LIVEENERGY (DEMETER)

A GREEN BUILDING PLUGIN FOR GOOGLE SKETCHUP

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(and thanks to John Kennedy, Autodesk GreenBuildingStudio)
Energy Innovation Zone

- CnES local authority, UHI (university), HIE regional economic development agency, and EU Regional Development Funds developing

Energy Innovation Zone

- Large natural resource base for renewables in Scotland.
- Scotland has an estimated potential of 36.5 GW of wind and 7.5 GW of tidal power
- 25% of the estimated total capacity for the European Union
- Up to 14 GW of wave power potential, 10% of EU capacity.

A low carbon built environment drives adoption of renewable energy
Energy Performance of Buildings Directive (EPBD)

- 160 million buildings in the EU
  - over 40% of Europe’s energy
  - over 40% of carbon dioxide emissions
- Heating fuel
  - 57% of domestic consumption
  - 52% of non-residential building consumption
- Water heating
  - 25% of domestic consumption and 9% of non-residential use.
- Lighting
  - 25% of emissions due to commercial buildings.
- A cost-effective savings potential of around 22% of present consumption in buildings can be realised by 2010.
- EPBD directive: deliver up to 45 million tonnes of carbon dioxide reduction by 2010.

Whenever a building is constructed, sold or rented out, an energy performance certificate (EPC) must be made available.
20-30% REDUCTIONS

Significant reductions in CO₂ emissions from 2002 notional building!!

For a basic heated and mechanically ventilated office building;

\[ C_{\text{notional}} \times (1-0.2) \times (1-0.1) = 0.72 \times C_{\text{notional}} \]

<table>
<thead>
<tr>
<th>Building Servicing Strategy</th>
<th>Improvement Factor</th>
<th>LZC Benchmark</th>
<th>Target Emission Rate (TER)</th>
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</thead>
<tbody>
<tr>
<td>Heated and Naturally Ventilated</td>
<td>0.15</td>
<td>0.1</td>
<td>23.5% reduction</td>
</tr>
<tr>
<td>Heated and Mechanically Ventilated</td>
<td>0.2</td>
<td>0.1</td>
<td>28% reduction</td>
</tr>
<tr>
<td>Air Conditioned</td>
<td>0.2</td>
<td>0.1</td>
<td>28% reduction</td>
</tr>
</tbody>
</table>

NOTIONAL + IMPROVEMENT = TARGET

ACTUAL > TARGET = FAIL

ACTUAL ≤ TARGET = PASS
BUILDING INFORMATION MODELS

- 100,000-240,000 EPCs per year in UK
- Energy Performance Certificates (EPCs) will need detailed models (new and existing buildings)
- These information models will be valuable long term data assets (business case as well as legal requirement)
- Our view is that ‘whole-building/lifecycle’ BIM models are better investment than ‘energy-only’ models
- Internet accessibility, collaboration, interoperability and scaleability - a must
- Highly popular, easy to use modelling tools like Google SketchUp - also a must (where’s the modelling army coming from?)
SIMULATION CHALLENGE

- Vast scale - distributed, universally accessible model of the world’s built environment is required
- Interoperability required
- Benefits - rich information assets available throughout building lifecycle
ENERGY ANALYSIS

WEB ARCHITECTURE

XML
- gbXML
- SBEMXML
- trnSysXML
XML + WEB SERVICES

- XML 10 years old
- Internet and problem domain vocabularies
- XSLT - vocabulary transformation
- E4x - XML objects
- Web Services - Internet ‘RPC’
- WSDL - expose application APIs across Internet

NOTE: Every Web service component uses XML as a communication language
## WEB SERVICES

This call reference describes the elements and attributes for each call in the eBay Shopping Web Services.

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<th>Call</th>
<th>Summary</th>
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<td>FeedProducts</td>
<td>Searches Half.com for stock product information (stock description and item Specifics), such as information about a particular kind of DVD or book. Also, retrieves up to 50 Half.com listings associated with a product.</td>
<td><a href="#">view</a></td>
</tr>
<tr>
<td>FixItems</td>
<td>Searches for items based on a query or a category ID. If you use keywords, this call returns items that contain the keywords in the title. A maximum of 50 items is returned.</td>
<td><a href="#">view</a></td>
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<tr>
<td>FindCategories</td>
<td>Searches for items based on many possible input fields. Detailed information is returned about items.</td>
<td><a href="#">view</a></td>
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<tr>
<td>FindCategoriesByKeyword</td>
<td>Searches for backing items based on a category or keyword. Returns WatchCount in addition to item information.</td>
<td><a href="#">view</a></td>
</tr>
<tr>
<td>FindCategoriesByKeywordAndFilter</td>
<td>Finds the words more frequently used by eBay users when searching for listings. If you use keywords, this call returns available alternative keywords. In addition to popular related keywords.</td>
<td><a href="#">view</a></td>
</tr>
<tr>
<td>FeedProducts</td>
<td>Searches for stock product information (stock description and item Specifics), such as information about a particular kind of DVD or camera. Also, retrieves up to 200 eBay listings associated with a product.</td>
<td><a href="#">view</a></td>
</tr>
</tbody>
</table>

**Customer Portal users can access their own accounts and any account shared with them.**

**Fields**

- Sosl
- Find clause syntax
- ApexClass object
- ApexController object
- ApexPage object
- ApexTrigger object
- APIUsage metering

---

Over 25,000 developers
1,900 certified applications
8 billion Web service requests per quarter in 2005

