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## Precinct Information Modelling

Technical Investigations:

PIM Prototype Tools



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## Contents

Acknowledgements.....	3
Contents .....	4
List of Tables.....	5
List of Figures.....	6
Acronyms.....	7
Executive Summary.....	8
Introduction .....	9
PIMViewer.....	10
PIM add-ins for BIM tools.....	11
PIM add-in for Revit.....	12
PIM add-in for ArchiCAD.....	14
Case 1: Planning Zones .....	14
Case 2: Development Types.....	14
Further Implementations.....	15
PIM web service .....	16
PIM/ETWW interfaces.....	17

## List of Tables

No table of figures entries found.

## List of Figures

Figure 1 PIMViewer interface .....	10
Figure 2 Interface of PIM add-in for Revit.....	12
Figure 3 Parameters created using the PIM add-in settings function.....	12
Figure 4 PIM add-in tag spatial zone function .....	13
Figure 5 PIM add-in new spatial zone function.....	13
Figure 6 Creating a Land Use Type.....	14
Figure 7 Defining Land Use types:.....	14
Figure 8 Selecting the Council.....	14
Figure 9 Detailed Development Plan and 3D model: .....	15
Figure 10 PIM web service functions .....	16
Figure 11 Portion of ETWW input data in Excel.....	18
Figure 12 ETWW input data as a PIM model .....	18

## Acronyms

BIM Building Information Model

bsDD buildingSMART Data Dictionary

IFC Industry Foundation Classes

PIM Precinct Information Model



## Executive Summary

This technical investigation presents the precinct information (PIM) prototype tools that have been developed as part of the PIM research project:

- PIMViewer – to allow viewing and some limited editing capability for models that have been created using the proposed PIM data schema
- PIM add-in for Revit – to show functional precinct planning capability within a widely used BIM

modelling software application. The add-in allows a user to define land uses and development types using standardised concepts from the buildingSMART Data Dictionary (bsDD)

- PIM add-in for ArchiCAD
- PIM webservice – to provide a web-accessible reference source of carbon
- PIM/ETWW interface(s)

## Introduction

Extending the current buildings-centric IFC schema to become a precinct (PIM) schema (refer to Technical Investigation: Precinct Information Schema) has implications for existing IFC-based software. Existing software tools only support the official, published IFC standard. The proposed PIM schema does not break any of the existing IFC schema structure, but it does add additional class definitions for precinct-level entities, therefore in order to show how the extended PIM schema can add value for use cases at a precinct scale, it has been necessary to create a number of prototype tools.

## PIMViewer

The PIMViewer software has been built using the open source xBIM Toolkit (xBIM 2016). xBIM contains modules (libraries) for IFC entity definitions as well as an example graphical interface (Xplorer). Each IFC entity definition is encoded as a distinct software class. PIMViewer has added a number of new classes to correspond to the new PIM schema entities as described in the document Technical Investigations: Precinct Information Schema, as well as defining the semantic relationships between these new PIM classes and the existing IFC classes. The PIMViewer software implementation also extends the xBIM Xplorer interface in several areas. These additions allow for models defined using the PIM schema to be successfully parsed and displayed graphically. PIMViewer provides some capability to edit and save entity properties. Models

