Modelling of buildings and solar systems with EnergyPlus

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Content (75min)

- AA EnergyPlus (15 min)
- BB How to model Buildings by E+ (30 min)
- CC How to model Solar systems by E+ (30 min)

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BB MODEL BUILDINGS BY E+

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BB BUILDING MODELBY E+

- 1. Description
- 2. SIMULATION control
- 3. Location and climate
- 4. Schedule
- 5.Surface construction
- 6. Building geometry
- 7. HVAC
- 8. Output

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1 DESCRIPTION OF BUILDING

- Rectangular single story building – 15.24mx15.24mx4.57m
- 1 Zone, No windows,
- Lightweightconstruction
- Surfaces made of concrete 0.1m thick.
- **Internal Load:** no.
- **Space Conditioning:** Heating set-point 20C, Cooling set-point 24C, no setback
- **Environment:**Location: Denver, Colorado, USA
- **Simulation for Design Days (in** summer and winter) and for year.

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2.1 SIMULATION PARAMETERS -VERSION

```
Version,
  8.1;                    !- Version Identifier
```

- "The Version object allows you to enter the proper version that your IDF was created for. This is checked against the current version of EnergyPlus and a severe error issued (nonterminating) if it does not match the current version string."

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2.2 SIMULATION PARAMETERS
SIMULATION CONTROL

```
SimulationControl,
  No,                   !- Do Zone Sizing Calculation
  No,                   !- Do System Sizing Calculation
  No,                   !- Do Plant Sizing Calculation
  Yes,                  !- Run Simulation for Sizing Periods
  Yes;                  !- Run Simulation for Weather File Run Periods
```


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2.3 SIMULATION PARAMETERS - Building

```
Building,
  Simple One Zone (Wireframe DXF),  !- Name
  0,                    !- North Axis {deg}
  Suburbs,              !- Terrain
  0.04,                 !- Loads Convergence Tolerance Value
  0.004,                !- Temperature Convergence Tolerance Value {deltaC}
  MinimalShadowing,     !- Solar Distribution
  30;                   !- Maximum Number of Warmup Days
   6;                   !- Minimum Number of Warmup Days
```

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2.3 *Field: North Axis*

- The Building North Axis is specified **relative to true North. Buildings frequently do not line up** with true north. For convenience, one may enter surfaces in a “regular” coordinate system
- and then shift them via the use of the North Axis. The value is specified in degrees from “true north” (clockwise is positive).

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2.3 *Field:* Solar distribution

- **MinimalShadowing**
- **FullExterior**
- **FullInteriorAndExterior,**
- **FullExteriorWithReflections**
- **FullInteriorAndExteriorWithReflections**

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2.4 SIMULATION PARAMETERS-Algorithms

```
SURFACECONVECTIONALGORITHM:INSIDE

SurfaceConvectionAlgorithm:Inside,TARP;
```

```
SurfaceConvectionAlgorithm:Outside,
  DOE-2;                    !- Algorithm
```

```
HeatBalanceAlgorithm,
  ConductionTransferFunction;  !- Algorithm
```

Inside: Simple, TARP, CeilingDiffuser, and AdaptiveConvectionAlgorithm
Outside: SimpleCombined, TARP, MoWiTT, DOE-2.
HeatBalanceAlgorithm: AdaptiveConvectionAlgorithm,Conduction Transfer Function; MoisturePenetrationDepthConductionTransferFunction; ConductionFiniteDifference; CombinedHeatAndMoistureFiniteElement

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2.5. SIMULATION PARAMETERS - Timestep

```
Timestep,
  4;                    !- Number of Timesteps per Hour
```

The allowable choices are 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, and 60.

