a look into

Altergy's PEM Fuel Cells

Challenges bringing Hydrogen/Fuel Cell Products to Market

Hydrogen and Fuel Cell Technical Advisory Committee (HTAC)

May 9-10, 2012

Introduction to Altergy

- **Who is Altergy?**
  - A California based, privately-held Company located in Folsom (just outside Sacramento)
  - Having a 35,000 sq ft HQ & Manufacturing Plant
  - Recognized by Experts as World Class Cutting Edge Technology
  - All our Components are Designed & Engineered in-house, then out-sourced for manufacturing and returned to our facility for integration into the Finished Product
- **Addressing in U.S. and Internationally Markets**
  - Initial Wireless Backup Power Market Telecommunications/Cell Towers…$10B
  - Follow-On Applications: Cable Broadband, Data Centers, and Various Mission Critical Applications to numerous to count
  - Distributed Generation: Demand Response, Intermittency, Peak-Shaving, Off-Grid Power Generation
  - Off-Road – Forklifts, Highway and Airport Equipment
  - Residential – Back-up support leading to prime power

Altergy's Competitive Advantage

Video

Low Cost, High Volume Automated Assembly

- **World's first and only automated, high-volume assembly line**
- **Radically different from traditional designs**
  - Uses low cost materials
  - Designed for automated assembly
- **Design results in**
  - Key component cost reduced by more than 80% (excludes MEA)
  - Fast cycle times

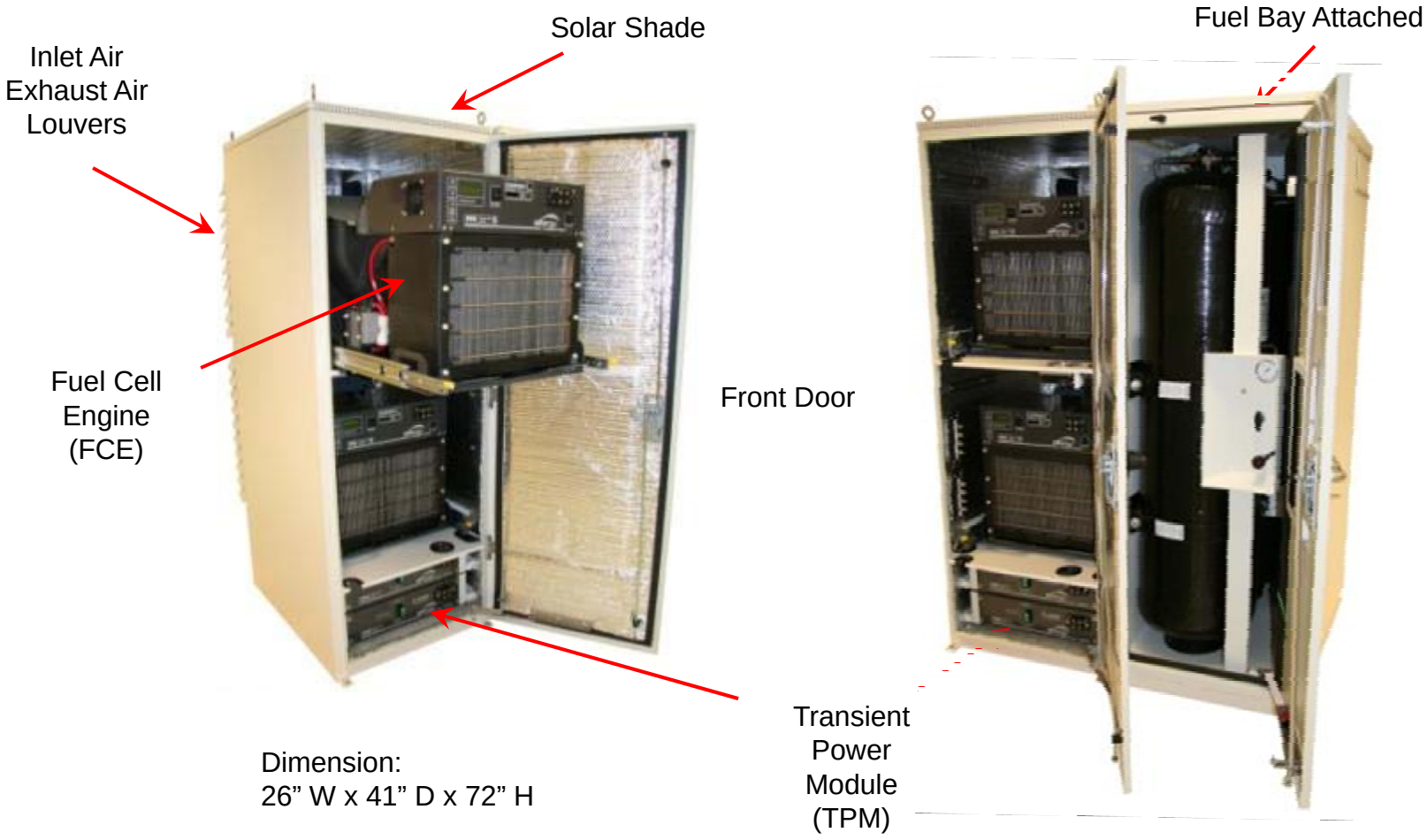
Equipment	Capacity
▪ 12 SCARA robots ▪ 5 lift and transfer stations ▪ 4 Turntables ▪ 170' automatic conveyor ▪ In-line, automated inspection and test	▪ 12,000 units per line per year ▪ Increased capacity to 36,000 units per year after installation of two lines ▪ New line not needed until 2010