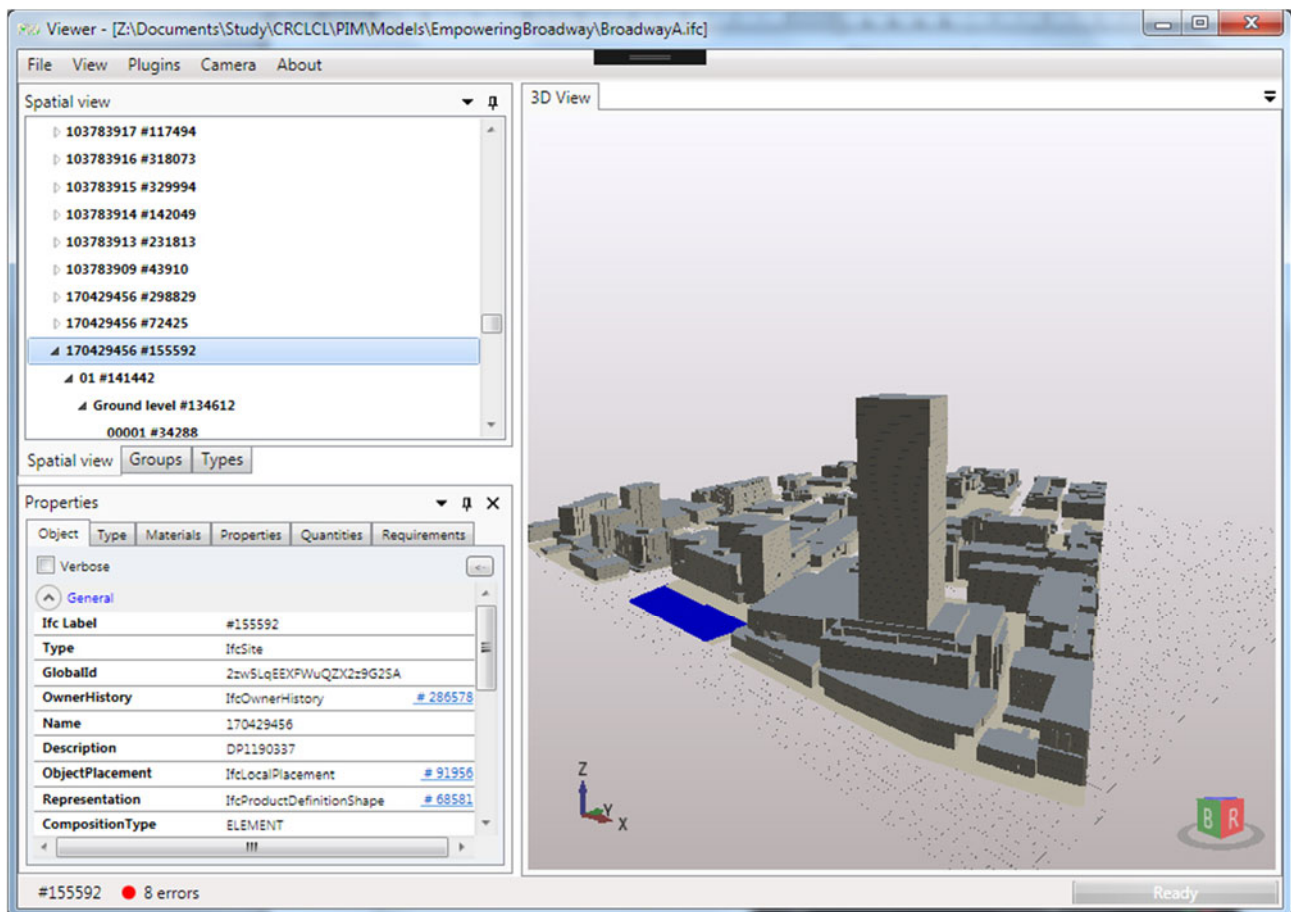
created in either IFC version IFC2x3 or IFC4 can also be parsed, displayed, and partially edited.

A model can be opened from a file or from a shared model server over the internet. The model can be alternatively saved back to a file (in a choice of file formats) or back to the model server.

Figure 1 shows the PIMViewer software interface in which a user has selected a particular site within the Broadway precinct in Sydney. The data for this model has been sourced from the City of Sydney's Floorspace Employment Survey and converted into PIM model format. In the graphical view this site is highlighted in dark blue. It is also highlighted in the spatial view panel at top left, and its properties are displayed under various tabs at bottom right.

The 3D view can be zoomed, panned, and rotated.

