IGATE-E CHP Deployment Tool

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Overview

Project Title: IGATE-E CHP Deployment Tool

Timeline:

Project Start Date: 10/1/2017

Budget Period End Date: 03/31/2019

Project End Date: 9/30/2020

Barriers and Challenges:

- Critical infrastructure facilities require enhanced energy resilience – improving the understanding of deployable CHP helps planning efforts for increased resilience at state, local, and utility levels

AMO MYPP Connection:

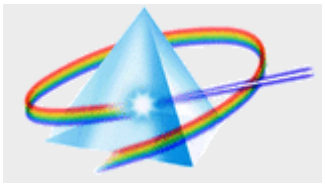
- MYPP Target 13.1 Achieve a ten-fold cumulative increase in direct CHP technical support activities to potential commercial, institutional, and industrial end-users.
- MYPP Target 13.2 Advance the development of cost-effective CHP systems that are responsive to site demands as well as grid requirements.

Project Budget and Costs:

Budget	DOE Share
Overall Budget	$425,000
Approved Budget (BP-1)	$250,000
Costs as of 3/31/19	$175,000

Project Team and Roles:

- **ORNL:** Lead, data collection, programming
- **ICF:** Program coordination, tool and report development, partner engagement and outreach
- **Entropy Research:** Technical guidance, oversight, and tool validation
- **Exergy Partners:** Technical guidance, oversight, and tool validation



IGATE-E CHP Deployment Tool

- **Support for AMO Goals:**
  - Developing one quarter of CHP technical potential would save 1 quadrillion BTUs (Quad) of energy and would save energy users $10 Billion a year compared to current energy use.
  - Provides online tools and decision support toolkits to aid in information dissemination and technical analysis

- **Problem Statement:**
  - A major barrier to distributed generation and CHP utilization in the U.S. industry is matching thermal loads with local and regional electrical loads. By matching industry thermal requirements and electrical requirements on a geographical basis (zip code, county, state, and region), it is possible to have plants provide DG for local and regional grid utilization or waste heat to a nearby plant

- **Project Objective:** Develop the Industrial Geospatial Analysis Tool for Energy Evaluations (IGATE-E) CHP tool. The IGATE-E CHP tool will address the following:
  - Evaluate the CHP feasibility at the manufacturing plant level while projecting the CHP penetration potential and energy impacts across the manufacturing sector in the US
    - Expand the IGATE-E CHP beyond manufacturing to commercial buildings and facilities
  - Assist CHP Technical Assistance Partnership (TAPs) in Qualification Screening (QS) and increase the deployment of CHP systems

IGATE-E CHP Deployment Tool

- **Project Objective:** Develop the Industrial Geospatial Analysis Tool for Energy Evaluations (IGATE-E) CHP tool
  - Create and validate a searchable repository of data for CHP deployment
  - Roll up all CHP capabilities within the industrial and commercial sectors and 10 Regional CHP TAPs to facilitate the faster deployment
  - Support DOE decision making process by quickly accessing the CHP potential data at zip code, county, congressional district, utility regions and city levels

IGATE-E CHP Deployment Tool

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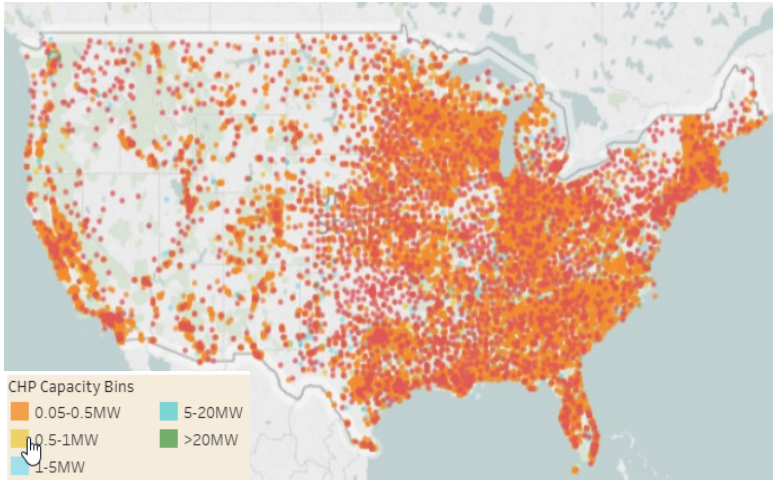
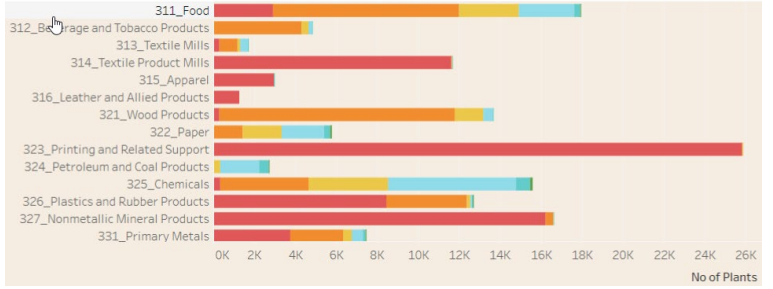
Technical Innovation

