A 2015 Update to "Early Stage Market Change and Effects of the Recovery Act Fuel Cell Program"

A Report Prepared for

Lawrence Berkeley National Laboratory

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Executive Summary

Introduction

In 2012, the U.S. DOE funded a study, *Early Stage Market Change and Effects of the American Recovery and Reinvestment Act (ARRA) Fuel Cell Program (Final Report),* that reported the early market effects of ARRA funding on the deployment of fuel cell materials handling equipment (MHE) at U.S. logistics and manufacturing sites and backup power (BUP) at telecommunication industry sites.[1] A goal of the study was to assess the market effects of ARRA funding on the rate of adoption of fuel cell MHE and BUP. The study presented deployment data for MHE and BUP from 2004 through Q1 2013.

Findings from that study indicated that the ramp up of purchases of FC MHE between 2009 and 2011 was influenced by the Fuel Cell ARRA (FC-ARRA) funding as well as other factors such as 1603 Tax Grants that were part of the FC-ARRA funding and tax incentives and state funding in some areas of the country. Therefore, there was uncertainty about the direct attribution of the effects of ARRA funding for increases in FC MHE and FC BUP systems.

The purposes of this study is to extend the time frame of the earlier study to allow further assessment of deployment of FC MHE from 2012 to November 15, 2014 and for BUP from 2012 through September 2014, and to identify and evaluate any additional or new evidence about the direct and/or indirect effects of FC ARRA funding on FC system deployments.

Methods

The methods used mirror the methods used in the previous report. The primary data collection strategy was to conduct Web searches for information about deployments of FC MHE and FC BUP systems subsequent to January 2013. The searches focused on collecting and documenting the timing and location of deployments, the number of units deployed, the firms purchasing or leasing the units, whether a deployment was a first deployment or a replication following a previous deployment at an existing or new site, and whether the deployment was part of a pilot program.[2]

The BUP data collection effort included the Web searches as well as Interviews with Ballard Power Systems, ReliOn Inc., and Altergy Systems, and the results of the interviews are reported at the end of the report.

Findings for FC MHE

Figure ES-1 displays the annual number of FC MHE deployed from 2004 to 2014. It shows a decline in the number of MHE deployed in 2012 and 2013 relative to the ARRA funding period and then a large increase in 2014. The large increase in 2014 was due to two firms

[1] "Early Stage Market Change and Effects of the Recovery Act Fuel Cell Program", Submitted to: Lawrence Berkeley National Laboratory, Prepared by EnerSys Innovation, LLC, Under Contract to Strategic Analysis, Inc., Prepared for Office of Energy and Renewable Energy, Department of Energy, January, 2014, Page xiii. http://www1.eere.energy.gov/analysis/pdfs/arra-fcp_report_jan2014.pdf (last accessed April 20, 2015)

[2] For this study, pilot programs were defined as the installation of 12 or fewer units that were not permanent. There were some installations with many more units that were described as pilots but the units remained in place.

replicating deployments at new sites. In addition, it shows the number of early pilot units deployed. This study extends the time frame of the earlier study allowing further assessment of deployment of FC MHE from 2012 to November 15, 2014 and for BUP from 2012 through September 2014. Analysis in the body of the report demonstrates that both the number of firms making first purchases and the number of firms replicating purchases declined from 2011 to 2014.

The ARRA funding was an important event clearly calling attention to FC MHE. The tax incentives and FC ARRA grants were important to the market as demonstrated by the larger number of units purchased. The events leading up to the ARRA funding were important to create market readiness.

If ARRA funding is assumed to be just the ARRA funds released by DOE, then the evidence of a significant impact is limited. The ARRA funded units were less than half the units in 2010 and less than 10 percent in 2011. These effects were likely symbolic. The increases in FC MHE systems in 2010 and 2011 and following are, therefore, best understood as the confluence of several events (including the ARRA funding) that drove the market.

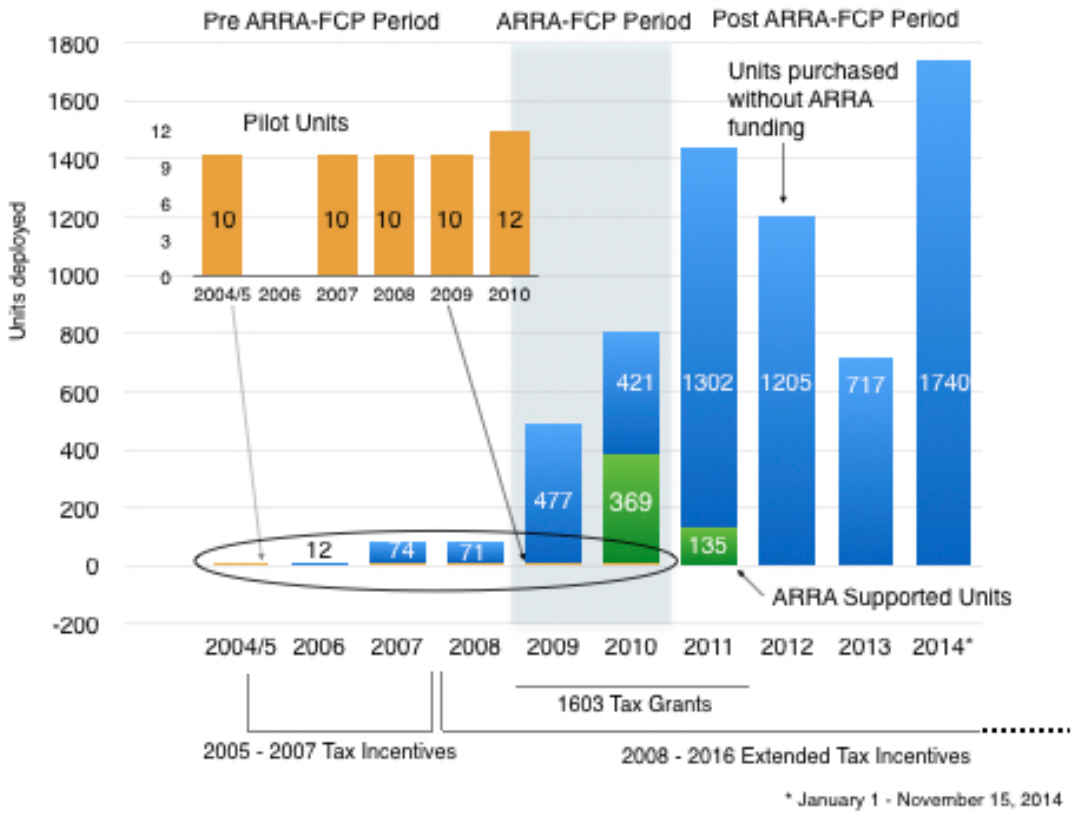


Figure ES-1 FC MHE Systems Deployed 2004-14 by Pilot Status and ARRA Funding

For this market to be viable in the long term, more first orders are needed as well as replications. It is not clear how many replications can occur beyond those that have already taken place without additional first purchases because many first purchasers have already

made repeated purchases. One positive note in terms of sustaining the market is that replacement units are starting to be needed. The replacements in combination with first purchases and replications will help to sustain and perhaps grow the market for several years.

The market seems to have not yet reached takeoff. If it had, there would be more first purchases and replications. The manufacturers have addressed the technical and fueling problems although more might be done. It is unclear if the solutions are adequate. Because appropriate data were not collected, the extent to which potential customers view battery technology and the rapid changes in battery technology as leveling the playing field is unclear.

The market seems to have not yet reached takeoff. If it had, there would be more first purchases and replications. The manufacturer has addressed the technical and fueling problems, at least in part. It is unclear if the solutions are adequate. What is also unclear is the extent to which customers view battery technology and the rapid changes in battery technology as leveling the playing field increasing the competitiveness of the battery option.

Findings for FC BUP

Figure ES-2 shows the estimated annual sales of BUP FC systems from 2004 to 2014. This figure might be interpreted to suggest that the ARRA-FCP appears to have influenced the BUP market until a comparison of the types and locations for the sales is made.

