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**Student Training Final Report Form**

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| **General Information** | | | | |
| 28-3-2025 | To: | 2-2-2025 | From: | Training Period |
| 15-4-2025 | | | | Report Date |
| King Abdullah Ⅱ of Engineering | | | | School |
| Electrical power and energy engineering | | | | Program |
| Ahmad Barakat | | | | Student Name |
| 20190771 | | | | Student Number |
| Dr. [Ibrahim Abuishmais](mailto:I.abuishmais@psut.edu.jo) | | | | Academic Supervisor Name |
| **Training Institution Information** | | | | |
| Mahatta Energy | | | | Name |
| https://mahattaenergy.com/ | | | | Website |
| Al-Mawaddah St. 307, Amman | | | | Address |
| Electrical Department | | | | Department Name |
| Abdullah Bdeir | | | | Supervisor Name |

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| **Description of the institution** |
| Mahatta Energy is a leading Jordanian company specializing in sustainable energy solutions, with a mission to foster healthier future communities through quality-centered strategies. Established in 2016 under the registered name National Energy Solutions Co., Mahatta Energy has become a key player in the renewable energy sector across Jordan and the broader MENA region.  The company offers a comprehensive suite of services, including:   * **Solar Photovoltaic Systems**: Design and installation of PV systems tailored to local regulations and diverse supply topologies. * **Heat Pump Systems**: Eco-friendly heating solutions that can save at least 50% energy, with smart, phone-controlled options. * **Energy Management and Audits (ESCO Services)**: Resource efficiency solutions, savings guarantees, and Measurement & Verification (M&V) services to enhance sustainability and reduce costs. * **Monitoring & Targeting**: Real-time energy usage analytics to identify and minimize unnecessary consumption. * **Operations and Maintenance**: Comprehensive services for solar PV plant needs, including asset protection, continuous monitoring, and troubleshooting. * **Energy Modeling and Simulation**: Accurate energy consumption estimates for projects, whether for ESCO retrofits or new constructions. * **IoT Solutions for Commercial and Industrial Usage**: Industry expertise combined with machine learning technologies to optimize processes and improve efficiency. * **Green Building Certifications**: Assistance in achieving certifications that recognize sustainable building practices.   Mahatta Energy's multidisciplinary team of engineers is highly qualified to provide reliable services that meet international standards. The company has completed over 2.5 MWp of installed capacity from both stand-alone and grid-connected photovoltaic systems, with projects in Jordan, Egypt, and Saudi Arabia. Additionally, Mahatta Energy is among the few licensed companies in Jordan authorized to perform energy audit services, with proven experience in commercial, industrial, and governmental facilities.([LinkedIn](https://www.linkedin.com/company/mahatta-energy/?utm_source=chatgpt.com))  For more information, visit their official website: [mahattaenergy.com](https://mahattaenergy.com/) |

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| **Weekly Duties (detailed description)** | | | |
| **Week 1:** | | | |
| **From:** | **2-2-2025** | **To:** | **6-2-2025** |
| * **1. Decommissioning & Commissioning of Darwazeh Complex PV System** * -Successfully decommissioned the old PV system by safely uninstalling components. * -Installed and configured new PV panels, ensuring proper string design and alignment with inverter specifications. * -Conducted thorough maintenance of the new system, including electrical testing (e.g., ROC cable tests using Metril) to validate system integrity. * -Repurposed functional components from old PV panels for future spare parts, reducing waste and costs. * -Learning Outcome: Enhanced expertise in PV system inspection protocols and troubleshooting. * **2. Al Kasih Food Factory PV System Upgrade** * - Continued decommissioning and commissioning efforts for the factory’s PV system: * - Replicated steps from the Darwazeh project (uninstallation, new PV installation, string design, and inverter integration). * -Conducted thorough maintenance of the new system, including electrical testing (e.g., ROC cable tests using Metril) to validate