

**"THIS BOOK IS A
TOUR DE FORCE ...
AS A WORK OF
POPULAR SCIENCE
IT IS EXEMPLARY"**

THE ECONOMIST

**"THIS IS TO
ENERGY AND CLIMATE
WHAT FREAKONOMICS
IS TO ECONOMICS"**

**CORY DOCTOROW,
BOINGBOING.NET**



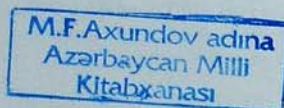
SUSTAINABLE ENERGY— WITHOUT THE HOT AIR

David JC MacKay

Sustainable Energy — without the hot air

David JC MacKay

i-40213



UIT
CAMBRIDGE, ENGLAND

315+

First published in England in 2009.

UIT Cambridge Ltd.

PO Box 145

Cambridge

CB4 1GQ

England

Tel: +44 1223 302 041

Web: www.uit.co.uk

Copyright © 2009 David JC MacKay

All rights reserved.

ISBN 978-0-9544529-3-3 (paperback)

ISBN 978-1-906860-01-1 (hardback)

The right of David JC MacKay to be identified as the author of this work has been asserted by him in accordance with the Copyright, Designs and Patents Act 1988.

While this publication intends to provide accurate and authoritative information in regard to the subject matter covered, neither the publisher nor the author makes any representation, express or implied, with regard to the accuracy of information contained in this book, nor do they accept any legal responsibility or liability for any errors or omissions that may be made. This work is supplied with the understanding that UIT Cambridge Ltd and its authors are supplying information, but are not attempting to render engineering or other professional services. If such services are required, the assistance of an appropriate professional should be sought.

Many of the designations used by manufacturers and sellers to distinguish their products are claimed as trade-marks. UIT Cambridge Ltd acknowledges trademarks as the property of their respective owners.

10 9 8 7 6 5 4

3.5.2 e1.3

Contents

I	Numbers, not adjectives	1
1	Motivations	2
2	The balance sheet	22
3	Cars	29
4	Wind	32
5	Planes	35
6	Solar	38
7	Heating and cooling	50
8	Hydroelectricity	55
9	Light	57
10	Offshore wind	60
11	Gadgets	68
12	Wave	73
13	Food and farming	76
14	Tide	81
15	Stuff	88
16	Geothermal	96
17	Public services	100
18	Can we live on renewables?	103
II	Making a difference	113
19	Every BIG helps	114
20	Better transport	118
21	Smarter heating	140
22	Efficient electricity use	155
23	Sustainable fossil fuels?	157
24	Nuclear?	161
25	Living on other countries' renewables?	177
26	Fluctuations and storage	186
27	Five energy plans for Britain	203
28	Putting costs in perspective	214
29	What to do now	222
30	Energy plans for Europe, America, and the World	231
31	The last thing we should talk about	240
32	Saying yes	250

	Acknowledgments	251
III	Technical chapters	253
A	Cars II	254
B	Wind II	263
C	Planes II	269
D	Solar II	283
E	Heating II	289
F	Waves II	307
G	Tide II	311
H	Stuff II	322
IV	Useful data	327
I	Quick reference	328
J	Populations and areas	338
K	UK energy history	342
	List of web links	344
	Bibliography	348
	Index	355
	About the author	367

“Müəlliflik hüququ və əlaqəli hüquqlar haqqında” Azərbaycan Respublikası Qanununa və nəşr ilinə, ölkə üçün mühüm əhəmiyyət kəsb etdiyinə görə bu elektron resursdan yalnız kitabxananın “Lokal şəbəkədən istifadə üzrə oxu zalı”nda istifadə etmək olar.

* * *

Due to Law of Azerbaijan Republic on “Copyright and related laws”, year of publication and for this reason that this material is important for our republic you can use this electron resource only in the “Local network reading hall”.

* * *

Принимая во внимание закон Азербайджанской Республики "Об авторском праве и сопутствующим правам", год издания, и чрезвычайную важность для страны, получить доступ к данному электронному ресурсу можно только в библиотечном "Читальном зале по использованию локальной сети".