Algorithms, Data & Analytics Methodology

The Construction Labor Market Analyzer® (CLMA®) is designed to provide detailed labor market analytics and intelligence 3-5 years out for construction industry project stakeholders for industrial and non-industrial (commercial, infrastructure, civil, etc.) project activity within the United States.

Origination of CLMA® Project Data

The CLMA® project database is very robust and is derived from the following 4 sources…

- **Owners** – The most highly valued data collected by the CLMA is directly from owners who then manage the project throughout its lifecycle. This source of data ranges from very early project planning phases through projects completed. (Primarily industrial projects)
- **Labor Providers** – Contractors provide project information when bidding/estimating and when requested by owners. Project data provided by contractors is not added to the aggregate database unless approved by the owner or verified by the CLMA team. This protocol prevents project data duplication.
- **Dodge Data & Analytics** – The primary source of non-industrial data in the database is Dodge Data & Analytics. This data is imported every 90 days and converted to skilled labor headcount using the PLF® and made available for aggregation along with industrial data. For 40+ years, Dodge forecasts, prepared by some of the industry's most respected economists, have served the industry's strategic, market planning, and analytic needs with comprehensive projections of building activity for virtually all geographies and construction categories.
- **CIR Team Research** – To ensure completeness of data, the CLMA team is constantly scanning the construction market for projects where the owner company is not yet participating. The projects are put into the CLMA database and then, as those owners begin participating and inputting their projects, the CLMA-researched projects are moved to the owners account, or removed, to prevent project duplication.

The CLMA® does not collect or report on residential construction project activity.

To ensure data reliability, all projects input into the CLMA® are first processed and scored through an automated de-duplication, followed by a manual review process to ensure each project in the CLMA® database is represented only once. Additionally, projects are reviewed and updated on a minimum 90-day rotation, by the owner or the CLMA®, to ensure accuracy.

Overall, the CLMA® database represents a critical mass of construction market spending; however, the exact percentage of regional markets varies depending on the location. The completeness of

the CLMA® database is continuously benchmarked against the most reliable government put-in-place non-residential construction spending estimates.

Treatment of Project Data

Regardless of the origination of project data into the CLMA® database, each project is processed through the proprietary Project Labor Forecaster (PLF®), which simplifies the task of translating project spending into construction craft labor demand profiles for projects which do not yet have detailed estimates.

The purpose of the PLF® is to assist the CLMA® in capturing project data very early the project conception and planning process and removes a significant amount of the work typically required when setting up a new project for which minimal information is known. The early capture of project data is how the CLMA® more effectively projects demand 3-5 years out.

The PLF® includes a combination of hundreds of algorithm configurations for capital and maintenance/turnaround/outage projects which convert project budgets (TIC) into craft labor hours and headcount estimates. After the project is created and the PLF® generates the project profile, the project labor can be adjusted by the CLMA® User, if desired, through 2 specific approaches to achieve more refined outputs.

- The PLF® tool enables full capacity to change every aspect of the project profile
  - ✓ Add/remove craft disciplines
  - ✓ Adjust craft labor curves
  - ✓ Adjust when craft arrive on and depart the project
  - ✓ Adjust labor distribution percentages
  - ✓ Assign craft labor to off-site construction locations
  - ✓ Adjust hours, days and shifts
  - ✓ Adjust the labor percent of Total Installed Cost (TIC)
  - ✓ Adjust wage rates based on BLS wages or customized wage tables
- The Excel spreadsheet uploader enables a labor profile to be assigned to the project based on setup work already completed in other applications (E.g., Primavera)

No adjustment to the project parameters and/or labor profiles is required if the PLF® produces a craft demand profile that is within an acceptable margin of error. The margin of error will vary based on the industry type selected and the breakdown of the budget categories. This is discussed in more detail below.

