Energy Efficiency Measure Data Structure and Naming Conventions

A proposed structure to facilitate the reliable transfer of information and calculation of life-cycle costs and benefits

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Overview of Energy Efficiency Measure Data Structure

The data structure presented here for defining the energy savings associated with conservation measures is an update to the format used in previous DEER projects. The update is motivated by a number of issues and concerns, and high among them is the desire to associate specific deemed energy impacts with IOU tracking data in a clear and reliable way.

The structure defined here is intended to cover the range of issues and data types that will be needed as the CPUC and IOU energy conservation efforts move forward. While the structure described here may appear to be more complicated than necessary, the intent is to simplify those processes that rely on these data. The underlying requirements of the data structure include:

- The data structure needs to support the simple case of "when widget A replaces widget B, X kilowatt hours are saved per year", but also needs to support the increasingly sophisticated data requirements that are needed to accurately determine life-cycle costs and benefits.
- The structure needs to prevent the definition of redundant technologies and measures.
- In the case where some measure data may not be known, such as an hourly impact loadshape, the data structure should assure that best-practice values can be readily utilized.
- The structure needs to connect (future) tracking data to deemed cost, energy impact and other values, such as NTG and EUL. This must be done in a consistent and clear manner that easily repeatable.
- The structure needs to facilitate the use of standard values for some fields (EUL and NTG, for example) and also allow for the use of custom values when appropriate.

All details of this process are open to modification and involved parties are encouraged to offer ideas for improvements, including restructuring of the current plan.

Three Major Categories of Data Requirements

The various elements of energy savings data fall into three major categories. These categories are defined by how the data they contain relate to each other. In this report, the categories are referred to as **Technologies**, **Measures** and **Energy Impacts**.

As used in this discussion, a "technology" defines a certain state of the energy components of interest. For example, a "SEER 13" technology definition will include the performance characteristics of a residential air-conditioning unit, including the energy characteristics of the compressor and outdoor condenser fan. In some situations, the

indoor evaporator fan may or may not be included in the definition of a "SEER 13 unit"; but in this situation the technology definition must be perfectly clear about which components are included.

A "measure" in this context defines the replacement of one technology (base technology) for another technology (the measure technology), motivated by the goal of energy savings. Utilizing the definition of technology as stated above, a measure can be seen as the replacement of one state of energy components by another state of energy components. An AC efficiency improvement measure, for example, may be defined as replacing a "SEER 13" technology with a "SEER 21" technology.

Finally, "energy impacts" are the change in energy use caused by an energy efficiency measure under a certain set of circumstances. The AC efficiency measure described above, for example, may save 100 kWh per ton annually, for a typical, existing single-family house in climate zone 12. In this case, the "typical, existing single-family house in climate zone 12" describes the circumstances associated with the annual energy impact of 100 kWh per ton.

Figure 1 shows the relationship of these three categories of data along with some details of their content.

