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Report on the Development of the Format for a Texas Residential Registry

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1 EXECUTIVE SUMMARY

The 80th Texas Legislature passed H.B. 3693 which updated Texas Code House § 388.008 Development Of Home Energy Ratings and tasked the Energy Systems Laboratory to create a standardized report format for a Texas home registry. The Laboratory has complied with this directive by developing the format described in this document. This format currently serves as the database foundation for the Laboratory's IC3 and TCV software, and will be expanded in the future to accommodate planned projects.

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2 INTRODUCTION

The Energy Systems Laboratory (the Laboratory) has created a standardized format to support a Texas Home Energy Registry, as requested by the 80th Texas Legislature in H.B. 3693, and made a part of the Texas Code House §388.008 Development Of Home Energy Ratings. This report provides a description of the report format, provides an overview of how this format is currently being used for the Laboratory's IC3 and TCV programs, and outlines how the format will be expanded to accommodate future programs.

Currently, the registry consists of a central data repository that is fed by the existing IC3 and TCV web-based Code Compliance Calculators. The data stored in the registry began in July 2007 when the first version of IC3 was released.

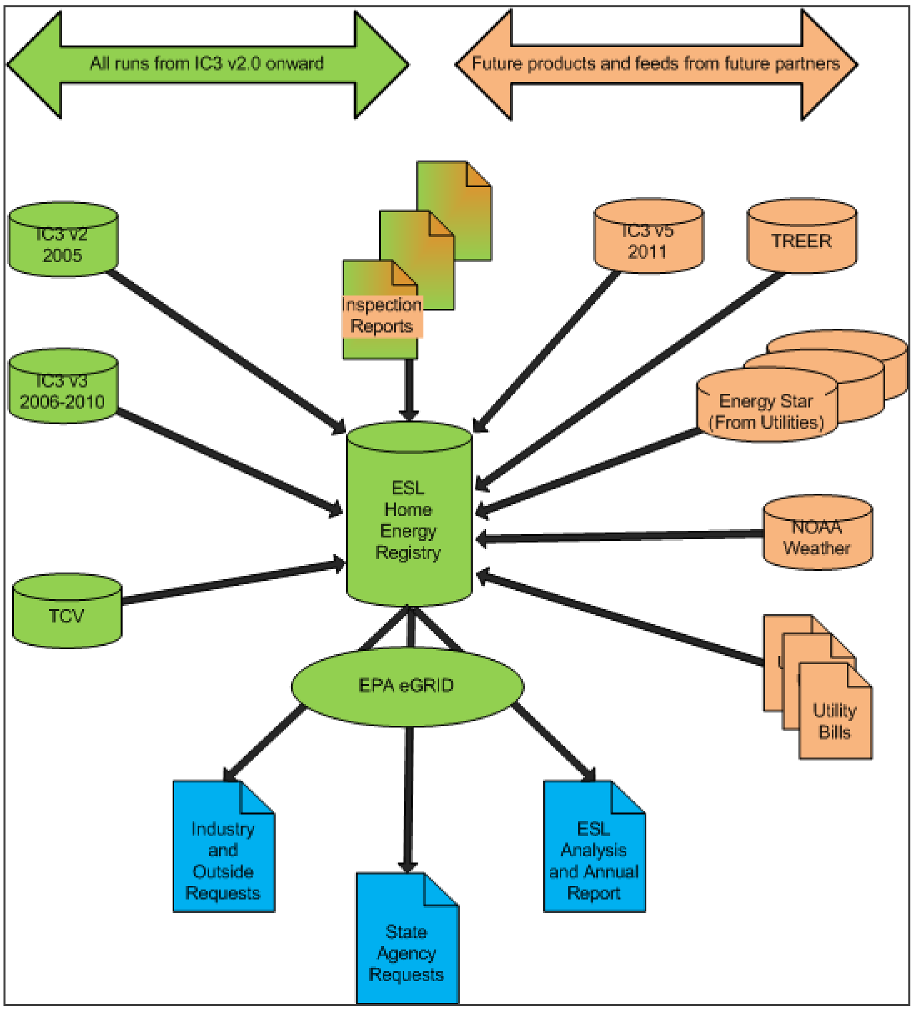

FIGURE 1 - LABORATORY HOME ENERGY REGISTRY

Existing modules are shown in Green, on the left side of the illustration. In the future, the system will be expanded to include IC3 Inspections, weather data, existing home ratings, existing home upgrades, and historical utility bills.

The **IC3 v2 Module** was the first code compliance calculator developed by the Laboratory. This version was in operation from the summer of 2007 through the summer of 2008. It featured simplified input of about 14 fields and handled homes with rectangular floorplans.

The **IC3 v3 Module** is currently in production. It captures more specific home data that drives a more accurate simulation, including non-rectangular floor plans, and other features. This module is accessible at http://ic3.tamu.edu.

The **TCV Module** reflects the US Department of Energy/Austin Energy/State Energy Conservation Office/Energy Systems Laboratory, web-based code compliance tool built specifically for Austin from the IC3 technology. This module was delivered to Austin in December of 2008.

The **Inspection Module** was developed for TCV and will be added to IC3 in the future. It provides a secure web page for an independent 3rd party inspector to input the measured values of the as-built home. It is used after an inspection has been completed. Then, a final simulation is run and a Certificate is printed.

The future **IC3 v5 Module** is the next generation code compliance calculator. It features the capability to model multi-family buildings and continues to enhance the data entry by allowing for a graphical input. This version will have increased flexibility in accomodating differences in jurisdictions codes.

The future **Energy Star Module** will provide a batch loading capability for houses registered as Energy Star homes. This capability would support a minimum listing of homes, inspection dates, and utility provider and could support design and inspection data.

The future **TREER Module** represents a state wide effort, requested by the Comptroller of Public Accounts, to provide a tool for existing homeowners to assess their current home's energy rating and identify cost effective upgrades. The database storage for this system will also be designed so that it feeds into the existing Registry.

The future **NOAA Weather Module** allows additional, measured, weather data to be loaded into the Registry where it will serve two purposes:

1. Weather normalizing the Utility Bills (see below)
2. Weather normalizing the simulation runs used by IC3/TCV or TREER for purposes of NOx, SOx and CO2 emissions

The future **Utility Bills Module** will allow for a weather-normalized analysis of a building's monthly utility bills.

Reporting is handled by SQL queries into desktop databases or spreadsheets. If a certain report is requested on a repeated basis, then server-based reports can be created and run according to a schedule.

Finally, the US EPA's **eGRID Module** is used to calculate emissions reductions resulting from energy savings as part of the Reporting module, which is reported to the user and retained for later use in the Laboratory's Annual Report to the Texas Commission on Environmental Quality (TCEQ).

Overall quality is addressed by following the same procedures used by the Laboratory for the eCalc project in 2004 for the US EPA[1]. The approach is detailed in the Quality Assurance Project Plan (QAPP)[2]. The Laboratory updated the QAPP in 2006 and will update it again in 2009.

