NATIONAL RENEWABLE ENERGY LABORATORY

Economic Contribution of Operations and Capital Investments on the Region, the State of Colorado, and the Nation in Fiscal Year 2019

Study Funded by: Alliance for Sustainable Energy, LLC

Consulting Report by:

The Business Research Division
Leeds School of Business
University of Colorado Boulder

May 2020

Leeds School of Business
UNIVERSITY OF COLORADO **BOULDER**

Business Research Division

The Business Research Division (BRD) of the Leeds School of Business at the University of Colorado Boulder has been serving Colorado since 1915. The BRD conducts economic impact studies and customized research projects that assist companies, associations, nonprofits, and government agencies with making informed business and policy decisions. Among the information offered to the public are the annual Colorado Business Economic Outlook Forum— now in its 55th year—which provides a forecast of the state's economy by sector, and the quarterly Leeds Business Confidence Index, which gauges Colorado business leaders' opinions about the national and state economies and how their industries will perform in the upcoming quarter. The Colorado Business Review *is a quarterly publication that offers decision makers industry-focused analysis and information as it relates to the Colorado economy.*

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EXECUTIVE SUMMARY

The National Renewable Energy Laboratory (NREL) is the U.S. Department of Energy's (DOE) primary national laboratory for renewable energy and energy efficiency research and development (R&D). NREL advances the science and engineering of energy efficiency, sustainable transportation, and renewable power technologies and provides the knowledge to integrate and optimize energy systems. NREL is managed by the Alliance for Sustainable Energy, LLC, a partnership between Battelle and MRIGlobal, on behalf of the Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy.

In an effort to address the nation's energy, economic, environmental, and security goals, scientists, researchers, analysts, and other staff at NREL develop advanced technologies and work closely with industry both to transfer NREL-originated knowledge and innovations and to provide technical capabilities to advance the innovations of its industry partners. NREL actively engages in commercialization and deployment activities with private- and public-sector organizations to successfully transfer technologies into commercially viable products and businesses for the marketplace. In FY2019, NREL had 871 active partnership agreements across 47 states and 29 countries, with federal agencies, small and large businesses, educational institutes, nonprofits, and state and local governments.

NREL's world-class staff regularly earns many prestigious awards and holds high educational measures in both Jefferson County and Colorado. NREL's employees continue to earn higher-than-average wages in the state. The lab is a top 5 employer in Jefferson County. The laboratory contributes a multitude of research and operational jobs to the local economy, which helps to diversify and strengthen the local workforce. Given the nature of the research and development conducted at NREL, employment and expenditures represent only a fraction of the benefits to the state, which range from university-laboratory-business collaborations, to spinoff technologies that are commercialized, to the development of localized business clusters.

The economic impacts of NREL on Jefferson County, the state of Colorado, and the nation are quantified in this study using a 544-sector IMPLAN input-output model. The report details the direct, indirect, and induced economic impacts in terms of output, employment, and income using primary data collected from several departments within NREL.

The total economic impact of NREL on the nation exceeded $1.4 billion nationally and $875 million on the state of Colorado in FY 2019. The employment impact (including direct and support jobs) totaled 4,527 jobs in Colorado, and the income impact totaled $351 million. This level of activity is driven by more than $360 million in direct facility expenditures in the state and full-time, part-time, and contract workers earning and spending in Colorado. Accounting for leakage in purchasing, as well as workers' distribution of residences, NREL's impact on Jefferson County summed $617 million. A majority of NREL's operating expenditures remain in Colorado, boosting the overall impact on the state. Based on occupation titles, 63% of workers contribute to core research and development at NREL (e.g., engineers, postdoctoral researchers, IT professionals, and research analysts), while 37% are in business support roles (e.g., attorneys, human resources, budgeting, administration, and communications).

PURPOSE OF THE STUDY

The Business Research Division (BRD) at the Leeds School of Business was asked by the Alliance for Sustainable Energy LLC (Alliance) to objectively measure the economic and fiscal impacts of the National Renewable Energy Laboratory (NREL) for fiscal year 2019. NREL is managed by the Alliance for Sustainable Energy, LLC, a partnership between Battelle and MRIGlobal, on behalf of the Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy.

NREL is the DOE's primary national laboratory for renewable energy and energy efficiency research and development. It develops renewable energy and energy efficiency technologies and practices, advances related science and engineering, and transfers knowledge and innovations to address the nation's energy and environmental goals.

Operating for more than 40 years, research and development at NREL focuses on innovations in energy system component technologies, advanced systems designs and design tools, control systems and operating practice and energy materials and processing techniques. Increasingly, NREL is playing leadership roles in research related to major national initiatives such as electricity grid modernization, advanced energy storage, manufacturing, and circular economy. The deep technical expertise, capabilities, and facilities of NREL support transformative research concerning the energy systems of the United States. Research conducted at NREL reduces investment risk in new technologies while creating new business opportunities throughout the economy.

