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# Singapore in a Post-Kyoto World

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# Singapore in a Post-Kyoto World

*Energy, Environment  
and the Economy*

TILAK K. DOSHI



**INSTITUTE OF SOUTHEAST ASIAN STUDIES**

*Singapore*

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*To my late father, who made it all possible,  
and to my mother, the most courageous person I know.*



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# PREFACE

Twenty-five years ago, the publicly accessible literature of what can be broadly termed the “energy economics” of Singapore was practically non-existent. Outside of specialized trade publications, proprietary consultant reports and periodic assessments by government agencies often for an internal civil service and ministerial audience, there was little by way of information about how energy issues, at global, regional and domestic levels, were affecting Singaporeans. To be sure, it is also true that the demand for such information primarily emanated from those relative few who “did” energy, that is, those who were in the energy industry as businessmen, academics, or civil servants responsible for some area of activity in the industry.

Energy issues occupied policymakers whose bailiwick include aspects of the energy sector, ranging from managing state-owned power utilities and attracting foreign direct investments in the export-oriented oil refining and petrochemical industry to setting up competitive domestic markets for petrol and diesel. But outside of these government responsibilities, the energy scene in the first decades of independence was primarily a private sector one, revolving around oil. Coal, natural gas, and other primary fuels had little or no role to play in the early years of the city-state. Post-independence government policy with respect to energy sector issues, wrought in an environment which saw the loss of its Malayan hinterland in the Malaysian Federation in 1965, was essentially one of properly managing public utilities, providing a hospitable investment climate for large investments in an export-oriented downstream oil sector, and ensuring a competitive domestic retail market for transport fuels.

Singapore had, by the 1980s, emerged as one of the world’s great oil refining and trading centres, with the “East of Suez” region within its sphere of influence. Yet, little systematic work was done on the country’s role in energy affairs, unique among its developing country counterparts

in Asia, Africa, and elsewhere. The city-state's policymaking went against the grain in much of its practice of economic development. It ensured that energy products were bought and sold in the domestic market at essentially global prices (adjusted for indirect taxes), in contrast to the common practice in developing countries of subsidizing energy fuels for social equity. Without a drop of oil of its own, Singapore also managed to attract large foreign investments in the capital-intensive oil refining and petrochemical manufacturing sectors in an export-oriented strategy. This was at a time when governments of most newly independent countries were busy trying to promote heavy industry by protectionist trade policies and import-substituting industrialization.<sup>1</sup>

The first publicly available report covering Singapore's petroleum industry and ancillary activities such as oil trading and ship bunkering was only published in 1989.<sup>2</sup> It was not until 1997, with the publication of Paul Horsnell's book *Oil in Asia*,<sup>3</sup> that the full range of the city-state's role in the global oil industry was assessed in a focused, analytical manner. In the past decade and a half since Horsnell's book, popular interest in, and concern with, energy affairs, has risen dramatically.

The rise of resource nationalism and the ensuing oil shocks emanating from the Middle East in the 1970s have long been factors of critical concern in energy policy circles. It is only more recently that the environmental impacts of energy use on regional and global climate systems have become of interest to wider sections of a richer and more educated population, both in Singapore and in other countries around the world. For Singapore, the traditional policy focus on "keeping the lights on" and in encouraging manufactured exports in high-value-added sectors (such as petrochemicals) has been expanded to include a myriad of energy-related initiatives that aim to meet the perceived needs of energy security and environmental sustainability while ensuring continued economic growth.

The purpose of this book is twofold. It is intended to introduce a host of energy-related discussions relevant to a wider group of readers who do not "do energy" for a living, yet are keenly interested in understanding the many complexities of modern industrial societies which need to balance economic, environmental, and security priorities of ordinary citizens. It aims to bring to the fore the many aspects of energy choices, in terms of both private behaviour and public policy, affecting Singapore. Comparative examples of energy issues and policy choices in other countries are discussed to set the context for the many similar challenges facing Singapore.