Figure 1 PIMViewer interface



The PIM Viewer is therefore an example of a flexible, generic model viewer similar in many ways to existing software tools in the marketplace, but with the added capability to interact with models conforming to the PIM schema.

## PIM add-ins for BIM tools

Model creation requires modelling software. Revit software from Autodesk and ArchiCAD from Graphisoft are building information modeling (BIM) software that are widely used by architects, structural, and services engineers worldwide. Models created using both softwares can be exported and imported in IFC format. If the PIM schema extensions are adopted in a future release of IFC, then those extra entities will also be supported for import/export to similar BIM specialist software. In the meantime, it is possible to show some of the functionality proposed by the PIM team using this software.

## PIM add-in for Revit

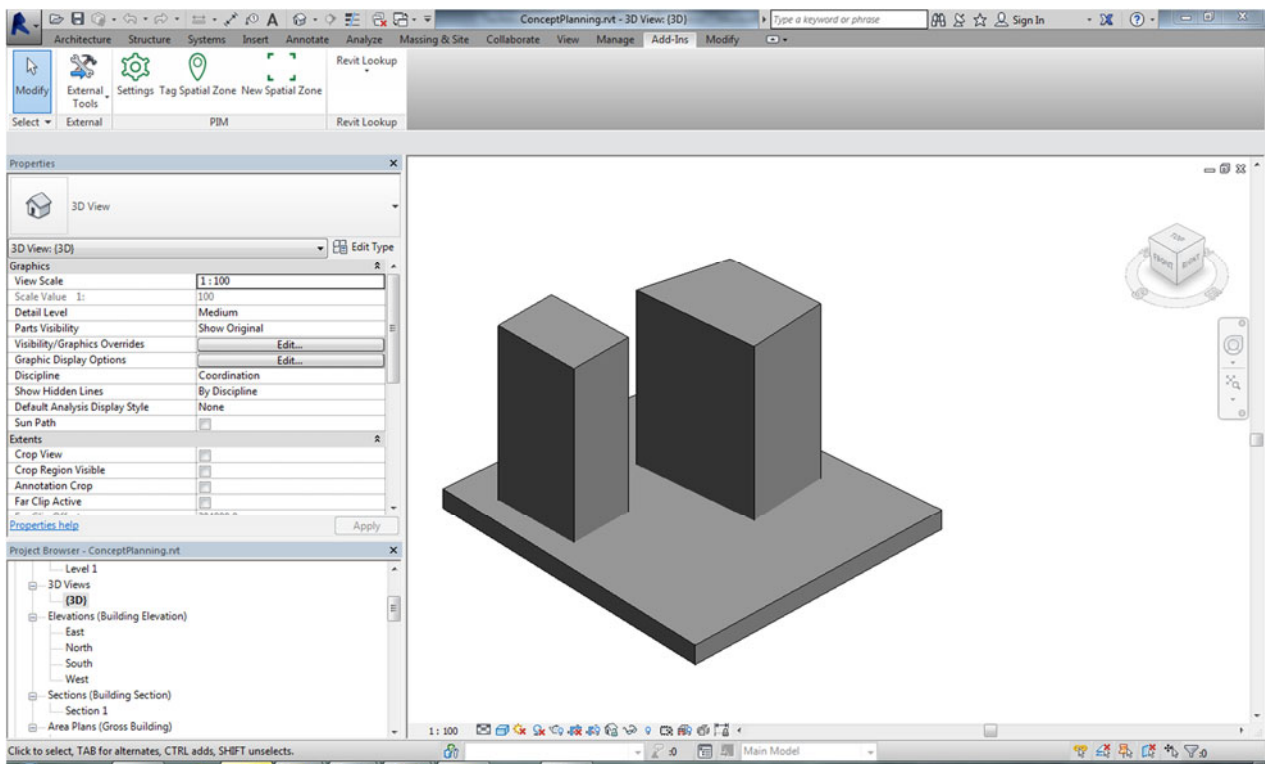
Revit provides an application programming interface that enables software developers to create add-in packages that integrate seamlessly into the Revit interface. We have created a PIM add-in that demonstrates how objects can be created with naming and typing that references the buildingSmart Data Dictionary (bsDD) concept definitions for land uses and/or development types (refer to our document Technical Investigations: Land Use and Development Types for a fuller explanation for why and how this is useful for precinct-level modelling). A land use is created as a Revit 2-

dimensional area. A development type is created as a Revit 3D mass.