Development of CLMA® Algorithm Configurations

The proprietary algorithm configurations employed by the PLF® within the CLMA® were developed over a number of years, through a validated and consistently applied methodology that includes the following steps…

1. Knowledgeable, experienced cost engineers with relevant construction sector experience were engaged to develop initial algorithm configurations based on certain project information usually known or easily estimated early on during a project's planning phase.
2. Key pieces of data were determined to be essential for the algorithms to calculate efficiently and effectively…
    a. Capital vs. Maintenance/Turnaround/Outage spending
    b. Type of project (E.g., power generation, manufacturing, refinery, hospital, etc.)
    c. Total installed cost of the project
    d. Anticipated project construction start/end dates
    e. Project phase (E.g., FEL)
    f. Zip code for project
    g. Probability of project commencement
3. Based on these data criteria and the engineers' understanding of related projects within their respective industry qualifications, initial algorithm configurations were validated internally to assure correct craft mix and profile.
4. The algorithm configurations, processes and outputs were then validated against completed and/or ongoing projects provided by owners and contractors where the exact specifications were known. This process helped determine if the margin of error was within an acceptable tolerance.
5. When needed, adjustments were made to the algorithm configurations.
6. Re-validation of the outputs were completed when necessary.
7. Final validated algorithms were then deployed to the CLMA®

It is important to note that the current algorithm configurations within the CLMA® are generic and designed to broadly apply to most construction projects. Generic algorithms are used because typically, no two projects are the same and therefore, it would be difficult, if not impossible to create, test and deploy an algorithm for every conceivable project possibility. A CLMA® User's capacity to easily make project adjustments using the PLF® tools, as discussed earlier in this document, offset the need to deploy countless additional configurations.

The approach used by the CLMA® provides highly effective market intelligence outputs when applied to the trillions of dollars of construction spending represented within the CLMA® database. We have consistently validated this assumption through our economic analysis, as well as feedback from the CLMA® User network.

The CLMA® also engages in a continuous improvement effort to update and adjust the algorithm configurations whenever verifiable information is received from the User network. Additionally, CLMA® Users may request very specific, customized algorithms to assist in project setup and management processes with the CLMA®.

