

# **EDUCATION IN NEW YORK STATE: THE NEW HOPE PILOT CASE STUDY IN TEACHER TRAINING**

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## **1. Introduction**

### **1.1 Background**

There is widespread agreement that lack of education is a barrier to introduction and advancement of hydrogen in the economy. Today's teachers and their students -- tomorrow's consumers and citizens -- are essential to our energy future. Experience suggests that one of the best ways to reach students is through their teachers. As a vehicle for technology transfer, it is the teachers who will educate students in hydrogen science and technology. But who will teach the teachers and how will the training be delivered?

New York State, a pioneer in the field of energy education, has found a solution. New York has committed to education through its Energy Smart Students Program. Cognizant of the important role teachers and students will play in New York's energy future, a powerful team consisting of the New York State Energy Development Authority (NYSERDA) and its collaborators, the New York Power Authority (NYPA) and the Long Island Power Authority (LIPA) selected M.R.S. Enterprises, LLC (M.R.S.) to deliver the New HOPE Pilot TM training workshops for high school teachers. HOPE stands for Hydrogen Outreach Program for Education.

### **1.2 The New York State Hydrogen Experience**

NYSERDA and collaborators believe that education is key to facilitating adoption and penetration of hydrogen in the economy at all levels – local, state and federal. NYSERDA has in fact developed a New York State Hydrogen Roadmap for advancement of hydrogen in the economy in three phases (demonstration, adoption and commercialization). Outreach and education figure largely in the New York State implementation strategy.<sup>2</sup>

### **1.3 M.R.S. Enterprises' Perspective**

M.R.S. Enterprises, LLC, provides management consulting and government relations services in energy and environment for technology and infrastructure development as well as education. M.R.S. believes that education is requisite to maintenance of a democratic society as well as to economic competitiveness in the global community. In offering hydrogen education, our view is that we are performing a public service consistent with the NYSERDA vision of equipping

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<sup>1</sup> Mary Rose de Valladares is President of M.R.S. Enterprises, LLC.

<sup>2</sup> *New York State Hydrogen Energy Roadmap*, prepared for NYSERDA, NYPA and LIPA by Energetics, Albany Nanotech and the National Hydrogen Association (NHA), October 2005.

New York teachers to prepare their secondary school students for an environmentally benign hydrogen energy future.

## **2.0 The New HOPE Pilot TM**

### **2.1 The Product**

The original M.R.S. proposal was based on delivery of hydrogen training via existing products, the Hydrogen Outreach Program for Education (HOPE) Pilot curriculum and a reversible fuel cell. The HOPE Pilot TM, chartered by the U.S. DOE, was developed to teach secondary students about the potential and benefits of hydrogen as a fuel and energy carrier. It is available in two versions, one for high school students and the other for middle school students.<sup>3</sup>

However, NYSERDA preferred a more compact edition targeted specifically to either a “one-day” or “one-week” hydrogen program for the classroom or an after-school program. Consequently, the New HOPE Pilot TM was excerpted from the original HOPE Pilot to meet these requirements. Furthermore, NYSERDA decided to target two teacher groups, science teachers and technology teachers. Therefore, two versions of the New HOPE Pilot TM were developed, one for science teachers and the other for technology teachers. In addition to being correlated with the National Science Standards, all New HOPE Pilot TM content is correlated with the New York State Math, Science and Technology (MST) standards. The science version is also correlated with the New York State “ChemCore Guide Concepts” that were formulated to better prepare students for the New York State Regent’s Examination.

Lesson plans were developed for both the nominal “one-day” and “one-week” hydrogen program for the classroom as well as an after-school program. M.R.S. developed and led the teacher training workshops. M.R.S. calls its Hydrogen Educators “the New HOPE team.”

### **2.2 The New HOPE team**

The New HOPE team consists of three experts in hydrogen and fuel cells, and technology education: Mary-Rose de Valladares, Ken Kenyon and Ernie Ruiz. The HOPE team’s professional expertise cross-cuts hydrogen science, engineering, business and education.