The interface for the PIM add-in is shown in Figure 2. It consists of 3 functions:

- Settings – to setup the additional parameters for storing the bsDD-derived data
- Tag spatial zone – to lookup the bsDD, choose a required definition, and set the values of the bsDD parameters for a chosen Revit area or mass
- New spatial zone – to draw an area or mass and then to tag the new spatial zone with the chosen bsDD-derived data

Figure 2 Interface of PIM add-in for Revit



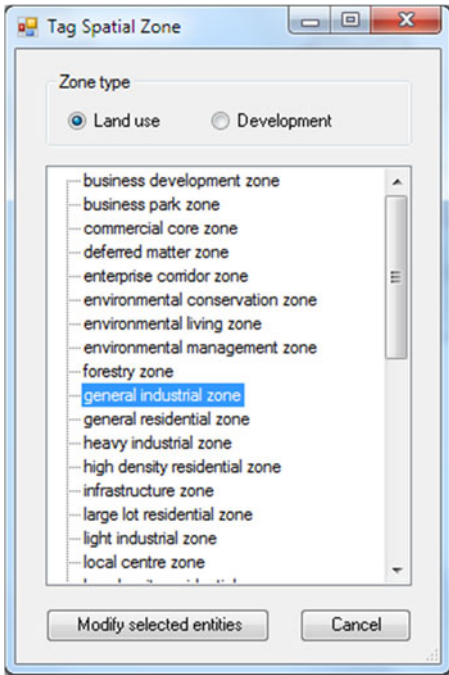
The Settings function has no interface. When clicked, it updates a Revit shared parameters file that is the source for the properties of the areas and masses as shown in Figure 3. These parameters include the unique identifier of the chosen bsDD concept (bsDD GUID), its name (bsDD Name), and the properties from a standardised set of properties related to sustainability metrics.

Figure 3 Parameters created using the PIM add-in settings function

Areas (1)	
Green Building Properties	
bsDDGuid	0MSgIvUHb9600IiSK0KTK
bsDDName	commercial core zone
NonRenewableEnergyConsumption	
RenewableEnergyConsumption	
AtmosphericAcidification	
ClimateChange	
RadioactiveWaste	
TotalPrimaryEnergyConsumption	
StratosphericOzoneLayerDestruction	
NonHazardousWaste	
PhotochemicalOzoneFormation	
ResourceDepletion	
Eutrophication	
InertWaste	
WaterConsumption	

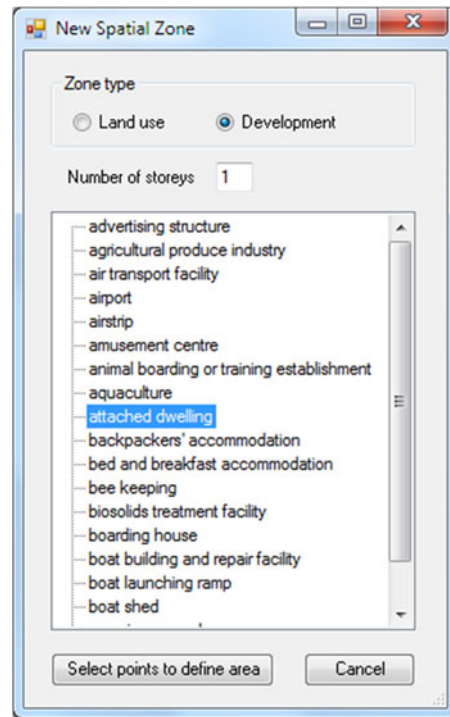
Figure 4 shows the interface for the tag spatial zone function. The list is created by lookup from the bsDD database over the internet. In this case it is showing a selection of possible land uses. The PIM add-in uses a Revit area to represent a land use.

