



Solar Energy Projects for the Evil Genius



Evil Genius Series

Bionics for the Evil Genius: 25 Build-it-Yourself Projects

Electronic Circuits for the Evil Genius: 57 Lessons with Projects

Electronic Gadgets for the Evil Genius: 28 Build-it-Yourself Projects

Electronic Games for the Evil Genius

Electronic Sensors for the Evil Genius: 54 Electrifying Projects

50 Awesome Auto Projects for the Evil Genius

50 Model Rocket Projects for the Evil Genius

Mechatronics for the Evil Genius: 25 Build-it-Yourself Projects

MORE Electronic Gadgets for the Evil Genius: 40 NEW Build-it-Yourself Projects

101 Spy Gadgets for the Evil Genius


123 PIC[®] Microcontroller Experiments for the Evil Genius

123 Robotics Experiments for the Evil Genius


PC Mods for the Evil Genius: 25 Custom Builds to Turbocharge Your Computer

Solar Energy Projects for the Evil Genius

25 Home Automation Projects for the Evil Genius



Solar Energy Projects for the Evil Genius



GAVIN D. J. HARPER



New York Chicago San Francisco Lisbon London Madrid
Mexico City Milan New Delhi San Juan Seoul
Singapore Sydney Toronto

Copyright © 2007 by The McGraw-Hill Companies, Inc. All rights reserved. Manufactured in the United States of America. Except as permitted under the United States Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the publisher.

0-07-150910-0

The material in this eBook also appears in the print version of this title: 0-07-147772-1.

All trademarks are trademarks of their respective owners. Rather than put a trademark symbol after every occurrence of a trademarked name, we use names in an editorial fashion only, and to the benefit of the trademark owner, with no intention of infringement of the trademark. Where such designations appear in this book, they have been printed with initial caps.

McGraw-Hill eBooks are available at special quantity discounts to use as premiums and sales promotions, or for use in corporate training programs. For more information, please contact George Hoare, Special Sales, at george_hoare@mcgraw-hill.com or (212) 904-4069.

TERMS OF USE

This is a copyrighted work and The McGraw-Hill Companies, Inc. ("McGraw-Hill") and its licensors reserve all rights in and to the work. Use of this work is subject to these terms. Except as permitted under the Copyright Act of 1976 and the right to store and retrieve one copy of the work, you may not decompile, disassemble, reverse engineer, reproduce, modify, create derivative works based upon, transmit, distribute, disseminate, sell, publish or sublicense the work or any part of it without McGraw-Hill's prior consent. You may use the work for your own noncommercial and personal use; any other use of the work is strictly prohibited. Your right to use the work may be terminated if you fail to comply with these terms.

THE WORK IS PROVIDED "AS IS." McGRAW-HILL AND ITS LICENSORS MAKE NO GUARANTEES OR WARRANTIES AS TO THE ACCURACY, ADEQUACY OR COMPLETENESS OF OR RESULTS TO BE OBTAINED FROM USING THE WORK, INCLUDING ANY INFORMATION THAT CAN BE ACCESSED THROUGH THE WORK VIA HYPERLINK OR OTHERWISE, AND EXPRESSLY DISCLAIM ANY WARRANTY, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. McGraw-Hill and its licensors do not warrant or guarantee that the functions contained in the work will meet your requirements or that its operation will be uninterrupted or error free. Neither McGraw-Hill nor its licensors shall be liable to you or anyone else for any inaccuracy, error or omission, regardless of cause, in the work or for any damages resulting therefrom. McGraw-Hill has no responsibility for the content of any information accessed through the work. Under no circumstances shall McGraw-Hill and/or its licensors be liable for any indirect, incidental, special, punitive, consequential or similar damages that result from the use of or inability to use the work, even if any of them has been advised of the possibility of such damages. This limitation of liability shall apply to any claim or cause whatsoever whether such claim or cause arises in contract, tort or otherwise.

DOI: 10.1036/0071477721



Professional



Want to learn more?

