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Modeling the Renewable Energy Transition in Canada

Techno-economic Assessments for Energy Management

Springer

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ISSN 2191-5520 ISSN 2191-5539 (electronic)
SpringerBriefs in Energy
ISBN 978-3-319-31503-4 ISBN 978-3-319-31505-8 (eBook)
DOI 10.1007/978-3-319-31505-8

Library of Congress Control Number: 2016934419

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG Switzerland

Preface

The purpose of this work is to demonstrate a techno-economic model (TEM) of power generation for a cost-effective integration of renewable energy sources (RES) in order to reduce greenhouse gas (GHG) emissions in Canada. This will ultimately contribute to reduction of global climate change and will eventually bring a significant benefit for industrial countries.

Canada possesses a variable power generation portfolio in which hydro power has the largest share, followed by fossil fuels, nuclear power, and other renewables. After analysis of the current state of Canadian electricity infrastructure, it can be determined that the National Energy Board of Canada (NEB) is planning for more fossil and nuclear power to overcome its future needs till 2025, in which only 3 % RES capacity will be added. This model has been named as NEBM-2025 in this research.

A techno-economic model (TEM-2025) presented in this work demonstrates that 10 % RES transition is possible, practical, and affordable by using an effective policy till 2025. The methodology used by the author investigates the level of future investment and determines that the country can reduce its heavy reliance on fossil and nuclear fuel and can supply a significant amount of power with RES within a specific timeline. The results of TEM show that 75 % of power can be generated through RES, while reducing 7 % nuclear and 3 % fossil power generation in Canada till 2025. The demand side reliability of wind and PV in the context of intermittency factor has been addressed by utilizing 6823 MW of gas power plants as a standby power. The second and most important goal was to estimate and integrate a significant amount of RES that could potentially be harnessed within the boundaries of available finances without introducing any feed-in tariff or loan-based financial mode. This target has been achieved by periodic simulation of price variations in which all projects could be financed fully, while the total price increase remained less than one CDN $ cent/kWh for only 7 years.

Acknowledgments

The genesis of this book is a renewable energy research work on the Canadian power system, which I have done at Brandenburg University of Technology Cottbus, Germany, and at School of Business Management SCAAT, Toronto, Canada. However, the idea to compile the work in a book form was born in correspondence with Ms. Tiffany Gasbarrini, Senior Editor for Engineering and Energy at Springer New York. My deepest appreciation goes to Tiffany for her excellent cooperation, encouragement, and guidance in a very friendly and efficient manner. My gratitude goes to the whole Springer team, in particular to Brian Halm, Project Coordinator Springer USA, for his comprehensive evaluation and valuable suggestions during the reviewing process.

This book owes its existence to Prof. Dr. Gerhard Lappus, my supervisor at Brandenburg University of Technology, Cottbus, Germany, and my co-supervisor Prof. Dr. A. Naveed Tariq at School of Business Management, SCAAT, Toronto. I am very thankful for their outstanding patience, understanding, and precious time. My thanks are also due to all institutes, utilities, and personalities that helped me to collect the data for this work, particularly to Mr. David Watson at Wind Energy Institute of Canada.

I dedicate this work to my departed mother, Sakina, who made countless sacrifices to ensure that I received a well-rounded education.

I hope that this book will be a vital resource for energy economics, energy policy, and energy planning with the integration of renewable energy sources in Canada and will contribute to maintain an environmental friendly and sustainable planet gifted to all of us by divine providence.

Toronto — Tanveer Ahmed
February 2016

Contents

1 Introduction 1
1.1 Problem Overview 1
1.2 Objective Setup 2
1.3 Roadmap of the Thesis 2
1.4 Data Quality and Approach 3
References 4

2 Case Study 5
2.1 System Introduction 5
2.2 Structure of Future Power 7
2.3 RES Analysis 11
2.4 Findings 13
References 15

3 Methodological Approach 17
3.1 Overview 17
3.2 Recalculation of Future Power Planning 17
3.3 Data Simulation 19
3.3.1 Capacity Factor Calculation 20
3.3.2 Power Generation Calculation for 2025 20
3.4 Cost Profile and Power Adjustment 21
3.4.1 RES Intermittency Control Costs 22
3.4.2 Capital Costs Shift from Nuclear Power into Hydropower 22
3.5 Wind Power Integration 23
3.6 PV Power Integration 25
3.7 Synopsis 27
References 28