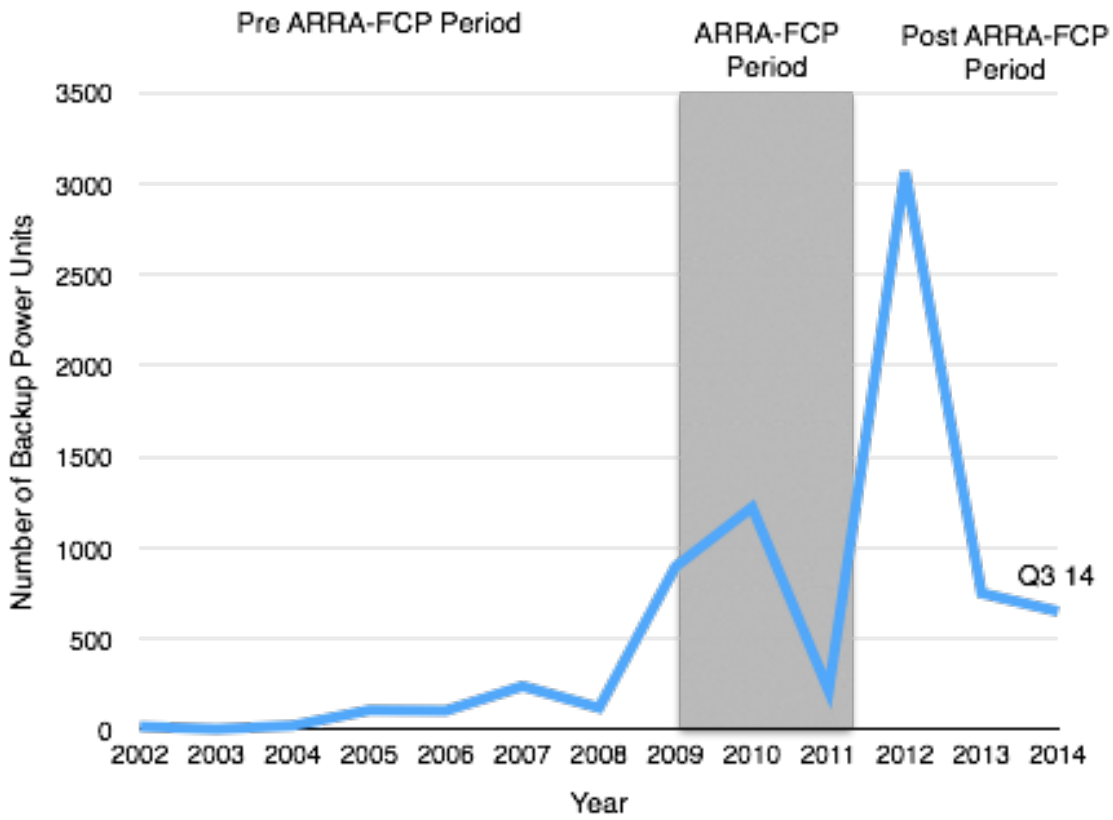


Figure ES-2 Annual Sales of BUP FC Systems 2004 to 2014

The ARRA-FCP BUP sales were in the U.S. with BUP fuel cell systems operating almost exclusively on hydrogen. The MetroPCS purchase supports the influence of the ARRA-FCP post funding with the purchase of hydrogen fueled BUP for U.S. applications. The post ARRA-FCP sales for 2013 and 2014 are predominantly non-U.S. sales of methanol and hydrogen fueled systems. Countries with inadequate and fragile power grids which experience multiple and extended outages daily and which lack an established hydrogen infrastructure, are an emerging market for methanol fueled BUP. Countries with a well-established hydrogen infrastructure, such as Europe, are an emerging market for hydrogen fueled BUP.

Table of Contents

1. Introduction

In 2012, the U.S. DOE funded a study, *Early Stage Market Change and Effects of the American Recovery and Reinvestment Act (ARRA) Fuel Cell Program (Final Report),* that reported the early market effects of ARRA funding on the deployment of fuel cell materials handling equipment (MHE) at U.S. logistics and manufacturing sites and backup power (BUP) at telecommunication industry sites.[3] A goal of the study was to assess the market effects of ARRA funding on the rate of adoption of fuel cell MHE and BUP. The study presented deployment data for MHE and BUP from 2004 through Q1 2013.

There was a significant ramp up of FC MHE installations between 2009 and 2011 and of FC BUP in 2009, 2010, and 2012. After the FC MHE ramp up, there was a decline in shipments in 2012 (the first year after the main ARRA deployments) and first quarter 2013 FC MHE, as well as a decline in the number of firms making first purchases and firms replicating purchases of FC MHE. Because only Q1 2013 data were available, it was unclear whether the decline in 2012 was a short-term anomaly or the beginning of a decline or perhaps a leveling off of purchases of FC MHE.

FC BUP saw a rapid expansion of sales in 2012 but declines in 2013 and 2014. If the hydrocarbon fuel FC BUP systems and the international sales are removed, very small numbers of direct hydrogen fueled FC BUP remain in 2012.

Findings from that study also indicated that the ramp up of purchases of FC MHE between 2009 and 2011 was influenced by the Fuel Cell ARRA (FC-ARRA) funding as well as other factors such as 1603 Tax Grants that were part of the FC-ARRA funding and tax incentives, and state funding in some areas of the country. Therefore, there was uncertainty about the attribution of the effects of ARRA funding for increases in FC MHE and FC BUP systems.

This study extends the time frame of the earlier study allowing further assessment of deployment of FC MHE from 2012 to November 15, 2014, and for BUP from 2012 through September 2014. No announcements of additional FCE MHE deployments have been made since November 15, 2014, so the numbers in this report likely represent the whole of FC MHE deployments in 2014. However, the 2014 annual report for a key firm has not yet been released, so there could be additional fourth quarter FC MHE deployments. Likewise, there may be changes to FC BUP deployments in Q4 2014. Another study purpose is to identify any additional or new evidence about the direct and/or indirect effects of FC ARRA funding on FC system deployments.

[3] "Early Stage Market Change and Effects of the Recovery Act Fuel Cell Program", Submitted to: Lawrence Berkeley National Laboratory, Prepared by EnerSys Innovation, LLC, Under Contract to Strategic Analysis, Inc., Prepared for Office of Energy and Renewable Energy, Department of Energy, January, 2014, Page xiii.

2. Study Methods

2.1 Data Collection Methods for FC MHE

The methods used mirror the methods used in the previous report. The primary data collection strategy was to conduct Web searches for information about deployments of FC MHE and FC BUP systems subsequent to January 2013. The searches focused on collecting and documenting the timing and location of deployments, the number of units deployed, the firms purchasing or leasing the units, whether a deployment was a first deployment, a replication following a previous deployment at an existing or new site, and/or whether the deployment was a pilot.

All of the data from prior searches were confirmed. During this process, some sources of data that were not available at the time of the research for the previous report were located. In all but a handful of cases, the numbers from the new data corroborated the earlier data. There were a few cases where the deployment numbers changed by one to a few units and which was likely the result of rounding in either the old or the new source. In those instances, the sources were compared, and numbers that were reported close in time but after the actual deployment date and reported by and/or attributed to the firm doing the deployment were chosen over numbers from other timeframes and sources or that had evidently been rounded.

FC MHE units were assigned to deployment year and not year of sale. Deployment is defined as the actual delivery of a unit. In a few instances, the new data sources resulted in a more accurate assignment of the deployment date. As an example, it was discovered that units were reported as being sold in one year but were actually delivered in the next year. The difference in the date of reported sale and deployment occurred because: units were sold for green field facilities were not ready for occupancy, time was needed to construct fueling facilities, or other reasons.

There were a few instances where assignment to a deployment year required judgment because the announcement of the opening of a facility occurred within a few days of the beginning of a year. These deployments were assigned to the previous year because it was assumed that the units had been manufactured and shipped prior to the end of the calendar year and that some training and commissioning had occurred after their receipt.

Pilot projects were defined as the deployment of FC systems involving 12 or fewer units for a short-term period. For example, one pilot program moved two units among four or five manufacturing firms for two-week trials. For firms that participated in a pilot program, subsequent purchases of additional units were considered to be replications rather than first purchases. There were some purchases of 20 or more units that were described as pilots by the participants, but these units remained in place, were re-deployed, or there is no accessible record indicating that they were removed so they were treated as deployments.

Three lists of the number of FC MHE units deployed at various sites were located: lists from various years from *Fuel Cell 2000*, a list compiled and mapped using Google Maps,[4] and a

[4] https://maps.google.com/maps/ms?msa=0&msid=215394972384509175867.0004da7b8ad896f04c443&dg=feature

list that was part of a presentation by Air Liquide in 2013.[5] None of these lists contained data more recent than 2013. The *Fuel Cell 2000* list was consistent with the sources developed for this project, although there were some variations in deployment dates attributable to the changes described above. The Google Map list and the list in the Air Liquide presentation (2013) each had a few deviations in numbers of units from the source data developed for this project. The Google Map used the date when the site was added to the map rather than deployment date. An attempt was made to trace the inconsistent numbers, but supporting sources for the inconsistent numbers could not be found, and these numbers were not used.

2.2 Data Collection Methods for FC BUP

The approach for updating data about the influence of the ARRA Fuel Cell Program (ARRA-FCP) on commercialization of BUP fuel cell systems involved the review of the following:

- Presentations, reports, program records, and publications by the Fuel Cell Technologies Office of the U.S. Department of Energy
- Publications, composite data products, and presentations prepared by the National Renewable Energy Laboratory
- Review of press releases and publications of Altergy Systems, Ballard Power Systems, ReliOn Inc., and Plug Power
- Review of quarterly reports of Ballard Power Systems and Plug Power
- *Business Case for Fuel Cells 2013 and 2014* – by Breakthrough Technologies Institute
- The Fuel Cell Industry – by E4tech[6]

Interviews with Ballard Power Systems, ReliOn Inc., and Altergy Systems were conducted and the results of the interviews are reported at the end of this report.

At the time of the initial project,[7] the firms offering FC BUP were privately held. Thus, public data about sales were not available. Therefore, the approach was to conduct interviews with relevant stakeholders. In the current round of interviews, the stakeholders were asked about sales, but they were not responsive to the questions. They did provide information about the state of the market and information about their products. These interviews were conducted by telephone by a member of the study team using a modified version of the interview guides developed for the earlier project. The interviews lasted an hour to an hour and a half.

[5] http://www.ifema.es/ferias/genera/jornadas/aeh2_27/juangomez.pdf

[6] "The Fuel Cell Industry Review, 2014", E4tech, November, 2014 (revised version)

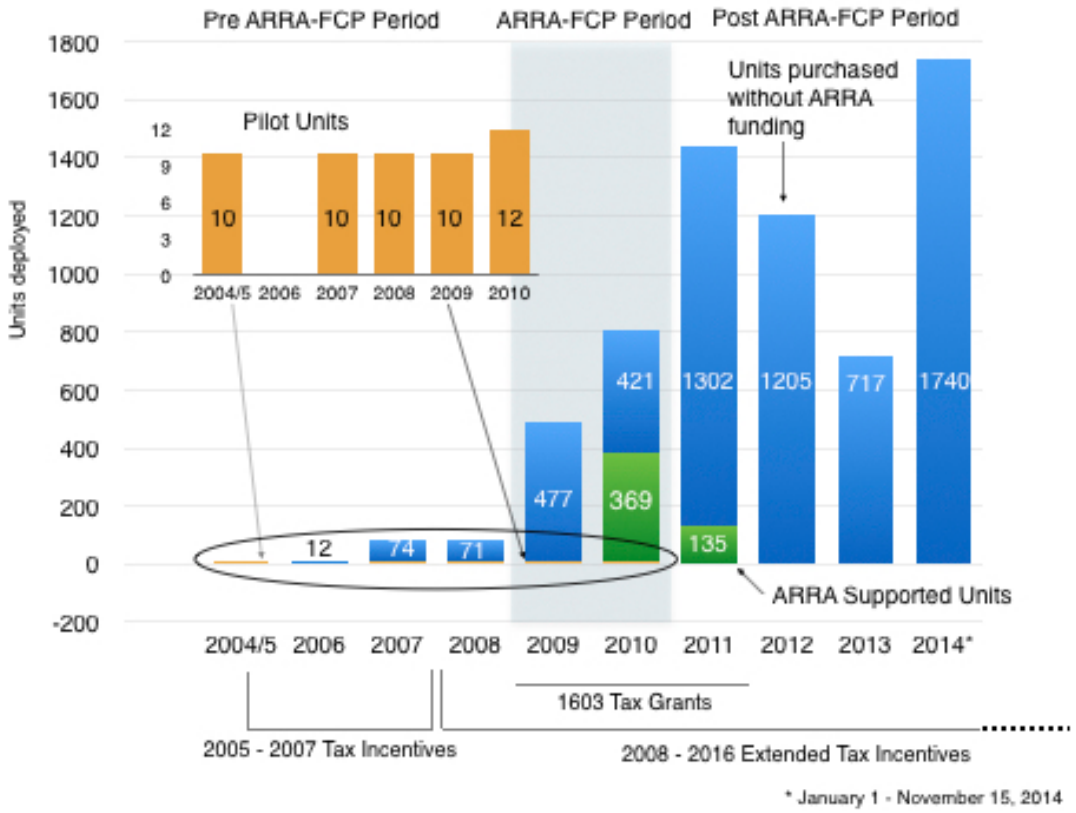
[7] "Early Stage Market Change and Effects of the Recovery Act Fuel Cell Program", Submitted to: Lawrence Berkeley National Laboratory, Prepared by EnerSys Innovation, LLC, Under Contract to Strategic Analysis, Inc., Prepared for Office of Energy and Renewable Energy, Department of Energy, January, 2014, Page xiii.

