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Energy Optimization and Prediction in Office Buildings

A Case Study of Office Building Design in Chile

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Symbols and Abbreviations

A_i	Area of the element i (m^2)
A_c	Area of the opaque surfaces (m^2)
A_E	Area of the building envelope (m^2)
$A_{sol,k}$	Effective collecting area of surface k with given orientation and tilt angle (m^2)
$A_{sol,op}$	Effective collecting area of opaque surface k with given orientation and tilt angle (m^2)
A_w	Overall projected area of the glazed element (m^2)
$b_{ve,k}$	Adjustment factor of temperature for the airflow k
C_m	Corrected internal heat capacity, (KJ/m^2K)
F_F	Frame area fraction, ratio of the projected frame area to the overall projected area of the glazed element
$F_{r,k}$	Form factor between the element and the sky
$F_{sh,gl}$	Shading reduction factor for movable shading provisions
$F_{sh,ob,k}$	Shading reduction factor for external obstacles for the solar effective collecting area of surface k
$f_{ve,t,k}$	Time fraction of operation over the calculation period (full time: ft = 1)
h_r	External radiative heat transfer coefficient ($W/(m^2K)$)
H_{tr}	Heat transfer coefficient by transmission (W/K)
H_{ve}	Heat transfer coefficient by ventilation and infiltration (W/K)
$I_{sol,k}$	Solar irradiance, the total energy of the solar irradiation during the calculation period per sqm of collecting area of surface k (W/m^2)
i, k	Dummy integers
N_f	A factor based on climate region, number of stories of a building, and sheltering from wind which is used to convert to estimated air changes in a building by natural means, without a fan (methodology from LBL)
$Q_{C,n}$	Cooling need, or building energy need for cooling (MJ)
$Q_{C,ht}$	Total heat transfer for the cooling mode (MJ)
$Q_{C,gn}$	Total heat gains for the cooling mode (MJ)
$Q_{H,n}$	Heating need, or building energy need for heating (MJ)

$Q_{H,ht}$	Total heat transfer for the heating mode (MJ)
$Q_{H,gn}$	Total heat gains for the heating mode (MJ)
Q_{int}	Sum of internal heat gains over the given period (MJ)
Q_{sol}	Sum of solar heat gains over the given period (MJ)
Q_{tr}	Total heat transfer by transmission (MJ)
Q_{ve}	Total heat transfer by ventilation (MJ)
$q_{ve,k}$	Airflow rate (k element) (m^3/s)
$q_{ve,k,mn}$	Time-average airflow rate from source k (m^3/s)
Q_{50}	Air changes per hour at 50 pascal (infiltration) (ACH_{50} (1/h))
R_{se}	External surface heat resistance of the opaque part (m^2k/W)
SF_i	Total solar energy transmittance of the transparent part of the element
t	Duration of the calculation period (Ms)
U	Thermal transmittance (W/m^2K)
U_i	Thermal transmittance element i (W/m^2k)
α	Dimensionless numerical parameter depending on the time constant,τ
α_0	Dimensionless reference numerical parameter
$\alpha_{s,c}$	Dimensionless absorption coefficient for solar radiation of the opaque part
γ_C	Heat balance ratio for cooling
γ_H	Dimensionless heat balance ratio for the heating mode
ε	Emissivity of a surface for long-wave thermal radiation
$\eta_{H,gn}$	Gain utilization factor for heating
$\eta_{C,ls}$	Utilization factor for heat losses
$\theta_{int,set,H}$	Set-point temperature for heating (°C)
$\theta_{int,set,C}$	Set-point temperature for cooling (°C)
θ_e	Exterior temperature (°C)
$\Delta\theta_{er}$	Average difference between the external air temperature and the apparent sky temperature (°C)
ρaCa	Heat capacity of air per volume ($J/(m^3K)$)
τ	Time constant of the building or building zone (h)
τ_0	Reference time constant (h)
$\Phi_{int,mn,k}$	Heat flow gains from internal heat source k (W)
$\Phi_{r,k}$	Extra heat flow due to thermal radiation to the sky from building element k (W)
$\Phi_{sol,k}$	Solar heat gains through building element k (W)
ACH	Air Changes per Hour
ACH_n	Natural Air Changes per Hour
ACH_50	Air Changes per Hour at 50 Pascal
ANN	Artificial Neural Networks
ANOVA	Analysis of Variance
AR5	Fifth Assessment Report
BFGS	Broyden–Fletcher–Goldfarb–Shanno Algorithm
CEF	Cooling Emission Factors
CO_2	Carbon Dioxide

CO_2eq	Carbon Dioxide Equivalent Emission Factor
COP	Coefficient of Performance
E	East
ECM	Mean Quadratic Error
EER	Energy Efficiency Ratio
EPBD	Energy Performance of Buildings Directive
EPW	Energy Plus Weather
EU	European Union
FA	Floor Area
FR	Form Ratio
GCM	Global Climate Model
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GHR	Global Horizontal Solar Radiation
H	Hidden Layer
HadCM3	Hadley Centre Coupled Model, Version 3
HEF	Heating Emission Factors
INE	Chile Bureau of Statistics
IPCC	Intergovernmental Panel on Climate Change
IRES	International Recommendation on Energy Statistics
ISO	International Organization for Standardization
LBL	Lawrence Berkeley Laboratory
LCV	Low Calorific Value
MAE	Mean Absolute Error
MLR	Linear Regression Model
N	North
NE	Northeast
NEB	National Energy Balance
NS	Number of Storeys
NW	Northwest
OECD	Organization for Economic Cooperation and Development
Op	Opaque Surfaces
Op%	Percentage of Openings in the Façade
PM	Multilayer Perceptron Model
R2	Determination Coefficient
RH	Relative Humidity
S	South
SA	Aysén Electrical System
SIC	Central Interconnected Electrical System
SIEC	Standard International Energy Classification
SING	Norte Grande Interconnected Electrical System
SM	Magallanes Electrical System
TDRe	Terms of Reference for Standardized Environmental Control and Energy Efficiency
UHI	Urban Heat Island

UNEP	United Nations Environment Programme
W	West
WMO	World Meteorological Organization
WWR	Window-to-Wall Ratio