Chapter 5
Soft Computing and Computational Intelligent Techniques in the Evaluation of Emerging Energy Technologies

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ABSTRACT
The global warming and energy need requires developing emerging energy technologies for the electricity, heat, and transport markets. The emerging energy technologies aim at increasing efficiency of energy utilization processes from energy sources and diminish CO₂ exhalation. The main aim of the chapter is to exhaustively present soft computing and computational intelligent techniques in the evaluation of emerging energy technologies. In the scope of the chapter, classification of emerging energy technologies, their application trends in the literature, a brief explanation for soft computing and computational intelligent techniques, and literature survey of related techniques on both emerging energy technologies and energy planning are included. Moreover, technique for order performance by similarity to ideal solution, analytic hierarchy processes, and their fuzzy structures are introduced.

INTRODUCTION
Energy is a vital issue for human society and also an important topic for economical development. Energy consumption has physically started with the industrial revolution. In the initial phase of the industrial revolution, steam machine has been utilized to obtain power by using coal. Because of the hard structure of steam machine and environmentally negative effects of coal, new fossil fuels emerged such as gas and crude oil. Comparing with the coal, gas has provided cleaner burning power...
plants and cleaner heating of homes. In addition, crude oil made possible new transportation options such as road vehicle and aircraft by invention of the internal combustion engine (Vanek and Albright, 2008). Nowadays, fossil fuels play an important role in the transport and stationary. However, it is thought that current energy systems are not sustainable since most of the world primary energy use is from fossil fuels (Kajikawa et al., 2007). There are two serious hazards with fossil fuels; the first is that the production of fossil fuel has been predicted to diminish at the middle of this century (Kajikawa et al., 2007; Jefferson, 2006) and the other is that fossil fuels have caused emission of greenhouse gases into the atmosphere and also global warming. Global warming and fossil fuel depletion are two of the most important issues of this century. The considerations of energy security and climate change have increased societal interest in technologies that enable a reduction in the use of fossil fuels. It has been well-recognized that an effective solution to these issues is to develop non-carbon-dioxide-emitting and inexhaustible energy resources and energy technologies (Chen et al., 2009). Recently, discovering of nuclear power have provide both to diminish our dependence on fossil fuel resources, and also to provide electricity without any emissions of harmful air pollutants. Although nuclear power is cleaner than many other forms of energy production and although nuclear energy can be produced in large quantities over short periods of time, nuclear power generates harmful radiation and throwing out of nuclear waste which is produced by nuclear power plants is difficult and expensive. Negative effects of both fossil and nuclear technology, renewable energy technologies became more advanced and the range of their applications became broader (Vanek and Albright, 2008). Therefore, sustainable and renewable energy sources such as sun, wind, geothermal, biomass, wave etc. and emerging energy technologies have been attracted greater interest as an important concept while energy planning of a country. In addition, it is thought that it is an urgent need to develop highly efficient energy utilization processes from energy sources effectively and substitute energy sources since the emerging energy technologies are still in an early phase of development (Jacobsson and Bergek, 2004; Kajikawa et al., 2007). Therefore, recent budgets for governmental research and development (R&D) for energy technologies have increased to support emerging energy researches (Hultman and Koomey, 2007). Moreover, European Union is committed in supporting the development of emerging energy technologies, in improving the use of renewable energy, and in increasing the energy efficiency, to reach global objectives of sustainability, competitiveness, and security of energy supply (Segurado et al., 2009).

When any investment or design decision about energy systems is required, a number of goals or criteria that are local, regional, or global must be taken into account. It is possible to classify these into three categories; (1) Physical goals which meet physical requirements that make it possible for the system to operate. (2) Financial goals which are monetary objectives related to the energy system. (3) Environmental goals which are the objectives related to the way in which the energy system impacts the natural environment. Regional or global impacts include the emissions of greenhouse gases that contribute to climate change, air pollutants that degrade air quality and physical effects from extracting resources used either for materials or energy (Vanek and Albright, 2008). Therefore, the emerging technologies have high degree of uncertainty and it represents the large variety of opportunities that a new technology has to offer. This uncertainty creates opportunities for investors to engage in emerging technologies. Thus, the relation between uncertainty and the decision of investors to engage in emerging technologies is very complex (Mejer et al., 2007). Furthermore, traditional techniques or conventional (hard) computing models may not present an effective solution dealing with the problems in which the dependencies between variables are complex or...