Overview of Altergy's Product

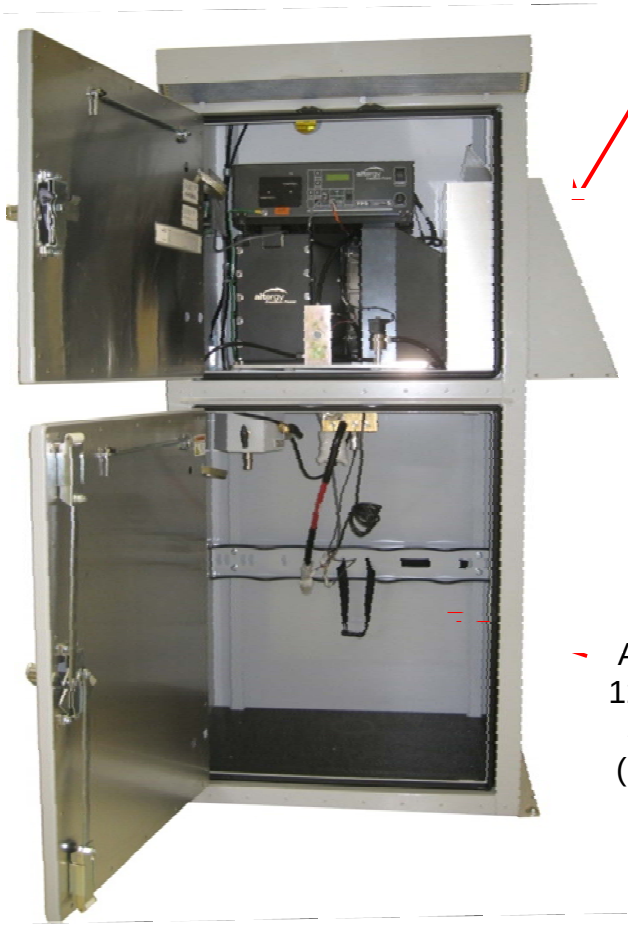
Altergy Product Offerings

- **Fuel Cell Engine**
  - Fully integrated power generator
    - Advanced Altergy™ fuel cell
    - Integrated digital electronics and power management
    - Integrated thermal management
    - 5 to 100kW plug and play capability
  - Modular subassemblies
  - Lightweight and compact footprint
- **Power cabinets**
  - Welded aluminum, all weather enclosure
  - House up to two 5kW fuel cell engines and its TPM
  - Lightweight and compact footprint
- **Fuel cabinets**
  - Welded aluminum, all weather enclosure
  - High pressure composite or standard high pressure steel
  - Hot swappable or refillable onsite
  - Lightweight and compact footprint
- **Transient Power Module (TPM)**
  - Battery or ultra capacitor based bridge power
- **Wireless communication/monitoring**
  - Monitors operating parameters, fuel level and ambient conditions, real time

Power Cabinet (shown with 2 - 5kW engines & fuel cabinet)



Power Cabinet (2.5kW engine with built-in fuel cabinet)



Inlet Air
Exhaust Air Louver

At 2.5kW
12+ Hrs of
Storage
(150 Bar)

Fuel Cell
Engine
(FCE)