3. FC MHE Deployment Update

3.1 FC MHE Deployments Updates

Figure 1 displays the annual number of FC MHE deployed by whether the units were part of a pilot project, received ARRA funding, or were purchased without ARRA funding. The pilot programs for FC MHE occurred between 2004 and 2010. The total number of deployed FC MHE systems in any one year in these pilots was 12 or fewer as shown in yellow (and in the enlarged area). Prior to 2008, fewer than 75 units were deployed in any one year.

In 2009, compared to 2008, there was a sharp increase in deployments. Part of this was due to the delivery of a very large order to a midwestern grocer. In 2010 and 2011, the number of units deployed increased by about 75 percent each year to a total of 1,437 units. In 2012 and 2013, the number of units deployed declined to 717, which was fewer than the number deployed in 2010. With six weeks left in 2014, the total number of MHE FC systems deployed reached its highest number, 1,740 units.



Pilot units are the deployment of 12 or fewer FC systems 12 or fewer for a short-term period

Figure 1 FC MHE Systems Deployed 2004-14 by Pilot Status and ARRA Funding

The goal of ARRA was to encourage economic growth following the economic downturn in 2008. ARRA projects were to be "shovel ready," that is, ready to go in the ground as soon as possible after funding, within a year or two. For the Fuel Cell Technology Office (FCTO), an earlier Funding Opportunity Announcement (FOA) provided an opportunity to contribute

shovel ready projects and to provide an early stimulus to the FC MHE market. The 369 ARRA FC MHE system deployments in 2010 combined with another 135 in 2011 represented the total ARRA funded FC MHE systems (504 units). The timing of the 2011 deployments was influenced by whether it was a greenfield[8] installation and/or whether a fueling installation was needed. ARRA funded installations were about 48 percent of the total 2010 installations and nine percent of the total 2011 installations. Thus, the majority of the installations in both years were non-ARRA installations

Some of the FC MHE installations received Tax Grants. It is quite likely that the remaining firms made use of tax incentives although the number of firms receiving tax incentives cannot be confirmed. Figure 1 also shows the tax incentives were available between 2005 and 2007 and these were extended to 2016. From 2009 to 2011, firms could receive a tax grant in lieu of the tax incentive. Tax grants were attractive to some firms that needed access to capital because the tax grant was received when the project was commissioned rather than when a corporate tax filing was completed. Some tax grants were received after 2011, but a firm had to have started the project before the end of 2011 and filed a form indicating that the project was started but not completed. There were at least eight FC MHE projects that received tax grants that went directly to the firm purchasing the MHE fuel cells. We know that some equipment leasing firms used tax grants to lease FC systems for MHE but these cannot be identified. Firms could receive a 30 percent grant subject to a cap or a credit for installing FC MHE. In addition, some states provided grants to assist firms purchasing FC MHE to install fueling stations.

Figure 2 provides another perspective by categorizing FC systems deployments as first time sales to new customers, existing customers making additional purchases at the same site or at different sites, and customers replacing a previously purchased fuel cell system. The increase in the number of systems sited is dependent on selling to new customers and making repeat sales to existing customers. Replications or repeat sales are particularly important because the sales process is generally easier, and these sales confirm the value of the FC MHE system to the customer. It is also important to generate new customers, because this signals continued customer acceptance of the value proposition of the technology and the potential for additional sales to those new customers with multiple sites.

Because of the fueling infrastructure requirements, sites generally need a minimum of 50 to 70 FC MHE to be cost effective. This limits deployments at sites with fewer MHEs. This also limits replications to multi-site customers, to sites where deployments are being staged, or to sites where expansion is occurring.

[8] The term “greenfield” alludes to ground up construction of a new facility. Many units were retrofit in existing logistic facilities (brownfield sites) and to existing battery powered MHE units.

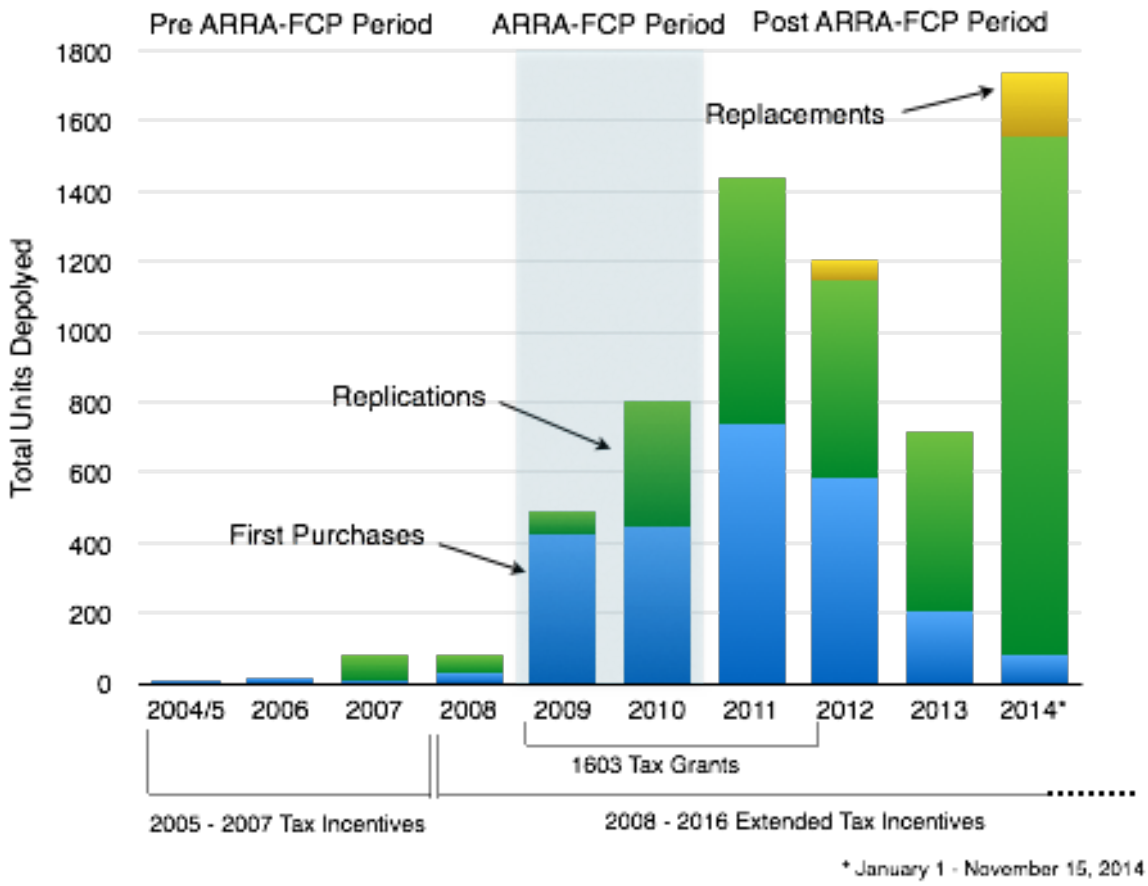


Figure 2 FC MHE Systems Deployed by Whether They Were a First Purchase, Replication, or Replacement

In terms of FC systems, as would be expected in the early stages of product diffusion, first purchases predominated from 2009 to 2011 as interest and acceptance of the technology increased. After the first two or three years, one would expect continued and perhaps increased first purchases of FC MHE systems with some variation between years, but the total number of first purchases declined starting in 2012 from about 600 systems to 50 systems in 2014.

The yellow portion of the bars indicates the number of replacement MHE systems. The actual total number of new systems is the combined number of first purchases and replications. The manufacturer benefits from selling replacements, but replacements do not increase the total number of units in operation. MHE Fuel cell systems currently have a lifetime of up to five or six years.[9] Systems purchased in 2009 are approaching their useful life in 2014 or 2015. There were replacements in 2012 and additional replacements in 2014. The 2012 replacements were for 55 FC MHE systems that a customer purchased as part of an earlier 2007 trial. In 2012, this customer also added new units resulting in the entire site being converted to FC MHE. The 2014 replacements were for the first very large order of FC

[9] The site life of BUP Fuel Cell systems is closer to ten years because they operate less frequently.

systems installed in 2009 at Central Grocers. In 2015 and beyond, replacement of FC Systems may generate a stream of as many as 600 to 1500 sales annually assuming that FC systems are replaced with FC systems.

