

Chapter 72

Modern Optimization Algorithms and Applications in Solar Photovoltaic Engineering

Igor Tyukhov

All-Russian Research Institute for Electrification of Agriculture (VIESH), Russia

Hegazy Rezk

Minia University, Egypt

Pandian Vasant

Universiti Teknologi PETRONAS, Malaysia

ABSTRACT

This chapter is devoted to main tendencies of optimization in photovoltaic (PV) engineering showing the main trends in modern energy transition - the changes in the composition (structure) of primary energy supply, the gradual shift from a traditional (mainly based on fossil fuels) energy to a new stage based on renewable energy systems from history to current stage and to future. The concrete examples (case studies) of optimization PV systems in different concepts of using from power electronics (particularly maximum power point tracking optimization) to implementing geographic information system (GIS) are considered. The chapter shows the gradual shifting optimization from specific quite narrow areas to the new stages of optimization of the very complex energy systems (actually smart grids) based on photovoltaics and also other renewable energy sources and GIS.

INTRODUCTION

All processes in surrounding material world and life on Earth are driven by energy. Vaclav Smil, author of many books on energy, wrote: "...energy's role in world history seems to be a natural proposition, with history seen as a quest for increased complexity made possible by mastering higher energy flows" (Smil V., 2004). This may be because of an extraordinary difficulty and exceptional nature of the coming energy transition—but, given the enormous challenges of ushering in a post-fossil world, it may also

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be because of the possibility of an unprecedented and persistent commitment to a rapid change (Smil V., 2010).

Any process can be analyzed in terms of its underlying energy conversions; any object, as well as any bit of information, can be valued for its energy content and for its potential contribution to future energy transformations (Smil V., 2008).

Energy and information are including in the infrastructure of whole activity of modern humankind. Energy and communicative revolutions are the main driving forces in the human development. Education and information are also connecting by very strong relationship. Very often these technologies are considered separately. It is totally incorrect and inappropriate. Table 1 shows roughly the main steps of appearing the new energy, communicational and educational technologies.

Before the industrial revolution, our energy needs were modest. The level of development civilization is characterized by the rate of liberation from nature influences. The history of civilization and liberation from nature influences is the history of new types of energy conquest.

This work is stimulated by the modern trends or diffusion in developing the most important sphere of humankind activity – energy and new computer technologies. Last decades traditional electrical power industry, which basic principles were formed more than hundred years ago, is changing and transforming very fast.

Table 1. Energy, communicative and educational revolutions

Years Ago (Very Approximately)	Communicative and Educational Revolutions	Energy Revolutions	Stages of Development
10 ⁶	Oral communication through language	Conquer of fire, biomass	Forming human society based on additional to biological type energy sources Renewable energy – first stage Exchange information between people
10 ⁵	Picture and symbol communication	Solar energy, animal energy	
10 ⁴	Writing (from internal biological memory to external recorded memory)	Wind and hydro energy (from muscles to machines)	
10 ³	Book printing, forming of scientific systems Forming schools and universities	Mechanical energy, Thermal energy (coal, oil, gas)	Using fossil fuels (accumulating solar energy) Human civilization, scientific and technology revolutions
10 ²	System of education Mass media, radio, TV	Steam energy, electrical energy, atomic energy	
10 ¹	Computers, Internet, MOOC	Photovoltaic revolution	Current technology revolution (informatization, robotization, artificial intelligence) Extra planetary activity
Now	Practically total interconnectivity Satellite communication Mobile communication Mass open education	Smart grids, Energy mixt Decentralized energy Space technologies	
Near future	Global earth and near space communication Internet of things Big data technology	Mixt of traditional energy and renewable energy – second stage, new sources of energy Thermonuclear energy Global energy system	Energy and information everywhere Moon and Mars exploitation
Future	Trends of dominating distributed energy and information networks integrating by smart technologies Global technologies and Internet of everything including energy, artificial intelligence		Solar energy for the future of mankind
Far future	Widen areal of mankind from Earth to near space		

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