Dimension:
38” W x 24” D x 84” H

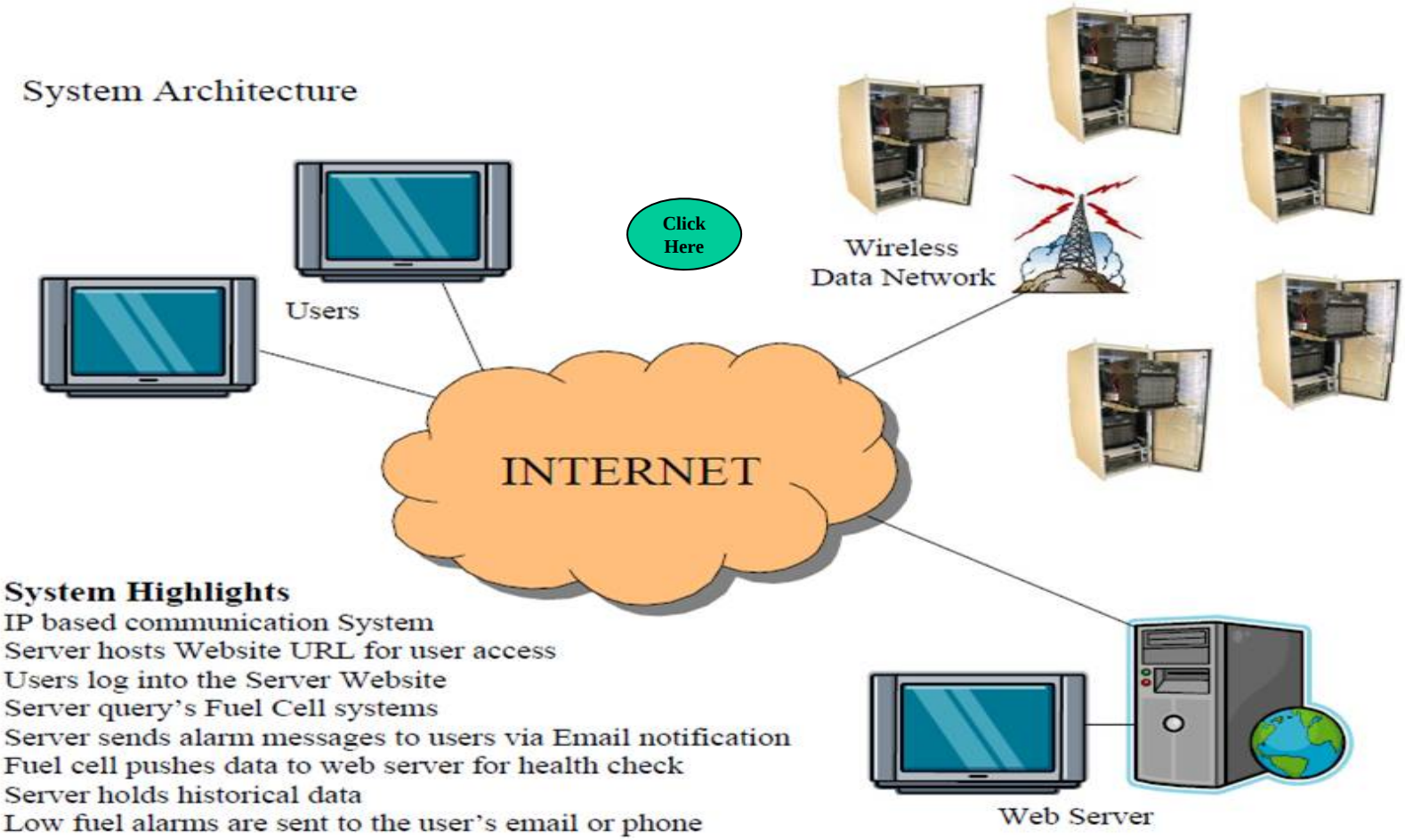
Hybrid Fuel Cell Solution

Rack Mount

TPM: Transient Power Module (bridge power)

- Designed to bridge power
- Sized for momentary needs
  - > 5 kW power for 10 min
  - > 5 kW-min energy
- 24 / 48 VDC configurations
- Temperature requirements
- Lifespan: About 5 years
- Cycles: About 1,500 cycles
- Ultra capacitor solution also available

Remote Monitoring



System Highlights

IP based communication System
Server hosts Website URL for user access
Users log into the Server Website
Server query's Fuel Cell systems
Server sends alarm messages to users via Email notification
Fuel cell pushes data to web server for health check
Server holds historical data
Low fuel alarms are sent to the user's email or phone

Hydrogen Storage

- **Steel K Bottles**
  - Bottles can be either;
    Swapped Out or Filled On-Site
  - Enclosure Holds 8 or 12 Bottles Depending on Enclosure
  - 16 Cylinder Cabinet not shown
- **Composite Tanks**
  - Tanks are Filled On-Site
  - Enclosure Holds Up to 2 or 4 Tanks Depending on Enclosure
- **Composite Tanks**
  - Fill Nozzle Identical to the One Used for Fuel Cell Vehicles
  - Filling Operation Takes Less Than 15 Minutes (1kg/minute)

At 5kW - 12+ Hrs of Storage (150 Bar)

At 5kW - 18+ Hrs of Storage (150 Bar)

At 5kW - 25+ Hrs of Storage (350 Bar)

2 Bay Composite or 8 cylinders

At 5kW - 50+ Hrs of Storage (350 Bar)

4 Bay Composite or 12 cylinders

Delivery of Fuel for the Total Solution

Hydrogen Fuel Storage and Refueling Solutions

- High pressure composite or steel tanks
- Refillable onsite
- Easy site access with standard pickup truck
- US & Canadian DOT approved
- Collaborations with fuel partners assures worldwide availability

AIR PRODUCTS

MATHESON TRI•GAS
ask. . .The Gas Professionals™

THE LINDE GROUP

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Fill-in-Place Application

- **What is Fill-in-Place?**
  - Industry Reference – “Bump-in-Place”
  - Filling either steel or composite hydrogen cylinders on-site
  - Eliminates “Cylinder Swapping”
  - Eliminates loss in Fuel
- **Fill-in-Place Application:**
  - Used in both –
    - Ground Sites Installations
    - Or Rooftops
- **Installation:**
  - Ground applications
    - Has in cabinet connection
  - Roof Applications
    - Simple 3/8” stainless piping from roof to ground fill port access box

Roof-top ground mount port

In-cabinet ground sites

Examples of the Fuel Delivery

Altergy's Product Safety

- Altergy's Fuel Cell products are fully tested, certified, and listed by CSA-America