Figure 3 shows the number of firms making first purchases, firms replicating their earlier purchases to add units at existing or new sites, and firms purchasing replacement units. The number of firms making first purchases increased to 10 firms until 2010 after which the number of firms making first purchases declined to two firms in both 2013 and 2014. The number of firms replicating purchases peaked at 10 in 2011 and then declined to five in 2013 before increasing to eight firms in 2014. However, five of the eight replications were a result of decisions at two firms, one of which accounted for 848 of the 2014 systems and the other 380 systems. In other words, there were five unique firms that replicated purchases. Two firms accounted for 74 percent of the replications in 2014, and the replacements are represented by one firm each in 2012 and 2014.

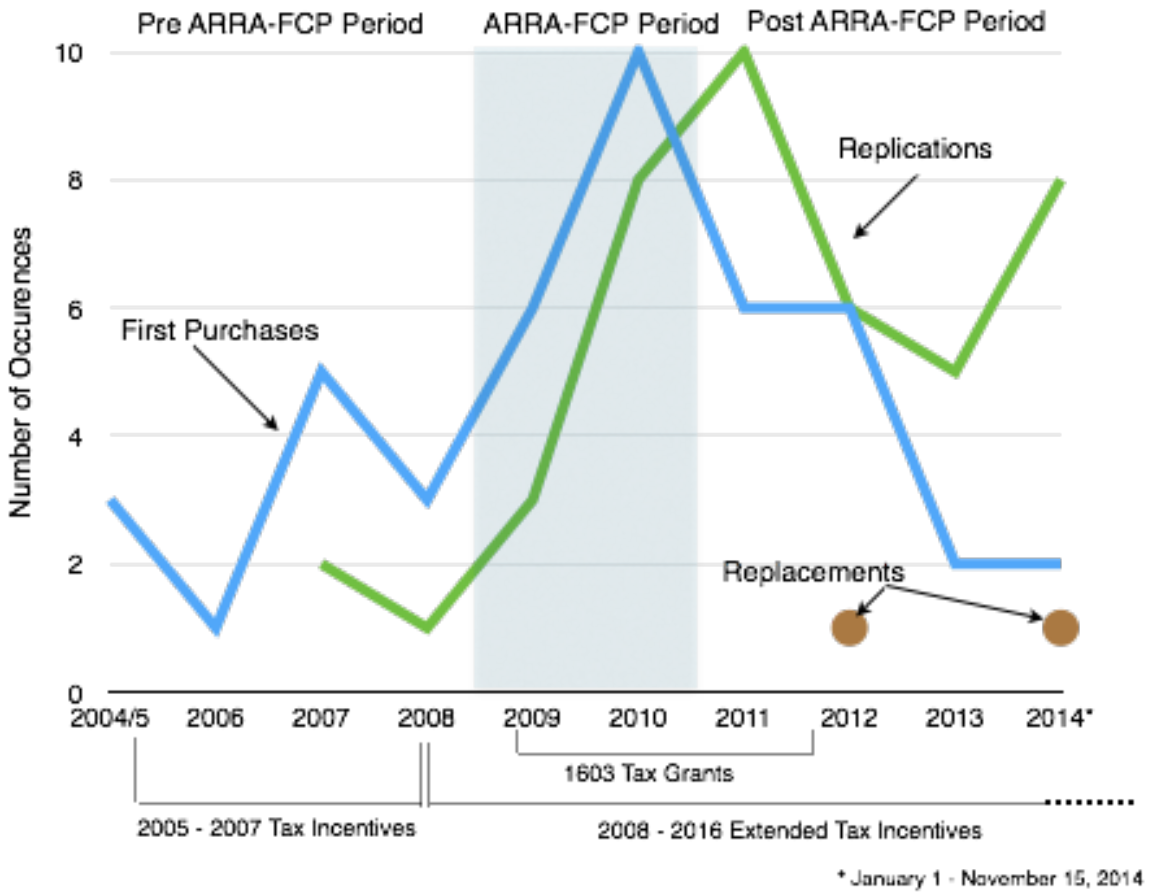


Figure 3 Number of Firms Making First Purchases, Replications, and Replacements

Looking at the overall picture, the deployment of fuel cell systems increased from 2009 to 2011 (slightly more than 1,400 units). This corresponds with the ARRA funding but ARRA funding accounted for fewer than 50 percent of the units sold in 2009. It also coincided with

the availability of tax grants and tax incentives. From 2011, systems deployments decreased by about half to 717 systems in 2013 with the number of firms making first purchases declining from 10 in 2010 to one in 2014.

The largest annual net number of deployments occurred in 2014 as a result of 8 replications that were attributable to 5 firms. The two and a half fold increase in systems deployments in 2014 was largely accounted for by two firms that replicated systems purchases at three and two sites respectively accounting for 1,228 of the systems. An additional, 182 systems replaced existing FC MHE systems for a net increase of 1,558 FC systems.

For the market to remain healthy, the number of firms making first purchases needs to increase. Market growth will also be driven by replications and replacements, but the number of replications may be limited by the number of opportunities for replications among firms that have made first purchases. Replacements of early fuel cell systems have started, and there is a potential for sales increasing assuming that FC MHE systems are replaced with FC MHE systems.

3.2 The Market Effect of ARRA FC-MHE

The purpose of this report is to assess the effects of ARRA funding on the market for FC-MHE. As described above, the number of FC-MHE systems in the market increased dramatically during the ARRA funding period, then declined and increased again. Tax grants and tax incentives and other non-Federal incentives were present during the ARRA funding period as well. The tax grants were a part of the ARRA funding legislation, so therefore, in some sense they could be considered part of the ARRA stimulus. However, in the 2014 publication and this report, ARRA funding and tax grants are distinguished. It is likely that most firms that purchased FC-MHE systems in this period benefitted from ARRA funding, a tax grant, or a tax incentive. Thus, it is difficult, if not impossible, to disentangle the direct effects of the ARRA funding supplied by the FCTO as separate from the incentives and grants.

If ARRA funding is assumed to be just the ARRA funds released by DOE, then the evidence of a significant impact is limited. The ARRA funded units were less than half the units in 2010 and less than 10 percent in 2011. These effects were likely symbolic. The increases in FC MHE systems in 2010 and 2011 and following are, therefore, best understood as the confluence of several events (including the ARRA funding) that drove the market. Figure 4 shows the timing and approximate duration of selected key events between 2004 and 2014 many of which contributed to the rapid expansion of the market in 2010 and 2011.

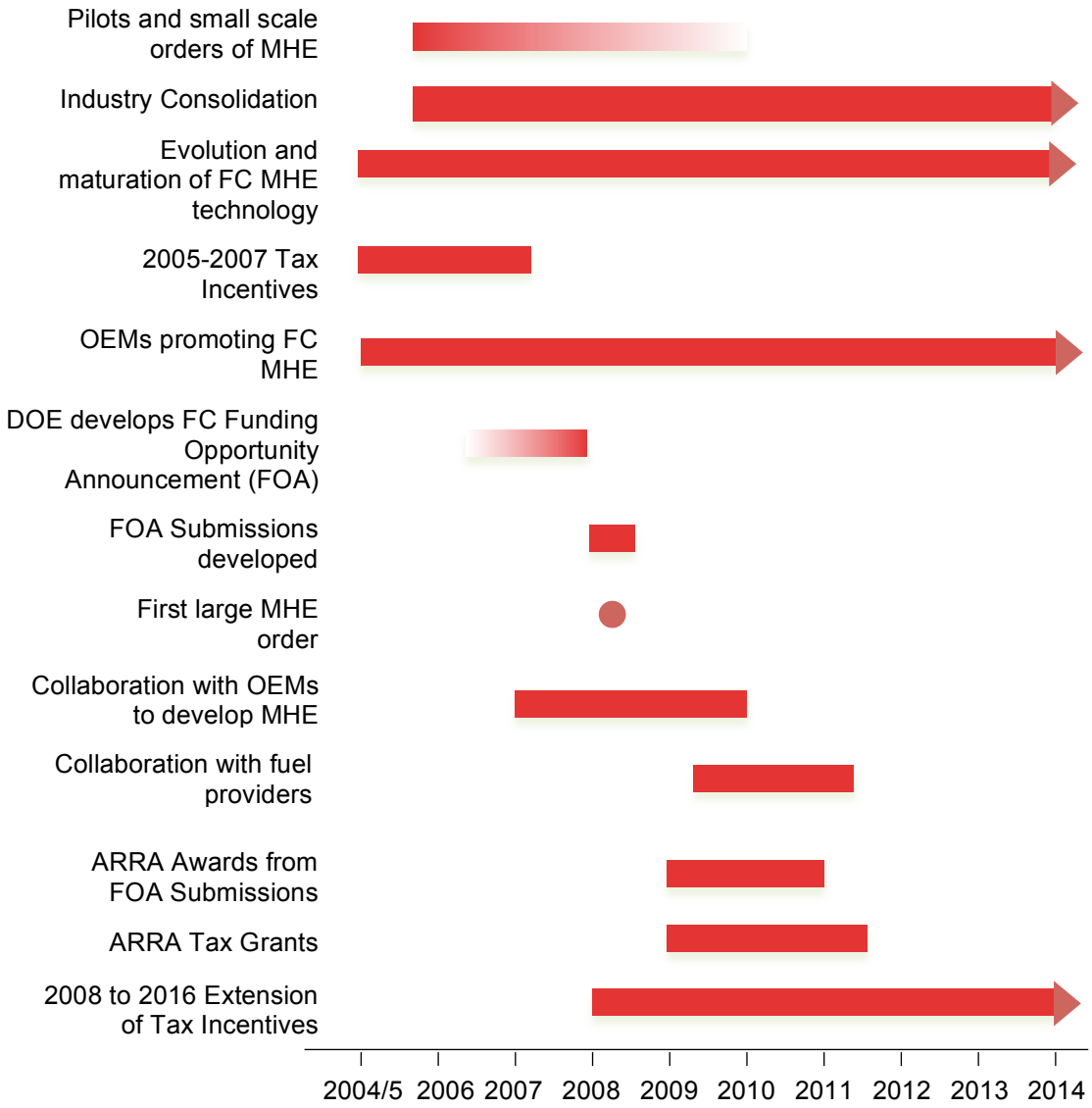


Figure 4 Timeline of Events Influencing FC MHE Sales

A detailed explication of events includes:

- Numerous small pilot projects between 2004 and 2009 provided proof of concept and visibility for FC MHE.
- Industry consolidation resulted in fewer players and reduced the number of FC offerings for MHE and increased the chances that firms offering FC systems for MHE industry could survive.
- Maturation of FC technology resulted in improvements to reliability and lifetimes.
- FC systems makers interacted with MHE original equipment manufacturers (OEMs) to make FC systems compatible with existing MHE designs, thus allowing FC MHE systems to be retrofitted in existing MHE systems and compete in the MHE market without the redesign of the truck.

