TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

Page

LIST OF TABLES

Table **Page**

LIST OF TABLES (Continued)

Table **Page**

LIST OF FIGURES

Figure **Page**

LIST OF FIGURES (Continued)

Figure **Page**

LIST OF FIGURES (Continued)

Figure **Page**

LIST OF FIGURES (Continued)

Figure **Page**

LIST OF FIGURES (Continued)

Figure **Page**

LIST OF ABBREVIATIONS

MES	= multi-energy system
RE	= renewable energy
PDP	= power development plans
HS	= hydrogen storage
AEDP	= alternative energy development plan
EH	= energy hub
TOC	= total operating costs
EP	= electricity peak from the grid
TCE	= total carbon emissions
OMES-WSPHS	= optimal scheduling of multi-energy systems with wind-solar power and hydrogen storage
NG	= natural gas
PSO	= particle swarm optimization
LP	= linear programming
PSO-LP	= hybrid particle swarm optimization and linear programming
MES-WSPHS	= multi-energy system with wind-solar power and hydrogen storage
MES-WSP	= multi-energy system with wind-solar power
FMOO	= fuzzy muti-objective optimization
MCS	= Monte Carlo simulation
WTs	= wind turbines
PVPs	= photovoltaic panels
PDF	= probabilistic density function
GA	= genetic algorithm
MIP	= mixed integer programming
GAMS	= general algebraic modeling system
EA	= evolutionary algorithm
CPLEX	= C programming language for mathematical programming execution

LIST OF ABBREVIATIONS (Continued)

MINLP = mixed-integer non-linear programming
GA-PSO = hybrid genetic algorithm and par
PtG = power-to-gas
WSMO = weight sum multi-objective optimization
CHP = combined heat and power
MOPSO = multi-objective particle swarm optimization
TOU = time of use
SAUGMECON = stepwise augmented ε-constraint method
VIKOR = VIseKriterijumska Optimizacija i Kompromisno Resenje
RO = robust optimization
BESS = battery energy storage system
ESS = energy storage system
PV = photovoltaic
EL = electrolyzer
FC = fuel cell
RTP = real-time pricing
TR = transformer
GB = gas boiler
MT = micro-turbine
DC = direct current
AC = alternative current
SOT = state of the tank
FSMF = fuzzy-satisfaction membership function
TGO = Thailand greenhouse gas management organization
OBJ = objective function
SD = standard deviation
THB = Thai baht

LIST OF NOMENCLATURE

Variable

$\mathbf{P}$ = The matrix contains a scheduling variable.

η = Efficiency (%).

P = The power inputs or the power flow through the device (kW).

L = The power outputs or power demands (kW).

NT = The total number of wind turbines.

v = The velocity (m/s).

Y = The parameter indicates the operation state.

C = The cost of the energy input (THB/kWh).

PNF = The penalty functions.

ρ = The penalty factor.

LHV = The low heat value (MJ/kmol).

$\Re$ = The gas constant (J/mol·K).

T = The mean temperature (K).

V = The volume (m^3).

p = The pressure (bar).

n = The molar flow (mol/s).

h = The times (hour).

z = The height (m).

α = The power law exponent.

A = Area of PVPs installed (m^3).

β = PVPs efficiency (%).

SI = Solar irradiance (W/m^2).

w = Inertia weight.

c = Learning factor.

LIST OF NOMENCLATURE (Continued)

$rand$ = A random number between 0 and 1.

$pbest$ = personal best.

$gbest$ = global best.

$initial$ = initial setting value.

μ = The satisfactory membership function.

a = Shape.

b = Scale.

f = The probability density function.

σ = The standard deviation of the normal distribution.

M = The mean value of the normal distribution.

SOT = The state of the tank (%).

TOC = The total operating costs (THB).

TCE = The total carbon emissions (kg/CO_2).

EP = The electricity peak from the grid (kW).

Subscript and Superscript

1 = The number which indicates the order.

2 = The number which indicates the order.

E = Electricity.

H = Heat.

NG = Natural gas.

H_2 = Hydrogen.

EL = Electrolyzer.

FC = Fuel cell.

MT = Micro-turbine.

TR = Transformer.

LIST OF NOMENCLATURE (Continued)

GB	= Gas boiler.
L	= The power outputs or power demands.
WSP	= Wind-solar power.
AC/DC	= AC-to-DC converter.
DC/AC	= DC-to-AC converter.
r	= Reference.
WTs	= Wind turbines.
SI	= Solar irradiance.
i	= Power injected into the grid.
ex	= The excess power.
$PVPs$	= Photovoltaic panels.
tank	= The storage of hydrogen.
$rated$	= The maximum limit.
$\min$	= The minimum limit.
T	= Total.