The 327-acre campus in Golden, Colorado, is NREL's primary campus. The Energy Systems Integration Facilities (ESIF), Integrated Biorefinery Research Facility, National Center for Photovoltaics, and National Bioenergy Center are all part of NREL. NREL's Flatirons Campus is located 13 miles north of the Golden campus, situated on 305 acres near Boulder, Colorado. In addition to hosting the National Wind Technology Center, a DOE investment of more than $40 million over the next three years will expand research capabilities at the Flatirons Campus to address large-scale energy systems integration challenges.

NREL is a leader in sustainability. Its goal is to reduce energy, material, and water use, while performing valuable research in the field of clean energy. For example, the Research Support Facility (RSF) is one of the largest zero-energy office buildings globally and it has influenced the implementation of renewable technology and energy-efficient approaches to more than 50 buildings.

METHODOLOGY

This study was conducted in cooperation with the NREL organization, replicating prior studies with a comparable methodology that were conducted for NREL and for CO-LABS, a consortium of Colorado-based federally funded scientific laboratories, universities, businesses, local governments, and community leaders. CO-LABS was organized to establish Colorado as a global leader in research and technology, and to facilitate the interaction between the labs and the business community in an effort to develop commercialization.

The research team queried NREL about its facility, employment, operating, and capital expenditures (including construction) for fiscal year 2019. Data were reorganized by function and applied to a 544-sector IMPLAN input-output model that quantified the economic impacts of NREL on Jefferson County, the state of Colorado, and the nation as a whole. This study employs a similar methodology used to examine NREL's impact in previous years.

Direct industry employment, wages, funding, and expenditures were the basis for economic impact estimates and for subsequent multiplier analysis to illustrate ripple effects of industry spending within the economy.

Direct industry employment refers to companies directly producing or delivering products—the vertical supply chain. There are also a number of firms supporting the industry, such as financial, legal, accounting, and consulting services firms.

Multipliers refer to the interindustry relationships within a study area in terms of input-output (I-O) economic impacts.[1] Multipliers are useful for analyzing project decisions to understand the incremental impacts that such activities have on the local economy. IMPLAN multipliers are static and thus do not consider large-scale disruptive impacts on the economic fabric without calculating specific infrastructure changes.

For the purpose of this study, all multipliers are comprised of direct, indirect, and induced effects. Direct refers to direct spending or employment in the study industry or firm. Indirect is the spending or employment in related industries impacted by spending or employment in the study industry or firm. Induced refers to changes in household expenditures impacted by spending or employment in the study industry or firm.

Other studies have been conducted measuring the economic contribution of other federal labs and research and development. For a summary of studies, see Appendix 1.

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[1]Bureau of Economic Analysis, Regional Multipliers, http://www.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf, retrieved September 2, 2019.

DEFINITIONS

Gross Domestic Product (GDP): A measure of economic activity, GDP is the total value added by resident producers of final goods and services.

Gross Output (Output): The total value of production is gross output. Unlike GDP, gross output includes intermediate goods and services.

Value Added: The contribution of an industry or region to total GDP, value added equals gross output, net of intermediate input costs.

Labor Income: Total compensation of employees (wages and benefits) and sole proprietors (profits).

Employment: Full-time and part-time workers.

Direct Impact: Initial economic activity (e.g., sales, expenditures, employment, production, etc.) by a company or industry.

Indirect Impact: The upstream (backward) economic activity impacted by purchases along a company or industry supply chain.

Induced Impact: Economic activity derived from workers spending their earnings on goods and services in the economy.

ECONOMIC OVERVIEW

Data from the Bureau of Economic Analysis show that the domestic economy grew at real rates of 1.6% in 2016, 2.4% in 2017, and 2.9% in 2018; but slowed to a seasonally adjusted annual rate of 2.1% in Q3 2019. According to a report from Consensus Forecasts, U.S. real GDP growth is anticipated to remain relatively steady over the near future, with growth estimates of 1.9% in 2019 and 2020.

Government consumption expenditures and gross investment posted positive growth every year, but grew at a slower pace than the overall economy. With the exception of 2018, *Federal* government consumption expenditures and gross investment growth has been modest. The subsector of Federal nondefense outpaced the growth in overall Federal spending, with the exception of 2018.

TABLE 1: GOVERNMENT SPENDING COMPONENTS OF GDP

Component of GDP	2014	2015	2016	2017	2018
Gross domestic product	2.5%	2.9%	1.6%	2.4%	2.9%
Government consumption expenditures and gross invest.	-0.9%	1.9%	1.8%	0.7%	1.7%
Federal	-2.6%	-0.1%	0.4%	0.8%	2.9%
National defense	-4.1%	-2.1%	-0.6%	0.7%	3.3%
Nondefense	-0.1%	3.1%	2.0%	0.8%	2.4%
State and local	0.2%	3.2%	2.6%	0.6%	1.0%

Source: Bureau of Economic Analysis.

