

## Hydrogen and Fuel Cells:

*Hydrogen* is a colorless, odorless, gas that is the most abundant element in the Universe and can be used in a variety of fueling capacities, from mobile cell phones to motor vehicles. A *fuel cell* is an electrochemical device that combines hydrogen and oxygen to produce electricity, with water and heat as its only by-products. It is clean, quiet and highly efficient – two to three times more efficient than petroleum fuel burning. Together, hydrogen and fuel cells are the cleanest form of alternative energy currently available.

## Jobs and Investment Growth

South Carolina is named a “Top 5 Fuel Cell State” in 2010<sup>1</sup> and 2011<sup>2</sup> by Fuel Cells 2000. To maintain our competitive edge, South Carolina needs the continued support and adoption of hydrogen fuel cell technologies through the use of tax credits, active involvement from government, increased deployment efforts and the continued education of South Carolina companies about the benefits of implementing hydrogen fuel cells in material handling equipment in markets where certain requirements are met for maximum potential<sup>3</sup>.

In a February 2012 report by Pike Research, worldwide investment in 2012 alone in hydrogen and fuel cells is expected to reach \$785 million<sup>4</sup>. Hydrogen fuel cells are a largely domestic technology, but that does not mean competition does not exist. Many other countries, including Germany, Korea, the United Kingdom, Japan and China are all competing for the energy security and job creation that is associated with hydrogen fuel cell technology.

Toyota, Mercedes, Honda, Hyundai-Kia<sup>5</sup> and Nissan<sup>6</sup> have all committed to commercially releasing their respective hydrogen fuel cell vehicles by 2015.

As you can see below in Chart 1, fuel cell patents are significantly higher than other clean tech patents currently being filed, even when compared to solar and wind<sup>7</sup>. Tech giant Apple recently filed two patents for hydrogen fuel cell technologies in regards to powering a portable

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<sup>1</sup> <http://www.fuelcells.org/info/StateoftheStates.pdf>

<sup>2</sup> <http://www.fuelcells.org/info/StateoftheStates2011.pdf>

<sup>3</sup> <http://schydrogen.org/documents/Hydrogen%20and%20Fuel%20Cells%20%20Lift%20Trucks,%20A%20Practical%20Application.pdf> – growth in these certain markets will spur more competition and a reduction in costs that will allow for more markets to benefit from hydrogen fuel cell technologies

<sup>4</sup> <http://www.pikeresearch.com/newsroom/worldwide-revenue-from-fuel-cells-and-hydrogen-will-reach-785-million-in-2012>

<sup>5</sup> [http://www.cbsnews.com/8301-505123\\_162-43144252/tens-of-thousands-of-fuel-cell-cars-in-2015-take-that-dr-chu/](http://www.cbsnews.com/8301-505123_162-43144252/tens-of-thousands-of-fuel-cell-cars-in-2015-take-that-dr-chu/)

<sup>6</sup> <http://inhabitat.com/nissan-to-release-hydrogen-fuel-cell-vehicle-by-2015/>

<sup>7</sup> [http://cepgi.typepad.com/heslin\\_rothenberg\\_farley/](http://cepgi.typepad.com/heslin_rothenberg_farley/)

computing device<sup>8</sup> and is planning to build a fuel cell farm at its new technology center in North Carolina that boasts to be the largest non-utility installation operating in the Country<sup>9</sup>.