system integrity. * - Performed quality checks and system optimization to ensure a seamless transition to the new setup. * - Collaborated with the team to address site-specific challenges during installation. * **3. Heat Pump Commissioning** * - Conducted maintenance checks on heat pump systems to verify operational efficiency. * - Ensured proper calibration and functionality aligned with performance requirements. * - Documented system behavior and resolved minor operational discrepancies. * **4. Technical Reading & Knowledge Development** * - Reviewed audit reports for **Petra**, **Orbit**, and **Spartan** to understand project histories and technical requirements. * - Studied technical materials on: * - **Cooling towers:** Operational principles and maintenance best practices. * - **Boilers**: Efficiency optimization and safety protocols. * - **Friction loss in piping systems:** Calculations and mitigation strategies. * -**HVAC systems**: Explored operational mechanisms, energy efficiency practices, and auditing methodologies to assess performance and compliance. * -**LED lighting:** Researched audit techniques for evaluating installation quality, energy savings, and lifecycle cost analysis. * - **Goal:** Strengthen foundational knowledge to support future projects and audits. * **5. Administrative & Documentation Tasks** * - Prepared **daily monitoring reports** to track system performance and identify anomalies promptly. * - Compiled **monthly reports** summarizing project progress, maintenance activities, and resource utilization. * - Ensured all documentation adhered to organizational standards for clarity and compliance. * 6. Aqaba University for Technology Maintenance * - Traveled to **Aqaba** to conduct scheduled monthly maintenance for the university’s PV systems. * - Performed inspections, cleaned panels, and tested electrical connections to ensure optimal performance. * - Addressed minor faults and updated maintenance logs to reflect system status and recommendations. * - **Objective**: Maintain system longevity and minimize downtime for critical infrastructure. | | | |
| **Week 2:** | | | |
| **From:** | **8-2-2025** | **To:** | **10-2-2025** |
| **1. Document Review**  - Cooling Towers: Read and analyze technical documents related to cooling towers, focusing on their operation, maintenance, and energy efficiency.  - Energy Audit of Boilers: Studied materials on conducting energy audits for boilers, including key performance indicators (KPIs), common inefficiencies, and optimization strategies.  **Outcome**: Enhanced understanding of cooling tower operations and boiler energy audits, which will support future energy efficiency projects.  **2. Site Visits for Operations and Maintenance**  **Aqaba Visit**  -**ABB Inverter Communication Disconnection**: Traveled to Aqaba to resolve a communication disconnection issue in an ABB inverter. Diagnosed the problem, re-established communication, and ensured the system was functioning correctly.  - **Huawei Inverters Commissioning**: Conducted commissioning for Huawei inverters, ensuring they were properly installed, configured, and operational.  - **Heat Pump Commissioning:** Performed commissioning for a heat pump system, verifying its performance and integration with existing systems.  - **Inverter Electrical Breaker Sizing Issue:** During the site visit, I discovered that one of the inverters was disconnected due to an incorrect sizing of the Breaker. The Breaker was undersized for the inverter's load, causing it to fail and disconnect the system.  **Outcome**: Successfully resolved the ABB inverter issue, completed commissioning tasks, and identified a critical sizing issue that, once fixed, will prevent future disconnections.  **3. Monitoring and Reporting for PV Systems**  - Monitored the performance of PV systems for multiple customers.  - Identified and documented any issues, such as reduced efficiency, inverter faults, or communication errors.  - Prepared detailed reports for customers, outlining the issues and recommended solutions.  **Outcome**: Improved customer satisfaction by proactively identifying and addressing PV system issues, ensuring optimal performance.  **4. Professional Development**  - Seminar Attendance: Attended a seminar hosted by Philadelphia Solar. The seminar covered the latest advancements in solar technology, including new inverter designs, energy storage solutions, and best practices for system maintenance.  **Outcome:** Gained valuable insights into emerging solar technologies and industry trends, which can be applied to future projects.  **Summary of Achievements**  - Resolved a critical communication issue in an ABB inverter in Aqaba.  - Completed commissioning for Huawei inverters and a heat pump system.  - Discovered and diagnosed an inverter disconnection caused by an incorrectly sized breaker, providing a solution to prevent future issues.  - Monitored and reported on PV system performance for customers, ensuring timely issue resolution.  - Enhanced technical knowledge through document reviews and seminar attendance. | | | |
| **Week 3:** | | | |
| **From:** | **11-2-2025** | **To:** | **15-2-2025** |
| 1. Summary of Tasks CompletedTechnical Work & Maintenance  * **Battery Replacement at JHCO**: Replaced faulty batteries in the monitoring system to ensure uninterrupted data transmission. * **PV Inverter Maintenance (Al Wazir Factory)**: Inspected inverters, resolved performance issues, and optimized power conversion efficiency. * **PV Array Decommissioning**: Safely dismantled solar arrays, adhering to environmental regulations during disposal. * **Site Inspections**: Conducted safety and compliance checks at utility-scale solar farms and rooftop PV installations. * **Rooftop PV Array Issue**: Identified and flagged two broken PV modules for urgent replacement.  Renewable Energy System Optimization  * **PV System Monitoring**: Tracked performance of three solar projects using KOSTAL, FusionSolar, and AuroraVision platforms. * **Performance Reporting**: Analyzed monthly data (kWh output, performance ratios) to pinpoint inefficiencies like shading and inverter failures.  Challenges & Solutions  * **Battery Failure at JHCO**: Addressed urgent replacement to restore monitoring functionality. * **Inverter Issues at Al Wazir**: Troubleshooting and calibration resolved erratic power output. * **PV Decommissioning**: Managed risks during electrical disconnections and component disposal.   **Next Steps**:   * Monitor replaced batteries at JHCO for stability. * Coordinate PV module replacements for the rooftop array.  Solutions Implemented:  * **Battery Replacement & Troubleshooting:** Ensured uninterrupted monitoring and trained staff on battery health checks. * **PV Inverter Maintenance:** Restored inverters to optimal operation, minimizing downtime and maximizing efficiency. * **Safe PV Array Decommissioning:** Followed safety protocols to disconnect, dismantle, and dispose of old solar panels properly. * **Inspection & Repair Recommendations:** Identified and documented damaged PV modules for replacement. * **Energy Optimization Measures:** L**arger diameter** **pipes** are suggested to reduce compressor energy losses. * **Heat Pump Commissioning Support:** Verified refrigerant charge levels, performed functional tests, and trained operators on maintenance procedures. | | | |
| **Week 4:** | | | |
| **From:** | **18-2-2025** | **To:** | **22-2-2025** |
| 1. Completed Tasks  1. **PVsyst Simulation Finalized**    * **Project Overview**: 168 kWp grid-connected system in Hayy al Husayniyah, Jordan.    * **Key Results**:      + Annual energy production: **254,791 kWh/year** (Specific production: **1,514 kWh/kWp/year**).      + Performance Ratio (PR): **77.77%** (slightly below the industry standard of 80%, likely due to system losses).    * **Loss Analysis**:      + **Soiling losses**: 5.0%      + **Thermal losses**: 29.0 W/m²K (ambient temperature impact).      + **System unavailability**: 2.0% (7.3 days/year). 2. **Daily Monitoring Updates (22 March 2025)**:    * **Alwazir**: Offline since 21 March (under investigation).    * **Petra Inverter 1**: Persistent high deviation observed.    * **Alalami**: Remains offline.  2. Ongoing Projects  1. **Harmonic Distortion (THDi) Analysis**    * **Weekdays**:      + Phase 3 THDi peaks at **100%** (12 AM–9 AM), linked to industrial load activation (e.g., motors, machinery).      + Phases 1 & 2: Lower maxima (~70% and ~40%).    * **Off-Days**:      + Phase 3 averages **10–25% THDi** (mornings), minimal afternoon distortion. 2. **Load Profile Review**    * **Weekdays**: Midday peak (~800,000 kW) at 12 PM–2 PM (industrial/commercial demand).    * **Off-Days**: PV system exports power to the grid (negative load values: **-100,000 kW**).  