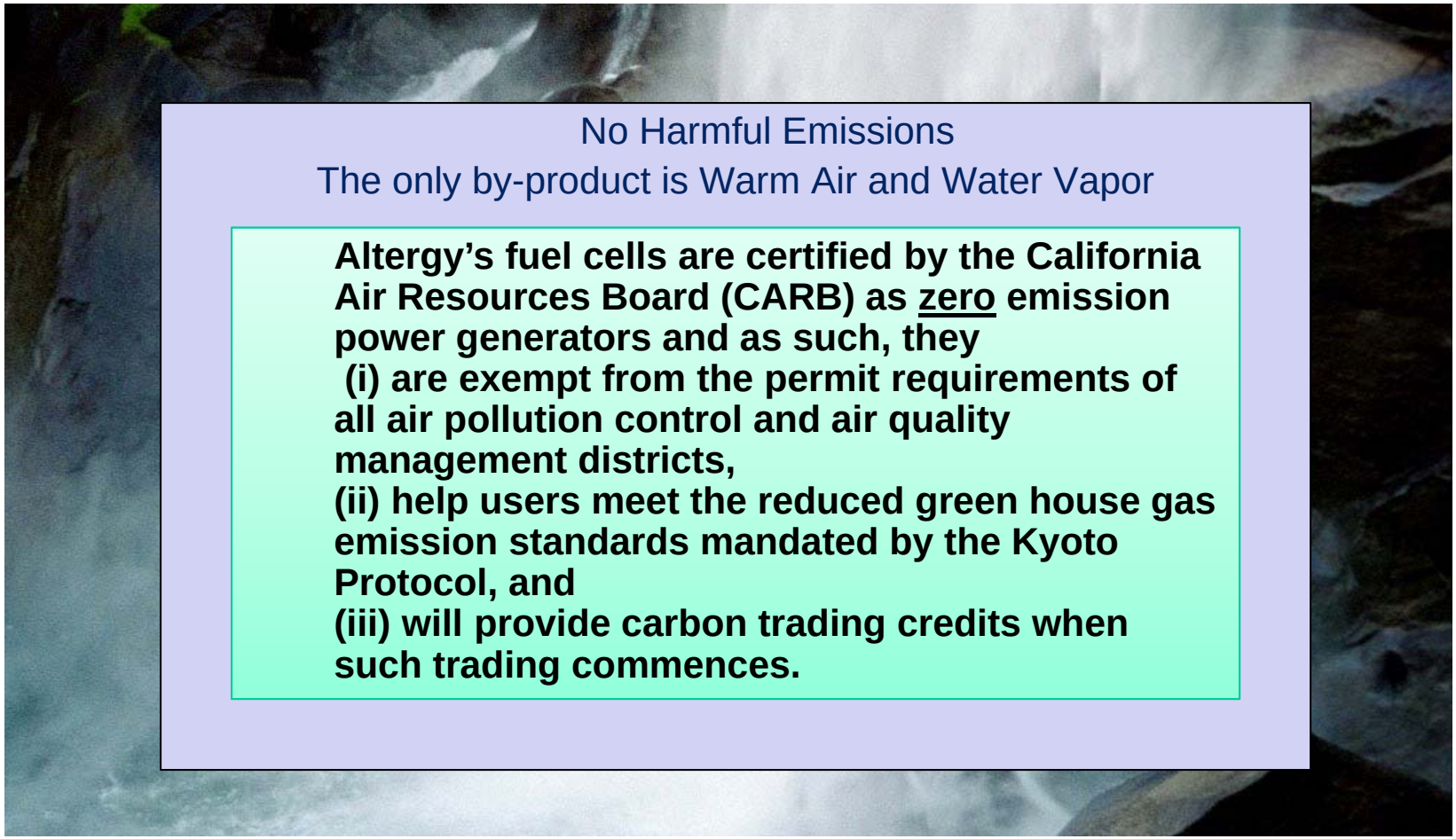
- The products meets or exceeds the requirements of:
  - The State Fire and Building Codes
  - NFPA 1 – Uniform Fire Code
  - NFPA 55 – Standard for Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks
  - NFPA 853 – Standard for the Installation of Stationary Fuel Cell Power Systems
  - NFPA 70 - The National Electric Code (NEC)
  - The International Fire Code (IFC)
  - ANSI/CSA FC-1 – Standard for Stationary Fuel Cell Power Systems
  - Federal Communications Commission (FCC) – Part 15 of the FCC rules
  - IEC - European Standards (CE)

System Approval Gas Approval FCC Approval System Approval

- Each system is installed through the permitting and zoning requirements of a given jurisdiction

Altergy's Product Meets or Exceeds all Required Codes and Standards

Altergy's Fuel Cells are "Green"