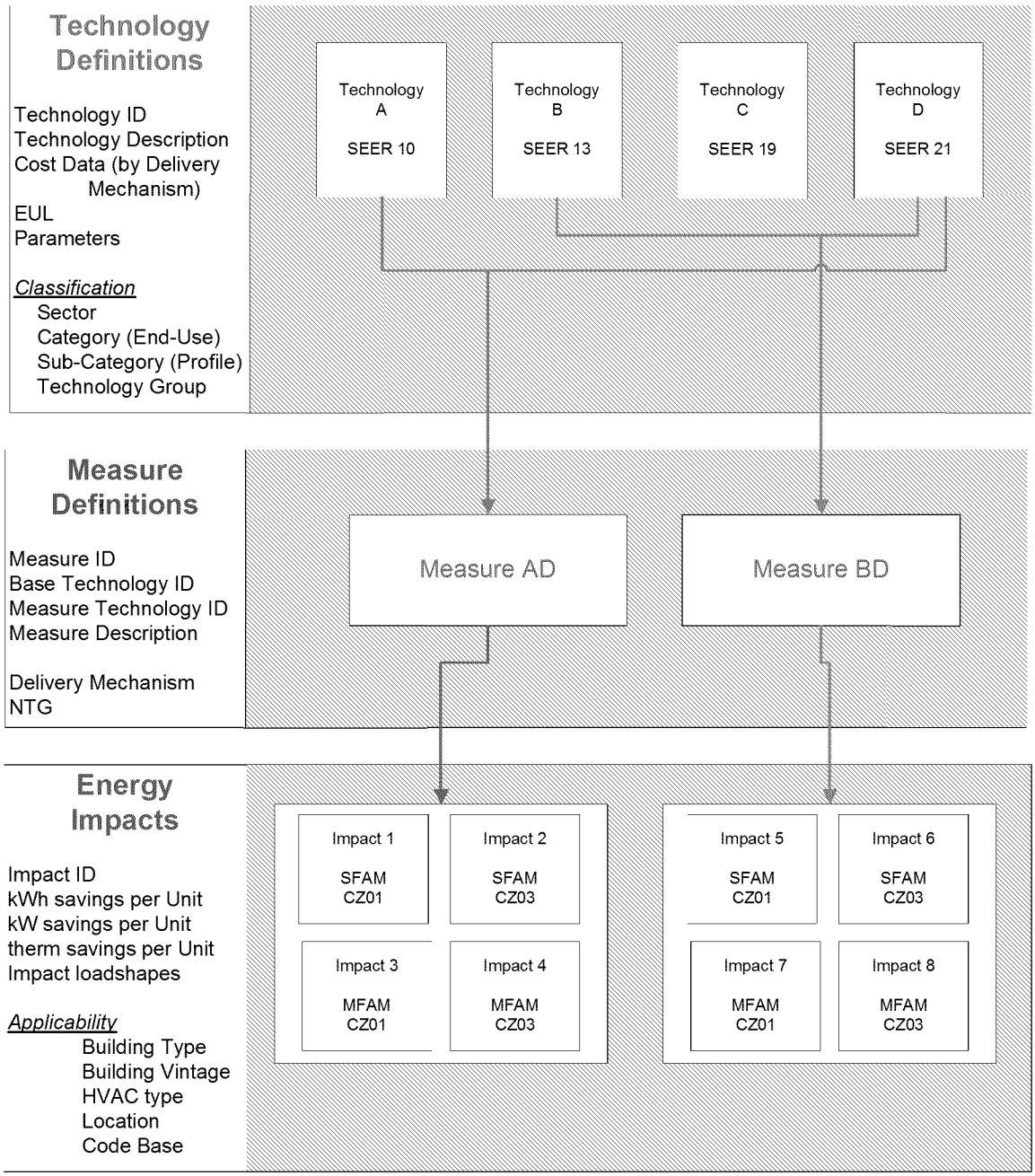

Figure 2. Information Flow within the Energy Efficiency Measure Data Structure

Technology Definition

The technology definition describes the characteristics of a set of energy-related components. A technology definition by itself does not imply any energy savings or energy use. It instead describes the beginning state or the ending state of an energy

saving ***measure definition***. A single technology definition can be referred to by a multitude of energy saving measures.

Besides characteristics that relate to energy use, the technology definition also references cost data, associated parameters and technology classification.

Technology Cost Data

Definitions that describe a ***measure*** technology (as opposed to a ***base case*** technology) will typically have associated technology cost information. When technology costs vary by program delivery method, multiple sets of costs data may be required. For example, for a technology described as "18 Watt Screw-in CFL lamp", there may be one set of costs for upstream programs and a different set of costs for downstream programs. There may also be differing sets of cost data based on the CFL packaging (2-packs, 4-packs, et cetera).

Definitions that describe a base case technology may also require associated costs, though for technologies that are used as starting points for an early-retirement measure, costs are typically not be needed. Costs for existing customer equipment fall into this latter category.

The cost data associated with a technology are not limited to the standard material and labor costs, but may include periodic costs and other cost-related values, such as tax credits, transportation costs, and others.

Technology Parameters

The technology definition includes a reference to parameters that may be of interest in determining or evaluating energy savings.

For the example of a residential air-conditioning system, technology parameters may include the rated EER, the rated capacity in tons, the measured indoor fan power, the manufacturer, the age of the system and so forth. Not all parameters may be known for all measure installations, but the list of associated parameters will allow tracking data to include relevant parameter data when it does exist.

Technology Classification

The addition of "classification" to the technology description is a key feature needed to organize and identify technologies and their associated measures. Classification is merely a way to group technologies that share common features or applications. The current structure includes four classification fields along with the actual technology description. These classification fields are described in Table 1.

