CHAPTER I

INTRODUCTION

Rationale for the study

The increment population in world population, modernisation and industrialisation of society has brought increased demands on energy sources and power production. The usage of the conventional energy sources based on fossil fuels (i.e. coal and petroleum products) began with the industrialisation of the world. Even though useful energy from conventional energy sources is considered to be cheap, the realisation of its undesirable effects on environment and unsustainable nature (i.e. availability for only short time period) has driven the world in search for clean and sustainable energy.

We have to face tremendous changes in our energy supply – a complete change of existing systems has to be organized within the next decades. The talk about the energy revolution is in the daily scenarios – science and research are demanded to present alternative solutions.

Renewable energy sources (RES) answer the search for a non-polluting and inexhaustible (i.e. compared to the time span of human existence) energy source. Renewable energy is a collective term for the energy captured from an energy resource that is replaced rapidly by a natural process such as power generated from the sun, flow of wind, flow of water, biological processes and geothermal heat flows. However, the cost of conversion technologies, converting the freely available RES into useful energy is expensive compared to conventional technologies. Increased concern about environment, rapid depletion of fossil fuels and high rocketing fossil fuel prices has driven the research and development on RES. Decades of research and development have brought the cost of conversion technologies down, simultaneously increasing efficiency and improved system design. Currently, the most promising and economically most feasible alternative energy sources include wind power, solar power, and hydroelectric power.

The study is focussing on the use of solar thermal power plants and its ability to produce two types of energy – electricity and thermal energy. Concentrating solar power plants (CSP) seem to be the most economical solution under circumstances and suitable climate conditions. These conditions are obviously found in the Sun Belt region of our planet, but also tropical condition might be suitable for small scale thermal power plants as shown in first projects in Thailand. This study shows the economies and suitability of these applications.

Purpose of the study

The purpose of this study is to develop models showing the macro-economic suitability of projects using small scale solar thermal power plants. The models will include technical, as well as macro-economic aspects and factors given for the different criteria following their importance for the specific project at its particular site. A verification showing the sensitivity of the result will be the outcome of the study and allow short-term validation of a project proposal.

The study is focussing on the use of solar thermal power plants and its ability to produce two types of energy – electricity and thermal energy. Concentrating solar power plants (CSP) seem to be the most economical solution under circumstances and suitable climate conditions. These conditions are obviously found in the sunbelt region of our planet, but also tropical condition might be suitable for small scale thermal power plants as shown in first projects in Thailand. This study shows the economies and suitability of these applications.

Significance of the study

The energy revolution of today impacts a mighty change in the use of appropriate technologies – CSP systems have the great chance to become the leading technology beside other solar technologies. It also seems to be obvious that within the next decades until 2050, solar energies is the major supplier for the electrical energy. CSP technology would allow to receive also a major part of our demanded thermal energy from the sun. A closer look to this technology seems to be interesting; especially as CSP technology can be transferred to small scale units as well. This work takes a detailed look on the economics of small scale CSP power plants for rural or

decentralized use. A positive result of this work may lead to the fact, that solar thermal power plants get integrated into the normal energy supply system of South East Asia. As newest thoughts and results about the technology are represented within this study, the significance is meant to be high for experts, researches and multiplicators.

Scope of the study

Parabolic trough solar technology is the most proven and lowest cost large-scale solar power technology available today, primarily because of the nine large commercial-scale solar power plants that are operating in the California Mojave Desert. However, no new plants were built during 1991 to 2006 because the cost of power from these plants is more expensive than power from conventional fossil fuel power plants. Several technical feasibility studies were conducted to identify the potential for reducing the cost of energy from parabolic trough solar power plant technology based on the latest technological advancements and projected improvements from industry and sponsored R&D. It has to be emphasized that while comparing between several energy conversion technologies or even within the CSP technologies with or without storage the primary and meaningful parameter is the levelized cost of electricity (LCOE).

Levelized cost of electricity (LCOE) refers to a calculated stream of equal cash flows whose Net positive value (NPV) is equal to that of a given stream of variable cash flows. If a project's levelized annual cash flow is divided by the annual amount of energy produced, the result is referred to as the levelized cost of energy. This result is widely used to compare competing energy sources and normally calculated using constant currency (i.e., in real terms that are net of inflation) [5]. The LEC is the sum of the annual fuel cost, annual operation and maintenance cost and the product of the capital cost times the fixed charge rate.

The LCOE is considered as the most meaningful parameter because the specific investment costs might mislead the readers due to the following reasons

1. Although the specific investment costs for conventional power is lower than CSP technologies, the cost for fuel and hence the Operation and Maintenance (O&M) costs are several fold higher for the conventional systems.

2. The mode of financing and taxation of the power plants also varies for each technology.

3. Even considering within the CSP technologies, a solar field without storage is significantly lower than the field with storage leading to different specific costs for the same technology. But the hidden fact is that the latter plant produces much higher MWh per year than the former. In addition, it needs less O&M for the MWh produced per year.