



BuildingSync Webinar

Nicholas Long, Katherine Fleming, Cory
Mosiman, NREL

Harry Bergmann, DOE

Mark Borkum, PNNL

Ted Summer, Devetry

Christopher Naismith, Audette

September 11, 2020

Webinar Outline

- Overview
- DOE Updates
- BuildingSync Version 2.1 Updates
- BuildingSync Proposed Changes to Version 2.2
- Audit Template Tool Integration Update
- Audette.io Demonstration
- Looking Ahead

Poll #1

- What is your current level of familiarity with BuildingSync?



Recently became aware



Currently use BuildingSync to guide naming or to structure research/software/etc.



Currently integrating BuildingSync



Already integrated BuildingSync



Developer



Other



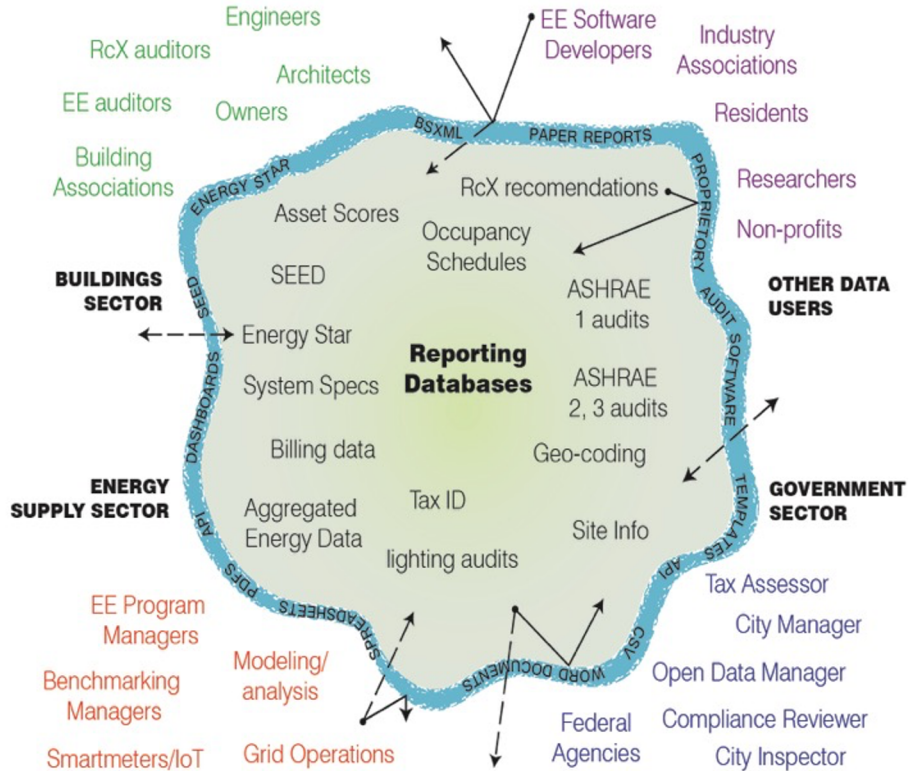
What is BuildingSync?

- A common file format for exchanging building data (characteristics, energy audit data, and building performance) that can be utilized by different software and databases to streamline reporting and data transfer
- Directed by DOE and developed by NREL and PNNL with working group of industry leading subject matter experts
- Built on terms from the Building Energy Data Exchange Specification (BEDES)