We hope you enjoy this McGraw-Hill eBook! If you'd like more information about this book, its author, or related books and websites, please [click here](#).

To the late Mr. P. Kaufman
who never failed to make science exciting

About the Author



Gavin Harper is a sustainable technology advocate and popular author of how-to books. His other publications include *50 Awesome Auto Projects for the Evil Genius*, *Model*

Rocket Projects for the Evil Genius, and *Build Your Own Car PC*, all for McGraw-Hill ... and if you enjoyed the chapter on fuel cells, his forthcoming book *Fuel Cell Projects for the Evil Genius* will hit the shelves later this year. Gavin has had work published in the journal *Science* and

has written for a number of magazines and online weblogs. His family continue to be bemused by his various creations, gadgets, and items of junk, which are steadily accumulating. He holds a BSc. (Hons) Technology with the Open University, and has completed an MSc. Architecture: Advanced Environmental & Energy Studies with UeL/CAT. He is currently studying towards a BEng. (Hons) Engineering with the Open University, and filling in spare time with some postgraduate study at the Centre for Renewable Energy Systems Technology at Loughborough University. He is rarely bored. Gavin lives in Essex, United Kingdom.

Contents

Foreword by Willie Nelson	ix	Project 17: Build Your Own Parabolic Dish Concentrator	69
Acknowledgments	x	Project 18: Experiment with Fresnel Lens Concentrators	72
1 Why Solar?	1	9 Solar Pumping	75
2 The Solar Resource	9	Project 19: Build a Solar-Powered Fountain	76
3 Positioning Your Solar Devices	17	10 Solar Photovoltaics	81
Project 1: Build a Solar-Powered Clock!	20	Project 20: Grow Your Own “Silicon” Crystals	85
Project 2: Build Your Own Heliodon	22	Project 21: Build Your Own “Thin-Film” Solar Cell	87
Project 3: Experimenting with Light Rays and Power	25	Project 22: Experimenting with the Current–Voltage Characteristics of a Solar Cell	92
4 Solar Heating	27	Project 23: Experimenting with Current–Voltage Characteristics of Solar Cells in Series	93
Project 4: Build Your Own Flat Plate Collector	31	Project 24: Experimenting with Solar Cells in Parallel	93
Project 5: Solar Heat Your Swimming Pool	33	Project 25: Experiment with the “Inverse Square Law”	94
Project 6: Useful Circuits for Solar Heating	35	Project 26: Experimenting with Different Types of Light Sources	96
5 Solar Cooling	39	Project 27: Experimenting with Direct and Diffuse Radiation	96
Project 7: Solar-Powered Ice-Maker	42	Project 28: Measurement of “Albedo Radiation”	99
6 Solar Cooking	45	11 Photochemical Solar Cells	105
Project 8: Build a Solar Hot Dog Cooker	46	Project 29: Build Your Own Photochemical Solar Cell	107
Project 9: Build a Solar Marshmallow Melter	48	12 Solar Engines	113
Project 10: Cook Eggs on Your Driveway Using the Sun	49	Project 30: Build a Solar Bird Engine	113
Project 11: Build a Solar Cooker	50	Project 31: Make a Radial Solar Can Engine	116
Project 12: Build a Solar Camping Stove	51		
7 Solar Stills	55		
Project 13: Build a Window-Sill Demonstration Solar Still	56		
Project 14: Build a Pit-Type Solar Still	57		
Project 15: Build a Solar Basin Still	58		
8 Solar Collectors	61		
Project 16: Build Your Own “Solar Death Ray”	64		