The IC3 version was accredited by RESNET in early 2010. At this time IC3 is only one of three energy code compliance systems so accredited. This assures builders and code officials that the values simulated are realistic and credible.

3 Building Database Selected Details

The following tables[3] give an overview of the tables that comprise the registry. These tables provide the "domain" information of interest about the buildings, builders, and inspectors. The Project details (i.e., Job) information is presented in this format for clarity.

3.1 Builder's Data

These data are entered by the Builder upon registering.

TABLE 1 - BUILDER'S DATA DICTIONARY

Field Name	Field Description	Type	Length
CompanyName	Name	VarChar	100
Address	Address	VarChar	100
City	City	VarChar	50
State	State	Char	2
Zip	Zip	VarChar	10
WorkPhone	Phone 1	VarChar	15
CellPhone	Phone 2	VarChar	15
Fax	Fax	VarChar	15
TRCC	TNRCC #	Int	
RegisteredOn	RegisteredDate	Date/Time	
EmailAddress	Email	VarChar	50
Status	Status	Char	10
Class	Class	VarChar	255

3.2 Project

These data are entered by the builder upon the creation of each project.

TABLE 2 -PROJECT DATA DICTIONARY

Field Name	Field Description	Type	Length
Name	ProjectName	VarChar	50
Address	Address	VarChar	50

[1] Texas Emissions and Energy Calculator (eCALC): Documentation of Analysis Methods, Report to the TCEQ, Haberl, J. S.; Gilman, D.; Culp, C. (Energy Systems Laboratory (http://esl.tamu.edu), Texas A&M University, 2004)

[2] Quality Assurance Project Plan, filed by LABORATORY, and TCEQ, 2004

[3] Tabular Examples do not show Primary Keys or the Foreign Keys that link to other tables, nor index information.

City	City	VarChar	50
State	State	Char	2
Zip	Zip	VarChar	10
County	County	VarChar	50
CreatedOn	Entered On	Date/Time	
Notes	Notes	Text	
StatusComposite	Status	VarChar	10

3.3 Job Detail (Parameters for Simulations)

These data are a mix of User[4] entered, calculated, measured and IECC Code Compliant House values.

3.3.1 *Transformed Wall Measures*

In the current configuration of IC3 and TCV, the user enters the area and perimeter of the house which are then processed together with the window geometry and IECC Code Compliant House requirements to generate the building dimensions shown below in Table 3 - Block BLDG0: Data Dictionary. Item 9 is an internal "debug switch."

TABLE 3 - BLOCK BLDG0: DATA DICTIONARY

ID	Block	Field Description	Min	Max	Type	Length	Source
1	BLDG0	Front Side, 1st Floor	6	1666.66667	Smallint		Calc
2	BLDG0	Back Side, 1st Floor	6	1666.66667	Smallint		Calc
3	BLDG0	Right Side, 1st Floor	6	1666.66667	Smallint		Calc
4	BLDG0	Left Side, 1st Floor	6	1666.66667	Smallint		Calc
5	BLDG0	Front Side, 2nd Floor	3	3333.33333	Smallint		Calc
6	BLDG0	Back Side, 2nd Floor	3	3333.33333	Smallint		Calc
7	BLDG0	Right Side, 2nd Floor	3	3333.33333	Smallint		Calc
8	BLDG0	Left Side, 2nd Floor	3	3333.33333	Smallint		Calc
9	BLDG0	Switch to deactivate reports	ON	OFF	Char	5	System

3.3.2 *Block BDG1: Other Structure Measures*

Table 4 describes other details of the house using a combination of baseline values, User inputs and derived values. All Fixed values are traceable back to the 2001 IECC Code Compliant House, ASHRAE, or other peer-reviewed sources.

TABLE 4 - BLOCK BLDG1: DATA DICTIONARY

ID	Block	Description	Min	Max	Type	Length	Source
1	BLDG1	Thermal Mode	N/A	N/A	Char	1	Fixed
2	BLDG1	Location			Char	10	User *
3	BLDG1	Azimuth of building (degree)	0	360	Smallint		User *
6	BLDG1	Height of wall (ft)	6.67	40	Num	9,4	User *
7	BLDG1	Door height (ft)			Num	9,4	Fixed
8	BLDG1	Door width (ft)			Num	9,4	Fixed
9	BLDG1	1st Floor Area	100	10000	Smallint		User *
10	BLDG1	Option of second floor (1 or 2)	1	2	Smallint		User *
11	BLDG1	Floor type			Char	2	Fixed

[4] Builder for IC3 and TCV, Inspector for the Inspector Module and any authorized User for TREER.

12	BLDG1	Height of first floor/crawl space wall above ground(ft)	0.01	4	Smallint		Fixed
13	BLDG1	Height of crawl space wall under ground(ft)	0.01	4	Smallint		Fixed
14	BLDG1	Roof configuration			Char	10	Fixed
15	BLDG1	Pitch of roof (degree)	1	45	Num	9,4	Fixed
18	BLDG1	Second Floor Height	6.67	40	Num	9,4	User *
19	BLDG1	Amendment			Char	10	System
20	BLDG1	Input Method			Char	10	System
21	BLDG1	2nd Floor Area	9	10000	Smallint		User *
22	BLDG1	Radiant Barrier	Y	N	Char	2	User *
23	BLDG1	Wall framing factor	.01	.5	Num	9,4	Fixed
24	BLDG1	Roof framing factor	.01	.5	Num	9,4	Fixed
25	BLDG1	Ceiling framing factor	.01	.5	Num	9,4	Fixed
26	BLDG1	Floor framing factor	.01	.5	Num	9,4	Fixed
28	BLDG1	Garage Type	A	B	Char	2	Fixed
29	BLDG1	Overhang Area (2nd floor over ambient)	0	10000	Num	9,4	User *

3.3.3 Block: BLDG2: Garages (Reserved for future use)

This table describes the garage feature of the house and will be available for future use.

TABLE 5 - BLOCK BLDG2 DATA DICTIONARY

ID	Block	Description	Min	Max	Type	Length	Source
3	BLDG2	Height of garage wall (ft)	7	Height of 1st floor	Num	9,4	Fixed
4	BLDG2	Garage coordinate X	0		Num	9,4	Fixed
6	BLDG2	Garage coordinate Y	0		Num	9,4	Fixed
8	BLDG2	Garage Wall Insulation	Y	N	Char	2	Fixed
9	BLDG2	Garage Roof Insulation	Y	N	Char	2	Fixed
10	BLDG2	2nd Floor Coordinates for X	0		Num	9,4	Fixed
11	BLDG2	2nd Floor Coordinates for Y	0		Num	9,4	Fixed
12	BLDG2	Garage door insulation	0	13	Num	9,4	Fixed

3.3.4 Block CONS1: Envelope Measures

The Envelope Measures block continues the BLDG0 block, with a focus on the details of walls and windows. Provisions are made here (and elsewhere) to accommodate future building types and construction details that go beyond the IC3 or TCV tools.