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2.6 SIMULATION PARAMETERS - Run Period

```
RunPeriod,
  1,                !- Begin Month
  1,                !- Begin Day of Month
  12,               !- End Month
  31,               !- End Day of Month
  Tuesday,          !- Day of Week for Start Day
  Yes,              !- Use Weather File Holidays and Special Days
  Yes,              !- Use Weather File Daylight Saving Period
  No,               !- Apply Weekend Holiday Rule
  Yes,              !- Use Weather File Rain Indicators
  Yes;              !- Use Weather File Snow Indicators
```


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3.1 LOCATION

```
Site:Location,
  DENVER_STAPLETON_CO_USA_WMO_724690,  !- Name
  39.77,            !- Latitude {deg}
  -104.87,          !- Longitude {deg}
  -7.00,            !- Time Zone {hr}
  1611.00;          !- Elevation {m}
```

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3.2 CLIMATE- Winter design day

```
SizingPeriod:DesignDay,
  DENVER_STAPLETON Ann Htg 99% Condns DB,  !- Name
  -16,                !- Maximum Dry-Bulb Temperature {C}
  0.0,                !- Daily Temperature Range {deltaC}
  -16,                !- Humidity Indicating Conditions at Maximum Dry-Bulb
  83411.,               !- Barometric Pressure {Pa}
  2.3,                !- Wind Speed {m/s}
  180,                !- Wind Direction {deg}
  0.00,               !- Sky Clearness
  0,                  !- Rain Indicator
  0,                  !- Snow Indicator
  21,                 !- Day of Month
  12,                 !- Month
  WinterDesignDay,        !- Day Type
  0,                  !- Daylight Saving Time Indicator
  WetBulb;              !- Humidity Indicating Type
```


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3.3 CLIMATE-Summer design day

```
SizingPeriod:DesignDay,
  DENVER_STAPLETON Ann Clg 1% Condns DB=>MWB,  !- Name
  32.6,               !- Maximum Dry-Bulb Temperature {C}
  15.2,               !- Daily Temperature Range {deltaC}
  15.5,               !- Humidity Indicating Conditions at Maximum Dry-Bulb
  83411.,               !- Barometric Pressure {Pa}
  4,                  !- Wind Speed {m/s}
  120,                !- Wind Direction {deg}
  1.00,               !- Sky Clearness
  0,                  !- Rain Indicator
  0,                  !- Snow Indicator
  21,                 !- Day of Month
  7,                  !- Month
  SummerDesignDay,        !- Day Type
  0,                  !- Daylight Saving Time Indicator
  WetBulb;              !- Humidity Indicating Type
```

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4.1 SCHEDULE: Compact

```
Schedule:Compact,
   ALWAYS 20,              !- Name
   Any number,             !- Schedule Type Limits Name
   Through:12/31,           !- Field 1
   For: AllDays,           !- Field 2
   Until:24:00,            !- Field 3
   20;                  !- Field 4

Schedule:Compact,
   ALWAYS 24,              !- Name
   Any number,             !- Schedule Type Limits Name
   Through:12/31,           !- Field 1
   For: AllDays,           !- Field 2
   Until:24:00,            !- Field 3
   24;                  !- Field 4
```


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4.1 SCHEDULE

- **Field: Name**. a unique name.
- **Field: ScheduleType** See a list of ScheduleTypes.
- **Field-Set (Through, For, Interpolate, Until, Value)** Each compact schedule must contain the elements Through (date), For (days), Interpolate (optional), Until (time of day) and Value.
- See Schedules.idf in Datasets

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5.1 SURFACE CONSTRUCTION ELEMENTS - MATERIAL

```
Material,
  CONCRETE,   !- Name
  MediumRough,        !- Roughness
  0.1014984,          !- Thickness {m}
  1.729577,           !- Conductivity {W/m-K}
  2242.585,           !- Density {kg/m3}
  836.8000,           !- Specific Heat {J/kg-K}
  0.9000000,          !- Thermal Absorptance
  0.6500000,          !- Solar Absorptance
  0.6500000;          !- Visible Absorptance
```

See ASHRAE_2005_HOF_Materials.idf in Datasets

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5.2 CONSTRUCTION

```
Construction,
  R13WALL,            !- Name
  CONCRETE;           !- Outside Layer

Construction,
  FLOOR,              !- Name
  CONCRETE;           !- Outside Layer

Construction,
  ROOF31,             !- Name
  CONCRETE;           !- Outside Layer
```