Algorithm & Data Methodology

Industrial Algorithm Configurations	Non-Industrial Algorithm Configurations
Chemical Facility	Airport Runways & Taxiways
Chemical Facility (Ethylene Cracker)	Auto Sales & Service Facilities
Electric Power Generation (2x1 Gas-Fired Combined Cycle Unit)	Bridge (Multi-Span)
Electric Power Generation (Combined Cycle Major Outage)	Bridge (Single Span)
Electric Power Generation (Fossil)	Capitols / Court Houses / City Halls
Electric Power Generation (Fossil) (Environmental)	Dormitories (1-4 Floors)
Electric Power Generation (Fossil) (New Generation)	Funeral Homes
Electric Power Generation (General)	Hospital (5+ Floors)
Electric Power Generation (Hydro)	Hotels/Motels (1-4 Floors)
Electric Power Generation (Large Drum Boiler Outage)	Landscaping
Electric Power Generation (Large Drum Boiler Turbine Generator Outage)	Lighting - Athletic Fields
Electric Power Generation (Large Supercritical Boiler Generator Outage)	Lighting - Roadways & Airports
Electric Power Generation (Large Turbine-Generator Outage)	Lodges & Clubs
Electric Power Generation (Nuclear)	Medical Office Building (1-4 Floors with TI)
Electric Power Generation (Solar)	Medical Office Building (1-4 Floors without TI)
Electric Power Generation (Supercritical Boiler Outage)	Medical Office Building (TI only)
Electric Power Generation (Wind)	Mobile Home Parks
Electric Power Generation 2x1 Gas-Fired Combined Cycle Unit	Nursing Homes
Electric Power Transmission, Control, and Distribution	Office Building HR (5+ Floors, TI only)
Engineered Scaffolding (120+ feet)	Office Building HR (5+ Floors, with 80% Pre-Lease TI)
Manufacturing - Apparel / Clothing	Office Building HR (5+ Floors, without TI)
Manufacturing - Beverage Products	Office Building LR (1-4 Floors, TI only)
Manufacturing - Computer and Electronic Products	Office Building LR (1-4 Floors, with TI)
Manufacturing - Electrical Equipment, Appliances, and Components	Office Building LR (1-4 Floors, without TI)
Manufacturing - Fabricated Metal Products	Parking Lots (Surface)
Manufacturing - Food	Parking Structure
Manufacturing - Furniture and Related Products	Parks & Playgrounds
Manufacturing - Leather and Allied Products	Railroads
Manufacturing - Machinery and Equipment	Retail (TI only)
Manufacturing - Medical Devices	Retail (without TI)
Manufacturing - Miscellaneous	Roadways (DOT Resurfacing)
Manufacturing - Nonmetallic Mineral Products	Roadways (DOT Widening)
Manufacturing - Paper	Roadways (DOT with Bridges)
Manufacturing - Petroleum and Coal Products	Roadways (Municipal)
Manufacturing - Pharmaceutical Products	Roadways (Signs & Guardrails)
Manufacturing - Plastics and Rubber Products	Schools
Manufacturing - Primary Metals	Sewage Treatment Facility (City)
Manufacturing - Tobacco Products	Sewage Treatment Facility (Municipal)
Manufacturing - Transportation Equipment	Sewer Line Replacement / Upgrade
Manufacturing - Wood Products	Shopping Centers (with TI)
Maritime / Shipping	Shopping Centers (without TI)
Natural Gas (Down-Stream) Refinery, Terminal	Stadiums & Sport Arenas
Natural Gas (Mid-Stream) Compressor Stations/Pads	Swimming Pools
Natural Gas (Mid-Stream) Drilling, Fracking	Tanks (Oil / Other)
Natural Gas (Mid-Stream) Transmission & Distribution	Towers (Radio/TV)
Natural Gas (Up-Stream) Wellpads, Water Impoundment, Roads	Transit Terminals
Other / Misc	Transmission Lines (Communications)
Pipeline - Distribution (Down-Stream)	Transmission Lines (Power)
Pipeline - Transmission & Distribution	Warehouse Distribution Facility (TI only)
Pipeline - Transmission (Mid-Stream)	Warehouse Distribution Facility (without TI)
Printing and Related Support Activities	Water Line Replacement / Upgrade
Process (Other)	Water Treatment Facility
Refinery	Water, Sewage and Other Systems
Refinery (Major Turnaround)	Worship Facilities
Refinery (Outage / Non-Major Turnaround)	
Shipbuilding	
Steam and Air-Conditioning Supply	
Textile Mills	
Textile Product Mills	

Specific Algorithm Considerations

One of the challenging project inputs upon which the PLF® relies and for which clarification is warranted, is the assumption used for estimating of the percentage of the total installed project cost that will be expended on direct construction craft wages and on craft labor wage rates.

Using traditional Work Breakdown Structures (WBS), project costs can generally be broken into the following general categories:

1. Project Management (2%)
2. Engineering (15%)
3. Owner Supplied Materials (40%) (Equipment and Materials purchased directly by the owner)
4. Construction (40%)
5. Startup (3%)

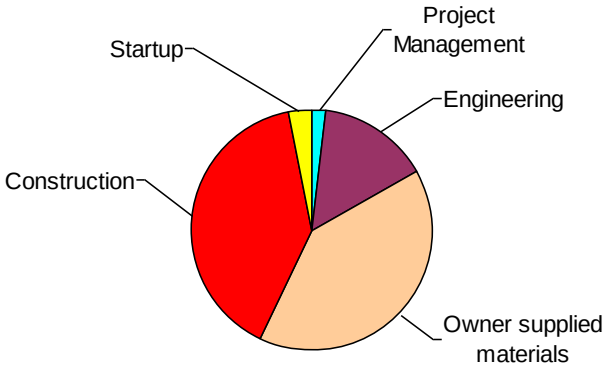

Chart 1: Estimated allocation of project costs.

Note that these percentages are illustrative only. While the allocation of project budgets vary by the nature of the project and the scope of the work to be performed, budgets can generally be allocated as shown in Chart 1.

