DTE Energy
Hydrogen Technology Park
2004 DOE Hydrogen, Fuel Cells & Infrastructure Technologies Program Review

Robert Regan
DTE Energy Co.
May 26, 2004

Objectives

DTE Energy

Project Objectives

Develop and test a hydrogen co-production facility having stationary fuel cell power and vehicle fueling capability that uses renewable & non-renewable resources

Employ representative commercial units under real-world operating conditions

Based on performance data, project experience, and market assessments evaluate the technical and economic viability of the power park system

DOE Objective

By 2008, validate stationary fuel cell systems that co-produce hydrogen and electricity from non-renewable and renewable resources

Objectives

DTE Energy

Project Objectives

Contribute to development of relevant safety standards & codes required for commercialization of hydrogen-based energy systems

Identify system optimization and cost reduction opportunities including design footprint, co-production, and peak-shaving applications

Increase public awareness and acceptance of hydrogen-based energy systems

DOE Objectives

Determine the relevant codes, safety standards, and engineering data required for Power Parks

Obtain real-world operating data to better understand performance, maintenance, operation, and economic viability of Power Parks

Budget

DTE Energy

Budget Category	FY04 DOE Budget	Total DOE Budget
Personnel (incl. fringe & indirect)	$ 170,936	$ 364,918
Travel	$ 6,406	$ 16,500
Equipment	$ 1,186,183	$ 1,216,183
Supplies	$ 27,000	$ 27,000
Other direct	$ 655,780	$ 824,378
Total	$ 2,046,305	$ 2,448,979
DOE Share	$ 1,000,000	$ 1,200,000
Cost Share	$ 1,046,305	$ 1,248,979
Total	$ 2,046,305	$ 2,448,979

Barriers Addressed

This project addresses the following technical barriers from the Technology Validation section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year R,D&D Plan:

C. Hydrogen Refueling Infrastructure

E. Codes and Standards

H. Hydrogen from Renewable Resources

I. Hydrogen and Electricity Co-production

Approach: Overview

DTE Energy

Tasks

Design, install, and operate an integrated hydrogen co-production facility utilizing:

- Electrolytic hydrogen production
- On-site gas storage
- 50kW stationary fuel cell power
- 5000 psig vehicle dispensing
- Renewable on-site solar energy
- Grid-connected biomass energy

Collect, analyze, and report system performance data & lessons learned for an integrated co-production facility operating under real-world conditions