FIGURE 1: PERCENT CHANGE FROM PRECEDING PERIOD IN U.S. REAL GROSS DOMESTIC PRODUCT

Source: Bureau of Economic Analysis.
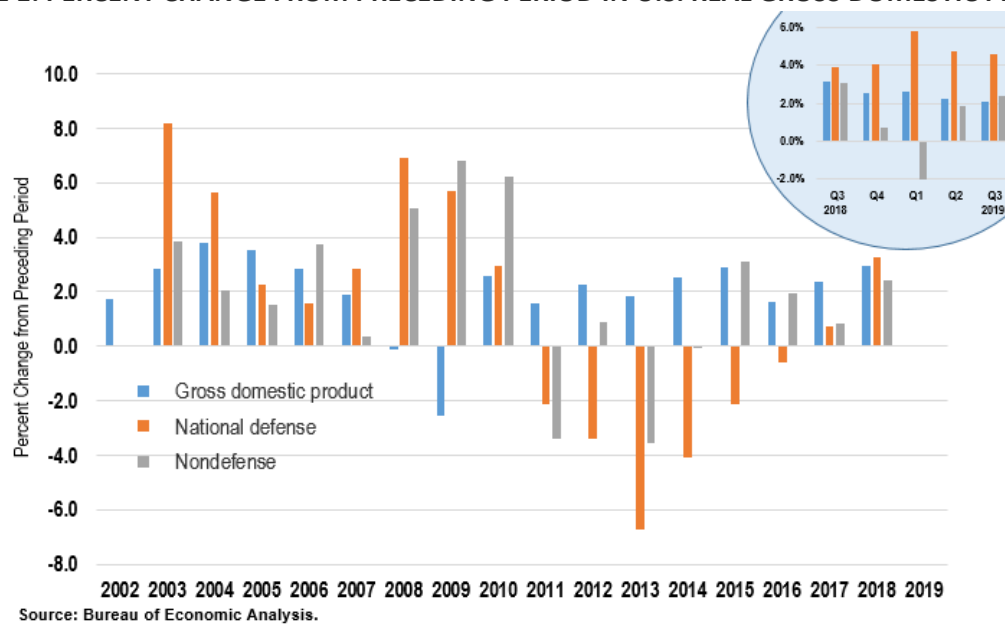
Job creation after the recession accelerated through 2014, peaking at 251,000 jobs added per month that year. Since then, the pace of job creation has slowed with 227,000 jobs added per month in 2015, 193,000 in 2016, 179,000 in 2017, and 223,000 in 2018. U.S. job growth in 2019 averaged 176,000 each month, the slowest rate since 2011. Total U.S. employment continues to set new employment records each month after surpassing pre-recession levels in 2014. Aside from employment spikes that coincide with the U.S. Census, federal government employment has remained relatively flat over the past 19 years.[2]

While Colorado employment growth has followed a similar path as the nation, state employment growth has outperformed national employment growth over the past 19 years. Employment in Colorado recorded

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[2]NREL is managed by a private-sector entity, the Alliance for Sustainable Energy, LLC. Within the labor files, employees are counted in the private sector.

a 10-year compound annual growth rate (CAGR) of 2.4% in December 2019 compared to 1.6% nationally. The Denver-Aurora-Lakewood metropolitan statistical area (MSA), where NREL resides, recorded an employment CAGR of 2.7% over the same period. Colorado and Denver-Aurora-Lakewood MSA employment has also fully rebounded from the recession, recording employment levels 18.8% and 22.7%, respectively, above the pre-recession peak, compared to 10% for the United States. The nation's average annual pay was $57,266 in 2018, while Colorado's was 2.9% higher, at $58,941.
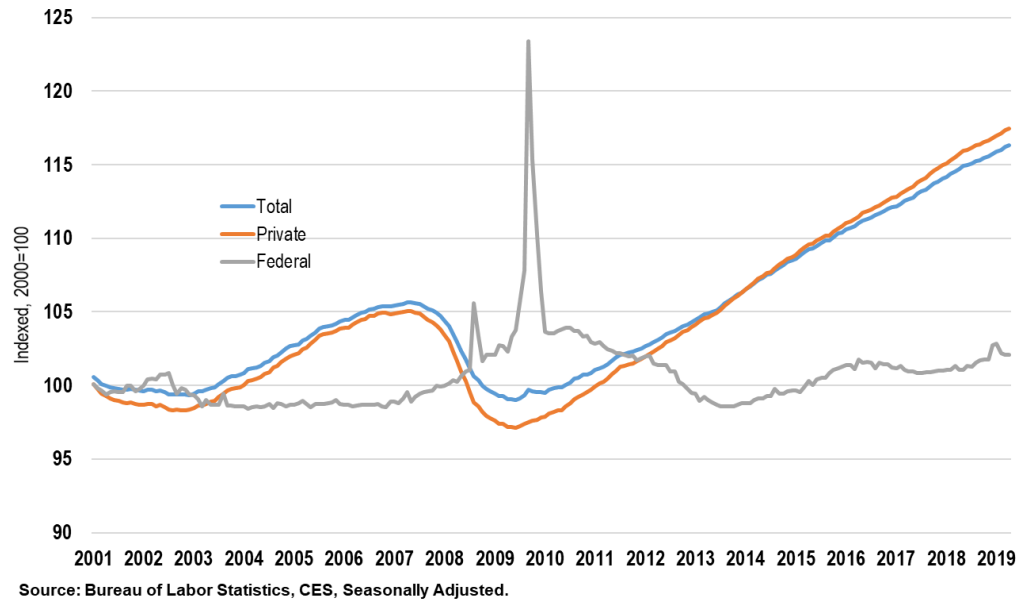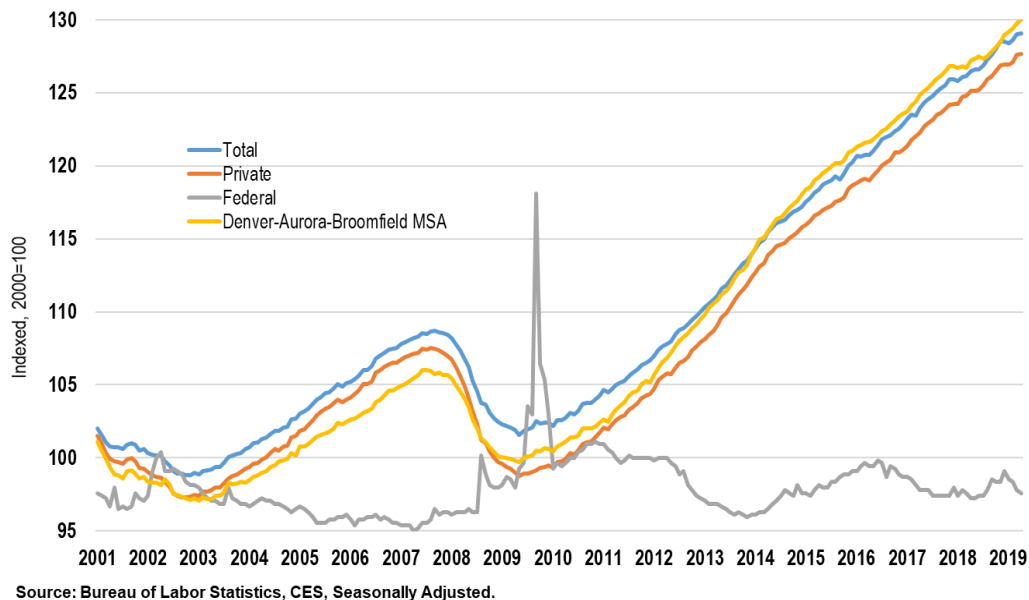
FIGURE 2: INDEXED NATIONAL EMPLOYMENT GROWTH