Using this budget allocation, the construction cost category includes more than just direct construction craft labor. Typical construction cost components include:

1. Direct construction labor costs (craft wages which appear on the workers W2 forms)
2. Construction labor adds (E.g. Workers' Comp Insurance, Health & Welfare Benefits)
3. Construction tool and equipment costs
4. Contractor Supplied Materials (Equipment and materials purchased directly by the construction contractor)
5. Construction services costs (E.g. temporary facilities, gases, electrical service, water)
6. Construction supervision and management costs
7. Contractor overhead and profit

As with the overall project budgets, the allocation of these costs vary by the nature of the work and specific contractor performing the work. Assuming that total construction costs will consume about 40% of the total installed cost of the project (as shown in Chart 1 above), a typical allocation of the WBS elements related to construction costs can be allocated further as shown in Chart 2:

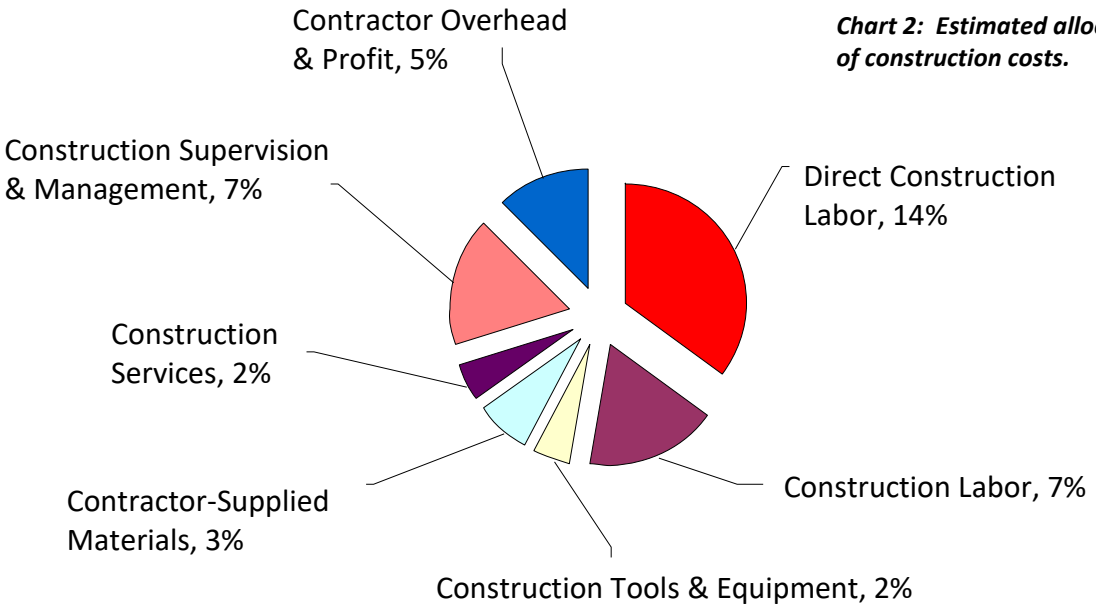

Chart 2: Estimated allocation of construction costs.

The CLMA® is pre-populated with craft labor wage rates supplied by the U.S. Department of Labor Bureau of Labor Statistics (BLS) for each state. These rates generally reflect 90th Percentile unburdened W-2 wage rates and may or may not be applicable to each project. In addition to the bare wage rates, the CLMA® provides factors for burdening the rates, as well as General Services Administration (GSA) per diem rates.

Using a project example which includes the BLS wage rates, the labor percent of the TIC is presumed to be 14%–20% (see Chart 2 above) with respect to the project cost allocated to direct construction labor. Conversely, if fully burdened craft labor wage rates were used to reflect the total cost of construction labor, the labor percent of the TIC would be presumed to be 30%–40% with respect to the project cost allocated to direct construction labor.

Depending on the nature of project and the scope of the work, it is recommended that the direct construction labor cost percentage appropriate the specific project is used. All wage rates supplied by the CLMA® may also be replaced or augmented by a User's specific wage data. The percentages shown above are for illustration only and do not represent recommended values for any specific project.