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<sup>3</sup> HOPE Pilot TM is an integrated student/ teacher curriculum organized into modules that consist of multiple lessons. The 75 lesson high school curriculum contains seven modules: Fundamentals; Production; Storage; Distribution and Safety; Utilization; Renewables & Renewable Hydrogen; Scavenger Hunts; and final project Hydrogen Fueling Station. The 30 lesson middle school curriculum contains five modules: Basics; The Hydrogen Story – Past, Present and Future; Scavenger Hunts; The Pollution Solution; Storage and Safety; and final project Hydrogen Fueling Station. All HOPE content is correlated with the National Science Standards. Video products enhance both versions both versions of the curriculum. The Pollution Solution and Beakman’s World – Hydrogen – It’s a Gas! are distributed with the curricula.

Mary-Rose de Valladares, President of M.R.S. Enterprises, LLC, has been involved with hydrogen and fuel cells in both public and private sectors. Her private sector involvement included DCH Technology and Virent Energy Systems, LLC. She currently manages the International Energy Agency's Hydrogen Implementing Agreement. A master teacher and developer of the Hydrogen Outreach Program for Education (HOPE), Ms. de Valladares has worked with and trained teachers from all parts of the country.

Mr. Ken Kenyon, a chemical engineer, gained experience in the use of hydrogen and fuel cells at Enable Fuel Cell Corporation. At Virent Energy Systems, he led the engineering effort on Virent's novel hydrogen production technology. Earlier, he managed battery development activities including manufacturing, marketing, sales and engineering at Rayovac Corporation. He is a strong proponent of hydrogen and fuel cell education

Mr. Ernie Ruiz is a retired New York State middle school technology teacher. He was an instructional specialist in the Central School District. Formerly President of the Suffolk County Technology Educators Association, he was also an officer of the New York State Technology Educators' Association. Mr. Ruiz is a member of the New York State Academy for Teaching and Learning.

### **2.3 The New HOPE Pilot Workshop experience**

Since late 2005 the M.R.S. New HOPE team has conducted six full day workshops and one half day workshop in locations around the state. The half day workshop was for the Science Teachers Association of New York (STANYS) conference. In April 2008, the New HOPE team is scheduled to deliver two more workshops for NYSERDA.

The format for the workshops is a mixture of lecture, demonstrations, hands-on activities (featuring a reversible fuel cell and hydrogen powered fuel cell toy car supplied by the Fuel Cell Store) as well as interactive dialogue. Workshop topics span the full range of learning in hydrogen production, storage, distribution and utilization, as well as fuel cells. The learning was linked to the curriculum with an emphasis on classroom application. Participating teachers received the New HOPE Pilot, a user friendly curriculum with lesson plans tailored to busy classroom schedules. They also received two kits: a fuel cell kit equipped with a car chassis; and a HOPEmobile™ materials kit. Teachers can use these kits to continue the design and engineering learning process in the classroom.

### **2.4 The New HOPE Pilot Workshop Results**

In the first phase of the New HOPE workshops from 2005-2006, over 130 teachers were trained at four full day and one half day workshop. In the second phase from 2007 to mid 2008, over 160 teachers will have participated in four full day workshops. One of these workshops was held in conjunction with a larger event. The other workshops were stand-alone events, sometimes held during the week and sometime on Saturday.

The six full day workshops held to date under the aegis of the NYSERDA Energy \$mart Program consistently garnered the highest possible ratings on scale of 1-5 in both the overall evaluation category and the specific performance categories. The Science Teachers Association of New York State (STANYS) workshop received the highest rating awarded by STANYS. In addition, M.R.S. also received an invitation to present at future STANYS conferences.<sup>4</sup> The ratings and teacher comments are a clear measure of teacher satisfaction with their learning experience, which encompasses the workshop content and organization as well as the applicability of the material to the classroom.

In phase 1, the workshop training in the New HOPE Pilot curriculum is expected to impact some 13,000 students. Over a five year period, the anticipated impact of this pilot project increases to 65,000 New York state students. In phase 2, the workshop training in the New HOPE Pilot curriculum is expected to impact some 15,000 students. Over a five year period a total of some 75,000 students will be impacted. Altogether, it is anticipated that the New HOPE Pilot training will impact 140,000 New York State secondary school students.

