# CHAPTER 1

# INTRODUCTION

## BACKGROUND

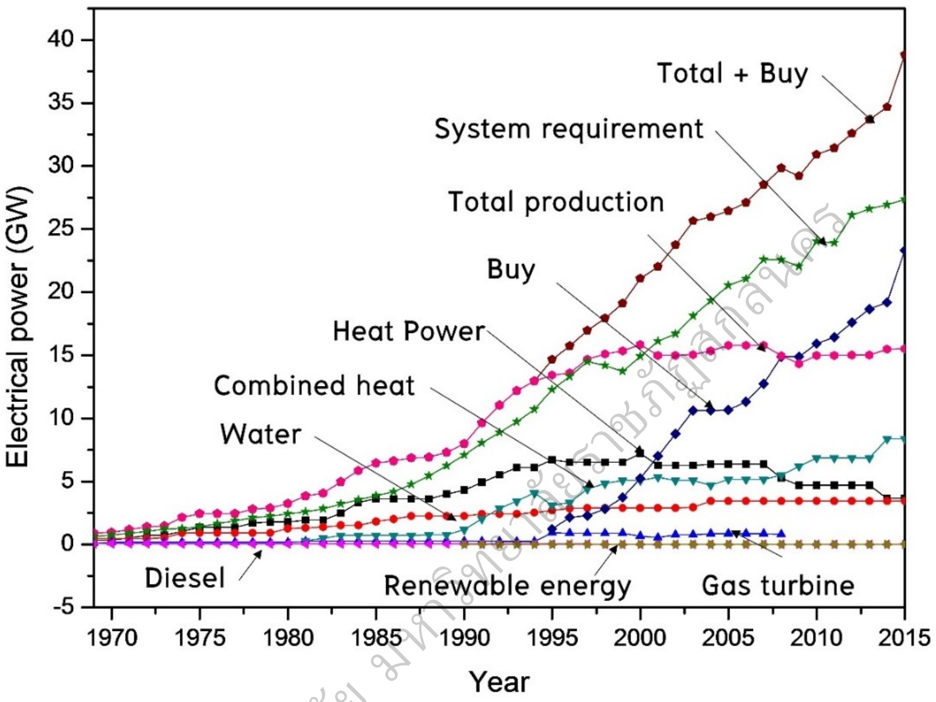


Figure 1 Statistics of an annual production electricity and system requirements from the Electricity Generating Authority of Thailand



Thailand has developed continuously of industry and economy which increases demand for using resources and energy have effect to electric cost. In other hand, the resource for generating electricity decrease fossil fuels as show in Fig. 1. Moreover, the result of continuously burning fossil fuels has affect to generation greenhouse effect causing global warming. Thus finding new generating electricity technology or using renewable energy can help reduce fossil fuels. One is finding new clean, sustainable, high efficient energy sources and optimization. Thus, solar thermal, solar cells, hydrogen technology (fuel cells), wind turbines, vibration, etc. have been developed and enhance efficiency for increase energy source.

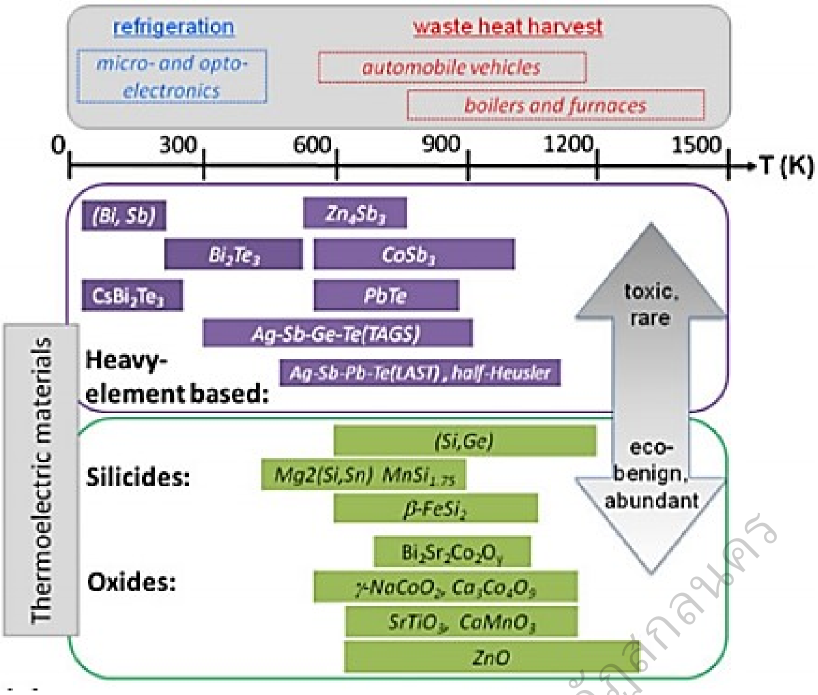


Figure 2 Schematic comparison of various TE materials in terms of the applicable temperature range, abundance and environmental effect (He, Liu & Funahashi, 2011, pp. 1762–1772)