Craft, Engineering & Project Management Disciplines

Craft Disciplines	Engineering & PM Disciplines
Boilermaker	Construction Manager
Boilermaker Welder	Contract Administrator
Boilermaker Welder (Mig)	Designers (Cad)
Boilermaker Welder (Tig)	Engineer (Civil)
Bricklayer / Blockmason	Engineer (Cost & Schedule)
Carpenter (All Unspecified)	Engineer (Field)
Carpenter (Concrete Form / Rough)	Engineer (Mechanical)
Carpenter (Finishing)	Engineer (Power & Control)
Carpenter (Floor Covering Installer)	Engineer (Process)
Carpenter (Interior Systems)	Engineer (Resident)
Carpenter (Lather)	Engineer (Safety)
Carpenter (Pile Driver / Operator)	Engineer (Structural)
Carpenter (Scaffold Builder)	Engineer (Utility Systems)
Carpenter (Welder)	Engineering Project Manager
Concrete Finisher / Cement Mason	Estimator
Craft Helper	Field Procurement Representative
Electrician	Finance/Accounting
Elevator Installer and Repairer	Inspector / Quality Assurance / Quality Control
Firewatch	Lean Construction or Productivity Improvement Resource
Floorhand	Maintenance / Turnaround / Outage Manager
Glazier	Safety Specialist / Representative
HVAC/Refrigeration Mechanic	Specialists for Craft Training & Development
Instrumentation Technician	Superintendent
Insulator	Tools and Equipment Manager
Ironworker (Reinforcing)	
Ironworker / Welder (Structural)	
Laborer	
Lineman	
Machinist	
Millwright	
Millwright (Welder)	
Motorman	
Operator (Driller and Blaster)	
Operator (Heavy Crane)	
Operator (Heavy Equipment Mechanic)	
Operator (Heavy Equipment)	
Operator (Material Handler)	
Operator (Rotary Driller Oil and Gas)	
Operator (Truck Driver)	
Other	
Painter	
Pipefitter	
Pipefitter (Sprinkler Systems)	
Pipefitter / Combo Welder	
Pipelayer (Under Ground)	
Plasterer / Stucco Mason	
Plumber	
Rigger / Signalperson	
Roofer	
Roughneck	
Sheet Metal Worker	
Tile / Marble Setter	
Tool Drag	
Welder (Specialty)	
Welder (Underwater)	

CLMA® Labor Supply

Supply (E.g., workers in the market) data is derived from the following source(s):

- ***Bureau of Labor Statistics (BLS)*** – This data represents non-residential craft disciplines that are most likely employed or able to be employed on commercial, civil, transportation and/or industrial projects, depending on skill level. BLS does not provide craft headcount data based on zip code; therefore, the CLMA® distributes the total BLS headcount for each state based on zip code population density.

- ***Adjusted Bureau of Labor Statistics (ABLS)*** – This data represents the BLS craft disciplines that are most likely employed or able to be employed on more complex industrial projects (E.g., refinery, chemical and process plants) based on CLMA® industrial factors.

- ***Market Supply*** – This data represents craft disciplines that have been provide directly from contractor, union, labor broker and self-performing owner payroll and/or HR records.

- ***Pipeline Supply*** – This data represents craft disciplines specific to the pipeline industry and related projects.

CLMA® Labor Demand

As noted earlier, CLMA® demand data is derived from actual non-residential projects submitted into the CLMA® database by owners, contractors, Dodge Data & Analytics, and robust internal market research methods. Regardless of the source, all projects are uploaded in the same process, which creates individual labor profiles for each specific project and translates them into headcount and hours on a project-by-project basis. Data outputs within the CLMA® Market Intelligence tools and/or for CIR reports are based on carefully aggregated data for the requested region, timeframe and other factors. Additionally, for every project uploaded, there is also a deduplication process which examines specific criteria (electronically and manually) to identify and resolve any potential duplicates not already addressed when uploading project information.