- FC MHE systems makers and manufacturers actively promoted their technology with Congress and state entities seeking tax and other incentives.
- The release of a DOE FOA called attention to and stimulated interest in FC MHE.
- The development of firms' and vendors' responses to the FOA increased the understanding of the benefits and costs of FC MHE and FC BUP systems among potential end users.
- The early 2005 to 2007 tax incentives were extended from 2008 to 2016 providing stable financial incentives.
- The ARRA Tax Grants 2009 to 2011 allowed firms to recover capital quickly.
- A widely publicized purchase in 2008 of more than 200 FC MHE systems deployed by a grocery distribution center in early 2009 significantly raised the visibility of the FC MHE technology.
- ARRA awards were made in April 2009 based on the FOA submissions.
- A rapid decline in the economy after October 2008 led to a decrease in orders for all MHE but the subsequent recovery in 2010 led to an increase in orders for all types of MHE.
- Hydrogen fueling was recognized as a problem. FC MHE system manufacturers and fuel suppliers worked together on solutions.
- There was a rise in the number of firms, especially large firms, that used MHE to support sustainability goals and who embraced the practical and symbolic value of hydrogen in those efforts.

As the orders and deployment of fuel cells began to increase in 2010, the following were observed in the period that followed:

- During the early roll out of commercial FC MHE, there were reliability issues with some of the FC systems.
- One of the FC system providers made significant changes simplifying the technology and increasing the reliability of the products it was supplying.
- FC system providers learned that field support for FC MHE required more effort than they had anticipated and that they were not well organized and structured for that support role.
- A manufacturer entered into an arrangement with a fueling partner to address fueling issues and also explored reformer technology (natural gas to hydrogen) to provide hydrogen at sites with smaller numbers of FC MHE.
- An additional key event was the announcement by Plug Power that they were going to provide a product call GenKey Systems. This is an end-to-end solution that provides hardware, fueling, and maintenance solutions in a single package. It was anticipated that this would simplify the purchase, installation, and use of FC MHE systems.

At this writing in early 2015, the situation appears to be as follows. Plug Power experienced significantly reduced deployments in 2013 resulting in what its CEO described publicly as "a near death experience." In the Q4 of 2013, Plug Power executed an major purchase order for 1,700 FC MHE to be delivered in 2014 and 2015. This same firm placed a follow-on order for about 250 additional FC MHE systems. Another retailer ordered FC MHE for two additional sites. There were follow-up orders from additional companies, and two companies placed first orders. Market observers expected that there would be a significant bounce from

the very large order from the retailer. That order did create some momentum but the momentum was not as great as the observers expected. The number of first orders in 2014 is down compared to the period between 2010 and 2012. Although the volume of FC MHE replications was significantly up in 2014, the number of firms replicating orders was down.

For this market to grow, more first orders are needed as well as replications. Replications are a primary source of market growth. It is not clear how many replications can occur beyond those that have already taken place because existing first purchasers may have met their needs. One positive note in terms of sustaining the market is that replacement units are starting to be needed. If those who have purchased FC MHE replace them, that will help to sustain the market for several years.

The ARRA funding was an important event clearly calling attention to FC MHE. The tax incentives and grants were important to the market as demonstrated by the larger number of units purchased. The events leading up to the ARRA funding were important to create market readiness.

The market seems to have not yet reached takeoff. If it had, there would be more first purchases and replications. The manufacturer has addressed the technical and fueling problems, at least in part. It is unclear if the solutions are adequate. It is also unclear the extent to which customers view battery technology and the rapid changes in battery technology as increasing the competitiveness of the battery option.

4. BUP Deployment Update

This section begins with a a foundational discussion of FC BUP by briefly reviewing the 2004 to Q1 2013 baseline found in the original report.[10] Following this, the data for Q1 2013 through Q3 2014 from the Fuel Cell Technologies Office and from the NREL CPD are presented. A third part of this section discusses manufacturers data' for this same period. Finally, the overall trends from 2004 to 2014 are presented.

Part of the discussion about BUP centers around the differences in technologies: hydrogen fueled backup and hydrocarbon backup power. In North America telecommunications BUP, the demand is for instant power with 99.9999 percent reliability and the avoidance of costly per minute cell tower downtime that effects provider reputation. Hydrogen fueled backup power is most frequently used where infrastructure exists to produce and distribute hydrogen. Compared to direct hydrogen, reformer based solutions (hydrocarbon) have a longer start up time and require some form of hybridized power system (for example, batteries, generators, or in combination with hydrogen fueled backup) to meet the instant power requirement.[11] The hydrocarbon back-up units may use reformers to produce hydrogen or direct oxidation of hydrocarbons such as methane, ethane, etc. Hydrocarbon fuel cells tend to be used in areas where hydrogen infrastructure is limited (frequently in developing nations) and where hydrocarbon fuels are more accessible than hydrogen. Therefore, sales, orders, deliveries, or commissioning of fuel cell systems operating on hydrogen and reformed methanol, LPG, or natural gas are reported separately.

4.1 The 2004 to Q1 2013 BUP Baseline

4.1.1 Direct Hydrogen FC BUP Sales in the U.S.

Figure 5[12] identifies direct hydrogen based BUP sales during three periods from 2004 to Q1 2013: Pre ARRA-FCP (2002 – 2008), ARRA-FCP (2009-2010), and Post ARRA-FCP (2011 through Q1 2013). The data from 2004 to 2010 are shown as a trend. Through 2008, the number of hydrogen based units sold or deployed was 100 or fewer annually. In 2009 and 2010, the number of units increased to about 900 and 1,200, respectively. The number of units from 2011 to Q1 2013 was about 3,200 units. These are represented as a green circle because the was combined for parts of two years. In Q1 2013, there were 819 BUP systems deployed as a result of the ARRA-FCP.[13]

[10] Early Stage, *Ibid*.

[11] http://fuelcellsworks.com/news/2011/01/11/idatech-issues-product-and-trading-updates/ and Early Stage, Ibid. p. 66.

[12] Early Stage, *Ibid*. p72.

[12] J. Kurtz, S. Sprik, C. Ainscough, G. Saur, M. Post, and M. Peters, "Early Fuel Cell Market Deployments: ARRA and combined (IAA, DLA, ARRA), Quarter 1, 2013, Composite Data Products – Deployment, May 9, 2013

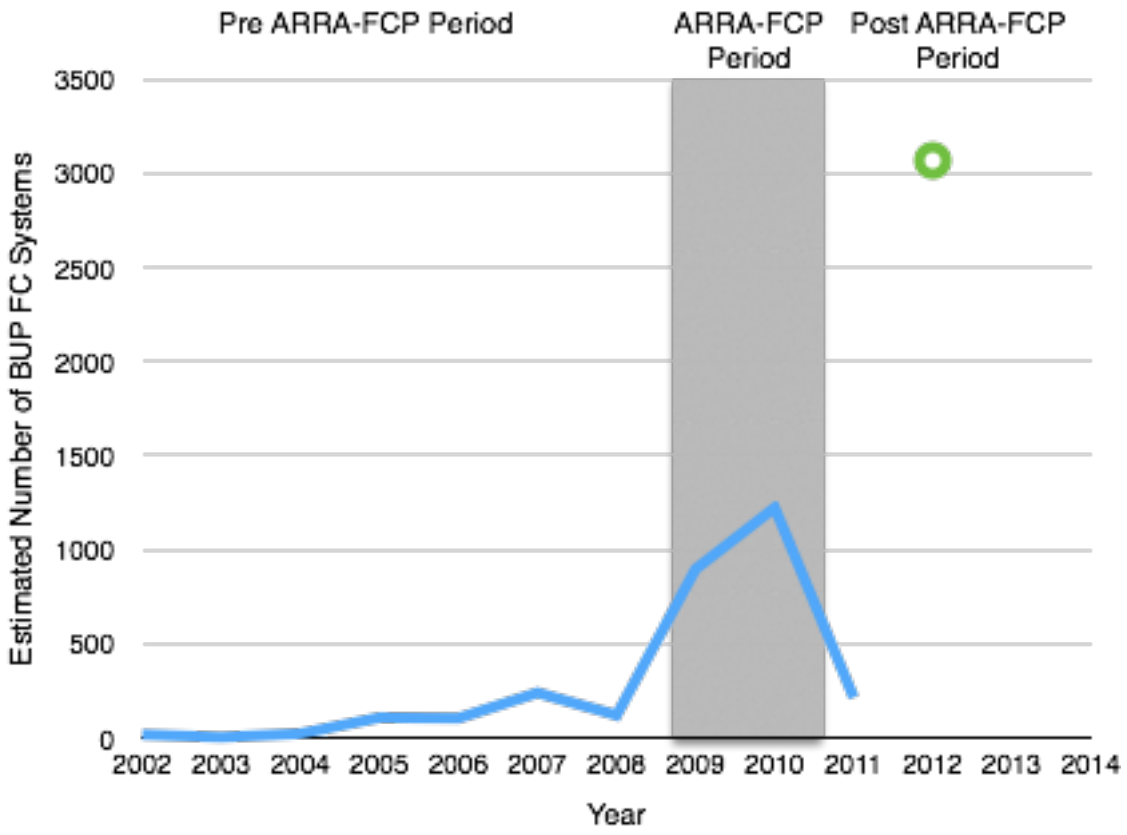


Figure 5 Annual Sales for BUP Fuel Cell Systems Entering the Market

Altergy Systems reported sales or orders for 3,067 units (Table 1) in the Post ARRA-FCP period (through 2012). This large number of sales is reflected in the large aggregate data point in the Post ARRA-FCP data in Figure 5. The total power for the Altergy Systems in Table 1 sums to 30-40 MW, but Altergy reported only 7.9 MW of systems deployed in Q1 of 2013, indicating that many of these systems were yet to be deployed.[14]

Table 1. Altergy Sales/Orders Post ARRA-FCP - 2012

Manufacturer	User	Number of Units	Power
Altergy Systems	MetroPCS	1,528	10 kW
Altergy Systems	MetroPCS	537	15 kW
Altergy Systems	India	1	2.5 kW
Altergy Systems	India	1	5 kW
Altergy Systems	Not Identified	1,000	7.5 kW

BUP fuel systems operating on reformed fuels, did not benefit from the ARRA-FCP. IdaTech, a manufacturer of BUP systems, had non-ARRA funded sales of 445 and 350 BUP FC

[14] Altergy Systems Corporate News, "Altergy's Freedom Power Systems Achieve more than 20 Million Hours of Field Operation", Corporate News, September 20, 2013; Telecom Backup Power Solutions http://www.altergy.com/telecom-3/

systems in 2009 and 2010, respectively. IdaTech sales were not sufficient to sustain the company, and in July 2012, Ballard Power announced the acquisition of IdaTech's backup power system product lines, intellectual property, and customer base. The IdaTech sales shown in Table 2 are international and account for IdaTech's 2009 and 2010 sales.

