

EMERGING OCCUPATIONS AND SKILLS IN THE HYDROGEN/ FUEL CELL ECONOMY AND ASSOCIATED EDUCATION AND TRAINING REQUIREMENTS

Cavendish Energy LLC
www.cavendish-e.com
September 2016

DOE estimates that widespread market penetration of hydrogen energy systems and fuel cell technologies could create 180,000 new jobs in the U.S. by 2020, and 675,000 jobs by 2035.¹ Further, occupational data indicate that the hydrogen and fuel cell industries will create a variety of new high-paying jobs, many of which take advantage of technical and manufacturing skills currently going unused as industry continues to undergo restructuring in the U.S. States, regions, and cities can recruit these emerging industries and companies.

As shown in Table 1, wages and salaries in many sectors of the emerging hydrogen, fuel cell, and related industries are higher than U.S. average wages. Although many high-tech industries almost exclusively require highly educated workers with masters or doctoral degrees, these emerging industries require a wide variety of occupations. Nevertheless, many occupations in these industries include jobs which require associate's degrees, long-term on-the-job training, or trade certifications – and lead to jobs that pay higher than U.S. average wages.

Unlike some industries, the hydrogen and fuel cell industries are a realistic target industry for job creation in most states. With a wide variety of the required skills as well as ongoing research into various technologies, communities can choose to build clusters around different segments of the industries. However, states and cities must recognize that they will be in fierce competition as communities around the U.S. compete for new emerging energy industries with traditional university-centered research areas, including Palo Alto (Stanford University), Ann Arbor (University of Michigan), Trenton (Princeton University), the Research Triangle in North Carolina, and other university-industry complexes. In addition, communities must compete for these jobs with traditional high-tech metropolitan areas like San Jose, Boston, and Washington D.C., along with metropolitan areas traditionally associated with manufacturing, like Dothan, Alabama. The wide variety of entrance points to these industries makes this market easier to penetrate if states and cities can market their strengths in high-tech, research, education, and construction and operation.

¹U.S. Department of Energy, Fuel Cell Technologies Office, "Careers in Fuel Cell Technologies," https://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/green_jobs_factsheet.pdf

The bottom line is that growth in the hydrogen and fuel cell sectors of the U.S. economy will lead to vast new employment opportunities as businesses expand to meet the new, clean, and sustainable energy requirements and mandates. DOE notes that “As market demand for hydrogen and fuel cell technologies increases across sectors of our economy, there will be an increasing need for trained and experienced personnel and accompanying services such as qualified maintenance technicians, installers, manufacturing professionals, trainers, insurers, and educators.”²

Cavendish finds that jobs will be created across a new spectrum of work activities, skill levels, and responsibilities. Many of these jobs do not currently exist and do not have occupational titles defined in federal and state government occupational classifications and standards. In addition, many of these new jobs require a different set of skills than current jobs, and training requirements must be assessed so that this rapidly growing sector of the U.S. economy and labor market has an adequate pool of trained and qualified job applicants. At some point in the future many of these occupations will grow in the number of employees classified in the occupation and the federal government will add them to the employment classification system. Until that time, economic and employment analysis and forecasting is usually conducted using the current set of U.S. Labor Department occupational titles.³ In the meantime, Cavendish has developed the methodology and database illustrated here.

Table 1 identifies by occupational title some of the new jobs that Cavendish estimates will be created in the expanding hydrogen energy economy.⁴ New occupational titles are listed in the first column of the table. The average U.S. salary, listed in the second column, represents the average of the starting salary and highest salary for that occupation. Wages may be 15-20 percent lower at the beginning of employment and may rise to a level 15-20 percent higher as the person becomes an experienced employee.⁵ In addition, wages and salaries are usually much higher in urban areas than in rural areas and in some regions than in others.

The third and final column lists the minimum recommended educational attainment to gain entry into that occupation, and a recommended degree is listed for the advanced educational requirements. Obviously, employers will not hold fast to these recommendations, but this information can be useful to energy policymakers and educational planners in providing an idea of the knowledge and skills that the employer is seeking in a candidate. Note that the education requirements listed include HSD/GED/OJT (high school degree, General Education Development, or on-the-job training), and Apprenticeship/TS (trade school) to a Master’s degree. With the more advanced (Bachelor’s degree and up) college requirements, some standard abbreviations were used to further define the recommended degree: CE, ME, EE – for chemical, mechanical, and electrical engineer degrees, etc. Also note that many jobs can

²ibid.

³These are listed in the *2000 Standard Occupational Classification Code*, U.S. Department of Labor, Bureau of Labor Statistics. Also see the BLS *Occupational Outlook Handbook*.

⁴Estimates derived by Cavendish Energy from a variety of sources.

⁵These salary and wage estimates have been adjusted to reflect average U.S. 2015 salary and wage levels.

be filled by a candidate with one of several related science or engineering degrees and they are listed generically as such.