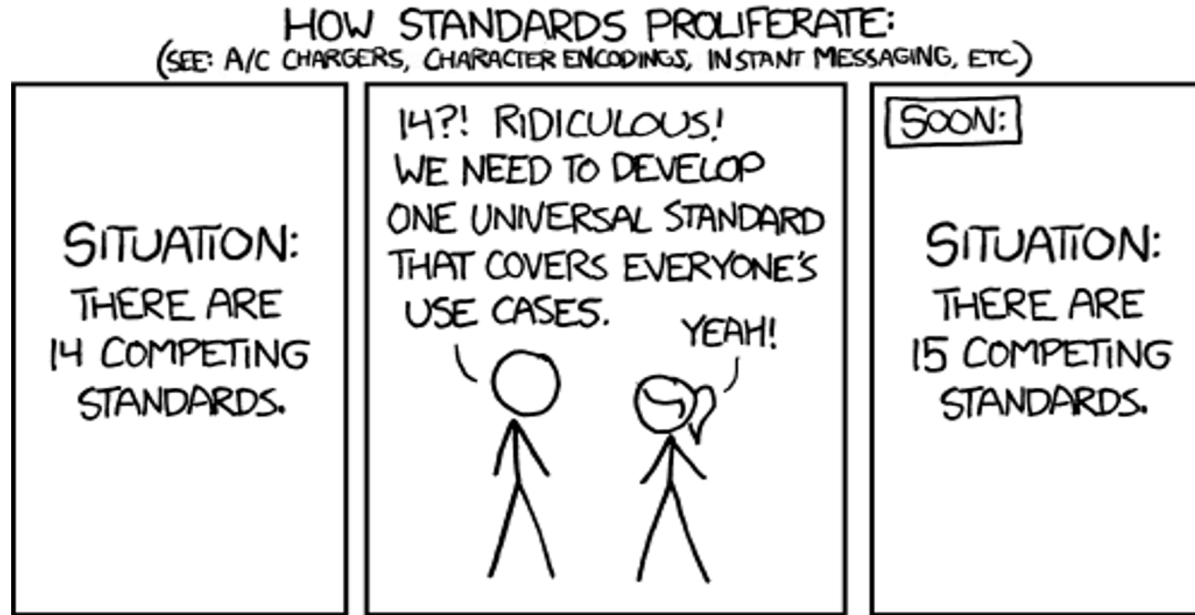


Building Data Exchange Landscape

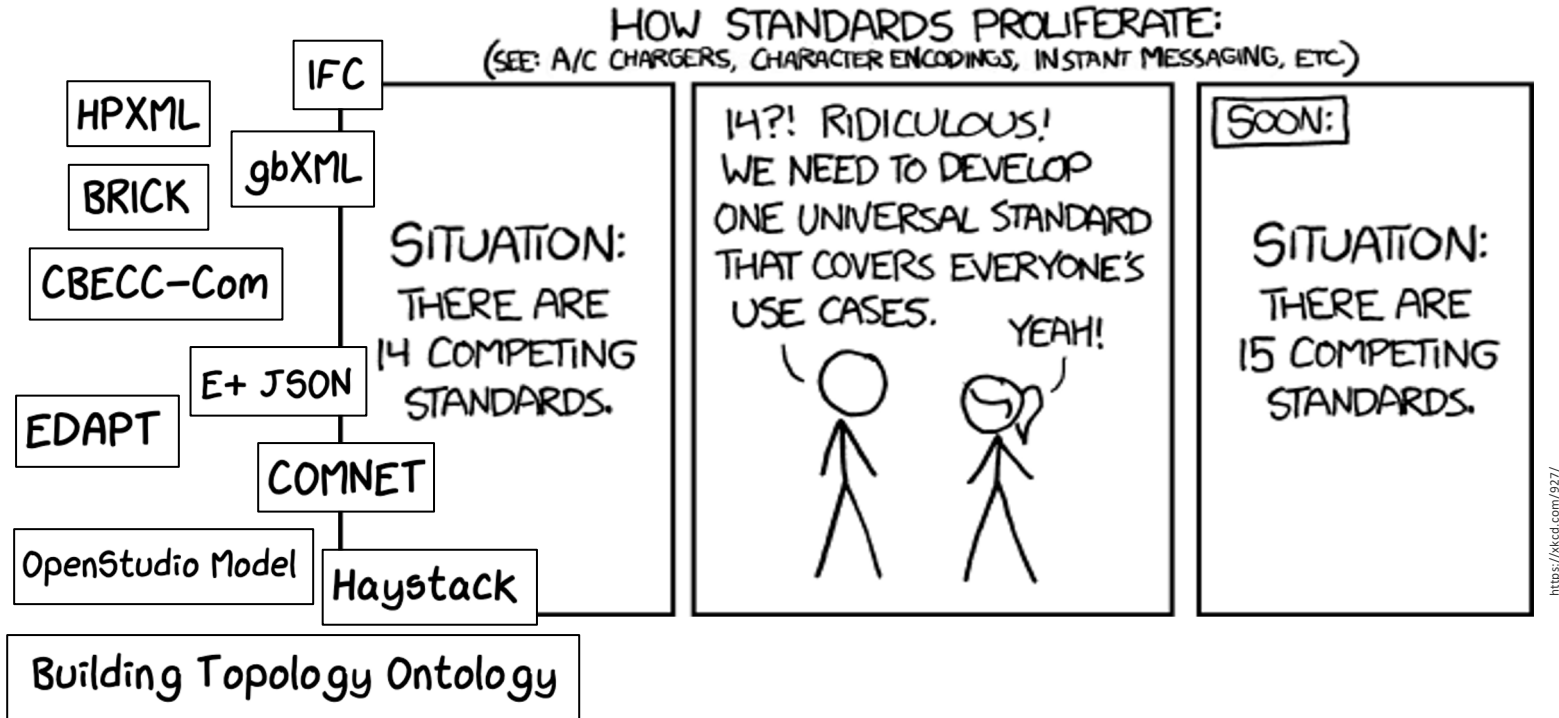
There are many consumers of commercial building data, including auditors, engineers, designers, operators, inspectors, researchers, etc. The data are typically provided in *varying formats* with *varying definitions*. This **lack of standardization limits the data's usefulness**.



