

# Model-based Development of Thermoelectric Energy Harvesting Systems

Marco Nesarajah



# **Model-based Development of Thermoelectric Energy Harvesting Systems**

## **Modellbasierte Entwicklung von thermoelektrischen Energy Harvesting Systemen**

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## Abstract

The motivation of this work is the study of thermoelectric energy harvesting systems (EHS). The main research focus in the scientific community is on the development of new, more efficient, cheaper and environmentally friendly thermoelectric materials. But besides the material research, the complete development, build-up and optimization of thermoelectric EHSs are also necessary points to be studied. For this reason, this work deals with the **model-based development of thermoelectric EHSs**. The first objective is the modeling and simulation as well as design and controlling of these systems. For this purpose, a library should be developed and published to provide end-users with an easy tool to configure and build-up these systems in a simulation environment (Modelica/Dymola). The second objective is the elaboration and presentation of a development process to support the setup of a thermoelectric EHS. Finally, to show the usefulness of the developed scheme and library, three real application examples will be presented. These are an EHS at a radiator to supply an electronic thermostat valve in an office, the green barbecue and an EHS at a heating mockup of an oil-fired heater.

Diese Arbeit befasst sich mit thermoelektrischen Energy Harvesting Systemen (EHS). Der aktuelle Forschungsschwerpunkt in der Wissenschaft liegt vor allem in der Entwicklung neuer thermoelektrischer Materialien. Diese sollen effizienter, kostengünstiger und umweltfreundlicher sein. Neben der Materialforschung sind jedoch auch die komplette Entwicklung, der Aufbau sowie die Optimierung der thermoelektrischen Gesamtsysteme von hoher Bedeutung. Aus diesem Grund beschäftigt sich diese Arbeit mit der **modellbasierten Entwicklung thermoelektrischer EHS**. Eine erste Zielsetzung dabei ist die Modellierung und Simulation sowie Auslegung und Regelung solcher Systeme. Zu diesem Zweck soll eine Modellbibliothek entwickelt und veröffentlicht werden. Diese soll einem Endnutzer als einfaches Werkzeug dienen um die Systeme in einer Simulationsumgebung (hier: Modelica/Dymola) zusammensetzen und konfigurieren zu können. Die zweite Zielsetzung besteht in der Ausarbeitung und Präsentation eines Entwicklungsprozesses zur Unterstützung des Aufbaus eines thermoelektrischen EHS. Zur Demonstration des entworfenen Entwicklungsprozesses sowie der entwickelten Modellbibliothek, werden abschließend drei reale Anwendungsbeispiele vorgestellt. Dabei handelt es sich um ein EHS, welches an einem Heizkörper in einem Büro angebracht wurde um ein elektronisches Thermostatventil zu versorgen, den „grünen Schwenker“ sowie ein EHS an einem Heizungsnachbau einer ölbefeuerten Heizungsanlage.

# Contents

<b>1</b>	<b>Introduction .....</b>	<b>1</b>
1.1	Problem Definition.....	1
1.2	Motivation and Goals.....	1
1.3	Demarcation of the Work.....	3
1.4	Structure of the Thesis.....	4
<b>2</b>	<b>Basics of Thermoelectric Energy Harvesting Systems .....</b>	<b>7</b>
2.1	Energy Harvesting .....	7
2.2	Thermoelectric Energy Harvesting Systems.....	10
2.3	Thermoelectricity .....	12
2.4	Thermoelectric Device.....	14
2.4.1	Thermoelectric Generator .....	14
2.4.2	Thermoelectric Materials.....	20
2.4.3	Fabrication.....	22
2.4.4	Fields of Application.....	23
2.4.5	Commercially Available Thermoelectric Generators .....	24
2.4.6	Sources of Failure .....	25
<b>3</b>	<b>Multiphysics Simulation.....</b>	<b>29</b>
3.1	V-model Approach .....	29
3.2	Modelica/Dymola.....	30
3.3	Model of a Thermoelectric Device.....	31
3.3.1	Component Design .....	31
3.3.2	Validation .....	33
3.3.3	ThermoelectricGenerator Library.....	35
3.4	Model of a Heat Pipe – HeatPipe library .....	38
3.4.1	Component Design .....	38
3.4.2	Validation .....	41
3.5	Further System Components.....	43
3.5.1	Heat Source .....	43



## Contents

---

3.5.2	Heat transfer.....	43
3.5.3	Cooling Elements.....	44
3.5.4	Electrics.....	46
3.5.5	Controlling.....	47
3.6	Energy Harvesting Library - EHSTEG.....	47
3.7	Modeling Instructions.....	50
<b>4</b>	<b>Development Process.....</b>	<b>51</b>
4.1	Overview.....	51
4.2	Exemplary Development Process.....	54
4.3	Thermal Design.....	56
4.4	Selection of Thermoelectric Device.....	58
4.5	Mechanical Design.....	65
4.6	Electrical Design.....	66
<b>5</b>	<b>Control Concepts.....</b>	<b>69</b>
5.1	System Description and Modeling.....	69
5.2	Cooling Control.....	72
5.2.1	Air Cooling.....	72
5.2.2	Liquid Cooling.....	74
5.3	System Reconfiguration.....	74
5.3.1	Single Thermoelectric Generators.....	74
5.3.2	Pairs of Thermoelectric Generators.....	77
5.3.3	Arrays of Thermoelectric Generators.....	81
5.4	Control Laws.....	82
5.5	Model-based System Assessment.....	82
<b>6</b>	<b>Application Examples.....</b>	<b>87</b>
6.1	Thermostat.....	87
6.1.1	System Analysis.....	87
6.1.2	Development of Energy Harvesting System.....	89
6.1.3	Results and Evaluation.....	92

---

6.2	Green Barbecue .....	94
6.2.1	System Analysis.....	94
6.2.2	Development of Energy Harvesting System.....	95
6.2.3	Results and Evaluation.....	98
6.3	Heating Mockup .....	100
6.3.1	System Analysis.....	100
6.3.2	Development of Energy Harvesting System.....	103
6.3.3	Results and Evaluation.....	107
7	<b>Conclusions and Outlook .....</b>	<b>111</b>
	<b>Appendix.....</b>	<b>113</b>
	<b>List of Figures.....</b>	<b>117</b>
	<b>List of Tables.....</b>	<b>123</b>
	<b>List of Abbreviations.....</b>	<b>125</b>
	<b>List of Symbols .....</b>	<b>127</b>
	<b>Bibliography.....</b>	<b>131</b>
	Publications of the Author .....	131
	References.....	132