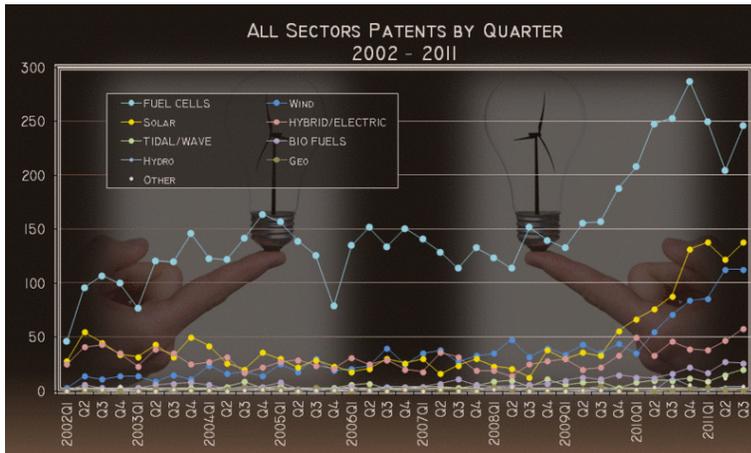


Chart 1

According to four recent studies, 20,000 - 28,000 new jobs could be created in South Carolina by expanding our commitment to energy efficiency and renewable energy<sup>10</sup>. Four further national comparisons show that these clean-energy investments create 16.7 jobs for every \$1 million spent, whereas spending on fossil fuels creates only 5.3 jobs for the that same \$1 million investment<sup>11</sup>.

Through direct state appropriations and support of the South Carolina Centers of Economic Excellence program during 2004-2009, South Carolina and private investments resulted in leveraging its hydrogen investment dollars at a rate of more than 10 to 1<sup>12</sup>.

In data collected between 2004-2009<sup>13</sup>, job growth resulted in a 65% increase. Eight hydrogen and fuel cell related start-up companies were created during this time in addition to the already established 40 private companies in the Cluster.

The South Carolina Hydrogen and Fuel Cell Alliance (SCHFCA) is currently working on an Economic Development Administration (EDA) project that will report current job standings within the "SC Hydrogen & Fuel Cell Cluster" as well as produce a supply chain map and detailed strategic Action Plan<sup>14</sup>.

<sup>8</sup> [http://www.appleinsider.com/articles/11/12/22/apple\\_investigating\\_fuel\\_cell\\_powered\\_macbooks.html](http://www.appleinsider.com/articles/11/12/22/apple_investigating_fuel_cell_powered_macbooks.html)

<sup>9</sup> [http://www.appleinsider.com/articles/12/02/20/apples\\_north\\_carolina\\_solar\\_fuel\\_cell\\_plants\\_will\\_be\\_largest\\_of\\_their\\_kind.html](http://www.appleinsider.com/articles/12/02/20/apples_north_carolina_solar_fuel_cell_plants_will_be_largest_of_their_kind.html)

<sup>10</sup> <http://www.charlestongreencommittee.com/charlestongreenplan2010.pdf> - pg. 43

<sup>11</sup> <http://www.charlestongreencommittee.com/charlestongreenplan2010.pdf> - pg. 43 and [http://images2.americanprogress.org/CAP/2009/06/factsheets/peri\\_sc.pdf](http://images2.americanprogress.org/CAP/2009/06/factsheets/peri_sc.pdf)

<sup>12</sup> [http://schydrogen.org/documents/Factsheets/Fact\\_Sheet\\_-\\_ROI\\_Analysis.pdf](http://schydrogen.org/documents/Factsheets/Fact_Sheet_-_ROI_Analysis.pdf)

<sup>13</sup> [http://schydrogen.org/documents/Factsheets/Fact\\_Sheet\\_-\\_ROI\\_Analysis.pdf](http://schydrogen.org/documents/Factsheets/Fact_Sheet_-_ROI_Analysis.pdf)

<sup>14</sup> [http://schydrogen.org/EDA%20overview\\_January%202012\\_PDF.pdf](http://schydrogen.org/EDA%20overview_January%202012_PDF.pdf) and <http://www.eda.gov/NewsEvents/PressReleases/PRU.S.EDA.xml>

## **South Carolina's Business Hub Expands**

In the past few years, South Carolina has become a magnet for hydrogen fuel cell technology, especially at the Midlands Technical College Enterprise Campus<sup>15</sup>. Hydrogen fuel cell related companies such as Trulite<sup>16</sup>, LOGANEnergySC<sup>17</sup>, Proterra<sup>18</sup> and WeylChem Sustainable Materials<sup>19</sup> have all opened locations in South Carolina. Despite a lack of state incentives, hydrogen fuel cell companies see the value in South Carolina because of our business friendly environment and active Cluster participation. We could significantly improve our recruitment efforts with more state incentives that encourage local deployments of hydrogen fuel cells that would save South Carolinian's money in energy costs.