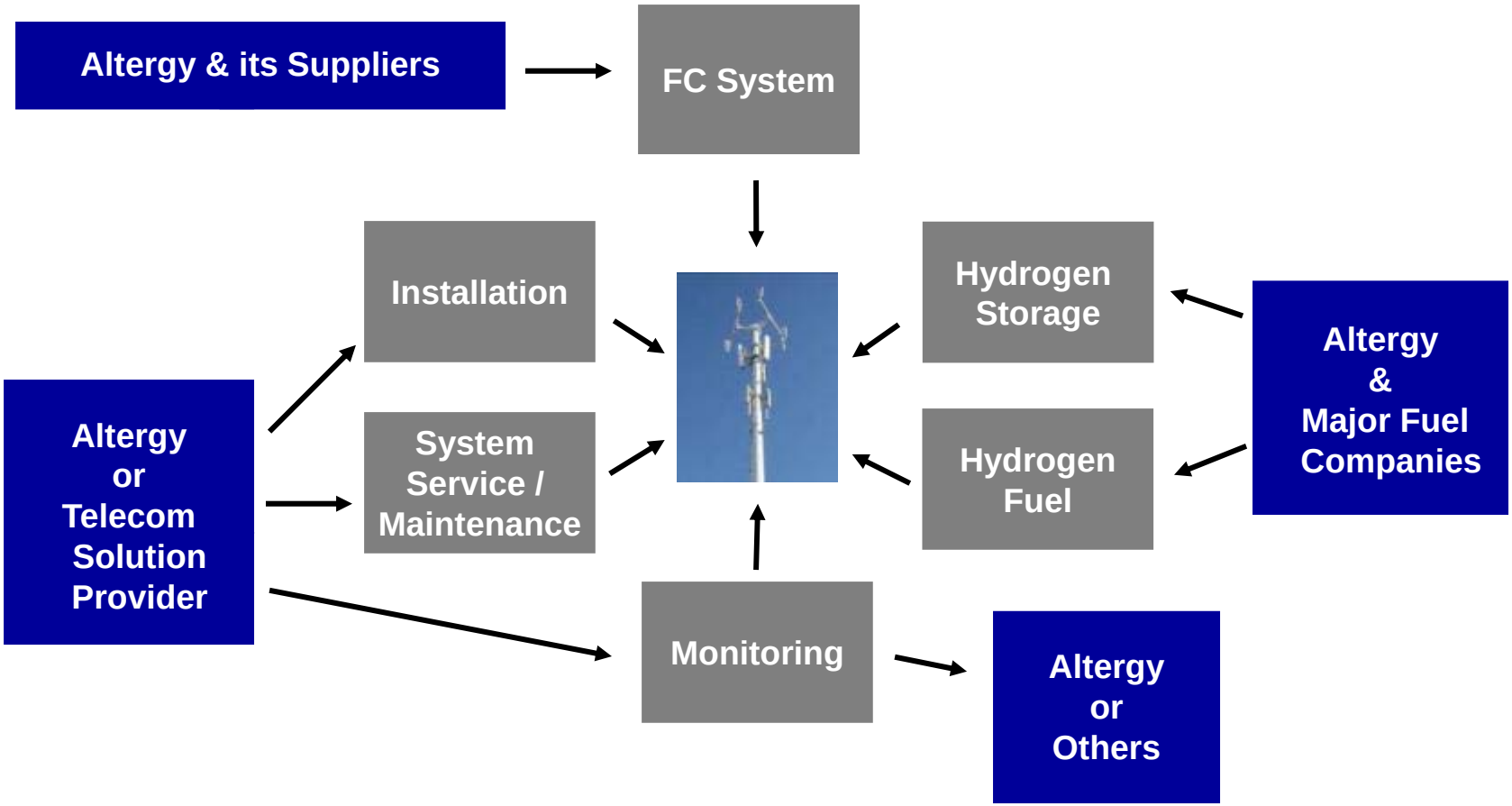


No Harmful Emissions

The only by-product is Warm Air and Water Vapor

Altergy's fuel cells are certified by the California Air Resources Board (CARB) as zero emission power generators and as such, they
(i) are exempt from the permit requirements of all air pollution control and air quality management districts,
(ii) help users meet the reduced green house gas emission standards mandated by the Kyoto Protocol, and
(iii) will provide carbon trading credits when such trading commences.

Collaborations Provide Total Solutions



Strategic Alliances Provides Validation and Market Penetration

altergy systems

Strategic Alliances

EnerSys - the world's largest industrial battery company
28% of the global industrial battery market
Largest battery supplier to the Federal Government

Eaton - a global leader in power quality systems and components

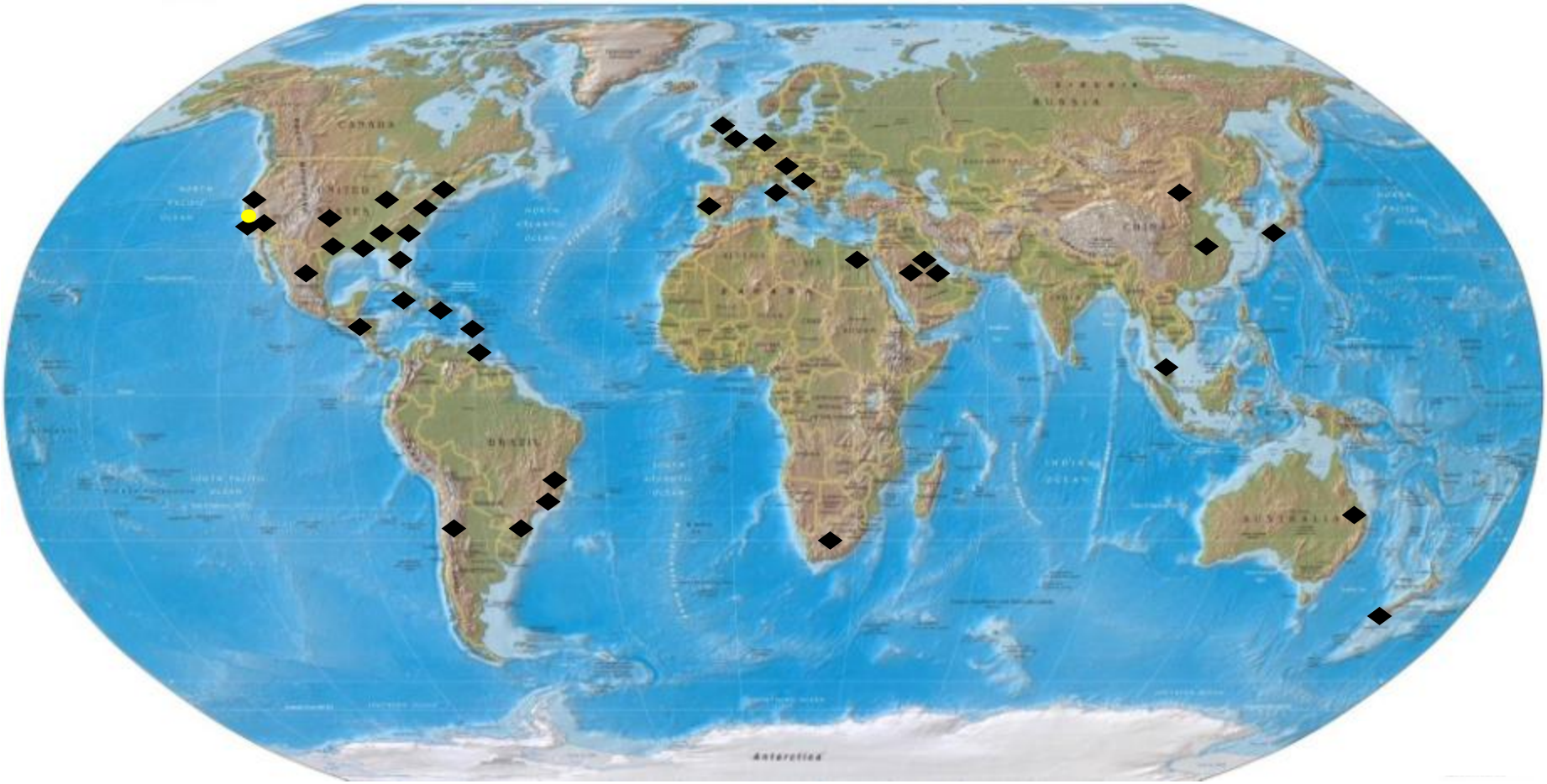
Nokia Siemens Networks (NSN) – one of the world's largest telecom equipment supplier