BuildingSync Motivation



BuildingSync Motivation



Poll #2

- Current formats used to exchange building data

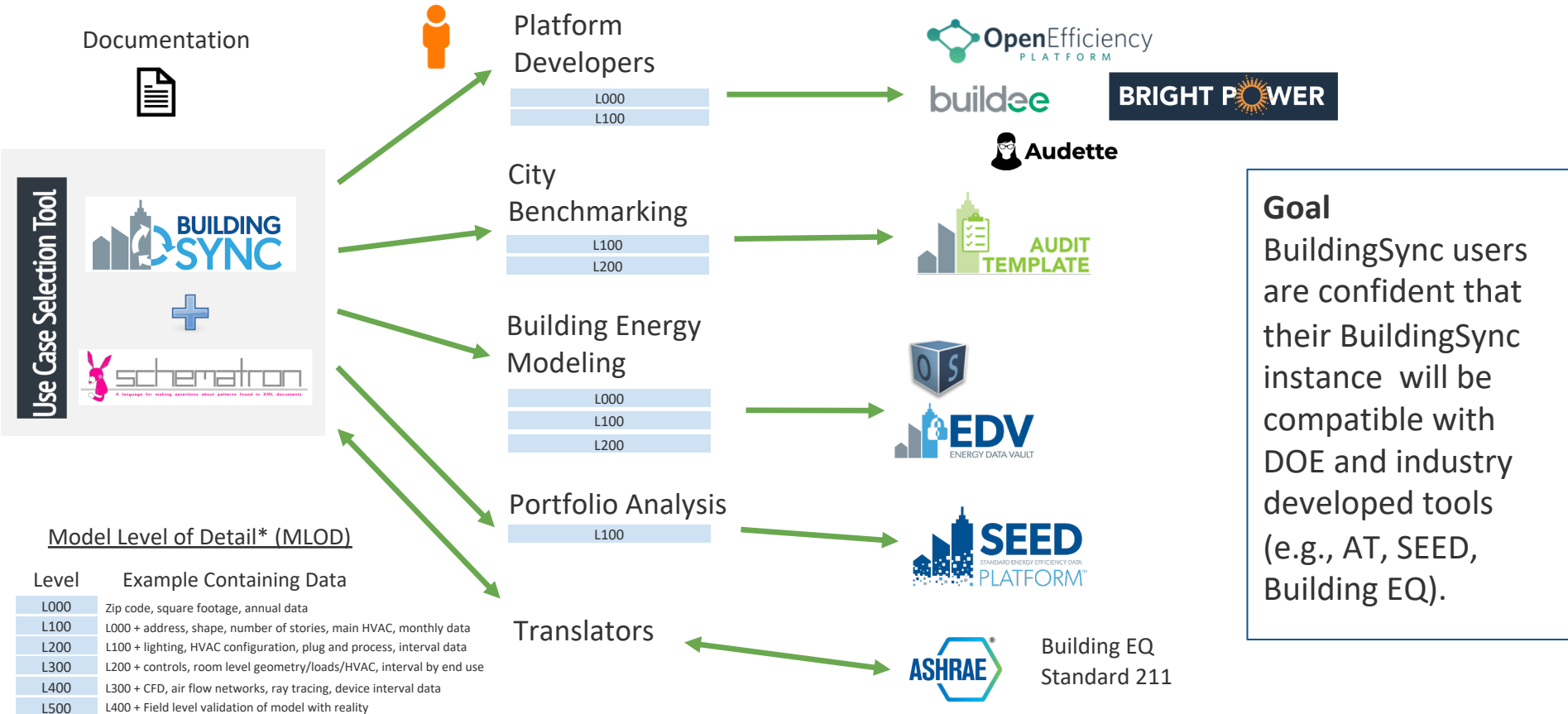


DOE Updates

DOE Updates

- BuildingSync for Scale & Usability
 - Schema Server w/Carmel Soft (gbXML, bEQ)
 - Modularization for ease of use & extensibility
- Ongoing support for private sector providers & partners
- Close integration with Audit Template & support for local programs
- Open Question: where does BuildingSync interface with Operations?

BuildingSync for Scale & Usability



Interoperability (Semantic & Otherwise)

Discussed the need for measure-standardization in June.
This is still a need.

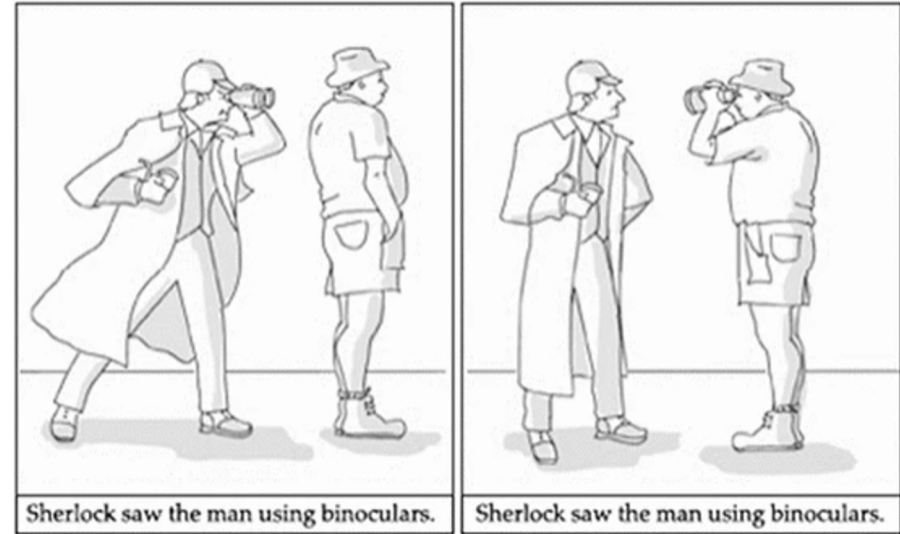
Next need: Semantic Standardization

Why?

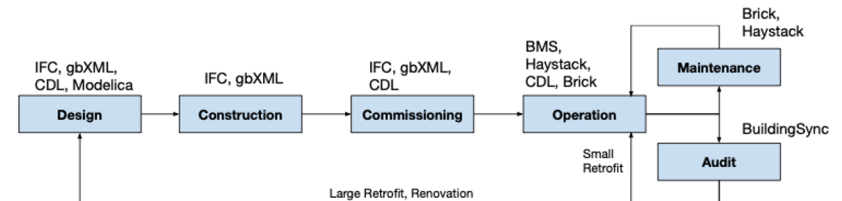
Semantic information is critical to understanding “how” a building works and enable grid-interactive and “smart” buildings.

Ultimately, the work to create a semantic standard will create a consistent ontology, applied through the semantic standard, but extensible to other use cases like BIM.

What does this look like? Brick. RDF. Haystack V4.
Question: Where does this interface with BuildingSync?



Source: von Fintel, Kai. 24.903 Language and its Structure III: Semantics and Pragmatics, Spring 2005.