CompositeWallConstructions.idf

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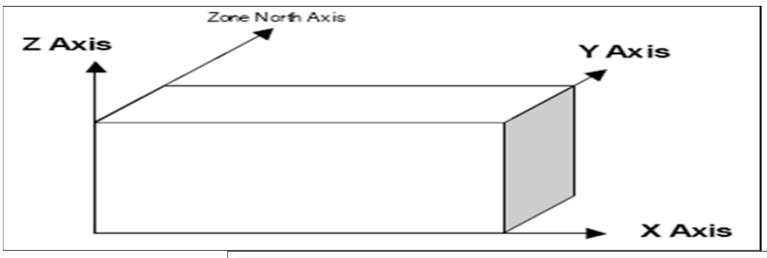
6.1 GLOBAL GEOMETRY RULES




```
GlobalGeometryRules,
   UpperLeftCorner,        !- Starting Vertex Position
   CounterClockWise,       !- Vertex Entry Direction
   WorldCoordinateSystem;  !- Coordinate System
```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6.2 ZONE

```
Zone,
   ZONE ONE,           !- Name
   0,                  !- Direction of Relative North {deg}
   0,                  !- X Origin {m}
   0,                  !- Y Origin {m}
   0,                  !- Z Origin {m}
   1,                  !- Type
   1,                  !- Multiplier
   autocalculate,      !- Ceiling Height {m}
   autocalculate;      !- Volume {m3}
```

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6.3 BUILDING SURFACE: DETAILED

```
BuildingSurface:Detailed,
    Zn001:Wall001,          !- Name
    Wall,                   !- Surface Type
    R13WALL,                !- Construction Name
    ZONE ONE,               !- Zone Name
    Outdoors,               !- Outside Boundary Condition
    ,                       !- Outside Boundary Condition Object
    SunExposed,             !- Sun Exposure
    WindExposed,            !- Wind Exposure
    0.5000000,              !- View Factor to Ground
    4,                      !- Number of Vertices
    0,                      !- Vertex 1 X-coordinate {m}
    0,                      !- Vertex 1 Y-coordinate {m}
    4.572000,               !- Vertex 1 Z-coordinate {m}
    0,                      !- Vertex 2 X-coordinate {m}
    0,                      !- Vertex 2 Y-coordinate {m}
    0,                      !- Vertex 2 Z-coordinate {m}
    15.24000,               !- Vertex 3 X-coordinate {m}
    0,                      !- Vertex 3 Y-coordinate {m}
    0,                      !- Vertex 3 Z-coordinate {m}
    15.24000,               !- Vertex 4 X-coordinate {m}
    0,                      !- Vertex 4 Y-coordinate {m}
    4.572000;               !- Vertex 4 Z-coordinate {m}
```


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7.1 Zone HVAC: Ideal Loads Air System

```
ZoneHVAC: IdealLoadsAirSystem,
   Zone Air,              !- Name
   Zone Supply Inlet,     !- Zone Supply Air Node Name
   50,                    !- Heating Supply Air Temperature {C}
   13,                    !- Cooling Supply Air Temperature {C}
   0.015,                 !- Heating Supply Air Humidity Ratio {kg-H2O/kg-air}
   0.01,                  !- Cooling Supply Air Humidity Ratio {kg-H2O/kg-air}
   NoLimit,               !- Heating Limit
   autosize,              !- Maximum Heating Air Flow Rate {m3/s}
   NoLimit,               !- Cooling Limit
   autosize,              !- Maximum Cooling Air Flow Rate {m3/s}
   NoOutdoorAir,          !- Outdoor Air
   autosize;              !- Outdoor Air Flow Rate {m3/s}
```

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7.2 Zone HVAC: Equipment List

```
ZoneHVAC:EquipmentList,
  Zone Equipment,          !- Name
  ZoneHVAC:IdealLoadsAirSystem,  !- Zone Equipment 1 Object Type
  Zone Air,                !- Zone Equipment 1 Name
  1,                       !- Zone Equipment 1 Cooling Priority
  1;                       !- Zone Equipment 1 Heating Priority
```