## **South Carolina Hydrogen and Fuel Cell State Policy:**

South Carolina is the first and only state in the U.S. to permit hydrogen and fuel cell deployments at the state level using existing internationally recognized codes and standards.

The South Carolina Hydrogen and Fuel Cell Permitting Law<sup>20</sup> (H. 3835) was passed into law in June of 2010. It places the authority and responsibility of permitting hydrogen and fuel cells in South Carolina in the jurisdiction of the Office of the State Fire Marshal. Benefits of the law include, (1.) Increases public safety by creating a state expert at the Office of the State Fire Marshal (2.) Creates a better business environment for the placement of hydrogen and fuel cell facilities (3.) Raises South Carolina's profile as a progressive place for hydrogen and fuel cells and (4.) Helps local communities recognize hydrogen as a transportation fuel.

South Carolina also offers a wide reaching tax exemption<sup>21</sup> for "any device, equipment, or machinery operated by hydrogen or fuel cells, any device, equipment, or machinery used to generate, produce, or distribute hydrogen and designated specifically for hydrogen applications or for fuel cell applications, and any device, equipment, or machinery used predominantly for the manufacturing of, or research and development involving hydrogen or fuel cell technologies."

The Hydrogen Infrastructure Development Fund<sup>22</sup> is a program that offers South Carolina taxpayers, who contribute to the Fund, 25% of the donation as a credit against their SC income tax, license fees, or insurance premium tax. Funds are distributed in the form of Grants used to promote the development and deployment of hydrogen production, storage, distribution and dispensing infrastructure.

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<sup>15</sup> <http://www.mtcenterprisecampus.com/>

<sup>16</sup> <http://www.trulitetechnology.com/>

<sup>17</sup> <http://www.loganenergy.com/index.html>

<sup>18</sup> <http://www.proterra.com/index.php>

<sup>19</sup> <http://www.weylchem.com/en/company.html>

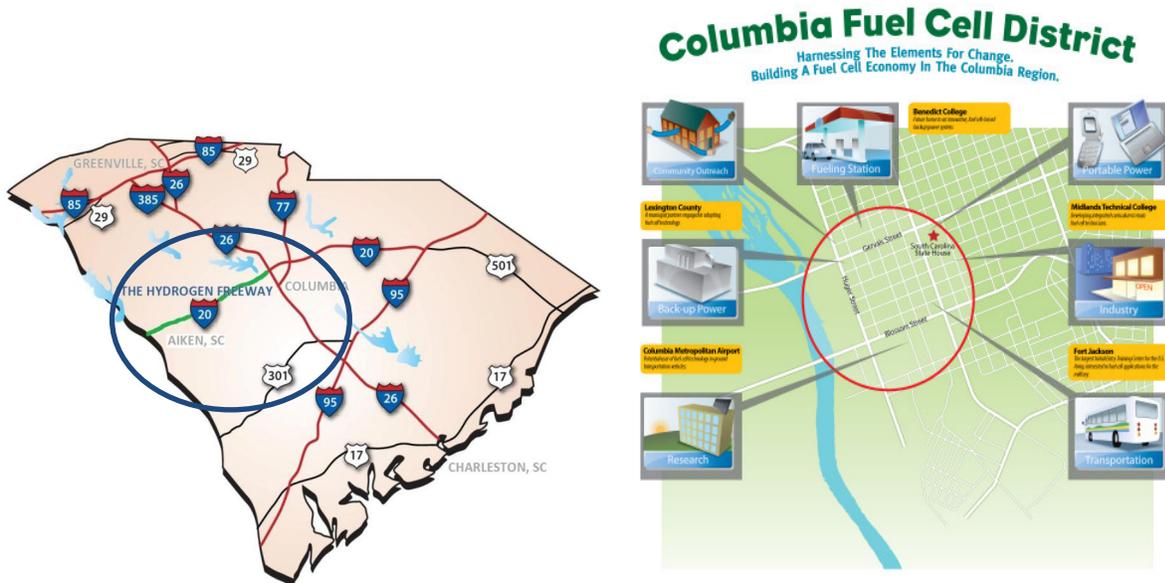
<sup>20</sup> [http://scstatehouse.gov/sess118\\_2009-2010/bills/3835.htm](http://scstatehouse.gov/sess118_2009-2010/bills/3835.htm) and [http://schydrogen.org/html/for\\_press.html](http://schydrogen.org/html/for_press.html)