TABLE 6 - BLOCK CONS1: DATA DICTIONARY

ID	Block	Description	Min	Max	Type	Length	Source
1	CONS1	Roof outside emissivity	0.04	0.95	Num	9,4	Calc
2	CONS1	Roof absorptance	0.194	0.97	Num	9,4	Calc
3	CONS1	Roof roughness			Num	9,4	Fixed
4	CONS1	Roof/Ceiling R-value (Hr-sq.ft-F/Btu)	13	99	Smallint		User *
5	CONS1	Wall absorptance	0.30	.78	Num	9,4	Fixed
6	CONS1	Wall roughness			Num	9,4	Fixed
7	CONS1	Wall outside emissivity	0.00	0.90	Num	9,4	Fixed
8	CONS1	Wall R-value (Hr-sq.ft-F/Btu)	0.05	99	Num	9,4	User *
9	CONS1	Ground reflectance			Num	9,4	Fixed

ID	Block	Description	Min	Max	Type	Length	Source
10	CONS1	Window option (S or D)	S	D	Char	2	Fixed
11	CONS1	U-Factor of glazing (Btu/hr-sq.ft-F)	0.25	1.22	Num	9,4	User *
12	CONS1	Solar Heat Gain Coefficient(SHGC)	0.1	0.87	Num	9,4	User *
13	CONS1	Glass type Code House	0	9999	Num	9,4	Fixed
14	CONS1	Frame absorptance of glazing			Num	9,4	Fixed
15	CONS1	Frame type - A,B,C,D,E			Char	2	Fixed
16	CONS1	Frame width (ft.)	0	0.5	Num	9,4	Fixed
17	CONS1	Floor weight (lb/sq-ft)			Num	9,4	Fixed
18	CONS1	Spacer-type-Code House			Smallint		Fixed
21	CONS1	Percentage of window area (%) for whole area or front side wall	0		Num	9,4	Calc
22	CONS1	Percentage of window area (%) for back side wall	0		Num	9,4	Calc
23	CONS1	Percentage of window area (%) for right side wall	0		Num	9,4	Calc
24	CONS1	Percentage of window area (%) for left side wall	0		Num	9,4	Calc
25	CONS1	Percentage of window area (%) for LEFT side wall for 2nd floor	0		Num	9,4	Calc
26	CONS1	Floor R-Value (hr-sq.ft-F/Btu)	0.05	99	Smallint		Fixed
27	CONS1	Crawl space wall R-value (hr-sq.ft-F/Btu)			Smallint		Fixed
29	CONS1	Slab perimeter R-value and depth			Num	9,4	Calc
30	CONS1	Percentage of window area (%) for RIGHT side wall for 2nd floor	0		Num	9,4	Calc
31	CONS1	Percentage of window area (%) for FRONT side wall for 2nd floor	0		Num	9,4	Calc

3.3.5 BLOCK CONS2: ENVELOPE CONSTRUCTION

The CONS2 block focuses on how the walls and roof are constructed. This block can be expanded to include new areas and new construction materials.

TABLE 7 - BLOCK CONS2: DATA DICTIONARY

ID	Block	Description	Min	Max	Type	Length	Source
1	CONS2	Wall type			Char	2	Fixed
2	CONS2	Stud type			Char	2	Calc
5	CONS2	Wall exterior insulation R-value	0	10	Smallint		Fixed
6	CONS2	Wall exterior finish			Char	5	Fixed
10	CONS2	Roof type			Char	2	Fixed
11	CONS2	Roof structure			Char	2	Fixed
14	CONS2	Roof/ceiling insulation position			Char	2	Fixed

19	CONS2	Roofing	Char	5	Fixed
21	CONS2	Exposed/interior floor structure	Char	2	Fixed
23	CONS2	Exposed/Interior floor finish	Char	5	Fixed
30	CONS2	Crawlspace wall type	Char	5	Fixed

3.3.6 Block SPC01: Operational Parameters

The SPC01 block deals more with operational parameters of the house. Many of the values are fixed to the same values used for the code-compliant house.

TABLE 8 - BLOCK SPCO1: DATA DICTIONARY

ID	Block	Description	Min	Max	Type	Length	Source
1	SPC01	Number of people	0	25	TinyInt		Fixed
2	SPC01	Number of bedrooms	1	10	TinyInt		User *
3	SPC01	Lighting heat gain	0	1	Num	9,4	Fixed
4	SPC01	Equipment heat gain	0	1	Num	9,4	Fixed
5	SPC01	Infiltration	0	1	Num	9,4	Fixed
6	SPC01	Wind speed factor/ Infiltration method	ACH	CSF/SG	Num	9,4	Fixed
14	SPC01	Terrain Parameter 1	0.47	1.3	Num	9,4	Fixed
15	SPC01	Terrain Parameter 2	0.1	0.35	Num	9,4	Fixed
16	SPC01	Shielding Parameter	0.1	0.31	Num	9,4	Fixed
17	SPC01	Horizontal Leakage Fraction	0	1	Num	9,4	Fixed
18	SPC01	Neutral Level	0	∞	Num	9,4	Fixed
19	SPC01	Fractional Leakage Area	0	1	Num	(9,6)	Fixed
20	SPC01	Fractional Leakage Area for Attic	0	1	Num	9,4	Fixed

3.3.7 Block SHAD01: Shading Values

This block captures the building's shading surfaces. These include the eaves of the roof and eave-like extensions between the first and second floor.

TABLE 9 - BLOCK SHAD01: DATA DICTIONARY

ID	Block	Description	Min	Max	Type	Length	Source
1	SHAD01	Front eave shade (ft)	<nul>	99'11"	Char	6	User *
2	SHAD01	Back eave shade (ft)	<nul>	99'11"	Char	6	User *
3	SHAD01	Left eave shade (ft)	<nul>	99'11"	Char	6	User *
4	SHAD01	Right eave shade (ft)	<nul>	99'11"	Char	6	User *
5	SHAD01	Front eave shade on 2nd floor (ft)	<nul>	99'11"	Char	6	User *
6	SHAD01	Back eave shade on 2nd floor(ft)	<nul>	99'11"	Char	6	User *
7	SHAD01	Left eave shade on 2nd floor (ft)	<nul>	99'11"	Char	6	User *
8	SHAD01	Right eave shade on 2nd floor (ft)	<nul>	99'11"	Char	6	User *

3.3.8 Block SYS01: Systems

This block describes the systems that operate the house. Energy sources presently include natural gas and electricity for heating and domestic hot water. Cooling is either Heat Pump or Air Conditioning.