4 Energy Management with RES 29
4.1 Summary 29
4.2 Planning Computation Methodology 30
4.3 Project Planning 42
4.4 Investment Planning 42
References 47

5 Conclusion 49

Index 55

Acronyms

%	Per Cent or Percent
AB	Alberta
BC	British Columbia
CDN $	Canadian Dollar
CDN $ Cent	Canadian Dollar Cent
CDN $ Cent/kWh	Canadian Dollar Cent per Kilowatt-Hour
CDN $/MW	Canadian Dollar per Megawatt
CDN Cent/kWh	Canadian Cent per Kilowatt Hour
Cent/kWh	Canadian Cent per Kilowatt-Hour
CF	Capacity Factor
CO_2	Carbon dioxide
EC	Environmental Canada
GHG	Greenhouse Gases
GW	Giga-watt
GWh	Giga watt hour
h	Hour
hrs	Hours
HOMER	Hybrid Optimization Model for Electric Renewables
km	Kilometer
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt hour
kWh/kW	Kilowatt Hour per Kilowatt
MB	Manitoba
MW	Megawatt
NB	New Brunswick
NEB	National Energy Board of Canada
NEBM	National Energy Board Model
NEBM-2025	National Energy Board Model for Year 2025
NL	Newfoundland
NS	Nova Scotia

NT	Northwest Territories
NU	Nunavut
ON	Ontario
P_{ac}	AC Power
P_{dc}	DC Power
PE	Prince Edward Island
PP	Power Plant
PV	Photovoltaic
QC	Quebec
RES	Renewable Energy Sources
SK	Saskatchewan
STC	Statistics Canada
STC	Standard Test Conditions
TEM	Techno-economic Model
TEM-2025	Techno-economic Model for Year 2025
TWh	Terawatt Hour
USA	United States of America
YT	Yukon Territory

List of Figures

Figure 2.1 Power generation by source in each province and territory in Canada in 2013 6
Figure 2.2 Total power generation by source in Canada in 2013 6
Figure 2.3 Power distribution in Canada by sector in 2013 7
Figure 2.4 Import/export and transmission capacity between Canada and USA 8
Figure 2.5 Comparison of installed capacity of future power planning (NEBM-2025) 10
Figure 2.6 Deployment of fossil and nuclear fuel against RES in NEBM-2025 10
Figure 2.7 Sir Adam Beck Hydro Power Plant at Niagara Falls 11
Figure 2.8 Installed capacity of RES Energy Mix Portfolio—2013/14 12
Figure 3.1 Wind speed and net capacity factor in Alberta at 80 m 24
Figure 4.1 New electricity price after integration of RES 2015–2021 47
Figure 5.1 RES, Nuclear and fossil power generation till 2025 by NEBM-2025 52
Figure 5.2 Comparison of TEM-2025 power generation configuration with present power generation 52
Figure 5.3 Projection of price increase under TEM-2025 scenario 53
Figure 5.4 Projection of RES power generation in TEM-2025 scenario 53

List of Tables

Table 2.1 National energy board model for 2025 (NEBM-2025) (Planned installed capacity of power generation) 9
Table 3.1 Calculation of commissioning/refurbishment and decommissioning of nuclear power plants installed capacity till 2025 18
Table 3.2 Calculation of commissioning/refurbishment and decommissioning of fossil power plants installed capacity till 2025 18
Table 3.3 Detail of power generation in 2013 19
Table 3.4 Additional power planned by NEB till 2025 21
Table 3.5 PV hotspots in terms of annual PV potential for south-facing panels 26
Table 4.1 Power planning scenario for year 2015 31
Table 4.2 Power planning scenario for year 2016 32
Table 4.3 Power planning scenario for year 2017 33
Table 4.4 Power planning scenario for year 2018 34
Table 4.5 Power planning scenario for year 2019 35
Table 4.6 Power planning scenario for year 2020 36
Table 4.7 Power planning scenario for year 2021 37
Table 4.8 Power planning scenario for year 2022 38
Table 4.9 Power planning scenario for year 2023 39
Table 4.10 Power planning scenario for year 2024 40
Table 4.11 Power planning scenario for year 2025 41
Table 4.12 Projects-planning scenario for future 10 years 43
Table 4.13 Total RES-installed capacity, power output and costs till 2025 44
Table 4.14 Investment adjustment with reference to price increase (2015–2018) 45

Table 4.15 Investment adjustment with reference to price increase (2019–2021). 46
Table 5.1 Quantification of installed capacity and power generation under present, NEBM-2025 and TEM-2025 scenarios 50