3. Challenges/Blockers  1. **Inverter Issues**:    * Petra Inverter 1’s high deviation impacts system efficiency.    * Alwazir and Alalami are offline, reducing operational capacity. 2. **Harmonic Distortion**:    * Severe THDi in Phase 3 risks equipment longevity and grid stability. 3. **System Losses**:    * Soiling and thermal losses require mitigation strategies (e.g., cleaning schedules, and cooling solutions).  4. Next Week’s Priorities  1. **Address Inverter Deviations**:    * Troubleshoot Petra Inverter 1 and prioritize reactivation of Alwazir/Alalami. 2. **THDi Mitigation Plan**:    * Install harmonic filters on Phase 3; review industrial load schedules. 3. **Loss Reduction**:    * Propose soiling mitigation (automated cleaning) and thermal management (ventilation upgrades). 4. **Inventory Review**:    * Assess spare parts and equipment availability (awaiting detailed inventory from Eng. Abdullah). | | | |
| **Week 5:** | | | |
| **From:** | **25-2-2025** | **To:** | **29-2-2025** |
| Energy Tariff & Load Management  * **Tariff Structure Review**: Assessed new residential, commercial, and industrial electricity pricing models. * **Load Curve Analysis**: Mapped Jordan’s daily grid demand to propose strategies for peak shaving and efficiency improvements.  Engineering & Energy Studies  * **Compressor Efficiency**: Recommended larger pipe diameters to reduce energy consumption in compressors. * **Renewable Energy Research**: Explored solar, wind, geothermal, and storage technologies (batteries, hydrogen, flywheels). * **Co-Generation Applications**: Evaluated waste heat recovery for industrial heating, cooling, and desalination.  Technical Knowledge & Training  * **Equipment Operations**: Analyzed differences between compressors, blowers, and fans for operational efficiency. * **Scatter Diagrams**: Applied data visualization to identify energy trends and outliers. * **Resource Efficiency (REFF)**: Developed methods to optimize water, material, and energy use.  Challenges & Solutions  * **Heat Pump Commissioning**: Conducted functional tests and operator training to ensure seamless integration. * **Grid Stability**: Proposed solutions for Jordan’s load curve challenges, including demand-side management.   **Next Steps**:   * Finalize tariff optimization strategies for client proposals. * Validate compressor efficiency recommendations with field trials. | | | |
| **Week 6:** | | | |
| **From:** | **1-3-2025** | **To:** | **6-3-2025** |
| 1. Completed Tasks  1. **Tops Chocolate Factory Walkthrough (Ahmad Barakat)**    * **Facility Overview**:      + Two-floor factory with 4 production lines (3 on 1st floor, 1 on 2nd floor).      + Small PV system (50 kW inverter installed in October 2024).    * **Electrical System Findings**:      + **Main Panel Readings**:        - Phase currents: Blue (88.1 A), Red (120 A), Yellow (126.9 A), Neutral (33.2 A).        - PV Breaker: Balanced phases (Blue: 80 A, Red: 76 A, Yellow: 78 A).      + **Issues Identified**:        - Blown capacitor in the capacitor bank.        - Semi-melted wires and fluctuating currents.        - Suspected harmonic distortion due to nonlinear loads (e.g., motor controls).    * **Recommendations**:      + Detailed harmonic analysis and capacitor bank repair. 2. **JHCO Khalda Solar Performance Report (February 2025)**    * **Energy Consumption**:      + Total consumption: **6,984.03 kWh** (higher than January’s 6,050.7 kWh).      + Weekend vs. weekday usage: **100 kWh/day** (weekends) vs. **200 kWh/day** (weekdays).    * **Solar Production**:      + Actual production: **959.46 kWh** (vs. expected **968.99 kWh**; **1% underperformance**).      + Performance decline aligned with annual degradation rate (0.7%). 3. **Aqaba University of Technology (AUT) Maintenance Visit**    * **Inverters**:      + Replaced faulty **30mA RCD** on Inverter 6 with **500mA RCD** to prevent nuisance tripping.      + Reconnected **RS485 cable** and restored data collection.    * **PV Panels**:      + Current readings showed minor fluctuations (±0.5–1 A) due to uneven soiling.      + Visual inspection confirmed below-average cleaning; prioritized cleaning schedule.    * **Safety Compliance**:      + Identified and recommended replacement of a **cut earth wire** in the distribution board.  