IGATE-E is a unique tool that utilizes statistical and engineering models to evaluate CHP potential/capabilities across manufacturing sectors at the ZIP code level using a bottom-up approach.

The tool:

- Utilizes multiple publicly available and proprietary datasets[1]
- Evaluates CHP feasibility (using statistical and engineering models) at the manufacturing plant level
- Projects the CHP penetration potential and the energy impacts across the U.S. manufacturing sector.
- Has ability to aggregate analysis results on the zip code, state, and national level by industrial subsector (NAICS/SIC).
- Has an easy to use interface with rich visualization interface
- Support DOE decision making process by quickly accessing the CHP potential data at zip code, county, congressional district, utility regions and city levels



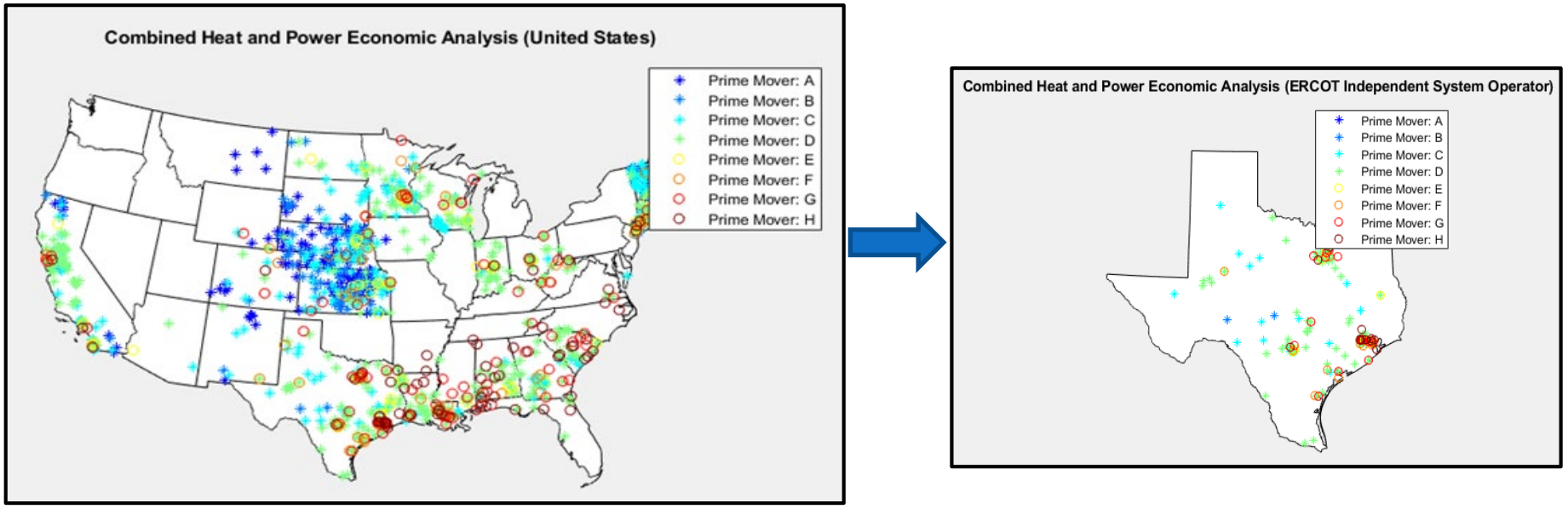


Estimated CHP capacity and number of plants by Industry

[1]Including: Energy Information Agency - Manufacturing Energy Consumption Survey (EIA-MECS); Industrial Assessment Center (IAC); and Manufacturer's News Inc.(MNI) database