Credit: Gabe Fierro, UCB

Version 2.1 Updates

Version 2.1 Release

- Version 2.1 released to GitHub on July 30th, 2020
- Use Case Selection Tool has been updated
- Audit Template Tool has been updated

Category	Count
Controls	0
General	7
Measures	0
Reports	0
Systems	2
Validation	2
Other	5
Total	16

Minor Breaking and Non-Breaking Changes

Non-Breaking Breaking Changes

- Documentation/Support
 - [#180](#), Update Audit Template examples
 - [#186](#), Add BRICR example generated by Audit Template
 - [#201](#), use BEDES term for referring to ASHRAE 211
 - [#209](#), Update annotations for consistency
- Modifications
 - [#185](#), Add EnergyCostIndex element
 - [#188](#), Add Canadian provinces
 - [#192](#), add LinkedPremises to FanSystem and MotorSystem
 - [#196](#), update OccupantQuantityType enumerations with definitions
 - [#199](#), update PrimaryHVACSystemType enumerations in line with AT tool
 - [#202](#), Add OriginalOccupancyClassification element to Section

Minor Breaking Changes

- Validation
 - [#178](#), Validate format of telephone number
 - [#179](#), Validate format of postal codes.
 - [#193](#), Require IDs on all elements with an ID attribute
 - [#194](#), Require version attribute with semantic versioning restriction

Documentation - HVAC Systems

System definition requirements for Standard 211 Level 1 audit are relatively minimal

Space Number	A
Function type*	
Original intended use	
Gross Floor Area* (per space)	
Conditioned Area* (Approx % of total function space)	
Number of Occupants	
Approximate Plug Loads (W/sf)	
Use (hours/week)	
Use (weeks/year)	
Principal HVAC Type*	
Principal Lighting Type*	

Example:

Level 1 audit requirements for an HVAC System by Space - only need to define a single enumerated element:

<PrimaryHVACSystemType>

```
<xs:element name="PrimaryHVACSystemType" minOccurs="0">
  <xs:annotation>
    <xs:documentation>Primary HVAC type.</xs:documentation>
  </xs:annotation>
  <xs:simpleType>
    <xs:restriction base="xs:string">
      <xs:enumeration value="Packaged Terminal Air Conditioner"/>
      <xs:enumeration value="Four Pipe Fan Coil Unit"/>
      <xs:enumeration value="Packaged Terminal Heat Pump"/>
      <xs:enumeration value="Packaged Rooftop Air Conditioner"/>
      <xs:enumeration value="Packaged Rooftop Heat Pump"/>
      <xs:enumeration value="Packaged Rooftop VAV with Hot Water Reheat"/>
      <xs:enumeration value="Packaged Rooftop VAV with Electric Reheat"/>
      <xs:enumeration value="VAV with Hot Water Reheat"/>
      <xs:enumeration value="VAV with Electric Reheat"/>
      <xs:enumeration value="Warm Air Furnace"/>
      <xs:enumeration value="Ventilation Only"/>
      <xs:enumeration value="Dedicated Outdoor Air System"/>
      <xs:enumeration value="Water Loop Heat Pump"/>
      <xs:enumeration value="Ground Source Heat Pump"/>
      <xs:enumeration value="VRF Terminal Unit"/>
      <xs:enumeration value="Chilled Beam"/>
      <xs:enumeration value="Other"/>
    </xs:restriction>
  </xs:simpleType>
</xs:element>
```

Documentation - Level 2 HVAC Systems

System definition requirements for Standard 211 Level 1 audit are relatively minimal

However, for a Level 2 audit, significantly more detailed information is required, specifically around:

- (6.2.1.1) Schedules
- (6.2.1.2) Envelope Systems
- (6.2.1.3) HVAC Systems
- (6.2.1.4) SHW Systems
- (6.2.1.5) Lighting
- (6.2.1.6) Process and Plugs

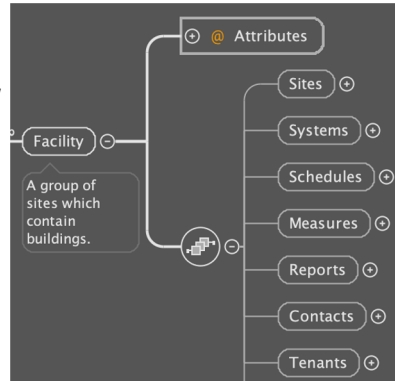
Documentation - Systems

System definition requirements for Standard 211 Level 1 audit are relatively minimal

However, for a Level 2 audit, significantly more detailed information is required, specifically around:

- (6.2.1.1) Schedules
- (6.2.1.2) Envelope Systems
- (6.2.1.3) HVAC Systems
- (6.2.1.4) SHW Systems
- (6.2.1.5) Lighting
- (6.2.1.6) Process and Plugs

The BuildingSync XML is not structured to follow the Standard 211 normative appendix. When trying to define complex systems, specifically HVAC Systems, it is important to understand the mechanisms used by BuildingSync for working with HVAC Systems.



Documentation - Systems

System definition requirements for Standard 211 Level 1 audit are relatively minimal

However, for a Level 2 audit, significantly more detailed information is required, specifically around:

- (6.2.1.1) Schedules
- (6.2.1.2) Envelope Systems
- (6.2.1.3) HVAC Systems
- (6.2.1.4) SHW Systems
- (6.2.1.5) Lighting
- (6.2.1.6) Process and Plugs

The BuildingSync XML is not structured like the Standard 211 normative appendix. When trying to define complex systems, specifically HVAC Systems, it is important to understand the mechanisms used by BuildingSync for working with HVAC Systems

[TestSuite](#) / [examples](#) / [HVACSystems](#) / **BSync Sample Models-v2.0-003.pdf**

System Type ¹	Description	Status
PSZ-HP	Single stage heat pump, DX compressor, fan	Complete
PSZ-AC with gas coil	Two stages of heating, cooling, and fan	Complete
DOAS with fan coil air-cooled chiller with boiler	DOAS and FCU's fed by central chiller and boiler. The DOAS includes a thermal wheel. Three stages on Chiller and 3 stages on Boiler.	In Progress
VAV with reheat		Not Started
PVAV with PFP boxes		Not Started
VAV chiller with no reheat with zone heat pump		Not Started
Water source heat pumps cooling tower with boiler		Not Started
Fan coil chiller with district hot water		Not Started
Window AC with forced air furnace		Not Started
Direct evap coolers with gas unit heaters		Not Started

For this reason, we have begun putting together:

1. Example files adhering to Level 2 audit requirements for typical HVAC Systems one might encounter in the real world
2. A pdf walking through how these system topologies are connected together (see next).