2. Ongoing Projects  1. **Seyagha Solar Project (PVsyst Analysis)**    * **System Performance**:      + Annual production: **254,791 kWh/year** (PR: **77.77%**).      + Key losses: **5% soiling**, **2% thermal**, **2% system unavailability**.    * **Challenges(AL-wazir)**:      + High harmonic distortion (THDi) in Phase 3 (100% on weekdays).      + Persistent inverter deviations (Petra Inverter 1) and offline units (Alwazir, Alalami). 2. **Harmonic Distortion Mitigation**    * Analyzing root causes (e.g., industrial loads, capacitor resonance).    * Planning installation of harmonic filters for Phase 3.  3. Challenges/Blockers  * **Inverter Reliability**:   + Petra Inverter 1 deviations and Alwazir/Alalami downtime require urgent resolution. * **Safety Risks**:   + Cut earth wire at AUT and blown capacitor at Tops Chocolate pose operational hazards. * **System Losses**:   + Soiling and thermal losses impacting Seyagha’s PR (below industry standard of 80%).  4. Next Week’s Priorities  1. **Address Immediate Safety Concerns**:    * Replace cut earth wire at AUT and repair Tops Chocolate’s capacitor bank. 2. **Inverter Troubleshooting**:    * Reactivate Alwazir/Alalami and resolve Petra Inverter 1 deviations. 3. **Loss Mitigation**:    * Propose automated cleaning for Seyagha’s PV panels.    * Finalize harmonic filter specifications for Tops Chocolate. 4. **Data Validation**:    * Cross-check JHCO Khalda’s solar production data with PVsyst simulations. | | | |
| **Week 7:** | | | |
| **From:** | **10-3-2025** | **To:** | **15-3-2025** |
| Progress Summary This week, I focused on understanding the foundational concepts of **industrial steam systems**, with emphasis on: **Introduction & Context**  * Explored the critical role of steam in industrial applications such as heating and power generation. * Reviewed UNIDO’s focus on aligning industrial energy efficiency efforts with Sustainable Development Goals (SDGs).  **Steam System Fundamentals**  * Studied the major components of a typical steam system: generation, distribution, end-use, and condensate recovery. * Reviewed core thermodynamic principles, including saturation, superheat, enthalpy, and entropy, and familiarized myself with tools such as Mollier diagrams.  **Scoping the System**  * Learned how to apply the US DOE Steam System Scoping Tool (SSST) for identifying performance improvement areas. * Practiced qualitative assessment of steam system management practices and profiling techniques.  **Boiler Efficiency**  * Compared direct and indirect methods for calculating boiler efficiency. * Analyzed various loss components: shell losses, blowdown losses, and stack losses due to flue gas temperature and combustion inefficiencies.  Key Learnings**Systems Approach**  * Recognized the importance of a holistic view when optimizing steam systems. * Noted that optimizing elements such as blowdown control can improve boiler efficiency while reducing resource input.  **Boiler Efficiency Tools**  * **Direct Method**: Evaluates efficiency using steam mass flow, enthalpy change, and fuel characteristics. * **Indirect Method**: Focuses on loss quantification and subtracts all heat losses from 100% to estimate efficiency.  **Stack Loss Analysis**  * Understood the influence of flue gas temperature, oxygen content, and fuel type on stack loss. * Learned to use tools such as stack loss calculators to assess heat losses more accurately.  **Fuel Properties**  * Differentiated between Higher Heating Value (HHV) and Lower Heating Value (LHV) in fuel assessments.  Challenges  * **Thermodynamic Calculations**: Applying enthalpy and entropy values from steam tables in practical scenarios proved complex and required additional practice. * **Blowdown Loss Estimation**: Initially found it challenging to calculate blowdown flow rates based on conductivity ratios. * **Stack Loss Tables**: Needed to cross-reference multiple parameters, such as flue gas oxygen levels and temperatures, to interpret values accurately.  Practical Applications  * **Case Study Insight**: A real-world example of steam optimization demonstrated a significant reduction in fuel costs through boiler performance improvement. * **Instrumentation Importance**: Reinforced the need for tools like thermal imaging and stack gas analyzers in diagnosing inefficiencies in steam systems.  