Empowering Energy Efficiency Awareness through a Holistic Educational Approach

ENERGEIA

(Østfold University College/Høgskolen i Østfold)

TITLE: Successful projects on RES and Energy Efficiency in EEA & Norway Grants in the frame of the Energy Programme Romania

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Abstract: This newsletter presents two successful projects on renewable energy sources (RES) and Energy Efficiency in EEA & Norway Grants in the frame of the Energy Programme in Romania. The first project entitled "Sun Power cooperation fusion for cheaper Electrical Devices manufacturing – SPEED" was successfully closed this year in September and have had 3 partners, one from Romania, S.C. Amiras C&L Impex SRL, and two partners from Norway, Østfold University College and NxTech SA. The focus area was Renewable Energy/Increased Renewable Energy production. One of the project contributions was to reduce the CO2 emissions by installing and putting into operation a number of 7 new PV installations with a total estimated installed power of: 129.44kWp and the potential to reduce 47.04Tones of CO2 emissions. The second project was entites "Modern Solar powered Furniture Manufacturing" and the project promoter was SC e-Laborator Feeria SRL. One of the objectives of this project was to build a Microgrid based RES for energy security in a hybrid and modular way. The PV installed power on DC side was 130kWp, AC conversion was 90kVA+40kVA and the storage system capacity was 100kWh. Another important objective of these projects was to strengthening bilateral cooperation between Romania and Norway partners and to create and develop a strategic partnership.

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1. INTRODUCTION

This paper/newsletter presents the results of success stories financed by EEA & Norway grants in the framework of the Energy program in Romania with the goal of decarbonizing industrial sites. To increase and optimize PV (Photovoltaic) usage absorption and to incorporate energy efficiency solutions in SMD (Surface Mount Device) manufacturing, we can consider various models and use cases tailored to eco-design principles. Below are some approaches, solutions, and ideas to achieve these goals [5-10]:

PV System Optimization Model: Development of a model predictive that analyzes weather data, solar irradiance, and the manufacturing facility's energy consumption patterns to find the best location and to optimize the PV system size and placement. The model can be used to determine the optimal capacity of PV panels, their angles, and locations for maximum energy absorption throughout the year.

Smart Grid Integration: Implementing a smart grid system that integrates the PV system with the manufacturing facility's energy demand. Use real-time data and predictive algorithms to ensure the maximum utilization of solar energy when it's available and switch to grid power only when necessary.

Energy Storage Solutions: Designing a model that integrates energy storage solutions, such as batteries or supercapacitors, with the PV system. The model should optimize energy storage and discharge strategies to ensure smooth power supply during peak energy demand periods and non-sunlight hours. Storage systems at the utility customer level can also result in significant savings to businesses through smart grid and Distributed Energy Resource (DER) initiatives, where cars, homes and businesses are potential stores, suppliers and users of electricity.

Energy Management System: Developing an energy management system (EMS) that monitors and controls the energy consumption of different manufacturing processes. The EMS can optimize energy usage by scheduling energy-intensive tasks during solar peak hours and low-demand periods.

Eco-Design Guidelines for SMD Manufacturing: Creating eco-design guidelines for SMD manufacturing processes and products. These guidelines should focus on reducing energy consumption, minimizing waste, and using environmentally friendly materials. Incorporate life-cycle analysis to assess the environmental impact of products from raw material extraction to end-of-life disposal.

Renewable Energy-Powered SMD Manufacturing: Establishing a manufacturing unit that is solely powered by renewable energy sources like solar PV and wind turbines. Optimize energy consumption by adopting energy-efficient machines and processes. This model serves as a showcase for sustainable manufacturing practices.

Collaborative Supply Chain Efforts: Collaborating with suppliers to ensure the components used in SMD manufacturing adhere to energy efficiency standards. Work together to optimize transportation logistics to reduce emissions and energy consumption.

Employee Engagement and Awareness Programs: Implementing awareness programs to educate employees about energy conservation and eco-design principles. Encourage energy-saving habits and gather ideas from employees to improve energy efficiency in the manufacturing facility.