Classification Field	Description	Example
Sector	Major Sector associated with the technology.	Commercial, Residential, Industrial, Agricultural, Non-Building
Category	Major Category or End-Use associated with the technology.	HVAC, Water Heating, Indoor Lighting
Sub-Category	Category level that leads to common load shapes for a specific application of the technology.	General lighting, Exit lighting Gas storage, HP storage Packaged AC, Packaged HP
Technology Group	General technology name, accumulation of similar technologies. All entries within a single group share the same normalizing units.	CFL, Linear Fluorescent, LED, Refrigerator, Dishwasher
Technology	Specific measure technology	23 W spiral (CFL) Std Size, 0.65 EF (Dish Washer)

Table 1. Technology Classification

The classification fields allow a technology to be placed into a "tree" of technologies, with each field defining a new branch of the tree. See the supporting spreadsheet for an example of how this classification can work with the current DEER technologies.

The Technology ID

Every technology can be identified by its five associated classification fields (as listed in Table 1). An example is: **Commercial** => **Indoor Lighting** => **General** (lighting) => **CLF** => **23W spiral**. The technology description along with its classification fields uniquely identifies every technology and clarifies the technology's general usage.

In a database application, the use of multiple fields to identify a record does not necessarily present a problem. Within the database table that houses these data, each record is assigned an index. Internal to the database, the index is the quickest and most efficient way to target an individual technology record. External to the database, the classification fields are used to identify the individual technology record of interest.

However, if a single, descriptive text field is needed to identify a technology, the following method can be used to derive one:

- A short code can be assigned to each of the classification fields,
- A single text string can be created by concatenating the various codes associated with a technology's classification.
- Tags can be used to identify and/or differentiate the various elements of the technology ID.
- A resulting text ID might be: "Res-ILtg-Gen-CFL-23Wsp".

This method results in a consistent naming convention and allows a user (or a program) to identify other technologies within the same Sub-Category or Measure Group by parsing the technology ID. Other essential information, such as the source of the technology description and the associated cost information is linked to the technology

table via the technology ID and other fields. The structured nature of the technology definition lends itself to being best viewed with a database interface.

Measure Definition

A measure definition identifies a ***base case technology*** that is replaced by a ***measure case technology*** with the intent of saving energy. The measure description also specifies how the measure is to be delivered and references a standard or custom Net-to-Gross value to be associated with this measure.

The base case technology is typically either a customer average technology or a technology that meets a code requirement. In either case, the referenced technology must have an associated Technology Definition as described above.

Some measures require more than one base technology to be specified. An early retirement program, for example, requires that a customer average technology be used as the base case for the "remaining useful life" period of the measure, and that a code technology be use for the (expected useful life – remaining useful life) period.

The final requirements of the "measure definition" will be tailored to meet the requirements of all the involved parties.

The Measure ID

The same issues that apply to the Technology ID apply to the Measure ID, in that the identifier of the measure is not nearly as important as the content of the measure definition. Within the context of a database program, the identified can be any unique value. The measure itself can be identified through its associated classification, delivery type and technologies.

An informative measure ID can be created by expanding upon the technology ID naming convention described above. The measure ID should identify the delivery mechanism, the base case technology type (i.e. customer average, or 2008 Title-24 code requirement) and the measure technology. If the base case can have multiple technologies, then the base case technology should be identified explicitly.

An example of a measure ID: "dmUpStrm-btCA-mtRes-ILtg-Gen-CLF-23Wsp"

In this case, the "dm" tag identifies the delivery mechanism, the "bt" tag identifies the base technology type and the "mt" tag identifies the measure technology. For some measures, it may be more useful to not include the delivery mechanism as part of the measure name (i.e. for measures that may have multiple delivery mechanisms or for measures that are not specific to a delivery mechanism).

Energy Impact Definition

The energy impact definition specifies all of the changes in energy use associated with the application of a measure under a specific set of circumstances. The energy impact definition answers the question "How does energy use change when Measure A is applied to Building Type B in location C?"

The energy values of interest are referred to as "impacts" because they are the change in energy use due to the application of the measure. The most common values of interest are listed in Table 3.