Documentation - Systems

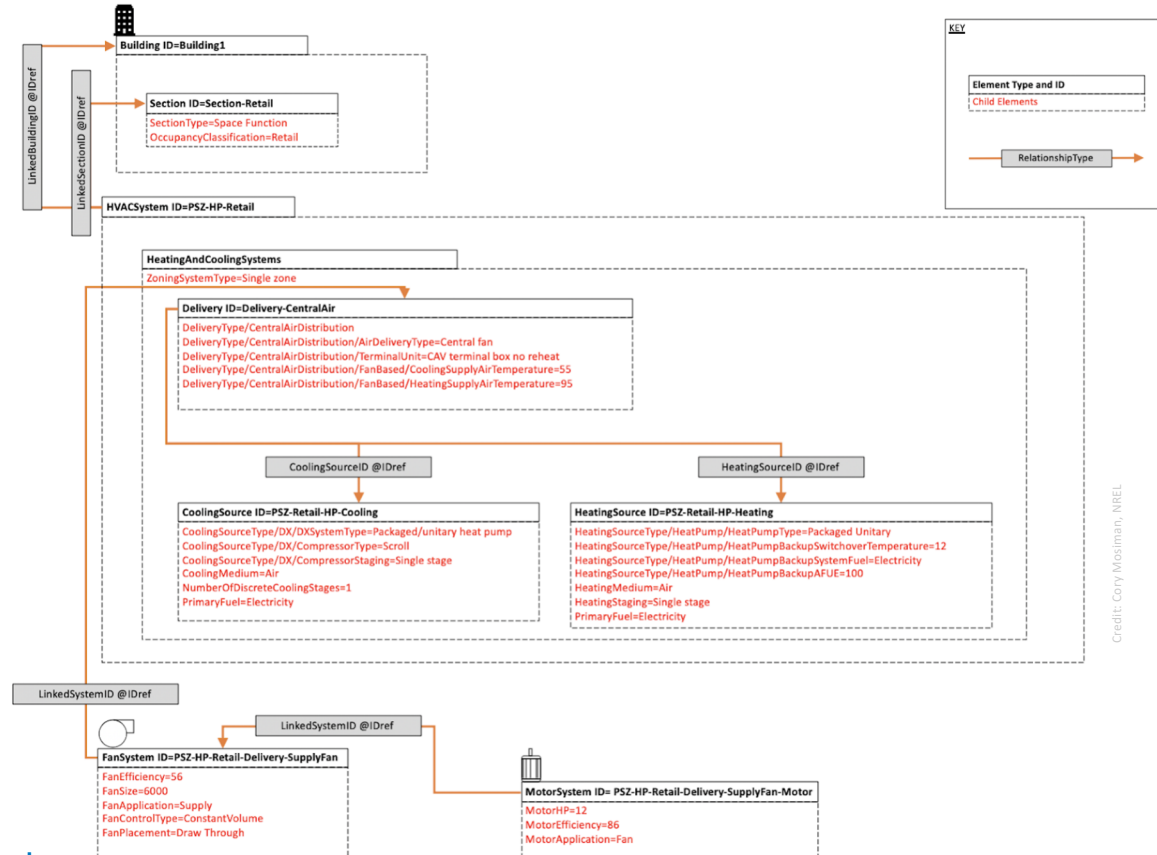
PSZ-HP BuildingSync Recommended Implementation

MotorSystem

- As the motor is the general driver of the Fan, it is directly linked to it
- The MotorApplication can be specified to specify the purpose of the motor without having to traverse relationships.

FanSystem

- The Fan corresponding to the Supply Fan of the Delivery system, it is directly linked to the Delivery
- FanControlType gets specified at the individual FanSystem level
- FanApplication can be specified in the event that multiple fans are directly linked to a Delivery. Allows for Supply, Exhaust, Return fans to be linked to same Delivery.



Credit: Cory Mosiman, NREL

Version 2.2 Proposed Changes

Version 2.2.0-PR1 Proposed Changes

- Version 2.2.0-pr1 released to GitHub on September 9th, 2020

Category	Count
Controls	0
General	3
Measures	0
Reports	7
Systems	1
Validation	0
Other	1
Total	12

Minor Breaking and Non-Breaking Changes

Non-Breaking Changes

- Additions
 - #200, Add ReadingType Cost to TimeSeries
 - #203, Add ResourceUseNotes to ResourceUse
 - #204, Add AnnualFuelCost to ResourceUse
 - #205, Add SimpleImpactAnalysis and CostCategory to PackageOfMeasures
 - #207, Add ExcludedSectionIDs to FloorArea
 - #208, Add LinkedPremises to Schedule
 - #213, Add AnnualFuelUseLinkedTimeSeriesIDs to ResourceUse
 - #214, Add multiple elements for energy use in AllResourceTotal
 - #216, pull rate elements out as distinct element types to reduce redundancy
 - #217, update tiered rate to include demand rate start and end dates
- Deprecation Flag
 - #215, Add choice between PrimaryHVACSystemType and PrincipalHVACSystemType
- Proposals
 - #219, feat(proposals): add proposal for versioning

Minor Breaking Changes

- None

Selection Tool Updates

The screenshot displays the 'BuildingSync® Use Case Selection Tool' interface. The top navigation bar includes links for 'SCHEMA VIEWER', 'USE CASES', 'VALIDATOR', 'DOCUMENTATION', and 'BUILDINGSYNC WEBSITE', along with a 'LOGIN' button. The main content area is titled 'VALIDATOR RESULTS' and shows a successful validation for 'EXAMPLE - A VALID SCHEMA.XML' with schema version 2.1.0. Below this, the 'USE CASES' section lists several use cases with their validation status: 'NEW YORK CITY AUDIT USE CASE' (invalid), 'SEED' (valid), 'L000 OPENSTUDIO SIMULATION' (invalid), and 'BRICR_SEED' (invalid). An 'ERRORS' section provides details for the invalid use cases, citing specific XML line numbers and element names. The footer contains trademark information for BuildingSync and NREL.