TABLE 10 - BLOCK SYS01: SYSTEMS DATA DICTIONARY

ID	Block	Description	Min	Max	Type	Length	Source
1	SYS01	Mode of system: 1, 2, 3	1	3	TinyInt		User *

ID	Block	Description	Min	Max	Type	Length	Source
2	SYS01	Cooling Capacity of cooling system (Btu/hr)			Int		Calc
3	SYS01	Heating Capacity of heating system (Btu/hr)			Int		Calc
4	SYS01	Seasonal Energy Efficiency Ratio (SEER)	13	21	TinyInt		User *
5	SYS01	Annual fuel utilization efficiency (afue)	0.60	1	Num	9,4	User *
6	SYS01	Heating seasonal performance factor (hspf)	7.70	12.00	Num	9,4	User *
7	SYS01	The number of pilot lights of DHW	0	10	TinyInt		Fixed
8	SYS01	The number of pilot lights of Furnace	0	10	TinyInt		Fixed
9	SYS01	The number of pilot lights of others	0	10	TinyInt		Fixed
10	SYS01	DHW-tank size	20	80	TinyInt		Calc
11	SYS01	Energy Factor (%) for Domestic Hot Water		1.00	Num	9,4	Calc
12	SYS01	Activates setback and setup for thermostat setting	Y	N	Char	2	Fixed
13	SYS01	Domestic Hot Water Option	GAS	ELECTRIC	Char	4	User *
14	SYS01	Supply duct leakage (Fraction)	0	1	Num	9,4	Calc
15	SYS01	Return leakage(Fraction)	0	1	Num	9,4	Calc
18	SYS01	R-value for supply duct	1	100	TinyInt		Fixed
19	SYS01	R-value for return duct	1	100	TinyInt		Fixed
22	SYS01	Duct location	ATTIC	ROOM	Char	6	User *
23	SYS01	Supply fan static pressure	0	15	Num	9,4	Fixed
24	SYS01	Switch (Y/N) to activate values for Energy Gauge comparison			Char	2	Fixed
25	SYS01	Switch (Y/N) to activate curves for energy gauge comparison			Char	2	Fixed
26	SYS01	Climate dependent factor for cooling EIR	0.1	2	Num	9,4	Fixed
27	SYS01	Climate dependent factor for heating EIR	0.1	2	Num	9,4	Fixed
28	SYS01	Switch (Y/N) for heating and cooling system auto sizing			Char	2	Fixed
29	SYS01	Switch (Y/N) for automatic calculation of supply cfm			Char	2	Fixed
30	SYS01	CFM/TON for supply fan (when sy29 = N) and for duct model	100	1000	SmallInt		Fixed

3.3.9 WEATHER

Weather data are kept in a lookup table for IC3 (and are fixed for TCV). It is stored to facilitate the use of real data in the future. There are no effective min/max values for the calculated data. The values are not stored as they are derived from lookup tables.

TABLE 11 - WEATHER - DATA DICTIONARY

ID	Description	Type	Length	Source
0	Weather Station	Char		Calc
1	Latitude	Num	9,4	Calc
2	Longitude	Num	9,4	Calc

3	Altitude (ft)	Num	9,4	Calc
4	Heating Degree Days	Int		Calc
5	Air Changes	Num	9,4	Calc

3.4 Simulation Results Table

After the system simulates both the Code Compliant House ("Code House") house and the Proposed House ("User") house, the results are stored in this table by the system. Some values are the result of the simulations; others are generated by the actual software for audit or debugging purposes as shown in Table 12. The ProjectType and Status help identify which results are inspected by third party inspectors and are to be separated out for maximum SIP credit.

TABLE 12 - SIMULATION RESULTS

FieldName	Field Description	Type	Length	Source
JobNum	Job Number	BigInt		System
ProjectNum	Project Number	BigInt		System
UserTotalEnergyMMBTU	Total MMBTU – User	Float		Simulated
UserGasEnergyMMBTU	Gas MMBTU – User	Float		Simulated
UserElectricEnergyMMBTU	Electric MMBTU – User	Float		Simulated
CodeTotalEnergyMMBTU	Total MMBTU – Code	Float		Simulated
CodeGasEnergyMMBTU	Gas MMBTU – Code	Float		Simulated
CodeElectricEnergyMMBTU	Electric MMBTU – Code	Float		Simulated
CEVersion	CE Version	VarChar	20	System
BDLName	BDL Version	VarChar	20	System
CEName	CalcServer	VarChar	20	System
StartTime	Time run started	Date/Time		System
ProcessingTime	Time to run	Num	9,4	System
ProjectType	Type of Project	VarChar	25	System
Status	Status	VarChar	10	System
eGridVersion	eGRID Version	VarChar	26	System
NOX_LBS	NOx	Num	9,4	Derived->eGRID
SOX_LBS	SOx	Num	9,4	
CO2_LBS	CO2	Num	9,2	
CertNo	Certificate #	BigInt		System

4 Appendix 1 - Module Details

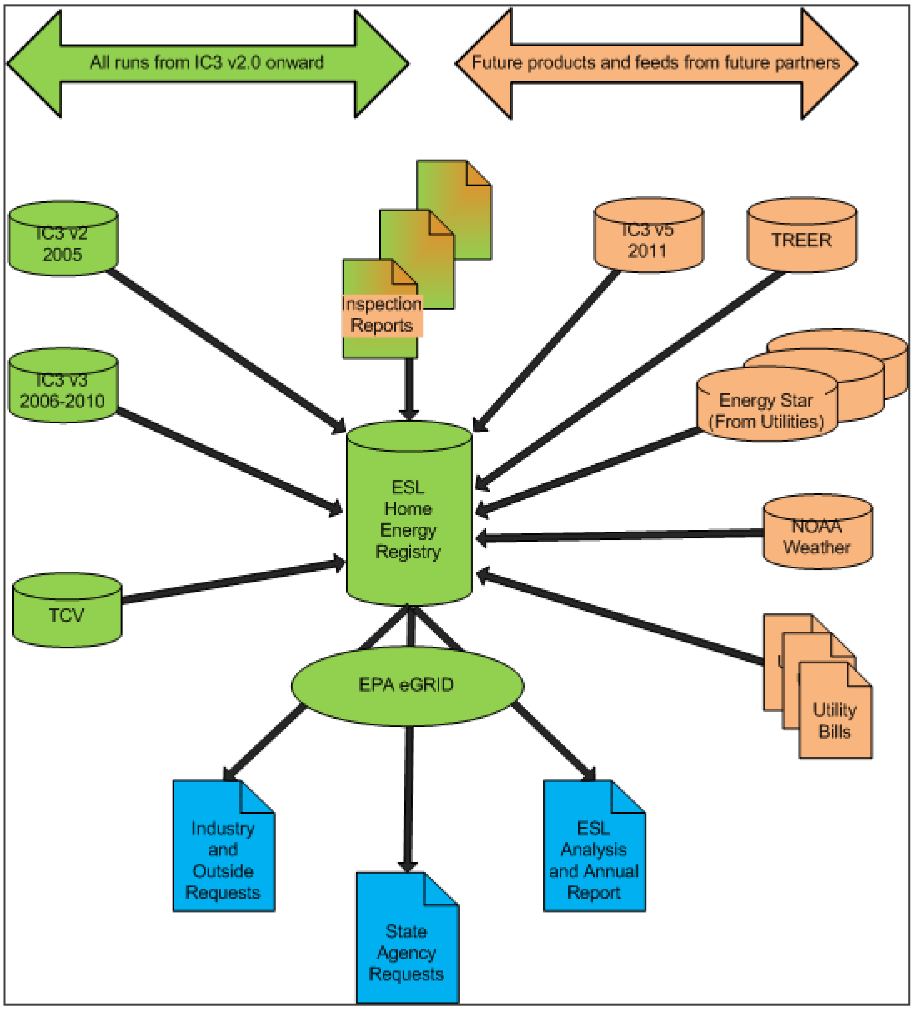

FIGURE 2 - LABORATORY HOME REGISTRY

4.1 Background

There have been four production versions of the Energy Systems Laboratory's (the Laboratory) web-based energy, Code House and emissions reduction calculators. They include:

4.1.1 eCalc v1.1

This software calculated energy efficiency and emissions reductions for buildings in any of the forty-one Texas counties that were deemed non-attainment or near non-attainment. It was published in mid-2004 and is still available at http://ecalc.tamu.edu.