Impact Field	Comment
Base Technology ID	reference to a defined TechID for the base case
Measure Technology ID	reference to a defined TechID for the technology case
Applicability Fields	
Building Type ID	if applicable
Building Vintage ID	if applicable
HVAC System Type ID	if applicable
Location ID	if applicable
Whole-Building Annual Electric Impact	kWh/Unit
Whole-Building Annual Gas Impact	therm/Unit
Whole-Building Electric Demand Impact	kW/Unit
Whole Building Electric Impact Hourly Profile	reference to a Sub-Category typical loadshape
Whole Building Gas Impact Hourly Profile	reference to a Sub-Category typical loadshape
End-Use Annual Electric Impact	kWh/Unit
End-Use Annual Gas Impact	therm/Unit
End-Use Annual Electric Demand Impact	kW/Unit
End-Use Electric Impact Hourly Profile	reference to a Sub-Category typical loadshape
End-Use Gas Impact Hourly Profile	reference to a Sub-Category typical loadshape

Table 2. Main Energy Impact fields

Applicability

Every energy impact is applicable to some instance of an energy-savings measure. The "instance" is defined by applicability fields, a concept that is somewhat parallel to the technology classification idea described above.

The current list of applicability fields are described in Table 3. New measure types may lead to additional applicability fields, with the sole goal being to easily and clearly describe the circumstances under which the energy impact is relevant.

Each of the applicability fields has an associated table of possible entries. The number of possible entries for each field is intentionally fairly small; locations, for example, are limited to the 16 standard climate zones, the four IOU territories or the entire state of California. If an appropriate entry is not in the current list of options, additional entries

van be suggested and incorporated on an on-going basis. Refer to the accompanying spreadsheet for a view of the current list of applicability options.

Applicability Field	Description	Example
Building Type	If the measure is applicable to Buildings, specifies the building type or group of building types a measure impact applies to.	Large Office, Residential (All)
Building Vintage	If the measure is applicable to Buildings, specifies the building vintage a measure impact applies to.	Existing, New, pre-1975
Building HVAC type	If the measure is applicable to Buildings, specifies the building HVAC type that the measure impact applies to.	Central Chiller, Packaged AC AC w/Gas furnace, AC w/electric resistance heating
Location	Specifies the specific or general location that the measure impact applies to.	CZ03, SCE Territory, CA

Table 3. Energy Impact Applicability Fields

The applicability of an energy impact potentially overlaps the measure definition itself. A central chiller measure, for example, is clearly applicable to a "Building HVAC type" of "central chiller". In this case the applicability to "Building HVAC type" can be specified as "not applicable". *The intent of the applicability fields is to differentiate multiple energy impact results for the same measure definition.*

Loadshapes

The hourly profile of electric energy impacts and the monthly profile of gas energy impacts are important components when determining the benefit of energy conservation measures. The current cost-benefit tools (E3) utilize a relatively small library of typical load profiles that limit the choices for the most appropriate profile for a given energy impact.

On the other end of this spectrum are the DEER2008 impact profiles. In the DEER2008 database there are 100s of thousand of impact profiles, but there is no ability to use them in the cost calculation tool. Within the DEER database there are impact profiles specific to a particular combination of base case and measure case simulations and also impact profiles weighted up to represent existing building stock within an IOU territory.

The assignment of classification fields, as described above, flows through from technologies where the classification fields are assigned to the measure definitions that utilize these technologies and to the energy impacts that are based on the measure definitions. By this process, every energy impact has associated classification fields. These classification fields and the Sub-Category field in particular, along with the applicability information, can be utilized to identify energy impact load profiles appropriate for the energy impact definition.

Significant processing will be required to create the "sub-category" level impact profiles. This will mainly involve identifying typical profiles within the sub-category or weighting

a set of technology-specific profiles within the sub-category. This process will make the large amount of impact profile currently available readily useable by non-DEER measures.

Whole-Building and End-Use Impacts

For all measures and energy impacts, it is the total (whole building) energy impact that is needed to calculate life-cycle costs and benefits. For new measures, often only the end-use impact is known. The data structure described here allows for HVAC interactive effects from related measures to be utilized to create whole-building impacts for measures that only have end-use energy impacts.

In the same way that the current DEER2008 impact profile data can be better utilized by the process described above, the whole-building and end-use energy impacts currently in the DEER2008 database can be utilized to add HVAC interaction effects to non-DEER energy impacts that have only end-use information.