Multiquip - one of the largest, most diversified manufacturers and suppliers of World Class Quality industrial products and solutions primarily focused in the Construction Industry

Altergy – Anglo Platinum – South African Govt. Alliance
Government adopted Hydrogen Strategy (HySA)
SA Government is equity owner
Automated manufacturing facility to be built in SA

Fuel Cell Installation Examples related to Telecom Networks

Altergy's Global Footprint



◆ 2008/2011 Deployments

Ground Site Deployment

Just a few ground sites shown here

Before

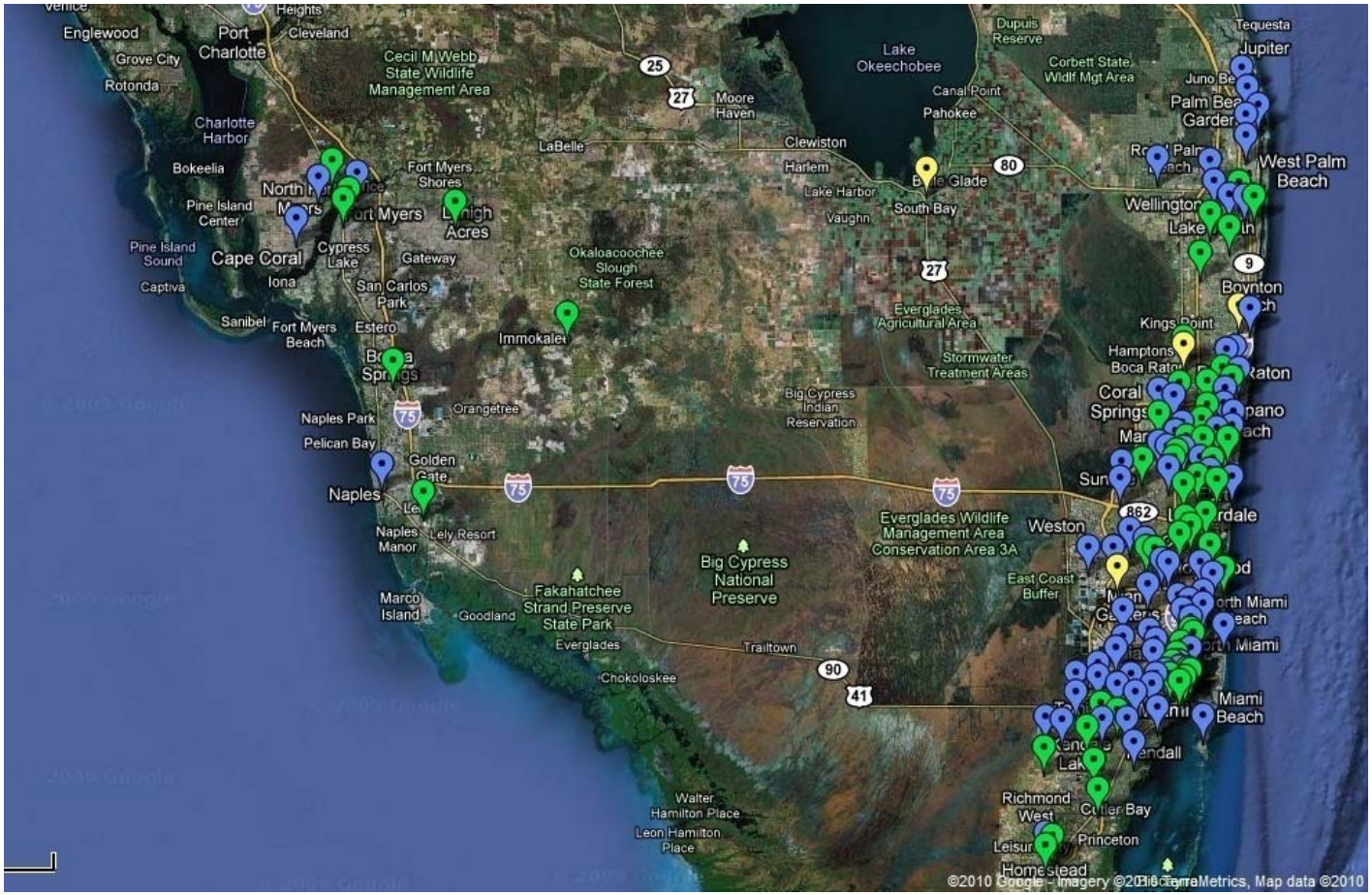
After

Roof Top Deployment

Just a few roof-top sites shown here.

These roof-top sites are part of the largest single deployment of fuel cells for one customer

Product Deployment



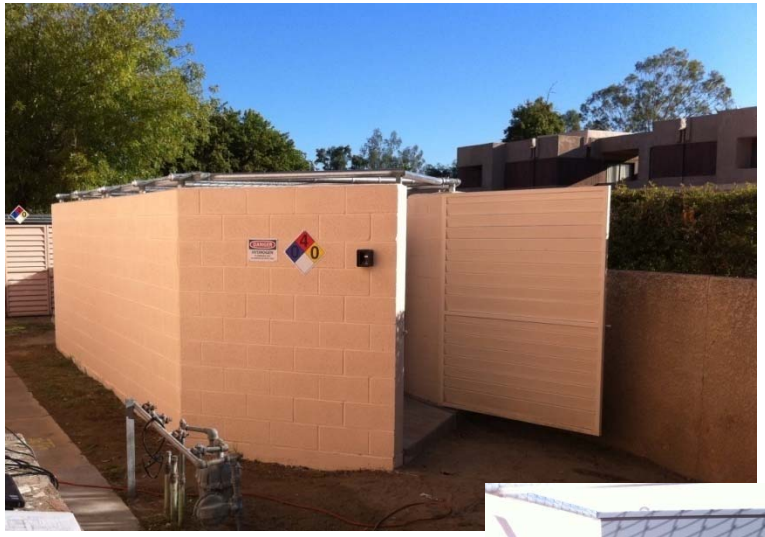
Largest single deployment in one location- Over 325 Engines at 140 Sites in Florida

Hybrid System - Extended Run Time Solution

Off grid runtime - 77 hrs (3.2 days)

- **5KW engine**
  - 60 g/kW/hr hydrogen required per 1 kW/hr load
- **Two Strings SBS190**
  - Battery supplies 25A load for 11 hrs, then FC on-line
- **Nine HP-350 K Bottles**
  - One HP350 bottle holds 640 grams
  - Nine bottle (5,760g) will support

Time Warner Cable - 30kW System



Governor's Mansion - 20kW System

Award Events – Academy Awards, SAG, Golden Globes, others

Provided Power at the 2010 Academy Awards® Turning the Red Carpet – "Green"

- Due to this Event's High Profile, Security is Performed by the United States Secret Service

- Altergy's Product Passed all Safety and Security Reviews Performed by the Electrical, Fire, and Security Inspectors

Highway and Film Industry Applications

American Assoc. of State Highway & Transportation Officials (AASHTO)

Randy Iwasaki ,
Past - Caltrans Director (center)
Note: Talking while the fuel cell is running

Academy Awards - setup night before

American Assoc. of State Highway & Transportation Officials (AASHTO)

Notice: The incredible lighting of the space

Employs;
Altergy 5kW PEM fuel cell
4- 5,000 psi tanks of H_2 (4kg) ~ 62 hour duration
Multiquip Trailer
8 - Luxim Plasma Lights (2.5 kW total)

Caltrans chain “checkpoint” along Route 80

Storage of Fuel Cell Mobile Light in Caltrans Yard

