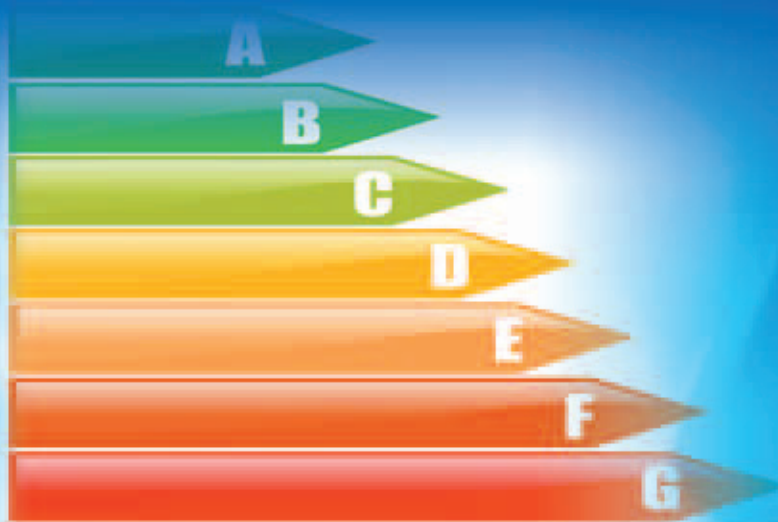


STEVEN FAWKES

Energy Efficiency

The Definitive Guide to the Cheapest,
Cleanest, Fastest Source of Energy



A **Gower** Book

ROUTLEDGE

Energy Efficiency

*Dedicated to Sophie
who brought light, warmth and
renewed energy to our lives.*

7th September 2011 to 10th January 2013

Energy Efficiency

The Definitive Guide to the
Cheapest, Cleanest, Fastest
Source of Energy

STEVEN FAWKES

First published 2013 by Gower Publishing

Published 2016 by Routledge

2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

711 Third Avenue, New York, NY 10017, USA

Routledge is an imprint of the Taylor & Francis Group, an informa business

Copyright © Steven Fawkes 2013

Steven Fawkes has asserted his right under the Copyright, Designs and Patents Act, 1988, to be identified as the author of this work.

All rights reserved. No part of this book may be reprinted or reproduced or utilised in any form or by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying and recording, or in any information storage or retrieval system, without permission in writing from the publishers.

Notice:

Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library.

The Library of Congress has catalogued the printed edition as follows:

Fawkes, Steven, 1959-

Energy efficiency : the definitive guide to the cheapest, cleanest,
fastest source of energy / by Steven Fawkes.

pages cm

Includes bibliographical references and index.

ISBN 978-1-4094-5359-8 (hardback) 1. Energy policy. 2. Energy consumption. 3. Energy conservation.

4. Energy policy--United States. I. Title.

HD9502.A2F383 2013

333.79--dc23

2013010235

ISBN 9781409453598 (hbk)

ISBN 9781315579542 (ebk)

Contents

<i>List of Figures</i>	<i>vii</i>
<i>List of Tables</i>	<i>ix</i>
<i>List of Abbreviations</i>	<i>xi</i>
<i>Acknowledgements</i>	<i>xvii</i>
<i>About the Author</i>	<i>xix</i>
<i>Foreword by The Rt Hon Gregory Barker</i>	<i>xxi</i>

1	What Do We Mean By Energy Efficiency?	1
2	The Global Energy System – Stresses and Strains	11
3	Potentials and Barriers	35
4	A Systematic View of the Benefits of Efficiency	55
5	Jevons, Rebound and Backfire	67
6	Management Techniques	83
7	Energy Management Examples	101
8	Technologies for Energy Efficiency	115
9	Designing for Energy Efficiency	151
10	Financing Energy Efficiency Investment	159
11	Energy Efficiency Policies	191
12	Energy Efficiency Policy Examples	215

13	Energy Suppliers and Energy Efficiency	231
14	Summary and Conclusions	243
	<i>Appendix 1: The Energy Efficiency Ecosystem</i>	247
	<i>Appendix 2: Energy Conversion Table</i>	253
	<i>Index</i>	255

List of Figures

3.1	Drivers of energy efficiency potential	37
3.2	Energy efficiency potentials	38

This page has been left blank intentionally

List of Tables

3.1	Summary of studies of potential	42
5.1	Estimates of rebound	72
A2.1	Energy conversion table	253

This page has been left blank intentionally

List of Abbreviations

Note: Not all of these terms are used in the text, but they are commonly encountered in discussions of energy efficiency.

A	Ampere – unit of current
A&E	Architecture and Engineering (as in A&E firms)
AC	Alternating Current
ACEEE	American Council for an Energy Efficient Economy
AEE	Association of Energy Engineers
aM&T	Automated Monitoring and Targeting
AMR	Automated Meter Reading
ARRA	American Recovery and Reinvestment Act 2009
ASE	Alliance to Save Energy
BAMF	Biological Alternative Methane Fuels
bbl	Barrels – unit of volume
BMS	Building Energy Management System
BOE	Barrels Oil Equivalent
BOO	Build, Own and Operate
BPIE	Buildings Performance Institute Europe
BTS	Base Transceiver Station
BTU	British Thermal Unit
CEM	Contract Energy Management
CERT	Carbon Emissions Reduction Target – mandatory energy efficiency supplier obligation for UK utilities – (operational 2008–2012)
CESP	Community Energy Saving Programme – mandatory energy efficiency supplier obligation for UK utilities – (operational 2009–2012)
CFL	Compact Fluorescent Lamp
CGE	Computable General Equilibrium – a type of economic model
CHP	Combined Heat and Power
CO	Carbon monoxide
CO ₂	Carbon dioxide

COP	Coefficient of Performance – usually applied to heat pumps
CSR	Corporate Social Responsibility
D3	Shorthand for Demand Management (DM), Demand Response (DR) and Distributed Generation (DG)
DC	Direct Current
DCF	Discounted Cash Flow
DEC	Display Energy Certificate
DECC	Department of Energy and Climate Change (UK government department)
DG	Distributed Generation
DH	District Heating
DHW	Domestic Hot Water
DM	Demand Management – permanent reduction of load through energy efficiency
DNO	Distribution Network Operator (UK term for regional electricity distribution companies)
DOE	Department of Energy (US government department)
DR	Demand Response – short-term reduction in load or time shifting of load
DSM	Demand Side Management
EBRD	European Bank of Reconstruction and Development
ECCJ	The Energy Conservation Center, Japan
ECEEE	European Council for an Energy Efficient Economy
ECM	Energy Conservation Measure
ECM	Electronically Commutated Motor
ECO	Energy Company Obligation (UK scheme to mandate spending on energy efficiency by energy suppliers)
EDF	Électricité de France
EDF	Environmental Defense Fund – US-based NGO
EDR	Electricity Demand Reduction (used by DECC in the UK)
EE	Energy efficiency
EEC	Energy Efficiency Commitment – mandatory energy efficiency obligation for UK utilities (operational 2002–2005)
EEDI	Energy Efficient Design Index (design standard introduced by International Maritime Organization)
EEDO	Energy Efficiency Deployment Office, office within UK Department of Energy and Climate Change
E-FiT	Energy efficiency Feed-in Tariff
EIA	US Energy Information Administration
EIB	European Investment Bank

EJ	Exajoules – unit of energy
ELENA	European Local Energy Assistance – an initiative of the European Investment Bank and the European Commission to provide technical assistance to towns and regions to help develop large energy efficiency and renewable energy projects
EMA	Energy Managers Association (UK)
EMR	Electricity Market Reform – major changes to the UK electricity market being implemented in 2013/2014
EPC	Energy Performance Contract
EPC	Energy Performance Certificate
EPS	Energy Efficiency Portfolio Standard – mandatory requirement on utilities (USA)
ESA	Efficiency Services Agreement (similar to MESA)
ESCO	Energy Service Company
ESKOM	South African utility
ESPC	Energy Savings Performance Contract
ESTA	Energy Services and Technology Association – UK trade association for energy efficiency industry
EVO	Efficiency Valuation Organization – international not-for-profit organization administering IPMVP
FCM	Forward Capacity Market
FHFA	Federal Housing Finance Agency
FiT	Feed-in Tariff
FM	Facilities Management
GAO	General Accountability Office – the audit, evaluation and investigative agency of the US Congress (formerly General Accounting Office)
GHG	Greenhouse Gases
GIB	Green Investment Bank (UK)
GSA	General Services Administration – US government agency supporting the functioning of federal agencies
GSHP	Ground Source Heat Pump
GSMA	Organization representing mobile telecommunications operators
GW	Gigawatts – unit of power
GWh	Gigawatt hour – unit of energy
GWP	Global Warming Potential
HTS	High Temperature Superconductivity
HVAC	Heating, Ventilation and Air Conditioning
ICAO	International Civil Aviation Organization
ICP	Investor Confidence Project

IDM	Integrated Demand Management – demand side programmes run by ESKOM
IEA	International Energy Agency
IFC	International Finance Corporation
IFI	International Financial Institution
IGA	Investment Grade Audit
IHD	In Home Display
IIGCC	International Investors Group on Climate Change
IISD	International Institute for Sustainable Development
IMO	International Maritime Organization
IOU	Investor-owned utility (USA)
IP	Intellectual Property
IPMVP	International Performance Measurement and Verification Protocol
IRR	Internal Rate of Return
ISO	Independent System Operator (USA)
ISO 50001	International Standard 50001 Energy Management
ISO-NE	Independent System Operator – New England
JESSICA	Joint European Support for Sustainable Investment in City Areas – initiative of the European Commission, the European Investment Bank and the Council of Europe Development Bank
KEMCO	Korean Energy Management Company
KPI	Key Performance Indicator
kW	Kilowatt – unit of power
kWh	Kilowatt hour – unit of energy
LBNL	Lawrence Berkeley National Laboratory – US Department of Energy national laboratory
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
LNG	Liquefied Natural Gas
M&T	Monitoring and Targeting
M&V	Measurement and Verification
MACC	Marginal Abatement Cost Curve
mCHP	Micro-Combined Heat and Power
MEE	Mobile Energy Efficiency – benchmarking programme run by the GSMA
MESA	Managed Energy Services Agreement
MIT	Massachusetts Institute of Technology
Mtoe	Million tonnes of oil equivalent
MUSH	Municipal, University, School and Hospital sector (in USA)
MW	Megawatt – unit of power
MWh	Megawatt hour – unit of energy

NDEE	Non-Domestic Energy Efficiency – term used by UK Green Investment Bank to describe non-residential energy efficiency
NO _x	Oxides of nitrogen
NPI	Normalized Performance Indicator
NPV	Net Present Value
OBR	On Bill Repayment
ODP	Ozone Depletion Potential
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
OPEC	Organization of the Petroleum Exporting Countries
ORC	Organic Rankine Cycle
ORNL	Oak Ridge National Laboratory – US Department of Energy National Laboratory
PACE	Property Assessed Clean Energy
PE	Private Equity
PEMFC	Proton Exchange Membrane Fuel Cell
PGE	Pacific Gas & Electric – Californian utility
ppm	Parts Per Million
PV	Photovoltaic
PWR	Pressurized Water Reactor
QBTU	Quadrillion British Thermal Units
R&D	Research and Development
R, D & D	Research, Development and Demonstration
RE:FIT	London-based programme to encourage use of Energy Performance Contracts
RF	Radio Frequency
RHI	Renewable Heat Incentive – UK support mechanism for renewable heat
RMI	Rocky Mountain Institute
ROC	Renewable Obligation Credit – UK renewable electricity support mechanism
RTG	Radioisotope Thermal Generator
RTO	Regional Transmission Operator (USA)
SAAS	Software as a service
SEC	Specific Energy Consumption
SEEMP	Ship Energy Efficiency Management Plan (management system for ships introduced by International Maritime Organization)
SME	Small or Medium Enterprise
SMUD	Sacramento Municipality Utility District
SOFC	Solid Oxide Fuel Cell
SO _x	Oxides of sulphur

SRI	Socially Responsible Investing
TJ	Terajoules – unit of energy
toe	Tonnes of oil equivalent – unit of energy
TSO	Transmission System Operator (USA)
TVA	Tennessee Valley Authority
TWh	Terawatt hour – unit of energy
UAA	Utility Alliance Agreement – multi-utility contract form used by RWE and Diageo in UK and Ireland
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCC	United Nations Framework on Climate Change
USAID	United States Agency for International Development
USGBC	United States Green Building Council
V	Volt – unit of electric potential, difference in electric potential or electromagnetic force
VC	Venture Capital
VOC	Volatile Organic Compound
VRLA	Valve Regulated Lead Acid batteries
VSD	Variable Speed Drive
W	Watt – unit of power
WEC	World Energy Council
WHO	World Health Organization
WHP	Waste Heat to Power

Acknowledgements

As ever, the process of writing a book is in many ways a solitary one, but the end result is based on the inputs of many people over many years which somehow get processed into new ideas, new connections and a linear sequence of words that attempt to describe a complex, interconnected world. It is impossible to catalogue and acknowledge all these inputs, but major ones this time round include: Dr Keith Jacques who introduced me to soft systems a long time ago; the late Mr Peter Morimura for giving me opportunities and an excuse to learn about Japan over a 20-year period; MCC for introducing me to the financial world; Graham Meeks of the CHPA for collaborating on D3 and policy matters; numerous energy efficiency practitioners around the world, including Dipak Shah and the Energy Excel team, John Romano of Telstra and Peter Garforth of Garforth International, to name only a few; numerous innovators of amazing new technologies, including the late Dr Jens Müller, Scott White of Autonomic Materials, the teams at Nanoco and Ilika, and many others; and the numerous experts I have met and interacted with who are working to move the energy efficiency financing market forward, notably Amory Lovins, Greg Kats and Matt Golden in the USA, Sean Kidney and Ingrid Holmes in Europe and Flora Kan in China. On the work front I would also like to acknowledge the friendship and efforts of Bayju Thakar and the entire Day One Energy Solutions team for advancing the UK market and also introducing me to Indian concerns. Thanks are also due to Paul Blanchard for introducing me properly to the world of Twitter and blogs, Sarah Nutter for editing, and the Gower team. The final thank you, as ever, goes to my dear wife Kathy, whose commitment to family, profession and education always inspires and encourages me. As always, any errors are my responsibility.

Steven Fawkes

www.gowerpublishing.com/ebooks

We hope you enjoy this ebook with its interactive features and the wealth of knowledge contained within it.

We'd love to keep you informed of other Gower books available to you from your chosen provider. Why not join our monthly email newsletter? It features new books as they are released, links you to hints and tips from our expert authors and highlight free chapters for you to read.

To see a sample copy, please go to www.gowerpublishing.com/newsletter and then simply provide your name and email address to receive a copy each month. If you wish to unsubscribe at any time we will remove you from our list swiftly.

Our blog www.gowerpublishingblog.com brings to your attention the articles and tips our authors write and, of course, you are welcome to comment on anything you see in them. We also use it to let you know where our authors are speaking so, if you happen to be there too, you can arrange to meet them if you wish.

About the Author

Dr Steven Fawkes is an internationally recognized, award-winning energy efficiency, new energy and clean technology expert with more than 25 years' experience of implementing energy management programmes and advising governments on energy efficiency policy. He has worked in the UK, Europe, Asia and America, developed large-scale energy programmes in both the private and public sector, built a number of energy services businesses from start-up and advised governments in Europe and Asia. Much of his current work is concerned with the issues of aggregating energy efficiency projects and financing them.

Currently Steven is an adviser to a number of energy and clean technology companies and also a Director of Energypro Limited and a Non-Executive Director of Bglobal plc, an AIM-listed smart meter and energy services company. Prior to these posts he was Corporate Finance Partner at Matrix Corporate Capital, leading the team specializing in energy and clean technology. While at Matrix, Steven also led the research team rated by Extel as number one in the New Energy and Clean Tech sector.

Steven has worked in Japan, advising a leading Japanese consulting engineering company on energy efficiency projects, including for the British Embassy in Tokyo. He has also worked for the EU Phare programme, the United Nations Development Programme, the United States Agency for International Development (USAID) and the World Bank implementing national energy efficiency programmes in Romania, going on to co-found one of the first industrial energy service companies in Romania. In 2000 he joined Enron and was part of the team that implemented innovative energy supply and efficiency contracts for Sainsburys and Diageo, and in 2002 Steven led that team in their transition to RWE Solutions, going on to build a successful business that became part of RWE npower in 2006.