Source: Bureau of Labor Statistics, CES, Seasonally Adjusted.

FIGURE 3: INDEXED COLORADO EMPLOYMENT GROWTH

Source: Bureau of Labor Statistics, CES, Seasonally Adjusted.

Federal obligations for R&D reached a new peak in 2019 (preliminary); applied and basic research both reached new levels, while development remained 24% below the 2011 peak despite posting three-consecutive years of growth. Of the preliminary $146.1 billion in federal obligations for research and development in 2019, $83.4 billion was for basic and applied research, while $58.1 billion was for development and $4.6 billion for R&D plant.

In FY2018 and FY2019, the federal agency with the greatest percentage of outlays for research and development was by the Department of Defense (39%). The DOE, the primary funder of NREL, ranked third in total funding outlays, accounting for 11.4% of federal outlays for R&D by agency.

FIGURE 4: FEDERAL OBLIGATIONS FOR RESEARCH AND DEVELOPMENT

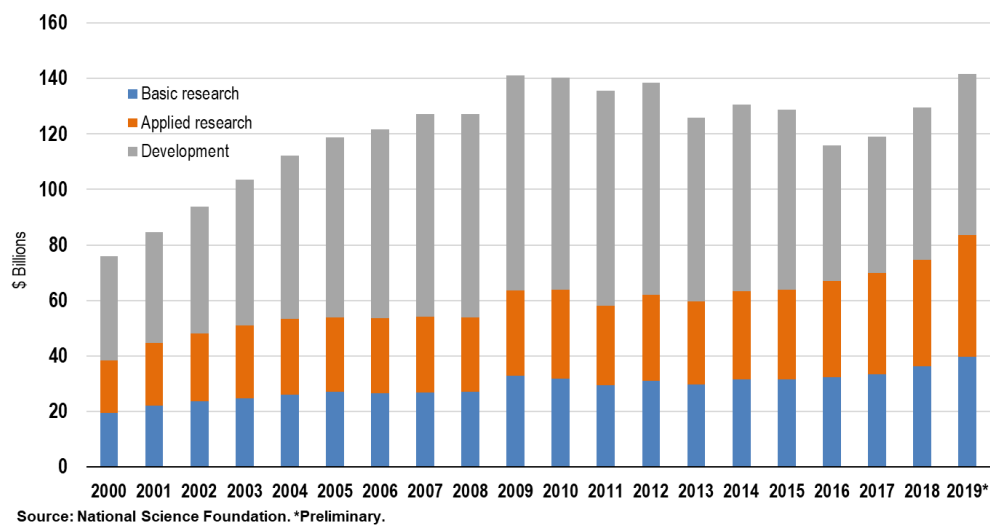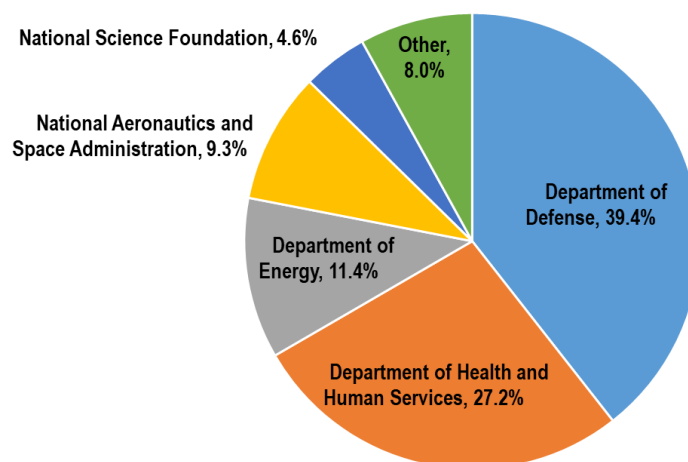Source: National Science Foundation. *Preliminary.

