



HVAC

1 HVAC

	HVAC	
		(LCC ) HVAC

가가

HVAC  
HVAC

LCC  
HVAC

가가 가

2.1

가

가

(1)

(degree-day)

18.3 (65 )

18.3

가

(2)

가

가

가

(3)

(Bin Method)

가

「 (bin)」

(time frequency)

가

2.8

(balance point temperature)

(4) (Modified Bin Method)

(diversified load)

가  
(cooling load factor)

## 2.2

가

$$\frac{\partial^2 T}{\partial x^2} = \frac{1}{\alpha} \frac{\partial T}{\partial t}$$

1

( 3

1 ).

(1)

(transmission matrix

method)

2

가

(transfer

fuction)

가 가

가

(frequency - domain)

(time - domain)

( ) sine cosine

가

Stephenson and Mitalas(1967 )

(thermal response factor; TRFs)

Z

. Z

가

가

가

. ASHRAE

가 (homogenous)  
1 . (response  
factor) 가 (weighting factor) DOE-2 HASP, AHSRAE  
TRNSYS , 가

(2)  
가  
가

CFD ,  
(nodes) 가 ,  
(FEM: finite element method) (FDM: finite difference method),  
(FVM: finite volume method)  
(heat-balance)  
FDM FEM  
, FVM

HVAC ,  
ESP-r, BLAST, EnergyPlus가 ,  
가

**III**  
**3.1 DOE-2**

(1)  
DOE-2 Lawrence Berkeley Laboratory  
가  
, , , 가  
(TMY, TRY, CTZ, WYEC )

FORTTRAN ,  
NTIS ,  
DOE-2 DOE-2.1E , 1993 DOE-2.2

3.4 EnergyPlus가 DOE-2

(2)

DOE-2

5

1

가

BDL(Building Description Language) 가  
 LOADS  
 HVAC(SYSTEMS PLANT)

LCC ECON  
 DOE-2

HVAC time step

TRNSYS EnergyPlus

가 HVAC

LOADS

( )

1

(8760 )

1 DOE-2

가

SYSTEMS

HVAC 2 ( , , )

SYSTEMS

LOADS

SYSTEMS

PLANT

PLANT HVAC 1 ( , , , , )

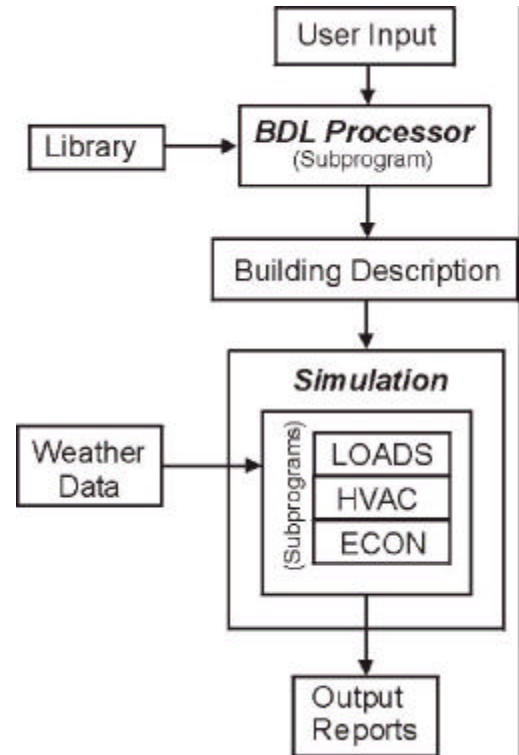
가

PLANT

LOADS

SYSTEMS

ECONOMICS



ECONOMICS  
LCC(Life Cycle Cost)

3.2 TRNSYS

(1)

TRNSYS(TRaNsient SYstem Simulation) 1975  
ver. 15

Wisconsin

3000

TRNSYS

가

가

. 1996

, Windows

ver. 14.1

Windows 95

ver. 14.2

가

FORTRAN77

HVAC

가 가

가

가

가

가

NT)

RAM

TRNSYS 15

16MB,

Windows

65MB

IBM

(Windows 95/98, ME, 2000,

PC( )

가

ver. 14.x

, Windows

95/98/NT

2000

가

2 TRNSYS

KERNAL	
TYPES	57 (components) subroutine)가 . : , ,
UTILITY	(TYPEs)
OPTION	TYPE

(2)