Steven has an interdisciplinary BSc focused on energy resources from the University of Birmingham, a Diploma in Technological Economics and a PhD concerning the potential for energy efficiency in UK industry from the University of Stirling, and a Postgraduate Diploma in Sustainable Business from Cambridge University. Steven is an experienced public speaker and has undertaken engagements in the UK, Europe, the USA, Asia and Africa. He has published more than 150 articles and papers, and a previous book on energy efficiency: *Outsourcing of Energy Management*. Steven advised the UK government on energy efficiency policy and to establish the Energy Efficiency Deployment Office (EEDO) within the Department of Energy and Climate Change (DECC). He was an Adviser to EEDO during its formation phase. In November 2012 he was awarded the Energy Institute's Individual Achievement Award.

As well as his interests in energy, Steven has been a Non-Executive Director of Autonomic Materials Inc., a company spun out of the University of Illinois, which is commercializing self-healing materials. Steven is also an aviation and space travel enthusiast. He has flown in the Russian zero-g cosmonaut training aircraft and a MiG-25 to 25,000 metres. He has also authored papers and articles on space tourism. Steven is married and lives in London.

Steven's blog can be found at: www.onlyelevenpercent.com

Foreword

I have long been committed to ensuring that energy efficiency is given the proper role and precedence in our national energy policy that it rightly deserves.

In a global race for limited resources, it will be those countries which are the greenest and crucially those which are the most energy efficient which will succeed in the long-term and whose economies will prosper. Energy efficiency therefore has a key role to play in all our lives. For it will be those businesses which are best protected from energy price shocks which will have a clear competitive edge and in the domestic sector, it is those consumers who are least vulnerable to changing energy prices whose household bills will be the lowest.

Greater energy efficiency therefore belongs at the very heart of our low carbon economy. Finding ways to do more, or even the same, with less makes real economic sense. It improves the energy security of our country, reduces our carbon emissions, stimulates growth and creates jobs.

So, this Coalition Government is determined to break with past indifference to energy efficiency. We have a clear mission to seize the energy efficiency opportunity, which is why we published our Energy Efficiency Strategy in November 2012, identifying the untapped energy efficiency potential in the UK economy and setting out the barriers to this potential and how we can address them.

I firmly believe the public and private sector must work hand in hand to deliver this opportunity, to unlock investment and stimulate innovation. By working collectively we can lead the world in becoming more energy efficient. We are at the early stage of an exciting journey in terms of greater energy efficiency but Steve Fawkes has been a powerful and expert advocate of

efficiency for many years. I very much welcome the contribution Steve's new work can play in helping us navigate an exciting path forward.

The Rt Hon Gregory Barker
Minister of State for the Department of Energy and Climate Change

What Do We Mean By Energy Efficiency?

What gets us into trouble is not what we don't know. It's what we know for sure that just ain't so.

Will Rogers, American humourist

Everything has changed but our way of thinking.

Albert Einstein, Theoretical physicist

Growing Interest in Energy Efficiency – Again

Interest in energy efficiency has grown significantly over the last five years, particularly so in the last three years. This growth has been driven by increasing energy prices and environmental concerns as well as increasing recognition of the value opportunity that energy efficiency presents in all parts of the economy. For those of us who have been active in energy efficiency for decades, since 1980 in my case, this increase in interest and activity represents the second up-wave during our careers. The last time there was as much interest in energy efficiency was between the mid-1970s and the mid-1980s in response to the oil crises of 1973 and 1979 which saw oil prices rise to \$34/barrel, about \$100/barrel in today's money.

This book is broad in scope rather than deep in any one aspect. It seeks to give a current overview of the issues and tries to offer insight into how we may effectively tackle the significant challenges ahead. Many other excellent texts exist which go much deeper on the various topics within energy efficiency, and some are referenced throughout. This book focuses on the various broad aspects of energy efficiency and covers:

- what do we really mean by energy efficiency?

- what is the potential (in different dimensions)?
- why is it important?
- what management processes lead to optimization of energy efficiency?
- what technologies are useful for improving energy efficiency?
- what policies can be used to promote energy efficiency?
- how can energy efficiency be financed?
- how can energy suppliers engage with energy efficiency?

Other topics could have been covered, and any of these could have been covered in depth, but that will have to await future books.

Where Are We Today?

I believe that we are at a critical inflection point for energy efficiency. Over the last two to three decades we have identified the potential and learnt and codified what works in energy management through standards such as ISO 50001 and IPMVP (International Performance and Measurement Protocol) – see Chapter 6 for more details. At the same time, incredible advances in technology, particularly around data, communication and materials, are giving us new approaches and new tools to allow us to design better equipment, systems and buildings that improve energy efficiency. In addition, new business and financial models are evolving and transforming energy efficiency into an attractive and practical investment opportunity, one which will continue to get attention from managers, entrepreneurs and investors even if there are reductions in energy prices.

As is often the case, however, government policy lags market reality on the ground, and in many countries governments are trying to catch up and accelerate the processes of improving energy efficiency. The challenge for policy makers and practitioners alike is how to massively scale up the deployment of energy efficiency. I believe that we know enough to do that; the question over the next decade or so is how successful will we be?

What Is Energy Efficiency?

We need to start a book on energy efficiency by defining energy efficiency and then putting it into its proper place in the context of the global energy scene. Definitions are needed as there is still confusion about the term 'energy efficiency', as well as associated terms such as 'energy productivity', 'energy intensity' and 'energy conservation'. Putting energy efficiency into its wider context powerfully illustrates both the potential for improvement and the vital importance of the topic.

So what do we mean by energy efficiency, and some of the associated ideas and terms such as energy conservation, energy intensity, energy productivity and energy management? The term energy efficiency is widely used but is sometimes misused. It conjures up different images, associations and models for different people. The term also carries with it a lot of baggage, bringing with it outdated ideas that inhibit understanding, hinder acceptance and block effective action. It really is important that everyone who has any interest in energy efficiency starts from the same basic set of concepts, and this is particularly true today as the growth of interest in the subject has inevitably and necessarily brought in many new entrants without a solid technical grounding in energy matters or long experience of energy efficiency.

ENERGY EFFICIENCY IS THE WRONG TERM

There is a view, and it is one I am sympathetic to because it is technically correct, that the use of the term energy efficiency is misleading in the sense that we normally use it. First of all, as Walt Patterson, one of the great energy gurus, pointed out (Patterson 2005), using the term 'energy', which came into widespread use in the 1970s, is in itself misleading because it fails to distinguish between two very different things: fuel and electricity. As Walt says, you cannot power your computer or smart phone using gasoline, only electricity of the right voltage and current will work, and you cannot run your gasoline engine car on diesel fuel. Each specific type of technology requires fuel or electricity with very specific characteristics. Walt also points out that the term energy conservation is technically incorrect because, as all energy engineers know, energy is always conserved under the First Law of Thermodynamics. The term energy efficiency is also problematical because, for example, you cannot measure all the inputs of ambient energy from the sun or the atmosphere, occupants or equipment, or the useful energy output of a building. Ideally we would change the language of energy and energy efficiency, but the terminology is in widespread use and any attempt to avoid it or change it will lead to even more confusion.

Cullen and Allwood (2010) make a very useful distinction when considering energy efficiency. They distinguish between ‘conversion devices’ (power stations, engines and light bulbs, for example), which convert energy from one form into another, and ‘passive systems’ (such as buildings), where useful energy is finally ‘lost’ by degrading to low-grade heat in exchange for it providing us with useful services. You can measure the energy efficiency of a conversion device, i.e. the useful energy out as a proportion of the total energy in, but you can’t measure the useful energy out/total energy in of a passive system such as a building. You can only measure energy productivity, i.e. energy in/some useful output.

INEFFICIENCY EVERYWHERE

Whatever level we look at, the degree of energy efficiency, or perhaps more accurately inefficiency, is quite stunning. The energy efficiency of many everyday conversion devices is surprisingly low. A filament light bulb converts electricity into light with an efficiency of about 2 per cent; the rest of the energy put into the device is emitted mostly as heat, which is not usually useful. Fluorescent lamps have efficiencies of about 10 per cent, and power transformers for devices like computers and mobile phones are typically only 50 per cent efficient. At a global level, Cullen and Allwood (2010) reported that for a total input of 475 exajoules of primary energy (oil, coal, gas, biomass, nuclear and renewable), we get 55 exajoules of useful energy services (motion, heat, light, cooling and sound): an overall efficiency of 11 per cent. Although some of this is, of course, unavoidable because of the laws of thermodynamics and the limitations of practical machines, with all our ‘advanced’ technology it is still a surprisingly low number.

‘ENERGY EFFICIENCY’ EQUALS ENERGY EFFICIENCY AND ENERGY PRODUCTIVITY

So the all-enveloping term ‘energy efficiency’ really incorporates two concepts. First, energy efficiency, useful energy out/energy in – usually reported as a percentage, for conversion devices. Secondly, energy productivity, usually reported as energy in/useful output, for passive devices. We are familiar with some everyday measurements of energy productivity, such as miles per gallon or litres per 100 kilometres for car fuel efficiency, and others including energy input to a building per square metre to produce a certain temperature for a certain period of time; energy use per passenger mile for aircraft; or energy per 1,000 tins of beans produced in a factory.

ENERGY EFFICIENCY AS A PROCESS

When we talk about energy efficiency in a macro sense we often mean a series of processes rather than a status at a single point in time. The energy efficiency of all technologies tends to improve over time because there is a basic human desire to spend less, invent new technologies and improve existing technologies. The process of making many small changes to improve things could be called 'tinkering', although applying that term to modern, focused development engineering seems disrespectful. As well as these constant incremental technological changes, there are the major paradigm-busting changes, such as a complete change of processes, that work to improve energy productivity over time. Improvements in energy efficiency are generally mirrored by improvements in the productivity of other resource use.

The process of improving energy efficiency or reducing energy input for a given output is a process of technical and/or behavioural change that is driven by technological, financial, management, social and political drivers and constraints. 'Energy', in the form of oil, gas, coal, or uranium, is made up of a set of unique physical resources. Therefore, the process of improving energy efficiency is actually the process of improving the productivity of energy resource use – in the same way as the process of improving productivity of any other resource, physical or human. So when we commonly talk about 'energy efficiency' we really mean 'the process of improving the productivity of energy use'. In later chapters, this book addresses the management of the process, the technologies that can be used, the social factors and policies that can accelerate or impede the rate of improving energy efficiency.

ENERGY INTENSITY

Energy intensity refers to the overall energy efficiency of an economy measured as energy usage per unit of Gross Domestic Product (GDP), typically in tonnes of oil equivalent (toe) per \$1,000 of GDP. The inverse of energy intensity, which is not so widely seen, is 'economic energy efficiency' – how many units of GDP are produced for each unit of energy. Energy intensity is influenced by the stage of economic development of an economy, the structure of the economy, climatic conditions, as well as overall energy efficiency. As countries start to industrialize, energy intensity tends to increase as the economies move from primarily agricultural activities to industrial activities. Once this change has occurred, energy intensity then decreases. This reduction is driven by structural

shifts in the economy, e.g. a move away from heavy industry to lighter industry or services, as well as overall energy efficiency, a pattern that has been seen many times in many countries (Rühl et al. 2012).

ENERGY MANAGEMENT

Energy management includes the management processes and tools used to manage both the supply side and the demand side of energy systems. Primarily, energy managers are the people who focus on the energy management processes, although energy management can, and must, involve far more people than just dedicated energy managers. Some energy managers are more involved in the issues of energy supply such as securing supplies at the best price and assessing risk levels, while some are more involved in energy demand, i.e. reducing energy input for a given output. Since the 1980s, the term 'energy manager' has been most associated with the demand side, i.e. managing the process of improving energy efficiency, but an integration of supply and demand functions is sensible to obtain optimal results. We will explore the demand side of the energy management process in Chapter 6.

ENERGY CONSERVATION

The other term often heard in discussions of energy efficiency is energy conservation. Energy conservation is often used interchangeably with energy efficiency although they are not the same, and fortunately this does appear to be happening less frequently. The term energy conservation became popular in the wake of the oil crises of the 1970s. Policy makers at the time talked about the three pillars of energy policy: coal, nuclear and conservation, all three together summarized as 'conuco'. Energy conservation means reducing energy use by reducing output. To use our examples from above, it means reducing the space temperature in the building, i.e. reducing comfort, producing fewer or inferior tins of beans, or driving fewer miles. There are many examples where energy conservation, saving by doing less, can and does make sense. However, it is one of our basic beliefs that people and organizations don't like to make do with less output or comfort and we cannot, and should not, base our energy decisions on conservation.

Development inevitably means increasing economic output, and some proponents of sustainability believe that the future will involve making do with less and giving up output or comfort. I do not think this is either likely or indeed desirable. We live in a world where 1.3 billion people exist without any

electricity (IEA 2012) and, despite good progress on global poverty reduction, about the same number live at 'the bottom of the pyramid' (Prahalad 2005) on an income of less than \$1.25 a day. An energy strategy based on doing less cannot practically or ethically be applied to the poor people in the developing world, or even the poorer parts of the developed world, an increasing number of whom are in fuel poverty.

We need to generate more wealth and more jobs everywhere in the world, particularly in the developing world where low incomes help drive social and international problems. But we also need to do this in developed countries which have been severely affected by the global financial crisis. What we need to do is grow output and make every unit of output much, much more energy efficient. The evidence at both the micro and the macro levels is that:

- we can do this to an extent beyond what is commonly held to be possible;
- it is financially attractive to do this;
- we know how to do it, we have the technologies and the management tools;
- doing it will reduce costs, reduce carbon emissions, increase the profitability of firms and create real jobs.

ENERGY EFFICIENCY AND RENEWABLE ENERGY

Perhaps surprisingly there is still confusion between energy efficiency and renewable energy. Energy efficiency is about reducing the end use of energy for a given output. Renewable energy is just another way of generating heat or electricity. Renewable energy does not reduce end-use efficiency, although it is clearly a way of substituting or reducing the consumption of fossil fuels. There is a difference between reducing the end use of electricity or fuel and substituting a renewable source for it. Renewable energy systems can help to achieve a higher overall efficiency in the electricity system if they can reduce peak loads and thereby avoid additional, usually inefficient, power stations being ramped up, e.g. by using solar in sunny climates to reduce peak air conditioning loads. But they should not generally be thought of as part of 'energy efficiency'.

D3 – DEMAND MANAGEMENT, DEMAND RESPONSE AND DISTRIBUTED GENERATION

Another important area to be clear about is the difference between energy efficiency, demand response and distributed generation. A useful term to encapsulate all aspects of energy demand-side issues is D3, which was first used in the UK a few years ago by a group (including the author) concerned with promoting the demand-side agenda within the context of the proposed UK Electricity Market Reform (EMR). D3 stands for Demand Management (DM), Demand Response (DR) and Distributed Generation (DG). DM is pure energy efficiency, the permanent reduction of demand. DR is the short-term reduction or shifting of load on the electricity supply system, usually in response to market signals at times of peak demand. DG is the local generation of electricity using systems connected directly to the end user (embedded) or the distribution network rather than the transmission network.

DG can use any form of generation technology, including Combined Heat and Power (CHP) of any kind, biomass, solar, wind, geothermal, as well as conventional fossil fuel-driven technologies. DR can reduce on-site energy use if it consists of switching off load to avoid high charges at times of peak demand on the electricity system, or it can involve simply shifting load to another time. It could, in an electricity market regime where there is negative pricing, involve increasing demand to take advantage of negative or low prices, possibly using some form of storage technology. Application of DR, even if there is no energy reduction at the site in question due to the load being shifted in time, may result in energy efficiency in the electricity system as a whole if it prevents the need to operate a standby power station, for example. DG does not reduce on-site energy use but in the particular case of CHP can reduce energy use, i.e. improve efficiency at the whole-system level by substituting CHP with an overall efficiency of up to 75 per cent for electricity and heat, for power and heat generated separately with an overall efficiency of 51 per cent efficiency (EPA 2012).

THE JEVONS PARADOX – A QUICK NOTE

Of course, as soon as we have defined energy efficiency as improvements in energy productivity, someone counters with the argument that reducing energy use per unit of output only leads to more energy use as people and firms spend some (or all) of the money saved by greater efficiency on more consumption, resulting in more energy use. This is the Jevons Paradox. This

issue is so important that it gets a short chapter to itself. The only comment to make here is that we don't say the same things about the use of other resources, e.g. metals. You do not hear the argument that we shouldn't improve productivity of metal use as it will only result in more metals use. It may be equally true in metals as it is in energy, but the argument isn't made nearly so often. Improving productivity of resource use, whether it be metals or energy or land, is one of the basic drivers of increasing wealth. The other main driver is creating resources out of 'thin air' by creative thinking; for example, turning something that has no value or is currently thought of as waste into a productive resource.