Next Steps  * Continue exploring the **Steam System Assessment Tool (SSAT)** to model system upgrades such as fuel changes or steam turbine integration. * Study sections on advanced topics like heat recovery, blowdown automation, and deaerator performance. * Practice indirect boiler efficiency calculations and apply SSST to a case study for scoring system practices.  Concept Review: Energy Efficiency Factors To support ongoing energy audit work, I also reviewed key operational factors used in both electrical and mechanical systems: **Demand Factor**  * Ratio of maximum demand to total connected load. * Helps size equipment more accurately by reflecting true usage patterns.  **Diversity Factor**  * Ratio of the sum of individual peak demands to the system’s peak demand. * Indicates time-based variability and reduces the need for oversizing.  **Load Factor**  * Ratio of average load to peak load over a period. * High load factors suggest efficient energy use; low ones indicate sporadic demand.  **Utilization Factor**  * Ratio of actual use time to total available operating time. * Provides insight into how frequently equipment is actually running.  **Duty Cycle (Duty Factor)**  * Percentage of time a system or load is active during an operational cycle. * Key in estimating heat buildup, wear, and energy draw. | | | |
| **Week 8:** | | | |
| **From:** | **16-3-2025** |  | **20-3-2025** |
| 1. Weekly Summary  * **Manual Review**: Completed a thorough review of the *EcoPhi Advanced and Pro Box Installation and Setup Manual* to ensure compliance with connection protocols (LAN/SIM/Wi-Fi), sensor installations, and inverter configurations. * **Daily Reports**: Compiled daily monitoring updates, tracking system performance and offline/error states. * **Site Visits**: Conducted on-site inspections to troubleshoot offline devices and validate sensor installations (e.g., AC clamps, energy meters). * **Heat Pump Commissioning**: Successfully commissioned a new heat pump system, ensuring integration  2. Key Issues Identified  1. **Alwazir System**:    * Offline since March 21. 2. **Petra Inverter 1**:    * Persistent high deviation in energy output.    * RS485 connection stability and sensor calibration      * + **Alalami System**:   + Remains offline.  3. Actions Taken  * **Heat Pump Integration**:   + Installed sensors for real-time monitoring.  4. Next Steps  * Prioritize on-site diagnostics for Alalami to resolve LAN/Wi-Fi connectivity. * Coordinate with EcoPhi Support (Section 8) for advanced troubleshooting of Petra Inverter 1 deviations. * Validate heat pump data consistency post-commissioning. | | | |

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| **Employability Skills** | | | | |
| During the training, which of the following skills did you improve? | | | | |
| **Example** | **N/A** | **No** | **Yes** | **Employability skill** |
| calling customers | ☐ | ☐ | ☐ | Communication |
| writing monthly reports and operation, and maintenance as well as energy audits | ☐ | ☐ | ☐ | Team Work |
| Designing PVs, on-grid, off-grid and hybrid systems | ☐ | ☐ | ☐ | Problem-Solving |
| Setting a fixed study schedule for technical topics like energy audit tools. | ☐ | ☐ | ☐ | Self-Management |
| At the start of the week, outlining which technical concepts | ☐ | ☐ | ☐ | Planning & Organizing |
| Simulates PVsyst performance and using AutoCAD and KEW that help identify savings opportunities. | ☐ | ☐ | ☐ | Technology |
| reading about HVAC,Heat pumps and Energy audits, as well as learning about the laws, regulations, and codes governing photovoltaic (PV) systems in Jordan. | ☐ | ☐ | ☐ | Learning |
| Identifying Optimization Opportunities | ☐ | ☐ | ☐ | Initiative & Enterprise |

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| **Conclusions.** | | | |
| **Training effect on your knowledge** | | | |
| learnt a lot about energy auditing and some of the mechanical sector as well as designing PVs | | | |
| **The training effect on your hands-on experience** | | | |
| very effective, learned a lot from a hands-on experience | | | |
| **Training effect on your soft skills** | | | |
| Affected my soft skills. | | | |
| **Feedback on the training site and the training experience** | | | |
| Very good training, it was a good experience. | | | |
| **References** | | | |
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| **Appendix (Attach necessary documents here if applicable)** | | | |
| 15-4-2025 | Date | Ahmad Barakat | Student signature |