TRNSYS 14.2

main directory

TRNWIN 13

sub-directory가

. TRNSYS

FORTRAN

가 가 가

4

2 4

TRNLIB.DLL DLL(Dynamic Link Library) DLL Windows

TRNSYS.EXE( ) 3 57

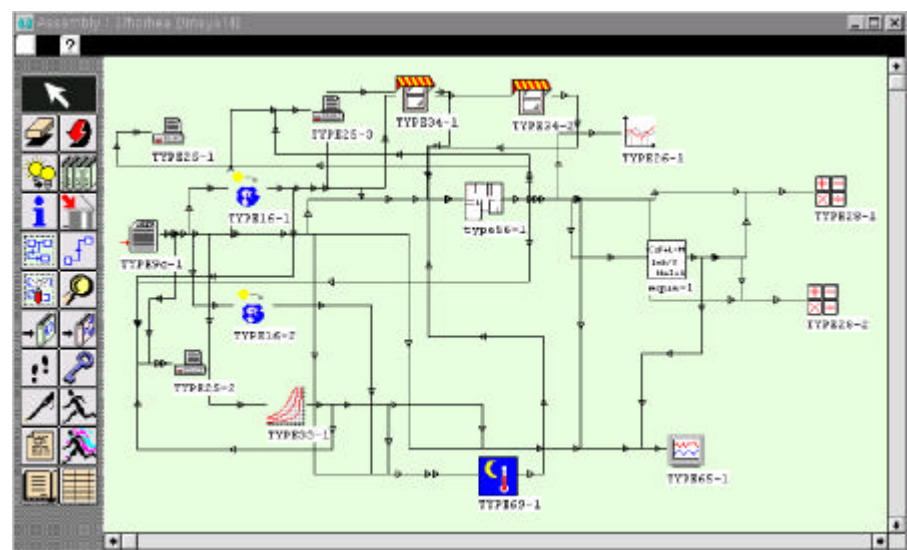
(TYPES) 가 가 ,

DLL

IISiBat(the Intelligent

Interface for the Simulation of Buildings) (GUI) 2

IISiBat



2

TRNSYS

TRNSYS

TYPE 19 TYPE 56 ASHRAE (transfer

function method)

( )

(zone) TYPE 19 ,

TYPE

56

가

(multi-zone building)

TRNSYS

PreBID

### 3 TRNSYS

	Data Reader Time-Dependent Forcing Function Algebraic Operator Radiation Processor Quantity Integrator Psychrometrics Load Profile Sequencer Collector Array Shading		Energy/ (Degree-Hour) House Detailed Zone(transfer function) Roof and Attic Overhang and Wingwall Shading Window Thermal Storage Wall Attached Sunspace Multi-Zone Building
	Quadratic Thermal Efficiency Data Detailed Performance Map Single or Bi-Axial Incidence Angle Modifier Theoretical Flat-Plate Theoretical CPC	/	Pump/Fan Flow Diverter/Mixing Valve/Tee Piece Pressure Relief Valve Pipe
	Stratified Liquid Storage Algebraic Tank Rockbed		Differential Controller with Hysteresis Three-Stage Room Thermostat Micorprocessor Controller
	On/Off Auxiliary Heater Absorption Air Conditioner Dual-Source Heat Pump Conditioning Equipment Cooling Coil Cooling Tower Chiller		Printer, Plotter, Histogram Plotter Simulation Summarazer Economics Online Printer
	Heat Exchanger Waste Heat Recovery		PV/Thermal Collector Storage Battery
	Data Interpolation First Order Differential Equations View Factors Matrix Inversion Least Squares Curve Fitting Psychrometric Calculations		Liquid Collector-Storage Air Collector-Storage System Domestic Hot Water Thermosiphon Solar Water Heater

### 3.3 ESP- r

(EU)

ESP-r (Environmental System Performance-reference)

· C++    FORTRAN(F77    F90)    , Unix    (Solaris,  
Sun/OS, SGI, Linux)    Pentium    PC