Evaluate commercialization opportunities for an advanced Power Park facility

Barriers Addressed

C. Hydrogen Refueling Infrastructure

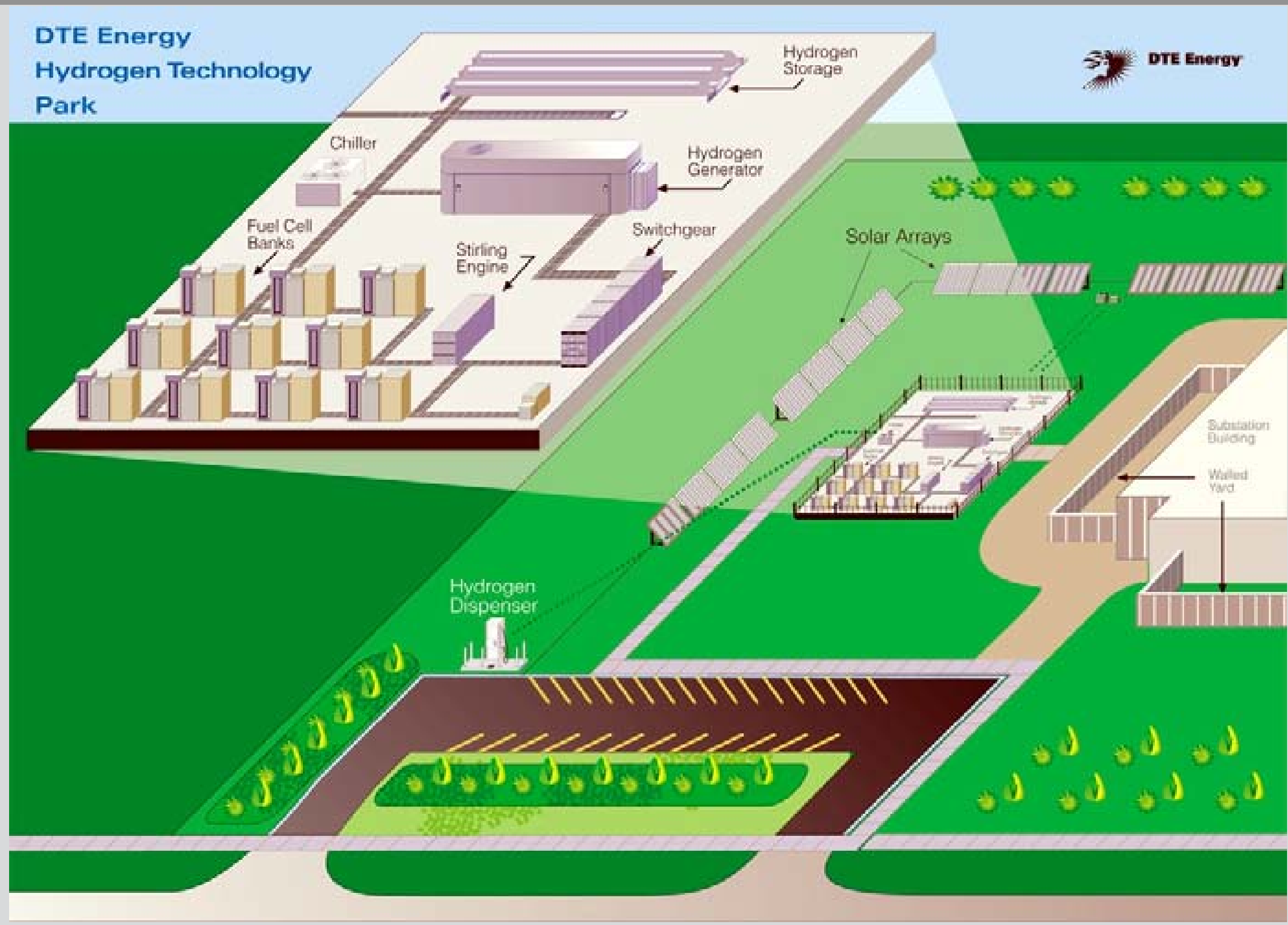
E. Codes and Standards

H. Hydrogen from Renewable Resources

I. Hydrogen and Electricity Co-production

Approach: Project Rendering

- Integrated, end-to-end co-production facility
- Simplified design & construction
- Minimal pad footprint
- Reduced capital and O&M costs
- Reduced permitting risk
- Integrated with on-site renewable energy source