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7.3 ZONE HVAC: EQUIPMENT CONNECTIONS

```
ZoneHVAC:EquipmentConnections,
  ZONE ONE,                !- Zone Name
  ZONE Equipment,          !- Zone Conditioning Equipment List Name
  ZONE Supply Inlet,       !- Zone Air Inlet Node or NodeList Name
  ,                        !- Zone Air Exhaust Node or NodeList Name
  ZONE ONE Air Node,       !- Zone Air Node Name
  ZONE ONE Return;         !- Zone Return Air Node Name
```

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7.4 ZONE CONTROL: THERMOSTAT

```
ZoneControl:Thermostat,
  ZONE ONE Thermostat,      !- Name
  ZONE ONE,                 !- Zone Name
  Always 4,                 !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,  !- Control 1 Object Type
  Office thermostat;        !- Control 1 Name
```


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7.5 THERMOSTAT SET POINT: DUALSETPOINT

```
ThermostatSetpoint:DualSetpoint,
  Office Thermostat,        !- Name
  ALWAYS 20,                !- Heating Setpoint Temperature Schedule Name
  ALWAYS 24;                !- Cooling Setpoint Temperature Schedule Name
```

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8.1 OUTPUT: Style

```
Output:VariableDictionary,
  IDF;                    !- Key Field

Output:Surfaces:Drawing,
  dxf;                    !- Report Type

Output:Constructions,
  Constructions;          !- Details Type 1

Output:Table:SummaryReports,
  AllSummary;             !- Report 1 Name

OutputControl:Table:Style,
  ALL;                    !- Column Separator
```


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8.2 OUTPUT:METER:METERFILEONLY

```
Output:Meter:MeterFileOnly,
  ExteriorLights:Electricity,  !- Name
  hourly;                      !- Reporting Frequency

Output:Meter:MeterFileOnly,
  EnergyTransfer:Building,     !- Name
  hourly;                      !- Reporting Frequency

Output:Meter:MeterFileOnly,
  EnergyTransfer:Facility,     !- Name
  hourly;                      !- Reporting Frequency
```

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8.3 OUTPUT:VARIABLE

```
Output:Variable,
    *,                        !- Key Value
    outdoor dry bulb,         !- Variable Name
    hourly;                   !- Reporting Frequency

Output:Variable,
    *,                        !- Key Value
Daylight Saving Time Indicator, !- VN
    daily;                    !- Reporting Frequency

Output:Variable,
    *,                        !- Key Value
    DayType Index,            !- Variable Name
    daily;                    !- Reporting Frequency

Output:Variable,
    *,                        !- Key Value
    Zone Mean Air Temperature, !- Variable
N   hourly;                   !- Reporting Frequency

Output:Variable,
    *,                        !- Key Value
Zone Total Internal Latent Gain, !- VN
    hourly;                   !- Reporting Frequency

Output:Variable,
    *,                        !- Key Value
    Zone Mean Radiant Temperature,!- VN
    hourly;                   !- Reporting Frequency

Output:Variable,
    *,                        !- Key Value
Zone Air Balance Surface Convec Rate,!- VN
    hourly;                   !- Reporting Frequency

Output:Variable,
    *,                        !- Key Value
Zone Air Balance Air Energy Storage Rate,!- VN
    hourly;                   !- Reporting Frequency

Output:Variable,
    *,                        !- Key Value
    Surface Inside Temperature,  !- Variable N
    daily;                    !- Reporting Frequency

Output:Variable,
    *,                        !- Key Value
    Surface Outside Temperature,  !- Variable N
    daily;                    !- Reporting Frequency

Output:Variable,
    *,                        !- Key Value
    Surface Int Convection Coeff,  !- Variable N
    daily;                    !- Reporting Frequency

Output:Variable,
    *,                        !- Key Value
    Surface Ext Convection Coeff,  !- Variable N
    daily;                    !- Reporting Frequency
```