BuildingSync® Use Case Selection Tool

SCHEMA VIEWER USE CASES VALIDATOR DOCUMENTATION BUILDINGSYNC WEBSITE LOGIN

VALIDATOR RESULTS

Validate Another XML File

FILE: EXAMPLE - A VALID SCHEMA.XML

Schema version: 2.1.0 Valid

USE CASES

NEW YORK CITY AUDIT USE CASE ✖

ERRORS 3

- line 138: element auc:PackageOfMeasures: element "auc:ReferenceCase" is NOT RECOMMENDED
- line 146: element auc:PackageOfMeasures: element "auc:ReferenceCase" is NOT RECOMMENDED
- line 160: element auc:FieldName: text "Recommendation Category": element "text()" MUST be "Application Scale", "Recommended Resource Savings Category", or "Shared Resource System ID"

SEED ✔

L000 OPENSTUDIO SIMULATION ✖

BRICR_SEED ✖

BUILDINGSYNC® IS A REGISTERED TRADEMARK OF THE ALLIANCE FOR SUSTAINABLE ENERGY, LLC.

NREL IS A NATIONAL LABORATORY OF THE U.S. DEPARTMENT OF ENERGY, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, OPERATED BY THE ALLIANCE FOR SUSTAINABLE ENERGY, LLC.

- Use cases that will be supported by end of September 2020
 - ASHRAE 211 Preliminary Analysis
 - ASHRAE 211 Level 1 Audit
 - ASHRAE 211 Level 2 Audit
 - OpenStudio Level 000
 - OpenStudio Level 100
 - OpenStudio Level 200

Poll #3

- Biggest pain points with BuildingSync

too many levels
similar elements na
documentation of use case
user defined fields
size the size na - not using
no top-level plants lighting info



Audit Template Tool Integration Update

Audit Template Tool / BuildingSync Integration

August 2020

- ~18% of new buildings uploaded as BuildingSync XML documents

Audit Template Tool / BuildingSync Integration

GET /api/v2/building_sync/download/rp/building/**id.xml?token**

- Export BuildingSync XML document for building with specified “id”
- Authentication required (“token” query parameter)
- Authorization required (either: admin, record owner, or shared record)

GET /api/v2/building_sync/download/rp/nyc/property/**id.xml?token**

- Export BuildingSync XML document for NYC property with specified “id”
- Authentication required (“token” query parameter)
- Authorization required (either: admin, record owner, or shared record)

POST /api/v2/building_sync/upload.json?**token&audit_file**

- Import BuildingSync XML document with specified “audit_file” content
- Authentication required (“token” query parameter)

Audit Template Tool / BuildingSync Integration

BUILDING ENERGY
Asset Score

Release 2020.2.0.....44444: Version :55555: U.S. DEPARTMENT OF ENERGY Energy Efficiency & Renewable Energy

Buildings Cities Manage Admin Help

AT_AS_Sta...

There are fields on this screen that need to be filled out for city reporting.

Please review each section of the forms. Items marked with a ⚙ correspond to ASHRAE Level II inputs, and items marked with a 🏠 correspond to city inputs. A ★ indicates a field that is required for city reporting.

Hide un-required fields

Validation Errors

Get an Asset Score Download

CSV (In-Progress) XML (In-Progress)

Facility Description

Building Characteristics Use Types Construction Lighting

Controls

Area Area

Source: <https://buildingenergyscore.energy.gov>

```
<?xml version="1.0" encoding="utf-8" ?>
<auc:BuildingSync xmlns:auc="http://buildingsync.net/schemas/bedes-auc/2019" version="2.1.0">
  <auc:Facilities>
    <auc:Facility ID="Facility-69909661798140">
      <auc:Sites>
        <auc:Site ID="SiteType-69909661796520">
          <auc:Buildings>
            <auc:Building ID="BuildingType-69909661355080">
              <auc:PremisesName>AT_AS_Stage1_Test</auc:PremisesName>
              <auc:PremisesNotes>Test building created for translation purposes</auc:PremisesNotes>
              <auc:PremisesIdentifiers>
                <auc:PremisesIdentifier>
                  <auc:IdentifierLabel>Custom</auc:IdentifierLabel>
                  <auc:IdentifierCustomName>Atlanta Building ID</auc:IdentifierCustomName>
                  <auc:IdentifierValue></auc:IdentifierValue>
                </auc:PremisesIdentifier>
                <auc:PremisesIdentifier>
                  <auc:IdentifierLabel>Custom</auc:IdentifierLabel>
                  <auc:IdentifierCustomName>City Custom Building ID</auc:IdentifierCustomName>
                  <auc:IdentifierValue></auc:IdentifierValue>
                </auc:PremisesIdentifier>
              </auc:PremisesIdentifiers>
              <auc:Address>
                <auc:StreetAddressDetail>
                  <auc:Simplified>
                    <auc:StreetAddress>123 Main Street</auc:StreetAddress>
                  </auc:Simplified>
                </auc:StreetAddressDetail>
                <auc:City>Baltimore</auc:City>
                <auc:State>MD</auc:State>
                <auc:PostalCode>21042</auc:PostalCode>
              </auc:Address>
              <auc:ConditionedFloorsAboveGrade>2</auc:ConditionedFloorsAboveGrade>
              <auc:ConditionedFloorsBelowGrade>0</auc:ConditionedFloorsBelowGrade>
              <auc:BuildingAutomationSystem>false</auc:BuildingAutomationSystem>
              <auc:HistoricalLandmark>false</auc:HistoricalLandmark>
              <auc:FloorAreas>
                <auc:FloorArea>
                  <auc:FloorAreaType>Cooled only</auc:FloorAreaType>
                  <auc:FloorAreaValue>0.0</auc:FloorAreaValue>
                </auc:FloorArea>
              </auc:FloorAreas>
            </auc:Building>
          </auc:Buildings>
        </auc:Site>
      </auc:Sites>
    </auc:Facility>
  </auc:Facilities>
</auc:BuildingSync>
```