References and Bibliography

- Allwood, J. 2010. *Energy and Material Efficiency*. Presentation at Zero Energy Kyoto, 19 August 2010. [Online]. Available at: <http://www.energy.kyoto-u.ac.jp/gcoe/en/symposium/2010/pdf/03Allwood.pdf> [accessed 26 January 2013].
- Cullen, J.M. and Allwood, J.M. 2010. 'Theoretical Efficiency Limits for Energy Conversion Devices', *Energy* 35(201): 2059–69.
- EPA. 2012. United States Environmental Protection Agency. *Combined Heat and Power Partnership – Efficiency Benefits*. [Online]. Available at: <http://www.epa.gov/chp/basic/efficiency.html> [accessed 26 January 2013].
- IEA. 2012. *World Energy Outlook 2012*. [Online]. Available at: <http://www.worldenergyoutlook.org/publications/weo-2012/> [accessed 26 January 2013].
- Patterson, W. 2005. *Getting Energy Right*. Presentation made to London Boroughs Energy Group Christmas Meeting, Southwark Cathedral, 9 December 2005. [Online]. Available at: <http://www.waltpatterson.org/gettingenergyright.pdf> [accessed 26 January 2013].
- Patterson, W. 2008. *Managing Energy Wrong. Working Paper One*. Chatham House. [Online]. Available at: <http://www.waltpatterson.org/mewfinal.pdf> [accessed 26 January 2013].
- Patterson, W. 2009. *Managing Energy Data. Working Paper Two*. Chatham House. [Online]. Available at: <http://www.waltpatterson.org/medfinal.pdf> [accessed 26 January 2013].
- Patterson, W. 2010. *Managing Energy Technology. Working Paper Three*. Chatham House. [Online]. Available at: <http://www.waltpatterson.org/metfinal.pdf> [accessed 26 January 2013].
- Prahalad, C.K. 2005. *The Fortune at the Bottom of the Pyramid*. Upper Saddle River NJ, Pearson Prentice Hall.

Rühl, C., Appleby, P., Fennema, A. and Schaffer, M. 2012. *Economic Development and the Demand for Energy: A Historical Perspective on the Next 20 Years*. [Online]. Available at: http://www.bp.com/liveassets/bp_internet/globalbp/STAGING/global_assets/downloads/R/reports_and_publications_economic_development_demand_for_energy.pdf [accessed 26 January 2013].

References

1 What Do We Mean By Energy Efficiency?

Allwood, J. 2010. Energy and Material Efficiency. Presentation at Zero Energy Kyoto, 19 August 2010. [Online]. Available at: <http://www.energy.kyoto-u.ac.jp/gcoe/en/symposium/2010/pdf/03Allwood.pdf> [accessed 26 January 2013].

Cullen, J.M. and Allwood, J.M. 2010. 'Theoretical Efficiency Limits for Energy Conversion Devices', *Energy* 35(201): 2059-69.

EPA. 2012. United States Environmental Protection Agency. Combined Heat and Power Partnership - Efficiency Benefits. [Online]. Available at: <http://www.epa.gov/chp/basic/efficiency.html> [accessed 26 January 2013].

IEA. 2012. World Energy Outlook 2012. [Online]. Available at: <http://www.worldenergyoutlook.org/publications/weo-2012/> [accessed 26 January 2013].

Patterson, W. 2005. Getting Energy Right. Presentation made to London Boroughs Energy Group Christmas Meeting, Southwark Cathedral, 9 December 2005. [Online]. Available at: <http://www.waltpatterson.org/gettingenergyright.pdf> [accessed 26 January 2013].

Patterson, W. 2008. Managing Energy Wrong. Working Paper One. Chatham House. [Online]. Available at: <http://www.waltpatterson.org/mewfinal.pdf> [accessed 26 January 2013].

Patterson, W. 2009. Managing Energy Data. Working Paper Two. Chatham House. [Online]. Available at: <http://www.waltpatterson.org/medfinal.pdf> [accessed 26 January 2013].

Patterson, W. 2010. Managing Energy Technology. Working Paper Three. Chatham House. [Online]. Available at: <http://www.waltpatterson.org/metfinal.pdf> [accessed 26 January 2013].

Prahalad, C.K. 2005. The Fortune at the Bottom of the Pyramid. Upper Saddle River NJ, Pearson Prentice Hall.

Rühl, C., Appleby, P., Fennema, A. and Schaffer, M. 2012. Economic Development and the Demand for Energy: A

Historical Perspective on the Next 20 Years. [Online].
Available at:
http://www.bp.com/liveassets/bp_internet/globalbp/

2 The Global Energy System - Stresses and Strains

Ackoff, R. 1974. Redesigning the Future. Hoboken NJ, John Wiley & Sons.

Al-Rodhan, K.R. 2006. The Impact of the Abqaiq Attack on Saudi Energy Security. [Online]. Available at: http://csis.org/files/media/csis/pubs/060227_abqaiqattack.pdf [accessed 26 January 2013].

Alyousef, Y. and Abu-ebid, M. 2012. 'Energy Efficiency Initiatives for Saudi Arabia on Supply and Demand Sides', in Morvaj, Z. (ed.) Energy Efficiency - A Bridge to Low Carbon Economy. [Online]. Available at: <http://www.>

Bellis, M. 2006. History of Electric Vehicles. The Early Years, Electric Cars from 1830 to 1930. [Online]. Available at: <http://inventors.about.com/od/estartinventions/a/History-Of-Electric-Vehicles.htm> [accessed 26 January 2013].

Black & Veatch. 2012. 2012 Strategic Directions in the U.S. Electric Utility Industry. [Online]. Available at:

Bloomberg. 2011. 'Atomic Power Heats Up French Election as Sarkozy Rival Backs Reactor Halts'. [Online]. Available at: <http://www.bloomberg.com/>

Bloomberg. 2012a. 'Saudi Arabia Plans \$109 Billion Boost for Solar Power'. 26 November 2012. [Online]. Available at: <http://www.bloomberg.com/>

Bloomberg. 2012b. 'Nigerian Delta Unrest Cuts Oil Output by 1 Million Barrels'. 5 March 2012. [Online]. Available at: <http://www.bloomberg.com/>

Boselli, M. 2012. 'World Oil Import Bill Heading for Record 1.25 Trillion Pounds'. [Online]. Available at:

Breslow, M. 2010. 'Massachusetts \$ Savings and Job Gains from Energy Efficiency in Buildings & Transportation'. [Online]. Available at: <http://www.>

Casey, Z. 2011. 'EU Energy Import Bill Amounted to €355 billion in 2010'. [Online]. Available at:

DECC. 2012. Business Plan 2012-2015. [Online]. Available at: <http://www.>

EIA. 2012. 'US Expected to Become Net Exporter of Natural Gas by End of Decade'. U.S. Energy Information Administration, 5 December 2012. [Online]. Available at: <http://www.eia.gov/radio/transcript/aeo-lng-12052012.pdf> [accessed 27 December 2012].

Electric Vehicle News. 2012. 'The History of Electric Vehicles'. [Online]. Available at:

Frost & Sullivan. 2012. 'Saudi Arabia puts Energy Efficiency on Radar'. [Online]. Available at: <http://www.frost.com/prod/servlet/press-release.pag?docid=266188072> [accessed 26 January 2013].

Hefner, R.A. 2009. The Grand Energy Transition: The Rise of Energy Gases, Sustainable Life and Growth, and the Next Great Economic Expansion. Hoboken NJ, John Wiley & Sons.

Hubbert, M.K. 1956. Nuclear Energy and Fossil Fuels. Presented to the Spring Meeting of the Southern District Division of Production, American Petroleum Institute, San Antonio, Texas, March 7-9, 1956. [Online]. Available at: <http://www.hubbertpeak.com/hubbert/1956/1956.pdf> [accessed 26 January 2013].

IEA. 2012. World Energy Outlook 2012. [Online]. Available at: <http://www.worldenergyoutlook.org/publications/weo-2012/> [accessed 26 January 2013].

Institute for 21st Century Energy. 2012a. Index of U.S. Energy Security Risk. [Online]. Available at: <http://www.energyxxi.org/us-index-of-energysecurity-risk> [accessed 26 January 2013].

Institute for 21st Century Energy. 2012b. International Index of Energy Security Risk. [Online]. Available at:

Kay, J. (2005). 'Bush's Lack of Guilt on Global Warming', Financial Times, 26 July 2005. [Online]. Available at: <http://www.johnkay.com/2005/07/26/bushs-lack-of-guilt-on-global-warming> [accessed 26 April 2013].

Kharas, H. 2010. The Emerging Middle Class in Developing Countries. OECD Development Centre Working Paper Number 285. [Online]. Available at: <http://www.oecd.org/dev/44457738.pdf> [accessed 26 January 2013].

Lahn, G. and Stevens, P. 2011. Burning Oil to Keep Cool: The Hidden Energy Crisis in Saudi Arabia. Chatham House. [Online]. Available at: <http://>

Malthus, T. 1798. An Essay on the Principle of Population. London, J. Johnson. [Also online]. Available at: <http://www.esp.org/books/malthus/population/malthus.pdf> [accessed 26 January 2013].

Marmot Review Team. 2011. The Health Impacts of Cold Homes and Fuel Poverty. [Online]. Available at:

Massachusetts Executive Office of Energy and Environmental Affairs. 2010. Massachusetts Clean Energy and Climate Plan for 2020. [Online]. Available at:

Meadows, D.H., Meadows, D.L., Randers, J. and Behrens, W.W. 1972. The Limits to Growth. New York, New American Library.

Ministry of Environmental Protection of the People's Republic of China. 2010. Report on the State of the Environment in China. [Online]. Available at:

Neme, C. and Sedano, R. 2012. US Experience with Efficiency As a Transmission and Distribution System Resource. [Online]. Available at: <http://www.raonline.org/document/download/id/4765> [accessed 26 January 2013].

NorthWestern Energy Stakeholders Group. 2009. Our Deteriorating American Infrastructure and the Role of Electric Distribution Systems. [Online]. Available at: <http://www.northwesternenergy.com/Documents/ISG/Sept-09/StakeholderSlides9-24-09.pdf> [accessed 26 January 2013].

Patterson, W. 1986. Nuclear Power. 2nd edition, with Postscript. Harmondsworth, Penguin. [Also online]. Available at: <http://www.waltpatterson.org/nppenguin.pdf> [accessed 26 January 2013].

Perlroth, N. 2012. 'In Cyberattack on Saudi Firm, U.S. Sees Iran Firing Back'. The New York Times, 23 October 2012. [Online]. Available at: <http://www>.

Peterson, P., Hurley, D., Jackson, S. and Schultz, M. 2012. The Road to Better System Planning: ISO-New England's Revised Energy Efficiency Forecast. [Online]. Available at: <http://www.synapse-energy.com/Downloads/>

Rimer, P. 2008. A World in Transition: Delivering Energy for Sustainable Growth. Presentation delivered at the 19th World Petroleum Congress, 2008. [Online]. Available at: <http://www.world-petroleum.org/docs/docs/speeches/wpc%20Presentation%20the%20Aging%20Workforce%202.swf> [accessed 26 January 2013].

Saudi Gazette. 2012. 'Five National Energy Conservation Targets Set'. Saudi Gazette, 10 February 2012. [Online]. Available at: <http://www.saudigazette>.

Simmons, M.R. 2005. Twilight in the Desert. Hoboken NJ, John Wiley & Sons.

Spencer, R. 2007. 'Pollution Kills 750,000 a Year in China Every Year', Daily Telegraph, 4 July 2007. [Online]. Available at: <http://www.telegraph.co.uk/>

Stern, R.J. 2010. 'United States Cost of Military Force Protection in the Persian Gulf, 1976-2007. Energy Policy, 2010. [Online]. Available at: <http://>

UNEP. 2012. Global Trends in Renewable Energy Investment 2012. UNEP, Frankfurt School and Bloomberg New Energy. [Online]. Available at:

United Nations. 1987. Report of the World Commission on Environment and Development: Our Common Future. [Online]. Available at: <http://www.undocuments.net/our-common-future.pdf> [accessed 26 January 2013].

United Nations. 2010. World Population Prospects: The 2010 Revision. [Online]. Available at: http://esa.un.org/unpd/wpp/Documentation/pdf/WPP2010_Volume-I_Comprehensive-Tables.pdf [accessed 26 January 2013].

UPI. 2012. 'China's Coal Miners Still at Risk'. [Online]. Available at: <http://>

US Department of Energy. 2012a. Large Power Transformers and the U.S. Electric Grid. [Online]. Available at: http://energy.gov/sites/prod/files/Large%20Power%20Transformer%20Study%20-%20June%202012_0.pdf [accessed 26 January 2013].

US Department of Energy. 2012b. FY 2013 Congressional Budget Request. [Online]. Available at: <http://www.cfo.doe.gov/budget/13budget/Content/Highlights>.

pdf [accessed 26 January 2013].

WHO. 2004. 'Global Burden of Disease Due to Indoor Air Pollution'. [Online]. Available at: http://www.who.int/indoorair/health_impacts/burden_global/en/ [accessed 26 January 2013].

WHO. 2011. 'Tackling the Global Clean Air Challenge'. [Online]. Available at: http://www.who.int/mediacentre/news/releases/2011/air_pollution_20110926/en/index.html [accessed 26 January 2013].

Wolfson, R. 2012. The Future of Energy. [Online]. Available at: <http://www.>

World Bank. 2007. Cost of Pollution in China: Economic Estimates if Physical Damage. [Online]. Available at: http://siteresources.worldbank.org/INTEAPREGTOPENVIRONMENT/Resources/China_Cost_of_Pollution.pdf [accessed 26 January 2013].

World Nuclear Association. 2013. 'World Nuclear Power Reactors and Uranium Requirements'. [Online]. Available at: <http://www.world-nuclear.org/info/reactors.html> [accessed 26 January 2013].

Yim, S.H.L. and Barrett, S.R.H. 2012. 'Public Health Impacts of Combustion Emissions in the United Kingdom'. *Environmental Science & Technology*, 46(8): 4291-6.

3 Potentials and Barriers

Allwood, J.M. 2009. Industrial Carbon Emissions: A 50% Reduction While Demand Doubles? Presentation at Smith School, Oxford. [Online]. Available at: <http://>

Allwood, J.M. 2011. The Physical Basis for a Low Carbon Economy. Presentation at Imperial College. [Online]. Available at: <https://workspace.imperial.ac.uk/energyfutureslab/Public/Events/JMA%20Feb%202011.pdf> [accessed 19 April 2013].

American Physical Society. 2008. Energy Future. Think Efficiency. How America Can Look Within to Achieve Energy Security and Reduce Global Warming. [Online]. Available at: <http://www.aps.org/energyefficiencyreport/report/aps-energyreport.pdf> [accessed 26 January 2013].

Boegle, A., Singh, D. and Sant, G. 2010. Estimating Technical Energy Saving Potential from Improved Appliance Efficiency in Indian Households. [Online]. Available at:

Brown, R., Borgeson, S., Koomey, J. and Biermayer, P. 2008. U.S. Building-Sector Energy Efficiency Potential. [Online]. Available at: <http://enduse.lbl.gov/info/LBNL-1096E.pdf> [accessed 26 January 2013].

Cullen, J.M. 2009. 'Engineering Fundamentals of Energy Efficiency'. PhD Thesis. University of Cambridge.

Cullen, J.M. and Allwood, J.M. 2010a. 'Theoretical Efficiency Limits for Energy Conversion Devices'. Energy 35 (2010): 2059-69.

Cullen, J.M. and Allwood, J.M. 2010b. 'The Efficient Use of Energy: Tracing the Global Flow of Energy from Fuel to Service'. Energy Policy 38 (2010): 75-81.

Cullen, J.M., Allwood, J.M and Borgstein, E.H. 2011. 'Reducing Energy Demand: What Are the Practical Limits?' Environmental Science & Technology, 45(4): 1711-18.

Energy Research Partnership. 2011. Industrial Energy Efficiency Key Messages. [Online]. Available at:

EPRI. 2009. Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S. (2010-2030). [Online]. Available at: <http://>

European Commission. 2009. Study on the Energy Savings

Potentials in EU Member States, Candidate Countries and EEA Countries. Final Report. [Online]. Available at:

Fawkes, S.D. 1985. 'The Potential for Energy Conserving Capital Equipment in UK Industries'. PhD thesis, University of Stirling.

Gillingham, K., Newell, R.G. and Palmer, K. 2009. Energy Efficiency Economics and Policy. [Online]. Available at: <http://www.rff.org/rff/Documents/RFFDP-09-13.pdf> [accessed 26 January 2013].

IEA. 2012. World Energy Outlook 2012, Executive Summary. [Online]. Available at:

IFC/The World Bank. 2008. Energy Efficiency in Russia: Untapped Resources. [Online]. Available at: <http://www1.ifc.org/wps/wcm/connect/400e2400>

Ikkatai, S. and Tsuchiya, H. 2011. 'Potential of Drastic Improvement of Energy Efficiency in Japan', in Zero-Carbon Energy Kyoto 2011. Green Energy and Technology 2012, pp. 5-13.