Methodology: Estimating CHP Potential

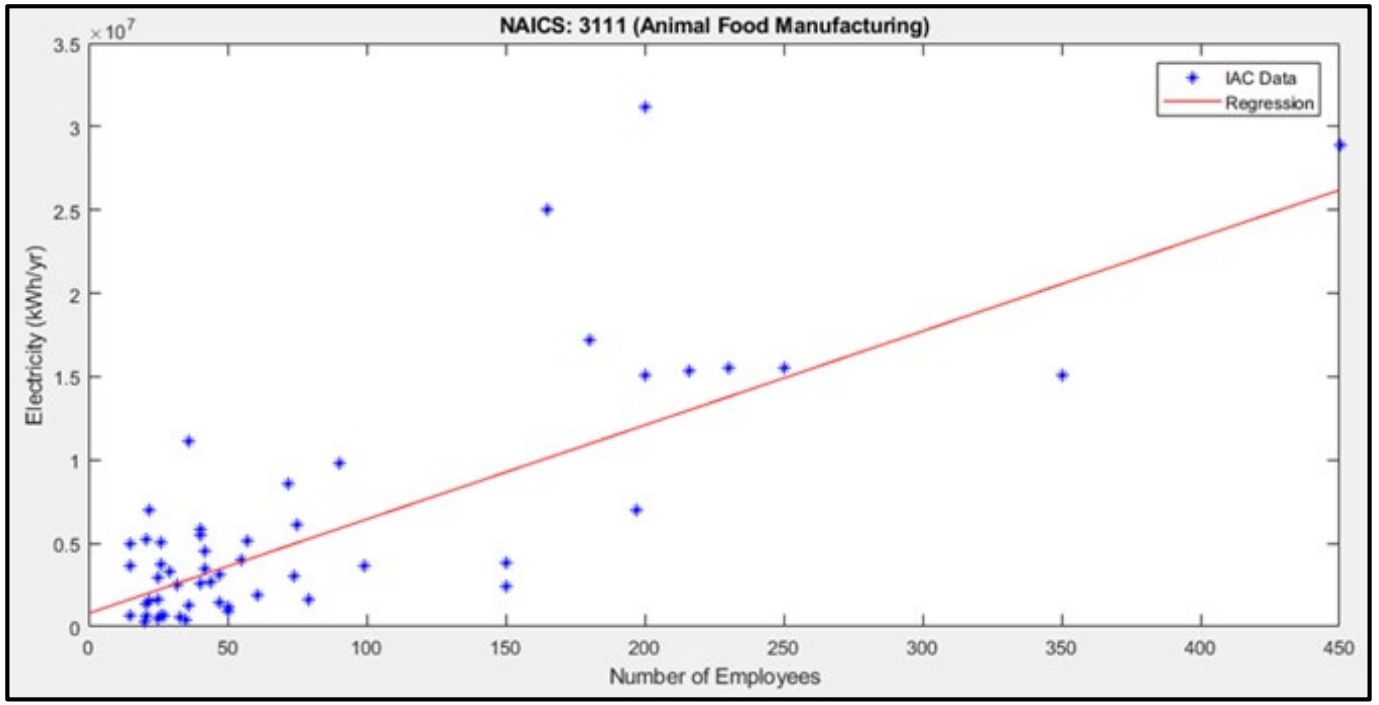
- To evaluate a plant's CHP potential, an estimates of its thermal demand is made based on industry specific power to heat ratios from "CHP Technical Potential in the US"
- Next, CHP potential is evaluated at the plant-level using the methodology developed by the CHP Technical Assistance Partnerships (CHP TAPs)
  - An appropriate CHP system size and type is identified (based on a plant's thermal needs) and a simple payback analysis is conducted
  - Cost and performance characteristics of various CHP systems are taken from the EPA's Catalog of CHP Technologies, while electricity and gas price information is collected from NREL's OpenEI and the EIA



Because plants are already geocoded, breaking out results into specific regions (like ERCOT) only requires a shape file