This book is also meant to serve as an introductory assessment of key energy-related issues for those who are planning to enrol in undergraduate courses in energy economics and energy policy studies, with a particular relevance for small advanced countries such as Singapore. The diverse issues affecting Singaporean consumers and businesses in making choices over energy-related economic activity and the role of government in setting an appropriate policy context are brought together within the covers of a single book. Hopefully, the interested general reader need not track down the many specialist journals and reports that focus on narrower aspects of this broad topic. If this book serves as the springboard for informed debate about key energy issues affecting Singapore and its surrounding region, it would have served its purpose.

Detailed notes and references are included for the interested reader to follow up on particular threads of argument. As many of the sections and chapters are based on reports and studies published at different times over the past few years by the ESI Economics Division, some of the data presented in tables and charts are outdated. However, rather than take more time to complete this book, the more urgent need was to have an earlier release. As much of the book is concerned with fast-evolving current affairs in the various areas of energy policy and international negotiations, it is hoped that the issues covered still offer a good guide to the reader interested in contemporary debates in the areas of energy and the environment. The emphasis throughout the book is on the underlying arguments and counterarguments about key issues raised by energy choices facing individuals and governments rather than on the contemporaneity of the data. In those areas of the energy industry which have undergone profound evolution over the past three to five years, the data available are primarily in scattered and varied formats in industry journals. Examples would include the global Liquefied Natural Gas (LNG) and solar photovoltaic (PV) industries. In such cases, much of the discussion is based on the latest data available in current news media and industry reports.

## Notes

1. For an assessment of the city-state's development policies during the tenure of Goh Keng Swee, Singapore's founding "economic architect", see Tilak K. Doshi and Peter A. Coclanis, "The Economic Architect: Goh Keng Swee", in Lam Peng Er and Kevin Tan, eds., *Lee's Lieutenants: Singapore's Oil Guard* (NSW:

- Allen & Unwin, 1999). See also Tilak Doshi and Peter Coclanis, "Goh Keng Swee: the Practicing Economist", *Business Times*, 16 June 2010, p. 20 <<http://www.esi.nus.edu.sg/docs/default-document-library/2010jun16-bt-goh-keng-swee-the-practising-economist.pdf>>.
2. Tilak K. Doshi, *Houston of Asia: The Singapore Petroleum Industry* (Singapore: Institute of Southeast Asian Studies, 1989). Other early studies include Shankar Sharma, "The Changing Structure of the Oil Market and Its Implications for Singapore's Oil Industry", *ASEAN Economic Bulletin* 4, no. 3 (1988): 271–86; Tilak Doshi, "The Energy Economy of a City State: Singapore", in *Energy Market and Policies in Asean*, edited by Shankar Sharma and Fereidun Fesharaki (Singapore: Institute of Southeast Asian Studies, 1991).
  3. Paul Horsnell, *Oil in Asia: Markets, Trading, Refining and Deregulation* (Oxford: Oxford University Press, 1997).

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The views and opinions expressed in this book are not to be attributed to ESI, ISEAS or any other institutions or companies I was, or am, affiliated with. Mistakes and shortcomings in this book are, of course, mine alone.

# ABBREVIATIONS

A*STAR	Agency for Science, Technology, and Research (Singapore)
ADB	Asian Development Bank
AEA	Association of European Airlines
AGD	Aviation Global Deal
AGF	Advisory Group on Climate Change Financing
AOSIS	Alliance of Small Island States
APAEC	ASEAN Plan of Action for Energy Cooperation
APEC	Asia-Pacific Economic Cooperation
APG	ASEAN Power Grid
ARA	Amsterdam-Rotterdam-Antwerp conurbation
ARs	IPCC's Assessment Reports
ASCOPE	ASEAN Council on Petroleum
ASEAN	Association of Southeast Asian Nations
B&L	borrowing and lending
BAU	business-as-usual
BCA	Building and Construction Authority (Singapore)
Bcf/d	billion cubic feet per day
BGSGM	BG Singapore Gas Management
bpd	barrels per day
CAAS	Civil Aviation Authority of Singapore
CAEP	Committee on Aviation Environmental Protection
CAFE	Corporate Average Fuel Economy standards
CAGR	compound annual growth rate
CBA	cost-benefit analysis
CCC	Committee on Climate Change (UK)
CCGTs	combined cycle gas turbines
CCS	carbon capture and sequestration
CDM	Clean Development Mechanism