Laitner, J.A. Nadel, S., Elliott, N.R., Sachs, H. and Khan, A.S. 2012. The LongTerm Energy Efficiency Potential: What the Evidence Suggests. American Council for an Energy Efficient Economy. [Online]. Available at: <http://aceee.org/research-report/e121> [accessed 26 January 2013].

Leach, G., Lewis, C., Romig, F., van Buren, A. and Foley, G. 1979. A Low Energy Strategy for the United Kingdom. The International Institute for the Environment and Development. London, Science Reviews.

Lovins, A. and Rocky Mountain Institute. 2011. Reinventing Fire. White River Junction VT, Chelsea Green Publishing Company.

Lyle, O. 1947. The Efficient Use of Steam. Ministry of Fuel and Power. London, HM Stationery Office.

Martinez, S., Ettenson, L., Long, N. and Wang, D. 2011. Public Power's Energy Efficiency Progress: An Evaluation of California's Publicly Owned Utility Energy Efficiency Achievements and Targets. [Online]. Available at: <http://switchboard>.

McKinsey & Company. 2007. Curbing Global Energy-Demand

Growth: The Energy Productivity Opportunity. [Online].
Available at: <http://www.mckinsey.com/>

McKinsey & Company. 2008. Capturing the European Energy Productivity Opportunity. [Online]. Available at:
<http://www.mckinsey.com/insights/>

McKinsey & Company. 2009. Unlocking Energy Efficiency in the US Economy. [Online]. Available at:
http://www.mckinsey.com/client_service/electric_

McKinsey & Company. 2012. Capturing the Full Electricity Efficiency Potential of the UK. Report commissioned by the Department of Energy and Climate Change. [Online].
Available at: <https://www.gov.uk/government/uploads/>

Rockefeller Foundation and Deutsche Bank Climate Change Advisers. 2012. United States Building Energy Efficiency Retrofits. Market Sizing and Financing Models. [Online].
Available at: <http://www.rockefellerfoundation.>

Roland Berger Strategy Consultants. 2011. Market Potential in Energy Efficiency in South East Asia. [Online].
Available at: <http://www.rolandberger.com/media/>

Sayathe, J. 2011. India's Energy Efficiency Potential. [Online]. Available at:

Shaw, J. 2012. 'A Green Empire', Harvard Magazine. [Online]. Available at: <http://harvardmagazine.com/2012/03/a-green-empire> [accessed 26 January 2013].

US Department of Energy. 2010. Energy Saving Potential of Solid-State Lighting in General Illumination Applications 2010-2030. [Online]. Available at: <http://>

US National Academy of Science, National Academy of Engineering and National Research Council. 2010. Real Prospects for Energy Efficiency in the United States. Washington DC, The National Academies Press.

World Business Council for Sustainable Development. 2009. Transforming the Market: Energy Efficiency in Buildings. [Online]. Available at: <http://www.wbcsd.org/transformingthemarketeeb.aspx> [accessed 26 January 2013]. This page has been left blank intentionally

4 A Systematic View of the Benefits of Efficiency

ACEEE. 2012. How Does Energy Efficiency Create Jobs? [Online]. Available at:

Akbari, H., Pomerantz, M. and Taha, H. 2001. 'Cool Surfaces and Shade Trees to Reduce Energy Use and Improve Air Quality in Urban Areas', *Solar Energy* 70: 295-310. [Online]. Available at: <http://www.sciencedirect.com/science/article/pii/S0038092X0000089X> [accessed 28 December 2012].

Bell, C.J. 2012. Energy Efficiency Job Creation: Real World Experiences. [Online]. Available at:

Consumer Focus. 2012. Jobs, Growth and Warmer Homes: Evaluating the Economic Stimulus of Investing in Energy Efficiency Measures in Fuel Poor Homes. [Online]. Available at:

Curwin, T. 2011. 'Energy Price Volatility Now A Major Factor in Corporate Efficiency Drive'. CNBC, 23 August 2011. [Online]. Available at: <http://www.>

Earth Advantage Institute. 2012. Economic Benefits. [Online]. Available at:

Fawkes, S. 2013. 'Setting the Stage for Energy Efficiency Investment'. *Environmental Finance*, 9 January 2013. [Online]. Available at: <http://www.environmental-finance.com/features/view/818> [accessed 26 January 2013].

Galitsky, C., Martin, N., Worrell, E. and Lehman, B. 2003. Energy Efficiency Improvement and Cost Saving Opportunities for Breweries. An ENERGY STAR ® Guide for Energy and Plant Managers. Lawrence Berkeley National Laboratory. [Online]. Available at: <http://ies.lbl.gov/iespubs/50934.pdf> [accessed 28 December 2012].

Hockaday, M. 2012. 'Costa Increases Production with Eco Measures', *Green Build News*, 16 July 2012. [Online]. Available at: <http://www.greenbuildnews.>

Institute for Building Efficiency 2012. Productivity Gains from Energy Efficiency. [Online]. Available at:

Institute for Market Transformation and Appraisal

Institute. 2012. Recognition of Energy Costs and Energy Performance in Real Property Valuation. [Online]. Available at:

Kats, G. 2003. The Costs and Benefits of Green Buildings: A Report to California's Sustainable Building Task Force. Capital E Analytics. [Online]. Available at:

Kats, G. 2006. Greening America's SchoolsL: Costs and Benefits. Capital E Analytics. [Online]. Available at: <http://www.usgbc.org/ShowFile.aspx?DocumentID=2908> [accessed 29 December 2012].

Loftness, V., Hartkopf, V., Gurtekin, B., Hansen, D. and Hitchcock, R. 2003. Linking Energy to Health and Productivity in the Built Environment. Center for Building Performance and Diagnostics, Carnegie Mellon. [Online]. Available at:

Lomonaco, C. and Miller, D. 1997. Environmental Satisfaction, Personal Control and the Positive Correlation to Increased Productivity. Johnson Controls.

L'Union Social pour l'Habitat. 2011. Plan européen pour la relance économique COM(2008) 800 final Mesure n°6: Améliorer l'efficacité énergétique dans les bâtiments. Reprogrammation des programmes opérationnels régionaux des Fonds structurels en faveur des logements sociaux. [Online]. Available at:

McGraw Hill Construction. 2009. Green Building Retrofit & Renovation. [Online]. Available at: http://mts.sustainableproducts.com/Capital_Markets_

McGraw Hill Construction. 2012. 2012 World Green Building Trends. [Online]. Available at:

Millennium Challenge Corporation. Promoting Energy-Efficient Solutions to Address Wintertime Pollution in Mongolia. [Online]. Available at: <http://www.>

Newsham, G.R., Veitch, J.A., Arsenault, C. and Duval, C. 2004. 'Effect of Dimming Control on Office Worker Satisfaction and Performance', in Proceedings of the Annual Conference of the Illuminating Engineering Society of North America, Tampa, Florida.

Philips Lighting. 2008. Lighting Upgrades Boost Workplace Productivity. Philips. [Online]. Available at:

Ries, R., Bilec, M., Gokhan, N. and Needy, K. 2006. 'The Economic Benefits of Green Buildings: A Comprehensive Case Study', *The Engineering Economist* 51(3): 259-95.

Seppänen, O., Fisk, W.J. and Faulkner, D. 2004. Control of Temperature for Health and Productivity in Offices. Lawrence Berkeley National Laboratory. [Online]. Available at: <http://www.escholarship.org/uc/item/39s1m92c#page-1> [accessed 29 December 2012].

Seppänen, O., Fisk, W.J. and Lei, Q.H. 2006. Effect of Temperature on Task Performance in Office Environment. [Online]. Available at: <http://www.osti.gov/bridge/servlets/purl/903490-F5SQYA/903490.pdf> [accessed 26 January 2013].

Shih, K. 2010. Improve Energy Efficiency and Weld Quality by Eliminating Expulsion Welds on Automobile Assembly Line. [Online]. Available at: <http://www.>

Singh, A., Syat, M., Grady, S.G. and Korkmaz, S. 2010. 'Effects of Green Buildings on Employee Health and Productivity'. *American Journal of Public Health*, 15 July 2010. [Online]. Available at: <http://news.msu.edu/media/documents/2010/08/840514e8-0b32-4aa4-9fc8-276b688dfed4.pdf> [accessed 26 January 2013].

UNEP. 2011. Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. [Online]. Available at: <http://www.unep.org/>

US Department of Energy, Office of Electricity Delivery and Energy Reliability. 2012. Infrastructure Security and Energy Restoration. [Online]. Available at:

Williamson, T., Grant, E., Hansen, A., Pisaniello, D. and Andamon, M. 2009. An Investigation of Potential Health Benefits from Increasing Energy Efficiency Stringency Requirements. *Building Code of Australia Volumes One & Two*. The University of Adelaide. [Online]. Available at: <http://www.abcb.gov.au/~media/Files/Download%20Documents/Archived/Major%20>

Wyon, D.P. 2004. 'The Effects of Indoor Air Quality on Performance and Productivity'. *Indoor Air* 14: 92-101. This page has been left blank intentionally

5 Jevons, Rebound and Backfire

Afsah, S., Sakcito, K., and Wielga, C. 2012. Energy Efficiency is for Real, Energy Rebound a Distraction. [Online]. Available at: <http://co2scorecard.org/Content/>

Alcot, B. 2009. The Rebound Effect: Introduction and Historical Perspective. Presentation at the University of Cambridge 14 May 2009. [Online]. Available at:

Barker, T. and Foxon, T. 2008. 'The Macroeconomic Rebound Effect and the UK Economy'. UK Energy Research Centre. [Online]. Available at: <http://www.sciencedirect.com/science/article/pii/S0301421507001565> [accessed 26 January 2013].

Barker, T. and Dagoumas, A. 2009. The Global Macroeconomic Rebound Effect of Energy Efficiency Policies: An Analysis 2012-2030 using E3MG. Presentation made at Cambridge University, 14 May 2009. [Online]. Available at:

Barrett, J. 2011a. Rebounds and Jevons: Nobody Goes There Anymore. It's Too Crowded. [Online]. Available at: <http://realclimateeconomics.org/wp/archives/654> [accessed 27 January 2013].

Barrett, J. 2011b. Rebounds Gone Wild. [Online]. Available at: <http://realclimateeconomics.org/wp/archives/647> [accessed 27 January 2013].

Bosshard, P. 2010. Energy Efficiency: Paid Lunch or False Shortcut? [Online]. Available at:

Brookes, L. 1990. 'Energy Efficiency and Economic Fallacies'. Energy Policy (March): 783-5.

Butler, K. 2011. Do Green Cars Just Make People Drive More? [Online]. Available at:

Chameides, B. 2011. Energy Efficiency on the Rebound. [Online]. Available at:

Goldstein, D. 2010. Some Dilemma: Efficient Appliances Use Less Energy, Produce the Same Level of Service with Less Pollution and Provide Consumers with Greater Savings. What's Not to Like? [Online]. Available at: http://switchboard.nrdc.org/blogs/dgoldstein/some_dilemma_efficient_applian_1.html [accessed 21 April 2013].

Herring, H. 2006. 'Energy Efficiency—A Critical View'. *Energy* 31 (2006): 10–20. [Online]. Available at: http://www.fraw.org.uk/files/economics/herring_2006.pdf [accessed 27 January 2013].

Herring, H. and Roy, R. 2007. 'Technological Innovation, Energy Efficient Design and the Rebound Effect'. *Technovation* 27(4): 194–203.

IEA. 2010. *World Energy Outlook 2010*. [Online]. Available at: <http://www.worldenergyoutlook.org/media/weo2010.pdf> [accessed 26 April 2013].

Jenkins, J. and Saunders, H. 2011. Hot Topic: Does Energy Efficiency Lead to Increased Energy Consumption. [Online]. Available at: <http://www.makingitmagazine.net/?p=3460> [accessed 27 January 2013].

IPCC. 2007. *Climate Change 2007. Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report*. [Online]. Available at:

Jenkins, J., Norhaus, T. and Shellenberger, M. 2011. *Energy Emergence. Rebound and Backfire as Emergent Phenomena*. The Breakthrough Institute. [Online]. Available at: http://thebreakthrough.org/blog/Energy_Emergence.pdf [accessed 26 January 2013].

Jevons, W.S. 1865. *The Coal Question; An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal Mines*. [Online]. Available at: <http://www.econlib.org/library/YPDBooks/Jevons/jvnCQ1.html> [accessed 28 April 2013].

Kemp, R. 2009. Responses to Increased Energy Efficiency in the Real World. Presentation at Cambridge University, 14 May 2009. [Online]. Available at:

Khazzoom, J.D. 1980. 'Economic Implications of Mandated Efficiency Standards for Household Appliances', *The Energy Journal* 11(2): 21–40.

Khazzoom, J.D. 1987. 'Energy Saving Resulting from the Adoption of More Efficient Appliances', *The Energy Journal* 8(4): 85–9.

Khazzoom, J.D. 1989. 'Energy Savings from More Efficient Appliances: A Rejoinder', *The Energy Journal* 10(1): 157–66.

Koerth-Baker, M., Turner, K., De Fence, J. and Xin Cui, C. 2011. The Rebound Effect: Some Questions Answered. Strathclyde Discussion Papers in Economics. [Online]. Available at: <http://www.strath.ac.uk/media/>

Komanoff, C. 2010. If Efficiency Hasn't Cut Energy Use, Then What? [Online]. Available at:

Koomey, J.G. 2011. A Fascinating Encounter with Advocates of Large Rebound Effects. [Online]. Available at: <http://www.koomey.com/post/3286897788> [accessed 27 January 2013].

Kotchen, M. 'Beware of the Rebound Effect', The New York Times, 20 March 2012. [Online]. Available at: <http://www.nytimes.com/roomfordebate/2012/03/19/>

Lee, R. and Wagner, G. The Rebound Effect in a More Fuel Efficient Transportation Centre. The Institute for Policy Integrity, New York University School of Law. [Online]. Available at: http://policyintegrity.org/files/publications/The_Rebound_Effect.pdf [accessed 27 January 2013].

Levi, M. 2010. Mangling Energy Efficiency Economics. [Online]. Available at:

Lomberg, B. 2011. If You Think Efficiency Reduces Our Energy Use, Think Again. [Online]. Available at: <http://www.thenational.ae/thenationalconversation/>

Lovins, A. 2011. Reply to 'The Efficiency Dilemma'. [Online]. Available at: <http://>

Maxwell, D., Owen, P., McAndrew, L., Muehmel, K. and Neubauer, A. 2011. Addressing the Rebound Effect. A report for the European Commission DG Environment. [Online]. Available at: http://ec.europa.eu/environment/eussd/pdf/rebound_effect_report.pdf [accessed 27 January 2013].

New Buildings Institute. 2011. Examples of Deep Energy Savings in Existing Buildings. [Online]. Available at: http://newbuildings.org/sites/default/files/NBI_NEEA_DeepSavingsSearchPhase1_FinalR2_June2011.pdf [accessed 26 April 2013].

Owen, D. 2010. 'The Efficiency Dilemma'. The New Yorker, 20 December 2010, p. 78. [Online]. Available at: <http://www.newyorker.com/>

reporting/2010/12/20/101220fa_fact_owen [accessed 27 January 2013].

Owen, D. 2012a. The Conundrum: How Scientific Innovation, Increased Efficiency, and Good Intentions Can Make Our Energy and Climate Problems Worse. New York, Riverhead Trade.

Owen, D. 2012b. 'Efficiency's Promise: Too Good to Be True'. The New York Times, 4 April 2012. [Online]. Available at: <http://www.nytimes.com/>

Polimeni, J.M., Mayumi, K., Giampietro, M. and Alcott, B. 2008. The Myth of Resource Efficiency. The Jevons Paradox. London, Earthscan.

Powell, B.A. 2010. Brother, Can You Spare a Fridge? [Online]. Available at: <http://>

Roberts, D. 2012. What's the Deal with the Rebound Effect? [Online]. Available at:

Sorrell, S. 2009. 'Jevons' Paradox Revisited: The Evidence for Backfire from Improved Energy Efficiency', Energy Policy 3(4): 1456-569.

Sorrell, S. 2009. The Rebound Effect. Mechanisms, Evidence and Implications. Presentation made at Cambridge University, 14 May 2009. [Online]. Available at:

Sorrel, S. 2010. 'Energy, Economic Growth and Environmental Sustainability: Five Propositions', Sustainability 2: 1784-809.

Sorrell, S., Dimitropoulos, J. and Sommerville, M. 2009. 'Empirical Estimates of the Direct Rebound Effect: A Review', Energy Policy 37(4): 1356-71.