Note: In the Audit Template UI, the terms “In-Progress” and “Submitted” indicate the audit report submission status (not the implementation status of the BuildingSync integration).

Audit Template Tool / BuildingSync Integration

BUILDING ENERGY
Asset Score

Release 2020.2.0:::44444:::

Version :::55555:::

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

BUILDINGS ▾ CITIES ▾ MANAGE ▾ ADMIN ▾ HELP ▾

Help Desk

Import BuildingSync XML

Building audit BuildingSync XML files downloaded from the Audit Template or generated from other software may be copied and edited, and used to import into the Audit Template to create a new audit report. After import, the new audit report building should appear on your list of buildings on the Audit Template home page. XML files that are not in the correct format will display an invalid warning and will not be imported.

Choose File

No file chosen

Import BuildingSync XML

Source: <https://buildingenergyscore.energy.gov>

Audit Template Tool / BuildingSync Integration

Join us at **2020 ASHRAE Building Performance Analysis Conference**

“Representation and Exchange of Audit Template Data using BuildingSync”

Topic:

Workflow and Tool Developments

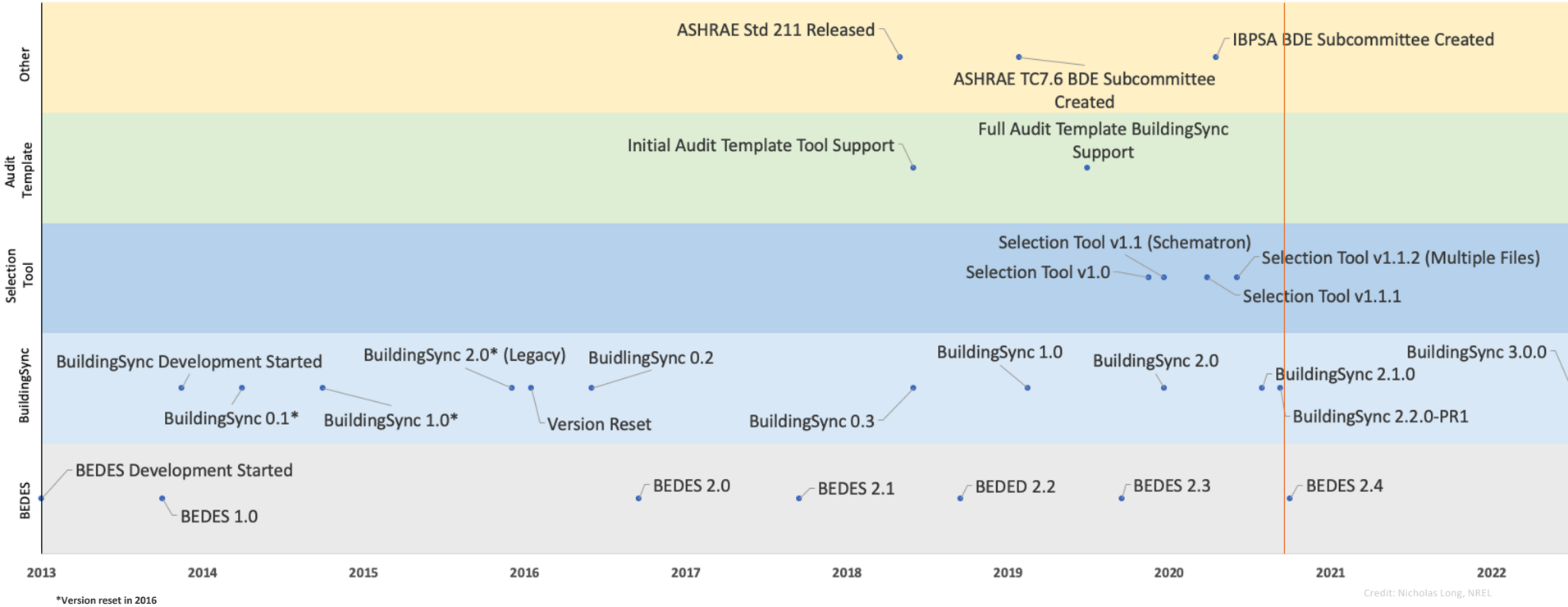
Slot:

Seminar 9: Thu, Oct 1, 2020: 3:30pm-4:45pm

Audette

Looking Forward

Timeline



Credit: Nicholas Long, NREL

FY21 and Beyond

- Version 2.x
 - Update of BuildingSync-Gem (BuildingSync to OpenStudio)
 - Alignment with UNIFORMAT (non-breaking changes)
 - Tighter integration with BTO-related tools (e.g., BETTER, SEED, etc.)
 - Adding elements for specific use cases (quashing user defined fields)
- Version 3.0
 - Modularize schema to allow for users to select lower level of details based on use cases

UNIFORMAT II Overview

- Developed by NIST in 1993
- Contains 4 levels of definitions
- Elements can contain Units of Measure (UOM)
- UNIFORMAT does not cover specific characteristics of components (e.g., boiler efficiencies, chiller performance curves, etc.)