13 Solar Electrical Projects	119	Project 43: Build Your Own Solar Airship	146
Project 32: Build Your Own Solar Battery Charger	119		
Project 33: Build Your Own Solar Phone Charger	120		
Project 34: Build Your Own Solar-Powered Radio	123		
Project 35: Build Your Own Solar-Powered Torch	124		
Project 36: Build Your Own Solar-Powered Warning Light	126		
Project 37: Build Your Own Solar-Powered Garden Light	127		
14 Tracking the Sun	129		
Project 38: Simple Solar Tracker	130		
15 Solar Transport	135		
Project 39: Build Your Own Solar Car	137		
Project 40: Hold Your Own Solar Car Race	142		
Project 41: Souping Up Your Solar Vehicle	143		
Project 42: Supercharge Your Solaroller	143		
		16 Solar Robotics?	149
		Project 44: Assembling Your Photopopper Photovore	153
		17 Solar Hydrogen Partnership	161
		Project 45: Generating Hydrogen Using Solar Energy	164
		Project 46: Using Stored Hydrogen to Create Electricity	168
		18 Photosynthesis—Fuel from the Sun	171
		Project 47: Proving Biofuel Requires Solar Energy	177
		Project 48: Proving Biofuel Requires Water	177
		Project 49: Looking at the Light-Absorption Properties of Chlorophyll	178
		Project 50: Make Your Own Biodiesel	180
		Appendix A: Solar Projects on the Web	185
		Appendix B: Supplier’s Index	188
		Index	195

Foreword

Gavin Harper's book *Solar Energy Projects for the Evil Genius* is a "must read" for every sentient human on this planet with a conscience, a belief in the bottom line, or a simple belief in the future of humanity.

At a time when such a book should be offered as suggested reading for the 19-year-old Gavin Harper, he's bucking the trend by actually being the author. Okay, so he's written a book on solar energy you say, big deal you say. You would be wrong. Not only is this Gavin's fourth book, it is nothing short of pure genius.

To be able to write about solar energy is one thing. But to possess the ability to put the knowledge of

solar energy into layman's terms, while including examples of do-it-yourself projects which make the practical applications obvious, gives this boy genius the "street cred" (industry savvy) he so very much deserves.

This is a "how-to" book, which debunks the myth that "these things are decades away," and, without exception, should be in every classroom under the same sun.

So crack this book, turn on your solar light, and sit back for a ride into our "present"... as in "gift" from God.

Willie Nelson

Acknowledgments

There are always a lot of thank-yous to be said with any book, and this one is no exception. There are a lot of people that I would like to thank immensely for material, inspiration, ideas, and help—all of which have fed in to make this book what it is.

First of all, a tremendous thank-you to the staff and students of the MSc. Architecture: Advanced Environmental & Energy Studies course at the Centre for Alternative Technology, U.K. I never cease to be amazed by the enthusiasm, passion, and excitement members of the course exude.

I'd like to say a big thank-you to Dr. Greg P. Smestad, for his help and advice on photochemical cells. Dr. Smestad has taken leading-edge research, straight from the lab, and turned it into an accessible experiment that can be enjoyed by young scientists of all ages. I would also like to thank Alan Brown at the NASA Dryden Flight Research Center for the information he provided on solar flight for Chapter 15.

Also a big thank-you to Ben Robinson and the guys at Dulas Ltd. for their help in procuring images, and for setting a great example by showing how companies can be sustainable and ethical.

I'd also like to thank Hubert Stierhof for sharing his ideas about solar Stirling engines, and Jamil Shariff for his advice on Stirling engines and for continuing to be inspirational.

Thanks also to Tim Godwin and Oliver Sylvester-Bradley at SolarCentury, and to Andrew Harris at Schuco for sharing with me some of their solar installations.

An immense thank-you to Dave and Cheryl Hrynkiw and Rebecca Bouwseman at Solarbotics for sharing their insight on little solar-powered critters, and for providing the coupon in the back of the book so that you can enjoy some of their merchandise for a little less.

A massive thank-you to Kay Larson, Quinn Larson, Matt Flood, and Jason Burch at Fuelcellstore.com for helping me find my way with fuel cells, and for being inspirational and letting me experiment with their equipment. It would also be wrong not to mention H₂ the cat, who was terrific company throughout the process of learning about fuel cells.

Also, many thanks to Annie Nelson, and Bob and Kelly King of Pacific Biodiesel for providing me with some amazing opportunities to learn about biodiesel.

