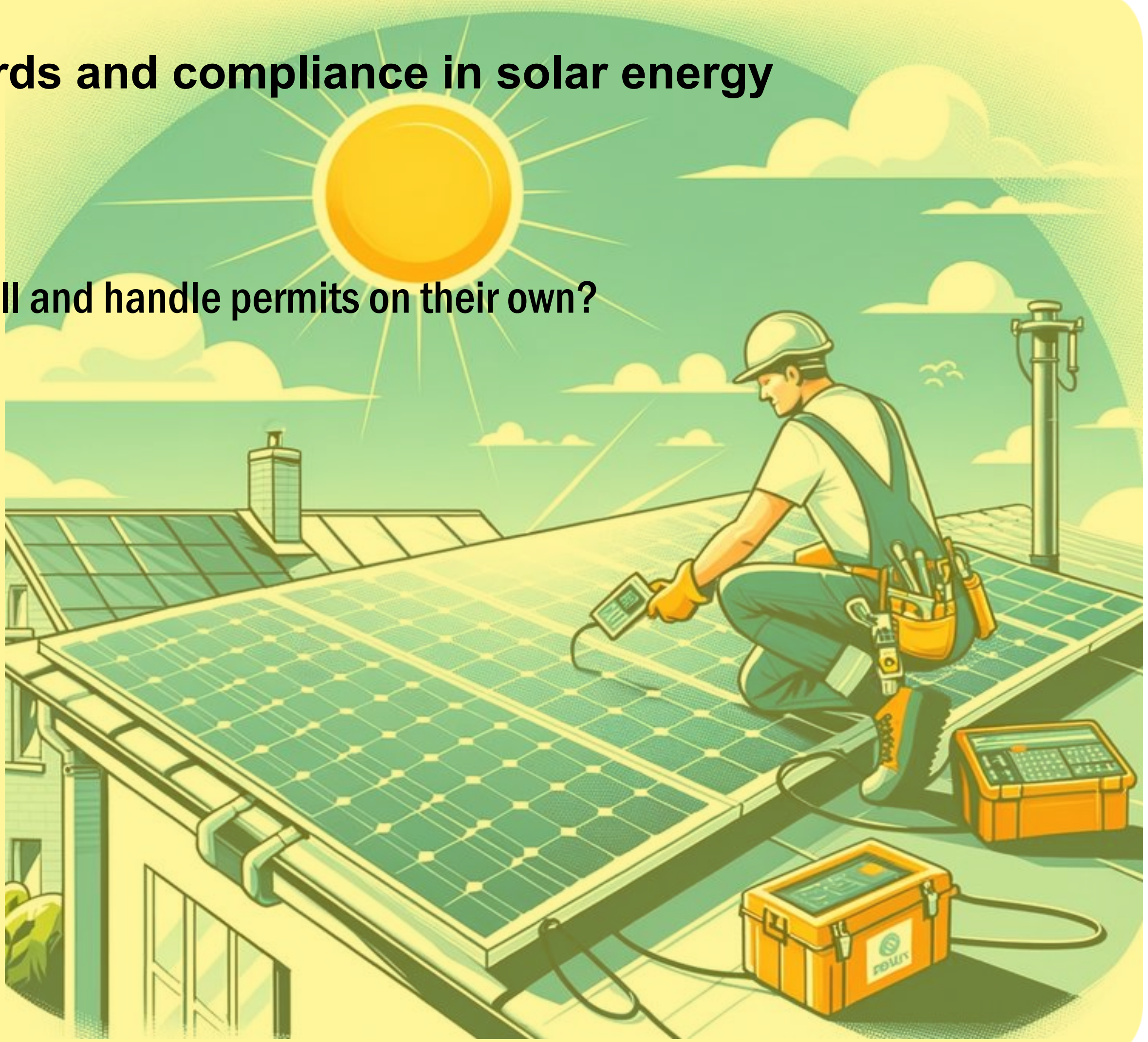
Legal framework, standards and compliance in solar energy

Discussion:

Can a solar station installer install and handle permits on their own?
Or teamwork needed?



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MODULE 1: Solar energy essentials and VET context

Green transition, energy efficiency and policy alignment

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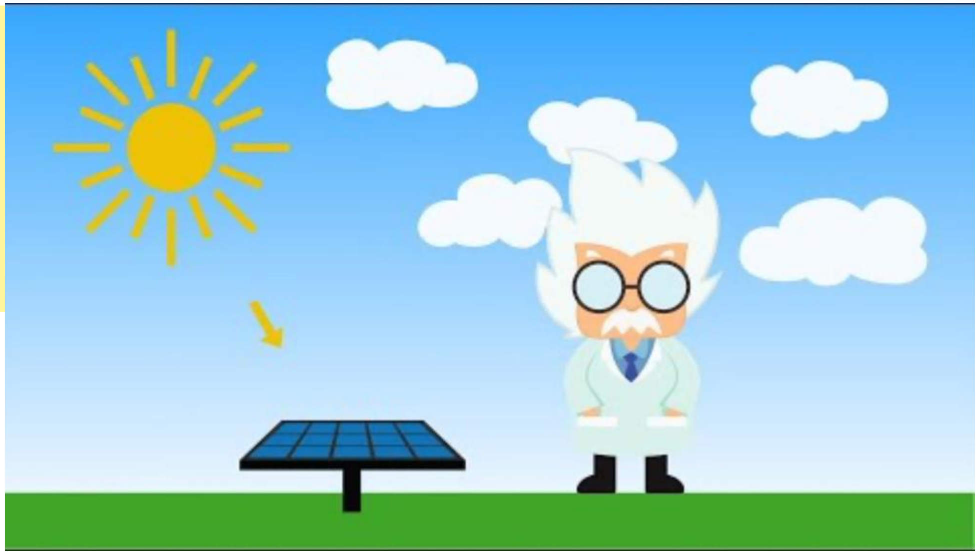
Solar Energy Essentials

Core Technologies:
- Photovoltaics (PV): Sunlight → electricity (homes/businesses)
- Concentrating Solar Power (CSP): Utility-scale heat → electricity
- Passive Solar & Heating: Building design/water heating
- Potential: 1.5 hours of sunlight = Global annual energy demand



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VET in Renewable Energy (NetVET-RE) EU-Wide Training Network:

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- Partners: Germany, France, Spain, UK, Turkey
- Skills Focus: Solar thermal, biogas, hydrogen, wind
- Goal: Standardized pan-European qualifications for green jobs

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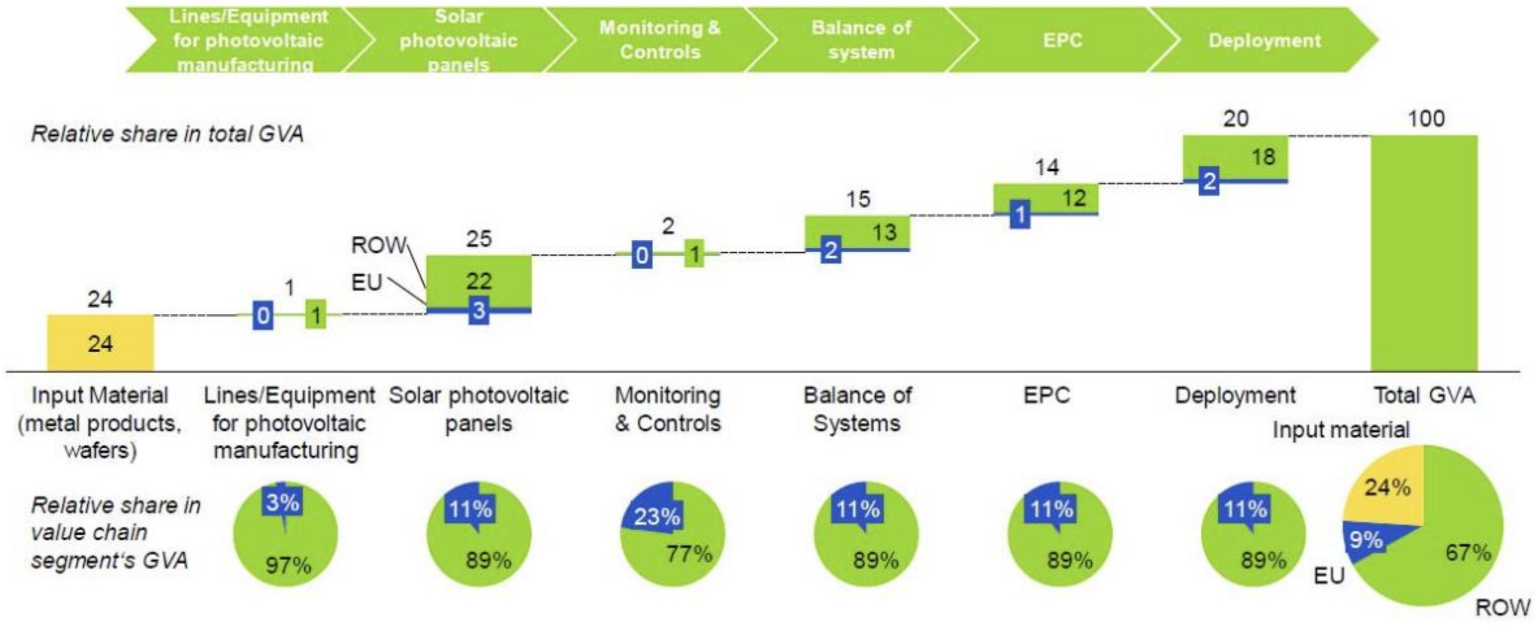
EU Solar Energy Strategy

Figure: Breakdown of Gross Value Added throughout solar PV value chain [43]



Source: Guidehouse Insights, 2020

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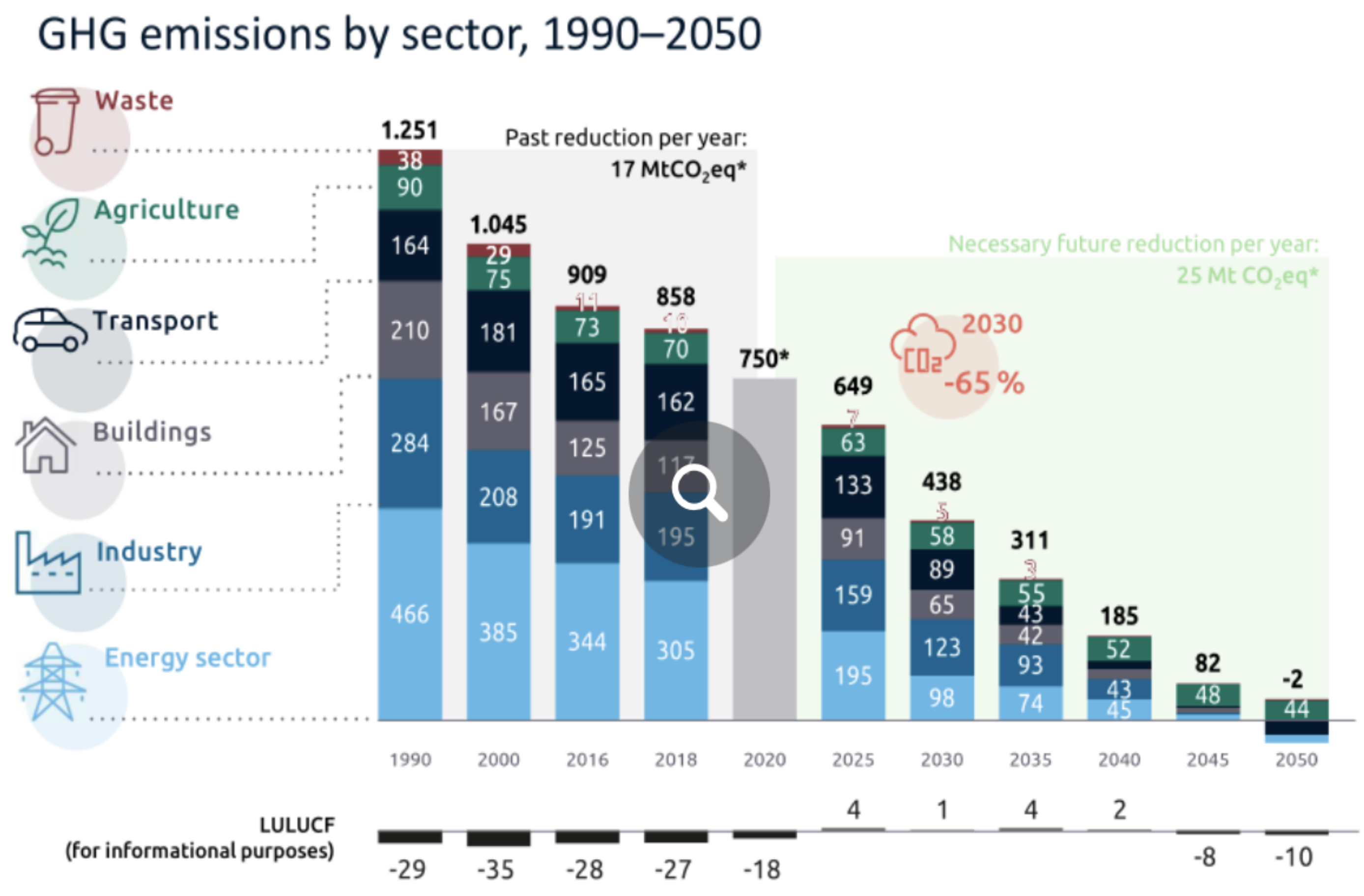
EU Green Deal: Framework for Transition

Key Targets:

- Climate neutrality by 2050; 55% emissions reduction by 2030 (vs. 1990)
- Fit for 55 Package: Legally binding roadmap
- Solar Role: Critical for decarbonizing energy (largest GHG source)



Annual emissions in Mt CO_2eq; Negative emissions are directly factored into the sectors.
* Target for 2020: GHG reduction of 40% relative to 1990.
Prognos, Öko-Institut, Wuppertal Institut (2020)

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Energy Efficiency Directive 2023

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Binding EU Targets:

- 11.7% reduction in final energy consumption by 2030
- Annual savings: 1.3% (2024) → 1.9% (2028+)
- Sector Focus: Public buildings (3% renovation/year), data centers, social housing

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Green Solar-VET-Policy Alignment Synergy Framework:

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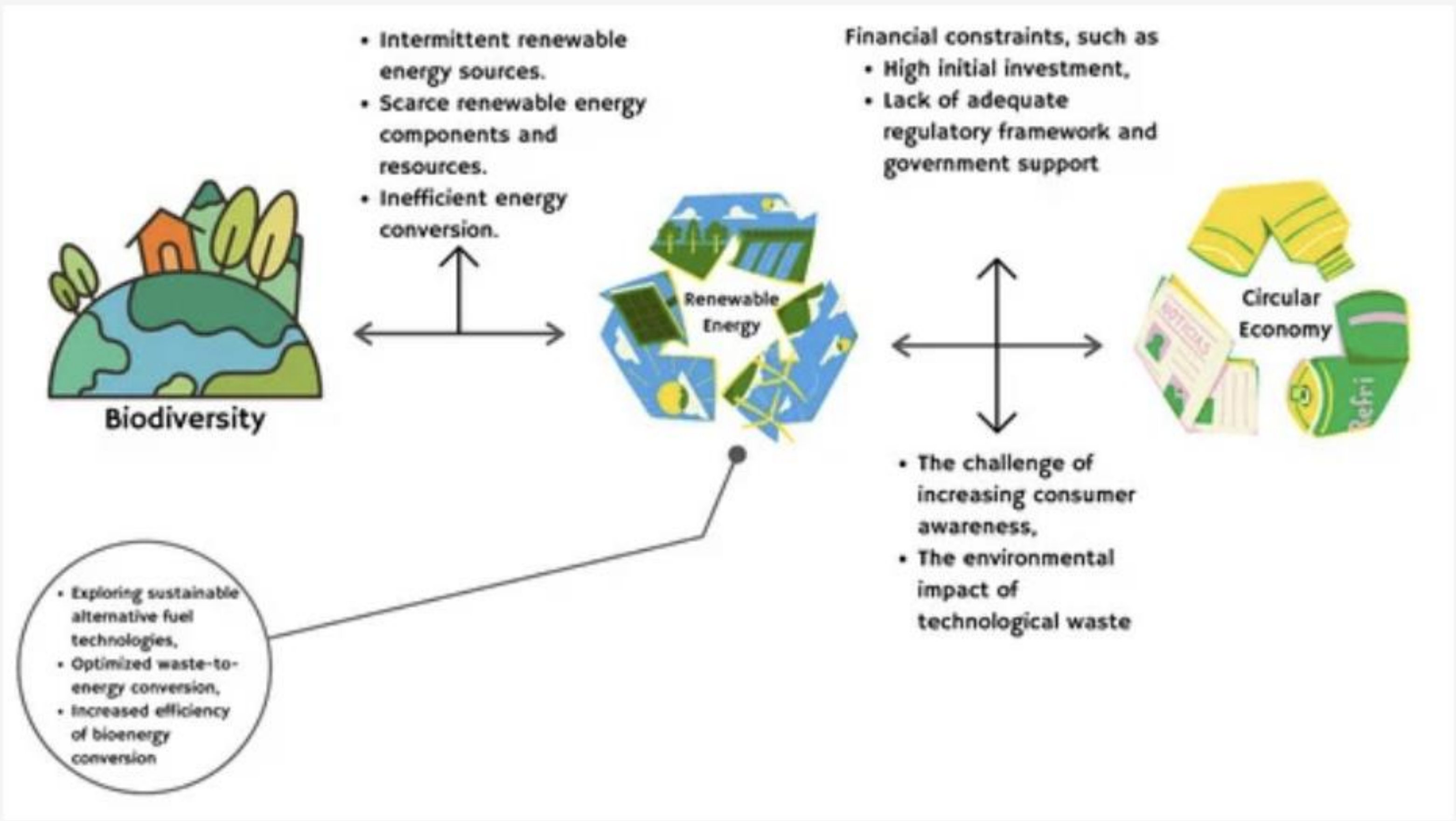

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Green Transition Investments Funding Landscape

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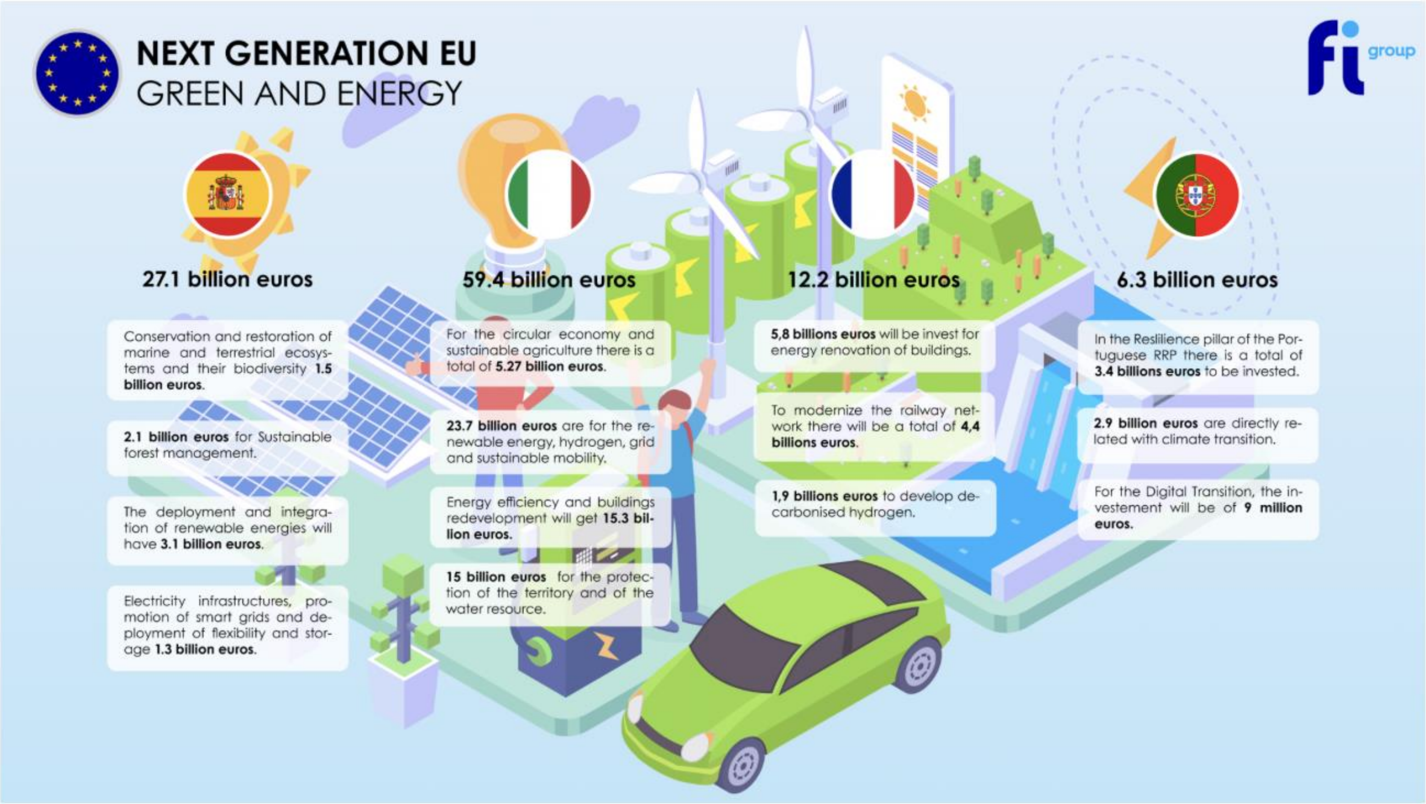
•€396B/year needed (2021–2030); 30% EU budget for climate

Instruments:

•Recovery and Resilience Facility

•Just Transition Fund (social equity)



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On-Grid (Grid-Tied) Solar PV Systems

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- Connected to the utility grid
- Solar panels supply power directly to your home and send excess energy to the grid
- Net metering allows you to earn credits for surplus electricity
- Advantages: Lower upfront cost, no need for batteries, high reliability
- Limitation: Does not provide power during grid outages

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Off-Grid Solar PV Systems

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- Completely independent from the utility grid
- Uses batteries to store solar energy for use at night or during cloudy periods
- Often paired with backup generators for reliability
- Advantages: Full energy independence, suitable for remote locations
- Limitation: Higher cost due to battery storage, requires careful energy management

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Hybrid and Backup Solar PV Systems

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- Hybrid systems: Combine solar panels, batteries, and grid connection
- Store excess energy in batteries for use during outages or at night
- Can draw from the grid when solar/battery supply is low
- Backup systems: Primarily grid-tied but include batteries for emergency power
- Advantages: Increased energy security, flexibility, and potential savings
- Limitation: Higher installation cost than standard on-grid systems

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Solar in Energy Efficiency Direct Contributions

- Building Integration: Passive solar design cuts heating/cooling needs
- Industrial Process Heat: Solar thermal for manufacturing Policy Lever: "Efficiency First" in EU energy law

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VET for Solar Workforce Curriculum Essentials

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- PV installation/maintenance
- Grid integration and storage
- Energy auditing (aligned with Efficiency Directive)

NetVET-RE Model: Shared modules across 5 countries

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Policy Drivers for Solar Growth EU Mechanisms

- Renewables Targets: Binding national contributions
- REPowerEU: Fast-tracking solar to replace Russian fuels
- District Heating: Solar integration mandated in municipalities

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Challenges & Solutions

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Challenge	Solution
Grid integration	VET for smart grid skills
Storage limitations	CSP with thermal storage
Skills gaps	NetVET-RE standardization

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Case Study: NetVET-RE Impact

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- Output: 5+ renewable training modules (solar focus)
- Scalability: Template for EU-wide VET programs

Quote: *"Cross-border collaboration accelerates green skills."*

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Future Pathways 2030–2050 Outlook

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- Solar to dominate EU energy mix (€520–575B/year post-2030)
- VET expansion: 500,000+ solar jobs by 2030 (ESTIMATE)
- Policy Link: Social Climate Fund for inclusive transition

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Recommendations

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1. Governments: Align VET funding with Efficiency Directive
2. Industry: Partner with VET institutions (e.g., NetVET-RE model)
3. EU: Include solar-VET metrics in National Energy Plans

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Conclusions

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Solar + VET = EU Green Transition Engine

•Policy Wins: Green Deal + Efficiency Directive create market certainty

•VET Role: Ensures workforce readiness for solar/energy efficiency

"Invest in skills to unlock solar's full potential."

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Questions and Answers

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Thank you

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EU Green Deal , https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1581

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MODULE 2:

SYSTEM DESIGN AND INSTALLATION (HANDS-ON)

Consolidated by: GREENTECH
Reviewed by: NPUA, ARPISOLAR

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CONTENT OF MODULE

1. Electrical basics and safety: circuits, tools, personal protective equipment (incl. workplace safety & first aid)
2. Solar system sizing and planning (manual and digital tools); wiring diagrams and design reading
3. PV installation: panels, inverters, batteries, mounting, hybrid systems
4. Monitoring systems, inverter function and troubleshooting
5. Testing, commissioning and maintenance
6. Capstone installation project (simulated project)

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Electrical basics and safety: circuits, tools, personal protective equipment

(incl. workplace safety & first aid)

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Understanding electricity

Electricity is the flow of electrons through a conductor such as copper wire. In solar PV systems, electricity is generated by sunlight striking the photovoltaic cells, causing electrons to move and produce a direct current (DC). Key electrical values include voltage (measured in volts), which represents the electrical pressure; current (measured in amperes), which represents the flow rate of electrons; and resistance (measured in ohms), which is the opposition to current. Ohm's Law, which states $V = I \times R$, defines the relationship between these values and is fundamental to electrical work.

Direct and alternating current

Solar panels produce direct current (DC), where the flow of electrons moves in one direction. Most household appliances and grid power operate using alternating current (AC), where the direction of flow changes periodically. In a solar power system, an inverter is used to convert the DC power from the panels into AC power for domestic use or export to the electrical grid. Understanding the difference between DC and AC is essential for designing safe and functional PV systems.

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Series and parallel circuits

In electrical systems, components can be connected in series or in parallel. In a series circuit, the current flows through each component sequentially, and the total voltage is the sum of the individual voltages. In a parallel circuit, each component is connected across the same voltage, and the total current is the sum of the individual branch currents. In solar systems, series connections are typically used to increase system voltage, while parallel connections are used to increase current capacity and redundancy.

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Essential tools for electrical work

Solar technicians use a variety of hand tools to perform installations and maintenance. A multimeter is used to measure voltage, current, and resistance. Wire strippers and cutters are used to prepare conductors. Crimping tools are essential for connecting lugs to cables securely. Torque wrenches ensure bolts and connections are tightened to the manufacturer’s specifications. All tools used for electrical work should have proper insulation and be rated for the voltages present in solar systems.

Electrical cable sizing and losses

As electricity flows through a cable, resistance in the wire causes energy loss in the form of heat. The amount of loss depends on the current and the length and thickness of the wire. To reduce losses, cables with a larger cross-sectional area (thicker wires) are used. Higher voltage systems reduce the current required for a given power level, which also helps to minimize losses. Proper cable sizing is critical to system efficiency and safety, and is usually guided by national electrical standards.

Personal protective equipment (PPE)

Electrical safety begins with wearing the correct PPE. Technicians must wear insulated gloves, safety boots with rubber soles, and non-conductive helmets. Additional gear includes flame-resistant clothing, safety goggles or face shields, and hearing protection if working near loud equipment. All PPE must meet international or national safety standards and be regularly checked for wear or damage. Using the right PPE significantly reduces the risk of injury from electric shock, burns, and falling objects.

Recognizing electrical hazards

Electrical hazards on a solar site include electric shock from live parts, arc flashes from short circuits, and fires caused by overloads or poor wiring. Other risks include falls from working at heights and equipment-related injuries. Arc flashes, in particular, can cause severe burns and should be avoided by ensuring that all connections are made with the power off. Recognizing potential hazards before beginning work is an important safety practice.

Safe work practices

Before beginning any electrical work, always ensure the system is de-energized and locked out using appropriate lock-out/tag-out (LOTO) procedures. Keep the workspace dry and clear of unnecessary tools and materials. Use insulated tools and follow manufacturer instructions for equipment. Never work alone on live systems, and always verify absence of voltage before touching any conductors. Good housekeeping and clear communication are key to maintaining a safe work environment.

First aid for electrical incidents

In the event of an electrical accident, the first priority is to disconnect the power source to prevent further injury. Do not touch the victim directly if they are still in contact with electricity—use a non-conductive object like a wooden stick. After the power is off, check the person’s breathing and pulse. If trained, perform CPR or use an automated external defibrillator (AED). Always call emergency services and report the incident as per workplace protocols.

Review and reflection

Understanding electrical principles, using proper tools, wearing the correct PPE, and following safety procedures are all essential parts of working with solar PV systems. These practices help prevent injuries and ensure the reliability of the installation. After reviewing this section, be prepared to explain how Ohm's Law works, describe the differences between series and parallel circuits, identify at least five pieces of PPE, and outline the first steps to take in an electrical emergency.

QUIZ

1. What does Ohm's Law state in relation to voltage, current, and resistance?

2. What type of current do solar panels produce?

3. Which tool is used to measure voltage, current, and resistance?

4. Why is cable sizing critical in PV systems?

5. Name three items of personal protective equipment (PPE) used in electrical work.

6. What should be done before touching a live electrical system?

7. What is the first step in providing first aid after an electrical accident?

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Solar system sizing and planning (manual and digital tools); wiring diagrams and design reading

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Principles of solar PV system sizing

Solar PV system sizing ensures that the generated energy matches the consumer's usage profile. It involves evaluating the daily and seasonal energy consumption, environmental conditions, and system efficiency. Proper sizing prevents system undersupply (causing outages) and oversizing (increasing cost unnecessarily).

Detailed load assessment

Load assessment includes:

- Listing all electrical devices
- Determining their power rating (W) and usage hours/day
- Identifying surge loads and duty cycles (e.g., fridge motors)
- Considering seasonal and peak loads

This data is summarized in a load profile table to compute daily energy demand (Wh/day).

Solar resource and peak sun hours (PSH)

Peak Sun Hours (PSH) convert variable irradiance into equivalent full-sun hours. Solar data can be sourced from:

- PVGIS (EU)

- NREL (US)

- Meteonorm (Global)

- NASA-SSE

Local PSH values influence array size directly. Orientation and tilt angles also affect effective irradiance received.

Array sizing formula and loss adjustment

PV Array Power (W) = Daily Load (Wh) ÷ PSH (h) × 1.2–1.3 loss factor.

Loss factors account for:

- Inverter inefficiency (~5–8%)

- Wiring and temperature losses (~10–15%)

- Dust/shading (~2–5%)

- Panel aging (0.5%/year). Total derating factor typically ranges from 1.25 to 1.4.

Battery bank sizing – technical considerations

Battery capacity = (Daily Load × Autonomy Days) ÷ (DoD × Voltage × Efficiency).

Key inputs:

- Depth of Discharge (DoD): 50% for lead-acid, up to 90% for Li-ion
- Round-trip efficiency: 70–90%
- Nominal Voltage: 12V/24V/48V

Li-ion offers higher energy density, lower maintenance, and longer lifespan but higher cost.

Inverter and charge controller sizing

Inverter:

- Rated for peak and surge loads

- Output: Pure sine wave preferred for compatibility

- Efficiency: ≥90%

Charge Controller:

- MPPT preferred (30% more efficient than PWM)

- Rated for maximum PV input voltage and current

- Must match battery voltage (12V, 24V, etc.)