The classification and applicability concepts will allow appropriate DEER or Non-DEER measures to be identified. The hourly interactive effects of these measures can be applied to the new energy impact that has only end-use information.

The Energy Impact ID

Every energy impact needs to have a unique ID, and the same issues that apply to the Technology ID and the Measure ID apply here. Internal to the database, a unique and simple identifier can be assigned. Individual energy impact records can also be identified by the technology IDs and applicability fields.

A single, descriptive identifying field can also be created by extending the method described for the Measure ID. In this case, the string identifier will need to include the applicability of the energy impact as well as the measure it is associated with.

An example of an energy impact ID: "blSFM-vtEx-htCAC-loSCE-btCA-mtRes-ILtg-Gen-CLF-23Wsp"

In this case, the "bl" tag identifies the building applicability, the "vt" tag identifies the building vintage applicability, the "ht" tag identifies the HVAC system applicability and the "lo" tag identifies the location applicability. The remaining text (in green) identifies the measure associated with the energy impact (and thus the base and measure technologies).

Energy Efficiency Measure Database Tables

All energy efficiency measure definitions (DEER and Non-DEER) are intended to reside in a central database and share a format similar to the one described in this document. Figure 3 shows the major tables in the planned database and the links between the tables. Fields associated with the arrows on the diagram are common to both tables.