Tables 1 shows some of the emerging job opportunities and corresponding salaries and education/training requirements in the hydrogen economy. This table illustrates that:

- Salaries vary widely, from \$20,000 - \$25,000 for various types of technicians, to nearly \$140,000 for a director of hydrogen development.
- Educational requirements span the gamut from apprenticeship/trade school and HSD/GED/OJT to advanced college degrees.
- However, there are a wide variety of jobs and education training requirements, and many of the jobs do not require college degrees.
- Similar jobs in different parts of the industries can have different salaries and education/training requirements. For example, a hydrogen lab technician requires an Associate Degree and earns a salary of nearly \$41,000, whereas a junior hydrogen energy technician may require only a HSD/GED earn a salary of less than \$25,000.
- Similarly, a hydrogen plant operations manager with a Bachelor's Degree may earn more than \$95,000, whereas a senior automotive fuel cell power electronics engineer with a Bachelor's Degree may earn less than \$70,000.
- There exist numerous career paths that allow employees with apprenticeship/TS and HSD/GED to earn relatively high salaries, such as hydrogen vehicle technician, fuel cell power systems operator and instructor, fuel cell backup power system technician, and hydrogen energy system operations engineer.

Table 1: Examples of Emerging Jobs, Salaries, and Education and Training Requirements in the Hydrogen and Fuel Cell Industries

Occupational Title	Average Salary	Minimum Education
Director of hydrogen energy development	\$138,000	Bachelor's (Business)
Hydrogen/fuel cell R&D director	\$129,000	Doctoral
Hydrogen fuel cell system technician	\$39,500	HSD/GED/OJT/TS/apprenticeship
Junior hydrogen energy technician	\$23,400	HSD/GED/OJT/TS/apprenticeship
Fuel cell engineering intern	\$6,800	HSD/GED/OJT/apprenticeship
Fuel cell manufacturing technician	\$45,650	Associate's
Fuel cell fabrication and testing technician	\$45,800	Associate's
Hydrogen power plant installation, operations, engineering. & mgt.	\$69,700	Bachelor's (EE, ME, CE)
Hydrogen energy systems designer	\$47,900	Apprenticeship/TS
Fuel cell plant manager	\$90,500	Bachelor's (EE, ME)
Hydrogen energy system operations engineer	\$68,100	HSD/GED
Hydrogen fueling station designer & project engineer	\$74,200	Bachelor's (Engineer)
Hydrogen fuel transporter – trucker	\$36,950	OJT
Hydrogen fueling station operator	\$29,700	OJT
Hydrogen fuels policy analyst & business sales	\$56,200	Bachelor's (Business)
Hydrogen systems program manager	\$73,220	Bachelor's (Engineer)
Emissions accounting & reporting consultant	\$64,200	Bachelor's (various)
Fuel cell quality control manager	\$74,600	Master's (Science/Engineering)
Hydrogen pipeline construction worker	\$46,300	HSD/GED/OJT/TS/apprenticeship
Fuel cell designer	\$78,200	Master's (Science)
Hydrogen energy engineer	\$72,300	Bachelor's (Engineer)
Fuel cell power systems engineer	\$76,400	Master's (EE)
Fuel cell fabrication technician	\$23,150	HSD/GED/OJT/TS/apprenticeship
Hydrogen systems & retrofit designer	\$90,600	Bachelor's
Fuel cell retrofit installer	\$41,600	HSD/GED/OJT/TS apprenticeship
Fuel cell retrofit manufacturer plant labor	\$36,500	HSD/GED
Hydrogen vehicle electrician	\$44,800	HSD/GED/OJT/TS apprenticeship
Fuel cell vehicle development engineer	\$69,800	Bachelor's (Engineer)
Hydrogen systems safety investigator - cause analyst	\$88,350	Bachelor's (various)
Hydrogen lab technician	\$40,600	Associate's
Hydrogen energy system installer helper	\$23,200	HSD/GED
Hazardous materials management specialist	\$55,300	Bachelor's (Science)
Hydrogen energy system installer	\$31,500	HSD/GED/OJT/TS apprenticeship
Fuel cell power systems operator and instructor	\$50,900	HSD/GED/OJT/TS apprenticeship
Fuel cell backup power system technician	\$40,200	HSD/GED/OJT/TS apprenticeship
Senior automotive fuel cell power electronics engineer	\$69,700	Bachelor's (EE)
Emissions reduction credit portfolio manager	\$47,400	Bachelor's (Business)
Emissions reduction project developer specialist	\$63,450	Bachelor's (various)
Emissions reduction project manager	\$78,600	Bachelor's (various)
Hydrogen systems sales consultant	\$53,800	Bachelor's (Business)
Hydrogen plant operations manager	\$95,200	Bachelor's (EE, ME)

Source: Cavendish Energy LLC.