Manual vs. software-based design

Manual: Spreadsheets for small systems, educational use.

Includes calculation sheets for load, array, battery, and wiring.

Software:

- PVsyst: Detailed simulation (losses, shading, temperature)

- HOMER: Hybrid system optimization

- Helioscope: 3D modeling and layout planning

Software includes climate data, cost analysis, and simulation tools.

Electrical wiring diagrams – purpose and types

Types:

- Block diagrams: High-level layout

- Schematic diagrams: Detailed electrical connections

- Single-line diagrams: Used for installation and inspection

Symbols and notations follow IEC/NEC standards. Proper labeling of breakers, fuse ratings, cable sizes, and grounding points is essential.

Interpreting system layout and safety provisions

Installers must check:

- Polarity and current direction
- Sizing and protection of wires
- Correct sequencing: PV -> Controller -> Battery -> Inverter -> Loads
- Grounding systems and lightning protection

All designs must comply with standards (e.g., IEC 60364, NEC 690).

Summary and key takeaways

- Accurate load calculation is the foundation of sizing
- PSH and local conditions dictate energy potential
- Every component (PV, battery, inverter) must be matched and protected
- Software tools enhance accuracy and compliance
- Understanding and reading diagrams ensures safe, correct installation

QUIZ

1. What does PSH stand for in solar energy design?

2. What data sources are used to determine local solar irradiance?

3. Why is it important to apply a loss factor in PV array sizing?

4. What is the depth of discharge for lithium-ion batteries typically set at?

5. What does MPPT stand for in charge controllers?

6. What is the purpose of a wiring diagram in system design?

7. What tool can simulate energy production and shading impacts in PV design?

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PV installation: panels, inverters, batteries, mounting, hybrid systems

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Overview of PV installation components

Installing a solar photovoltaic (PV) system involves the integration of several key components: solar panels, inverters, batteries (if off-grid or hybrid), and mounting structures. A well-executed installation ensures system safety, performance, and longevity. It also requires adherence to electrical standards and manufacturer specifications.

Installing PV panels – orientation and tilt

Panels should face true south in the northern hemisphere (or true north in the southern) for optimal exposure. Tilt angles are typically set equal to the site's latitude to maximize annual generation. Shading must be avoided at all times. Mounting structures should support this orientation while withstanding local wind and snow loads.

Panel wiring and string configuration

Panels are connected in series to increase voltage and in parallel to increase current. Proper configuration depends on the inverter’s input range and desired system voltage. Use MC4 connectors, appropriate wire gauge, and cable management practices. Ensure correct polarity and avoid reverse current using blocking diodes when needed.

Installing inverters – grid-tied and off-grid

Inverters convert DC from panels to AC for household use. Grid-tied inverters synchronize with the utility and may include export limiting. Off-grid inverters must manage loads and batteries independently. Install in cool, ventilated areas with sufficient clearance. Follow manufacturer torque specs and connect AC/DC sides as per diagrams.

Battery installation – safety and configuration

Batteries store excess energy and provide backup. Lead-acid and lithium-ion are common types. Install in ventilated, dry enclosures. For series connections, increase voltage; for parallel, increase capacity. Protect with fuses or circuit breakers. Monitor temperature and avoid deep discharges to extend life. Always use BMS with lithium systems.

Charge controllers – MPPT vs. PWM

Charge controllers regulate the voltage and current from PV panels to batteries. MPPT controllers optimize power conversion efficiency and are ideal for variable sunlight conditions. PWM controllers are simpler and more affordable but less efficient. Select based on array size, voltage compatibility, and battery chemistry.

Mounting structures – ground vs. roof

Mounting systems include:

- Roof-mounted (pitched or flat): Minimize land use, require roof integrity.

- Ground-mounted: Easier to maintain, suitable for large arrays.

Use corrosion-resistant materials (e.g., aluminum, galvanized steel). Ensure mechanical anchoring complies with wind and seismic codes.

Installation best practices

Follow safety codes (NEC, IEC) and manufacturer's installation guidelines. Ensure proper grounding and bonding. Use UV-resistant cables and conduits. Label all connections clearly. Perform insulation resistance tests and torque checks. Document all configurations and provide customer manuals.

Hybrid system integration

Hybrid systems combine PV, batteries, and the grid. They offer backup power and load shifting. Hybrid inverters manage multiple inputs/outputs and require precise programming. Installation must include current sensors, automatic transfer switches, and surge protection. System must be configured for priority (PV, grid, battery) operation modes.

Commissioning and final checks

Before activation, verify:

- Correct wiring and polarity
- Functional grounding and surge protection
- Battery and inverter configuration
- Monitoring system operation

Log all parameters and test for voltage/current under sunlight. Provide training to end users on safety and operation.

Register the system if required by local grid authorities.

QUIZ

1. Which direction should panels face in the northern hemisphere?

2. What is the purpose of using MC4 connectors?

3. What must be done to protect battery installations from overcurrent?

4. What type of inverter synchronizes with the utility grid?

5. Name one common material used for corrosion-resistant mounting structures.

6. What kind of cable is used to protect against UV damage?

7. What is the role of a hybrid inverter in a solar PV system?

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Monitoring systems, inverter function and troubleshooting

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Importance of monitoring in PV systems

Monitoring systems provide real-time and historical data on PV system performance, helping detect faults, assess efficiency, and improve maintenance planning. They are essential for verifying energy production, identifying shading or degradation issues, and ensuring return on investment (ROI) for both residential and commercial installations.

Types of monitoring solutions

Monitoring platforms can be:

- Local (on-site display)

- Remote (cloud-based dashboards)

They may use:

- Built-in inverter interfaces

- Data loggers with sensors

- Smart meters. Modern systems often support Wi-Fi, Ethernet, or GSM for connectivity, with alerts via email or SMS for system faults or performance drops.

Parameters measured in monitoring

Key parameters:

- PV voltage and current (DC side)
- Grid voltage and frequency (AC side)
- Inverter efficiency
- Daily/monthly energy yield (kWh)
- Battery state of charge (SOC), temperature, and cycle count (for hybrid systems)
- Fault/error codes and alarm logs

Inverter function – basic operation

Inverters convert direct current (DC) from solar panels into alternating current (AC) for grid connection or on-site usage. Functions include:

- MPPT (Maximum Power Point Tracking) for DC optimization

- Synchronization with grid voltage and frequency

- Power factor correction and anti-islanding protection

- Ground fault detection and self-diagnostics

Types of inverters

- String inverters: Centralized unit for multiple panel strings

- Microinverters: Attached to each panel; ideal for shading variation

- Hybrid inverters: Manage PV, batteries, and grid simultaneously

- Central inverters: Used in utility-scale plants

Each type differs in efficiency, monitoring detail, and application scope.

Common inverter faults and causes

Typical issues include:

- No AC output: Check breakers, grid connection

- Low voltage or frequency: Possibly caused by grid fluctuations

- Ground fault error: Caused by damaged insulation or moisture

- Overtemperature: Inadequate ventilation or high ambient temperatures

- MPPT errors: String mismatch or poor irradiance

Troubleshooting workflow

1. Review monitoring logs and fault codes
2. Visually inspect all system components (wiring, panels, inverters)
3. Measure voltages and currents using a multimeter
4. Verify correct inverter settings (e.g., country grid profile)
5. Consult the inverter manual or support database for specific fault codes

Remote troubleshooting techniques

Advanced monitoring allows remote access to system data and diagnostics. Technicians can:

- Reconfigure settings remotely (via secure portal)

- Restart inverters

- Evaluate long-term performance trends

Some platforms offer AI-driven fault prediction and automated alerts for critical conditions.

Safety protocols during troubleshooting

Before troubleshooting:

- Isolate the system and confirm it is de-energized

- Use appropriate PPE

- Follow lockout/tagout (LOTO) procedures

- Be cautious of stored energy in capacitors or batteries

- Document all actions and restart sequences according to guidelines

Summary and preventive measures

- Monitoring systems are essential for performance tracking and rapid fault detection

- Understanding inverter types and functions is key to diagnosis

- Regular inspection, firmware updates, and proper installation reduce fault rates

- Early issue detection prevents system downtime and extends equipment life

Summary and preventive measures

1. What are two main types of PV monitoring platforms?

2. What does an inverter do in a solar system?

3. List one parameter typically monitored by PV monitoring systems.

4. What does MPPT stand for and what is its function?

5. What is a common cause of overtemperature faults in inverters?

6. Why is grounding important in PV system design?

7. What is the first step in a troubleshooting workflow?

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Testing, commissioning and maintenance

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Overview of testing and commissioning

Testing and commissioning are critical final steps before placing a PV system into operation. These stages confirm that the installation is safe, compliant, and functioning as designed. Commissioning verifies that all electrical and mechanical components are correctly installed, configured, and operating under load conditions.

Pre-commissioning checklist

Before commissioning:

- Inspect all mechanical fixings (mounting hardware, panel clamps)

- Confirm cable routing and labeling

- Verify torque settings for terminals and connectors

- Check component grounding and surge protection

- Ensure signage and documentation are present and correct

Electrical testing – continuity and polarity

Continuity testing confirms that all electrical paths are complete. Use a multimeter to:

- Check string continuity end-to-end

- Confirm correct polarity of PV strings and battery terminals

- Identify any reversed connections which could damage the inverter or affect performance

Insulation resistance testing

Insulation resistance testing ensures that cables and components are not damaged or exposed to leakage currents. Conduct using a megohmmeter at 500–1000 V DC:

- Between live conductors and earth
- Minimum acceptable resistance: 1 MΩ or higher depending on local standards
- Test must be done before energizing the system

Voc and Isc measurements

Measure Open Circuit Voltage (Voc) and Short Circuit Current (Isc) of each string under sunlight.

Compare against panel specifications and expected site irradiance:

- Deviations >5% may indicate shading, mismatch, or damage

- Ensure consistent readings between parallel strings

- Record data for reference and warranty

Commissioning process

1. Power on inverter per manufacturer's steps
2. Monitor startup sequence and grid synchronization (for grid-tied systems)
3. Record operating parameters: DC input, AC output, MPPT activity
4. Check monitoring platform connectivity
5. Submit a commissioning report to the client and utility, if applicable

Maintenance objectives and schedule

Maintenance ensures long-term performance and safety. Objectives:

- Prevent energy loss due to soiling, shading, or aging

- Detect and replace faulty components early

- Maintain compliance with warranties and grid codes

Scheduled maintenance intervals:

- Visual checks monthly

- Electrical checks semi-annually

- Full performance audit annually

Common maintenance activities

- Cleaning panels using deionized water and soft tools
- Inspecting connectors, junction boxes, and mounting hardware
- Verifying inverter error logs and firmware updates
- Testing ground continuity and insulation
- Replacing degraded fuses or surge arrestors

Performance monitoring and degradation

Annual performance degradation is typically 0.5–0.8% for crystalline silicon panels. Compare expected vs. actual energy yield using:

- PR (Performance Ratio) analysis

- Daily/monthly monitoring data

- Inverter efficiency trends

Proactive analysis prevents long-term underperformance.

Documentation and reporting

Maintain detailed records of:

- Test results and measurements
- Maintenance activities and visual inspections
- Replaced components and software changes
- Safety incidents or anomalies

Documentation supports audits, warranty claims, and improves future system upgrades or troubleshooting.

QUIZ

1. What instrument is used for insulation resistance testing?

2. What should be included in a pre-commissioning checklist?

3. How is the open-circuit voltage (Voc) of a PV string measured?

4. What is the typical annual degradation rate for crystalline silicon panels?

5. What is one purpose of a torque check during commissioning?

6. What is the PR (Performance Ratio) used to evaluate?

7. What kind of water should be used when cleaning PV panels?

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Capstone installation project (simulated project)

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Purpose of the capstone project

The capstone installation project provides a simulated, real-world environment to apply technical knowledge gained in previous modules. It serves as a final, work-based learning task where students complete a full PV system installation—mirroring industry practices, safety procedures, and documentation requirements.

Learning objectives

Participants will:

- Plan and install a complete solar PV system

- Apply electrical safety and commissioning procedures

- Interpret and use system diagrams

- Use correct tools, PPE, and measurement equipment

- Practice team-based installation in a structured worksite environment

Project scope and system type

The simulated project involves:

- Installing a small-scale solar PV system (e.g., 1.5–3 kWp)
- Grid-connected or off-grid depending on learning focus
- Including modules, inverter, optional batteries, charge controller, DC/AC protection, and monitoring system
- Full compliance with electrical codes and safety standards

Planning and site assessment

Learners will begin by:

- Evaluating the mock rooftop or ground-mount scenario
- Determining optimal orientation, tilt, and panel layout
- Assessing shading and structural constraints
- Planning cable routes, grounding, and safety signage placement

Equipment preparation and safety briefing

Before installation:

- Inventory and inspect tools and components

- Review installation manuals and datasheets

- Assign team roles (e.g., lead installer, electrical tech, safety officer)

- Conduct safety briefing covering PPE, electrical hazards, and LOTO procedures

Installation tasks and sequencing

Installation is completed in the following sequence:

1. Mounting structure setup and mechanical fastening
2. PV panel mounting and alignment
3. DC wiring and connection to combiner box
4. Inverter installation and AC connection
5. Optional battery and controller setup
6. Grounding and surge protection installation

Testing and commissioning

Once installed, the system is tested using:

- Continuity and polarity testing

- Insulation resistance testing

- Open-circuit voltage and short-circuit current validation

- Monitoring system setup

- System energization under supervision and final commissioning checklist completion

Documentation and reporting

Learners prepare complete project documentation:

- Wiring diagrams and site plan

- Test reports and installation photos

- Maintenance and user manual (summary)

- Final report and handover sheet (client simulation)

This reinforces compliance, record-keeping, and communication skills.

Reflective evaluation and feedback

Post-project evaluation includes:

- Self-assessment of technical skills and teamwork

- Peer feedback on communication and problem-solving

- Trainer evaluation based on technical accuracy, safety, and documentation

- Identification of strengths and areas for improvement

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Work-based competency outcomes

Upon successful completion, students demonstrate workplace readiness:

- Safe, effective PV system installation practices
- Ability to follow technical instructions and safety protocols
- Confidence in using diagnostic tools and understanding system behavior
- Practical experience aligned with national solar training standards

QUIZ

1. What is the purpose of the capstone installation project?

2. What size system is typically used in the simulated capstone project?

3. What document should be prepared after testing and commissioning?

4. Name one team role assigned during a simulated PV installation.

5. What test must be performed before system energization?

6. What is one goal of the reflective evaluation stage?

7. What does successful project completion demonstrate in terms of workplace readiness?

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Module 3:

Work-based learning (WBL) and practical skills

Consolidated by: Škoda Auto University
Reviewed by: ASUE

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Block 1: Introduction to Work-Based Learning (WBL)

Objective:
To understand the importance of work-based learning as an educational tool.

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What is Work-Based Learning (WBL)?

- Why is it important for companies to be involved in education?

- What is WBL and how is it different from a field trip/excursion?

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Definition of WBL (EU)

WBL: Systematic learning in the workplace.

- Field trip/Excursion: One-time visit without active involvement.

- Structured internship: Planned tasks, mentor, evaluation.

- Goal: Development of competencies, not just presence in a company.

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Benefits of WBL for involved stakeholders

- Pupils/Students: Practical skills, career decision-making.

- Schools: Connection with real-world practice, improved reputation.

- Companies: Future employees, loyalty, partnerships.

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Models of WBL

Dual system of education (collaboration with companies
vs.
traditional internship/ vocational practice.

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Standardization and Integration of WBL

- National frameworks: Unified goals and tasks for practice.
- Integration: In national curricula and vocational education legislation.
- Comparison: Armenia – Czech Republic – other EU countries.
- Importance of contracts/MoUs and other relevant documentation.