Figure 4 PIM add-in tag spatial zone function



And, Figure 5 shows the interface for the new spatial zone function, this time with a list of development types from the bsDD. Because the PIM add-in uses a Revit mass to represent a development type, an additional number of storeys field is displayed in the interface so that a user can indicate a nominal height for the resultant mass.

Figure 5 PIM add-in new spatial zone function



## PIM add-in for ArchiCAD

Using ArchiCAD's scripting language, GDL, we have developed a library object to make the process of creating development proposals more efficient and more accurate in modelling. The examples below are based on the Zonal and Built Asset typologies.

### Case 1: Planning Zones

In this case a planner is making *land use* selections for the development precinct. A master list of NSW Land Use Types is used and a selection made. This functionality matches what the consultants have done for the Tonsley Park Master Plan. All attributes of the land use object conform to the terminology, graphic presentation, and attributes of the NSW LEP system.

In the example below the designer has selected *R4 High Density Residential* as the land use zone type.

Figure 6 Creating a Land Use Type.

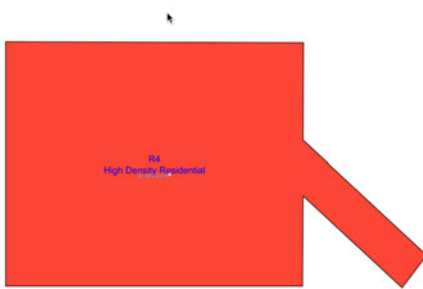
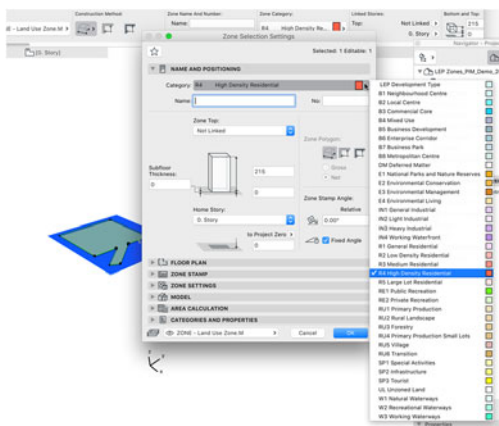


Figure 7 Defining Land Use types:



The add-in mirrors the format of Local Governments' gazetted Local Environment Plans (LEP). The library object *Zone\_LEP\_LandUses.gsm* has a predefined classification of the 28 standard land use types, including the colour defined by NSW Department of Planning. Collections of these zones can be an LEP, or a proposal for a green/grey/brown field development.

The zone representation is a 2D polygon, defining the extent of the use. The Revit Add-in example demonstrates access to the bsDD which allows importing the environmental and embodied carbon properties. This specific library part demonstrates the ease of support for library objects for planning functionality and embodied carbon performance.