Stavins, R.N., Jaffe, J. and Schatzki, T. 2007. Too Good to Be True? An Examination of Three Economic Assessments of California Climate Change Policy. AEIBrookings Joint Center for Regulatory Affairs. [Online]. Available at: <http://www.nber.org/papers/w13587.pdf> [accessed 27 January 2013].

Street, K. 2011. Does Improving Efficiency Do Any Good? [Online]. Available at:

Thompson, C. 2012. 'Clive Thompson on Unsaving the Planet', Wired (March 2012). [Online]. Available at: http://www.wired.com/magazine/2012/02/st_thompson_energy/

[accessed 27 January 2013].

Tiernery, J. 2011. 'When Energy Efficiency Sullies the Environment', The New York Times, 7 March 2011. [Online]. Available at: http://www.nytimes.com/2011/03/08/science/08tier.html?_r=2&hp [accessed 27 January 2013].

Tlhalefang, J.B. 2009. 'The Impact of Increased Efficiency in the Transport Sectors' Energy Use: A Computable General Equilibrium Analysis for the Botswana Economy', Botswana Journal of Economics. [Online]. Available at: <http://www.ajol.info/index.php/boje/article/view/72975/61866> [accessed 27 January 2013].

Tsao, J.Y., Saunders, H.D., Creighton, J.R., Coltrin, M.E. and Simmons, J.A. 2010. 'Solid-State Lighting: An Energy-Economics Perspective', J.Phys. D: Appl. Phys. 43: 354001.

UKERC. 2007. The Rebound Effect: An Assessment of the Evidence for Economy-Wide Energy Savings from Improved Energy Efficiency. [Online]. Available at: http://www.blakealcott.org/pdf/Rebound_Report_UKERC.pdf [accessed 27 January 2013].

Vaughn, K. 2012. Jevons Paradox: The Debate That Just Won't Die. [Online]. Available at: http://blog.rmi.org/blog_Jevons_Paradox [accessed 27 January 2013].

Vienneau, R. 2011. Blah, Blah, Jevon's Paradox, Blah, Blah, Backfire. [Online]. Available at:

6 Management Techniques

BPF. 2011. Energy Management in Plastics Processing. A Signposting Guide by the British Plastics Federation. [Online]. Available at: <http://www.tangram.co.uk/>

British Beer and Pub Association. 2005. The UK Brewing Industry: Reducing Emissions. [Online]. Available at: <http://www.fcfn.org.uk/sites/default/files/BBPA.pdf> [accessed 27 January 2013].

British Beer and Pub Association. 2006. The British Brewing Industry. Thirty Years of Environmental Improvement 1976-2006. [Online]. Available at: <https://www.ibd.org.uk/cms/file/338> [accessed 31 January 2013].

British Beer and Pub Association. 2011. Great British Pint Keeps Getting Greener - 25 per cent Rise in Energy Efficiency Adds to Great Record for UK Brewers. [Online]. Available at:

Broad, L. 2012. How to Engage Your Employees on Energy Management: Dos and Don'ts. [Online]. Available at: <http://www.2degreesnetwork.com/groups/>

Checkland, P.B. 1981. Systems Thinking, Systems Practice. Chichester, John Wiley & Sons.

Drucker, P.F. 1964. Managing for Results. New York, Harper & Row.

Ekins, P., Kesicki, F. and Smith, A.Z.P. 2011. Marginal Abatement Cost Curves: A Call for Caution. [Online]. Available at: <http://www.bartlett.ucl.ac.uk/energy/news/documents/ei-news-290611-macc.pdf> [accessed 27 January 2013].

EPA (United States Environmental Protection Agency). 2012. 3M Lean Six Sigma and Sustainability. [Online]. Available at: <http://www.epa.gov/lean/environment/studies/3m.htm> [accessed 28 December 2012].

Fawkes, S. 2007. Outsourcing Energy Management. Aldershot, Gower Publishing.

IMO (International Maritime Organization). 2012. Energy Efficiency and the Reduction of GHG Emissions from Ships. [Online]. Available at: <http://www.imo.org/MediaCentre/HotTopics/GHG/Pages/default.aspx> [accessed 27 January 2013].

ISO. 2009. Environmental Management. The ISO 14000 Family of International Standards. [Online]. Available at: http://www.iso.org/iso/theiso14000family_2009.pdf [accessed 26 April 2013].

ISO. 2012. ISO 50001 - Energy Management. [Online]. Available at: <http://www.>

Langrish, J. 1979. 'The Effects of Technological Change', in Baker, M. (ed.) Industrial Innovation: Technology, Policy and Diffusion. London, Macmillan.

Lavery, G. 2011. ERICs Replacing Marginal Abatement Cost Curves (MACCs). [Online]. Available at: <http://drgreglavery.wordpress.com/erics-replacingmaccs/> [accessed 27 January 2013].

McKinsey and Company. 2007. Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost? [Online]. Available at: <http://www.mckinsey.com/>

McKinsey and Company. 2009. Increasing the Energy Efficiency of Supply Chains. [Online]. Available at: http://www.mckinseyquarterly.com/Increasing_the_energy_efficiency_of_supply_chains_2414 [accessed 27 January 2013].

McLean-Conner, P. 2009. Energy Efficiency. Principles and Practice. Tulsa OK, PennWell.

Oung, K. 2013. Energy Management in Business. Farnham, Gower Publishing.

Schultz, S. 2010. Implementing a Corporate Energy Management System. Presented at the US Department of Energy Industrial Technologies Program, 3 June 2010 Webcast. [Online]. Available at <http://www1.eere.energy.gov/>

Vesma, V. 2012. Energy Management Principles and Practice. London, British Standards Institute. [Online]. Available at: <http://shop.bsigroup.com/>

7 Energy Management Examples

Abe, A., Taguchi, E., Karakai, M., Kato, M. and Fujie, Y. 2012. Energy Efficiency Measures in Japan: Case Studies. [Online]. Available at: http://www.thegreengrid.org/~media/WhitePapers/WP40%20%20JapanCaseStudyWP0711Final_en.pdf?lang=en [accessed 27 January 2013].

Dow. 2012. 2011 Annual Sustainability Report. [Online]. Available at: <http://>

Ecopare. 2012. Lean Energy Management Case Study. [Online]. Available at:

EPA (United States Environmental Protection Agency). 2012. 3M Lean Six Sigma and Sustainability. [Online]. Available at: <http://www.epa.gov/lean/environment/studies/3m.htm> [accessed 28 December 2012].

Garforth, P. 2005a. Corporate Energy Productivity and GHG Reduction Strategy. 'The Owens Corning Experience'. Presented at Competing in a Carbon Constrained World, Berkeley CA, 19 April 2005.

Garforth, P. 2005b. Managing Energy Productivity. 'A Competitive Prerequisite'. [Online]. Available at: <http://aceee.org/files/pdf/conferences/ssl/2005/05ssgarforth.pdf> [accessed 27 January 2013].

Garforth, P. 2008. Energy in a Carbon Constrained World. Connecting the Dots of Opportunity. [Online]. Available at:

GSMA. 2012. Mobile Energy Efficiency. [Online]. Available at: <http://www.gsma.com/publicpolicy/mobile-energy-efficiency> [accessed 27 January 2013].

IATA (International Air Transport Association). 2009. 'A Global Approach to Reducing Aviation Emissions'. [Online]. Available at: <http://www.iata>.

IMO (International Maritime Organization). 2012. Energy Efficiency and the Reduction of GHG Emissions from Ships. [Online]. Available at: <http://www.imo.org/MediaCentre/HotTopics/GHG/Pages/default.aspx> [accessed 27 January 2013].

IMO. 2013. 'Work on Updating Greenhouse Gas Emissions

Estimate for International Shipping Moves Forward at Expert Workshop'. [Online]. Available at:

Kuse, C. 2012. Challenges for Shipping Industry. Could New Fuels and Scrubbers be the Answer? [Online]. Available at: <http://www.markis.eu/fileadmin/Arkiv/Dokumenter/MARCOD/CarstenKruise-StenaLine.pdf> [accessed 27 January 2013].

Motegi, N., Piette, M., Kinney, S. and Dewey, J. 2003. Case Studies of Energy Information Systems and Related Technology: Operational Practices, Costs and Benefits. [Online]. Available at: <http://gaia.lbl.gov/btech/papers/53406.pdf> [accessed 27 January 2013].

O'Brien-Bernini, F. 2011. Sustainability at Owens Corning. [Online]. Available at:

Prindle, W.R. 2010. From Shop Floor to Top Floor: Best Business Practices in Energy Efficiency. Pew Center on Global Climate Change. [Online]. Available at:

Public Sector Sustainability Association. 2012. Case Studies - Energy Management. [Online]. Available at: <http://pssa.info/category/case-studies/>

Shippingefficiency.org. 2012. 'Major Charterers Opt for More Efficient Vessels', Tanker Operator, 5 October 2012. [Online]. Available at: <http://>

United Nations Industrial Development Organization. 2010. Global Industrial Energy Efficiency Benchmarking. An Energy Policy Tool. [Online]. Available at:

United States Department of Energy Advanced Manufacturing Office. 2012. Case Studies. [Online]. Available at: http://www1.eere.energy.gov/manufacturing/tech_deployment/case_studies.html [accessed 27 January 2013].

Urlaub, J. 2010. Energy Efficiency: A Gateway to Employee Engagement. [Online]. Available at:

US Department of Energy Industrial Technologies Program, June 3 2010. [Online]. Available at: <http://www1.eere.energy.gov/manufacturing/>

Wilkinson, L. 2012. Energy Management in Practice: A Retail Case Study. [Online]. Available at:

http://www.esta.org.uk/EVENTS/2010_11_MSED/documents/2010_11_MSED_t-mac.pdf [accessed 27 January 2013]. This page has been left blank intentionally

8 Technologies for Energy Efficiency

Acker, B., Duarte, C. and Van Den Wymelenberg, K. 2012. Office Space Plug Load Profiles and Energy Saving Interventions. [Online]. Available at: <http://>

Air Movement and Control Association International Inc. 2010. Inmotion, Spring 2010. [Online]. Available at: http://www.amca.org/UserFiles/file/AMCA_Spring2010Revlores.pdf [accessed 22 April 2013].

Allen, M. 2005. 'Looking for a Miracle: We Test Automotive "Fuel Savers"', Popular Mechanics, 25 August 2005. [Online]. Available at: <http://www>.

AMSC. 2013. AMSC. [Online]. Available at: <http://www.amsc.com> [accessed 28 April 2013].

Aspen Aerogels. 2013. Case Studies. [Online]. Available at: <http://www.aerogel.com/markets/cases.html> [accessed 27 January 2013].

Autonomic Materials. 2013. Autonomic Materials. [Online]. Available at: <http://www.autonomicmaterials.com> [accessed 28 April 2013].

Barney, G. 2007. Energy Efficiency of Lifts - Measurement, Conformance, Modelling, Prediction and Simulation. [Online]. Available at: <http://www.cibseliftsgroup.org/docs/Barney-on-energy%20efficiency%20of%20lifts.pdf> [accessed 27 January 2013].

Boeing Research & Technology. 2010. Subsonic Ultra Green Aircraft Research SUGAR Final Review. [Online]. Available at: <http://www.scribd.com/>

Breathing Buildings. 2013. Breathing Buildings. [Online]. Available at: <http://www.breathingbuildings.com/home> [accessed 28 April 2013].

Brendel, M. 2010. The Role of Fan Efficiency in Reducing HVAC Energy Consumption. [Online]. Available at: http://www.amca.org/UserFiles/file/AMCA_Spring2010RoleOfFE.pdf [accessed 27 January 2013].

Buildings Performance Institute Europe. 2011a. Principles for Nearly Zero-Energy Buildings. [Online]. Available at: <http://www.institutebe.com/InstituteBE/>

Buildings Performance Institute Europe. 2011b. Europe's

Buildings Under the Microscope. [Online]. Available at:
[http://www.europeanclimate.org/
documents/LR_%20CbC_study.pdf](http://www.europeanclimate.org/documents/LR_%20CbC_study.pdf) [accessed 27 January 2013].

CamSemi. 2013. CamSemi. Controllers for Low Cost, Energy
Efficient Power Conversion. [Online]. Available at:
<http://www.camsemi.com> [accessed 28 April 2013].

Carbon War Room. 2012. Improving Building Performance.
Reduce Energy Consumption by 20% with Little or No Cost.
[Online]. Available at: <http://www.>

CDW-G. 2012. Data Center Solutions that Deliver Energy
Efficiency. [Online]. Available at:
<http://www.cdwnewsroom.com/2012-energy-efficient-itreport/>
[accessed 27 January 2013].

Cisco. 2007. Cisco Energy Efficient Data Center Solutions
and Best Practices. [Online]. Available at:
<http://www.cisco.com/en/US/solutions/ns708/>

Commercial Buildings Consortium. 2011. Next Generation
Technologies Barriers & Industry Recommendations for
Commercial Buildings. [Online]. Available at:

Committee on Integrated Computational Materials
Engineering, National Research Council. 2008. Integrated
Computational Materials Engineering: A Transformational
Discipline for Improved Competitiveness and National
Security. Washington, DC, National Academies Press.

Council of Energy Ministers, Canada. 2009. On the Road to a
Fuel-Efficient Truck. [Online]. Available at:
[http://fleetsmart.nrcan.gc.ca/documents/PDF/ trucking.pdf](http://fleetsmart.nrcan.gc.ca/documents/PDF/trucking.pdf)
[accessed 27 January 2013].

Datum Phase Change. 2013. Datum Phase Change. [Online].
Available at: [http://
www.datumphasechange.com/index.php?home](http://www.datumphasechange.com/index.php?home) [accessed 28 April
2013].

de Beer, J., Worrel, E. and Blok, K. 1998. 'Future
Technologies for EnergyEfficient Iron and Steel Making,
Annual Review', Energy Environment 23: 123-205.

Delta Energy & Environment. 2011a. Home Energy Management
in Europe: Lots of Solutions, but What's the Problem?
[Online]. Available at: <http://www.delta-ee.>

Delta Energy & Environment. 2011b. Driving a Resource

Efficiency Power Generation Sector in Europe. [Online]. Available at: <http://www.delta-ee>.

Ecomagination. 2013. Ecomagination. [Online]. Available at: www.ecomagination.com [accessed 28 April 2013].

Energetix. 2013. Energetix. [Online]. Available at: <http://energetixgroup.com> [accessed 28 April 2013].

Energy Deck. 2013. Energy Deck. [Online]. Available at: <http://www.energydeck.com/home/> [accessed 28 April 2013].

EnergyFlo. 2012. How Dynamic Insulation Works. [Online]. Available at:

Energy Savings Trust. 2011. Lit Up: An LED Lighting Field Trial. [Online]. Available at:

Financial Times. 2013. 'Entrepreneurship: Chinese Turn Attention to Waste Heat Recovery'. [Online]. Available at:

Fine, C. and Roth, R. 2010. Lightweight Materials for Transport: Developing a Vehicle Technology Roadmap for the Use of Lightweight Materials. [Online]. Available at: http://www.alum.mit.edu/sites/default/files/IC_assets/news/images/alumninews/Fine_Roth.pdf [accessed 27 January 2013].

Freeman, C. 1974. The Economics of Industrial Innovation. Harmondsworth, Penguin Modern Economic Texts.

Green Pocket. 2013. Green Pocket. [Online]. Available at: <http://www.greenpocket.de> [accessed 28 April 2013].

Ilika. 2013. Ilika. [Online]. Available at: <http://www.ilika.com> [accessed 28 April 2013].

International Aluminium Institute. 2012. Improving Sustainability in the Transport Sector. [Online]. Available at: http://www.world-aluminium.org/media/filer_public/2013/01/15/none_1 [accessed 27 January 2013].

International Energy Agency. 2010. Guidebook on Energy Efficient Electric Lighting for Buildings. [Online]. Available at: http://www.ecbcs.org/docs/ECBCS_Annex_45_Guidebook.pdf [accessed 27 January 2013].

Intelligent Energy Europe. 2010. Energy Efficient Elevators and Escalators. [Online]. Available at: <http://www.e4project.eu/documenti/wp6/E4-WP6Brochure.pdf> [accessed 27 January 2013].

Jaguar Cars. 2012. Innovation, Imagination, Intelligence. [Online]. Available at:

Kaneda, D., Jacobson, B. and Rumsey, P. 2010. Plug Load Reduction: The Next Big Hurdle for Net Zero Energy Building Design. [Online]. Available at: <http://>

Knowledge Transfer Network. 2012. UK Air Vehicle Technology. Emerging and Disruptive Technologies for Future Vehicles and Concepts. [Online]. Available at: https://connect.innovateuk.org/c/document_library/get_

Kroo, I. 2008. Sustainable Aviation: Future Air Transportation and the Environment. [Online]. Available at: <http://aa.stanford.edu/events/50thAnniversary/media/Kroo.pdf> [accessed 27 January 2013].

kWhOURS. 2013. kWhOURS. [Online]. Available at: <http://www.kwhours.com> [accessed 28 April 2013].