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Examples and Participant Activity

Objective:
To share experiences and identify challenges.

- Examples: Škoda Auto (CZ), other EU countries.

- What works: Onboarding, mentoring, scholarships.

- **Activity:** Discussion – Describe how the internship looks like at your school today.

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Block 2: Roles and responsibilities of involved stakeholders

Objective:
To understand the roles and responsibilities within the internship, to create create your own RACI model.

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The role of the school

- Selection of suitable companies for the internships.
- Supervising the progress of the internship and communicating with the companies.
- Ensuring documentation and contracts (school-company-pupil/student).
- Evaluation and feedback after the internship.

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The role of the professional educator

- Developing the internship content and assigning tasks.

- Supporting pupils/students during the internship.

- Reflection and evaluation of student´s performance.

- Working with a supervisor/a mentor in the company.

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The role of the company, the supervisor/mentor and the pupil/student

- Company/supervisor/mentor: mentoring the student, assessment, soft skills development.

- Pupil/Student: proactive approach, responsibility, keeping a logbook, reflection.

- Mutual communication and cooperation between all parties.

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RACI model and expectations

- RACI: Responsible - Accountable - Consulted – Informed.

- **Example:** Pupil/Student (R), Supervisor/Mentor (A), Educator (C), School Coordinator (I)

- Clarification of responsibilities and expectations of all involved stakeholders.

- Ensuring transparency and effectiveness of collaboration.

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Activity: Creating your own RACI matrix

Objective: To clarify responsibilities and opportunities for improving cooperation.

- Design a RACI matrix for a specific professional practice.
- Think about the role of each stakeholder.
- Discuss the design with colleagues and compare.

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Block 3: Planning and organizing the internship

Objective: To design and deliver high-quality, well-structured, and meaningful practical training that creates value for students, schools, and companies alike.

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Selection of companies and preparation of cooperation.

- Criteria for selecting suitable companies (field, location, capacity)
- Long-term partnership and communication
- Company preparation: onboarding, occupational health and safety, welcome pack
- The role of the school in establishing cooperation

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Contracts and legal framework

- School–company–pupil/student agreement: what it should include
- GDPR and personal data protection
- Insurance for students during their internship
- Obligations and expectations of all parties

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Taskbook and Logbook

- WBL Taskbook: a tool for assigning tasks

- Logbook: daily record of activities, reflections, evaluations

- Documentation kept by both the /pupilstudent and mentor/supervisor

- Examples of tasks and record forms

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DE model and internship schedule

- 4 phases of the DE model: Diagnosis – Measure – Fix – Record
- Action plan and workplace rotation
- Adaptation of the school year schedule to the company
- Coordination between the school and the company

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Activity: Internship planning simulation

Assignment:

- Design an internship plan for the third year
- Select a company, determine the duration and content of the internship
- Design tasks for the taskbook and entries for the logbook
- Present your proposal to other teams

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Block 4: Internship content and task management

Objective: To create meaningful and structured content for professional internship that supports active learning among students.

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Internship content: Instructions for pupils/students

- How to approach tasks during the internship
- Setting goals and expectations
- Responsibility for your own learning
- Regular recording of progress

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Communication within the company

- Communication with mentors / supervisors
- The art of presentation and self-presentation
- Principles of professional conduct
- Problem solving and feedback

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Taskbook and Logbook

- Taskbook: task entry and tracking
- Logbook: daily record of activities and reflections
- Support for self-assessment and competence development
- Tools for the internship evaluation

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DE model: Diagnose – Measure – Fix – Record

- Diagnose: identification of the problem or task

- Measure: analysis and measurement of parameters

- Fix: design and implementation of solutions

- Record: documentation of results and reflection

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Activity: Task design for students - *Installation of a photovoltaic system*

- **Assignment**:
  Design a task based on the DE model

  Specify the objectives, steps, and expected outcomes.

- Discussion: How does the task support learning in practice?

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Block 5: Practical internship teaching methods

Objective: To design tasks that enable students to learn actively by solving specific problems.

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Internship practical teaching methods

- Internship as an active educational method – not just measuring the performance

- Development of skills, independence, and critical thinking

- Methods: individualization, project-based learning, problem-based learning (PBL), reflection.

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Individual approach in the internship settings

- Assign tasks according to the abilities and level of the student

- Take into account the pace, learning style, and interests

- Goal: motivation, involvement, personal growth.

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Project-based and problem-based learning (PBL)

- Project-based learning: students solve specific tasks (e.g., diagnostics + repair)

- Problem-based learning (PBL): students look for solutions to problems (e.g., why the switch isn't working)

- Development of analytical thinking, cooperation, and creativity

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Reflection and self-assessment

- Part of every task: What went well? What would I do differently?
- Support for metacognition and responsibility for learning
- Forms, logbook, interviews with mentor/supervisor

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Activity: Creating a problem-based-learning (PBL) task

- Assignment: ‘Why isn't the switch working?’

- Task: Design a PBL-style task structure.

- Describe the context, objectives, expected outcomes, and reflection.

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Block 6: Mentoring and feedback

Objective: How to effectively guide students during their professional internship using a supportive and coaching approach.

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Mentoring as coaching

- Mentoring = guidance, not management (not bossing)

- Coaching approach: asking questions, encouraging independence

- The goal is pupil´s / student´s development, not control

Formative assessment

- Ongoing feedback during the internship

- Praise, recommendations, suggestions for next steps

- Focus on the learning process, not just the result

How to provide feedback

- Feedback should be constructive, not hurtful
- Use supportive language: “What went well?”, “What could be improved?”
- Avoid personality judgments – focus on behavior

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Guiding pupil´s / student´s reflection

- Encouraging self-reflection: “What went well today?”, “What would you do differently?”

- Reflection as a learning tool

- The mentor helps the student to identify work experience

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Activity: Practicing a mentor-pupil/student conversation

- Scenario: a pupil/student made a mistake during assembly

- Task: conduct a conversation in the form of coaching

- Goal: strengthen trust, promote learning from experience

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Block 7: Problem solving and crisis management

Objective: To be able to respond to problems during the internship.

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Problem solving and crisis management

- Identifying typical problems: tardiness, passivity, conflicts
- The importance of early recognition and support
- The role of the teacher and mentor in resolving situations

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Communication and legal framework

- Communication with parents – openness, cooperation, trust
- Communication with the company – feedback, conflict resolution
- Legal responsibility of the school and the company
- Documentation of incidents and resolution procedures

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Developmental psychology (15–19 years)

- Need for autonomy, search for identity, sensitivity to authority
- Emotional swings, need for recognition, group dynamics
- Influence of developmental aspects on behavior in practice
- How to approach adolescents with respect and empathy

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Specific learning and behavioral disorders

- Dyslexia, ADHD, anxiety, introversion – manifestations in practice

- How to recognize and adapt student´s guidance

- Emphasis on empathy, consistency, understanding – not punishment

- Cooperation with a guidance counselor or psychologist

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Case study: A student is silent – what to do?

Activity: Analysis of the situation and proposed course of action.

Possible reasons for silence: uncertainty, fear, introversion.

How to build trust and encourage openness.

Conversation practice: open questions, active listening.

Reflection: What would you do differently?

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Block 8: Sharing experience and inspiration

Objective: To exchange experience and draw inspiration from examples of good practice.

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Sharing experience and inspiration

- Compare different models of professional internship in Europe

- Identify transferable principles for Armenia

- Design your own WBL model for the school

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Model from the Czech Republic – Škoda Auto

- Internship system

- Financial remuneration for pupils/students during the internship

- Contractual cooperation between a school, a company, and a pupil/student

- Emphasis on long-term partnership and quality of preparation

Model from Germany – Bosch

- Employment contract from the first year of study
- Scholarship of EUR 900–1,200 per month
- Strong tradition of the dual system
- High level of corporate responsibility for education

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Model from Austria

- Companies receive Ausbildungsprämie (training bonuses) from the state
- Financial incentives for companies to participate in training
- Practical experience as part of the vocational training system
- Support for quality and standardization

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Legal framework and financing

- Contracts between the school, company, and pupil/student – what they should contain
- GDPR, insurance, occupational health and safety, length of internship
- Financing agreements: pocket money/scholarship/contractual remuneration for performance
- Penalty mechanisms for non-compliance with obligations

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Project and support opportunities

- Erasmus+ – exchanges, internships, sharing of good practices

- Other sources of funding (partnership concept, sponsorship)

- Online expert input and experience sharing

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Local specifics in Armenia

- Challenges: lack of partners, legal uncertainty, financing
- Opportunities: development of the renewable energy sector
- Need to adapt models to local conditions
- Role of schools as initiators of cooperation with companies

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Activity: Design your own WBL model

- Group work: design a model of professional internship for your school.

- Consider: length of the internship, funding, roles of participants, documentation.

- Draw inspiration from models from the Czech Republic, Germany, and Austria.

- Presentation of designs and joint discussion.

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MODULE 4:

Teaching, Soft Skills & Communication for VET Staff

Consolidated by: IHF & VICTORIA/RISEBA
Reviewed by: ASUE colleague

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UNIT 1 – Use of visual tools, simulations and engineering design

UNIT 2 – Soft Skills and Communication for Solar Technicians

- 2.1: Introduction to Soft Skills for Technicians
- 2.2: Soft Skill 1 – Teamwork
- 2.3: Soft Skill 2 – Problem Solving
- 2.4: Soft Skill 3 – Time Management
- 2.5: Soft Skill 4 – Pitching
- 2.6: Communication

UNIT 3 – Marketing, Sales & Customer Relations in the Solar Sector

- 3.1: Introduction: Why Marketing, Sales and CRM Matter in Solar Energy
- 3.2: Marketing
- 3.3: Sales
- 3.4: Customer Relationship Management (CRM)

UNIT 1 – Use of visual tools, simulations and engineering design

🎯 Learning Objectives:

- Understand the role of visual tools in VET education
- Apply simulations in teaching solar energy principles
- Integrate engineering design for practical learning

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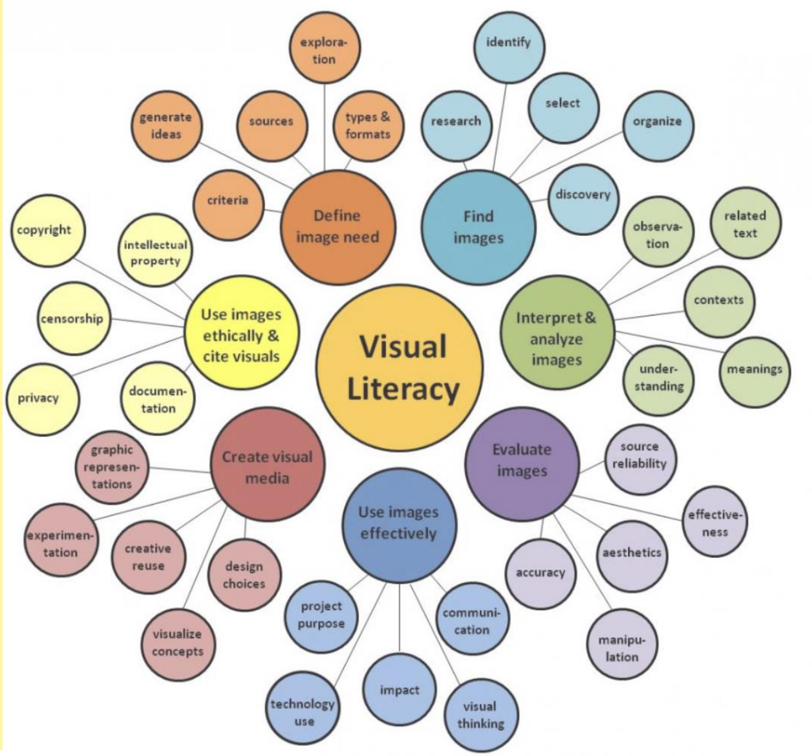
Importance of Visual Tools in VET

- Increases learner engagement and comprehension
- Enhances memory retention
- Breaks down complex concepts
- Visual literacy as a modern skill



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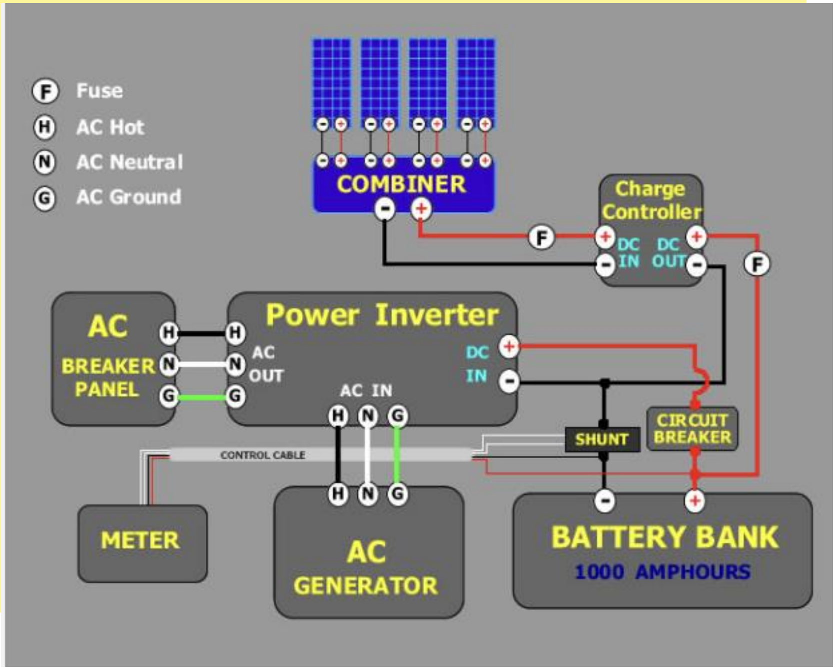
Types of Visual Tools

- Diagrams and schematics (e.g., PV system layout)
- Flowcharts (e.g., solar energy conversion steps)
- Infographics (statistical and conceptual)
- Interactive whiteboards and AR/VR



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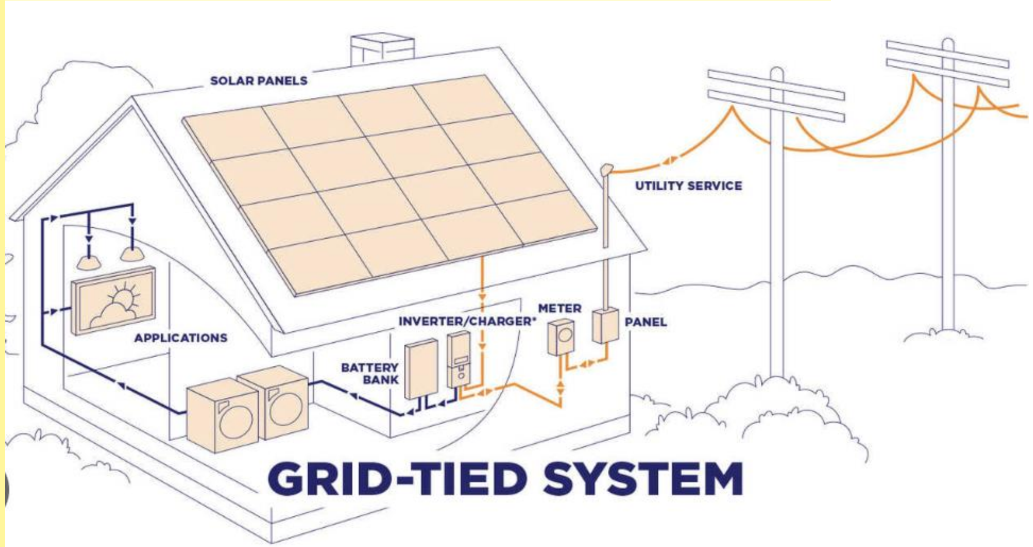
Simulation in Solar Energy Training