### **3.0 Lessons Learned**

#### **3.1 General**

This entire process has been a continuous learning experience. The venue and conditions for each workshop have varied considerably, as has the composition of workshop participants relative to discipline. The discipline differentiation can be characterized first by the split between science and technology teachers, and then by teacher experience and interests.

Moreover, the “personality” of each workshop group has differed in terms of degree of interactivity and interest in particular topics. Consequently, the training has evolved as MRS and the New HOPE team made improvements in response to teacher feedback and our own workshop experiences.

M.R.S. and the HOPE team learned many lessons from the New HOPE Pilot training. We are pleased to share them with the National Hydrogen Association and its “Hydrogen Educators.” In the interest of clarity, the New HOPE Pilot lessons are divided into five categories:

- Approach
- The Supply Chain – Logistics and Learning Delivery

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<sup>4</sup> This accolade came with the explicit recognition by STANYS organizers that high ratings in the multi (vs. the single) hour STANYS sessions are exceptional because of the high opportunity cost to teachers associated with foregoing so many other hourly presentations.

- Marketing
- Learning Styles and Participation
- Content
- Fun and the Unexpected

## 3.2 Approach

*“Imagination is more important than knowledge”*      Albert Einstein

### 3.2.1 Hand-on Activities and the Discovery Process

Today, the prevailing pedagogy of science education holds that students must discover and experience learning through hands-on activity in order to appreciate and assimilate learning. “Hands-on” learning through the discovery process is, if you will, the “mantra” of contemporary science education. Consequently, Hydrogen Educators can expect teachers to use this approach in the classroom. This means that Hydrogen Educators must offer “hands-on” activities and a discovery experience when teaching either teachers or students.

The “hands-on” training activities should, at a minimum, engage teachers in at least one method of hydrogen production. Water electrolysis via solar energy using a photovoltaic (PV) panel is preferable but water electrolysis via battery power is a practical alternative. The hydrogen should be utilized in an energy conversion device, preferably a fuel cell, to produce electricity that can power an application. Relative to applications, a mobile vehicle is a perennial crowd pleaser.

### 3.2.2 “Talking Heads” Unwelcome

The corollary to this lesson is that teachers do not respond well to a straight lecture format -- which they refer to as “talking heads” -- despite their recognition that some lecture is unavoidable. Demonstrations occupy a middle ground between lecture and hands-on activities. While a mix of all three approaches is optimal, the balance is critical, if not to the effectiveness of the workshop learning, at least to teacher satisfaction with the experience. This is a challenge because there is a lot of background (government policy, for example) that lends itself best to the “talking heads” approach.

### 3.2.3 Classroom, Classroom, Classroom

Teachers want the workshop and the materials they use to be directly related to their classroom experience. Just as the first three rules of real estate are location, location, location, the first three rules of science and technology teachers might well be classroom, classroom, classroom. To be effective as Hydrogen Educators, you must relate the training learning to the classroom experience.

### 3.2.4 Beyond “discovery” to Problem Solving and Interdisciplinary Learning

The New HOPE workshop series targets science and technology teachers but the pedagogy for these groups differs in some critical aspects. As previously

mentioned, the pedagogy for science education centers on discovery. In contrast, the pedagogy for technology curriculum focuses on the related area of problem solving. The New HOPE Pilot TM curricula address both science and technology disciplines and their respective pedagogies. However, the curricula also take an interdisciplinary approach in order to convey the full context for hydrogen in the economy. By way of extension, the New HOPE Pilot training provides essential interdisciplinary background in relevant history and civics since these topics set the stage for better appreciating the benefits and potential of hydrogen.

### 3.2.5 Mobility Matters

HOPE Pilot training and curricula emphasize the automotive sector from all perspectives (science, technology and interdisciplinary). The New HOPE Pilot takes this approach because mobility, cars and driving have a tremendous appeal, especially for all young people.