FIGURE 5: FEDERAL OUTLAYS FOR RESEARCH AND DEVELOPMENT BY AGENCY, AVERAGE FY2018–19

Source: National Science Foundation. Note: FY2019 figures are preliminary.

> *Basic research* is defined as systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind.
>
> *Applied research* is defined as systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met.
>
> *Development* is defined as systematic application of knowledge or understanding that is directed toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.
>
> Source: National Science Foundation, https://www.nsf.gov/statistics/2017/nsf17316/. Retrieved May 4, 2018.

MODEL INPUT DATA AND ASSUMPTIONS

NREL, located at 15013 Denver West Parkway in Golden, Colorado, is within about an hour's proximity of numerous major research universities, federal laboratories, and private R&D companies throughout the state. NREL is located 36 miles (45 minutes) from Denver International Airport, 18 miles (24 minutes) from downtown Denver, 28 miles (40 minutes) from Boulder, 70 miles (1 hour 15 minutes) from Fort Collins, and 6 miles (12 minutes) from the Denver Federal Center. The Golden facility totals nearly 1.3 million square feet on less than a square mile of land.

The Flatirons Campus, including the National Wind Technology Center, is located in Boulder County, Colorado, 20 miles (30 minutes) from NREL'S Golden campus. The Renewable Fuels and Lubricants Laboratory (ReFUEL) is located in Denver, Colorado, and the Laboratory also has an administrative office in Washington, D.C.