4.1.2 C3 v2.0

This is the original Code Compliance Calculator. An easy-to-use web based tool, focused on Code Compliance for the 2000/2001 IECC in the same forty one counties as eCalc. Published in the summer of 2007, and then replaced by version IC3 v3.2. This version is no longer available.

4.1.3 IC3 v3.x

The International Code House Compliance Calculator (IC3). This is an expanded version of C3, with coverage for all of Texas. IC3 uses IECC 2000 with the 2001 amendments. It was published in the summer of 2008. Users may access it at http://ic3.tamu.edu.

4.1.4 TCV v1.0

The Texas Climate Vision software (TCV). This is a modified version of IC3 that was modified for Austin Energy's customers in Travis County. TCV uses IECC 2006 with Austin's amendments. It will be available in January 2009. Austin Energy will publish a link to the site when they are ready.

4.2 Code Compliance Calculator (C3) v2.0

Version 2.0 of C3 was a three-tier web application. A web interface collected the building's data, checked it for reasonableness, and recorded it to a domain database. The building data was then picked up by Calculation Servers running the Calc Engines (CE) that parameterized the building data and passed it to the DOE-2 simulation and a customized Laboratory BDL script. The results of the hourly simulations (one for the house as entered, one for a Code House compliant version) were then stored in the CE database and presented to the User in the form of the % above (or below) Code House as well as a report in PDF format.

The v2.0 CE layer evolved from the v1.0 CE technology (eCalc) with the key difference in the parameters (and results) being stored in a SQL Database vs. the use of a SQL Database and XML file-based data store used in eCalc. The v2.0 web layer was a complete rewrite from the original eCalc program.

4.3 International Code House Compliance Calculator (IC3) v3.x

IC3 v3.xis familiar to users of v2.0, even though it allows for more parameters, improved usability, faster execution speed, and a more accurate simulation. While v2.0 had only one screen for entering the building's parameters, v3.x has seven. The current production version is 3.6 (as of April 2, 2010), and a version 3.7 is planned before focusing on development of v5.0[i].

4.4 Texas Climate Vision (TCV) v1.0

TCV v1.0 was built from IC3 v3.2. It uses 90% of the same programming as IC3. The underlying CE is the same, and the parameters are stored in the same tables as IC3 v3.2. A builder sees little differences between the two systems. However, Inspectors and Austin Energy see the differences in the workflow and the use of IECC 2006 with Austin Energy amendments (IC3 uses IECC 2000 with 2001 amendments).

4.5 Inspections

At this time (December 2008), only TCV has an Inspection module. IC3 can accommodate Inspections with minimal changes—however there are policy and procedural issues that would have to be solved in a consistent manner across Texas before a state-wide Inspection Module would be effective.

4.6 Texas Residential Energy Efficiency Registry (TREER)

TREER is a forthcoming tool that implements a simple process by which a very large number of home owners can gauge the relative energy efficiency of their existing homes over time. This software is intended to allow a homeowner to evaluate the efficiency rating of their house against a known standard.

4.7 NOAA Weather

The Weather Module will be a modernized version of the weather data collection work executed by the Laboratory in the 1990s. For the Registry, NOAA web-based weather feeds will be collected using the Really Simple Syndication (RSS) technology. The raw data will then be analyzed, and filled, by automated routines. If collected data values exceed specified threshholds, then a Laboratory engineer will be alerted to address and remedy the data quality issue.

Weather data is collected hourly, and indexed by the observation time and the reporting site. The Laboratory has cross referenced all 254 Texas Counties with the appropriate matching weather stations.

The weather data is invaluable in trueing up the simulation with measured data (such as Utiilty Bills, below). By running the simulation with actual data, instead of the typical meteorological year (which is a 30 yr average), linear regression techniques can be used to compare the predicted vs. actual performance of buildings. Given a valid statistical sample of homes, the Laboratory can further tune the model to increase forecasting accuracy.

4.8 Utility Bills

This module is being developed to support monitoring and verification for the Laboratory's Continuous Commissioning® activities. Many of the tools being developed will be useful for residential monthly utility bill analysis. Examples include:

- Inspecting bills for an account to ensure that there are no gaps or overlaps
- Normalizing the utility bills to the weather
- Determining an energy index for a home's actual energy use (i.e., energy consumed per square foot)

4.9 Reporting

The web modules detailed above are On-Line Transactional Processing (OLTP) systems. Their databases are designed to support processing effectiveness, not reporting.

When reporting is necessary, an Extract, Transform, and Load (ETL) process is executed to transform the data into a data mart (i.e., a mini data warehouse). From here, data can be extracted based on location, date, web module, weather station, utility, IECC Code Compliant House, size, system attributes (i.e. SEER rating), etc.

The basic extraction and transformation steps are: selection and aggregation of the desired data, downloading to a desktop program, analysis, and then presentation.

TCV has a simple reporting mechanism in place. This allows for a log of all houses passing inspection within a date range to be exported to an Excel spreadsheet along with their parameters. The spreadsheet also includes the estimated energy use for the User home as entered, the IECC 2006 (with Austin

Amendments) Code House home, and the 2000 with 2001 Amendments Code House. All three simulations are provided for emissions reporting purposes and as part of the deliverables for the TCV contract with the U.S. Department of Energy (DOE) and Texas State Energy Conservation Office (SECO).

As shown on the IC3 v3.2 Certificate, the approximate SOx, NOx, and CO2 emissions reductions are calculated from the above Code House energy savings. The calculations are further refined by U.S. Environmental Protection Agency's (US EPA) eGRID database and Texas Public Utility Commission (TPUC) power distribution data.

5 Appendix 2 - Stylized Entity Relationship Diagram (ERD)

The following figure provides a simplified overview of how the data is related in this system.