Of course, the environmental protection theme underpins this entire effort. International marketing experts recognize that concern about the environment is the strongest single characteristic of the global teenager market segment.<sup>5</sup>

### 3.2.6 Organization

Organization matters. cursory review of the organizational effort that characterizes a teacher's day in the classroom underscores their preoccupation with organization. They have earned the right to be tough taskmasters in this department. Teachers expect master teachers and trainers to have a clear and well-organized approach to every part of any program they are delivering. This extends to a strong preference for lesson plans that teachers can use in the classroom to deliver new learning. It also encompasses the need to provide teachers with curricula and other materials such as fuel cells. The teachers need to be fully equipped for success in preparing students for a hydrogen future.

## **4.0 Supply Chain Logistics and Learning Delivery**

*"Logistics: The time related positioning of resources."*

Webster

### 4.1 More Organization

For supply chain logistics and learning delivery, organization also matters – a lot. In fact, it underlies all links in the supply chain and cross-cuts all operations. In this case the subject is teacher training. Organizing training is not a casual exercise and success depends a great deal on unflagging attention to detail.

### 4.2 Planning

It all begins with planning. Consider first the teacher's calendar and the timing in the school year, as this can greatly affect participation. Don't forget the role of weather. In some locations there may be a preferred workshop season. Or,

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<sup>5</sup> *International Marketing*, Czinkota and Ronkainen, 1998, p. 505.

workshops may occur during every season in all kinds of weather. It may be necessary to devise contingency plans in case weather conditions ultimately preclude holding an event on a given day.

#### 4.3 Facilities

The facilities topic brings the location into focus. To increase the likelihood of success, select a desirable location as defined by your target audience. Make sure the facilities meet the event needs in terms of space, setup and audio-visual capabilities. The Hydrogen Educators must identify all facility needs. Space requirements and configuration dimensions should be communicated to the hosting facility upfront. Sketches and descriptions of all set-ups, including seating arrangements, should be prepared well in advance.

It is important to coordinate closely with the hosting facility. It is also important to understand the experience level of the hosts with the type of training being offered. As previously mentioned, the Hydrogen Educators must clearly articulate their facilities needs and requirements to the hosting facility. It is also important to understand the layout of the facilities to the greatest extent possible before the event, especially where the educator is working in an unfamiliar environment site unseen. Don't forget to plan for moving supplies, equipment and other materials that you carry into the facility (as opposed to ship in advance). Ascertain whether there are steps into the facility or multiple levels within the facility that must be negotiated with the supplies, materials and equipment required for the training.

#### 4.4 Registration

The registration system should be made as simple as possible from the user's (the teacher's) viewpoint. There should be clear provision for registration confirmation as well. The system should also include a method for notifying teachers of cancellation/postponement in the event of bad weather or other circumstance beyond the Hydrogen Educators' control. While no system is foolproof, the notification system needs some redundancy in an effort to ensure that registered participants are timely informed. E-mail and telephone are two standard communication methods. However, an e-mail might not be read in time. Likewise, a telephone call might not be answered or a voicemail might not be timely accessed. Local media may also provide a supplementary mechanism for emergency notice and should be investigated but this is not suggested as an alternative to personal contact.

#### 4.5 Electronic and Audio-Visual Equipment

Planning for Electronic and audio-visual equipment is crucial. But planning alone is insufficient: all equipment should be tested in advance of the event (the previous day if the workshop begins in the morning). Moreover, those Hydrogen Educators who will have to use the equipment should do a test run. Absent this precaution, the probability of a show-stopping issue related to equipment – major or minor – is very real. In addition, it is wise to plan for a techie to be on hand to

troubleshoot in the event that problems arise during the training. Because smooth operation of electronic and audio-visual equipment is essential to success, Hydrogen Educators are encouraged to pay (extra) for this service if needed.

#### 4.6 Materials, Curricula, Tools and Equipment

In moving workshop materials, tools, equipment and takeaway items, it is imperative to understand the supply chain. In other words, what must be moved where and when in order to make a timely appearance at the workshop. It is highly advisable to create a contingency plan that may be put into place in the event of a supply chain “issue.” Our experience is that “issues beyond the educators control” -- ranging from the trivial to the tragic -- are not uncommon.

