

**STRESZCZENIE W JĘZYKU ANGIELSKIM - SYNOPSIS**

**CZĘSTOCHOWA UNIVERSITY OF TECHNOLOGY  
FACULTY OF MANAGEMENT**

**Ph. D. DISSERTATION**

**PROJECT MANAGEMENT OF PHOTOVOLTAIC POWER PLANTS  
IN ENERGY EQUIPMENT MANUFACTURING COMPANIES**

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In the current reality, no matter what industry you operate in, project management is becoming increasingly important and this is undoubtedly a continuing trend. This is influenced by the diversity and multifaceted nature of tasks, as well as the number of projects to be delivered. Efficient management does much more than keep the iron triangle of management (time, budget and project scope) in check; it also increases productivity and overall quality of work, reduces project risks, improves relationships and increases customer satisfaction, as well as provides competitive advantage. From an entrepreneur's perspective, investment projects are particularly important because they carry the greatest risk. One example of such projects is investment in Renewable Energy Sources (RES). Since 2017, a very dynamic development of the RES industry can be observed, not only in Poland but also worldwide. According to data from July 2022, the largest share in this sector in Poland is accounted for by photovoltaic installations (10.6 GW), wind farms (7.5 GW), biomass (9.6 GW), biogas plants (2.6 GW). Due to the dynamics of this segment and the significant amount of new investments, the market for their financing by banks and other financial institutions has developed relatively slowly. Many foreign investors with global experience and funds started to invest in Poland, buying projects at the RTB (ready to build) stage, then entering into cooperation with local general contractors to build and commission the plant, and after the project was completed, concluding O&M (operation and maintenance) contracts to service the plant during its operation. However, on more than one occasion it was found that a significant proportion of the projects had been carried out in a careless and unprofessional manner and had been taken to the RTB stage for the sole purpose of quick disposal. Usually, in such cases, the developer would charge the general contractor with problems in the project, such as the lack of a grid connection point, waste on the plots intended for construction, archaeological work, unexploded ordnance left over from the war, the lack of an easement from the project to the connection point, which made it impossible to connect to the grid, or even the lack of access roads, resulting in additional costs and shifting responsibility for the many months of missed deadlines set for the construction of the project and its commissioning.

Having observed and actively participated in such processes, both as a general contractor of PV installations and as an entrepreneur in ELQ S.A., a company that has been thriving in the RES industry for years, the author of the dissertation decided to consolidate all the processes involved in creating a PV installation, from the moment of its conception, through construction and commissioning, to O&M service for the entire period of its operation, i.e. 25- 30 years. An undeniable advantage in this process is the fact that ELQ S.A., a company owned by the author, has been manufacturing transformer substations, which are the 'heart of a PV power plant', for almost 50 years, which allows them to be equipped with additional devices at the manufacturing stage, which

support the operation of the entire installation, but also allow for full control of the operation of the entire investment. The company has therefore started the process of project development, which is defined as the design of an investment from the very beginning, i.e. the lease the land, up to the moment of obtaining a building permit.

Linking the process of development, general contracting, energy equipment manufacturing, measurement and commissioning, and O&M services was supposed to eliminate the problems that could arise in the subsequent stages of the project. However, during the implementation phase, it became apparent that many processes had been incorrectly adopted, which continued to cause problems in the implementation of photovoltaic power plant projects. The multitude of tasks, the complexity of the issues and the correct approach to the topic of RES project management require many changes and analyses, and this is what prompted the start of the dissertation, which is intended to result in the solution of many of the problems encountered so far by all participants in all processes.

With the motives for taking up the topic of the study thus defined, the fundamental objective of the study and three specific objectives were formulated: theoretical-cognitive, empirical and utilitarian.

**The primary objective** was to identify, analyse and evaluate procedures for the comprehensive management of photovoltaic power plant projects in power equipment manufacturing companies. The theoretical and cognitive objective was to carry out a literature search on project management methods and tools, with particular emphasis on investment projects in the energy market, in the segment of renewable energy sources (RES).

**The empirical objective** was to determine and evaluate the basic functions and determinants of photovoltaic power plant project management in energy equipment manufacturing companies.

**The utilitarian objective** was to implement the developed procedures for the management of photovoltaic power plant construction in power equipment manufacturing companies, and to verify these procedures under the real conditions of the SPV 200 photovoltaic power plant construction.

**The utilitarian objective** is a case study of the implementation and verification of the research results obtained in the research process within the realisation of the doctoral dissertation.

With the objectives of the dissertation thus defined, a main hypothesis and supporting hypotheses were formulated. **The main hypothesis** of this dissertation is that: **A unified and focused approach to the management of photovoltaic power plant projects in both the development and execution phases ensures and determines the diffusion of RES investments**

**and thus the development of energy equipment manufacturing companies.**

Two research hypotheses were identified to extend and detail the main hypothesis: **HB 1.** *Expanding an offer of energy equipment manufacturing companies to include the design and implementation of photovoltaic power plants reduces the risk of the investment at each stage of its implementation from conception to commissioning.*

and

**HB 2.** *Investors in photovoltaic power plants currently expect power equipment manufacturing companies to provide a comprehensive solution in the development and implementation phases.*

The implementation of the formulated objectives of the doctoral dissertation and justification of the adopted research hypotheses were carried out using two research techniques, i.e. CAWI (Computer Assisted Web Interview) and PAPI (Paper & Pen Personal Interview). The first stage was an invitation to participate in the study in the form of an interview by sending a questionnaire or questionnaire via the Internet and completing it online by the respondent, which is currently the fastest growing technique due to the possibility of reaching a large number of people. The second stage was a face-to-face PAPI interview, which is the most commonly used method of data collection in market research as it offers the possibility to conduct extensive interviews. This stage took place in the form of an expert interview using a survey questionnaire on 'Project management of photovoltaic farms in power equipment manufacturing companies'. The invitation to participate in the survey was accepted by 24 of the 38 invited subjects, representing 63.2%.

As a result, the research sample consisted of 24 RES farm manufacturing companies in Poland.

The dissertation consists of an introduction, 5 main chapters, a summary, a bibliography, a list of figures and tables, and three appendices. Chapters 1, 2 and 3 are the theoretical and cognitive chapters, chapter 4 is the methodological and utilitarian chapter, and chapter 5, is the case study and utilitarianism of the dissertation research results obtained.

In particular, Chapter 1 focuses on the issue of project management in business organisations, discusses the taxonomy and classifies investment projects in business organisations, presents project management approaches as well as various project management methodologies.

Chapter 2 presents methods and tools supporting project management, defines and discusses the project maturity of an organisation, reviews and describes approaches and methodologies in project management, also evaluates IT tools supporting project management, and presents methods for scheduling and controlling project tasks.

Chapter 3 focuses on the issue of investment project diffusion in the energy market in the RES segment. The structure of the RES market and multidimensional investment support mechanisms are presented, the determinants of RES investment projects in the investment and execution activities of energy companies are identified, and the issue of comprehensive project management in relation to the value of energy companies on the execution side is discussed.

Chapter 4 summarises and analyses the survey of PV power plant contractors in Poland. The survey sample is defined, PV power plant investment project management is assessed in the surveyed companies, approaches and procedures in PV power plant project management are analysed and stimulants and barriers in PV power plant project management are described.

Chapter 5 is a case study of the SPV 200 project. The chapter identifies methods and tools to support the management of PV farm projects, describes management procedures and verifies PV power plant design procedures, based on a model project developed under real conditions with the support of an Expert Panel.