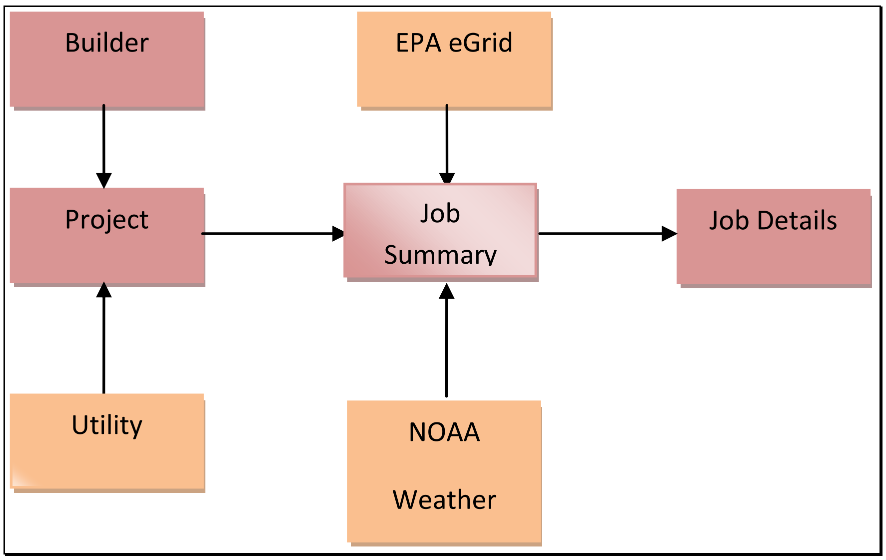

FIGURE 3 - STYLIZED ERD

A narrative links the components as follows:

- Builders build Projects
- Projects are simulated as Jobs
- Projects have Utility Bills
- Jobs have Details
- Jobs have NOAA Weather for their County
- Jobs lookup Emissions Data from EPA eGrid

This is a relational database system intended to be operated as a database application (vs. the calculators which are custom software applications).

Each Builder has a record, and that record has a unique Builder ID value called a Primary Key (PK). Each Project has a unique record and PK as well. To link these, we place the PK of the Builder into the Project record as a Foreign Key (FK). This links the two without duplicating the Builder's data in every Project. As you "normalize" the project, you can see that the space savings are significant to the "record once, link many" approach and the ease of updating. Updating the Builder's phone number, means all of his Projects then have an updated Builder phone number.

6 APPENDIX 3 – EXAMPLE VALUES

This appendix provides an example of how a house is represented by the Laboratory's Residential Registry. Table 16 provides a detailed description of the house. Tables 13-15 and Tables 14-25 show the values in the database used to report the house in Table 16 as well as the applicable code-compliant house that is used for comparison.

6.1 PROJECT AND BUILDER'S SAMPLE VALUES

TABLE 13 - BUILDER'S DATA EXAMPLE

Field Description	Example	Type	Length
Name	Gilco	Char	50
Address 1	4994 Westin Rd	Char	50
Address 2	<NULL>	Char	50
City	Houston	Char	25
State	TX	Char	2
Zip	77058	Smallint	
Phone 1	281.870.1568	Char	14
Phone 2	281.877.4755	Char	14
TNRCC #	12456	Char	6
RegisteredDate	9/18/2008	Date/Time	
Status	Active	Char	10

TABLE 14 -PROJECT DATA EXAMPLE

Field Description	Example	Type	Length
ProjectName	Cloyington	Char	50
Address1	9334 B Queens Ride	Char	50
Address2	<NULL>	Char	50
City	Houston	Char	25
State	TX	Char	2
Zip	77079	Smallint	
County	Harris	Char	25
Entered On	10/2/2008	Date/Time	
Notes	Duct tradeoff in effect.	Char	255
Status	Active	Char	10

TABLE 15 - SIMULATION RESULTS

Field Description	Example	Type	Length	Source
MMBTU User	33.5	Num	9,4	Simulated
MMBTU Code House	47.2	Num	9,4	Simulated
BDL Version	2.50.07	Char	10	System
CalcServer	TCS23	Char	10	System
Run At	2008.11.17 18:49	Date/Time		System
TimeSec	4.5	Num	9,4	System
ProjectType	TCV_Builder	Char	25	Project
ProjectNum	24883	Integer		System
JobNum	38193	BigInt		System
Status	Complete	Char	10	System

NOx	12	Num	9,4	
SOx	11	Num	9,4	Simulated->eGRID
CO2	54.6	Num	(9,2)	
Certificate #	4888484	BigInt		System

6.2 Laboratory Standard Simulation Model

The following table provides the detailed information for the example house used in Tables 13-15 and 17-25[5]. The right hand column is highlighted to call attention to the different values used to model a Heat Pump.

TABLE 16 - LABORATORY BASE CASE PARAMETERS

Attribute	HVAC (default)	Heat Pump (if different)
Building type	Single family, detached house	
Gross area	2,325 sq. ft. (48.22 ft. x 48.22 ft.)	
Number of floors	1	
Floor to floor height (ft.)	8	
Orientation	South facing	
Construction	Light-weight wood frame with 2x4 studs spaced at 16” on center	
Floor	Slab-on-grade floor	
Roof configuration	Unconditioned, vented attic	
Roof absorptance	0.75	
Ceiling insulation (hr-sq.ft.- °F/Btu)	Varies with WWAR[6]	
Wall absorptance	0.75	
Wall insulation (hr-sq.ft.-°F/Btu)	Varies with WWAR	
Slab Perimeter Insulation	None	
Ground reflectance	0.24	
U-Factor of glazing (Btu/hr-sq.ft. °F)	Varies with WWAR	
Solar Heat Gain Coefficient (SHGC)	Varies with WWAR	
Window area	Range 25% - 55%	
Exterior shading	None	
Space Conditions		
Space temperature set-point	68°F Heating, 78°F Cooling, 5°F set-back/ set-up for winter and summer, respectively, for 6 hours per day	
Internal heat gains	0.88 Watts (modeled as 0.44 Watts for lighting and 0.44 Watts for equipment)	
Number of occupants	None	

[5] Standard as of version 2.50.07 of the DOE-2 Building Description Language created by LABORATORY

[6] Window to Wall Area

Attribute	HVAC (default)	Heat Pump (if different)
Mechanical Systems		
HVAC system type	Electric cooling (air conditioner) and natural gas heating (gas fired furnace)	Electric cooling and heating (air conditioner with heat pump)
HVAC system efficiency	SEER 13 AC 0.78 AFUE furnace	SEER 13 AC, 7.7 HSPF heat pump
Cooling capacity (Btu/hr)	55,800	
Heating capacity (Btu/hr)	-44,997	
DHW system type	40-gallon tank type gas water heater with a standing pilot light	50-gallon tank type electric water heater (without a pilot light)
DHW heater energy factor	0.54	0.86
Duct location	Unconditioned, vented attic	
Duct leakage (%)	Supply - 20% Return - 10%	
Duct insulation (hr-sq.ft.-°F/Btu)	R-8 (supply) and R-4 (return)	

6.3 Transformed Wall Measures

TABLE 17 - BLOCK BLDG0 EXAMPLE

ID	Field Description	Proposed House	Code House	Type	Length	Source
1	Front Side, 1st Floor	50	50	Smallint		Calc
2	Back Side, 1st Floor	50	50	Smallint		Calc
3	Right Side, 1st Floor	50	50	Smallint		Calc
4	Left Side, 1st Floor	50	50	Smallint		Calc
5	Front Side, 2nd Floor	0	0	Smallint		Calc
6	Back Side, 2nd Floor	0	0	Smallint		Calc
7	Right Side, 2nd Floor	0	0	Smallint		Calc
8	Left Side, 2nd Floor	0	0	Smallint		Calc
9	Switch to deactivate reports	ON	ON	Char	5	System