For those of you who are not science teachers, it may be quite surprising to learn how much material, equipment and tools are required to stage a science training workshop.<sup>6</sup> Plan in terms of moving curricula and other takeaway items such as fuel cell kits, demonstration materials and equipment, “hands-on” and other activity materials and equipment, as well as administration materials. While some items can be shipped in advance, many items must be carried in at the time of the workshop.

#### 4.7 Hospitality, i.e., “food”

And last, but not least, is food. Teachers are also food critics, so apart from the obvious need to nourish the group in the healthiest manner possible, be aware that uninteresting or sub-par food may impact the training experience and the teacher feedback. Be sure to inquire about special dietary considerations. It is also wise to provide for vegetarian and other dietary fare (vegan, kosher) if possible.

### **5. Marketing**

*“Marketing is Everything.”*

Regis McKenna

#### 5.1 Clear Information

After the planning comes the marketing – to hold a teacher training event you have to reach your target audience and entice them to attend. They need to know why this training will be beneficial to them as classroom teachers. Hydrogen Educators must provide sufficient information to attract teacher participation. Teacher participation typically requires the consent of school administrations so teachers have to be motivated to undertake the administrative measures are necessary to obtain approval.

In addition to a clear explanation of the subject matter and a brief description of the event agenda, potential participants will want to know date, time, address, exact location and parking provisions. They will also need driving and /or public

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<sup>6</sup> This is particularly relevant for those who resist even carrying extra materials at conferences.



transit directions. Free lunch is a draw so don't forget to mention hospitality if it will be offered.

## 5.2 Resources and the Need for Substitute Stipends

Since resources are an important issue in most schools and school districts, teacher substitute stipends may be necessary to provide for the cost of substitute teachers. These substitutes pay for the costs associated with replacing classroom teachers who are attending a training event during school time.

It bears mention that the participating teachers (as opposed to the teacher substitutes) sometimes receive a stipend simply to attend a workshop. Thankfully, this was not the case for the New HOPE Pilot training workshops. Hopefully, hydrogen training will remain so attractive to teachers that stipends will not be necessary to secure training participation. However, participant stipends are a fairly common practice in the American education system.

The marketing process continues till the training ends. Marketing entails not just registration but communication with teachers about location, directions to the site and contingency plans in case of bad weather or unforeseen circumstances. Marketing should also include an evaluation at the end of the training with a formal survey instrument that provides for measurable teacher feedback on the training.

## **6.0 Learning Styles and Participation**

*"It is commonly believed that most people favor some particular method of interacting with, taking in, and processing stimuli or information."* Wikipedia

### 6.1 Teachers as Independent Thinkers

The New HOPE experience is that science and technology teachers are independent thinkers who are dedicated to making a difference in their students' lives through their respective disciplines. They generally exhibit strong concern for the environment as well as curiosity and enthusiasm for learning. Frequently, they also display a fair amount of skepticism about the introduction of new technology, especially technology that purports to have a life changing impact and/or entails significant change to everyday "business as usual" in the government or business worlds. Therefore, the Hydrogen Educator's challenge is to manage the teachers' skepticism by building on their curiosity and enthusiasm as well as their concern for the environment.

There is particular reservation about the seriousness of the federal government. There is equal reservation about the veracity of the business world relative to technology readiness. Teachers are very aware of the general thrust, if not the details, of what is going on in government and business – it is hard to "fool" them. They ask a lot of questions in these areas and the educators should be prepared to answer these questions to the best of their ability. Demonstrations and displays

of real life technology (ride and drives, fuel cell installations) can play a very important role in allaying teachers' reservations about the viability of technology.

## 6.2 Teacher Formation

The teachers' formation, i.e., the discipline(s) they studied and teach, affects their participation in the training because formation relates directly to their knowledge base and skill set. This is particularly apparent in "hands-on" activities that require the use of tools and equipment. For example, the technology teachers are accustomed to building things which requires tools that science teachers may be less skilled or completely unfamiliar with. Similarly, technology teachers are not familiar with the electrolysis equipment found in every high school chemistry laboratory. So the Hydrogen Educators must make allowances for difference in formation.