During the day, the unit is stored in a shed that has one side exposed to the elements, no heating in shed

Challenges Bringing PEMFC Product to Market

Three major hurdles:

- **PEMFC Stationary Market Penetration**
- **Membrane Electrode Assemblies (MEA's)**
- **Hydrogen Delivery**

PEM Stationary Fuel Cell - Market Penetration

- **Federal Government – Needs to Step up and Invest in Product**
  - Has funded millions in R&D dollars to labs, universities and large corporations for PEMFC technology well into the future but not investing in the robust commercialized stationary product developed over the last five years
  - For years the Feds have asked entrepreneurs' to step-up and build PEMFC product for tomorrow's stationary energy needs but have not purchased but a handful of product
  - They have invested heavily into solar and wind, but not fuel cells, why the bias?
  - Considering Capacity Factor vs. Solar and Wind, PEMFC's are the only mission critical solution in combating diesel generators and its pollution
- **It's volume that will drive new PEMFC technology**
  - With millions of square feet of government office space, military bases, laboratories, etc. that exist today, one can easily count the amount of PEMFC installed to date
  - Subsidize the PEM stationary fuel cell industry, like oil has been
  - Mandate a percentage of government owned properties be hydrogen based applications for a period of years to help launch the market
  - Feds need to step up and buy product – not one-off R&D projects, but volume product
  - The way to get fuel cell's cost-competitive is simply put….
    - **Economics 101 -– The more we build the cheaper they get**

Membrane Electrode Assemblies (MEA's)

The most expensive part of our system is the PEM MEA

- It attributes to >63% of the cost of our product
- Equates to roughly $0.16 cents /sq.cm, that in itself needs to be cut in half
- Streamlining the MEA manufacturing process, drive costs down
- Increasing power density of an MEA would reduce surface area
- Best of Class MEAs to date are produced overseas in turn importing, exporting, packing, shipping and duty need a reprieve

Present high costs is mainly due to low volume of production !!