CEPO	Clean Energy Programme Office (Singapore)
CER	certified emission reductions
CERP	Clean Energy Research Programme (Singapore)
CERT	Clean Energy Research and Testbedding Programme (Singapore)
CHP	combined heat and power
CNG	compressed natural gas
CO <sub>2</sub>	carbon dioxide
CO <sub>2</sub> e	carbon dioxide equivalent
COE	certificate of entitlement (Singapore)
COP	Conference of the Parties (UNFCCC)
DES	delivered ex ship
E <sub>2</sub> PO	Energy Efficiency Programme Office (Singapore)
EAS	East Asia Summit
EASE	Energy Efficiency Improvement Assistance Scheme (Singapore)
EC	European Commission
EDB	Economic Development Board (Singapore)
EEDI	Energy Efficiency Design Index (IMO)
EENP	Energy Efficiency National Partnership (Singapore)
EEOI	Energy Efficiency Operational Indicator (IMO)
EIA	Energy Information Administration (US)
EIPO	Energy Innovation Programme Office (Singapore)
EITs	economies-in-transition
EMA	Energy Market Authority (Singapore)
EPA	Environmental Protection Agency (US)
EPG	Energy Policy Group (Singapore)
EPMA	Environmental Protection and Management Act (Singapore)
ERC	Energy Research Centre (South Africa)
ERI@N	Energy Research Institute @ Nanyang Technological University (Singapore)
ESCAP	Economic and Social Commission for Asia and the Pacific
ESU	Energy Sustainability Unit (National University of Singapore)
ETS	EU Emission Trading System
EU	European Union
EVs	electric vehicles

EVS	electricity vending system
FITs	feed-in tariffs
G-77	Group of Seventy-seven developing countries
G-8	Group of Eight
GATT	General Agreement on Tariffs and Trade
GCF	Green Climate Fund
GDP	gross domestic product
GFA	gross floor area
GHG	greenhouse gas
GIACC	Group on International Aviation and Climate Change
GMS	Greater Mekong Subregion
GNI	gross national income
GREET	Grant for Energy Efficient Technologies (Singapore)
GSA	gas sales agreement
GtCO <sub>2</sub> e	gigatonnes of carbon dioxide equivalent
GTP	Global Trader Programme
GWh	gigawatt-hour
HDB	Housing Development Board (Singapore)
HDI	Human Development Index
HHI	Herfindahl-Hirschmann Index
IA	Investment Allowance Scheme (Singapore)
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICE	Intercontinental Exchange
IE	International Enterprise (Singapore)
IEA	International Energy Agency
IMCSD	Inter-Ministerial Committee for Sustainable Development (Singapore)
IMF	International Monetary Fund
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
IPPR	Institute for Public Policy Research (UK)
IPP	independent power producer
JKM™	Japan Korea Marker
JTC	Jurong Town Corporation
LCOE	levelized cost of electricity
LNG	liquefied natural gas
LPG	liquefied petroleum gas