<sup>21</sup> [http://schydrogen.org/Hydrogen%20and%20Fuel%20Cell%20TAX%20INCENTIVES\\_final.pdf](http://schydrogen.org/Hydrogen%20and%20Fuel%20Cell%20TAX%20INCENTIVES_final.pdf)

<sup>22</sup> [http://schydrogen.org/documents/hydrogen\\_fund.pdf](http://schydrogen.org/documents/hydrogen_fund.pdf)

## South Carolina's Hydrogen Freeway and Fuel Cell District:

South Carolina has two hydrogen filling stations: (1.) the Sage Mill Hydrogen Station, which has a capacity of 80 kg/day and (2.) the Columbia Hydrogen Station, which has a capacity of 120 kg/day. These two hydrogen stations are part of South Carolina's Hydrogen Freeway that bridge Aiken and Columbia together. South Carolina is leading the industry in developing higher throughput stations. The Sage Mill station provides enough hydrogen to fuel on-road internal combustion vehicles and off-road fuel cells used in material handling equipment at Bridgestone-Firestone and GENCO-Kimberly Clark. This is the only place in the U.S. that is using this innovative configuration. Columbia is also home to South Carolina's fuel cell district<sup>23</sup>.



## Potential Uses of Hydrogen Fuel Cells:

The potential uses for hydrogen fuel cells seem endless. Essentially any thing that is powered by electricity can be powered by a fuel cell. Current uses of hydrogen fuel cells include, but are not limited to, off-road capabilities, such as Forklifts and Segways; Combined Heat and Power (CHP); Stationary Power, which can power homes and businesses; Fuel Cell Vehicles; and portable devices, like mobile phones and cameras.

## Some Examples of Hydrogen Fuel Cells in South Carolina:

South Carolina companies see there are hydrogen fuel cell applications that are market-ready from a price, durability and performance perspective *today* - in particular with backup power and forklift trucks. For example, BMW currently has 85 fuel cell forklifts<sup>24</sup> in operation at its

<sup>23</sup> [http://fuelcellcollaborative.com/client\\_resources/aboutUs/fuelCellDistrict.jpg](http://fuelcellcollaborative.com/client_resources/aboutUs/fuelCellDistrict.jpg)

<sup>24</sup> <http://schydrogen.org/documents/Hydrogen%20and%20Fuel%20Cells%20-%20Lift%20Trucks,%20A%20Practical%20Application.pdf>

Greenville location and will soon begin phase 2 of their nationally recognized landfill gas-to-hydrogen project.<sup>25</sup> GENCO-Kimberly Clark has 25 fuel cell forklifts<sup>26</sup> in operation and Bridgestone-Firestone has 43 fuel cell forklifts.<sup>27</sup>

The U.S. Army base Fort Jackson in Columbia currently utilizes ten 5KW hydrogen fuel cells, which serve as a back-up power source for three on-post facilities (Telecommunications Center, Emergency Services Center, and Energy Monitoring and Control Facility)<sup>28</sup>.

The Savannah River National Laboratory (SRNL) is one of the top hydrogen research labs in the U.S. with 50+ years of research experience. SRNL was recently honored as a R&D Top 100 for its Porous Walled Hollow Glass Microspheres which has the potential for use in targeted drug delivery, hydrogen storage and other applications<sup>29</sup>.

Regionally, ARC:Hydrogen's co-location with the Savannah River National Laboratory provides for a space where industrial and academic partners can collaborate. Internationally, ARC:Hydrogen houses the administrative facility for the ITER project, which concerns hydrogen function of the multi-country reactor. ARC: Hydrogen is home to the Chevrolet Silverado 4x4 hydrogen internal combustion engine truck, which is the first registered hydrogen vehicle in South Carolina.