## 6.3 Level of Instruction

Participation also varies by the level of instruction, i.e., middle school vs. high school. High school teachers need a more in-depth understanding of hydrogen and fuel cell technology than middle school teachers. However, even at the middle school level, technology teachers have an engineering "problem-solving" orientation that is not characteristic of science teachers at either level.

## 6.4 Impact of Gender

Our observation is that gender can also affect participation. As a group, females tend to have less experience with (non-scientific) tools and equipment. They also tend to want to complete tasks (e.g., a "hands-on" project) and express more dissatisfaction than males when unable to do so, which typically occurs because of time constraints. Hydrogen Educators can organize training activities to take these observations into account.

## 6.5 MTV Teachers

Finally, going back to the "talking heads" comments, remember that teachers often don't like to sit still anymore than their MTV generation students. So this means the educators should vary active and passive activities and be sensitive to "pace."

## **7.0 Content and Message**

*"Truth is the strongest weapon we have."*

Mark Twain

## 7.1 Hydrogen 101

The bottom line here is science and technology. The learning delivered in the training and the materials disseminated after the training should explain the relevant science and technology at the appropriate level and depth. NYSERDA asked M.R.S. to deliver hydrogen "101," which includes all the basics of production, storage, distribution, safety and utilization. It also includes all the fuel cell basics, meaning principles of fuel cells, types of fuel cells and uses of

fuel cells. Hydrogen Educators should focus first on delivering the hydrogen and fuel cell basics.

### 7.2 The Role of Standards

The New HOPE Pilot curriculum is related to the national science standards and the applicable state standards. For New York State, this meant correlating lessons to the “Chem Core” that govern material covered by the New York Regent’s examination as well as state standards applicable to Math, Science and Technology. Correlation of learning material to national and state standards is clearly a best practice, one that Hydrogen Educators should utilize.

### 7.3 Differentiation by Target Group

The New HOPE Pilot curricula are also differentiated to meet the needs of NYSERDA’s two target groups, science and technology teachers. The training is organized to meet the needs of both groups but the emphasis varies depending on the composition of the group. Every effort is made to gear the training to classroom realities for both science and technology teachers.

Hydrogen Educators should understand the needs of their target audiences and teach accordingly.

### 7.4 Interdisciplinary Content

Irrespective of the target audience, Hydrogen Educators should be aware that the need for interdisciplinary content that goes beyond science and technology. With the New HOPE Pilot training, M.R.S. provides an interdisciplinary training experience that puts considerable emphasis on the non-science areas. The original HOPE curricula provide many interdisciplinary lessons and activities for M.R.S. to draw from.

In order to prepare teachers to convey a picture of the hydrogen future and the pathway to its evolution, Hydrogen Educators will have to integrate history, government/civics and economics content in their training. How much information Hydrogen Educators want to provide depends upon several factors: duration of the training; the target audience(s) and its needs; and how much risk Hydrogen Educators are willing to take, given everything that has been said about teachers’ learning preferences.

### 7.5 “Takeaways”: Tools and Materials for Future Use in the Classroom

In order to enable teachers to utilize their hydrogen training it is essential to provide tools – curricula, lesson plans, materials and kits that are collectively referred to as “takeaways” --- which they can take back to classroom and use. By providing takeaways, Hydrogen Educators have the assurance that teachers possess the tools necessary to institute a program/unit in the classroom. Optimally, the takeaways should include both curriculum and a fuel cell kit that supports hands-on activities.

## 8.0 Fun and the Unexpected

*“...the unexpected constantly occurs.”*

Sir John Pentland Mahaffy

Let's not forget fun with teacher training. Teachers believe that learning can be fun. So, they want to have a good time with their own training experience. Another New HOPE team lesson learned is that it's not hard to have fun when teaching teachers about hydrogen. And if the Hydrogen Educator is having a good time, there's a good chance the participating teachers are, also.

And last but not least: let's not forget the unexpected, which happens more often than one might expect, notwithstanding the most meticulous research and planning. In delivering hydrogen training, Hydrogen Educators should be prepared to think fast and move quickly to deal with the unexpected. It's part of the fun, adding to the rewards of participating in a valuable teacher training process that is preparing teachers to educate students about the potential and benefits of a hydrogen future.