가

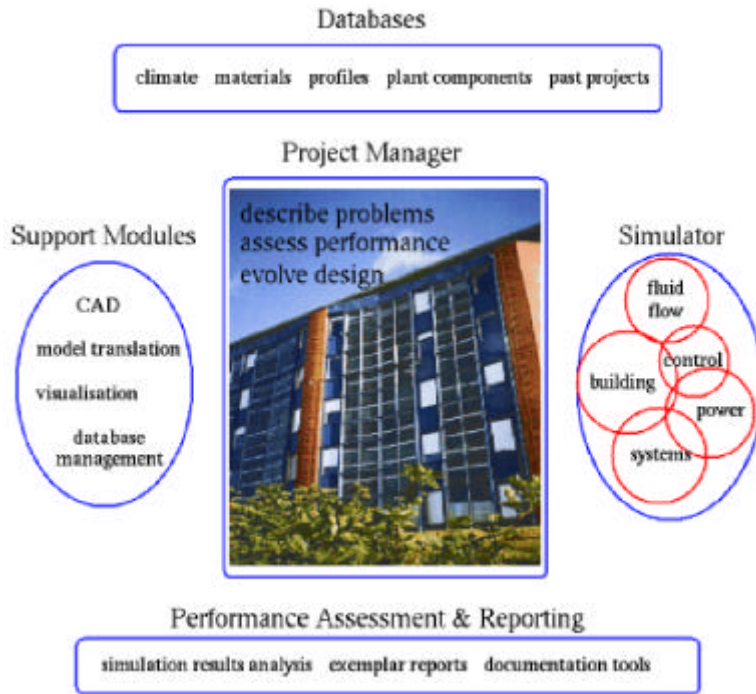
Windows

가    가

matrix partition

가    ,    가    ,





3 ESP-r

ESP-r 3 PM(Project Manager) PM PM

가 가

가 CAD Ray-tracing

RADIANCE 가 가

가 가

1974 ESP-r 가 가

가 ESP-r PASSYS

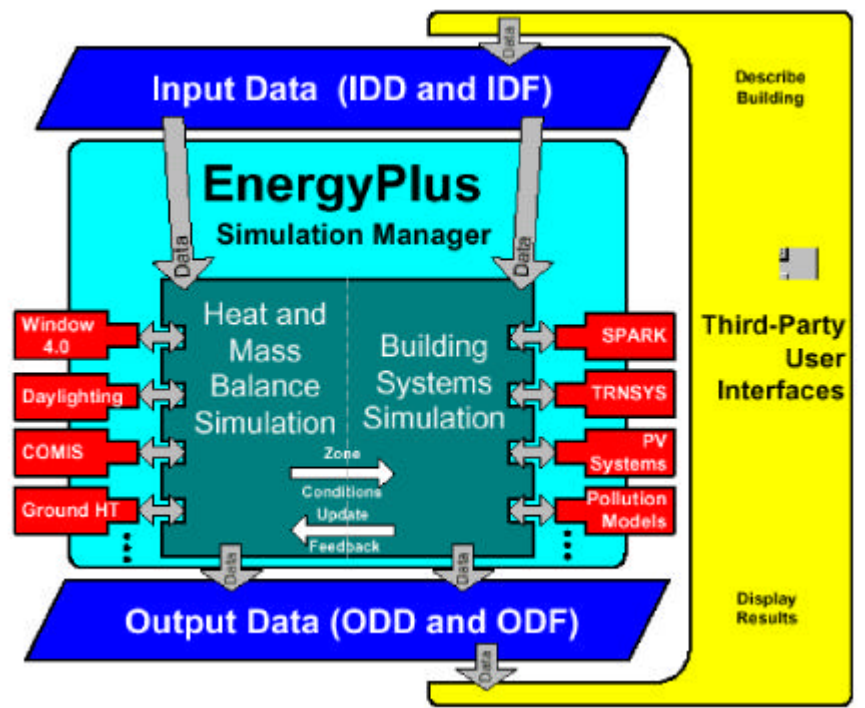
1990 가 1 ESP-r 가

3 3 ESP-r CFD(Computational Fluid

Dynamics) ESP-r CFD , TRNSYS ,  
 ,  
 , RADIANCE ESP-r ,  
 , ESP-r ,  
 , 2 3 ESP-r ,  
 , 가 ,  
 가 ESP-r .