The University of South Carolina (USC) is a major player in the Cluster and is continuing to recruit high level scientists to its new Innovista Research Center<sup>30</sup> in Columbia. USC's Green Quad<sup>31</sup> dormitory uses an educational fuel cell that serves to show residents the benefits of fuel cells and also powers the lighting and hot water for the Center for Sustainability. The University is currently leasing a Ford hydrogen fuel cell bus<sup>32</sup> and owns (2) fuel cell powered Segways<sup>33</sup> Their Carolina baseball stadium scoreboard<sup>34</sup> is also powered by a fuel cell.

A group of USC graduates started Greenway Energy, which provides innovative and timely solutions to in-depth characterization of fuel cell systems, system development and education of future employees in the fuel cell industry.

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<sup>25</sup> <http://www.bmwblog.com/2011/07/25/bmw-manufacturing-announces-study-to-convert-landfill-gas-to-hydrogen/>

<sup>26</sup> <http://schydrogen.org/documents/Hydrogen%20and%20Fuel%20Cells%20-%20Lift%20Trucks,%20A%20Practical%20Application.pdf>

<sup>27</sup> Where the Jobs Are: Hydrogen Fuel Cells in South Carolina

[http://schydrogen.org/html/presentations\\_H101.html](http://schydrogen.org/html/presentations_H101.html)

<sup>28</sup> <http://www.army.mil/article/21460/> and

[http://www.fchea.org/core/import/PDFs/FCEUF\\_Presentation%20Format%2021%20April%2011\\_Dib.pdf](http://www.fchea.org/core/import/PDFs/FCEUF_Presentation%20Format%2021%20April%2011_Dib.pdf)

<sup>29</sup> [http://www.srs.gov/general/news/releases/nr11\\_srnl-rd100.pdf](http://www.srs.gov/general/news/releases/nr11_srnl-rd100.pdf)

<sup>30</sup> <http://innovista.sc.edu/>

<sup>31</sup> <http://www.housing.sc.edu/pdf/brochures/GreenQuadExecutiveBrochure.pdf>

<sup>32</sup> <http://www.columbiabusinessreport.com/news/38524-usc-to-operate-hydrogen-powered-bus?rss=0> and

[http://schydrogen.org/html/news/mar\\_11\\_news.html#mar3](http://schydrogen.org/html/news/mar_11_news.html#mar3)

<sup>33</sup> [http://www.che.sc.edu/centers/PEMFC/USC\\_news\\_102507.html](http://www.che.sc.edu/centers/PEMFC/USC_news_102507.html) - one of the Segways is home to the Innovista Research Center and the other is on loan to the City of Columbia

<sup>34</sup> <http://www.fuelcellcollaborative.com/aboutUs/Partners.aspx>

Clemson University is also a major player with its CU-ICAR research campus<sup>35</sup> as well as SC State University's work with biofuels at the James E. Clyburn University Transportation Center (JECUTC)<sup>36</sup>.

The Ridge at Chukker Creek<sup>37</sup>, a green subdivision featuring a hydrogen fuel cell, is currently under construction in Aiken, SC.

SCRA is leading the state with recruiting efforts and helping companies see the benefit of setting up shop in South Carolina. SCRA recently announced the closing of their 2012 Industry Partnership Fund (IPF) which spurred a total of \$6 million in private contributions<sup>38</sup>.

### **Resources:**

- South Carolina's Hydrogen and Fuel Cell Economy  
[http://schydrogen.org/documents/SC\\_H2-FuelCellEconomy-Rev\\_3\\_2-20-08\\_x2x.pdf](http://schydrogen.org/documents/SC_H2-FuelCellEconomy-Rev_3_2-20-08_x2x.pdf)
- The South Carolina Hydrogen Economy: Capitalizing on the State's R&D Assets  
<http://www.energy.sc.gov/publications/SCH2%20ROADMAP.pdf>
- South Carolina Hydrogen and Fuel Cell Cluster Successes  
<http://schydrogen.org/documents/Reports/SCHFCA%20Cluster%20Successes.pdf>

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<sup>35</sup> <http://cuicar.com/>

<sup>36</sup> <http://utc.scsu.edu/>

<sup>37</sup> <http://www.theridgeaiken.com/green.php>

<sup>38</sup> [http://www.scra.org/press/IPF\\_Fund\\_2012\\_Full.html](http://www.scra.org/press/IPF_Fund_2012_Full.html)