FIGURE 6: NREL LOCATIONS AND UNIVERSITY PARTNERSHIPS

Flatirons Campus
Lousiville, CO

NREL
Golden, CO

ReFUEL
Denver, CO

NREL
Washington, D.C.
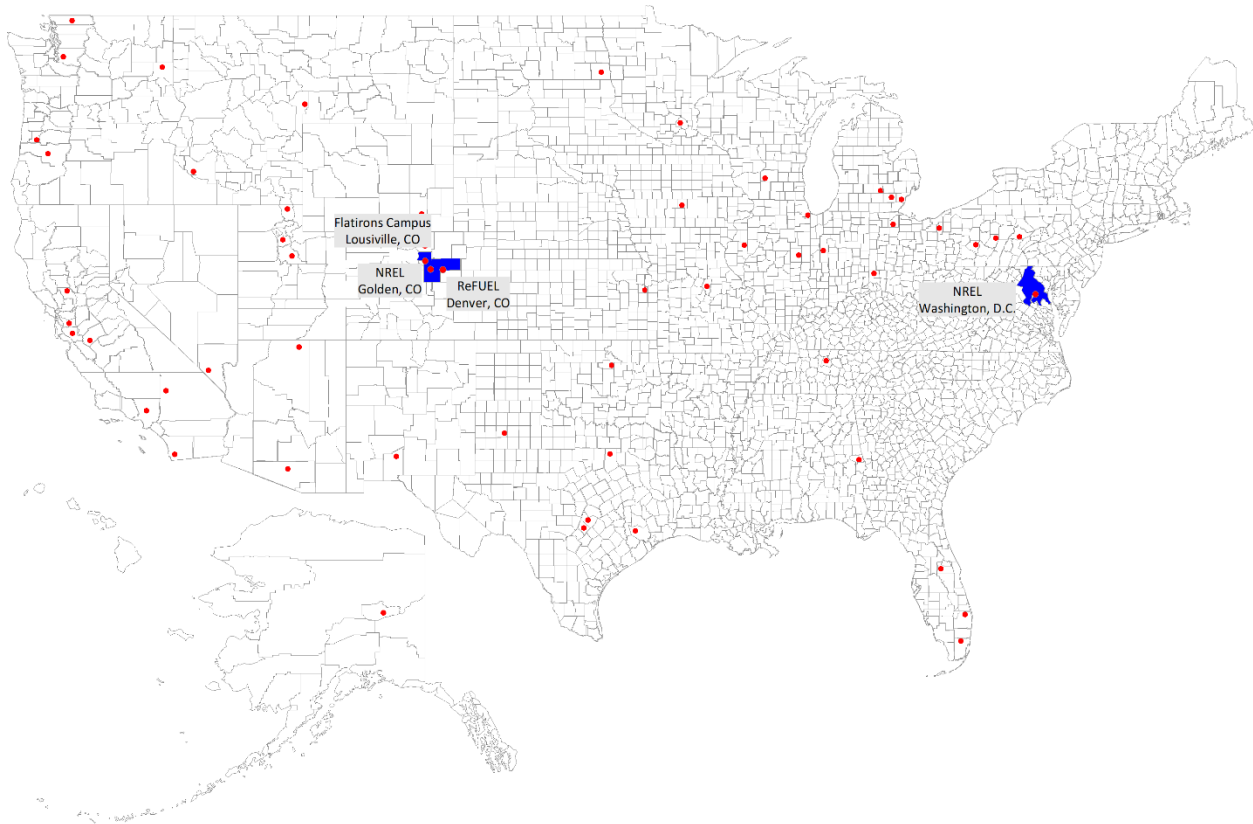
Note: Each red dot represents a partner university in FY2019.
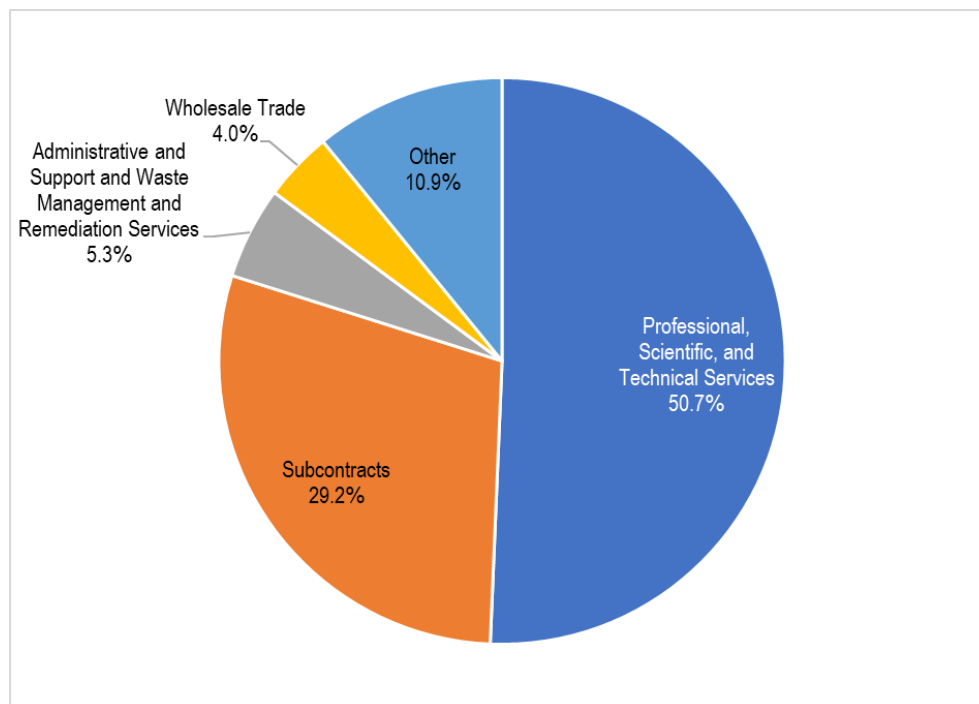
Expenditures

Operating and capital expenditures are detailed by expenditure type, including general operating costs, lease payments, supplies, compensation, construction, and subcontracted research and development. NREL identified budget expenditures of $491.8 million in FY2019, with the majority of funding coming from the DOE (87%). NREL's facility expenditures that remained in Colorado totaled $359.6 million in FY2019, and the amount remaining in Jefferson County totaled an estimated $186.1 million.

TABLE 2: NREL'S DIRECT EXPENDITURES, IN MILLIONS

Expenditures	National	Colorado	Jefferson County
Labor	$291.3	$283.6	$161.2
Operating Expenditures	$187.1	$62.6	$11.5
Construction	$13.4	$13.4	$13.4
Total Direct Expenditures	**$491.8**	**$359.6**	**$186.1**

Note: Includes direct spending in the county. Labor estimate summarizes only the income of individuals who live *and* work in Colorado and Jefferson County.

FIGURE 7: NON-LABOR OPERATING EXPENDITURES BY TYPE

Note: Expenditures by type are based on spending patterns established in the 2018 study.

Construction

NREL reported an estimated $13.4 million in construction expenditures in FY2019, attributed primarily to facility renovation and remodeling projects. Construction projects during this time period are relatively modest compared to previous activity that created the Energy Systems Integration Facility (ESIF) and the Research Support Facility (RSF).

Construction includes hard costs (e.g., materials), soft costs (e.g., professional fees, engineering and design fees, environmental testing, and nondirect costs), and labor. The commercial and institutional buildings multiplier was applied to construction costs.

Operations Expenditures and Subcontracted Services

NREL's operating and capital expenditures include supplies, materials, equipment, computers, software, training, maintenance, and subcontracted research. These estimates exclude labor, employee benefits, and construction costs; approximately 31% of nonlabor operating expenditures remained within the state of Colorado, and about 10% stayed in Jefferson County. In the prior economic contribution study, expenditures were provided by spending type and by ZIP code, which were reclassified by industry as totals within Jefferson County, the state of Colorado, and nationally.