Ballard Power Systems, through its distribution partner Dantherm, supplied its ElectraGen™ BUP FC system products to telecommunication end users in Europe. The BUP FC systems are available in modular units of either 2.5 or 5 kW. Ballard sold more than 2,200 ElectraGen™ systems globally, including in Europe by the end of 2012 (Table 2).

Table 2. Hydrocarbon BUP Sales (2004 – 2012)[15]

Company	Number	Power	Fuel	Locations
IdaTech	795	5 kW	hydrocarbon	Europe, India, Indonesia, Australia
Ballard Power Systems	>2,200	2.5-5 kW	hydrogen and hydrocarbon	Caribbean, South Africa, China, Latin America

Nuvera operated a BUP system on natural gas. A total of 237 BUP systems were operated prior to the ARRA-FCP period, but BUP systems were inter-mixed with its stationary power demonstrations so the exact number of BUP telecom is uncertain. The hydrocarbon fueled BUP systems of Plug Power, IdaTech, Nuvera, and the previously reported Ballard systems presaged a new era for hydrocarbon fueled BUP that the ARRA-FCP had not anticipated with its concentration on hydrogen fuel.

4.2 Results in the Post ARRA-FCP Q1 2013 to Q3 2014

4.2.1 DOE / NREL Data

The Fuel Cell Technologies Office (FCTO) Program Record #14009 (Rev. 1) Industry Deployed Fuel Cell Backup Power results published in August, 2014, are reproduced in Table 3.[16] These data include data from the ARRA-FCP presented at the U.S. Department of Energy Annual Merit Review and Peer Evaluation Meetings for the Hydrogen and Fuel Cells Program and the Vehicle Technologies Office for the years 2013 and 2014. Industry BUP fuel cell system shipments are distinguished from BUP fuel cell systems on order.

The total BUP fuel cell systems in Table 3 includes the DOE ARRA-FCP funded BUP (824) and funding from a separate appropriation for BUP (83). Industry shipments and orders are also shown.

[15] Early Stage, Ibid. pps. 67, 84, & 89.

[16] P. Devlin and K. Kiuru, DOE Hydrogen and Fuel Cells Program Record, Record #14009 (Rev. 1), Approved by S. Satyapal and R. Farmer, August 12, 2014.

Table 3 BUP Fuel Cell Deployments 2009 to August 2014[17]

	DOE ARRA	Other DOE Funded [b]	DOE Total	Industry Funded Shipments [c]	Units On-Order [c]	DOE-Industry Total [c]
Number of BUP Deployments[a]	824	83	907	2,876	1,240	5,023

[a] Current and Planned
[b] Appropriations as of 8/2014
[c] (Globally) From 2009 – 8/2014

Figure 6 from the National Renewable Energy Laboratory (NREL) composite data products (CDPs), [18] shows that 842 ARRA-FCP BUP systems were deployed through Q3 of 2013 with a total of 852 deployed at the end of the Q4 of 2013. There appears to be a discrepancy of approximately 12 units between the two sources that may be attributable to the seven-month time difference between the data collection dates. Twenty-eight ARRA-FCP BUP fuel cell systems were deployed over the nine-month period from Q2 2013 to the end of the Q4 2013. From Figure 6, it appears that there were no additional ARRA-FCP funded units after 2014. So, there appears to be a total of 28 additional ARRA FCP systems between Q2 2013 and the end of 2014.

4.2.2 Manufacturers' Shipments and Orders

As reported in Table 3 the combined industry total (shipments plus orders) of 4,116 units is roughly 4.5 times greater than the DOE total. This indicates industry demand for BUP fuel cell systems. As previously reported, Altergy Systems accounts for 3,067 BUP of the industry orders and shipments. The remaining 1,049 global shipments or orders include BUP fuel cell systems operating on either hydrogen or hydrocarbon fuels.

Ballard acquired IdaTech in July 2012. Ballard's acquisition of IdaTech expanded Ballard's telecom base in methanol fueled systems. Prior to their acquisition by Ballard Power Systems, IdaTech reported it sold a total of 795 ElectraGen™ systems (Table 2). Ballard Power Systems maintained the ElectraGen™ product name and continued shipping and taking orders for the BUP ElectoGen™ units through the 3rd quarter of 2014. The Ballard ElectraGen™ units were available as either hydrogen fueled or hydrocarbon fueled with reformer.

[17] Early Stage, Ibid. p. 1 Table 1

[18] J. Kurtz, S. Sprik, and G. Saur, "Spring 2014 Composite Data Products: Backup Power", Technical Report NREL/TP-5400-62025, June, 2014

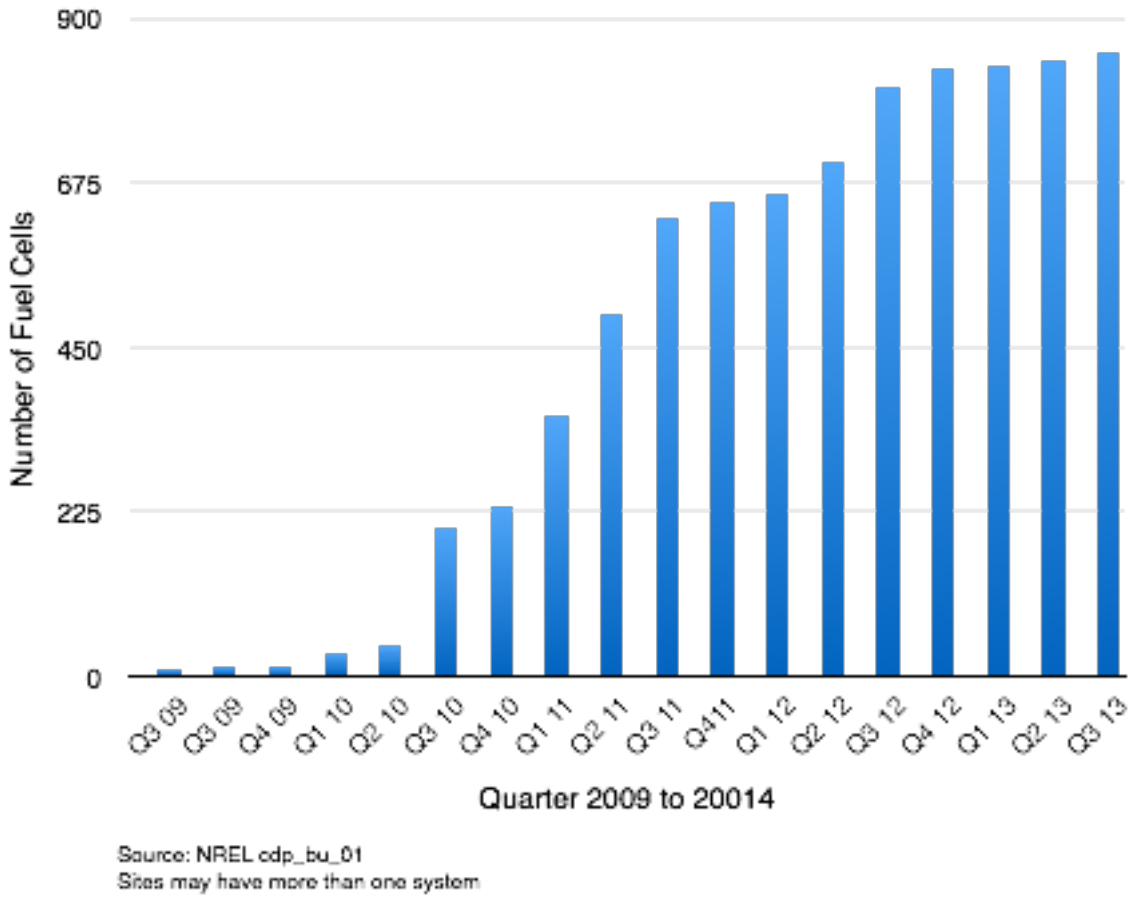


Figure 6 ARRA / DOE Backup Power Deployments

On its own, Ballard had identified two distinct BUP telecom markets: BUP for regular power outages in markets with unreliable grids, and BUP for markets vulnerable to extended power outages in crisis situations.[19] Ballard BUP shipments/orders from the 1st quarter of 2013 to the 3rd quarter 2014 are presented in Table 4. In June of 2013, Ballard reported they had shipped more than 200 ElectraGen™ systems to South Africa and Indonesia (Table 4).

Ballard also reported shipping more than 300 ElectraGen™ to Nokia Siemens Networks for telecom service in Japan. The total number of Ballard BUP shipments/orders was 1,373 for the period Q1 2013 to Q3 quarter 2014. These shipments and orders for the Ballard ElectraGen™ BUP system are external to the U.S. with a mix of hydrogen and methanol fueled systems.