6.4 Other Structure Measures

TABLE 18 - BLOCK BLDG1 EXAMPLE

ID	Description	Proposed House	Code House	Type	Length	Source
1	Thermal Mode	T	T	Char	1	Fixed
2	Location	TRAVIS	TRAVIS	Char	10	User *
3	Azimuth of building (degree)	0	0	Smallint		User *
6	Height of wall (ft)	8	8	Num	9,4	User *
7	Door height (ft)	6.67	6.67	Num	9,4	Fixed
8	Door width (ft)	3	6	Num	9,4	Fixed
9	1st Floor Area	1000	1000	Smallint		User *
10	Option of second floor (1 or 2)	1	1	Smallint		User *

ID	Description	Proposed House	Code House	Type	Length	Source
11	Floor type	S	S	Char	2	Fixed
12	Height of first floor/crawl space wall above ground (ft)	2	2	Smallint		Fixed
13	Height of crawl space wall underground (ft)	3	3	Smallint		Fixed
14	Roof configuration	A12	A12	Char	10	Fixed
15	Pitch of roof (degree)	23	23	Num	9,4	Fixed
18	Second Floor Height	8	8	Num	9,4	User *
19	Amendment	TCV	TCV	Char	10	System
20	Input Method	U	S06	Char	10	System
21	2nd Floor Area	0	0	Smallint		User *
22	Radiant Barrier	Y	Y	Char	2	User *
23	Wall framing factor	0.25	0.25	Num	9,4	Fixed
24	Roof framing factor	0.07	0.07	Num	9,4	Fixed
25	Ceiling framing factor	0.07	0.07	Num	9,4	Fixed
26	Floor framing factor	0.12	0.12	Num	9,4	Fixed
28	Garage Type	A	A	Char	2	Fixed
29	Overhang Area (2nd floor over ambient)	0	0	Num	9,4	User *

6.5 Garages (Future Use)

TABLE 19 - BLOCK BLDG1 EXAMPLE

ID	Description	Proposed House	Code House	Type	Length	Source
3	Height of garage wall (ft)	8	8	Num	9,4	Fixed
4	Garage coordinate X	0	0	Num	9,4	Fixed
6	Garage coordinate Y	0	0	Num	9,4	Fixed
8	Garage Wall Insulation	N	N	Char	2	Fixed
9	Garage Roof Insulation	N	N	Char	2	Fixed
10	2nd Floor Coordinates for X	0	0	Num	9,4	Fixed
11	2nd Floor Coordinates for Y	0	0	Num	9,4	Fixed
12	Garage door insulation	0	0	Num9,4		Fixed

6.6 Envelope Measures

TABLE 20 - BLOCK CONS1 EXAMPLE

ID	Description	Proposed House	Code House	Type	Length	Source
1	Roof outside emissivity	0.93	0.9	Num	9,4	Calc
2	Roof absorptance	0	0.75	Num	9,4	Calc
3	Roof roughness	1	1	Num	9,4	Fixed
4	Roof/Ceiling R-value (Hr-sq.ft-°F/Btu)	32	30	Smallint		User *
5	Wall absorptance	0.75	0.75	Num	9,4	Fixed
6	Wall roughness	2	2	Num	9,4	Fixed
7	Wall outside emissivity	0.9	0.9	Num	9,4	Fixed
8	Wall R-value (Hr-sq.ft-°F/Btu)	21	13	Num	9,4	User *
9	Ground reflectance	0.24	0.24	Num	9,4	Fixed
10	Window option (S or D)	D	D	Char	2	Fixed

ID	Description	Proposed House	Code House	Type	Length	Source
11	U-Factor of glazing (Btu/hr-sq.ft-F)	0.35	0.65	Num	9,4	User *
12	Solar Heat Gain Coefficient(SHGC)	0.32	0.38	Num	9,4	User *
13	Glass type Code House	0	0	Num	9,4	Fixed
14	Frame absorptance of glazing	0.7	0.7	Num	9,4	Fixed
15	Frame type - A,B,C,D,E	A	A	Char	2	Fixed
16	Frame width (ft.)	0.125	0.125	Num	9,4	Fixed
17	Floor weight (lb/sq-ft)	0	0	Num	9,4	Fixed
18	Spacer-type-Code House	1	1	Smallint		Fixed
21	Percentage of window area (%) for whole area or front side wall	0.2500	0.2500	Num	9,4	Calc
22	Percentage of window area (%) for back side wall	0.2500	0.2500	Num	9,4	Calc
23	Percentage of window area (%) for right side wall	0.2500	0.2500	Num	9,4	Calc
24	Percentage of window area (%) for left side wall	0.2500	0.2500	Num	9,4	Calc
25	Percentage of window area (%) for LEFT side wall for 2nd floor	000.00	000.00	Num	9,4	Calc
26	Floor R-Value (hr-sq.ft-°F/Btu)	11	11	Smallint		Fixed
27	Crawl space wall R-value (hr-sq.ft-°F/Btu)	5	5	Smallint		Fixed
29	Slab perimeter R-value and depth	000.00	000.00	Num	9,4	Calc
30	Percentage of window area (%) for RIGHT side wall for 2nd floor	000.00	000.00	Num	9,4	Calc
31	Percentage of window area (%) for FRONT side wall for 2nd floor	000.00	000.00	Num	9,4	Calc

6.7 ENVELOPE CONSTRUCTION

TABLE 21 - BLOCK CONS2 EXAMPLE

ID	Description	Proposed House	Code House	Type	Length	Source
1	Wall type	A	A	Char	2	Fixed
2	Stud type	b	a	Char	2	Calc
5	Wall exterior insulation R-value	0	0	Smallint		Fixed
6	Wall exterior finish	EFC	EFC	Char	5	Fixed
10	Roof type	A	A	Char	2	Fixed
11	Roof structure	c	c	Char	2	Fixed
14	Roof/ceiling insulation position	C	C	Char	2	Fixed
19	Roofing	AR02	AR02	Char	5	Fixed
21	Exposed/interior floor structure	a	a	Char	2	Fixed
23	Exposed/Interior floor finish	FIFA	FIFA	Char	5	Fixed
30	Crawlspace wall type	CSWA	CSWA	Char	5	Fixed

6.8 OPERATIONAL PARAMETERS

TABLE 22 - BLOCK SPCO1 EXAMPLE

ID	**Description**	**Proposed House**	**Code House**	**Type**	**Length**	**Source**
1	Number of people	0	0	TinyInt		Fixed