Employment

NREL's employment totaled 2,265 in FY2019, including full-time, part-time, and student workers, making NREL a top 5 employer in Jefferson County, Colorado.

NREL employed 2,120 full-time workers in FY2019. Average salary and benefits paid to these workers totaled $129,457. NREL recorded 145 part-time workers averaging $116,539 in compensation (salary and benefits) in FY2019. Additionally, NREL hires contract workers who are not estimated in the totals above, but whose compensation was included in operating expenditures as a supplier to NREL.

The number of student employees employed by NREL (included in the full-time and part-time totals above) totaled 168 in FY2019. Student salaries averaged $32,950.

Located in Golden, Colorado, the majority of NREL's Colorado employees (55%) live in Jefferson County. The Denver and Boulder metropolitan statistical areas are home to more than 95% of NREL employees. The metropolitan Front Range accounted for more than 97% of NREL employment. A total of 2.6% of NREL employees live outside of Colorado, residing in 20 other states.

FIGURE 8: NREL LABOR SHED IN COLORADO, FY2019
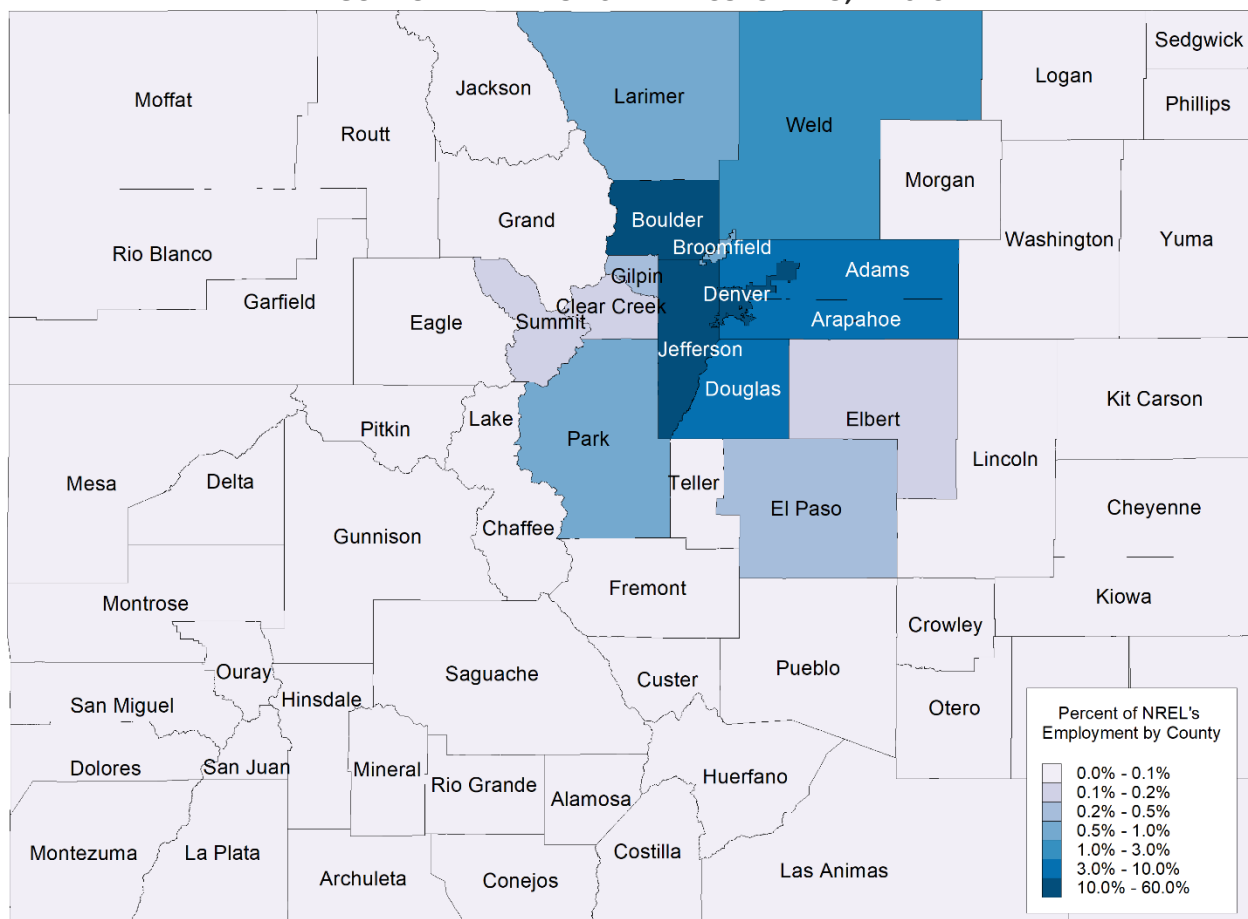
Educational attainment represents the highest degree earned. The educational attainment of the NREL workforce exceeds that of Jefferson County, the lab's home county, and the state as a whole. More than 96% of facility employees have a bachelor's degree or higher. Of these, 27.5% have a four-year degree, 32.5% have a master's degrees, and 36.4% have earned a doctoral degree.