Methodology: Regression Analysis to Estimate Facility-level Energy Consumption

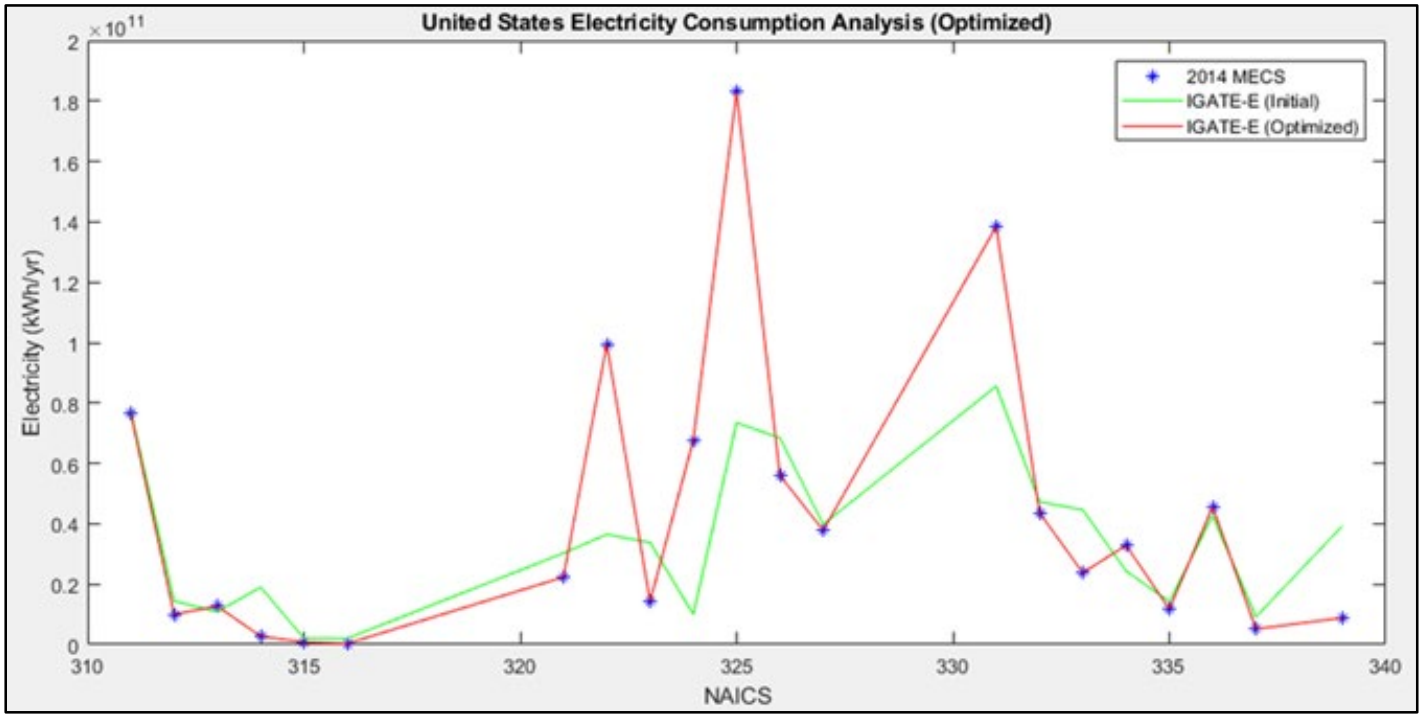
- Electricity and natural gas consumptions are estimated on a facility-level using regressions of energy consumption vs. number of employees
- Regressions are developed by industry (i.e. 3- and 4-digit SIC/NAICS code) using DOE's Industrial Assessment Centers (IAC) database (public)
  - Note: IAC database only contains data for small- and medium-sized plants (energy bills between $100,000-2,500,000/yr), limiting its relevancy in industries where large plants play a major role



Basic premise of IGATE-E: Manufacturing plants in similar industries will use similar processes and therefore have similar energy intensities (i.e. energy usage/product produced)

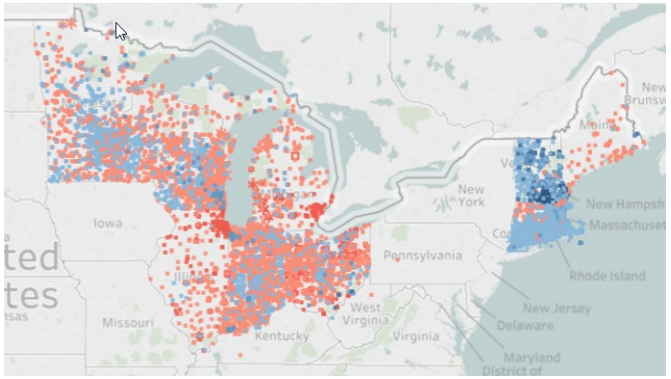
Methodology: Validating Manufacturing Energy Consumption Estimates