[19] Ballard press release; "Growing Demand for Ballard Backup Power Systems Driven By Two Distinct Telecom Needs", June 5, 2013, http://www.ballard.com/print/about-ballard/newsroom/news-releases/news06051301.aspx

Table 4. Ballard BUP Shipments/Orders by Quarter: 2013 to 3rd Quarter 2014[20]

Quarter – Year	Number	Country	Fuel
2009 to 1ST Q 2013	500		Methanol
2nd Q 2013	177	Asia, South Africa, Caribbean, Latin America	Not specified
3rd Q 2013	143	China & Philippines	Not specified
	12	Jamaica	Methanol
	120	China	Hydrogen
	100	China	Methanol
	20	Southeast Asia	Methanol
4th Q 2013	177		Not Specified
For 2013 Ballard reported ElectraGen Shipments at 796			
1st Q 2014	50 Stacks	Germany (FutureE)	Hydrogen
2nd Q 2014	12	Philippines	Not Specified
3rd Q 2014	111		Not Specified
	13	Jamaica	Methanol
Total	1,373	Non-U.S.	Hydrogen or Methanol

At the Hydrogen and Fuel Cells Program Annual Merit Review (AMR), ReliOn reported 165 telecom ARRA-FCP funded BUP sites with 370 commissioned fuel cells installed. At the same meeting, ReliOn said they had acquired 41 sites for BUP and construction was completed for an additional 43 sites (111 fuel cells).[21]

At the 2013 AMR, the Sprint presentation reported 260 new ARRA-FCP funded BUP installations in partnership with Altergy and ReliOn, fuel cell systems.[22] Sprint stated the total number of BUP systems and did not specify Altergy or ReliOn BUP systems installed and commissioned. However, in an interview, Altergy said that 32 of the sites were their's. The ReliOn and Altergy BUP systems are likely to have been included in Table 3 and the NREL composite data products in Figure 6 but the raw data are not available to confirm this.

Plug Power acquired ReliOn in 2014. The press release for that acquisition stated "…the company (ReliOn) had deployed more than 5,000 fuel cell stacks…"[23] The announcement emphasized *fuel cell stacks not BUP fuel cell systems,* making it difficult to interpret how many BUP systems ReliOn has actually deployed.

[20] Ballard Power Systems Quarterly Reports 2013 to third quarter 2014.

[21] M. Maxwell, "PEM Fuel Cell Systems Providing Backup Power to Commercial Cellular Towers and an Electric Utility Communications Network", Project ID H2RA006, U.S. Department of Energy Hydrogen and Fuel Cells Program Annual Merit Review, May, 2012.

[22] K. Kenny, "Use of 72-Hour Hydrogen PEM Fuel Cell Systems to Support Emergency Communications", Project H2RA012, U.S. Department of Energy Hydrogen and Fuel Cells Program Annual Merit Review, May, 2013.

[23] Plug Power press release, "PLUG POWER ACQUIRED RELION INC. BRINGING INNOVATIVE FUEL CELL STACK TECHNOLOGY IN-HOUSE," April 24, 2014.

At the 2014 AMR, Plug Power reported that two fleets of 10 BUP units had been installed: one fleet at Fort Irwin National Training Center and the other at Robins Air Force Base. These ARRA-FCP funded Plug Power Extended BUP systems combined the rapid start of hydrogen BUP with the extended run capability of a hydrocarbon fueled BUP. These hybrid systems used GenCore, with a start time of less than one minute and sufficient hydrogen fuel for four hours of operation, in conjunction with a slowly starting GenSys, using reformed natural gas, that allowed indefinite operating time given sufficient LPG. The Fort Irwin BUP provided backup of their Critical Engineering building, and the Robins Air Force Base BUP provided backup of their Air Defense Logistics building. The combined approach of Plug Power for these systems is shown in Figure 7. Both fleets were decommissioned at the conclusion of the ARRA-FPC funded effort.

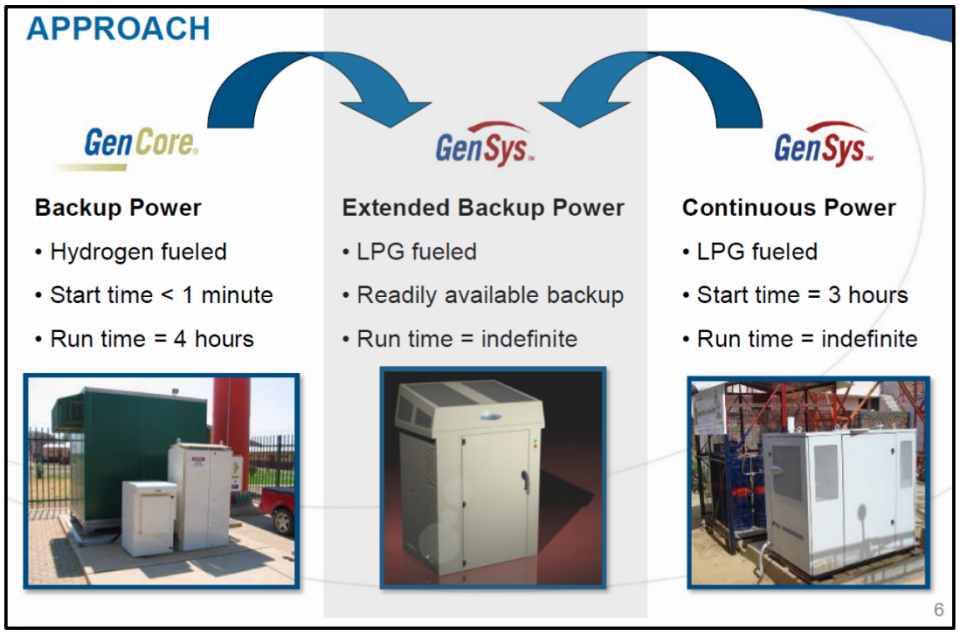


Figure 7 Plug Power GenSys Extended Backup Power Concept

Review of industry press releases and publications for ReliOn Inc. and Altergy Systems resulted in limited success in identifying shipments, orders, and deployments of their telecom fuel cell systems. These very limited results are provided in Table 5 along with shipments or orders from First Element Energy and Intelligent Energy. ReliOn had 200 fuel cell systems with railroad applications and backup power at Ghirardelli Square. First Element Energy announced 300 new shipments, orders, or sales for BUP fuel cell systems under 20 kW. Intelligent Energy installed a 3.5 kW BUP system in India. [24]

[24] J. Petrecky, "Accelerating Acceptance of Fuel Cell Backup Power Systems", Project H2RA007, U.S. Department of Energy Hydrogen and Fuel Cells Program Annual Merit Review, May, 2014.

Table 5. Shipments/Orders, Q1 2013 to Q3 2014

Organization	Number of Units	Manufacturer
CSX railroad applications	200	ReliOn
Ghirardelli Square	1	ReliOn
Acta Power	3	ReliOn
First Element Energy A	300	Nedstack (of grid application)
Essential Energy (India)	1	Intelligent Energy

Data for units ordered, sold, delivered, or commissioned by Altergy since the Q1 2013 were not found in the review of Altergy's news announcements, press releases, or on the Internet. In the Q1 2013, Altergy began installing the MetroPCS BUP system (Table 1). EnerSys, a leading manufacturer and distributor of industrial batteries, worked with Altergy on the MetroPCS BUP installations and formed a commercial alliance with Altergy in 2009 to be the exclusive distributor of the Altergy Extended Run Time Solution for telecommunications and uninterruptable power to certain markets.[25] The commercial alliance between Altergy and EnerSys was unsuccessful and was terminated in 2013[26]. Altergy received a $58.2 million award against EnerSys.[27] No information was found on the completion of the MetroPCS installations of by Altergy and EnerSys.

4.2.3 The Larger Picture for BUP for Telecommunications

Figure 8 updates Figure 5 with the year 2011 through the 3rd quarter of 2014 expanded to show additional detail. At the conclusion of the ARRA-FCP period, there was a downturn in sale of the BUP systems with 214 BUP sales reported. The large increase in sales in 2012 is a result of the Altergy Systems sales to MetroPCS (Table 1) and appears to be a one-time spike when compared to the preceding and following years.

The 2013 sales data are dominated by the Ballard's 796 BUP sales, most of which were outside of the U.S. Sales within the U.S. in 2013 and 2014 are in the volume range of the ARRA-FCP period sales for 2009 and 2010. The ARRA-FCP appears to have influenced the BUP market until a comparison of the types and locations for the sales is made. The ARRA-BUP sales were in the U.S. with BUP fuel cell systems operating almost exclusively on hydrogen. The MetroPCS purchase supports the influence of the ARRA-FCP post funding with the purchase of hydrogen fueled BUP for U.S. applications. The post ARRA-FCP sales for 2013 and 2014 are mostly non-U.S. sales of methanol and hydrogen based systems.

The FC BUP market changed significantly during the course of the project. ReliOn, a private company that was one of the key suppliers of FC BUP, systems, was purchased by Plug Power and made its own division within Plug. While this did not result in the release of historical data, Plug Power is now reporting sales for this unit. In early 2015, Plug Power announced the sale of $20 million in FC BUP to an unidentified firm.