Lowe, M., Golini, R. and Gereffi, G. 2010. U.S. Adoption of High-Efficiency Motors and Drives: Lessons Learned. [Online]. Available at: http://www.cggc.duke.edu/pdfs/CGGC-Motor_and_Drives_Report_Feb_25_2010.pdf [accessed 29 May 2013].

McKinsey & Company. 2012. Lighting the Way. Perspectives on the Global Lighting Market. [Online]. Available at: <http://www.mckinsey.com/~/>

Moore, G. 1991. Crossing the Chasm. Chichester, HarperCollins.

Moram, M. 2011. Energy-Efficient Lighting. [Online]. Available at: <http://>

The Motor Ship. 2010. 'Stena E-MAXair - Probably the Greenest Tanker in the World', The Motor Ship, 8 January 2010. [Online]. Available at: <http://www>.

Nanoco. 2013. Nanoco Group PLC. [Online]. Available at: <http://www.nanocotechnologies.com> [accessed 28 April 2013].

NASA. 2011. Subsonic Ultra Green Aircraft Research: Phase I Final Report. [Online]. Available at:

Neal, E., Molina, M. and Trombley, D. 2012. A Defining Framework for Intelligent Efficiency. [Online]. Available

at: <http://www.aceee.org/sites/default/files/publications/researchreports/e125.pdf> [accessed 27 January 2013].

NGenTec. 2013. About NGenTec. [Online]. Available at: <http://www.ngentec.com/about.asp> [accessed 28 April 2013].

NRDC. 2012. Is Cloud Computing Always Greener? [Online]. Available at: <http://www.nrdc.org/energy/files/cloud-computing-efficiency-IB.pdf> [accessed 27 January 2013].

Nujira. 2013. Nujira. [Online]. Available at: <http://www.nujira.com> [accessed 28 April 2013].

OECD and Eurostat. 2005. Oslo Manual. Guidelines for Collecting and Interpreting Innovation Data. Third edition. [Online]. Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/OSLO/EN/OSLO-EN.PDF [accessed 27 April 2013].

O-Flexx. 2013. About O-Flexx. [Online]. Available at: <http://www.o-flexx.com/en/company/about-o-flexx/about-o-flexx/> [accessed 28 April 2013].

Onzo. 2013. Onzo. [Online]. Available at: <http://www.onzo.com> [accessed 28 April 2013].

Patrão, C., Rivet, L., Fong, J. and Almeida, A. 2009. Energy Efficient Elevators and Escalators. [Online]. Available at: http://www.eceee.org/conference_proceedings/eceee/2009/Panel_4/4.037/paper [accessed 27 January 2013].

Patrão, C., Almeida, A., Fong, J. and Ferreira, F. 2010. Elevators and Escalators Energy Performance Analysis. [Online]. Available at: <http://www.aceee.org/files/proceedings/2010/data/papers/1981.pdf> [accessed 27 January 2013].

PAX Scientific. 2013. PAX Scientific. [Online]. Available at: <http://www.paxscientific.com> [accessed 28 April 2013].

Retroficiency. 2013. Retroficiency. [Online]. Available at: <http://www.retroficiency.com> [accessed 28 April 2013].

Rocky Mountain Institute, 2013. U.S. Price vs. Rated Efficiency of 250-hp Motors. [Online]. Available at: http://www.rmi.org/RFGGraph-US_price_vs_rated_

efficiency_250_hp_motors [accessed 29 May 2013].

Sefaira. 2013. Sefaira. [Online]. Available at:
<http://www.sefaira.com> [accessed 28 April 2013].

Subrato, C., Widder, S. and Jackson, R. 2011. 50 Pilot Deep Energy Retrofits. [Online]. Available at:
http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/ns/eemt082011_c7_50_pilot_deep.pdf
[accessed 27 January 2013].

Sumitomo. 2013. Sumitomo Electric Industries. [Online]. Available at: [http:// global-sei.com/super/index.en.html](http://global-sei.com/super/index.en.html)
[accessed 28 April 2013].

UK Department of Transport. 2009. A Quick Guide to Truck Aerodynamics. London, HMSO.

UKTI. 2012. UK Advanced Engineering. [Online]. Available at: <http://www.ukti.gov.uk/investintheuk/uktipublications/item/289700.html>
[accessed 22 April 2013].

United States Department of Energy. 2011. Best Practices Guide for Energy Efficient Data Center Design. [Online]. Available at: <http://www1.eere.energy.gov/femp/pdfs/eedatacenterbestpractices.pdf> [accessed 27 January 2013].

United States Department of Energy. 2012. Energy Savings Potential of Solid-State Lighting in General Illumination Applications. [Online]. Available at: <http://>

University of Leicester. 2011. When Size Matters: Nanotechnology for Energy Efficiency. [Online]. Available at: <http://www.alphagalileo.org/ViewItem.aspx?ItemId=105572&CultureCode=en> [accessed 27 January 2013].

View Glass. 2013. View Glass. [Online]. Available at:
<http://www.viewglass.com> [accessed 28 April 2013].

VPhase. 2013. VPhase Voltage Optimisation. [Online]. Available at: <http://www.vphase.co.uk> [accessed 28 April 2013].

Wasabi. 2013. Wasabi Energy. [Online]. Available at:
<http://www.wasabienergy.com> [accessed 28 April 2013].

Weightman, D. and Field, J. 2012. Office Plug Loads: Energy Use and Savings Opportunities. [Online]. Available at:

<http://www.esource.com/esource/>

Wellington. 2013. Wellington Energy Saving ECM Motors and Fans. [Online]. Available at: <http://www.wdtd.com> [accessed 28 April 2013].

Woodley, A. 2012. Composite Winglets Reduce Aircraft Emissions. [Online]. Available at: <https://connect.innovateuk.org/web/composites/articles/-/>

Wooley, J. 2011. Fostering the Development and Commercialization of Climate Appropriate Cooling Technologies. [Online]. Available at: http://aceee.org/files/pdf/conferences/eer/2011/BS5E_Wooley.pdf [accessed 27 January 2013].

World Bank. 2012. Air Transport and Energy Efficiency. [Online]. Available at:

Zenex. 2013. GasSaver. [Online]. Available at: <http://www.zenexenergy.co.uk/>

Zhai, J., LeClaire, N. and Bendewald, M. 2011. 'Deep Energy Retrofit of Commercial Buildings: A Key Pathway Towards Low-Carbon Cities', Carbon Management 2(4): 425-30.

Zimmerann, M. and Andersson, J. (eds). 1998. Low Energy Cooling. Case Study Buildings. [Online]. Available at: http://www.ecbcs.org/docs/annex_28_case_study_buildings.pdf [accessed 27 January 2013]. This page has been left blank intentionally

9 Designing for Energy Efficiency

Carmichael, C. 2011. GSA Net Zero Renovation Challenge Charette. [Online]. Available at: http://www.rmi.org/Knowledge-Center/Library/2011-18_GSANetZero [accessed 28 January 2013].

Kats, G. 2009. Greening Our Built World: Costs, Benefits and Strategies. Washington, DC, Island Press.

Lovins, A. 2007a. Public Lectures in Advanced Energy Efficiency. 1. Buildings. [Online]. Available at:

Lovins, A. 2007b. Public Lectures in Advanced Energy Efficiency. 2. Industry. [Online]: Available at: http://www.rmi.org/Content/Files/E07-03_Stanford_2Industry.pdf [accessed 27 January 2013].

Lovins, A. 2007c. Public Lectures in Advanced Energy Efficiency. 3. Transportation. [Online]. Available at: http://www.rmi.org/Content/Files/E07-04_Stanford_3Transport.pdf [accessed 27 January 2013].

Lovins, A. 2007d. Public Lectures in Advanced Energy Efficiency. 4. Implementation. [Online]. Available at: http://www.rmi.org/Content/Files/E07-05_Stanford_4Implement.pdf [accessed 27 January 2013].

Lovins, A. 2007e. Public Lectures in Advanced Energy Efficiency. 5. Implications. [Online]. Available at: http://www.rmi.org/Content/Files/E07-06_Stanford_5Implications.pdf [accessed 27 January 2013].

New Buildings Institute. 2011. NEEA Examples of Deep Energy Savings in Existing Buildings. [Online]. Available at: <http://www.betterbricks.com/sites/>

New Buildings Institute. 2012. Buildings Database. [Online]. Available at: <http://buildings.newbuildings.org> [accessed 27 January 2013].

Passivhaus UK. 2012. Passivhaus. The World's First Fabric Approach to Low Energy Buildings. [Online]. Available at: <http://www.passivhaus.org.uk/standard.jsp?id=122> [accessed 27 January 2013].

Reed, B. and Fedrizzi, S.R. 2009. The Integrative Design Guide to Green Building: Redefining the Practice of Sustainability. Hoboken NJ, John Wiley & Sons.

Rocky Mountain Institute. 2012a. Built Environment: Impact and Project Experience. [Online]. Available at: http://www.rmi.org/rmi/retrofit_consulting_project_experience [accessed 27 January 2013].

Rocky Mountain Institute. 2012b. True Stories. [Online]. Available at: <http://>

SEAI. 2009. Case Study: Lakeland Dairies. Sustainable Energy Authority of Ireland. [Online]. Available at: http://www.seai.ie/Your_Business/Energy_

SEAI. 2011. Energy Efficient Design Methodology. [Online]. Available at: <http://>

Sefaira. 2013. Sefaira. [Online]. Available at: <http://www.sefaira.com> [accessed 28 April 2013].

US Green Building Council. 2012. LEED. [Online]. Available at: <http://new.usgbc.org/leed> [accessed 27 January 2013].
This page has been left blank intentionally

10 Financing Energy Efficiency Investment

Adler, M. 2012. Revolving Fund for Housing in Estonia. [Online]. Available at:

Angell, C. 2009. Addressing the Energy Efficiency Financing Challenge: The Role and Limitations of a Green Bank. [Online]. Available at: <http://web.law.columbia>.

BASE and UNEP. 2006. Public Finance Mechanisms to Increase Investment in Energy Efficiency. [Online]. Available at: http://www.sefalliance.org/fileadmin/media/base/downloads/pfm_EE.pdf [accessed 28 January 2013].

Berger, S. 2011. Energy Saving Partnership Berlin. Supporting ESCO Markets on a Regional Basis. [Online]. Available at: http://www.seai.ie/News_Events/Previous_SEAI_events/Susanne%20Berger.pdf [accessed 28 January 2013].

Bleyl-Androschin, J.W. 2009. Integrated Energy Contracting (IEC). A New ESCo Model to Combine Energy Efficiency and (Renewable) Supply in Large Buildings and Industry. [Online]. Available at: <http://www.ieadsm.org/>

Bloomberg. 2012. Brazil May Invest \$3 Billion in Energy Efficiency as Loans Rise. [Online]. Available at:

Bocskay, S. 2012. Financing Your Retrofit. [Online]. Available at: <http://www>.

Borgeson, M., Zimring, M. and Goldman, C. 2012. The Limits for Financing Energy Efficiency. [Online]. Available at: <http://eetd.lbl.gov/ea/emp/reports/limits-financing-ee-2012.pdf> [accessed 28 January 2013].

Brown, M. 2008. State Energy Efficiency Policies. Options and Lessons Learned. Brief #1. Funding Mechanisms for Energy Efficiency. [Online]. Available at: http://ase.org/sites/default/files/file_Brief_1v3.pdf [accessed 28 January 2013].

Brown, M.H. and Braithwaite, H. 2011. Energy Efficiency Finance: Options and Roles for Utilities. [Online]. Available at: <http://www.swenergy.org/>

Bulgaria Housing Association. 2012. Energy Saving Measures in Residential Buildings in Bulgaria. [Online]. Available at: [http://www.e3g.org/images/uploads/E3G_EEFinance_061112_E-Gaydarova_\(Bulgaria\).pdf](http://www.e3g.org/images/uploads/E3G_EEFinance_061112_E-Gaydarova_(Bulgaria).pdf)

[accessed 28 January 2013].

Buonicore, A.J., O'Neil, K.E. and Bailey, J. 2013. Underwriting Energy Efficiency Financing in The Innovative Connecticut PACE Program. [Online]. Available at:

California First. 2013. Save Energy. Increase Cash Flow. Low-Cost, Long-Term Financing. [Online]. Available at: <https://californiafirst.org/overview> [accessed 27 January 2013].

California Statewide Communities Development Authority. 2012. Sustainable Energy Bond Program. [Online]. Available at: http://www.cacommunities.org/fileadmin/hb/cscda/energy_finance_programs/CSCDA_FREE_Webinar__9-13-12.pdf [accessed 28 January 2013].

CDFA (2013). The Pennsylvania Treasury Department Executes a Secondary Market Sale of Consumer Energy Loans. [Online]. Available at: <http://www.cdfa.net/>

Clarkson, D. 2012. Using Public and ARRA Funds to Leverage Private Capital to Finance Energy Efficiency Projects. [Online]. Available at: <http://www.eefinance.net/docs/EEFC%20Presentation--ACEEE--5-20-10.pdf> [accessed 28 January 2013].

Clinton Climate Initiative. 2009. Contracting Financing Options EPC Toolkit for Higher Education. [Online]. Available at: <http://www2.presidentsclimatecommitment.>

Clinton Climate Initiative. 2011. Policy Brief. Property Assessed Clean Energy (PACE) Financing: Update on Commercial Programs. [Online]. Available at: <http://eetd.lbl.gov/ea/ems/reports/pace-pb-032311.pdf> [accessed 28 January 2013].

Copithorne, B. and Fine, J. 2011. On-Bill Repayment: Unlocking the Energy Efficiency Puzzle in California. [Online]. Available at: <http://www.edf.org/>

Cruceru, M., Voronca, M.M. and Palita, V. 2009. Projects Financing in the Field of Rational Use of Energy. [Online]. Available at: http://synenergy.teipir.gr/papers/I_2.pdf [accessed 28 January 2013].

Duenas, M. 2012. Securing Finance for Energy Efficiency: EIB Experience and Strategic View. [Online]. Available at: [http://www.e3g.org/images/uploads/E3G_EEFinance_061112_M-Duenas_\(EIB\).pdf](http://www.e3g.org/images/uploads/E3G_EEFinance_061112_M-Duenas_(EIB).pdf) [accessed 28

January 2013].

Empire State Building. n.d. The Empire State Building: Creating a Replicable Model for Energy Efficiency Reinvestment. [Online]. Available at: <http://www.esbnyc.org>.

Energy Policy Institute. 2010. Energy Efficiency Financing Mechanisms. [Online]. Available at:

Energy Star. 2007. Financing Guidebook for Energy Efficiency Program Sponsors. [Online]. Available at: http://www.energystar.gov/ia/home_improvement/downloads/FinancingGuidebook.pdf [accessed 28 January 2013].

Farrell, D. and Remes, J. 2008. 'How the World Should Invest in Energy Efficiency', The McKinsey Quarterly, July 2008. [Online]. Available at: <http://www.mckinsey.com>

Fawkes, S. 2007. Outsourcing Energy Management. Aldershot, Gower Publishing.

Freehling, J. 2011. Energy Efficiency Finance 101: Understanding the Marketplace. [Online]. Available at: <http://aceee.org/files/pdf/white-paper/Energy%20Efficiency%20Finance%20Overview.pdf> [accessed 28 January 2013].

GAO. 2005. Energy Savings: Performance Contracts Offer Benefits, But Vigilance Is Needed to Protect Government Interests. [Online]. Available at: <http://www.gao.gov/assets/250/246803.pdf> [accessed 27 January 2013].

GEA. 2012. Global Energy Assessment - Toward a Sustainable Future. Cambridge UK and New York NY, Cambridge University Press, and the International Institute for Applied Systems Analysis, Laxenburg, Austria.

Gerdes, J. 2012. 'San Francisco Announces Biggest Commercial Clean Energy PACE Retrofit'. Forbes. [Online]. Available at: <http://www.forbes.com/sites/jeremy-gerdes/>

Ghekier, L. 2012. ERDF as a Lever to Mobilise Co-Financing. [Online]. Available at:

Hayes, S., Nadel, S., Granda, C. and Hottel, K. 2011. What Have We Learned From Energy Efficiency Financing Programs? [Online]. Available at: <http://aceee.org/research-report/u115> [accessed 28 January 2013].