The CLMA® database contains a significant and critical mass of market data for projecting skilled headcount demand over time. It is important to note, however, that while the CLMA® database is growing rapidly and capturing long-term data, project data 4-5 years out tends to be very challenging to acquire. The CLMA® database is dynamic and therefore labor curves are continuously advancing. The scarcity of data 3-5 years out should not be immediately interpreted as a market decline.

CLMA® Full Market Demand

The CLMA® Market Intelligence reports are derived from the actual non-residential construction projects in the database. Because the CLMA® uses actual construction information on a project-by-project basis, there is a high degree of granularity and confidence in the report outputs.

However, no project database, including the CLMA®, contains 100% of the construction spending actually occurring in the marketplace. Therefore, to assist our clients in understanding the entire non-residential construction market, CLMA® data is adjusted to represent our understanding of the full market. The term "Full Market CLMA® Demand" is an estimated percentage increase intended to reflect 100% of the spending and craft demand for the selected radius, region or state. These percentage adjustments are predicated on a detailed analysis of the CLMA® database versus known government construction spending data and/or based on a specific macro- and micro-economic analysis for a particular state or region.

CLMA® Econometric Forecasts

The CLMA® Market Intelligence projections rely primarily on proprietary project data from the CLMA® database, originating as indicated earlier in this document. The CLMA® translates individual construction projects into the hours and headcount demand for the skilled construction trades.

The use of project data provides extraordinary detail and great insight into skilled labor needs, but it is not perfect. The difficulty is that managers and corporate decision makers can see only so far into the future, so the outlook gets hazy toward the end of a five-year horizon. The result may be what appears as a "sudden" drop in the project queue during the last few forecast quarters, simultaneously reducing skilled trades demand. Because these declines defy what is expected to occur, the CLMA® approach may be to augment the final few forecast quarters using economic modeling. This approach is consistent with the CLMA® wage escalation modeling, which typically use 3 or more years of project data, augmented by 2 or more years (if required) of modeled data.

In each case, the models for the trades combine state economic variables, forecasts for the U.S. economy, and supply/demand equations for each occupation. We invoke the models, solving them over the last few quarters, as a substitute for project-driven demand. In some instances, select industrial trades – boilermaker, industrial carpenter, electrician, instrument fitter, insulation worker, ironworker (reinforcing), ironworker (structural), millwright, heavy crane operator, heavy equipment operator, pipefitter, pipefitter-welder, rigger, and sheet metal worker – are used in the models to understand the specific demand needs for the more highly complex industrial market.

It's important to note that generally forecasts become less reliable the further they reach into the future; therefore, careful attention and validation is essential in any longer-term projection.

Wage Data

The U.S. Department of Labor Bureau of Labor Statistics (BLS) produces Occupational Employment Statistics nationally, by state and metropolitan statistical area including 10th, 25th, Mean, Median, 75th, and 90th percentiles relative to the standard error for multiple craft disciplines (http://www.bls.gov/oes/current/oessrcst.htm). CIR extracts this data by state and maps the correct Standard Occupation Code (SOC) for each craft to its respective CLMA® craft code. The BLS wage data typically used in the PLF® and/or CLMA® reports is the 90th percentile for each occupational category, as it corresponds more closely to the typical wage for an industrial and heavy

civil craft worker. For areas or crafts that do not have a rate specified by the Bureau of Labor Statistics, a comparable region and/or craft was used to populate the wages for these craft by state.

BLS wages are provided in unburdened and fully burdened formats. The fully burdened formats include statutory benefits, company-specific benefits, project-specific benefits, and GSA per diem rates.

NOTE: CIR has not independently validated that these wages are 100% reflective of marketplace wages for the selected discipline and/or region. CIR uses these wages ONLY to create demand projections and to project escalation and de-escalation percentages. The User is expected to use their own sound judgement and knowledge of the marketplace when applying these wages.)