- Energy consumption is estimated for each plant using employee information from the MNI EZ Select database of ~294,000 manufacturing plants
- IGATE-E's initial consumption estimates differ from the EIA MECS 2014:
  - NAICS 322: Paper, 324: Petroleum and Coal Products, 325: Chemicals, and 331: Primary Metals were all significantly underestimated (according to MECS, have highest kWh/establishment)
    - Lack of regression data for large manufacturing plants may be limiting IGATE-E's accuracy here
  - For industries where energy consumption is significantly overestimated, discrepancies in the number of establishments considered by MECS compared to IGATE-E may be the primary issue.
- IGATE-E optimizes initial energy consumption estimates by industry (i.e. 3-digit NAICS) and census region to match the EIA MECS 2014

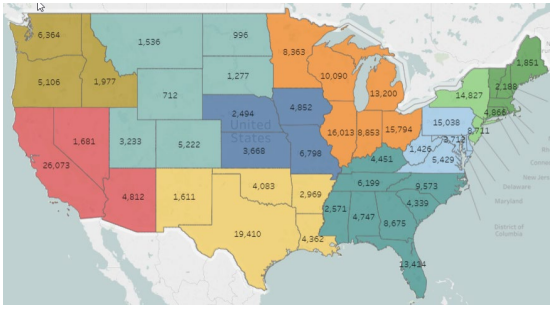


CHP TAPs Dashboard Targeted Screening

- The CHP Technical Assistance Partnership (TAPs) dashboard would allow TAPs to:
  - Quickly view the estimated CHP capacity for particular plant or industry sector in their region before visiting the plant
  - Aggregate the statewide or whole region CHP Potential
  - Visualize the current CHP installations and capacities
  - Tabulate the industry sector-wise capacities by capacity size bins
  - Search and track sites under development*
  - Track CHP TAP technical assistance activities*
  - Analyze commercial building types*



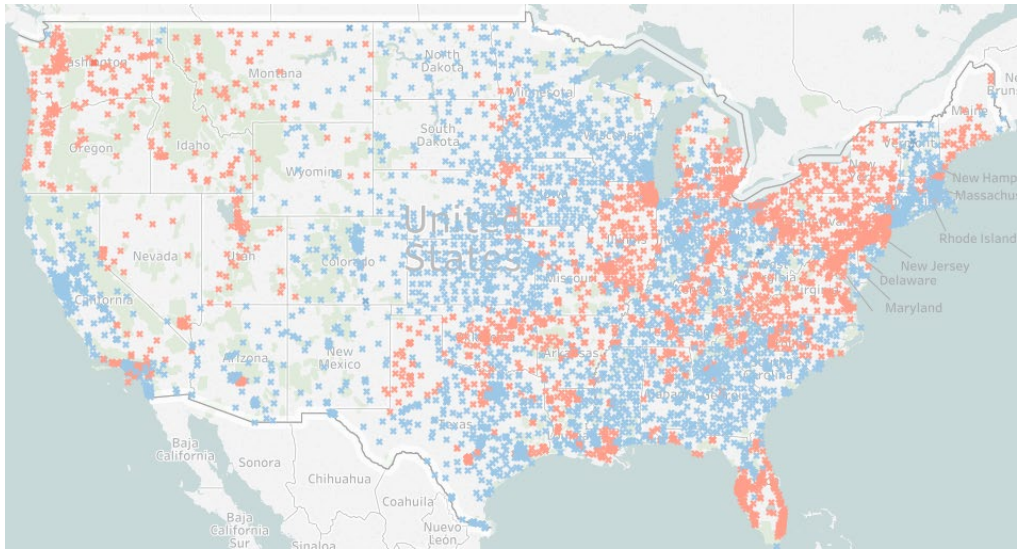
Plants in Midwest and New England TAP region