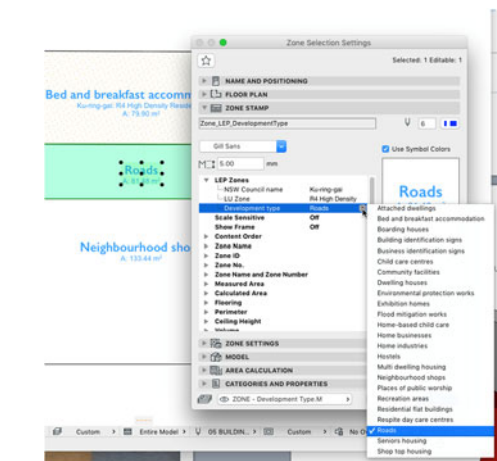
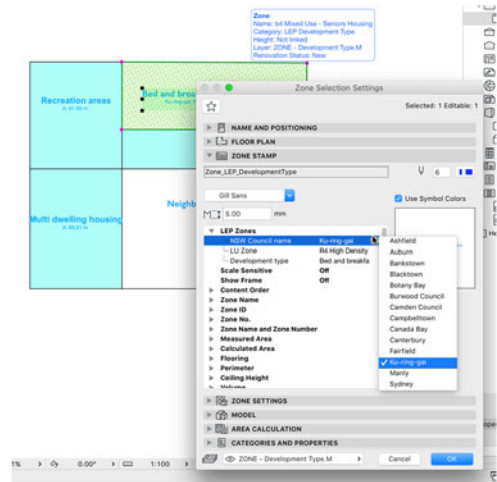
### Case 2: Development Types

This second example goes a step further by allowing 3D modelling of the LEP objects, enhancing the understanding of the development, and also potentially more precise geometric details such as the volume of a facility, number of storeys, surface areas etc.

The library object understands the land use zone setting: in this case R4 from the first case (Figs 6 & 7). As explained above whilst NSW Planning provides land use zone standard templates, a Council may (and usually does) modify its chosen permitted set to meet local conditions.

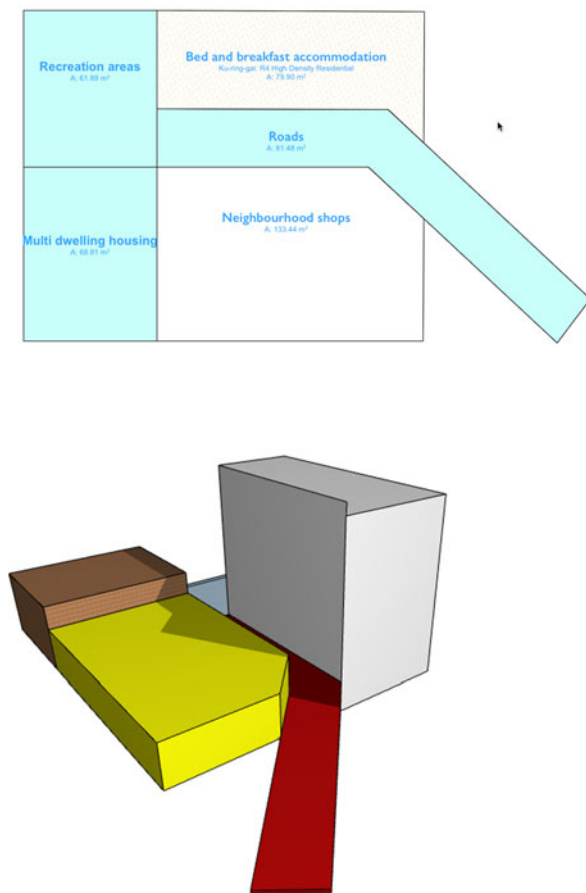
A number of Sydney suburban Council LEP details have been entered into a small demonstration database within the library part. Once the Council is selected, the Permitted Development types are configured.

Figure 8 Selecting the Council.



In the example (Fig. 8 above), the designer has set the Local Government context to be the Kur-ring-gai Council, and then (Fig. 9 below) selected six permitted land uses as his proposed design. The designer has now configured a development plan, always using valid permitted Use Types for that specific local government area. The result is a proposal that uses concepts and definitions entirely consistent with the planning regulations.

Figure 9 Detailed Development Plan and 3D model:



## Further Implementations

The examples above have demonstrated the ability to

- Use a standardised Land Use and Development Type terminology and classification, the core principles of which are used widely throughout Australia
- Customise the specific usages adopted by individual Councils
- Link these objects directly to Embodied Carbon data

Combining the functionality of the two examples, allows for rapid development, accuracy and more consistency during the proposal/compliance processes.