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RICH, EXPRESSIVE VOCABULARY
DE FACTO STANDARD
(YET UNDERUTILISED)
/**
 * Space_type0.as
 * This file was auto-generated from WSDL by the Apache Axis2 generator modified by Adobe
 * Any change made to this file will be overwritten when the code is re-generated.
 */

package com.greenspacereasearch.gbxml{

  public class Space_type0 {
    /**
     * Constructor, initializes the type class
     */
    public function Space_type0() {}

    public var Name:String;
    public var Description:String;
    public var Lighting:[ArrayElementType("Lighting_type0")];
    public var LightingControl:[ArrayElementType("LightingControl_type0")];
    public var LightingControl:Array;
  }
}

Or just use e4x - query and filter (‘search for spaces that use LightSys-4’)

gbXML.Campus.Building.Space.(Lighting.@lightingSystemIdRef == "LightSys-4")
gbXML = Interoperability

- SketchUp
- GreenBuildingStudio
- Revit
- IES
- Archicad
- Ecotect
Adding gbXML Data Model to SketchUp

Surfaces
Spaces
GBS
Server
Heavy Lifting!

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Paint these

Auto or manual

Server default, modify by user
### SURFACE TYPE OPTIONS
- InteriorWall
- ExteriorWall
- Roof
- InteriorFloor
- Shade
- UndergroundWall
- UndergroundSlab
- Ceiling
- Air
- UndergroundCeiling
- RaisedFloor
- SlabOnGrade

### OPENING TYPE OPTIONS
- FixedWindow
- OperableWindow
- FixedSkylight
- OperableSkylight
- SlidingDoor
- NonSlidingDoor
- Air
server default, modify by user

tricky
RESIZABLE RICH INTERNET USER INTERFACE (ADOBE FLEX)

gbXML SURFACES AND OPENINGS - MATERIALS PALETTE

gbXML COMPONENTS

SPACE TOOLS
WEBDIALOG (EMBEDDED INTERNET EXPLORER)

POPULATED WITH FLEX RICH INTERNET USER INTERFACE
FLEX IS MAGIC
# SketchUp Ruby API Class Index

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<td>Vector3d</td>
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<td>USECASE ID</td>
<td>DESCRIPTION</td>
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<td>Share and collaborate on project</td>
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<td>UC7</td>
<td>Import gbXML from web service</td>
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CLOSED SHELL TEST CASE
TWO WAY HIGHLIGHT
GREENBUILDING STUDIO RESULT
### gbXML COMPONENT

#### Zone (15)

<table>
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<tr>
<th>id</th>
<th>fanSchedIdRef</th>
<th>heatSchedIdRef</th>
<th>coolSchedIdRef</th>
<th>AirLoopId</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>zone-sp-11-Room_Z</td>
<td>FanSch-19</td>
<td>Heatsched-9</td>
<td>Coolsched-9</td>
<td>AirLoopId</td>
<td>OFFICE</td>
</tr>
</tbody>
</table>

#### AirLoop

<table>
<thead>
<tr>
<th>id</th>
<th>systemType</th>
<th>controlZoneIdRef</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>East1</td>
<td>PackagedVariableAirVolume</td>
<td>zone-sp.Room_P.Room_P</td>
<td>Air loop</td>
<td>East exterior system using schedule 'FanSch-19' on the top floor on the bottom floor</td>
</tr>
</tbody>
</table>

#### AirLoopEquipment

<table>
<thead>
<tr>
<th>id</th>
<th>equipmentType</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>East1-Equip-38</td>
<td>VAVBox</td>
<td>Hot water reheat boxes</td>
<td>Used for reheat on VAV systems with hot water terminal coils</td>
</tr>
</tbody>
</table>

#### HydronicLoop

<table>
<thead>
<tr>
<th>id</th>
<th>type</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>HydronicLoopId</td>
<td>hydronicLoopId: HydLoop-G, HydLoop-Type: HotWater</td>
</tr>
</tbody>
</table>
Import to LiveEPC for UK EPC production
Greenspace Research

LiveEPC

online building energy certificates

Energy Performance Certificate
Non-Domestic Building

Example building
56 London Road
LONDON
SW23 1HA

Certificate Reference Number:
0100-0038-0000-0029-0002

This certificate shows the energy rating of this building. It indicates the energy efficiency of the building fabric and the heating, ventilation, cooling and lighting systems. The rating is compared to two benchmarks for this type of building: one appropriate for new buildings and one appropriate for existing buildings. There is more advice on how to interpret this information on the Government’s website www.communities.gov.uk/epc.

Energy Performance Asset Rating

More energy efficient

A 0-25
B 26-50
C 51-75
D 76-100
E 101-125
F 126-150
G Over 150

Less energy efficient

Not zero CO₂ emissions

65

This is how energy efficient the building is.

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LiveEnergy - TrnSys

- “TrnSys is a complete and extensible simulation environment for the transient simulation of systems, including multi-zone buildings” [TrnSys manual]
TrnSys

- Modular Structure - possible to write custom components.

- Ideally suited to analysing Solar Systems, Low energy buildings, renewable energy systems, HVAC systems etc.

- Fairly steep learning curve.
TrnSys BUI (Type 56)
TrnBuild
gbXML to BUI

- XSLT style sheets used.

- Converts from gbXML to trnsysXML.

- Then from trnsysXML to standard BUI.

- Some default values have to be used as not all required information is present in gbXML files.
SUMMARY

- Google SketchUp energy plugin developed
- Built on gbXML
- Flex Rich Internet and Web services framework
- Communicates with GreenBuildingStudio
- Generates Energy Performance Certificates
- Interoperates with trnsys