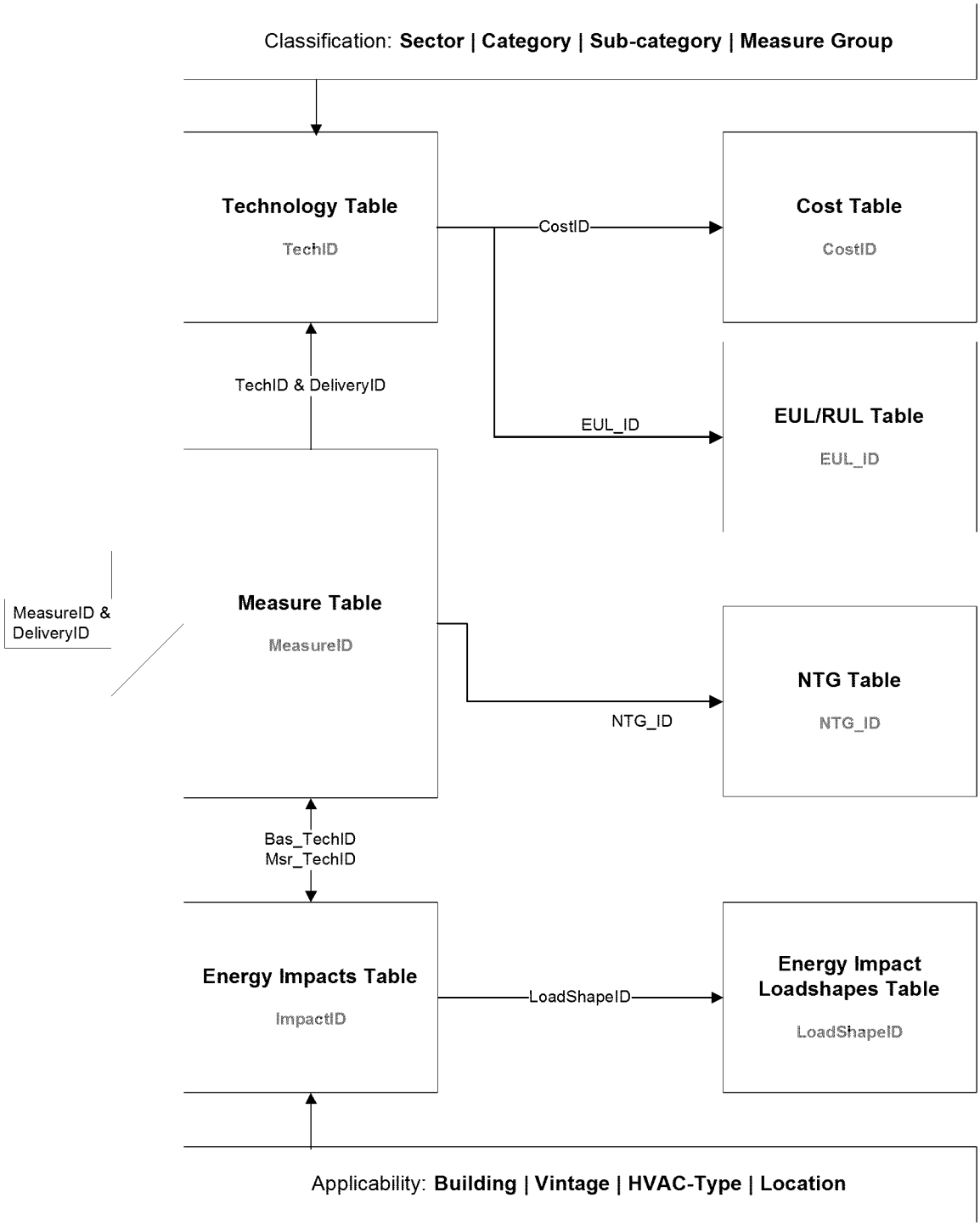

Figure 3. Energy Efficiency Measure Database Tables and Connections

One potential approach to the database is with a known Measure ID and a known Delivery ID. In this case, it is a relatively straightforward process to trace all known applicable energy impacts, impact load shapes, technologies, technology costs, EULs and NTG values. Life-cycle costs and benefits can be calculated based on these values,

summed by number of installations, organized by program type, and manipulated in any way that is useful to the user.

Measure Definition Summary

The following table summarizes the entries that would be required for a relatively simple new measure. Shaded entries are references to other records already in the database and don't require any new information.

Technology Table Entry:

1. Technology ID (Name)
2. Description
3. Classification
4. EUL ID
5. Delivery ID

Cost Table Entry:

6. Cost ID (Name)
7. Technology ID
8. Delivery ID
9. Total Material Cost
10. Total Labor Cost

Measure Table Entry:

11. Measure ID (Name)
12. Measure Description
13. Base Technology ID
14. Measure Technology ID
15. NTG ID

Energy Impact Table Entry:

16. Energy Impact ID (Name)
17. kWh/unit
18. kW/unit
19. therm/unit
20. Energy Impact Loadshape ID
21. Applicability

Tracking Data

As mentioned above, the common naming conventions and database structure described in this document are intended to support an updated format for the IOU tracking data submittals. An overview of the tracking data format is presented here. The new tracking data format is not yet formalized, but is being developed with these main points:

- All tracking data will refer to a DEER or a Non-DEER measure definition that is in the CPUC database of measures. This requires that all Non-DEER measures be approved and added to the CUPC database of measures.
- The measure definition in the CPUC database may or may not include all cost and energy impact data for a particular measure, but will always include standard descriptive information along with links to approved NTG, EUL, RUL values and links to documentation.
- Each tracking record will contain standard fields that identify the measure as well as any appropriate applicability fields (See Table 3 for applicability info). The applicability fields are used to link the measure's energy impact to the tracking record.
- Energy impact and cost data that override the measure definition values may be included in the tracking data.
- Tracking data will consist of a number of linked tables that segregate data by security levels and intended audience.

Separate tables will contain program-specific, measure-specific and site-specific data. Figure 4 shows the main contents of the core tracking data file and the linked data files.