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Circular Economy and Recycling Initiatives: Integrating circular economy principles into the manufacturing process, where materials are reused, remanufactured, or recycled. This approach reduces waste generation and conserves energy used in raw material extraction and processing.

Performance Monitoring and Feedback Loop: Establish a performance monitoring system that tracks energy consumption, PV system output, and overall energy efficiency. Use the data to continuously improve the models and processes, setting performance targets, and providing feedback to stakeholders.

By implementing these models and use cases, SMD manufacturing can significantly increase its energy efficiency, optimize PV usage, and move towards a more sustainable and environmentally friendly production process.

1.1. Microgrids as a feasible solution for energy security assurance

The main topics addressed in these projects were:

- Greening industrial sites
- Energy security assurance
- Self-consumption

1.2 A short description of the SYSTEM

Microgrids are small-scale, low-voltage power systems with distributed energy sources, storage devices and controllable loads. They are operated connected to the main power network or “islanded” in a controlled, coordinated way. The operation of microgrids offers advantages to customers and utilities by improving energy efficiency, reducing transmission and distribution losses, improving reliability, reducing environmental impact, improving network operational benefits, and providing more cost-efficient electricity infrastructure replacement. (Gartner Glossary definition)

By 2035, microgrids are envisioned to be essential building blocks of the future electricity delivery system to support resilience, decarbonization, and affordability. (Microgrid Program Strategy, US DOE)

The main components of a microgrid are:

- Distributed Renewable Energy Sources (RES) like: PV, Wind, microHydro, CHP
- Storage (AC or DC coupled) can be short term (solid state or chemical electric batteries) or seasonal storage (gravitational, hydraulic dams, hydrogen)
- Flexible loads (HVAC, auxiliary machinery and services)

2. SELF-CONSUMPTION GREEN FURNITURE MANUFACTURING

e-Laborator ™ is Romania’s leading manufacturer and supplier of laboratory furniture, chemical fume hoods and other solutions. Founded in 2004, the company’s main beneficiaries are schools, colleges and universities, research institutes, hospitals, water treatment and many other plants, pharmaceutical companies and other private contractors.

<u>The project</u> aimed at laboratory furniture manufacturing production cost reduction based on energy use from RES for lower Grid dependence and higher Energy Security.

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Identified needs

1- Total energy costs: to ensure safe and standardized working environment in the factory, combined with additional installations (special air exhaust, filter and recovery installation, large air compressors, a.o.) need to be powered on top of the CNC production machines. These raise the production cost and the effort to obtain standardized products which is not competitive in the Romanian market.
2- Electrical energy security: due to local grid insufficiency (weak Grid) the factory suffers frequent blackouts. These disrupt normal operations resulting in losses: materials, machine parts and accessories as well as in production delays. The estimated costs of these events are 10% higher than the production cost.
3- Electrical energy quality: poor voltage characteristic influences the proper operation of CNC machines and other factory equipment, there were recorded numerous situations in which parts were failing, incurring additional replacement costs. These events impact the average annually Operational Expenditures OpEx of the PP.
4- No Energy Management System: no automatic control for electricity power distribution / consumption optimization. Energy efficiency is an underling politic at EU level; the company strives to achieve higher levels by using efficient machines. Despite all the efforts, production costs are still high due to machines' long amortization period.
5- Minute awareness at stakeholder's side, local and regional level, about Energy efficient measures and Renewable Energy Sources benefits.

Technical solutions

1- Renewable Energy production for Self-consumption with minimum Grid dependency. A photovoltaic small-scale generator can be sufficient, provided enough storage exists on site for cloudy days situations. The estimated roof-top photovoltaic capacity at the PP site is over 200kWp, additional solar tracker-based installations can be considered. For present basic needs, our advising engineers concluded that a 120kWp PV generator is enough to cover present and short-term foreseen demands.
2- Reconfiguration of the Local Energy System (LES) by separating critical loads in behind UPS type system. An inverter based 3-phase system with LFP battery storage could cover essential production machines' energy consumption for at least 1h of operation. The estimated peak power to be provided on a short time basis was calculated (at 0.9 pF): CNC1 11.5kW, CNC2 17.1kW, CNC3 25.65kW, air compressor 11kW; total: 65.25kW. Estimated operating energy need / nominal cycle: 33kWh for 1h backup time.
3- The proposed technical solution can regulate weak voltage from the main Grid with support from the batteries. Strain imposed on stationary batteries in this scenario eliminated lead-acid technology from consideration, thus the use of lithium-iron-phosphate (LFP). By separating sensitive loads behind the inverters cluster, some degree of power quality will be achieved. It should be investigated if a power factor corrector or an active harmonics filter is needed.
4- Interconnection of all systems into proper energy management. Such EMS could also automate shut down procedure of critical equipment in case of low state of charge. The EMS could further enhance the energy efficiency (get greener) by exploiting the storage in an economical manner (in

