Energy Simulation as Analyzing/Design Tool with DIVA (EnergyPlus)

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**WHAT IS DIVA/EnergyPlus?**

**EnergyPlus**, developed by the U.S. Department of Energy, is a whole-building energy simulation program used widely by engineers, architects and researchers. It is the most robust current energy simulation tool, built upon the capabilities and features of DOE-2 and BLAST (Building Loads Analysis and System Thermodynamics) ¹

- Fully integrated building, envelope, HVAC, water and renewables simulation program
- One of the most robust simulation tools
- DOE-2 + BLAST but exceeds its precedents’ capabilities
- Sub-hourly calculations
- Has been validated under the comparative Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs BESTEST/ASHARE STD 140.
- Free!
- Simulation engine without a user interface

DIVA is a daylighting and energy modeling plug-in for the Rhino3D - NURBS modeler, providing GUI for Radiance and EnergyPlus simulation engines. The plug-in was initially developed at the Graduate School of Design at Harvard University and is now distributed and developed by Solemma LLC. ¹

¹. http://diva4rhino.com/
MODEL PREPARATION

1. 
- Consolidating spaces into thermal zones. Each thermal zone represents its consistent thermostat setpoints and schedules (Current DIVA only allows a single thermal zone).
- Thermal zone has to be perfectly tight (no leaking).
- No thickness necessary, all constructions’ thicknesses are defined in EnergyPlus materials
MODEL PREPARATION

2.
- Do not create voids on walls for windows. Windows should be overlaid on wall planes.
- Do not model windows’ frames and/or dividers. Reduce the overall window size in the model for these accountabilities.
3. Click on the **Location** button, choose a EnergyPlus weather data file relevant to the location of the study model.

EnergyPlus weather data file can be obtained from DOE website:
http://apps1.eere.energy.gov/buildings/energyplus/weatherdata_about.cfm

Unzip the file and copy the file having extension as **epw** into \DIVA\WeatherData\
4. Change building surfaces to their proper layers (These layers are fixed and predefined by DIVA).
5. Click on the **Materials** button > Assign Materials

- Select predefined materials per **Layer Names**.

These predefined materials based on recommendations per Climate Zones by **ASHRAE Standard 90.1** (Energy Standard for commercial buildings)

- Click on **Submit Material Information**
The default materials at the dropdown menu are good for early design stage. Materials can be customized and added by modifying the file named `04_material_construction.idf` located at `\DIVA\Thermal\Rhino\` (only recommended for people who is familiar to EnergyPlus modeling).

- For customizing Constructions

```
! ***** WALL ASHRAE CLIMATE ZONES 1-2 ASHRAE 90.1-2007
Construction,
Wall_ASHRAE_90.1-2007_Climate_Zone_1-2_Ext_Wall_Steel-Framed_R-13, !- Name
  Std MAT-SHEATH, !- Outside Layer
  Wall Insulation [1], !- Layer 2
  1/2IN Gypsum; !- Layer 3
```

- For customizing Materials

```
Material:Nomass,
  Std MAT-SHEATH, !- Name
  Rough, !- Roughness
  0.3626, !- Thermal Resistance (m2-K/W)
  0.9000, !- Thermal Absorptance
  0.7000, !- Solar Absorptance
  0.7000; !- Visible Absorptance
```
6. Click on the Materials button > Shading Controls

Conceptual Dynamic Shading

Conceptual dynamic shading considers the operation of an idealized blind that covers all windows in the scene without the need for modeling the device geometrically. The effect of this blind is to reflect all direct sunlight and allow only 25% of diffuse sunlight into the space. Using conceptual shading is very fast and takes the same amount of time as running an identical simulation with no dynamic shading. Conceptual shading devices are limited in their control, and it can be considered that all are down or all are up at the same time.
7. Click on the **Materials** button > **Lighting Controls**

![Lighting Controls in DIVA](image)
8. Click on the Metrics button > Thermal Single-Zone

- Modify the occupant density, equipment loads, heating and cooling setpoints.

9. Click on Run Simulation
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RESULTS

DIVA-Thermal (EnergyPlus) Simulation Report

Monthly Energy Use

- Equipment Energy
- Heating Energy
- Cooling Energy
- Lighting Energy

Heating and Cooling Energy Consumption

- kWh scale from 0 to 24
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DIVA-GRASSHOPPER

DIVA DAYLIGHTING CONTROL

PARAMETRIC OVERHANG

LEGEND CONTROL

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