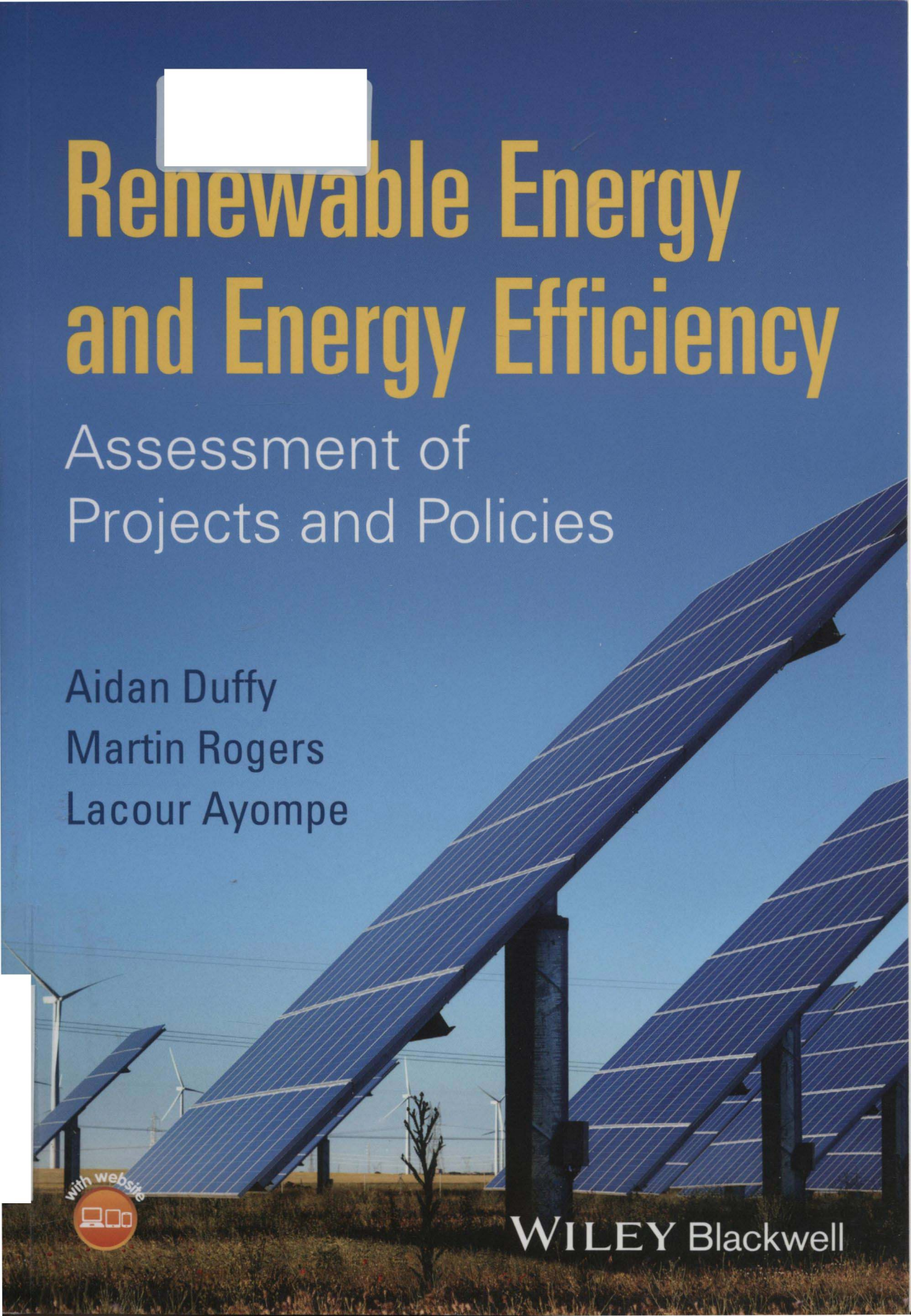
Renewable Energy and Energy Efficiency

Assessment of Projects and Policies

Aidan Duffy
Martin Rogers
Lacour Ayompe



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Renewable Energy and Energy Efficiency

Symbols, Units and Abbreviations

Abbreviations

AC	Alternating Current
AHP	Analytic Hierarchy Process
BAU	Business as Usual
BAWT	Building Augmented Wind Turbine
bbl	Barrel of oil
BOS	Balance of System
CAES	Compressed Air Energy Storage
CAPEX	Capital expenditure
CBA	Cost-benefit Analysis
CCGT	Combined Cycle Gas Turbine
CCS	Carbon Capture and Storage
CF	Capacity Factor
CHP	Combined Heat and Power
CHPC	Combined Heat and Power and Cooling
CNG	Compressed Natural Gas
CPC	Compound Parabolic Collector
CPI	Consumer Price Index
DC	Direct Current
EDC	Engine-driven Chiller
EIA	Environmental Impact Assessment
ETC	Evacuated Tube Collectors (SWHS)
ETS	Emissions Trading Scheme
FIT	Feed-in Tariff
FPC	Flat Plate Collector (SWHS)
GFA	Gross Floor Area
GHG	Greenhouse Gas
GHP	Gas Heat Pump
GWP	Global Warming Potential
HAWT	Horizontal-axis Wind Turbine
HHV	Higher (gross) heating value
HICP	Harmonised Index of Consumer Prices
HPS	High-pressure Sodium (lamp)
HVAC	Heating, Ventilation and Air Conditioning