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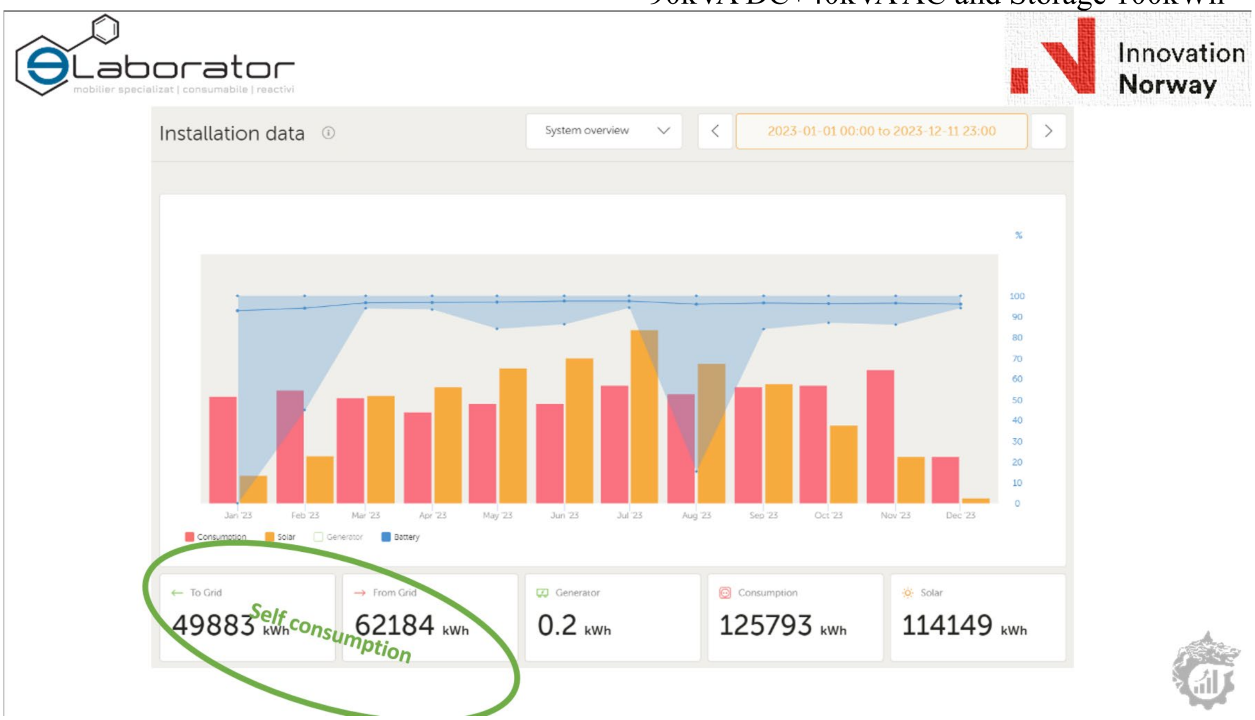
case of too many cloudy days, it can use over-night charge from Grid at low price). The EMS could balance all energy sources year around to assure total energy needs and peak Demand Response.

PV Generator 130kWp

Containerized Power conversion
90kVA DC+40kVA AC and Storage 100kWh



1 full year monitored performance data.