**FIGURE 9: NREL EMPLOYEE EDUCATIONAL ATTAINMENT**
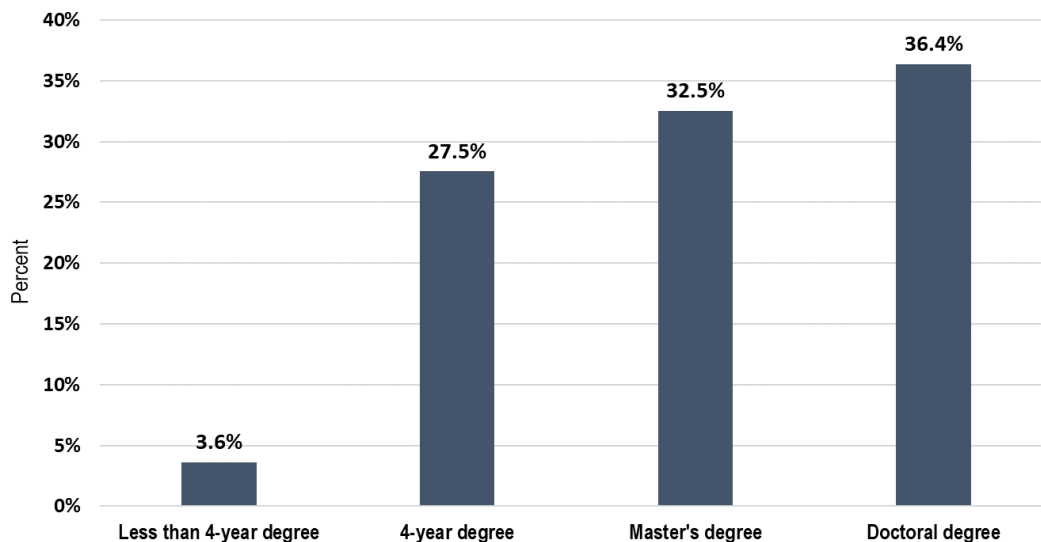
Source: NREL.

Occupations

NREL's work is conducted by scientific and support staff. Of full-time, part-time, and temporary positions in 2019, approximately 63% were in core research and development, while 37% were employed in business support operations. Core positions include engineers, scientists, postdoctoral researchers, IT professionals, and research analysts. Support positions include attorneys, human resources, budgeting, administration, and communications. In some instances, researchers are also in management roles, thus overstating business support operations and underestimating core research and development.

FIGURE 10: NREL OCCUPATIONS, FY2019
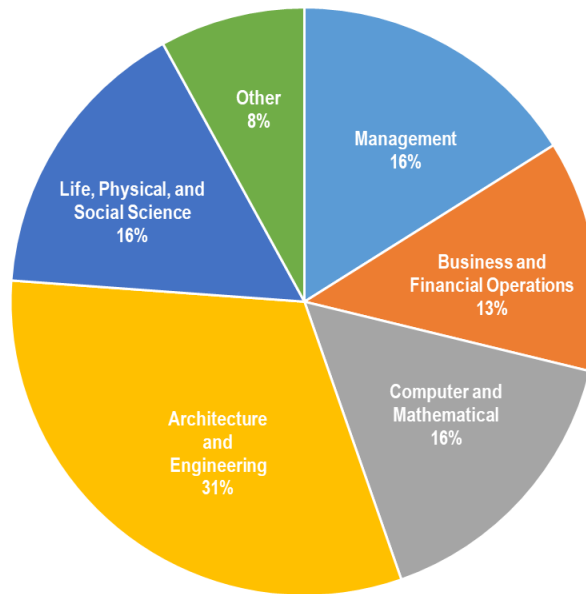
ECONOMIC IMPACT

Impact on the Nation

The economic impact of NREL operations on the nation totaled $1.4 billion in FY2019. Total (direct, indirect, and induced) employment impacts summed to nearly 7,000 jobs, driven off both operations and construction. The impact on the state of Colorado totaled $875 million with employment impacts of 4,527 jobs. The majority of the employment impacts are nested in the state given that nearly all workers are on site at installations in Colorado. The impact of the facility on salaries and benefits associated facility activity totaled $351 million in Colorado, or $77,425 per workers (including benefits). Focusing on Jefferson County, the economic impact narrowed given the comparatively limited supply chain and worker commuting patterns. The economic impact of NREL on Jefferson County totaled $617 million in FY2019, which includes the total budget spend emanating from the NREL site, as well as the local purchases. The impact on labor totaled 3,077 jobs and $264 million in income (salary and benefits).

TABLE 3: NREL ECONOMIC CONTRIBUTION, FY2019

Region	Employment (Average)	Labor Income (In Millions)	Value Added (In Millions)	Output (In Millions)
Jefferson County	3,077	$264	$375	$617
Colorado	4,527	$351	$519	$875
United States	6,988	$589	$858	$1,367

CONCLUSION

NREL provided significant economic benefits to the nation, to Colorado, and to Jefferson County in FY2019. Nationally, the economic contribution of NREL totaled $1.4 billion in FY2019, and statewide economic impacts were estimated at $875 million. Accounting for leakage in purchasing, as well as workers' distribution of residences, NREL's impact on Jefferson County summed $617 million.

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