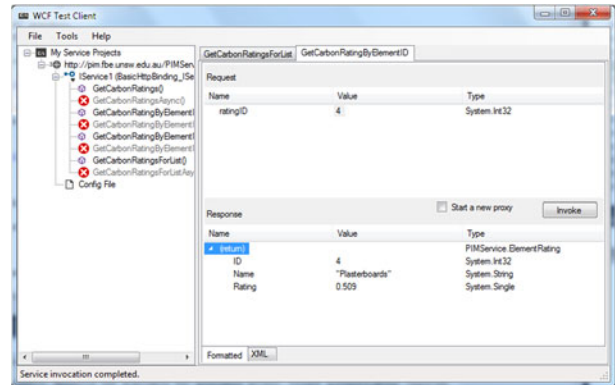


## PIM web service

A web service is a means to provide software functions that can be invoked by any other software over the internet. The interface for the web service is therefore not “visual” in the sense of the normal software we all use on our personal computers and mobile devices. This PIM web service is the front-end to a very simple database of embodied carbon ratings. At present only a few of the materials that have been identified and rated by the Integrated Carbon Metrics research project are in the database, so the web service at present is a proof of concept.

Figure 10 is a screen capture of a developer tool that allows us to look at the list of functions provided by the web service and invoke each one to test that it is correctly returning data. The function that has been invoked here is `GetCarbonRatingByElementID` which returns the data for a specific rating item in the database. Each record is composed of 3 fields: ID which is a unique identifier; Name which is the name of the rated entity (material, product, or other object type); Rating which is the embodied carbon metric per \$ spend (conforming to the way the ICM project identifies ratings).

Figure 10 PIM web service functions



A web service is not very useful if invoked in this way. It is much more useful when invoked from software. For the PIM research we have added functionality to the PIM Viewer software to call any webservice (not just this prototype one) using an external document reference link that is stored against an object in the PIM model.

## PIM/ETWW interfaces

The interfaces between the ETWW software tools and data stored in PIM format still need to be developed and tested. However, initial work has been completed to take the Excel input data that the ETWW research team have created for their own use, and to create equivalent PIM formatted models of the same data as samples that can

be tested. The data is demographically based so the PIM models do not contain any geometry. Figure 11 shows a portion of the ETWW Excel input data for the Lochiel Park site, and Figure 12 shows a portion of that data from the equivalent PIM model opened in the PIM Viewer.

Figure 11 Portion of ETWW input data in Excel

1	Descriptive	Item	Descriptive	Descriptor	Scenario A	
2						
3	Precinct	Geography and Timing	Precinct		Lochiel Park	
4	Precinct location within A		Precinct location within Australia	Latitude	-34.87892	
5				Longitude	138.650453	
6	Precinct location		Precinct location		Campbelltown, SA, 5074	
7	Season and Month		Season and Month		Spring, October	
8	Forecast Year		Forecast Year		2015	
9	Thornthwaite Index	Season	Thornthwaite Index		Index	
10				Lower		-9.6
11				Ave		-9.8
12				Upper		-10
13	Temperature		Temperature	Ave Max	23.05	
14				Ave Min	11.80	
15	Humidity		Humidity	Ave Max	-	
16				Ave Min	-	
17	Rainfall		Rainfall	Ave Monthly (mm)	98.85	
18	Solar profile		Solar profile	Ave Daily (MJ/m <sup>2</sup> m)	21.50	
19	Employment	Precinct-Structure	Employment	employed persons	0	
20				employed persons	0	
21				employed persons	0	
22				employed persons	0	
23				employed persons	0	
24				employed persons	0	
25				employed persons	0	
26				employed persons	0	
27	Education			Education	enrollments	0
28					enrollments	0
29				enrollments	0	
30	Infrastructures		Infrastructures	Panels	0	
31				kW.hr	0	
32				m2	10500	
33				size (kL)	0	
34						
35						

Figure 12 ETWW input data as a PIM model