3. SELF-CONSUMPTION GREEN LED STREET LIGHTS MANUFACTURING

Founded in 1992 the AMIRAS Company retained its valor in providing energy efficient solutions. The company's main activities are closely related to product research & development, design and development of electrical low/high voltage grids and power supplies, efficient public lighting solutions, production of electronic devices and manufacture of modules, lamps and LED lighting fixtures including the electronic devices for the control and command. Starting from 2012,

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based on an EU funded project, AMIRAS built a production line for LED lighting products. By current research, development and innovation activities, the company produces its own branded or cobranded (Osram) products. In its portfolio, there are several nationally recognized patents over LED street lamps, power electronics devices for lighting, remote communication devices and infrastructure for smart public lighting networks.

The need

Since the Waste Electrical and Electronic Equipment (WEEE), Restriction of Hazardous Substances (RoHS) and Ecodesign for Energy using Products (EuP) directives were passed by the European Union (EU), green supply chain management has been adopted as a proactive strategy by leading electronic industry companies. These are the main targets of AMIRAS, aligning by EU guidelines and regulations, in a day-by-day more competitive market.
The vast majority of electronics production, from chip making to final assembly, is concentrated in Asia, particularly in mainland China, but also in South Korea, Taiwan, Japan, and Vietnam. Electricity generation in all these countries is predominantly reliant on fossil fuels, particularly coal, with access to renewable sources of electricity extremely limited.
AMIRAS took important steps in designing its products in close regard to EU standards. The R&D and the design/engineering teams provide energy efficiency consulting to our customers. The need for a green electricity production for the supply needs of our facilities is closely related to a lower embedded carbon footprint for our products. The need for a more energy efficient and cleaner (better energy quality) local grid is necessary, providing that the high-tech equipment used in our facility requires higher standards in terms of the level of energy security and quality. Considering the inconsistent global energy balance, the need of storage integration along with RES generation is necessary to achieve consistent and sustainable results and for a better RES absorption.

The project's main objective translates to the development of a self-consumption photovoltaic generator. Self-consumption, as described in scientific literature involves the production and storage of energy for its own use. Also, from the scientific literature is well known that the fact the renewable energy sources main downside is the fact that their production is not constant. To assure energy security, one must have multiple energy sources to operate as backup or power assist. A photovoltaic generator coupled with the national distribution grid provides both above mentioned scenarios. When both generators are weak (PV and grid), seasonal stored power could cover peak loads. Considering the load profiles measured in AMIRAS manufacturing facilities, the engineers identified "windows" of idle consumption in between specific production cycles. These inconsistencies will be covered by the seasonal storage.

The SCADA system will ensure proper operation and precise energy vectors alignment (generation/storage). This system will constantly monitor the 3 generators, the national distribution grid and the Microgrid loads. Decisions will be made automatically in real-time based on predefined user input scenarios and forecasting of energy production/consumption. This system is described in scientific literature as SCADA/EMS (Supervisory Control and Data Acquisition / Energy Management System).
From an innovation aspect standpoint, the entire solution described above does not exist anywhere

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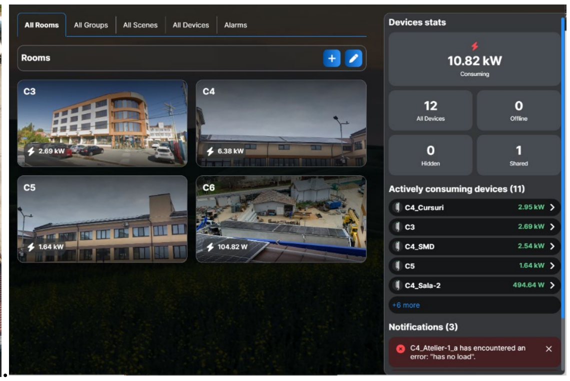
on the market as a single product/solution. Particular innovative aspects are identified in:
- Photovoltaic energy generation with storage for seasonal usage in the manufacturing process;
- Scheduled manufacturing workloads in sync with the Energy Management System;
- ERP interconnection with EMS to achieve optimized annual energy balance;
- Optimal seasonal storage usage interconnected at SCADA level with the Local Energy System;
- RES energy production forecast in EMS operation for scenario-based decision making;