Thanks to Michael Welch at *Home Power* magazine, and also to Jaroslav Vanek, Mark “Moth” Green, and Steven Vanek, the designers of the fantastic solar ice-maker featured in Chapter 5. Their solar-powered ice-maker has already proven its immense worth in the developing world ... and if you guys at home start building them at home and switching off your air-con and freezers, they stand to be a big hit in the developed world as well.

A big thank-you to my grandfather, who has seen the mess upstairs and manages to tolerate it, to my grandmother who hears about the mess upstairs and does not realize its magnitude, and to Ella who does a good job of keeping the mess within sensible limits—and knows when to keep quiet about it. Thanks are also long overdue to my dad, who is always immensely helpful in providing practical advice when it comes to how to build things, and to my mum who manages to keep life going when I have got my head in a laptop.

A huge thank-you to Judy Bass, my fantastic editor in New York who has been great throughout the trials and tribulations of bringing this book to print, and to the tremendous Andy Baxter (and the rest of his team at Keyword) who has managed to stay cool as a cucumber and provide constant reassurance throughout the editing process.

Chapter 1

Why Solar?

Our energy

In everyday life, we consume a tremendous amount of energy. Our lives are styled around consumption—consumption of natural resources and consumption of energy.

Figure 1-1 dramatically illustrates where all of this energy goes.

These figures are for a U.K. lifestyle, but we can take this as being representative for people who live in the “developed world.”

The bulk of our energy consumption goes on space heating—58%—this is something that can easily be provided for with passive solar design.

Next is water heating, which requires 24% of the energy which we use—again, we will see in this book how we can easily heat water with solar energy.

So already we have seen that we can meet 82% of our energy needs with solar technologies!

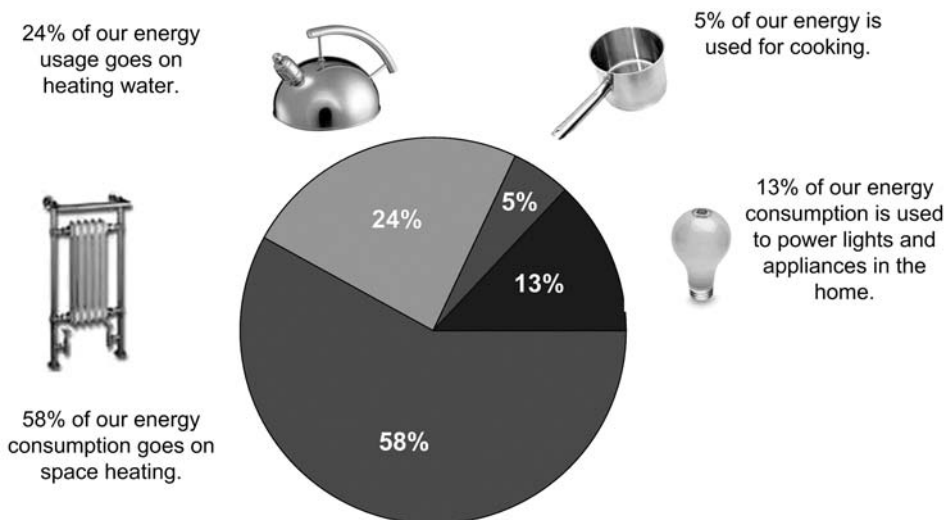
The next 13% of our energy is used to provide electrical power for our lights and home. In Chapter 10 on solar photovoltaics, we will see how we can produce clean electricity from solar energy with no carbon emissions.

The remaining 5% is all used for cooking—again we will see in this book how easy it is to cook with the power of the sun!

So we have seen that all of our energy needs *can* be met with solar technologies.

Why solar?

The short answer to this question, albeit not the most compelling is “Why not solar?”



Above is how UK household energy consumption can be split up into different uses.

Figure 1-1 Domestic energy use. Information extracted from DTI publication “Energy Consumption in the United Kingdom.” You can download this information from www.dti.gov.uk.