Thermoelectric device can solve this problem. Thermoelectric devices generate electricity from heat (a temperature gradient) on the other hand can created temperature different (hot–could side) from electric power which no moving part and low cost for maintenance. However, commercials TE materials already in practical applications are always based on alloy materials, such as $Bi_2Te_3$, PbTe (Lowhorn, 2011; Hsu, 2004). In comparison with TE alloys materials, metal oxides have advantages in better stability at high temperature, oxidation resistance, less toxic and low cost. However, oxides had not been considered to be candidates as TE materials due to their low carrier mobility, until the work of high performance TE oxide of $Na_xCo_2O_4$, $Ca_3Co_4O_9$. (Funahashi et al. 2006; Ohtaki et al. 1997)

TE device consist of 4 part are p–type material, n–type material, electrode and substrate shown in Figure 3. The p and n materials connected electrically series by using metal electrode on substrate, so that performance of TE device depend on conversion efficiency of a TE materials. The conversion efficiency of a TE materials evaluated by using dimensionless figure of merit (ZT) which is the key in this research. It correlates the three most important proprieties of a TE material, Seebeck coefficient ( $S$ ), electrical resistivity ( $\rho$ ), and thermal conductivity ( $\kappa$ ) as shown in Eq.1.1: (Rowe, 2006, p. 1).

$$ZT = \frac{S^2 T}{\rho \kappa} \tag{1.1}$$

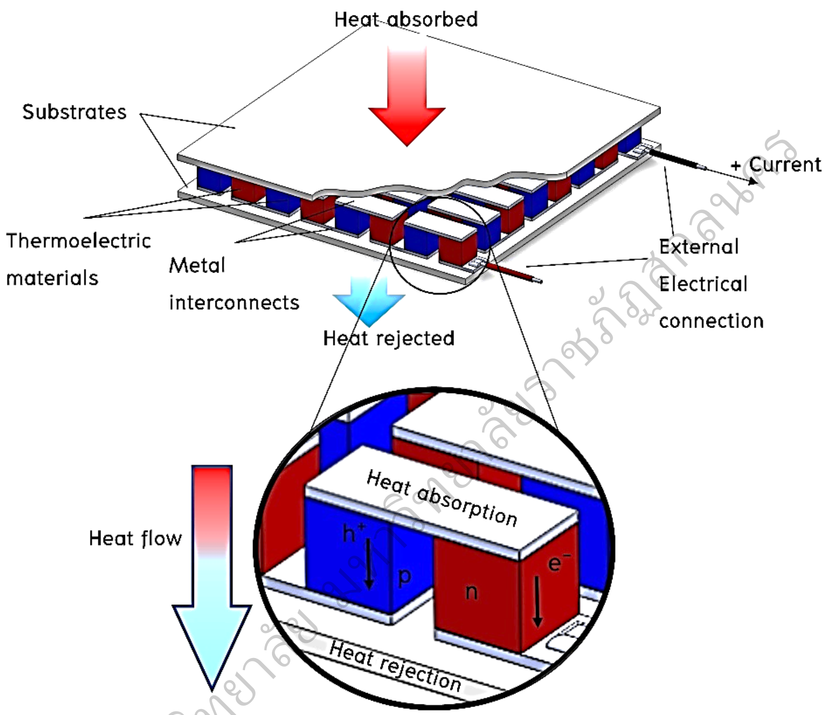


Figure 3 The Schematic illustration of a TE device

The scope of my research in this thesis is to develop all part of thermoelectric module and application with brick furnace. In addition, n-type $CaMnO_3$ TE materials improved by using Bi doping and p-type TE material $Ca_3Co_4O_9$ was added silver (Ag) powder for decrease electrical resistivity and thermal conductivity. TE substrate was fabricated by using silver electrode for connect with TE materials at high temperature. The application for brick furnace was used thermoelectric module for generation electricity to LED lamp in THREERAWUT commerce.

## RESEARCH OBJECTIVE

1. To develop the efficiency of thermoelectric module.
2. To create system of thermoelectric for generating electricity.
3. To apply thermoelectric module for brick furnace heat source.

## SCOPE AND LIMITATION OF THE THESIS

1. The $Ca_{1-x}Bi_xMnO_3$ (x = 0, 0.01, 0.02, 0.03, 0.04 and 0.05) thermoelectric materials were prepared by hot press method.
2. The crystal structure was characterized by XRD, SEM.
3. The thermoelectric power generation was measured by steady state method.
4. The heat source of thermoelectric module was used brick furnace.

## ANTICIPATED OUTCOMES OF THE THESIS

1. The efficiency and durability of the thermoelectric module are improved.
2. A system of thermoelectric can directly conversed waste heat to electricity.
3. The results of this project published in national or international journal or patent.

## THESIS STRUCTURE

The thesis consists of 5 chapters; Chapter 1 introduces, objectives, scope, and limitation, place of work and benefits of this thesis. Chapter 2 reviews the fundamental thermoelectric theory, history and thermoelectric properties of $CaMnO_3$ and $Ca_3Co_4O_9$ as well as fabrication thermoelectric module and applications. The research methodology are presented in Chapter 3. The results and discussion of this thesis are showed in Chapter 4. The conclusion and suggestion for further work are presented in Chapter 5.

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