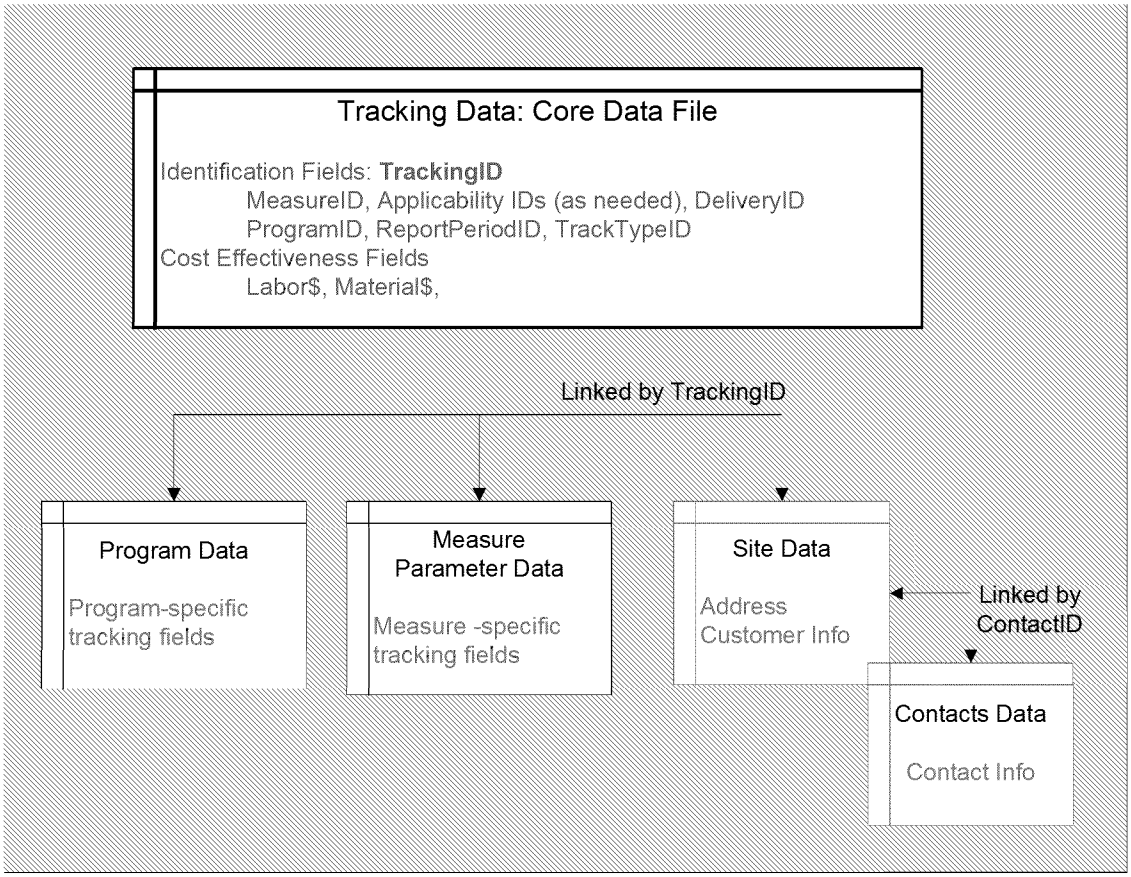

Figure 4 Tracking Data Files

Tracking Core Data File Contents

The Tracking Core Data file contains all the information required for energy and cost calculations. For the most common case of energy efficiency measures included in the DEER database, the Core Data file will supply all the information required (such as building type, measure, location, etc) to select a installation-specific Impact record, which has approved energy and cost savings values. The Tracking Core Data file will also contain the Tracking ID, a integer which is unique for each tracking record and utility, and is used to link Measure Parameter data to a specific site and Core Tracking record. Each row in the Tracking Core Data file is unique tracking record.

For Custom Measures only, the Tracking Core Data file will also contain energy and demand savings values, along with costs. For measures in the DEER database, energy, demand, and costs values can be supplied, but will not be used in the approved calculation of cost-effectiveness.

A table of primary values in the Tracking Core Data file follows.

Table 4. Main Core Tracking Data Fields

Record Fields	Data Type	Description	Example
IOU ID	text	Unique text identifies utility	PGE
TrackingID	integer	Unique integer per IOU for each Core Tracking record (row).	4567
ClaimsTypeID	Integer	From Standard Definition Table for Claims Types	1
ProgramID	text	From Standard Definition Table for Programs	PGE2500
ProjectID	text	Identifies multiple measures installed together at a site	ES-001
ReportPeriod	text	Monthly or Quarterly	Q32009
MeasureID	text	From CPUC Measure database	
BuildingTypeID	text	From Applicability Tables	SFM
BuildingVintageID	text	From Applicability Tables	75
LocationID	Integer	From Applicability Tables	94129
DeliveryTypeID	Text	From Standard Defintions	downstream
NumberUnits	integer	Number of measure normalizing units (i.e, # of CFLs for CFL measure)	34
AnnualEnergySavings	float	Required for Custom Measures, optional for DEER database measures (kwh per unit)	4502.3
PeakDemandSavings	float	Required for Custom Measures, optional for DEER database measures (kilowatt per unit)	120.1
Measure Cost Fields	float	Required for Custom Measures, optional for DEER database measures (dollar per unit)	1435.22