ICP. 2013. Investor Confidence Project. [Online]. Available at: www.eepperformance.org [accessed 28 April 2013].

IFC. 2011. IFC Energy Service Company Market Analysis. [Online]. Available at:

International Energy Agency. 2011. Joint Public-Private Approaches for Energy Efficiency Finance. [Online]. Available at: <http://www.iea.org/publications/freepublications/publication/finance-1.pdf> [accessed 28 January 2013].

International Energy Agency. 2012a. Plugging the Energy Efficiency Gap with Climate Finance. [Online]. Available at: <http://www.iea.org/publications/freepublications/>

International Energy Agency. 2012b. The Future of Energy Efficiency Finance. [Online]. Available at: http://www.iea.org/media/workshops/2012/energyefficiencyfinance/workshop_report.pdf [accessed 28 January 2013].

Jollands, N. 2012. Sustainable Energy Finance Facilities in the Residential Sector. [Online]. Available at: [http://www.e3g.org/images/uploads/E3G_EEFinance_061112_N-Jollands_\(EBRD\).pdf](http://www.e3g.org/images/uploads/E3G_EEFinance_061112_N-Jollands_(EBRD).pdf) [accessed 28 January 2013].

Kapur, N., Hiller, J., Abramson, A. and Langdon, R. 2011. Show Me the Money. Energy Efficiency Financing Barriers and Opportunities. [Online]. Available at:

Kim, C., O'Connor, R., Bodden, K., Hochman, S., Liang, W., Pauker, S. and Zimmermann, S. 2012. Innovations and Opportunities in Energy Efficiency Finance. [Online]. Available at: <http://www.wsgr.com/publications/PDFSearch/WSGR-EE-Finance-White-Paper.pdf> [accessed 28 January 2013].

Kirkpatrick, A.J. 2012. Closing the 'Energy-Efficiency Gap': An Empirical Analysis of Property Assessed Clean Energy. [Online]. Available at: http://pacenow.org/wp-content/uploads/2012/08/Kirkpatrick_PACE_MP.pdf [accessed 28 January 2013].

Kuma, S. 2010. Promoting Innovative Energy Efficiency Financing Mechanisms. [Online]. Available at: <http://asiaesco.org/pdf/presentation/6-2.pdf> [accessed 29 January 2013].

Larsen, P., Goldman, C. and Satchwell, A. 2012. Evolution of the U.S. Energy Service Company Industry: Market Size and Project Performance from 1990-2008. LBNL-5447-E, July. [Online]. Available at: <http://emp.lbl.gov/sites/all/files/lbnl-5447e.pdf> [accessed 27 April 2013].

MacLean, J. 2008. Mainstreaming Environmental Finance Markets (I) - SmallScale Energy Efficiency and Renewable Energy Finance. [Online]. Available at:

McCaffree, M. 2010. Alternative Financing Mechanisms for Energy Efficiency. [Online]. Available at: http://www.edisonfoundation.net/IEE/Documents/IEE_AltFinancingMech_McCaffree.pdf [accessed 28 January 2013].

Miliken Institute. 2009. PACE Finance: Innovative Funding to Accelerate the Retrofitting of America's Buildings for Energy Independence. [Online]. Available at:

Miliken Institute. 2010. Financing the Residential Retrofit Revolution. [Online]. Available at: http://www.milkeninstitute.org/pdf/FILab_Res_Retrofit_April_20.pdf [accessed 28 January 2013].

Nakagami, H. 2010. Recent Activity of the ESCO Industry in Japan and Asian Countries. [Online]. Available at: <http://www.asiaesco.org/pdf/presentation/3-1.pdf> [accessed 28 January 2013].

National Governors Association. 2011. State Clean Energy Financing Guidebook. [Online]. Available at: <http://www.nga.org/files/live/sites/NGA/files/pdf/1101CLEANENERGYFINANCING.PDF> [accessed 28 January 2013].

Neme, C., Gottstein, M. and Hamilton, B. 2011. Residential Efficiency Retrofits: A Roadmap for the Future. [Online]. Available at: <http://www.raponline>.

ORNL. 2007a. Evaluation of the Super ESPC Program - Reported Energy and Cost Savings. [Online]. Available at: http://www.ornl.gov/sci/femp/pdfs/200705_interim_report.pdf [accessed 27 April 2013].

ORNL. 2007b. Evaluation of the Super ESPC Program - Level 2 - Recalculated Cost Savings. [Online]. Available at: <http://info.ornl.gov/sites/publications/files/Pub6386.pdf> [accessed 27 January 2013].

PACENow. 2013. What is PACE? [Online]. Available at:
<http://pacenow.org/about-pace/what-is-pace/> [accessed 27
January 2013].

Palmer, K., Wells, M. and Gerarden, E. 2012. An Assessment
of Energy-Efficiency Financing Programs. [Online].
Available at: [http://www.rff.org/RFF/
Documents/RFF-Rpt-Palmeretal%20EEFinancing.pdf](http://www.rff.org/RFF/Documents/RFF-Rpt-Palmeretal%20EEFinancing.pdf) [accessed 28
January 2013].

Peretz, N. 2009. Growing the Energy Efficiency Market
Through Third-Party Financing. [Online]. Available at:

Planning Commission, Government of India. 2008. Eleventh
Five Year Plan (2007-2012). [Online]. Available at:
[http://planningcommission.nic.in/plans/
planrel/fiveyr/11th/11_v1/11th_vol1.pdf](http://planningcommission.nic.in/plans/planrel/fiveyr/11th/11_v1/11th_vol1.pdf) [accessed 29
January 2013].

Planning Commission, Government of India. 2011. Faster,
Sustainable and More Inclusive Growth. An Approach to the
Twelfth Five Year Plan. [Online]. Available at:
[http://planningcommission.nic.in/plans/planrel/12appdrft/
approach_12plan.pdf](http://planningcommission.nic.in/plans/planrel/12appdrft/approach_12plan.pdf) [accessed 29 January 2013].

PWC. 2011. Financing Mechanism for Energy Efficiency
Projects and Programmes. [Online]. Available at:
[http://www.iea.org/media/workshops/2011/ipeecweact/
Kumar.pdf](http://www.iea.org/media/workshops/2011/ipeecweact/Kumar.pdf) [accessed 28 January 2013].

RE:FIT. 2013. RE:FIT. [Online]. Available at:
<http://www.refit.org.uk> [accessed 28 April 2013].

Rezessy, S. and Beroldi, P. 2010. Financing Energy
Efficiency: Forging the Link Between Financing and Project
Implementation. [Online]. Available at: <http://>

Rickard, S., Hardy, B., Von Neida, B. and Mihlmester, P.
1998. The Investment Risk in Whole Building
Energy-Efficiency Upgrade Projects. [Online]. Available
at:

Savage, M. and Blyth, W. 2011. Financing Energy Efficiency:
A Strategy for Reducing Lending Risk. [Online]. Available
at: [http://www.chathamhouse.
org/sites/default/files/19462_0511pp_blythsavage.pdf](http://www.chathamhouse.org/sites/default/files/19462_0511pp_blythsavage.pdf)
[accessed 28 January 2013].

Schlein, B. 2009. Citi Energy Efficiency Finance
Initiative: An Integrated Approach. [Online]. Available

at: http://www.c2es.org/docUploads/July14_Schlein_Citi.pdf
[accessed 28 January 2013].

Taylor, P.T., Govindrarajalu, C., Levin, J., Meyer, A.S.
and Ward, W.A. 2008. Financing Energy Efficiency. Lessons
from Brazil, China, India and Beyond. [Online]. Available
at: [http://3countryee.org/FinancingEnergyEfficiency_](http://3countryee.org/FinancingEnergyEfficiency_Lessons.pdf)
[Lessons.pdf](http://3countryee.org/FinancingEnergyEfficiency_Lessons.pdf) [accessed 28 January 2013].

UNEP and Bloomberg New Energy Finance. 2012. Global Trends
in Renewable Energy Investment 2012. [Online]. Available
at: <http://fs-unep-centre.org/>

United Nations Environment Programme. 2009. Energy
Efficiency and the Finance Sector. [Online]. Available at:
[http://www.unepfi.org/fileadmin/documents/](http://www.unepfi.org/fileadmin/documents/Energy_Efficiency.pdf)
[Energy_Efficiency.pdf](http://www.unepfi.org/fileadmin/documents/Energy_Efficiency.pdf) [accessed 28 January 2013].

United States Department of Energy. 2012. Commercial
Property Assessed Clean Energy (PACE) Primer. [Online].
Available at: [http://www1.eere.energy.gov/](http://www1.eere.energy.gov/wip/pdfs/commercial_pace_primer_revised.pdf)
[wip/pdfs/commercial_pace_primer_revised.pdf](http://www1.eere.energy.gov/wip/pdfs/commercial_pace_primer_revised.pdf) [accessed 28
January 2013].

USAID. 2009. Innovative Approaches to Financing Energy
Efficiency in Asia. [Online]. Available at:
http://pdf.usaid.gov/pdf_docs/PNADR150.pdf [accessed 28
January 2013].

Velody, M. 2006. Energy Efficiency - Releasing the
Investment Potential. [Online]. Available at:
[http://www.ecologic-events.de/climate2012/sofia/](http://www.ecologic-events.de/climate2012/sofia/documents/8_mark_velody.pdf)
[documents/8_mark_velody.pdf](http://www.ecologic-events.de/climate2012/sofia/documents/8_mark_velody.pdf) [accessed 28 January 2013].

White, P. 2010. An Awakening in Energy Efficiency:
Financing Private Sector Building Retrofits. [Online].
Available at: <http://www.johnsoncontrols.com/>

Wilson, K., Spoonhour, B. and Alvarez, M.C. 2011. Property
Assessed Clean Energy (PACE) and the New Normal. [Online].
Available at: <http://>

World Bank Independent Evaluation Group. 2010. Assessing
the Impact of IFC's China Utility-Based Energy Efficiency
Finance Program. [Online]. Available at:

World Economic Forum. 2011. A Profitable and Resource
Efficient Future: Catalysing Retrofit Finance and
Investing in Commercial Real Estate. [Online]. Available
at: http://www3.weforum.org/docs/WEF_IU_

Xin, L. 2010. China's Experience of Financing in Energy Efficiency. [Online]. Available at:
http://www.unece.org/fileadmin/DAM/energy/se/pp/eneff/Astana_EEForum_Sep2010/d1s2_2_LiuXin.pdf [accessed 28 January 2013].

11 Energy Efficiency Policies

Becker, D. and Motta, J. 2011. Broader and Deeper. A Comprehensive Approach. [Online]. Available at: http://aceee.org/files/pdf/conferences/eer/2011/BS1A_Becker.Motta.pdf [accessed 28 January 2013].

Boardman, B. 2012. Achieving Zero. Delivering Future-Friendly Buildings. [Online]. Available at:

Burr, A.C. 2012. Energy Disclosure and The New Frontier for American Jobs. [Online]. Available at: http://www.imt.org/uploads/resources/files/Energy_Disclosure_New_Frontier.pdf [accessed 29 January 2013].

Burr, A.C., Keicher, C. and Leipziger, D. 2011. Building Energy Transparency: A Framework for Implementing U.S. Commercial Energy Rating and Disclosure Policy. [Online]. Available at: http://www.buildingrating.org/sites/default/files/documents/IMT-Building_Energy_Transparency_Report.pdf [accessed 29 January 2013].

Burr, A.C., Majersik, C. and Stellberg, S. 2012. Analysis of Job Creation and Energy Cost Savings from Building Energy Rating and Disclosure Policy. [Online]. Available at: http://www.imt.org/uploads/resources/files/Analysis_Job_Creation.pdf [accessed 29 January 2013].

Cabinet Office Behavioural Insights Team, Department of Energy and Climate Change and Department of Communities and Local Government. 2011. Behaviour Change and Energy Use. [Online]. Available at: <http://www.>

Calwell, C. 2010. Is Efficiency Sufficient? The Case for Shifting our Emphasis in Energy Specifications to Progressive Efficiency and Sufficiency. [Online]. Available at:

Center for Neighborhood Technology. 2013. Urban Sustainability Hackathon. [Online]. Available at: <http://www.cnt.org/events/reinventing-chicago/hackathon> [accessed 31 May 2013].

Centre for Analysis of Social Exclusion. 2012. Getting the Measure of Fuel Poverty. [Online]. Available at: http://sticerd.lse.ac.uk/dps/case/cr/CASereport72_Executive_Summary.pdf [accessed 28 January 2013].

Constantinescu, T. 2009. Energy Efficiency and Renewable

Energy – Challenges and Opportunities in Romania.
[Online]. Available at: http://www.iene.gr/3rdSEED/articlefiles/Session_IX/Constantinescu.pdf [accessed 28 January 2013].

Cooper, M. 2011. Locating Energy Efficiency in a 21st Century Least Costs Planning Environment. [Online]. Available at: http://aceee.org/files/pdf/conferences/eeer/2011/BS1C_Cooper.pdf [accessed 28 January 2013].

ECEEE. 2010. Workshop Summary: Is Efficient Sufficient? [Online]. Available at:

EERE (Energy Efficiency and Renewable Energy). 2009. Obama Administration Launches New Energy Efficiency Efforts. US Department of Energy website, 29 June 2009. [Online]. Available at: http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=12607 [accessed 27 April 2013].

Energy Star. 2012. Energy Star Celebrating Twenty Years. [Online]. Available at:

Goldman, C., Reid, M., Levy, R. and Silverstein, A. 2010. Coordination of Energy Efficiency and Demand Response. [Online]. Available at: <http://eetd.lbl.gov/ea/ems/reports/lbnl-3044e.pdf> [accessed 28 January 2013].

Greene, D. and Pears, A. 2003. Policy Options for Energy Efficiency in Australia. [Online]. Available at: <http://www.acre.ee.unsw.edu.au/downloads/AEPG%20Energy%20Efficiency%20report%20-%202003.pdf> [accessed 28 January 2013].

Growitsch, C. and Höffler, F. 2011. 'Impact of Fukushima on the German Energy Policy Debate', IAAE Energy Forum, Fourth Quarter 2011. [Online]. Available at: <http://www.iaee.org/documents/2011FallEnergyForum.pdf> [accessed 28 January 2013].

Guertler, P. 2011. Levelling the Playing Field Through Least-Cost Energy Planning: In Limbo, Too Late or Just Right? [Online]. Available at: <http://www.ukace.org>.

Hayes, L., Service, O., Goldacre, B. and Torgerson, D. 2012. Test, Learn, Adapt: Developing Public Policy with Randomised Controlled Trials. [Online]. Available at:

Hayes, S., Young, R. and Sciortino, M. 2012. The ACEEE 2012 International Energy Efficiency Scorecard. [Online]. Available at: <http://www.aceee.org/researchreport/e12a>

[available 29 January 2013].

Hirschey, M. and Britt, M. 2010. Energy Performance Certification of Buildings. [Online]. Available at: http://www.iea.org/publications/freepublications/publication/buildings_certification-1.pdf [accessed 28 January 2013].

IEA. 2012. World Energy Outlook 2012 Fact Sheets. [Online]. Available at: <http://>

IIGCC-INCR-IGCC-UNEP. 2011. Investment-Grade Climate Policy: Financing the Transition to the Low Carbon Economy. [Online]. Available at: <http://>

IISD (2012). Untold Billions: Fossil-Fuel Subsidies, Their Impacts and the Path to Reform. [Online] Available at:

International Energy Agency. 2007. Mind the Gap. Quantifying Principal-Agent Problems in Energy Efficiency. [Online]. Available at: http://www.iea.org/publications/freepublications/publication/mind_the_gap.pdf [accessed 28 January 2013].

International Energy Agency. 2010. Energy Efficiency Governance Handbook. [Online]. Available at: http://www.iea.org/publications/freepublications/publication/gov_handbook.pdf [accessed 28 January 2013].

International Energy Agency. 2011a. Innovations in National Energy Efficiency Strategies and Action Plans. [Online]. Available at: <http://www.iea.org/publications/freepublications/publication/Innovations.pdf> [accessed 28 January 2013].

International Energy Agency. 2011b. 25 Energy Efficiency Policy Recommendations. [Online]. Available at: http://www.iea.org/publications/freepublications/publication/25recom_2011.pdf [accessed 28 January 2013].

International Energy Agency. 2012. Progress Implementing the IEA 25 Energy Efficiency Policy Recommendations. [Online]. Available at: <http://www.iea.org/>

Janssen, R. 2008. Energy Efficiency Policy Explained: An Introduction. [Online]. Available at: <http://www.helio-international.org/EEPPolicyExplained.pdf> [accessed 28 January 2013].