3.4 EnergyPlus

EnergyPlus가  
 4 ver. 1 . DOE-2 BLAST  
 가 . BLAST (Building Loads Analysis and System Thermodynamics)



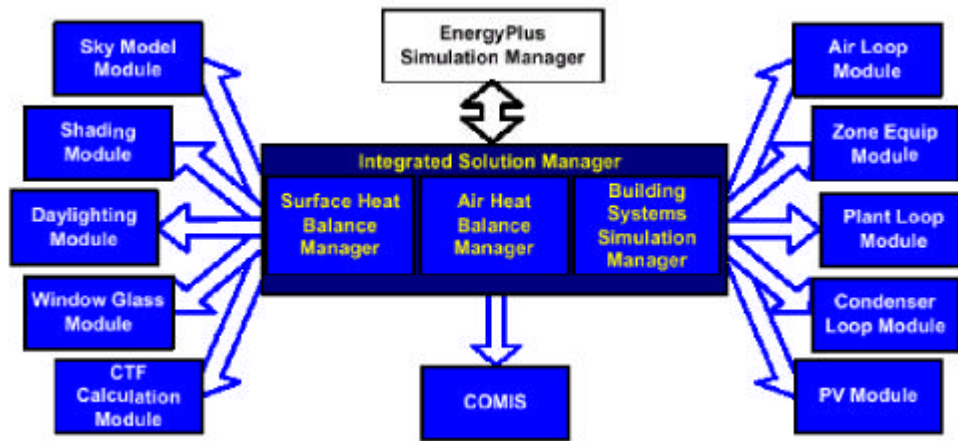
4 EnergyPlus

1960

, 가 , 가 ,  
 , 1995 BLAST DOE-2  
 FORTRAN90 , . BLAST

IBLAST heat balance based load calculation ,  
 가 .  
 4 EnergyPlus , 가  
 3 가  
 EnergyPlus 가  
 ( TRNSYS 가  
 TRNSYS ).  
 5 가 time step(1  
 가 )  
 , , ,  
 가가 가  
 4 EnergyPlus TRNSYS , TRNSYS  
 EnergyPlus  
 PV (photovoltaic) EnergyPlus

Window 95/98/NT





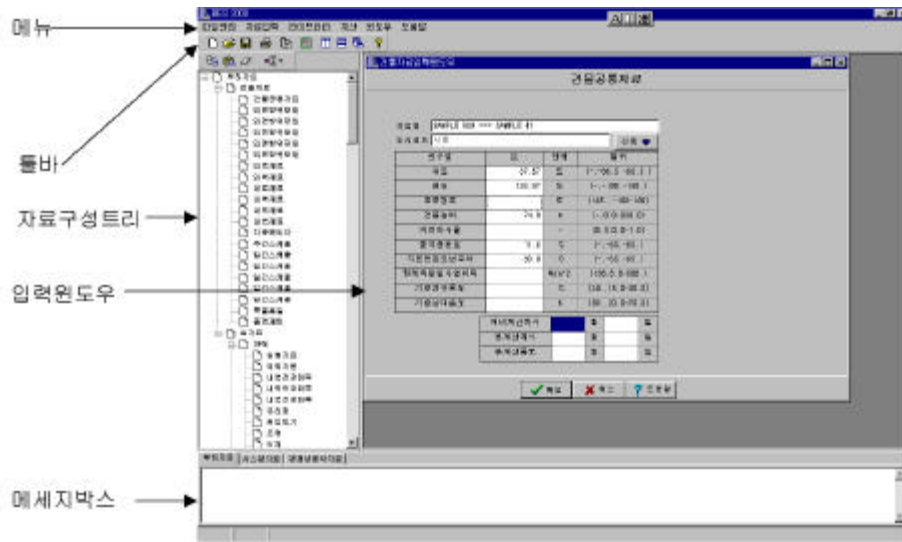
(User Interface System)

(GUI),

BES 2000

가

7 BES2000



7

IV.

가

EnergyPlus

3

HVAC

LCC

BES2000

, EnergyPlus

, TRNSYS ESP-r

1. DOE-2 EnergyPlus, <http://gundog.lbl.gov/>
2. TRNSYS, <http://sel.me.wisc.edu/>, <http://evl.cstb.fr/iisibat.htm>
3. ESPr (A Building and Plant Energy Simulation System), <http://www.esru.strath.ac.uk/>
4. , 2001 3 ,
5. , ESPr , 1999 ,