- Definition: Computer-based models to imitate real-world systems
- Examples:
- PV system simulators (e.g., PVSyst)
- Grid-tied/off-grid system modeling
- Benefits:
- Safe experimentation
- Cost-effective training



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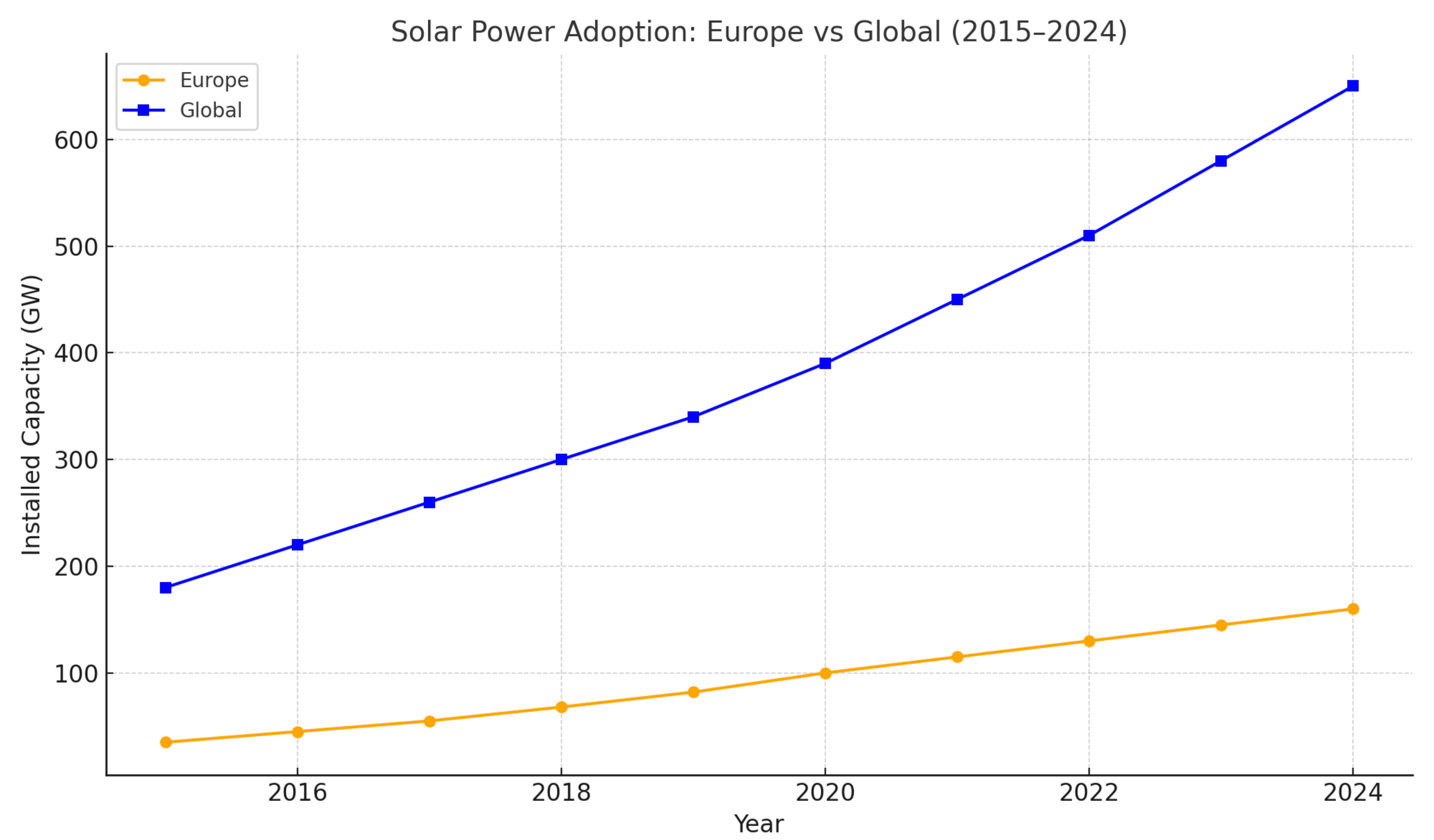
Solar Energy Growth (2010-2025)



Source: IRENA 2024

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Engineering Design Process in VET

- Problem Identification
- Ideation and Design
- Prototyping (mini PV models)
- Testing & Feedback
- Iteration & Deployment
- Practical example: Designing a solar-powered water pump

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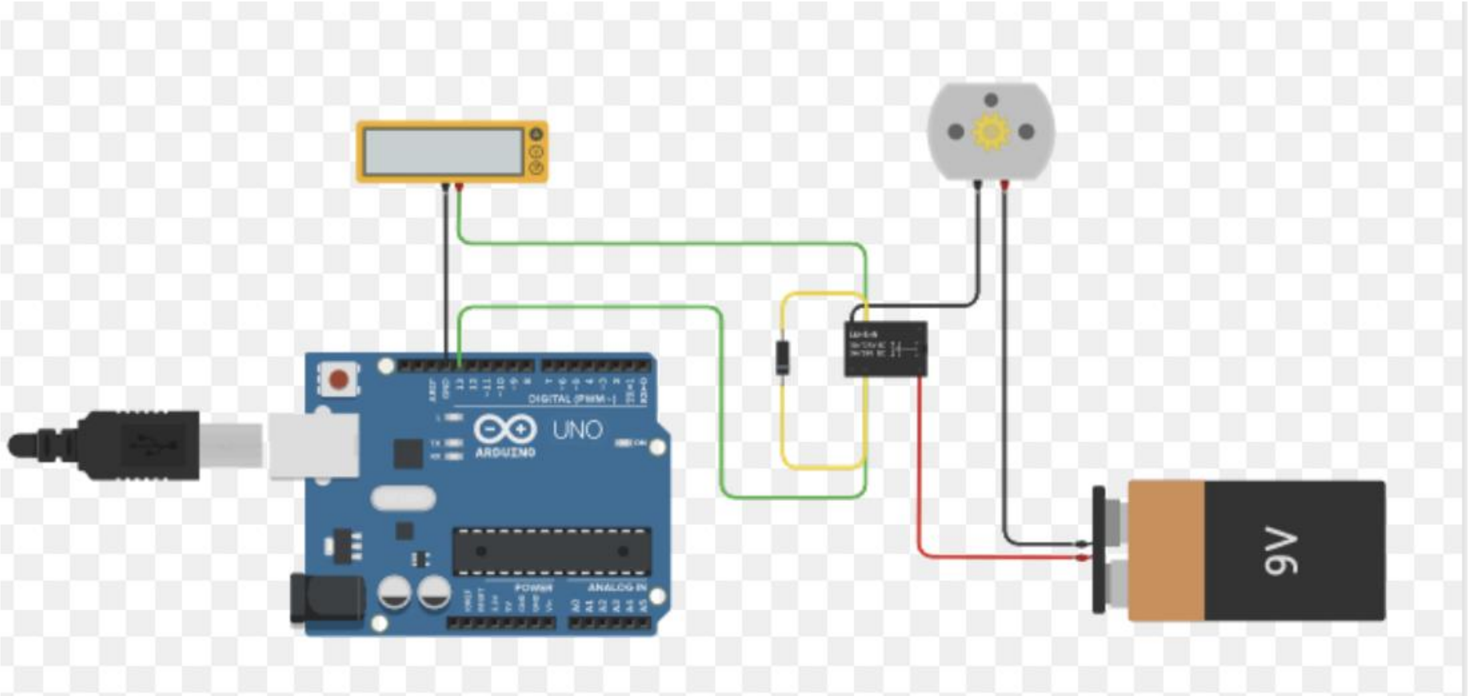
Case Study - Training Project Using Engineering Design

- Task: Students design solar-powered classroom lighting
- Tools used: SketchUp, circuit simulators, Arduino
- Output: Functional prototypes and peer presentations



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Pedagogical Strategies

- Blended learning (e-learning + hands-on)
- Inquiry-based approach
- Collaborative design projects
- Real-world challenges integration

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Vocational Learners and Solar Industry

- 85% of surveyed VET learners prefer visual/simulation-based content
- 40% of solar technicians come from VET backgrounds
- High job placement rate in solar sector post-training

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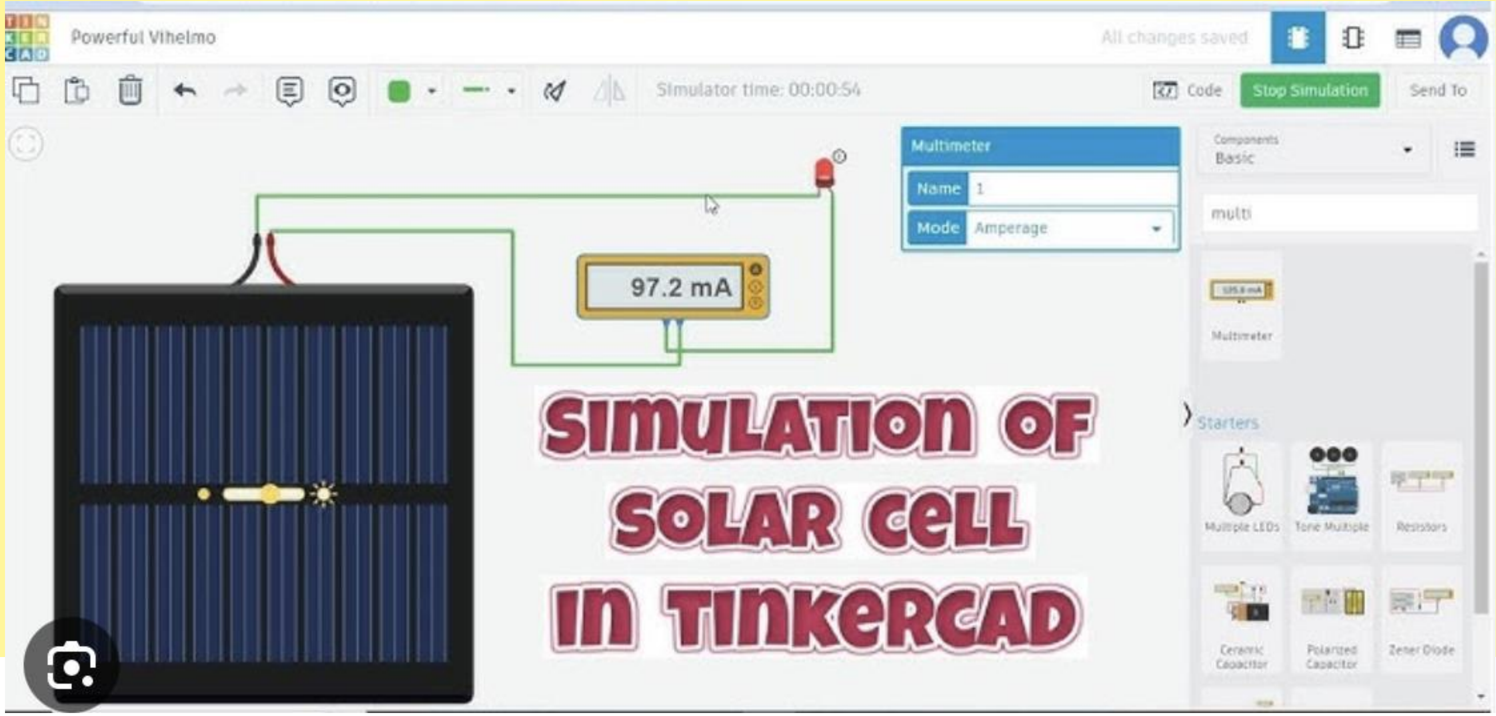
Tools and Platforms

- Software: PV*Sol, HOMER, Tinkercad Circuits
- Apps: Augmented reality (e.g., SunSeeker)
- Online platforms: OpenSolar, EnergySage for case research



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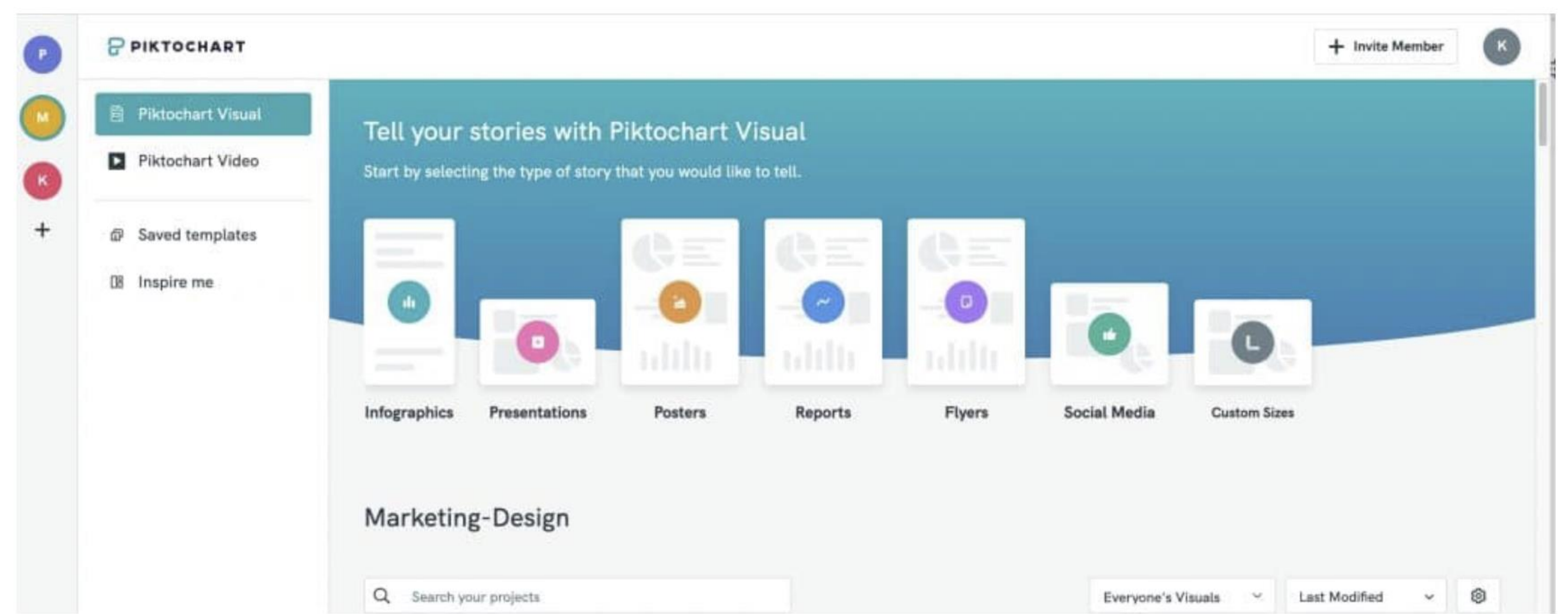
Creating Custom Infographics

- Platforms: Canva, Piktochart
- Use cases: Explaining irradiance, efficiency losses, system components
- Design tips: Consistency, clarity, color balance



Piktochart dashboard

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Feedback and Assessment Techniques

- Interactive quizzes
- Peer assessments of design projects
- Simulation-based performance tracking
- Use of rubrics aligned with practical objectives

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Summary

- Visual tools and simulations are essential for vocational solar training
- Engineering design builds critical thinking and creativity
- Infographics communicate technical content effectively
- Empower learners to be future-ready in clean energy