Level 1 Major Group Elements	Level 2 Group Elements	Level 3 Individual Elements
A SUBSTRUCTURE	A10 Foundations	A1010 Standard Foundations A1020 Special Foundations A1030 Slab on Grade
	A20 Basement Construction	A2010 Basement Excavation A2020 Basement Walls
B SHELL	B10 Superstructure	B1010 Floor Construction B1020 Roof Construction
	B20 Exterior Enclosure	B2010 Exterior Walls B2020 Exterior Windows B2030 Exterior Doors
	B30 Roofing	B3010 Roof Coverings B3020 Roof Openings

Level 4

6.2.3 Slab on Grade (A1030):

6.2.3.1 Includes:

- (1) Standard,
- (2) Structural,
- (3) Inclined slabs on grade,
- (4) Trenches,
- (5) Pits,
- (6) Bases,
- (7) Under-slab drainage, and
- (8) Under-slab insulation.

BuildingSync ECMs to UNIFORMAT

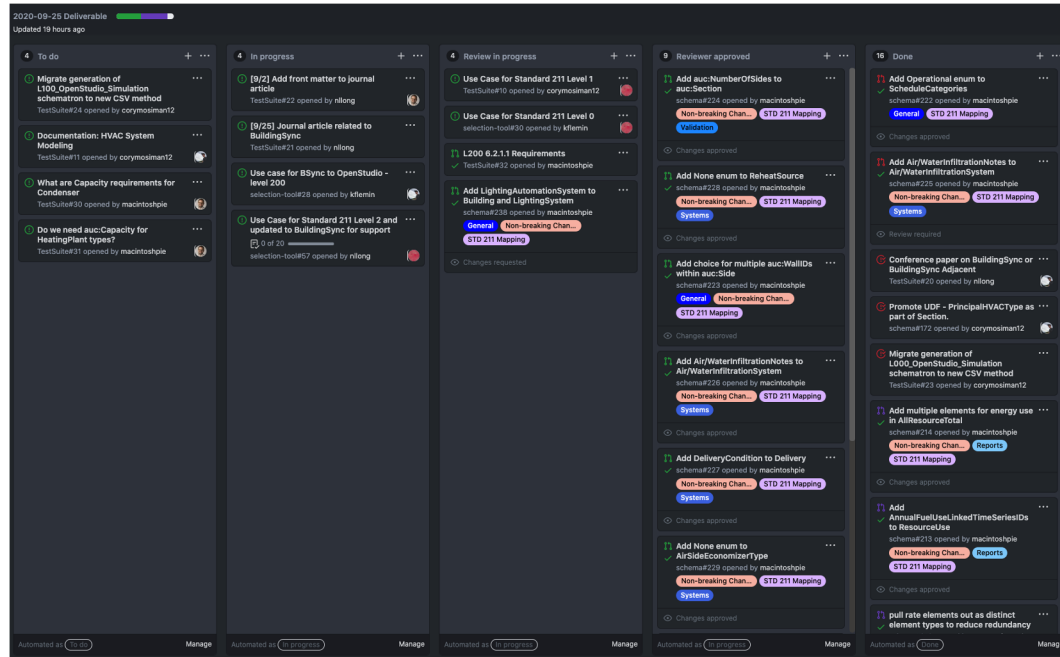
- Initial mapping from BuildingSync ECMs to UNIFORMAT

BuildingSync - Technology Category	ECM	UNIFORMAT Level 1	UNIFORMAT Level 2	UNIFORMAT Level 3
Building Envelope Modifications	Insulate foundation	A SUBSTRUCTURE		
Building Envelope Modifications	Increase floor insulation	B SHELL	B10 Superstructure	B1010 Floor Construction
Building Envelope Modifications	Add shading devices	B SHELL	B20 Exterior Enclosure	B2010 Exterior Walls
Building Envelope Modifications	Increase wall insulation	B SHELL	B20 Exterior Enclosure	B2010 Exterior Walls
Building Envelope Modifications	Install or replace solar screens	B SHELL	B20 Exterior Enclosure	B2010 Exterior Walls
Boiler Plant Improvements	Insulate boiler room	B SHELL	B20 Exterior Enclosure	B2010 Exterior Walls
Building Envelope Modifications	Add window films	B SHELL	B20 Exterior Enclosure	B2020 Exterior Windows
Building Envelope Modifications	Replace windows	B SHELL	B20 Exterior Enclosure	B2020 Exterior Windows
Building Envelope Modifications	Increase roof insulation	B SHELL	B30 Roofing	B3010 Roof Coverings
Building Envelope Modifications	Install cool/green roof	B SHELL	B30 Roofing	B3010 Roof Coverings
Building Envelope Modifications	Insulate attic hatch / stair box	C INTERIORS	C10 Interior Construction	C1020 Interior Doors
Conveyance Systems (e.g., Elevators)	Add elevator regenerative drives	D SERVICES	D10 Conveying	D1010 Elevators & Lifts
Conveyance Systems (e.g., Elevators)	Upgrade controls	D SERVICES	D10 Conveying	D1010 Elevators & Lifts
Conveyance Systems (e.g., Elevators)	Upgrade motors	D SERVICES	D10 Conveying	D1010 Elevators & Lifts
...

Credit: Amanda Webb and Apoorv Khanuja, University of Cincinnati, ASHRAE 1836-RP

Track Progress

- GitHub project is used to track the progress across BuildingSync Schema, Selection Tool, BuildingSync Gem, and other projects
- <https://github.com/orgs/BuildingSync/projects>



Credit: Nicholas Long, NREL



Thank you!

Mark Borkum, mark.borkum@pnnl.gov

Christopher Naismith, christopher@audette.io

Nicholas Long, nicholas.long@nrel.gov