[25] Fuel Cell Today, "EnerSys Invests in Altergy Systems", December 18, 2009

[26] Altergy Systems press release, "Altergy and EnerSys Agree to End Relationship", February 12, 2013

[27] Altergy Systems press release, "ALTERGY RECEIVES $58.2 MILLION ARBITRATION AARD AGAINST ENERSY", May 15, 2014

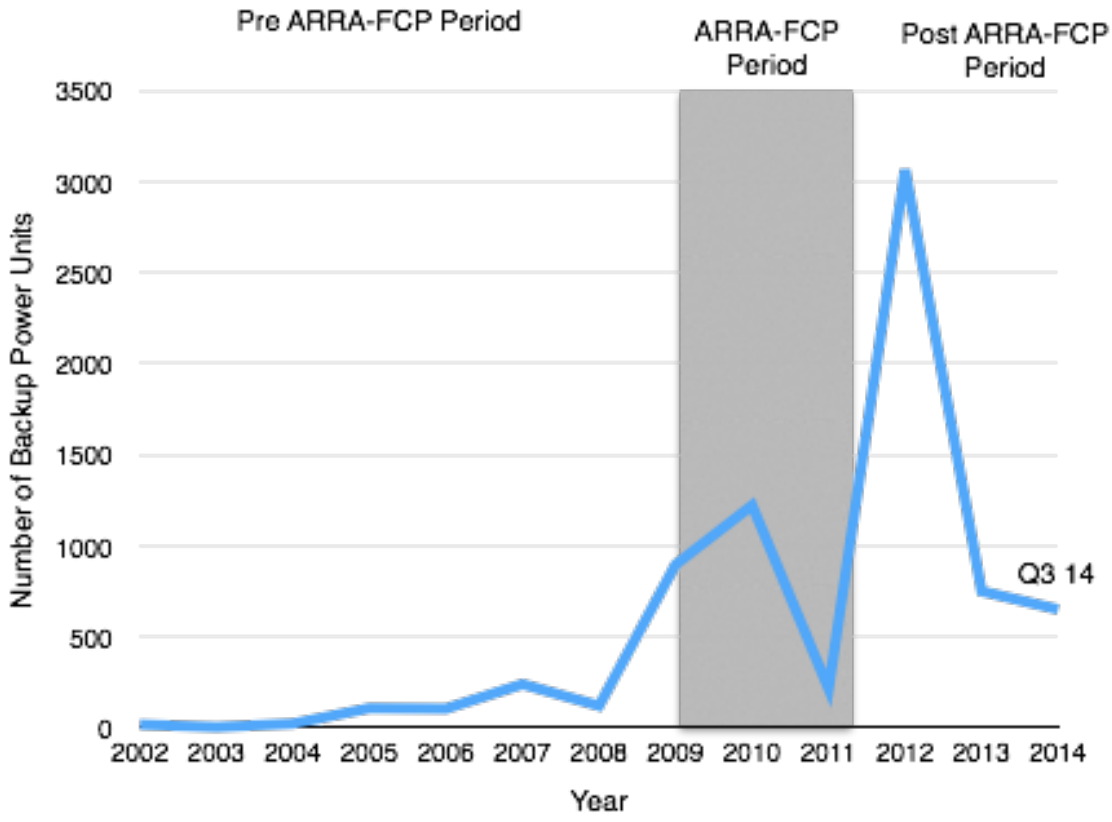


Figure 8 Annual Sales of BUP FC Systems 2004 to 2014

5. Insights from BUP Related Interviews

This section provides additional insights based on interviews conducted with relevant individuals. The commentary represents the perspectives of the persons being interviewed and their firms and may or may not be generalizable to the larger market. They are included because they potentially provide additional useful insight.

5.1 Altergy Systems

Altergy sales are on the order of 300 to 400 units per year in North America; however, their international sales for 2013 and 2014 are much greater. Sales increased at a rate of about 15% per year, and these represent new sales. Replacement sales have not started to make an impact at Altergy.

The expected site life as opposed to the lifetime of the Altergy System BUP is estimated at 10 years but units in the field have not reached the 10-year point. Altergy FC BUP systemsin Florida have six years on-line as intermittent backup. Altergy System fuel cell systems operating continuously have reached 12,000 hours, which is about 17 months lifetime use.

The ARRA-FCP funding had little effect on Altergy with only 32 sites at Sprint and six 5 kW units to Sandia Laboratory through Multiquip, a mobile light trailer manufacturer. The ARRA-FCP did increase customer awareness.

The Investment Tax Credit has been very important for maintaining BUP sales in the U.S. with Sprint making good use of it. State subsidies were also important. California, Connecticut, New York, and Florida have strongly supported alternative energy, but programs may be at risk because of budget constraints.

Cost reduction is a primary focus for Altergy, and the membrane-electrode-assembly (MEAs) is a large percentage of the overall cost. Because Altergy purchases their MEAs rather than manufacturing their own membrane, reducing cost may be a problem outside the technical reach of Altergy. Fueling cost is a major concern with hydrogen gas delivery costs at ten times the cost of methanol in some cases. Methanol reformer costs are also very high and need to be reduced.

5.2 ReliOn Inc.

ReliOn considers the ARRA-FCP a success that generated revenue that was critically needed by ReliOn in 2009-2012. ReliOn disagreed with the conclusion in the earlier report that the ARRA-FCP did not create many jobs.[28] They state the answer was biased by the criteria defining “jobs created” or “jobs retained.” Subcontractor jobs and jobs created at suppliers were not included in the previous report.

In 2014, ReliOn was acquired by Plug Power and is branded as ReliOn. ReliOn will pursue the stationary and BUP markets along with contributing to Plug Power’s material handling equipment MHE applications by designing core fuel cell stack technology. ReliOn will also pursue alternatives to hydrogen fuel.

[28] Early Stage, Ibid.

ReliOn agreed to be acquired by Plug Power because it needed capital, and had reached the point where new capital was difficult to obtain. The strategic combination of ReliOn and Plug helped both parties with benefits of economy of scale – i.e., they were able to consolidate general and administrative costs. Both were fuel cell companies with ReliOn emphasizing its core stack capabilities and Plug wanting to return to manufacturing their own stacks. Plug Power presently purchases its stacks from third parties.

The largest limiting factor for continued expansion and growth of fuel cell stationary and BUP telecom systems is the fuel supply, and an end-to-end solution is needed. The telecom market does not have an attached fueling station because demand for fuel (hydrogen) is not continuous. For telecom, delivery of hydrogen on an irregular schedule is challenging compared to other FC applications. ReliOn and Plug are looking for synergies where ReliOn has telecom stations in the proximity of Plug's MHE deployments that could utilize a common fuel source. They are working collaboratively on how to supply customers with fuel, and a logistic fuel model is needed that gives customers the confidence of timely, on-demand delivery at a reasonable cost.

Fuel delivery remains costly. There in an ongoing transition from deploying gas cylinders, to delivering hydrogen by refilling tanks that are permanently installed on-site. The DOE ARRA program helped to prove refillable tanks as a viable model and a large percentage of new orders have transitioned to the bulk refueling model. Eight-hour call out is considered equivalent footing for the fuel cell system with GenSets. Roof top systems are gaining market share with installations for dense urban applications such as sites at Ghirardelli Square in San Francisco, CA, and Pike Place Market in Seattle, WA.

ReliOn's competition is generators (GenSets – AC, DC, diesel, natural gas, and propane). These GenSets are easy to get, relatively low cost, and readily manufactured in countries with emerging markets. The GenSets respond to an unstable grid system where daily downtimes for the grid are several hours and there must be well organized fuel delivery infrastructure. There are certain applications that ReliOn's telecom products can solve that cannot be solved by GenSets. The ReliOn systems offer higher reliability and availability than GenSets technology. The ReliOn systems availability is greater than 95 percent compared to approximately 60 percent or GenSets.

ARRA-FCP continues to benefit ReliOn with increased visibility and accessibility to senior executives and decision makers brought and is considered one of the most important benefits of the ARRA-FCP program. ReliOn continues to deliver products to their current customers: Sprint, AT&T, and others.

There has been no uptick in the market for telecom. The ReliOn international and domestic markets are the same as during the ARRA-FCP period. There is a broad need in telecom (stationary power) in emerging markets (India, Asia, etc.), but there is a fuel limitation. It is very difficult to get hydrogen to remote sites, and there is a need to deliver an alternative fuel, potentially with integrated reformers. ReliOn stated the emerging markets are difficult to compete in – e.g., there are no policies or subsidies to support the fuel cell system. ReliOn believes there is only selective activity in emerging markets.

China is considered a very difficult market requiring domestic solutions. The need for incumbent competitors is considered a major stumbling block. China will develop its own incumbent technology, but it will take time before it is at a large scale.

The DOE contributions to codes and standards have been very beneficial. Education programs by DOE have also been beneficial. ReliOn would like to see DOE continue the codes and standards activities and the education programs.

Growth and volume of other fuel cell applications are critical for future expansion of the telecom industry. In particular, the emergence of the automobile fuel cell system will be of great benefit. Volume is needed to drive the market, and the development of a fuel cell supply chain remains very important for the industry.

The Investment Tax Credit was very important for those companies who are not yet profitable and, thus, could not take advantage of the current Federal tax credit. The loss of section 1603 had a negative impact and would be beneficial if it could be re-enacted.

5.3 Ballard Power Systems

Ballard has recorded increased order backlog and enhanced product deliveries from the telecom backup power segment. Also, the segment accounts for around 30 percent of total revenues, and the revenues from this segment are growing at about 60 percent per year. The growing order backlog is from Jamaica, Japan, Thailand, China, and the Philippines, and Ballard Power Systems is intent on capturing emerging markets.

International market growth for the telecom opportunities is at 10 to 15 percent per year. The North American market growth, in particular the U.S. telecom market growth, is 2 percent. To increase BUP market share, Ballard must drive down capital cost, maintain support via government funding, and better utilize the Investment Tax Credit.

The fuel cell telecom industry would benefit from government support of research and development (R&D) to reduce capital and manufacturing cost. Government R&D support for on-site reformers to drive down cost and improve manufacturing would benefit the fuel cell telecom industry.

Large- scale fuel cell manufacturing, such as automotive manufacturing, would improve the balance-of-plant supply chain for all fuel cell manufacturers. Fuel cell manufacturing investment would drive down cost.

The ARRA-FCP only indirectly benefited Ballard because they were not involved in the ARRA-FCP telecom activities. Ballard reported a benefit for their air-cooled system, most probably in MHE applications. Ballard would like to see the permitting process in the U.S. streamlined and continued national code development.

Methanol fueled BUP fuel cell systems is an important product offering for Ballard, and they are seeking a dominant position in methanol. The logistics of a methanol fueled BUP are easier than a hydrogen fuel supply especially for emerging economies. There is growing interest in methanol fueled BUP in Japan, South Africa, Germany, China, and South Asia.

Ballard acquired the transportation and stationary-related fuel cell intellectual property assets of United Technologies Corporation. These assets consist of approximately 800 patents and patent applications, as well as patent licenses, invention disclosures, and know-how primarily related to Proton Exchange Membrane (PEM) fuel cell technology. Ballard sold its Materials Products Division in January of 2013.