2	Number of bedrooms	2	2	TinyInt		User *
3	Lighting heat gain	0.20	0.20	Num	9,4	Fixed
4	Equipment heat gain	0.36	0.36	Num	9,4	Fixed
5	Infiltration	0.36	0.36	Num	9,4	Fixed
6	Wind speed factor/ Infiltration method	SG	SG	Num	9,4	Fixed
14	Terrain Parameter 1	0.85	0.85	Num	9,4	Fixed
15	Terrain Parameter 2	0.2	0.2	Num	9,4	Fixed
16	Shielding Parameter	0.24	0.24	Num	9,4	Fixed
17	Horizontal Leakage Fraction	0.4	0.4	Num	9,4	Fixed
18	Neutral Level	0.5	0.5	Num	9,4	Fixed
19	Fractional Leakage Area	0.00036	0.00036	Num	(9,6)	Fixed
20	Fractional Leakage Area for Attic	0.0033	0.0033	Num	9,4	Fixed

6.9 Shading Values

TABLE 23 - BLOCK SHAD01 EXAMPLE

ID	Description	Proposed House	Code House	Type	Length	Source
1	Front eave shade (ft)	1’0”	0	Char	6	User *
2	Back eave shade (ft)	1’0”	0	Char	6	User *
3	Left eave shade (ft)	1’0”	0	Char	6	User *
4	Right eave shade (ft)	1’0”	0	Char	6	User *
5	Front eave shade on 2nd floor (ft)	0	0	Char	6	User *
6	Back eave shade on 2nd floor(ft)	0	0	Char	6	User *
7	Left eave shade on 2nd floor (ft)	0	0	Char	6	User *
8	Right eave shade on 2nd floor (ft)	0	0	Char	6	User *

6.10 Systems

This block is focused on the systems that operate the house. Energy sources are natural gas and electricity. Cooling is either Heat Pump or Air Conditioning. Water heaters can be powered by either natural gas or electricity.

TABLE 24 - BLOCK SYS01 EXAMPLE

ID	Description	Proposed House	Code House	Type	Length	Source
1	Mode of system: 1, 2, 3	1	1	TinyInt		User *
2	Cooling Capacity of cooling system (Btu/hr)	24000	24000	Int		Calc
3	Heating Capacity of heating system (Btu/hr)	-24000	-24000	Int		Calc
4	Seasonal Energy Efficiency Ratio (SEER)	21	13	TinyInt		User *
5	Annual fuel utilization efficiency (afue)	1	0.78	Num	9,4	User *
6	Heating seasonal performance factor (hspf)	7.7	7.7	Num	9,4	User *
7	The number of pilot lights of DHW	0	0	TinyInt		Fixed
8	The number of pilot lights of Furnace	0	0	TinyInt		Fixed
9	The number of pilot lights of others	0	0	TinyInt		Fixed
10	DHW-tank size	30	30	TinyInt		Calc

ID	Description	Proposed House	Code House	Type	Length	Source
11	Energy Factor (%) for Domestic Hot Water	1	0.563	Num	9,4	Calc
12	Activates setback and setup for thermostat setting	N	N	Char	2	Fixed
13	Domestic Hot Water Option	GAS	GAS	Char	4	User *
14	Supply duct leakage (Fraction)	0.0	0.05	Num	9,4	Calc
15	Return leakage(Fraction)	0.0	0.05	Num	9,4	Calc
18	R-value for supply duct	8	8	TinyInt		Fixed
19	R-value for return duct	8	8	TinyInt		Fixed
22	Duct location	ROOM	ATTIC	Char	6	User *
23	Supply fan static pressure	1	1	Num	9,4	Fixed
24	Switch (Y/N) to activate values for Energy Gauge comparison	Y	Y	Char	2	Fixed
25	Switch (Y/N) to activate curves for energy gauge comparison	Y	Y	Char	2	Fixed
26	Climate dependent factor for cooling EIR	0.941	0.941	Num	9,4	Fixed
27	Climate dependent factor for heating EIR	0.582	0.582	Num	9,4	Fixed
28	Switch (Y/N) for heating and cooling system auto sizing	N	N	Char	2	Fixed
29	Switch (Y/N) for automatic calculation of supply cfm	N	N	Char	2	Fixed
30	CFM/TON for supply fan (when sy29 = N) and for duct model	360	360	SmallInt		Fixed

6.11 Weather

TABLE 25 - WEATHER (TMY SPECIFIC) EXAMPLE

ID	Description	Proposed House	Code House	Type	Length	Source
0	Weather Station	ATT	ATT	Char		Calc
1	Latitude	30.19	30.19	Num	9,4	Calc
2	Longitude	97.47	97.47	Num	9,4	Calc
3	Altitude (ft)	630.75	630.75	Num	9,4	Calc
4	Heating Degree Days	2000	2000	Int		Calc
5	Air Changes	0.456	0.456	Num	9,4	Calc

6.12 Shading Schedule

TABLE 26 - SCHEDULE (INTERNAL SHADING)

ID	Description	User	Source
1	January	0.9	Calc
2	February	0.9	Calc
3	March	0.9	Calc
4	April	0.9	Calc
5	May	0.7	Calc
6	June	0.7	Calc
7	July	0.7	Calc
8	August	0.7	Calc

ID	Description	User	Source
9	September	0.7	Calc
10	October	0.7	Calc
11	November	0.9	Calc
12	December	0.9	Calc

7 Appendix 4 - Technology

7.1 Hardware

The Laboratory's production database server (named SEG-PDB03) is presently an HP DL380 G3 system with 12Gb of RAM, 360 Gb of RAID 5+1 storage, and dual Xeon 3.1 Ghz processors.

A slightly less powerful HP DL380 G3 (named SEG-TDB10) serves the Laboratory as the Test database server. It has less RAM and smaller hard disks. Otherwise the server is identical. This is the system where the Laboratory's Software Engineering Group creates new software packages, or is experimenting with new database features.

Another DL380 is the standby spare system to support these machines and a fourth DL380 (PWS08) web server that runs IC3 and TCV.

A collection of multi-processor, multi-core machines serve as the CalcServers, which contain from four to sixteen instances of the Laboratory's CalcEngines. These are what perform the actual hourly simulations for each and every job submitted from IC3 and TCV as well as update the values in the Registry.

7.2 Software

The underlying technology is Microsoft SQL Server 2005 Standard Edition. This is a very robust product that provides powerful data loading services, a self-tuning database engine, and a flexible reporting engine. Analysis is performed by connecting desktop systems to the server and executing either server or local queries to the desktop using either Microsoft Access or Microsoft Excel. From there, the analyst can work with the smaller data set as necessary to fulfill reporting requests on behalf of the Laboratory.

7.3 Operations

The lab protects the State's data in several ways. As indicated above, the Production database server uses RAID 5+1, which translates to "several extra hard drives keeping extra copies of the data and an extra standby hard drive." It is powered by redundant power supplies connected to two different standby power supplies. The spare server provides a source of spare parts, and the HP Service contract provides the backstop for more serious problems.

The data is backed up every night to a different area of the hard disk, and then copied from the database server to the TEES Storage Area Network (SAN). The TEES SAN has extremely high reliability and is redundant, with one copy of the data physically located 12 miles away. Finally, once a week, the remote copy of the data is backed up to tape. The tapes are rotated to a fire proof vault at a third location. Several times a year, the Laboratory will test the backups to ensure that they are being made properly and can be retrieved.

[i] There is no v4 as a potential Commercial version of IC3 is being planned, and it would be called IC4.