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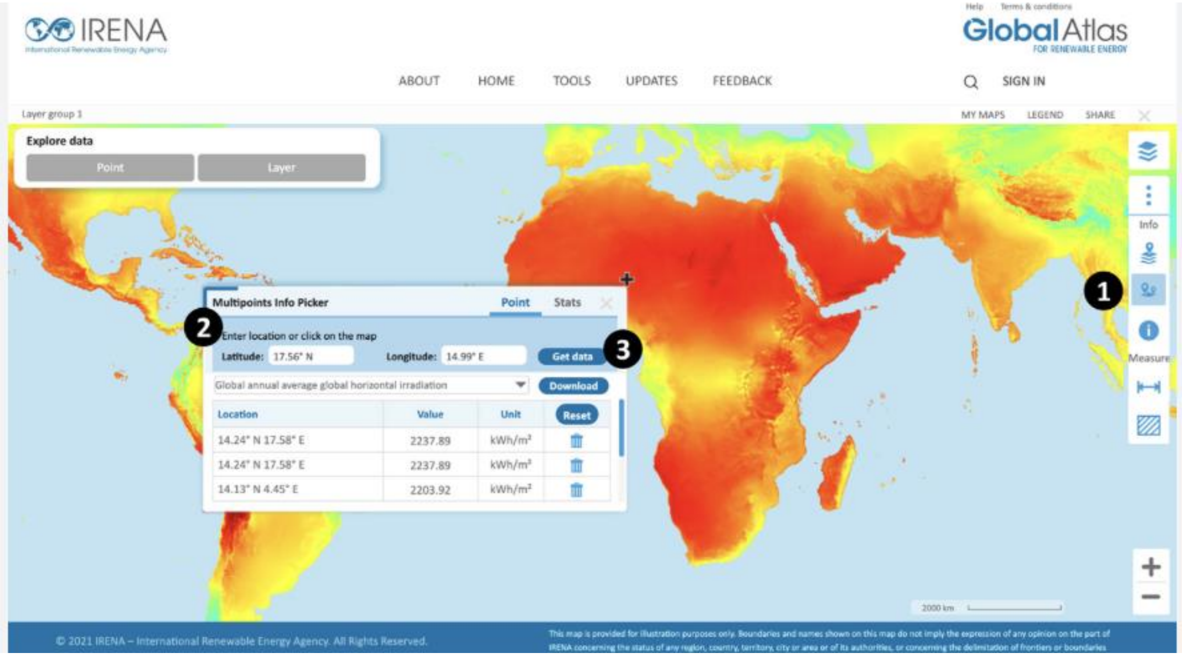
Q&As

- Suggested readings and tools:
- "Teaching Engineering" by Phillip Wankat
- IRENA solar PV data tools
- Websites: NREL, Solar Energy International (SEI)



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UNIT 2 – Soft Skills and Communication for Solar Technicians

🎯 **Objective:**

To help VET learners develop the interpersonal and behavioural skills necessary to succeed in technical solar energy environments, including:

👥 **Teamwork**

🧠 **Problem solving**

⏱️ **Time management**

📢 **Pitching**

💬 **Effective communication**

2.1 Introduction to Soft Skills for Technicians

Why are soft skills important for solar technicians?

- Soft skills are the “people skills” you need to work well in real jobs
- Even the best technician needs to communicate, solve problems, manage time and present ideas
- In solar projects, you will often work in teams, talk to clients and explain technical choices
- These skills make you a better worker, a better team member and maybe a future team leader or entrepreneur

Imagine you are installing solar panels on a school roof.

You need to:

✅ Plan the job

✅ Talk to your teammates

✅ Fix a cable that’s not working

✅ Show your work to the teacher or a visitor

👥 Soft Skill 1: TEAMWORK

🎯 **Objective:**

Understand what teamwork means, why it is essential in solar energy projects, and how to practice it effectively in group settings.

2.2.1 What is Teamwork?

Working Together to Get the Job Done

In any solar project, tasks are rarely completed by one person alone. Someone holds the ladder, another handles tools, while another checks the process. Collaboration is essential.

→ Teamwork means sharing tasks and supporting others

→ Each person plays a specific role, and every role is valuable

→ Group success depends not only on technical skills, but also on the ability to work together

Student-friendly motto: *"Alone goes faster, together goes further"*

2.2.2 Why is Teamwork Important in Solar Projects?

Photovoltaic installation involves **planning, mounting, wiring, testing** — each step connected to the next.

Solar energy work is **teamwork by default**.

- Safety rules require working in pairs or teams, especially on rooftops
- Division of tasks allows for faster and safer completion
- Working in a team reduces mistakes and builds efficiency
- Installing and maintaining PV systems is a multi-step job
- Each person brings a different skill – together you complete the system

Plan → **Share Tasks** → **Complete Job**

Mini-scenario – in a student group:

Mariam connects the cables

Arman mounts the panels

David checks the safety gear

2.2.3 Good Team Behaviours

What Makes a Good Team Member?

Being a skilled technician is also about being a reliable teammate. Respect and communication are just as important as technical precision.

CHECKLIST – the team code:

→ **Listen** first, then act

→ **Share** tools, ideas, space and responsibility

→ **Follow** the group and task plan

→ **Ask** when unsure

→ **Respect** all team roles equally

2.2.4 Bad Team Behaviours

What to Avoid in a Team

Even well-prepared teams can fail when there is poor communication or lack of responsibility.

❌ **Behaviours to avoid:**

→ Ignoring team instructions

→ Working alone without informing others

→ Blaming others for mistakes

→ Staying silent when there is a problem

→ Refusing to contribute to teamwork

Short story:
A student skipped the safety check without telling the team. A panel slipped, and the work had to start again. The issue was not just the mistake — it was the silence.

Class discussion prompt:
What could have prevented this situation?

2.2.5 Roles in a Solar Team

Who Does What?

Clear roles help teams function better. In solar energy tasks, assigning responsibilities makes each step more efficient.

Typical Roles			
Panel Installer	**Wiring Technician**	**Safety Officer**	**Checklist Leader**
Role – in brief: *Mounts and secures panels*	*Role – in brief:* *Connects cables, batteries, inverter*	*Role – in brief:* *Checks gloves, helmets, ladder safety*	*Role – in brief:* *Confirms each step is completed*

Teaching tip → Encourage rotation of roles during practice tasks so all students gain experience.

2.2.6 Practice: Teamwork Simulation

Plan and Work as a Solar Team

Scenario:
A group of three students is asked to install a small solar system on a school garage used for extracurricular activities.

Task instructions:
1. Assign roles: Installer, Wiring Technician, Safety Officer
2. Write down a 5-step plan to complete the task
3. Imagine the Installer forgets a key tool — describe how the team handles this issue
4. Prepare a short explanation of the group's plan and response
5. Share the plan with classmates or the instructor

Implementation tip:
15 minutes for teamwork. Groups can present or post their plans as part of a class gallery walk.

🧠 Soft Skill 2:
PROBLEM SOLVING

🎯 **Objective:**

Learn how to approach technical or organisational challenges using a clear, step-by-step method. Develop the ability to think critically and find solutions during solar panel installations and maintenance. Problem solving builds confidence, responsibility, and trust within a team.

2.3.1 What is Problem Solving?

Problem Solving → Finding Smart and Safe Solutions

Every job — even the best-planned one — can face problems. A good technician needs to stay calm, understand the issue, and choose the best solution.

- Problem solving means thinking before acting
- It involves analysing the situation and selecting the right option
- It helps prevent small problems from becoming big ones

Mini-example: A battery is not charging. Instead of guessing, the student checks the cable, the sun exposure and the inverter. The problem is found — the connector was loose.

Student phrase box: *"Think it through before fixing it fast"*

2.3.2 Common Problems in Solar Installation

Where do problems usually happen?

Knowing where problems might occur helps reduce errors and increases awareness during practice.

Examples – with real life scenario:

Loose or missing cable connections	Wrong polarity in wiring	Shadows blocking solar exposure	Wrong placement or angle of panels	Miscommunication between team members
During the wiring phase, a student forgets to connect one of the panel outputs to the battery. The system appears installed, but no electricity flows. This is a common error during fast-paced work.	A red (+) cable is accidentally connected to a black (–) terminal. This mistake can damage the controller or inverter. It usually happens when students rush or skip checking the labels.	The solar panel is placed near a tall fence or under a tree branch. Even partial shading reduces system performance. This kind of mistake often goes unnoticed during planning.	The panels are laid flat on a table instead of being tilted toward the sun. As a result, energy production is very low. Orientation and angle are key factors in any installation.	One student assumes the inverter is connected and starts the testing phase. Another was still adjusting the settings. Lack of coordination leads to errors and rework.

2.3.3 Four-Step Method to Solve Problems

Where do problems usually happen?

1 **IDENTIFY** – What exactly is going wrong?

2 **ANALYSE** – Why is it happening? What is the cause?

3 **DECIDE** – What are the options? Which is the best one?

4 **ACT** – Try the solution and check the result

EXAMPLE – the inverter is not turning on

1 – Check if it is connected

2 – Discover the main cable is not plugged in

3 – Decide whether to plug it or call a manager

4 – Reconnect it and verify

2.3.4 Poor Problem-Solving Examples

What Should Be Avoided?

- Guessing without checking
- Blaming a teammate without facts
- Ignoring the issue and continuing the task
- Fixing something without telling the group
- Not asking for help when needed

Teaching tip → Encourage open questions during practice — not every student has to know the answer, but everyone should feel safe asking.

2.3.5 Critical Thinking Tips

How to Think Like a Problem Solver

What to DO	What to AVOID
Stay calm under pressure – tension makes errors worse	Acting too quickly or emotionally
Look at the full system, not just one part	Focusing only on one wire or part
Use facts and observations – not opinions or assumptions	Guessing or assuming without proof
Ask "What's working?" and "What is not?"	Ignoring small signs of error
Discuss with the team	Trying to fix everything alone

Reflection Statement:

A good solar technician thinks like a detective — not a gambler. Each question leads to a clearer solution. And every mistake is a step toward better understanding.

2.3.6 Practice: Solve a Scenario

Solar System Not Working – What to Do?

Scenario:
A solar lighting system installed by a student group does not turn on at the end of the day.

Task for group work:
1. Identify possible reasons (list at least 3)
2. Use the 4-step method to propose a solution → skill no.2 (problem solving)
3. Explain how the group would divide the work to solve it → integration of skill no. 1 (teamwork)
4. Present the result: what was learned from the failure?

Instructions:
Groups of 3–4 students. 10–15 minutes. One presenter per group to share ideas.

4-step method

1. IDENTIFY
2. ANALYSE
3. DECIDE
4. ACT

Soft Skill 3:
TIME MANAGEMENT

🎯 **Objective:**

Understand how to organize time and tasks efficiently in daily solar work. Learn how to prioritize activities, meet deadlines, and avoid delays on-site.

2.4.1 What is Time Management?

Planning, Doing, Finishing with Purpose

Managing time means making sure tasks are completed in the right order, without stress and within the deadline. It is not about rushing — it is about being smart with hours and minutes. In technical professions like solar energy, time is not just a clock — **it is a resource**. Managing time means transforming a set of tasks into a structured, efficient and safe workflow.

- A solar installation has multiple steps: planning, setup, testing, final checks
- Delays often come from poor planning — not from difficult work
- A technician who knows how to plan will work better with others and make fewer mistakes

Example: A team begins installing a rooftop system. Midway through the day, they realize that the brackets needed for mounting were never brought to the site. The delay is over two hours. No mistake was made during installation — but the day fails due to **poor time and logistics planning → Reflection line:** A skilled technician thinks ahead — not just about what must be done, but also when, how, and in what order.

2.4.2 Planning Your Day on a Solar Job (1)

The day starts before the tools come out

In technical fields, time and materials are limited. Starting a workday without a clear plan is like installing a solar system without a layout diagram: everything becomes slower, riskier, and more expensive.

A structured pre-work plan includes:

1. **Reading the task brief carefully** – understanding client expectations, project steps, and required output
2. **Preparing all tools and materials in advance** – avoiding on-site improvisation
3. **Reviewing team responsibilities and safety protocols** – ensuring accountability and minimizing risk
4. **Breaking the task into time blocks** – estimating durations based on past experience
5. **Scheduling breaks and project reviews** – maintaining energy, clarity, and quality control

2.4.2 Planning Your Day on a Solar Job (2)

Elevated scenario and reflection prompt

Example: In a group of 4 students assigned to mount a hybrid PV system mock-up, one student creates a written plan and divides the time into 30-minute units. The team tracks progress during the day. As a result, they not only finish the job on time — they also spot an inverter configuration error early, thanks to the review checkpoints built into the plan.

Planning is not paperwork – it is a form of **technical leadership**. It builds precision, safety and respect for time.

Brief → Tools → Roles & Safety → Task Blocks → Review → Debrief

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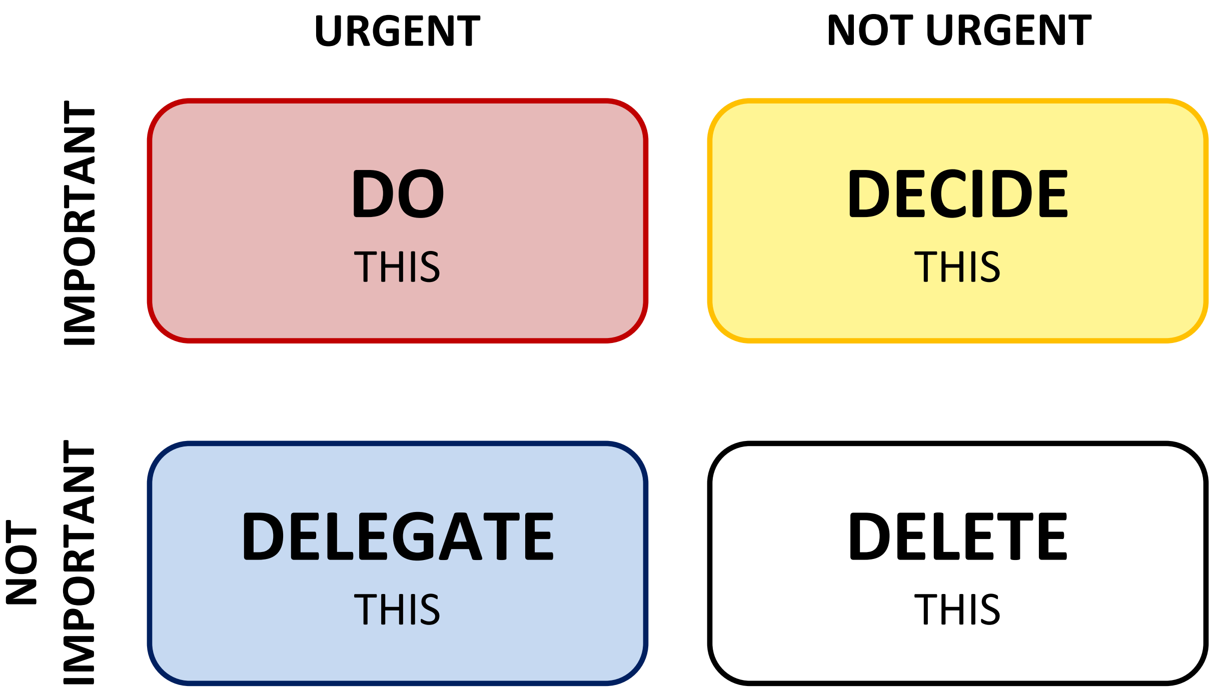
2.4.3 Setting Priorities: Urgent vs. Important

The Eisenhower Matrix – a simple prioritisation grid with related examples



Priority	Example
Urgent & Important	Safety check before rooftop work
Important, Not Urgent	Preparing cables for tomorrow's project
Urgent, Not Important	Answering a non-related question during work
Not Urgent & Not Important	Checking social media during break

2.4.4 Avoiding Time-Wasters

Where Does Time Disappear?

Time is lost in small moments – not always big mistakes. These moments, repeated across a workday, can undermine productivity, cause stress, and affect safety.

Common time-wasters:

- Starting work without a task checklist
- Searching for missing tools or equipment mid-task
- Repeating steps due to poor communication
- Waiting passively for instructions instead of asking
- Getting distracted by off-topic conversations

Mini-scenario: A student team begins wiring the system. The screwdriver is missing. Then the battery cable. Each stop adds 5 minutes. Over a single day, they lose nearly one hour. The task isn't difficult — but the lack of preparation makes it inefficient and frustrating.

