

Preface

Optimisation of large technical systems development makes it necessary to apply systems analysis and dynamic multi-step optimisation methods to observe reciprocal interconnections of system elements over time and space. A characteristic feature of systems analysis is that for selecting an optimal solution, sophisticated systems must be investigated within the development process. To realize this kind of approach, modelling methods of the existing system development have to be used. They must adequately reflect real systems characteristics and perform system technical, economic and ecological criteria calculation. Besides, effective optimization methods are required to solve optimization tasks with discrete variables.

The authors work at the Laboratory for Power Systems Mathematical Modelling (PSMM) of Institute of Physical Energetics, established in 1969. The sphere of scientific research of the laboratory is dynamic methods for electric power systems development optimization.

Initially, research work embraced medium voltage distribution networks; then it was extended to transmission grid and generation systems. In the nineties of the 20th century low voltage network dynamic development optimizations models were also created and development optimization models of generation systems and medium voltage distribution networks were dispersed. The research was conducted in line with practical problems solution in Latvia, former Soviet Union, Baltic States and European Union, in cooperation with power systems managers and designers.

In this book, with system sustainability we identify the fact that up to now in designing process of electrical power systems not enough attention has been drawn to consequences of the made decisions that must not be ignored. Taking into consideration the above-mentioned, we suggest using dynamic methods in system development sustainability analysis, which allows observing development process and far perspective.

Historically, research focused on dynamic methods elaboration was already initiated in the middle of the 20th century, when R. Bellman worked out his dynamic programming method. Still dynamic programming in direct way may only be used for large systems development tasks if the number of alternative

development actions is not considerable. Then, increasing variable number phenomenon appeared which R. Bellman named as dynamic programming “curse”—the exponential growth of calculation time. The specialists of Laboratory for Power Systems Mathematical Modelling (PSMM) have been working to overcome and clear this “curse” and have developed a new original method—“optimal initial states method” (OIS), which provides opportunity to consider up to 50 alternative development actions and solve real large technical systems development optimization tasks. OIS allows one to comprehensively motivate decisions, through modelling situation and its created consequences, thus evidently helping to select an optimal option. In case of electric power systems, nowadays the decisions must often be made at the state governmental level and under information uncertainty conditions employing fast operable information technologies.

The purpose of the book is to present Laboratory’s valuable long-term experience through elaboration of electric power systems development optimization methods in order to compile the basic principles of these methods and experience realization in practice, so that it might also be used for management of other large technical systems sustainable development with dynamic optimization methods.

The book is intended for engineering scientific and IT researchers, various systems management and operation control specialists and engineering technical staff, systems programmers, as well as for faculty lecturers and students of technical higher educational establishments.

The book is composed of ten Chapters which are divided into three parts:

Basic concepts and definitions—[Chapters 1, 2 and 3](#) (authors Z. Krishans and I. Oleinikova);

Family of optimal initial state methods—[Chapters 4, 5, 6 and 7](#) (authors Z. Krishans and A. Mutule);

Management technology for LTS sustainable development—[Chapters 8, 9 and 10](#) (authors Z. Krishans and Y. Merkuryev).

The first three Chapters review general mathematical basics of a dynamic model of large technical systems sustainable management. [Chapters 4 and 5](#) consider the basic principles of dynamic development optimization methods advancement (optimization area extension). [Chapters 6 and 7](#) examine a set of optimal initial states methods (OIS), considered by the authors as the best system for development optimization. Dynamic systems development optimization methods are discussed in detail in [Chapters 2 to 7](#). [Chapters 8 to 10](#) provide a review of information technology for electric power systems, transmission network and generation sources sustainable development management.

The aforementioned methods have been elaborated in the Institute of Physical Energetics, Laboratory for Power Systems Mathematical Modelling, for electric power systems development planning, including also problem solution on sustainable development management. We consider that these methods may also be employed for other systems sustainable development management. Therefore, we suggest creating dynamic development management systems in the systems with similar development problems. This shall be done now to ensure that the decisions made nowadays be adequate and viable for next generations.

We would be grateful to book readers for all remarks and recommendations. Our contact address is: Laboratory for Power Systems Mathematical Modelling, Institute of Physical Energetics, 21 Aizkraukles Street, LV-1006, Riga, Latvia.

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