IHA	International Hydropower Association
I-O	Input-output (LCA)
IRR	Internal Rate of Return
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
LCE	Life Cycle Emissions
LCOE	Levelised Cost of Energy
LED	Light Emitting Diode
LHS	Latent Heat Storage
LHV	Lower (net) heating value
LPG	Liquid Petroleum Gas
MAC	Marginal Abatement Costs
MARR	Minimum Acceptable Rate of Return
MAUT	Multi-attribute Utility Theory
MCDA	Multi-Criteria Decision Analysis
MIRR	Modified Internal Rate of Return
NHA	National Heritage Area
NPV	Net Present Value
O&M	Operation and Maintenance
OCGT	Open Cycle Gas Turbine
PCM	Phase Change Material
PEM	Proton Exchange Membrane (fuel cell)
PHS	Pumped Hydroelectric Storage
PM10	Particulate Matter (<10μm)
PP	(Simple) Payback Period
PPA	Power Purchase Agreement
PSH	Peak Sun Hour
PV	Photovoltaic
ROC	Renewable Obligation Certificate
ROCE	Return on Capital Employed
RoI	Return on Investment
SAC	Special Area of Conservation
SAW	Simple Additive Weighting
SEA	Strategic Environmental Assessment
SHS	Sensible Heat Storage
SMP	System Marginal Price
SPF	Shadow Price Factors
SWHS	Solar Water Heating System
TES	Thermal Energy Storage
TUoS	Transmission Use of System
TYM	Typical Meteorological Year
VAWT	Vertical-axis Wind Turbine
VSD	Variable Speed Drive
WECS	Wind energy conversion system

Symbols and Units

A	Area	m^2
A	Annuity Factor (Chapter 6)	dimensionless
C	Cost	€
CBR	Cost-benefit Ratio	dimensionless
CDF	Cumulative Discount Factor	dimensionless
CF	Capacity Factor	dimensionless
CF	Net Cash Flow	€
CO_2-eq	Carbon dioxide equivalent	g
COP	Coefficient of Performance	dimensionless
C_p	Power Coefficient (wind turbine)	dimensionless
C_p	Specific Heat Capacity	J/kg °C
CPI	Consumer Price Index	dimensionless
CS	Capital Subsidy	€/W
D	Debt	€
d	Discount Rate	%
DF	Discount Factor	dimensionless
DPP	Discounted Payback Period	y
E	Equity	€
E	Energy (or Electrical Energy)	J or Wh
e	Inflation	%
EAC	Equivalent Annual Cost	€/y
EI	Emissions Intensity	g CO_2-eq/€
F	Cash Flow	€/time interval
FIT	Feed-in Tariff	€/Wh
g	Acceleration due to gravity	m/s^2
G_t	In-plane Solar Radiation	W/m^2
H_{m0}	Significant Wave Height	m
HR	Heat Rate	kJ/kWh
irr	Internal Rate of Return	%
LCC	Life Cycle Cost	€
LCE	Life Cycle Emissions	gCO_2-eq
$LCOE$	Levelised Cost of Energy	€/Wh
LR	Learning Rate	%
M	Mass	g
$\dot{m}$	Fluid mass flow rate	kg/s
MAC	Marginal Abatement Costs	€/gCO_2-eq
MAD	Mean Absolute Deviation	dimensionless
$MAPE$	Mean Absolute Percentage Error	dimensionless
$MARR$	Minimum Acceptable Rate of Return	%
$mirr$	Modified Internal Rate of Return	%
MPE	Mean Percentage Error	dimensionless
N	Number	dimensionless

NPV	Net Present Value	€
P	*Power*	W
P	Cost	€
PI	Profitability Index	dimensionless
PP	(Simple) Payback Period	y
PR	Progress Ratio	dimensionless
Q	Fuel	Wh
Q	Heat	Wh
Q	Quantity	g, l, m^3 ,Wh, etc
r	Return (financial)	%
ROCE	Return on Capital Employed	%
RoI	Return on Investment	%
SF	Solar Fraction	dimensionless
SIR	Savings-to-investment Ratio	dimensionless
t	Time	y, h, s
T	Tariff	€/Wh
T	Corporate Tax Rate	%
Ta	Tariff	€/Wh
U	Unit Heat Loss Rate (U-Value)	W/m^2K
v	Velocity	m/s
WACC	Weighted Average Cost of Capital	%
η	Efficiency	%
ρ	Density	g/m^3
n_p	Payback Period	yrs

Subscript Symbols

aux	Auxiliary
av	Avoided
c	Investment, Capital
comp	Compressor
cw	Chilled Water
d	Debt
dem	Demand
dt	Displaced Technology
e	Equity
el	Electrical
ER	Round-trip
ex	Export
f	Fluid, Fuel
fv	Future value
g	Gas
gen	Generator

h	Heat
i, in	Input, Inflows
i,j,n	year
inv	Inverter
loss	Losses
main	Maintenance
n	Nominal
n	Net
no	Net Operating
o	Output, Outflow
out	Output
pv	Present Value
r	Real
s	Sector
s	Saving
sto	Stored
th	Thermal
TUoS	Transmission Use of System
u	Useful

About the Companion Website

This book's companion website www.wiley.com/go/duffy/renewable provides you with case study material to further your understanding of Renewable Energy and Energy Efficiency.

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