PV Generator 140kWp



EMS system dashboard

Technical room for Power conversion (90kVA) and storage (LiFePo4 100kWh)

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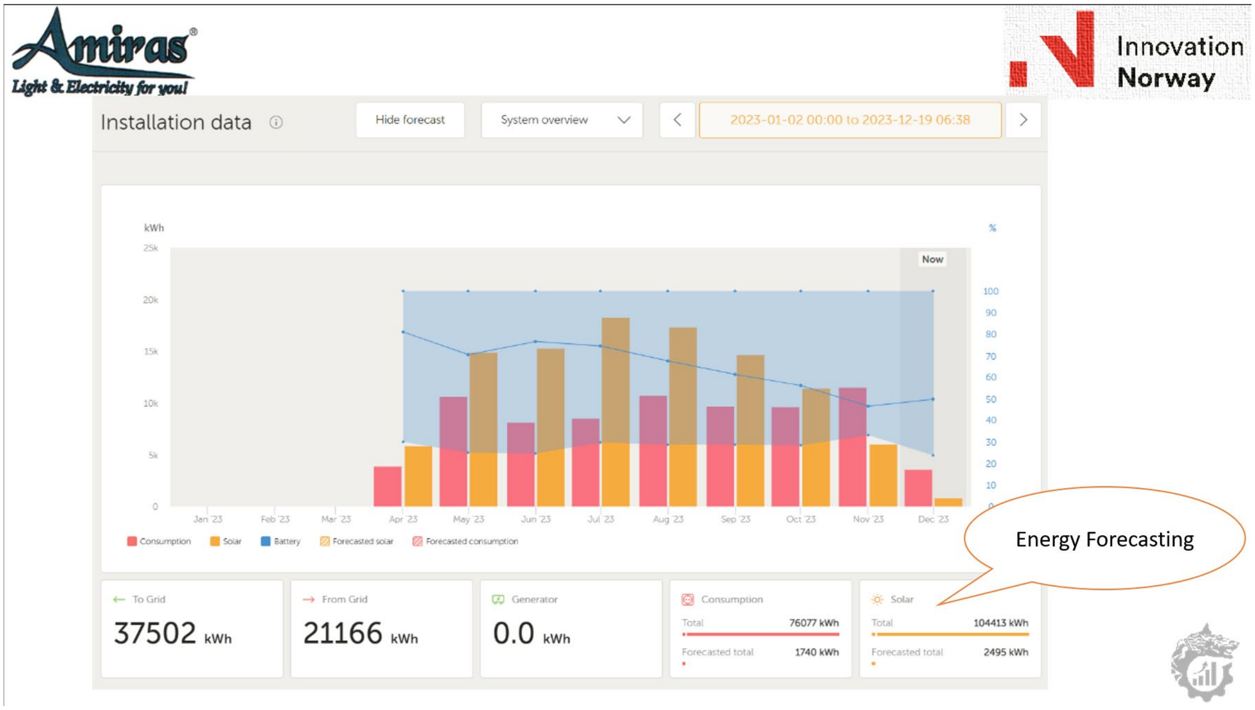

Monitored system performance with energy generation forecasting and consumption prediction.

Conclusion: The integration of the EMS with the Manufacturing ERP system enhances the manufacturing facility's ability to optimize energy usage, reduce costs, and improve overall efficiency. It enables data-driven decision-making, leading to a more sustainable and financially competitive manufacturing operation. Lowering the production cost of LED street lighting luminaires using eco-design techniques involves a comprehensive approach that considers material selection, manufacturing processes, product design, and end-of-life considerations. By implementing eco-design techniques across the product lifecycle, LED street lighting luminaire manufacturers can not only reduce the production cost but also enhance their environmental sustainability and market competitiveness. An eco-conscious approach leads to benefits beyond cost savings, including brand reputation, customer loyalty, and alignment with global sustainability goals. Installing a solar PV system to generate renewable energy for the production process and EV charging will reduce reliance on grid electricity and lowers carbon emissions associated with energy consumption. Combining the PV system with battery storage to store excess energy and use it during peak demand periods can also provide backup power during grid outages and improve energy efficiency.

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