LTA	Land Transport Authority (Singapore)
MBI	market-based instrument
MEPS	Minimum Energy Performance Standards (Singapore)
METI	Ministry of Economy, Trade and Industry (Japan)
MEWR	Ministry of the Environment and Water Resources (Singapore)
MFA	Ministry of Foreign Affairs (Singapore)
MITI	Ministry of International Trade and Industry (Japan)
MLA	multilateral agencies
mmcf/d	million cubic feet per day
MOF	Ministry of Finance (Singapore)
MOT	Ministry of Transport (Singapore)
MPA	Maritime and Port Authority of Singapore
MRT	mass rapid transit (Singapore)
MRV	measurement, reporting and verification
MTI	Ministry of Trade and Industry (Singapore)
Mtoe	million tonnes of oil equivalent
Mtpa	million tonnes per annum
MW	megawatt
MWp	megawatt-peak
NAMA	Nationally Appropriate Mitigation Actions
NATO	North Atlantic Treaty Organization
NBP	National Balancing Point (UK)
NCCS	National Climate Change Secretariat (Singapore)
NEA	National Environment Agency (Singapore)
NEMS	National Energy Market of Singapore
NGO	non-governmental organization
NHTSA	National Highway Traffic Safety Administration (US)
NICs	newly industrializing countries
NOC	national oil company
NPRA	National Petrochemical and Refiners Association (US)
NPV	net present value
NRF	National Research Foundation (Singapore)
OCIMF	Oil Companies International Marine Forum
ODA	official development assistance
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
OTC	over-the-counter

PAP	People's Action Party (Singapore)
PNG	piped natural gas
ppm	parts per million
PRD	Parks and Recreation Department (Singapore)
PV	photovoltaic
R&D	research and development
REDD	Reduced Emissions from Deforestation and Forest Degradation programme (UN)
RFP	request for proposal
RPS	Renewable Portfolio Standards
SCS	Solar Capability Scheme (Singapore)
SERIS	Solar Research Institute of Singapore
SINERGY	Singapore Initiative in New Energy Technologies
SLNG	Singapore LNG Corporation
SO <sub>2</sub>	sulphur dioxide
SOE	state-owned enterprise
SOMS	Straits of Malacca and Singapore
SPC	Singapore Petroleum Company
SSA	Singapore Shipping Association
SWF	sovereign wealth fund
TAGP	Trans-ASEAN Gas Pipeline
TEU	twenty-foot equivalent unit
TTF	Title Transfer Facility (Netherlands)
TUA	terminal user agreement
TWh	terawatt hours
UAE	United Arab Emirates
UN	United Nations
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
VLFS	very large floating structure
VQS	Vehicle Quota System (Singapore)
WEC	World Energy Council
Wp	watt peak
WTO	World Trade Organization

# INTRODUCTION

*The curious task of economics is to demonstrate to men how little they really know about what they imagine they can design.*

Friedrich August von Hayek

Policymakers in Singapore, like their counterparts elsewhere, are faced with balancing priorities in meeting the simultaneous requirements of economic growth, energy security and environmental sustainability. To be sure, each of these broad societal objectives can mean radically different things to different constituencies of the population. Academics, businessmen, and career civil servants, along with the ordinary man on the street, would naturally have their own perspectives and questions on what each of these objectives entail. How are such objectives ranked? What do they mean in terms of concrete policy initiatives and regulatory action on the part of government and how would such governmental action affect the daily lives of consumers and businesses? How are trade-offs (if they do occur) between one policy objective (say energy security) and another (say economic competitiveness) weighed and debated in public?

Policy challenges related to energy sector issues facing Singapore can be grouped into four broad areas. The first policy challenge, on the domestic front, is the perceived need to promote energy efficiency and 'renewable' energy initiatives among local households and businesses sensitive to new cost burdens on existing financial budgets and bottom lines. The potential for improving energy efficiency and adopting new energy technologies in cost-efficient ways has attracted the keen attention of policymakers. Can we reduce energy use and emissions while at the same time reducing consumer or production costs? Are there barriers to households or businessmen from discovering cheaper ways of using energy

or reducing pollutants and carbon emissions? What can governments do to help overcome these barriers?