Teaching Tip: Encourage students to prepare a 3-minute "pre-task checklist ritual" before every hands-on session. Repeating this habit reinforces discipline, self-management, and group responsibility.

2.4.5 Tips for Staying on Track

Small Habits, Big Impact – Core Habits of Time-Smart Technicians:

- **Use a structured task list** – break work into clear actions with priorities
- **Track time per activity** – set realistic limits and monitor delays
- **Review progress at fixed intervals** – do not wait until the end to discover errors
- **Raise doubts early** – the earlier a question is asked, the cheaper the solution
- **Align time expectations with the team** – agree on pacing before starting

Teacher insight: Instruct each student team to appoint a "**time captain**" during practical tasks — someone who quietly tracks time and calls for brief check-ins. This reinforces shared responsibility and mirrors real industry team dynamics.

2.4.6 Practice: Building Your Schedule

Simulation: Plan and Control a Full Workday

Scenario: A student team is assigned to install a small PV system (2 solar panels + inverter + battery) on a classroom shed. The task must be completed within one school day (6 hours total).

Instructions for student groups (4–5 members):
1. Create a work plan with time blocks for the following: Initial planning & tool preparation; Mounting the panel; Electrical wiring & connection; System testing; Final checks and presentation
2. Allocate specific time estimates (in minutes) for each block
3. Add a 15-minute break and 2 brief progress checks
4. Assign one team member as time coordinator
5. Present your plan using a simple visual format (table, timeline, or board)

Expected Output: A clean, realistic time schedule that reflects: Logical task order; Efficient use of the 6-hour window; Realistic time limits; Group awareness of pacing and roles

Teaching Tip: Invite each group to **review their plan after the task is complete**, comparing predicted vs. actual time used. This feedback loop builds time estimation skills — critical in any technical career.

📢 Soft Skill 4:
PITCHING

🎯 **Objective:**

Gain the ability to clearly present a project or product idea in front of others. Learn how to structure a short pitch using clear messages to attract clients, teachers, or team leaders.

2.5.1 What is Pitching?

Explaining Clearly & Convincingly

A pitch is a short, clear explanation of an idea, project, or product. It is **not a long speech** — but a focused message that helps the audience quickly understand the value of what is being presented.

In solar energy, pitching is used to:

- Propose an installation idea
- Explain how a system works
- Engage with a potential client
- Present a project or prototype

2.5.2 Key Elements: Message, Audience, Clarity

3 Golden Rules for a Good Pitch

In a pitch, how something is said can matter more than what is said. To make a good pitch, three things must be clear:

MESSAGE – What is being proposed or shown?
Short example: *“This system saves 20% on energy”*

3 GOLDEN RULES

AUDIENCE – Who is listening? What do they care about?
Short example: *“The client owns a hotel — focus on tourism benefits”*

CLARITY – Are words, tone, and visuals easy to follow?
Short example: *“Avoid technical words unless asked”*

2.5.3 Presenting Technical Content Effectively

Make It Understandable, Not Just Correct

Technical knowledge alone is not enough. A strong presenter knows how to translate complexity into clear and useful information, adapted to the listener.

A skilled presenter typically:

- Uses **visual elements** (diagrams, flowcharts) to support verbal explanations
- Substitutes technical jargon with **simple, concrete terms** — unless the audience is highly specialized
- Anchors ideas to **practical, real-life scenarios** that the audience can relate to
- Follows a logical path: Context → Solution → Key Feature → Value

Mini-Scenario: During a student pitch, the presenter avoids listing components like “MPPT controller” or “AGM battery.” Instead, she says: *“This off-grid system can power a farm’s irrigation pump for 12 hours a day, even during blackouts — using two panels, a battery bank, and a smart charging controller”.*

→ **The message is clear, specific and outcome-oriented.**

2.5.4 Common Presentation Mistakes

What Weakens a Pitch?

- Using too many slides or too much text
- Speaking too fast or too low
- Reading instead of explaining
- Skipping the goal or benefit
- Ignoring the listener's questions or body language

Weak Pitch	Strong Pitch
"This system uses PV, MPPT, and LiFePO4"	"This system works 12 hours a day and reduces bills"
No structure	Clear beginning and ending
Looking at paper	Speaking to the audience
Listing components without purpose	Explaining the benefit of each part
Using technical terms too early	Using simple language, then explaining terms only if needed
Same pitch for every audience	Adapting message to who is listening (e.g., school, hotel, household)

2.5.5 Visual Aids and Storytelling

Let Visuals and Stories Do the Heavy Lifting

In a technical presentation, visuals are not decoration — they are strategic tools. A good visual communicates the main message in 5 seconds or less. It helps the audience process complex information faster and with more interest.

1. Prioritize diagrams, icons or real images over full sentences
2. Highlight one / two core idea per slide — no more
3. Combine visuals with a short story or real example to create impact

Why storytelling works: A well-placed story turns a technical solution into something memorable and relatable.

"We tested this idea in the school garage. It failed twice. But after adding a charge controller, it powered our LED lights for 6 hours" → The audience remembers the challenge, the solution and the result — **all in one**.

2.5.6 Practice: 3-Message Pitch Simulation

Scenario: In real-life situations — from presenting a project in school to explaining a solution to a client — there is often no screen, no slides, no second chance. This simulation builds the skill of being clear, direct and engaging using only one's voice and ideas.

Task: Each team selects or invents a simple solar solution, such as:

- A solar lamp for emergency use
- A solar-powered outdoor classroom space
- A solar system for a small rural hotel or workshop

Then, prepare a **2-minute verbal pitch** with:

1. One clear title (e.g. "Bright Backup: A Solar Lamp for Power Cuts")
2. Three key messages, such as: What it does || Why it matters || How it helps
3. One direct benefit to the user, made relevant (e.g. saves energy, improves comfort, cuts costs)

Delivery Guidelines:

- No slides: focus on voice, structure, clarity
- Use hands or body to support the message if useful
- Think of the audience: a client, a class, a local mayor?
- One speaker per team
- Practice timing and impact — less is more

Facilitator Tip:
Before the exercise, show one short model pitch live or via video. After the presentations, ask peers to give feedback using three questions:

- Was it clear?
- Was it convincing?
- Was it memorable?

💬 COMMUNICATION

🎯 **Objective:**

Explore how to communicate clearly and professionally using verbal, non-verbal, and written skills. Learn how to adapt communication to different audiences in solar-related situations.

2.6.1 What is Communication?

Making the Right Information Reach the Right Audience

Communication is not just about talking — it is about delivering the right message at the right time in a way others can understand and act on. It is the ability to make information understandable, actionable, and relevant — whether speaking to a teammate, a trainer, or a client.

In technical work, communication ensures:

- The right tasks are done by the right people, in the right order
- Everyone works with the same understanding of the problem and the solution
- Errors are prevented, because questions and issues are raised early

Reflection insight: Professionals don't just "talk" — they listen, confirm and clarify. Communication is not extra — it is a technical skill in itself.

2.6.2 Types of Communication

Verbal, Non-Verbal, Written – Know the Channels

Type	Example	Practical Tip
🗣 **Verbal**	Giving safety instructions or assigning roles on-site	Use short, direct phrases — one idea per sentence
🤝 **Non-verbal**	Eye contact, hand gestures, body position, pointing during installation, maintaining open posture	Match gestures to words and avoid mixed signals
✍ **Written**	Filling out a daily installation log or writing up test results	Be structured and concise; use bullet points when possible

Skilled technicians **move fluidly between channels**. A verbal instruction may be supported by a gesture; a spoken decision should often be followed by a brief written confirmation — especially when safety, time or costs are involved.

2.6.3 Communication in Solar Projects

Where It Happens and Why It Matters

Each moment requires a different communication skill:

Phase	Purpose of Communication	Concrete Example
Planning	Align team roles, sequence tasks, and confirm materials	*“We’ll mount in pairs, you handle wiring, I do safety check”*
Safety	Prevent accidents through clear alerts and confirmations	*“Stop — panel is slipping. Hold position until I secure it”*
Client interaction	Build trust, explain features, and manage expectations	*“This system can lower your monthly bill by up to 30%”*
Testing	Report issues, log performance, and propose adjustments	*“Panel 2 is underperforming — possible shading, let’s verify”*
Handover & Follow-up	Ensure the user understands system use and maintenance	*“Clean the panels monthly and call us if the indicator light turns red”*

Note: Professional communication continues **after installation**. Providing clear handover instructions, being responsive to client feedback, and documenting performance logs are also key parts of **technical reputation and client retention**.

2.6.4 Mistakes to Avoid in Communication

Common Issues That Block Understanding

Mistake	Example	What to Do Instead
Using too much jargon	*"This system includes a PWM regulator..."*	Say: *"This device protects the battery"*
Not listening to feedback	Ignoring when someone says *"I don't get it"*	Pause, explain again in simpler terms
Speaking too fast or too low	Hard to follow in team meetings	Speak slowly, pause, and check for reaction
Interrupting or talking over others	Cutting off a teammate during task explanation	Wait, let others finish, then contribute clearly
Assuming understanding without checking	Moving forward without confirming if others followed	Ask: *"Is that clear?"* or *"Should I repeat that step?"*

🔍

Teaching tip & golden rules: Good communication is **two-way** — talking and listening. Students should check if the message was received, not just sent.

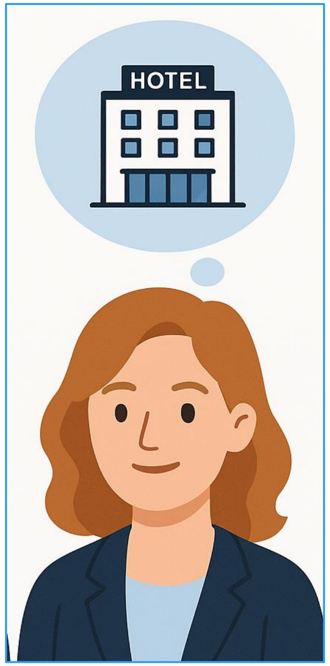
2.6.5 Communicating with Different Audiences

Same system – two or more ways to explain it. That's communication

A good communicator knows how to adjust tone, words and examples depending on who is listening:

Audience:
Teacher

Focus on:
Learning goal and technical accuracy



Audience:
Stakeholder / Client (e.g. hotel manager)

Focus on:
Savings, reliability, ease of use

Audience:
Teammates

Focus on:
Roles, timing, safety

2.6.6 Practice: Announce the Launch of a New Product via a Social Media Post

Communicate Your Project to the Wider Public

Task: Each student team will simulate the public launch of their solar prototype or school project using a professional-style social media post. The focus is on clarity, value and outreach.

Instructions:
1. Choose or create **one image** that best represents the project
2. Write a promotional post including:
    1. A **short and impactful title**
    2. A **brief paragraph** (max 3 sentences) that explains:
        - What the product is
        - Why it matters
        - What benefit it brings
    3. 2–3 hashtags to boost visibility
    4. A **final call to action** or benefit line (e.g. “Now available at your local tech fair!”)

Purpose: This exercise connects **technical content** with **audience-friendly communication**. It trains students to present their work to non-specialists in a clear, confident and appealing way.

UNIT 3 – Marketing, Sales & Customer Relations in the Solar Sector

🎯 **Objective:**

To introduce VET learners to core entrepreneurial and client-facing skills needed to promote, sell, and manage small-scale solar energy solutions, with practical focus on:

📈 **Marketing**

🤝 **Sales**

👦💼 **Customer Relationship Management (CRM)**

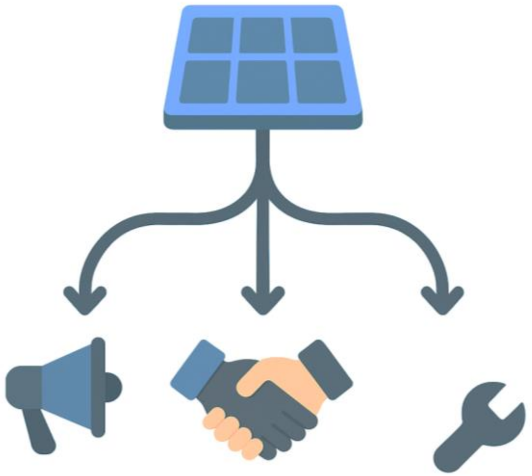
3.1 Introduction: Why Marketing, Sales and CRM Matter in Solar Energy

From Technical Skills to Real-World Opportunities

Knowing how to install solar panels is essential — but it is only part of the job. In the real world, technicians also need to know **how to present a product, engage with a client, and maintain professional relationships**.

Why it matters: Today's VET learners are not only future employees — they are problem solvers, innovators, and entrepreneurial minds. This unit gives them tools to:

1. Promote what they create (**MARKETING**)
2. Explain value to others (**SALES**)
3. Build professional trust and long-term collaboration (**CRM**)



Co-funded by the European Union

📈 MARKETING

🎯 Objective:

To introduce VET learners to the essential principles of marketing in the solar energy sector — including how to define a product, identify a target audience, and promote technical solutions effectively.

The focus is on developing practical, entry-level skills that allow students to communicate the value of their solar projects using simple tools, real-life examples and both online and offline strategies.

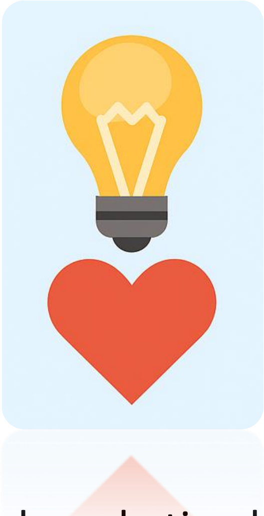
3.2.1 What is Marketing?

Making People Understand and Want What You Offer

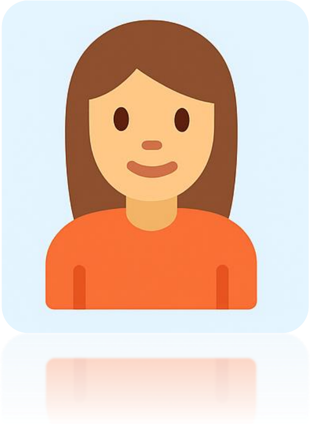
Marketing is not just advertising — it is the **full process** of understanding users, presenting value, and connecting the right product to the right people. In solar energy, marketing helps show:

What the solution does

Why it matters



Who benefits from it



Even in small projects (school, homes, workshops), good marketing helps others take the solution seriously.

3.2.2 Marketing Tools in the Solar Sector

Young technicians can use simple marketing tools to promote a solar solution:

Tool	Example	Purpose
Photos	Before/after pictures of a solar panel on a garage roof	Show visible impact and attract attention
Short videos	30-second clip explaining how a solar charger works	Explain function and increase engagement
Flyers or info sheets	Handout describing features, price and benefits of a solar lamp	Inform clearly and leave something physical
Word of mouth	Talking to family, neighbours or local shopkeepers	Build trust in familiar settings
Social media posts	Sharing a working prototype on Instagram, Facebook or Telegram	Reach wider audiences with low cost

Reflection: Marketing is not about selling fast — it is about **building interest** and **trust** in what the student team has built.

3.2.3 Digital vs Traditional Marketing

Online or Offline? Use the Right Channel

Approach	Example	When It's Most Effective
Digital	Social media posts, short explainer videos, project stories on Telegram or Instagram	When targeting a young, tech-savvy audience or aiming to spread a message quickly and widely
Traditional	Posters in schools, printed flyers at community events, word-of-mouth during fairs	When targeting local families, small business owners or older adults with limited internet use

Smart communication strategies combine both approaches, reinforcing the message across different groups.