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9.1 Text output files

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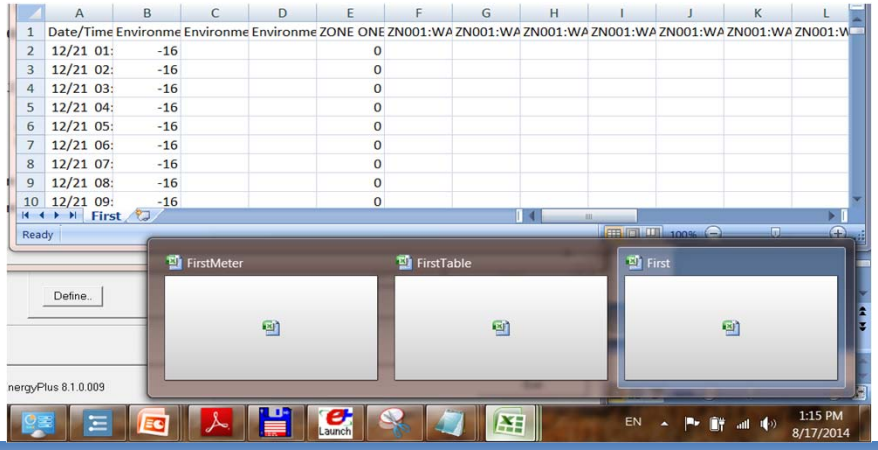
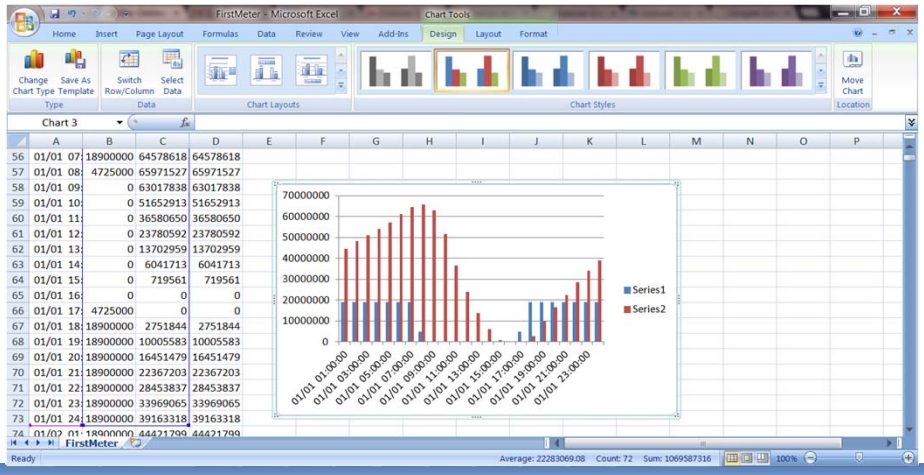
9.2 Spreadsheets



9.2 Spreadsheets and charts



9.3 HTLM output content

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9.3 HTLM output **Annual Building Utility Performance Summary**

file:///C:/first/Firsttable.html

Apps Mendeley Log In - Sign on... Google Scholar Elsevier Editoria... ECM Kurir ПИС: Портал и... Khan Academy Log In - Sign on... PD Elektrodistri...

Program Version:**EnergyPlus-Windows-64 8.1.0.009, YMD=2014.08.17 12:52**

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Tabular Output Report in Format: **HTML**

Building: **Simple One Zone (Wireframe DXF)**

Environment: **San Francisco Intl Ap CA USA TMY3 WMO#=724940**

Simulation Timestamp: **2014-08-17 12:52:12**

Report: **Annual Building Utility Performance Summary**

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For: **Entire Facility**

Timestamp: **2014-08-17 12:52:12**

Values gathered over 8760.00 hours

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	258.96	1114.98	1114.98
Net Site Energy	258.96	1114.98	1114.98
Total Source Energy	846.32	3643.87	3643.87
Net Source Energy	846.32	3643.87	3643.87

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