Policy attention in the international arena covers three concerns. The first lies in the need to participate in international and regional forums in a way which balances the need to commit to reasonable national targets in energy intensity and emissions reduction metrics while ensuring that the country's economic competitiveness and growth prospects are not compromised by inefficient or defective multilateral agreements. How would the financial costs of such agreements be allocated among the parties to such agreements? Who are the likely net donors and net recipients in possible future international or regional climate change agreements?

The second policy challenge on the international front concerns the means of handling the impacts of possible carbon emission mitigation measures, adopted voluntarily or as part of some future international treaty obligations, on Singapore's key export industries. As an extremely open, trade-oriented economy, the competitiveness of Singapore's export industries, some of which are energy intensive, is crucial to its economic growth prospects. Can Singapore-based oil refiners, petrochemical producers, and civil aviation and shipping companies be subject to international emission mitigation agreements while still keeping their competitive positions? What of those countries that are not party to such conventions or those which sign up but fail to implement measurement, reporting, and verification procedures? Are market-based incentives such as carbon taxes or carbon trading regimes the way to go in meeting international obligations or should governments have specific mandates to determine technology choices and consumer behaviour?

The third policy challenge in the international arena lies in the perennial concerns about enhancing energy security in the context of a small island-state importing all its energy needs. What steps should small countries like Singapore take to minimize vulnerabilities to energy supply disruptions? In the wake of 9/11 and the Arab Spring, this question has taken on an urgency not seen since the oil price shocks and the emergence of resource nationalism in the Middle East during the 1970s. The term has taken on a further dimension as climate change mitigation and adaptation measures begin to take higher billing in the policymakers' portfolio of "pressing security issues to deal with".

It is commonly observed that as a small "alternative energy disadvantaged" city-state without access to a number of low or zero

emission energy technologies such as hydroelectric, wind, geothermal or nuclear power, Singapore's options are limited. Singapore's pattern of energy use and carbon dioxide (CO<sub>2</sub>) emissions is examined in Chapter 1 with a view to describing the broad features of this "alternative energy disadvantage".

Chapter 2 sets the climate change negotiations from Copenhagen to Durban in context. It examines the economic and environmental criteria that have been raised by various academic, non-governmental and government analysts in climate change debates. The focus is on how to "widen" and "deepen" international participation, including non-OECD (Organisation for Economic Co-operation and Development) countries, in emission mitigation and climate change adaptation efforts. The chapter notes the implications for Singapore, a high per capita income non-OECD city-state.

The highly contested issue of "who pays?" and "who receives?" in climate change finance is the subject of Chapter 3. The transfer of financial resources and the distribution of the financial burden of emission mitigation and adaptation efforts are key areas of contention in climate change negotiations. The criteria which will qualify United Nation (UN) members as either donors or recipients as promulgated by different multilateral institutions, non-governmental organizations (NGOs), academics and government negotiators are discussed in the chapter.

Chapter 4 examines the likely impact of possible future international climate change agreements on Singapore's role as a regional and global hub for shipping and fuel bunkering, oil refining and petrochemicals, and civil aviation. As the world's most trade-oriented country, the impact of possible future international emission mitigation regulations on these export-oriented industries would have profound and far-reaching impacts on Singapore.

In Chapter 5, attention is turned to the government's five-pronged energy-policy framework meant to (i) promote competitive energy markets; (ii) diversify energy sources; (iii) enhance energy efficiency; (iv) develop Singapore's energy industries and invest in energy R&D; and (v) step up international and regional cooperation on energy security issues.

The final chapter draws conclusions on the need to balance competing policy objectives in meeting societal goals of economic development, energy security and environmental sustainability. Rigorous definitions of these oft-proclaimed goals form a critical first step towards understanding their implications for societal choice and policymaking. It is the contention of

the book that poor understanding of key terms such as “energy security” and “environmental sustainability” often gets in the way of an informed policy debate on the many issues involved. Clarity of policy objectives is not just a matter of “good science”, though this is a requirement. Good economics is critical — policy formulation and implementation require an informed way of valuing costs and benefits in the context of market-based economies and open societies where consumer choice and competitive politics matter.