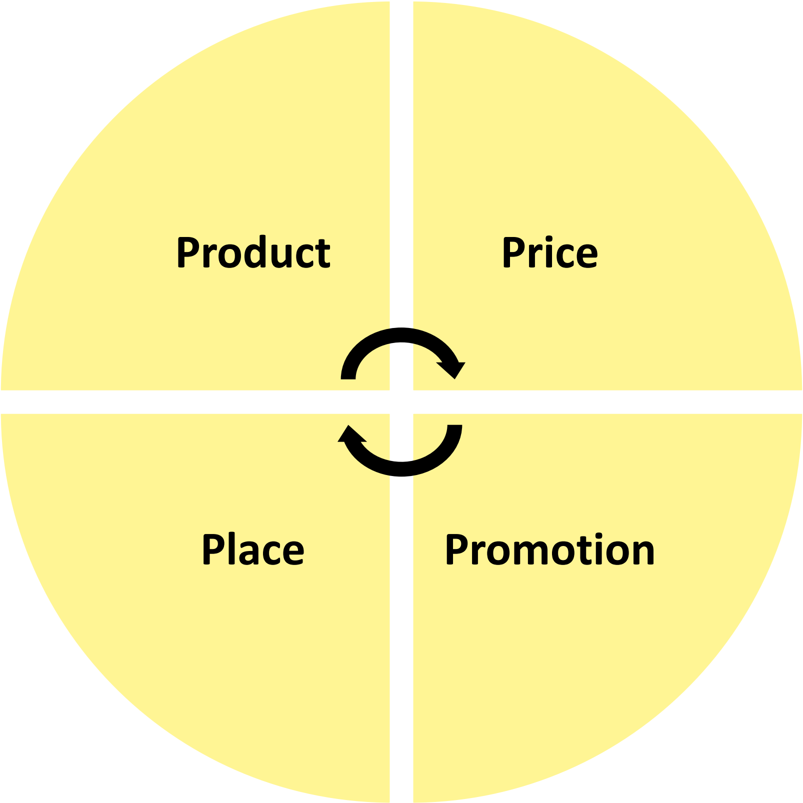
Teaching tip: Ask students to list which marketing methods they have seen used in their community — and which felt more convincing.

3.2.4 The 4Ps: Product, Price, Place, Promotion

The Marketing Mix: Simple and Effective

Product – What is it? What problem does it solve?
➤ e.g. A mini solar system for weekend homes

Price – How much does it cost? What is the value?
➤ e.g. €150 for 2 panels + battery = 5 hours of light/day



Place – Where can it be found or installed?
➤ e.g. Small homes, garages, outdoor sheds

Promotion – How do people hear about it?
➤ e.g. Social post, local event, word of mouth

3.2.5 Practice: Create a Budget-Based Mini Marketing Plan

Scenario: Each student team has designed a solar solution — now they must act as a **small start-up team** and create a basic marketing plan to promote it using a **budget of €350**. This activity helps students connect technical innovation to communication and planning — simulating real business or project launches.

Task:

1. Define the **4Ps** of your solar product:
   - Product – What is it?
   - Price – How much does it cost and why?
   - Place – Where will it be available?
   - Promotion – How will people know about it?
2. Choose **at least 2 promotional tools** (digital and/or traditional), justifying your choice based on the target audience.
3. Draft a short but structured marketing plan that answers:
   - **Who** is the target audience?
   - **What** is the main message?
   - **How and where** will the message be delivered?
   - **How** will the budget be distributed (basic cost breakdown)?
4. Prepare a **2-minute spoken pitch** to explain your plan to the class or trainer.

Expected Output: A clear, 1-page visual (paper or digital) showing the plan, strategy and budget breakdown.

🤝 SALES

🎯 Objective:

To help learners understand how to pitch and sell solar solutions by identifying client needs, presenting benefits clearly and responding to objections.

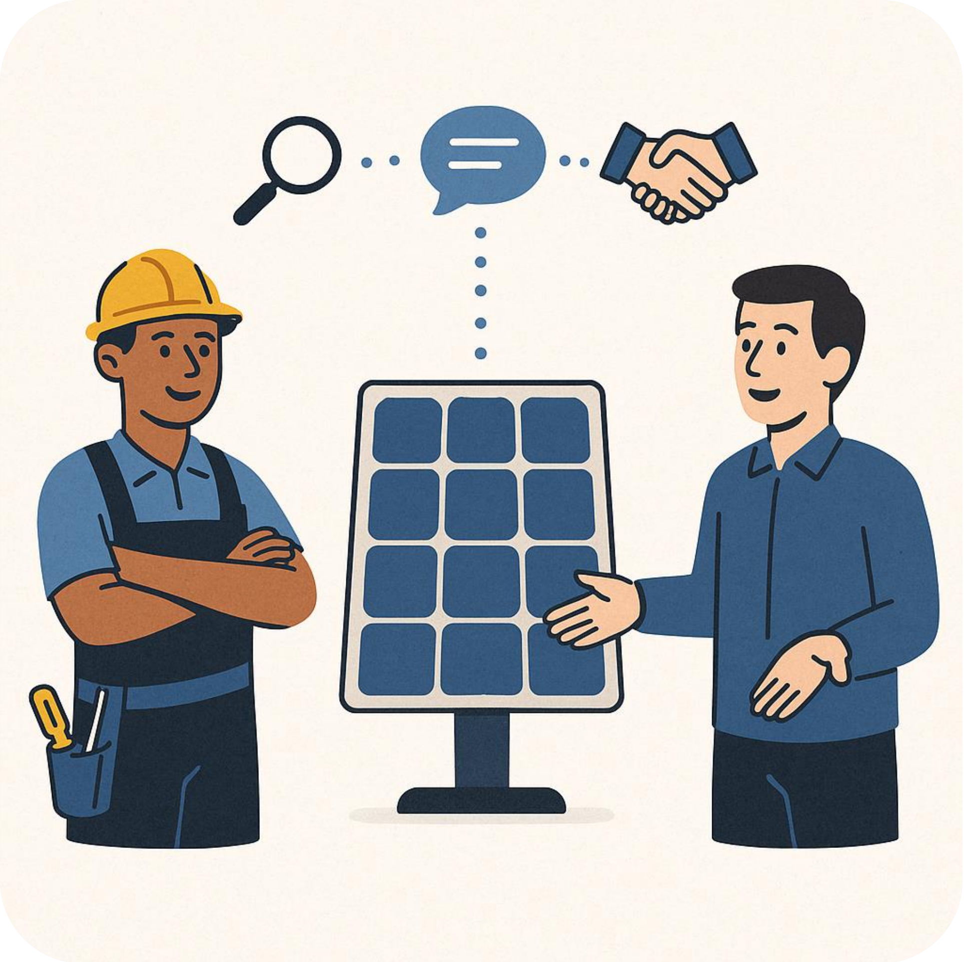
The section focuses on real-world interactions, with practical simulations tailored to typical customers in Armenia.

3.3.1 What Does Sales Mean in Solar Work?

Sales is not just "convincing" someone — it is about **understanding their needs** and offering something that helps. A client will only say yes when they trust both the product and the person.

In solar energy, this requires a mix of technical clarity and human connection. A successful sales approach includes:

- **Listening actively** – *What does the client truly need or worry about?*
- **Explaining clearly** – *What does the product solve? What value does it bring?*
- **Building trust** – *Can the client feel confident in both the system and the technician?*



3.3.2 (Most Typical) Clients an What They Care About

Different People, Different Priorities

Client Type	Main Concern	How to Respond
Family (home)	Cost and long-term savings	*"With this system, you reduce your electricity bills and protect yourself from future price increases"*
Hotel / B&B	Attracting eco-conscious guests, image	*"Offering solar-powered rooms can help you stand out and appeal to green-minded tourists"*
School or NGO	Reliability, education value	*"This system provides backup during outages and is also a tool for learning and awareness"*
Rural business	Energy independence, stability	*"You'll reduce reliance on the grid and work with consistent power for your tools or refrigeration"*
Small workshop	Operating costs, daily use	*"This system powers your tools during the day without affecting your main bill — it's quiet, clean, and steady"*

Teaching Tip:

Invite students to choose one client type and describe someone they know (a real or imagined person) who would benefit. Then role-play a pitch using the concerns and answers from the table.

3.3.3 Translating Features into Benefits

Sell the Outcome, Not Just the Object

Many beginner technicians focus on technical features: voltage, battery type, controller specs. But most clients care more about the **practical result** — what they get from using the product.

QUICK COMPARISON TABLE

Technical Feature	Client-Centered Benefit
2 solar panels (12V, 150W each)	Powers 5–6 LED lights and a small fan every day
100Ah battery storage	Stores energy to use during the night or on cloudy days
Smart inverter	Keeps devices safe and avoids overload problems
MPPT charge controller	Charges faster and works better in weak sunlight

3.3.4 Handling Objections (1)

What If They Say No? Turning Doubts into Dialogue

Objections are normal — they are not rejections, but opportunities to understand the client better and offer clarity. A skilled technician does not argue but **listens and redirects the focus to value**.

Tactical micro-skills – always:

1. Acknowledge the concern
2. Ask for clarification if needed
3. Reframe the issue in terms of practical benefit
4. Maintain a calm, respectful tone

3.3.4 Handling Objections (2)

What If They Say No? Turning Doubts into Dialogue

COMMON OBJECTIONS AND EFFECTIVE RESPONSES

Objection	How to Respond (Client-Centered)
“It’s too expensive”	*“Let’s look at total savings — you will reduce bills every month and the system pays for itself within 2–3 years”*
“I don’t use it enough”	*“Even if used part-time, it increases your comfort and adds long-term value to the property”*
“What if it breaks?”	*“The parts are tested, and we explain exactly how to care for the system. Plus, support is available”*
“I don’t understand how it works”	*“Let me show you simply — it is just solar in, battery stores, power out. No risk, no noise”*

3.3.5 Closing a Sale Professionally

End the Conversation with Clarity and (Professional) Confidence

When a client is ready, be clear about the **next steps:**

1. **Confirm agreement** (verbally or in writing) →
2. **Explain delivery or installation timeline** →
3. **Offer post-sale contact or support** →
4. **Thank the client with professionalism**

Mini-script: *“Great — we are installing install on Thursday. I will bring everything, and I’ll show you how it works. Feel free to call me with any questions”.*

3.3.6 Practice: Solar Sales Simulation

Task: Each team selects or invents a solar product (e.g. lamp, off-grid kit, mini station) and prepares two targeted sales pitches, adjusting tone, language and message based on the client profile.

Two Client Profiles:

Client A – Family	**Client B – Small Hotel**
1. Middle-income household in Yerevan with a summer house 2. Concern: *"Too expensive for something we use only in summer"* 3. Response focus: **Long-term value, added property benefit, reduced grid use**	1. Guesthouse in Tsaghkadzor looking for new ideas 2. Concern: *"Not sure guests really care about solar"* 3. Response focus: **Marketing advantage, green tourism appeal, cost efficiency**

Deliverable: Each team presents both interactions as a short **role-play** or scripted conversation. Teams must:

- Demonstrate active listening
- Adapt the pitch based on the client's concern
- Keep the tone confident, respectful and professional

Skills developed:

Communication || Persuasion || Adaptability || Product awareness

👦💼 CRM – Customer Relationship Management

🎯 **Objective:**

To introduce the basics of customer care and follow-up in technical services, showing how trust, reputation, and long-term communication impact success.

Students will explore how to deal with feedback, manage difficult clients, and represent their work professionally.

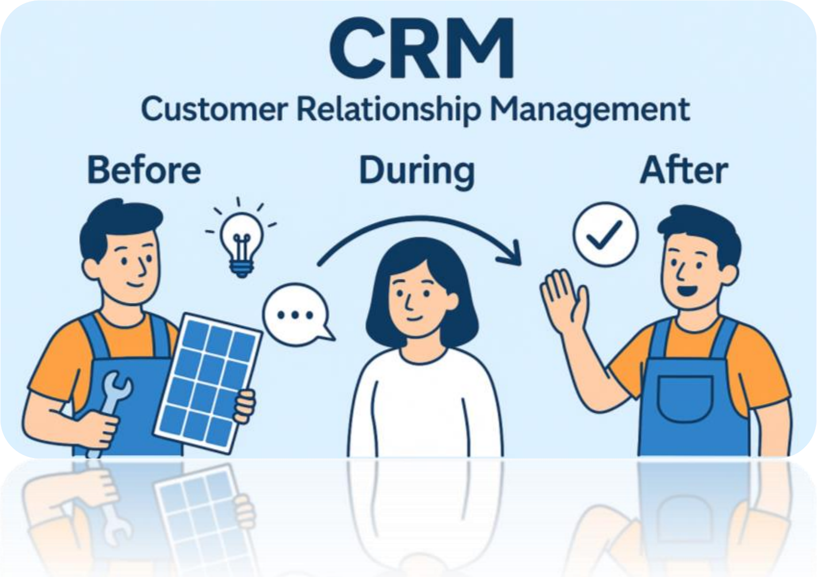
3.4.1 What is Customer Relationship Management (CRM)?

Taking Care of Clients Before, During and After the Work

Customer Relationship Management means more than answering questions — it means managing every interaction with the client in a way that builds long-term relationship and trust.

CRM is a technician's strategy to ensure the client:

- Understands how to use the system properly
- Receives quick and clear support if something goes wrong
- Feels respected, which increases the chance of referrals and loyalty



In solar energy — especially in local or rural communities — the technician's ability to stay present and helpful after installation becomes part of the product's value itself.

3.4.2 Key Elements of Good CRM

What Makes a Client Feel Valued?

Element	Description	Real Example
Follow-up	Contact the client after delivery or installation	*"Hi, just checking in — is the battery charging well this week?"*
Availability	Be reachable when questions or issues arise	Leave a WhatsApp number or define call hours clearly
Documentation	Provide clear, written instructions or simple guides	One-page flyer on how to maintain and reset the inverter
Attitude	Show professionalism: calm, helpful, and solution-focused	*"I will come by tomorrow morning and we will check it together"*

3.4.3 Difficult Clients and Smart Responses

When Things Go Wrong, Stay Clear and Constructive

Scenarios:

Client Statement	Professional Technician Response
“This never worked from day one!”	*“Let’s go step by step. Can you tell me exactly what happens when it is turned on?”*
“Too complicated!”	*“No problem — let me show you just the 3 main steps to use it safely”*
“I am unhappy with this result”	*“Thank you for telling me. Let’s check what can be improved or adjusted”*
“My neighbour got it cheaper”	*“Each system is tailored. I can explain what is included and why it fits your case”*

Micro-skill reminder:

- Stay calm
- Acknowledge the concern
- Re-focus on solutions, not blame
- Always maintain professional tone

3.4.4 Reputation and Word-of-Mouth

Good CRM = Free Marketing

In local communities or small cities, one client's experience can shape the reputation of an entire service. People talk — and what they say builds or breaks trust for future work. A technician with a good reputation will:

- Get recommended (→ **referrals**)
- Be remembered (→ **loyalty**)
- Attract future clients with no extra cost (→ **organic growth**)

From Good Work to More Work (simple loop)

Trust → **Satisfaction** → **Referral** → **New Client** → **Loyalty** → **More Work**

3.4.5 Practice: Solve a Customer Issue

Scenario: A client writes: *"It is only been two weeks and already the battery is not working. I feel disappointed. This was not cheap"*

Task: In pairs or small groups, students prepare a **short, professional response**, either written or spoken, that:
1. Acknowledges the client's concern
2. Asks a clear technical follow-up (e.g. *"Have you checked the charge indicator?"*)
3. Offers a next step (visit, call, guide)
4. Ends in a calm, supportive tone

Role-play (optional):
- One student is the client
- One student is the technician
- Practice tone, active listening, and confident communication

Skills in focus:
- Crisis response
- Empathy and tone control
- Basic tech troubleshooting
- Professional language under pressure