Janssen, R. and Staniaszek, D. 2012. How Many Jobs? A

Survey of the Employment Effects of Investment in Energy Efficiency of Buildings. [Online]. Available at: <http://>

Joshi, B. and the Regulatory Assistance Project. 2012. Best Practices in Designing and Implementing Energy Efficiency Obligation Schemes. [Online]. Available at: [http://www.ieadsm.org/Files/AdminUpload/\(1\)RAP_IEADSM%20Best%20Practices%20in%20Designing%20and%20Implementing%20](http://www.ieadsm.org/Files/AdminUpload/(1)RAP_IEADSM%20Best%20Practices%20in%20Designing%20and%20Implementing%20)

Larson, D. 2011. Energy Efficiency as a Resource. [Online]. Available at: http://aceee.org/files/pdf/conferences/ee/2011/Opening_Larson.pdf [accessed 28 January 2013].

Liubinas, A. and Harrison, P. 2012. Saving a Scarce Resource: A Case Study of Behavioural Change. [Online]. Available at:

Managan, K., Layke, J., Araya, M. and Nesler, C. 2012. Driving Transformation to Energy Efficient Buildings. Policies and Actions: 2nd Edition. [Online]. Available at:

NYC Open Data. 2013. Electric Consumption by Zip Code 2010. [Online]. Available at:

PJM. 2009. Reliability Pricing Model Demand Response and Energy Efficiency. [Online]. Available at: <http://www.pjm.com/~media/markets-ops/rpm/20090406-dr-ee-in-rpm-collateral.ashx> [accessed 27 April 2013].

Rocky Mountain Institute and Institute for Building Efficiency. 2011. Proposal for a New Deep Retrofit Program. [Online]. Available at: http://aceee.org/files/pdf/conferences/ee/2011/BS1A_Bell.pdf [accessed 28 January 2013].

Steenblik, R. 2012. A Subsidy Primer. [Online]. Available at: <http://www.iisd.org/gsi/sites/default/files/primer.pdf> [accessed 29 January 2013].

Sudarshan, A. and Sweeney, J. 2008. Deconstructing the 'Rosenfeld Curve'. [Online]. Available at: http://piee.stanford.edu/cgi-bin/docs/publications/Deconstructing_the_Rosenfeld_Curve.pdf [accessed 28 January 2013].

Supple, D. and Sheikh, I. 2010. Public Policies Driving Energy Efficiency Worldwide. [Online]. Available at: <http://www.institutebe.com/InstituteBE/media/>

UNIDO. 2011. Policy Options to Overcome Barriers to Industrial Energy Efficiency in Developing Countries. [Online]. Available at: <http://www.unido.org/>

Wade, J., Guertler, P., Croft, D. and Sunderland, L. 2011. National Energy Efficiency and Energy Savings Targets. [Online]. Available at: <http://www.eceee.org/Policy/Targets/TargetsFinalReport24May2011.pdf> [accessed 29 January 2013].

Weeselink, B., Harmsen, R. and Eichhammer, W. 2010. Energy Savings 2020. How to Triple the Impact of Energy Saving Policies in Europe. [Online]. Available at:

World Energy Council. 2010. Energy Efficiency: A Recipe for Success. [Online]. Available at: http://www.worldenergy.org/documents/fdeneff_v2.pdf [accessed 28 January 2013].

World Energy Council. 2011. World Energy Perspective: Nuclear Energy One Year After Fukushima. [Online]. Available at: <http://www.worldenergy.org/>

Worldwatch Institute. 2012. Fossil Fuel and Renewable Energy Subsidies on the Rise. [Online]. Available at:

York, D., Molina, M., Neubauer, M., Nowak, S., Nadel, S., Chittum, A., Elliott, N., Farley, K., Foster, B., Sachs, H. and Witte, P. 2013. Frontiers of Energy Efficiency: Next Generation Programs for High Energy Savings. [Online]. Available at: <http://www.aceee.org/research-report/u131> [accessed 28 January 2013].

Zimrig, M., Borgeson, G., Hoffman, I., Goldman, C., Stuart, E., Todd, A. and Billingsley, M. 2011. Delivering Energy Efficiency to Middle Income Single Family Households. [Online]. Available at: <http://eetd.lbl.gov/ea/emp/reports/lbnl-5244e.pdf> [accessed 28 January 2013]. This page has been left blank intentionally

12 Energy Efficiency Policy Examples

ABB. 2011a. Brazil: Energy Efficiency Report. [Online]. Available at: <http://>

ABB. 2011b. Saudi Arabia: Energy Efficiency Report. [Online]. Available at: <http://>

ABB. 2011c. South Korea: Energy Efficiency Report. [Online]. Available at: <http://>

AECOM. 2010. City of San Bernardino: Energy Efficiency Conservation Strategy Summary. [Online]. Available at: http://www.sustainablesanbernardino.org/documents/SB_EECS_strategy_final.pdf [accessed 28 January 2013].

Building and Construction Authority of Singapore. 2013. About BCA Green Mark Scheme. [Online]. Available at: http://www.bca.gov.sg/greenmark/green_mark_buildings.html [accessed 27 April 2013].

California Energy Commission. 2009. California Energy Demand 2010– 2020: Adopted Forecast. [Online]. Available at: <http://www.energy>.

California Energy Commission. 2010. Incremental Impacts of Energy Efficiency Policy Initiatives Relative to the ‘2009 Integrated Energy Policy Report’ Adopted Demand Forecast. [Online]. Available at: <http://www.energy>.

City of Melbourne. 2013. About 1200 Buildings. [Online]. Available at: <http://>

Community Energy Cooperative. 2007. Re-energizing Illinois. Building Real Demand for Energy Efficiency. [Online]. Available at: <http://www.cntenergy.org/download/25/FullReport-2007.03.08FINAL.pdf> [accessed 25 April 2013].

Energy Conservation Center of Ho Chi Minh City. 2011. Energy Efficiency Policies in Ho Chi Minh City. [Online]. Available at: http://www.iges.or.jp/en/kuc/pdf/activity20110314/4_WS-S1A-2-ECC-HCMC_E.pdf [accessed 28 January 2013].

Energy Market Authority. 2010. Update on Energy Efficiency Policies and Programmes in Singapore. [Online]. Available at: <http://www.egeec.apec.org/www/UploadFile/5-%20Singapore%27s%20EE%20update.pdf>

[accessed 29 January 2013].

European Commission. 2011. Energy Efficiency Plan 2011. [Online]. Available at:

Fawkes, S. 2013. 'Foundations Laid for UK Energy Efficiency Policy', Energy World 412 (February 2013).

Garforth International LLC. 2011. Community Energy Efficiency and Conservation Strategy Plan (CEP). [Online]. Available at: <http://hollandseenergyfuture.files.wordpress.com/2011/10/sept19.pdf> [accessed 28 January 2013].

Garforth International LLC and City of Holland Board of Public Works. 2011. Holland Community Energy Efficiency and Conservation Strategy. [Online]. Available at: http://cleanwater.org/files/publications/mi/final_cep_for_suscom_sept_9_2011_for_website.pdf [accessed 28 January 2013].

Heffner, G. 2010. Positioning to Deliver on Australia's Energy Efficiency Potential. [Online]. Available at: http://aie.org.au/StaticContent/Images/SYD110823_Presentation_Grayson.pdf [accessed 29 January 2013].

IEE Japan. 2012. Japan Energy Brief 18 (March 2012). [Online]. Available at: <http://eneken.ieej.or.jp/en/jeb/1203.pdf> [accessed 29 January 2013].

International Energy Agency. 2008. Energy Policy Review in Indonesia. [Online]. Available at: <http://www.iea.org/publications/freepublications/publication/Indonesia2008.pdf> [accessed 28 January 2013].

Jupest, J. and Suwa, A. 2011. 'Sustainable Energy Policy in Japan, Post Fukushima', IAEE Energy Forum (Fourth Quarter 2011). [Online]. Available at: <http://www.iaee.org/documents/2011FallEnergyForum.pdf> [accessed 28 January 2013].

KEMCO. 2013. Objective of Establishment and History. [Online]. Available at: http://www.kemco.or.kr/new_eng/pg01/pg01030000.asp [accessed 28 April 2013].

Ki-hyun, L. 2007. Korea's Promotion Policies for Energy-Efficient Products. [Online]. Available at: http://www.asiapacificpartnership.org/pdf/BATF/energy_

Kimura, O. 2010. Japanese Top Runner Approach for Energy Efficiency Standards. [Online]. Available at: <http://www.climatepolicy.jp/thesis/pdf/09035dp.pdf> [accessed 29 January 2013].

Kodaka, A. 2008. Japan's Top Runner Program: The Race for the Top. [Online]. Available at: http://www.eceee.org/eceee_events/product_efficiency_08/programme_presentations/Kodaka_TopRunnerProgram.pdf [accessed 29 January 2013].

Korea Energy Management Corporation. 2010. Energy Efficiency Policies in Korea. [Online]. Available at: <http://siteresources.worldbank.org/EXTENERGY2/Resources/4114199-1276110591210/Korea.pdf> [accessed 28 January 2013].

Levine, D. 2010. Energy Efficiency in China: Glorious History, Uncertain Future. [Online]. Available at: <http://www.aps.org/units/maspg/meetings/upload/levine.pdf> [accessed 28 January 2013].

Massachusetts Secretary of Energy and Environmental Affairs. 2010. Massachusetts Clean Energy and Climate Plan for 2020. [Online]. Available at:

McCormick, K. and Neij, L. 2009. Experience of Policy Instruments for Energy Efficiency in Buildings in the Nordic Countries. [Online]. Available at: <http://>

Mihlmste, P., Anderson, D., Dube, S., Hathaway, D., Medeiros, L. and Sankovski, A. 2010. BRIC'd Up Energy Efficiency: Energy and Climate Policies in Brazil, Russia, India, and China. [Online]. Available at: <http://www.aceee.org/files/proceedings/2010/data/papers/2027.pdf> [accessed 28 January 2013].

Nair, N.T. 2010. Energy Conservation Act: Indian Example. [Online]. Available at:

Neubauer, M., Watson, S., Laitner, J.A., Talbot, J., Trombley, D., Chittum, A. and Black, S. 2009. South Carolina's Energy Future: Minding its Efficiency Resources. [Online]. Available at: <http://aceee.org/research-report/e099> [accessed 28 January 2013].

New Zealand Ministry of Business, Innovation and Employment. 2013. Energy Efficiency and the Environment.

[Online]. Available at: <http://www.med.govt.nz/sectors-industries/energy/energy-environment> [accessed 28 January 2013].

North East Energy Efficiency Partnerships. 2012. A Regional Roundup of Energy Efficiency Policy in the Northeast and Mid-Atlantic States. [Online]. Available at:

Schlegel, J. 2011. Profiles in (EE) Courage: EE Leadership in New England. [Online]. Available at: http://aceee.org/files/pdf/conferences/eeer/2011/Schlegel_Closing.pdf [accessed 29 January 2013].

Sciotino, M., Nowak, S., Witte, P., York, D. and Kushler, M. 2011. Energy Efficiency Resource Standards: A Progress Report on State Experience. [Online]. Available at: <http://aceee.org/research-report/u112> [accessed 28 January 2013].

Sciotino, M. and Watson, S. 2011. State Energy Efficiency Resource Standard (EERS) Activity. [Online]. Available at: <http://aceee.org/files/pdf/policy-brief/State%20EERS%20Summary%20October%202011.pdf> [accessed 28 January 2013].

Singapore National Environment Agency. 2013. Energy Efficient Singapore. [Online]. Available at: <http://app.e2singapore.gov.sg> [accessed 28 January 2013].

Weigert, K. 2013. Sustainable Chicago. Presented at the American Council for an Energy Efficient Economy's 7th Annual Financing Forum, Chicago, 13-14 May 2013. [Online]. Available at: http://www.aceee.org/files/pdf/conferences/eeff/2013/Weigert_1A.pdf [accessed 31 May 2013].

World Energy Council. 2011. Policies for the Future. 2011 Assessment of Country Energy and Climate Policies. [Online]. Available at: <http://www.worldenergy.org>.

13 Energy Suppliers and Energy Efficiency

ACEEE. 2012a. Energy Efficiency Programs for Utility Customers. [Online]. Available at: <http://aceee.org/topics/energy-efficiency-programs> [accessed 29 January 2013].

ACEEE. 2012b. Lost Margin Recovery. [Online]. Available at: <http://aceee.org/>

Center for Climate and Energy Solutions. 2012a. Revenue Decoupling – An Overview. [Online]. Available at: <http://www.c2es.org/us-states-regions/policy-maps/decoupling/detail> [accessed 29 January 2013].

Center for Climate and Energy Solutions. 2012b. Decoupling Policies. [Online]. Available at: <http://www.c2es.org/sites/default/modules/usmap/pdf.php?file=7016> [accessed 29 January 2013].

Dadakakis, J. 2009. Energy Efficiency and Utility Decoupling. [Online]. Available at:

Emery, A. 2012. An Overview of Energy Efficiency and Demand Side Management in South Africa. [Online]. Available at: http://www.coaltech.co.za/Annual_Colloquium/2012/An%20overview%20of%20energy%20efficiency%20and%20demand%20side%20management%20in%20South%20Africa.pdf [accessed 31 May 2013].

Energy Efficiency Resource Central. 2012. Starting an Energy Efficiency Program for Your Utility and Community. [Online]. Available at: <http://www.>

Energy Innovation Business Council. 2012. Economic Impact of Residential/ Commercial Energy Efficient Products in Michigan. [Online]. Available at:

ESKOM. 2011. ESKOM Integrated Report 2011. [Online]. Available at: <http://>

Etzinger, A. 2011. Eskom's Approach to Integrated Demand Management. [Online]. Available at: <http://www.sanea.org.za/CalendarOfEvents/2011/SANEALecturesJHB/Jul19/AndrewEtzinger-Eskom.pdf> [accessed 29 January 2013].

Geller, H. 2012. The \$20 Billion Bonanza. Best Practice Electric Utility Energy Efficiency Programs and Their Benefits for the Southwest. [Online]. Available at:

Jannuzzi, G.M. 2008. Incentives and Disincentives for Utility-Driven DSM in Brazil. [Online]. Available at: <https://cdm.unfccc.int/UserManagement/FileStorage/Z1GDMJ3C4N8H6G3ANP7TWRD91060RT> [accessed 25 April 2013].

Moneyweb. 2013. Power Reserve for Thursday Less than 0.4% of Capacity. [Online]. Available at:

National Association of Regulatory Utility Commissioners. 2007. Decoupling for Electric and Gas Utilities; Frequently Asked Questions (FAQ). [Online]. Available at: http://www.epa.gov/statelocalclimate/documents/pdf/supp_mat_decoupling_elec_gas_utilities.pdf [accessed 29 January 2013].

National Renewable Energy Laboratory. 2009. Decoupling Policies: Options to Encourage Energy Efficiency Policies for Utilities. [Online]. Available at: <http://www.nrel.gov/docs/fy10osti/46606.pdf> [accessed 29 January 2013].

Natural Resources Defense Council. 2012. Gas and Electric Decoupling. [Online]. Available at: <http://www.nrdc.org/energy/decoupling/> [accessed 29 January 2013].

PG&E. 2012. How PG&E Makes Money. [Online]. Available at: <http://www.pge.com/myhome/myaccount/rateinfo/howwemakemoney/> [accessed 29 January 2013].

PJM. 2012. 2015/2016 RPM Base Residual Auction Results. [Online]. Available at:

Quackenbush, J.D., Isiogu, O.N. and White, G.R. 2011. 2011 Report on the Implementation of P.A. 295 Utility Energy Optimization Programs. [Online]. Available at: http://www.michigan.gov/documents/mpsc/eo_legislature_report2011_369985_7.pdf [accessed 29 January 2013].

Rocky Mountain Institute. 2011. Turbocharging Energy Efficiency Programs. [Online]. Available at: http://www.oilendgame.com/Content/Files/RMI_TEE_hi.pdf [access 29 January 2013].

Science Daily. 2013. 'Doubling Down on Energy Efficiency'. Science Daily, 17 January 2013. [Online]. Available at: <http://www.sciencedaily.com/releases/2013/01/130117142552.htm> [accessed 29 January

2013].

Smith, R. 2009. 'Less Demand, Same Great Revenue'. The Wall Street Journal, 8 February 2009. [Online]. Available at: <http://online.wsj.com/article/SB123378473766549301.html> [accessed 29 January 2013].

The Brattle Group. 2011. An Empirical Study of Impact Decoupling on Cost of Capital. [Online]. Available at: http://www.brattle.com/_documents/UploadLibrary/Upload952.pdf [accessed 29 January 2013].

WUSA. 2012. 'Pepco, BGE Outage Bills OK'd Under Energy Conservation Order', WUSA 9, 13 July 2012. [Online]. Available at: <http://www.wusa9.com>.