- Scaling up production to gain economies of scale through increased market penetration is what the MEA manufacturers say will reduce the cost more than anything else
- Like solar…. fund manufacturing
- Subsidize the PEMFC industry, like other industries

Hydrogen Delivery

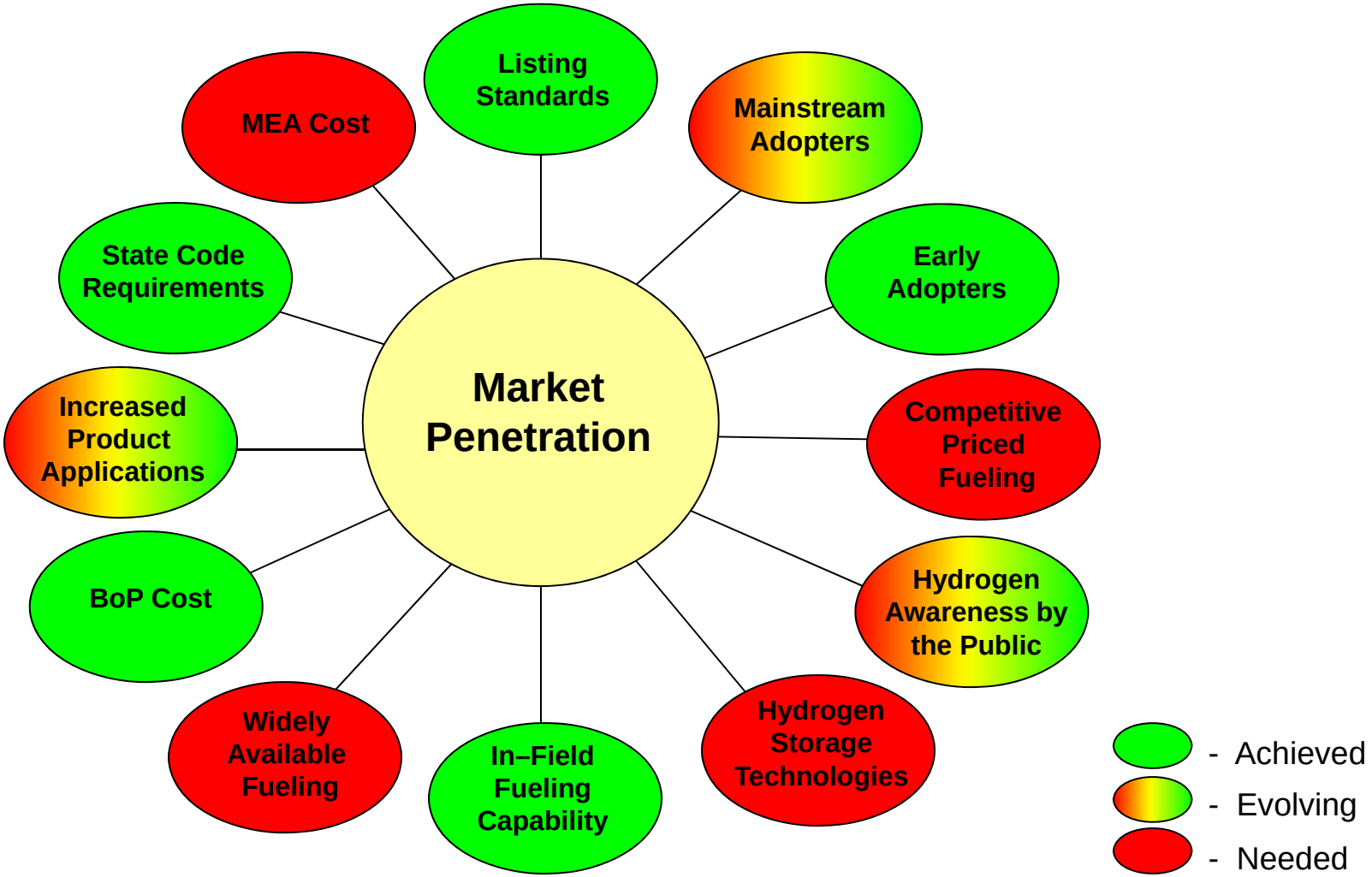
Lack of Competition

- Large gas suppliers firms - too large and not competing
  - No reason in giving competitive bids if you are the only game in town
- Help finance the grass-roots sub-contractor in delivering product
  - Follow the lead of the small independent gasoline supplier industry
  - Help develop small refueling trailers with capability of picking up at bulk plants, or encourage development of small satellite bulk storage stations

Collaborative Effort with the Gas Industry

- Oil Companies have been subsidized for years, do the same for the Hydrogen Industry, giving incentives to spark investment
- The Feds can pay millions to develop new ways to produce a breaker full of hydrogen, give incentives to deliver the gas cost-effectively
- Develop a nationwide delivery system using fill-in-place concepts, similar to that of the propane industry

Market Penetration



Thank you

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