Burden Rates

Typical burden rates for the construction industry are produced from three primary categories: statutory benefits, company specific-benefits, and project-specific benefits. Those categories each have multiple factors that make up their entirety and the following ranges and examples are typical:

Benefit Category	Labor Burden Components	Labor Burden Ranges	Average Burden Rate Applied*
Statutory	Social Security Tax	7.65%	7.65%
	Unemployment Insurance	1% — 4%	2.54%
	Workers Compensation Insurance	3% — 10%	4.84%
Company Specific	Additional Insurance Policies	4% — 10%	6.96%
	Holiday, Vacation, and Sick Benefits	0% — 9%	4.93%
	Employee Insurance	0% — 12%	8.86%
	Retirement Plans	0% — 10%	6.28%
	Employee Stock Ownership Program	0% — 6%	2.0%
Project Specific	Bonuses	0% — 2%	0.86%
	Safety Incentives	0% — 1%	0.5%
Total		**15.65%—71.65%**	**45.42%**
**This is illustrative. When requested, burden rates applied are based on client's inputs.*			

The Bureau of Labor Statistics Table 7, Private Industry by Region (http://www.bls.gov/news.release/ecec.t07.htm) summarizes the labor burden components by regional information. Using the regional information comparatively to the construction industry (Table 6 http://www.bls.gov/news.release/ecec.t06.htm) allowed CIR to develop statewide burden rates. The statewide data is refined to incorporate the average "new company" worker's compensation insurance and unemployment insurance to complete a state-by-state individual burden rate. The final burden rate for specific crafts by state contained other factors including labor supply/demand and industry knowledge—this enabled CLMA® to produce a burdened BLS wage rate that does not include per diem.

Per Diem Data

Per Diem rates primarily differ by location. The per diem rates displayed in the CLMA® Manage Wages tool are derived from the U.S. General Services Administration (GSA). CLMA® begins with the GSA allowable per diem information based upon a non-metro and metropolitan statistical area (MSA) basis (http://www.gsa.gov/portal/category/100120. GSA reports two unique per diem rates, one for lodging and one for meals & incidental expenses (M&IE). For each state, the CLMA®-provided per diem is the average of these two statewide rates, which is a closer (but imperfect) approximation of market per diem rates. To determine a statewide average, the rates for all MSA's within a particular state are averaged together, without regard for seasonal differences or changing schedules based on fiscal years. These rates are provided for reference and directional understanding purposes as averages for each of the 50 states, the District of Columbia, and for the entire United States.

NOTE: CIR has not independently validated that these per diems are 100% reflective of marketplace per diems for the selected discipline and/or region. User is expected to use their own sound judgement and knowledge of the marketplace when applying these per diems.

References

- Bureau of Labor Statistics, U.S. Department of Labor 2015 Employer Costs for Employee Compensation (Economic News Release, June) – See Tables 6 and 7 http://www.bls.gov/news.release/ecec.toc.htm
- Bureau of Labor Statistics, U.S. Department of Labor. 2016. May 2015 State Occupational Employment and Wage Statistics – See http://www.bls.gov/oes/current/oessrcst.htm
- Congressional Budget Office 2016. The Budget and Economic Outlook: 2016-2025. The CBO provides supplementary quarterly data from its first quarter forecast – See http://www.cbo.gov/publication/49892
- Energy information Administration, U.S. Department of Energy 2016. Short Term Energy Outlook (Sept) – See http://www.eia.gov/forecasts/steo/
- Economic Research, Federal Reserve Bank of Saint Louis 2016 FRED Economic Data. Data series for download and analysis – See http://research.stlouisfed.org/fred2/
- International Monetary Fund 2016 World Economic Outlook: Subdued Demand, Symptoms and Remedies (October 2016). See http://www.imf.org/external/pubs/ft/weo/2016/02/pdf/c1.pdf

CIR Confidentiality & Anti-Trust Commitment

We treat all information received within the CLMA® database from client sources as proprietary and confidential, and we aggressively work to ensure that data is never shared or revealed, except in blinded, aggregated chart, tabular and report formats, regardless of the type of data or the format in which it is provided. In addition, our report outputs conform to Federal anti-trust regulations to help prevent CLMA®-generated information from being used for inappropriate purposes. More information on CIR security and methodology is available at www.myCLMA.com.