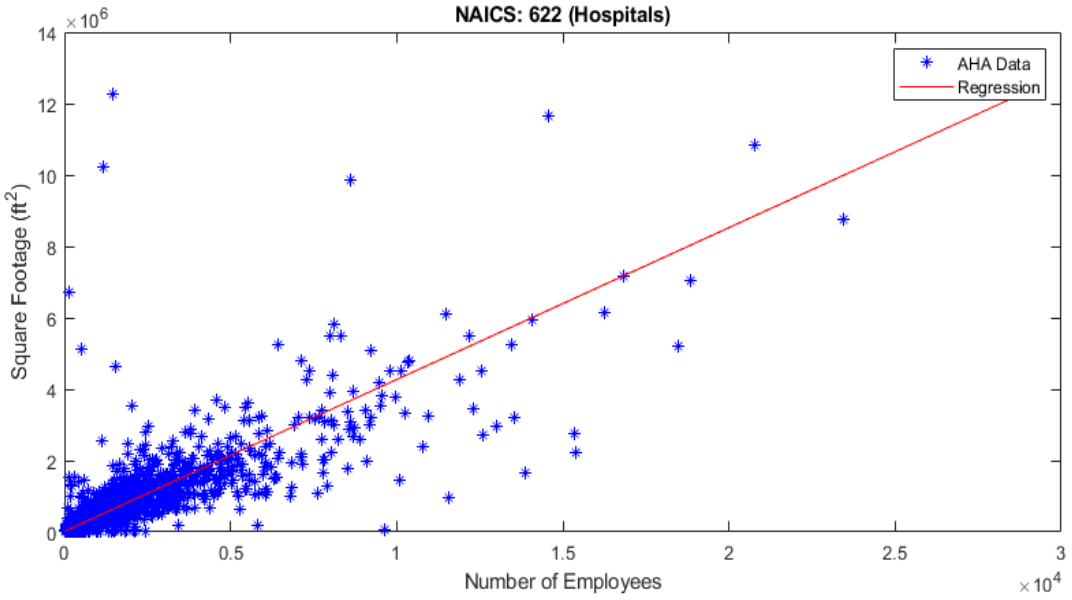


Region_indType	0.05-0.5MW		0.5-1MW		1-5MW		5-20MW		>20MW		Grand Total	
	Number of Sites	Capacity size	Number of Sites	Capacity size	Number of Sites	Capacity size	Number of Sites	Capacity size	Number of Sites	Capacity size	Number of Sites	Capacity size
Grand Total	42,353	10,025,835	11,929	8,754,840	15,207	30,595,421	2,112	17,956,912	363	16,741,403	71,964	84,074,410
311_Food	9,082	2,269,774	2,938	2,110,706	2,678	4,935,048	317	2,708,607	17	430,859	15,032	12,454,993
312_Beverage and Tobacco Products	4,328	1,088,742	319	227,164	177	311,837	8	57,710			4,832	1,685,453
313_Textile Mills	905	196,705	124	97,939	367	847,481	52	357,005			1,448	1,499,130
314_Textile Product Mills	56	11,473	7	5,356	4	9,697					67	26,526
315_Apparel	24	3,512	3	2,304			1	10,008			28	15,824
321_Wood Products	11,529	2,906,098	1,391	924,639	444	793,803	22	157,726			13,386	4,782,266
322_Paper	1,426	514,517	1,925	1,360,863	2,040	4,054,049	309	2,795,087	104	5,411,126	5,804	14,135,641
323_Printing and Related Support	21	3,136	1	677							22	3,813
324_Petroleum and Coal Products			321	252,026	1,940	5,461,767	426	3,589,366	57	2,812,465	2,744	12,115,623

*: Under development

IGATE-E Methodology Expanded to Commercial Buildings (e.g. Hospitals)





- Regressions of energy per square footage versus number of employees are developed using data from the American Hospital Association (AHA) database (private)
- Energy consumption is estimated for each location based on energy intensity estimates from the 2012 Commercial Buildings Energy Consumption Survey (CBECS)
- Load factors and thermal to electric ratios are estimated by climate zone based on EnergyPlus building energy modeling (using the DOE Commercial Prototype Building models)
- Finally, CHP potential is evaluated at the facility-level using the methodology developed by the CHP Technical Assistance Partnerships (CHP TAPs)

Future/Ongoing Activities

- Include a set of commercial buildings, such as Colleges, Universities, Nursing homes, correctional facilities, multi-family homes, into the IGATE-E Tool
- Add the interactive visualization of CHP installations and watch lists sites into the tool
- Searchable and display CHP installations by criteria such as:
  - TAP Region
  - Congressional District
  - Electric Independent Service Organizations (ISOs)
  - State
  - County
  - Zip Codes
- Incorporate CHP TAPs metrics spreadsheet for tracking the TAPs activities and impact