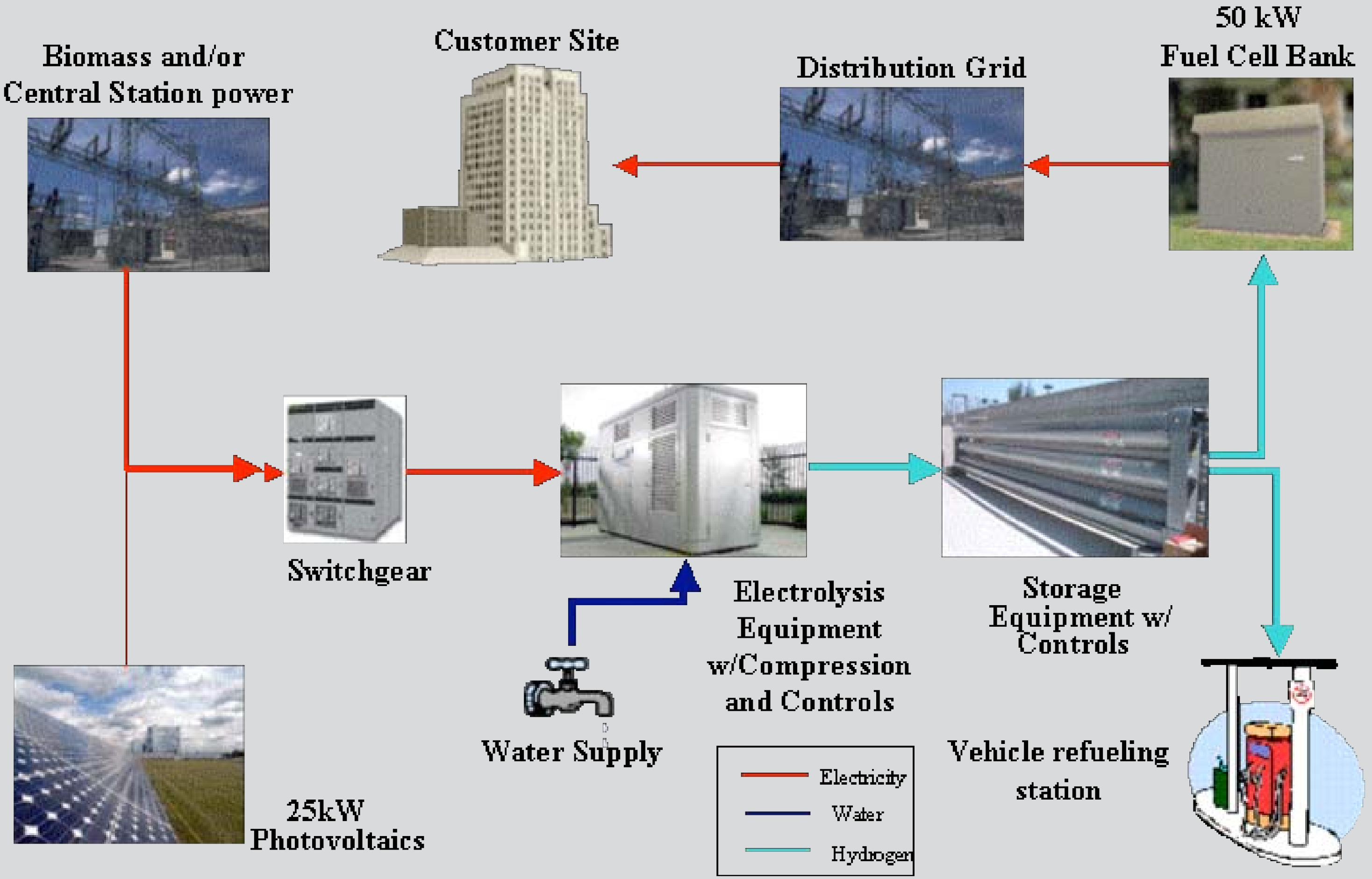


Approach:
Process Flow Diagram

DTE Energy

System Operations Center *(not shown)*:

- **Provides remote monitoring & control**
- **Improved economics through reduced O&M costs**
- **Allows for system optimization:**
  - grid congestion solutions (DG)
  - peak shaving applications
- **Fully integrated with site instrumentation to provide automated data collection & storage**



Approach:
Southfield Substation grounds

DTE Energy

- Real-world operating conditions
- Allows testing stationary and mobile fuel cell applications in cold-weather climate

Project Safety

Project Safety Plan includes:

- **FMEA or HAZOP covering all systems & components not listed by a nationally recognized testing laboratory**
- **Safety Interface Analysis**
- **Identification and design to applicable codes and standards:**
  - NFPA 50A Gaseous H2 Systems
  - NFPA 52 CNG Vehicular Fuel Systems
  - NFPA 77 Static Electricity
  - NFPA 780 Lightning Protection
  - NFPA 853 Stationary Fuel Cell Power Systems
- **Design Safety Review including Codes & Standards Compliance Review**
- **Operating and Support Hazard Analysis (O&SHA) including procedure review**
- **Emergency Stops**
- **Site Alarm System**

Project Safety

Risk Management Process:

- Defines subjective levels of severity and likelihood
- Defines levels of risk
- Describes levels of management with authority to accept risk based on residual risk level
- Residual risk is risk that remains with controls in place to mitigate severity or minimize likelihood

Risk Matrix		Likelihood			
		Very Likely	Like-ly	Un-likely	Very Unlike
Severity	Catastro-phic	Very High	Very High	Very High	High
	Serious	Very High	High	Medium	Medium
	Signifi-cant	High	Medium	Low	Low
	Nominal	Medium	Low	Very Low	Very Low

Safety Lessons Learned:

- ASME above-ground storage tanks vs. composite
- Site alarm system

Project Timeline

Oct '02 | Mar '03 | Fall '04 | Sep' 05

Phase I | Phase II* | Phase III

Phase I

Select Team

Establish technologies & sources

Establish codes & standards framework

Select Site

[complete]

Phase II*

Design system & obtain permits

Procure equipment

Install, commission system

Develop educational program

[in progress]

Phase III

Operate, monitor, and maintain system

Develop technical report

Assess economics and develop business plan

Document and publish project results

[planned]

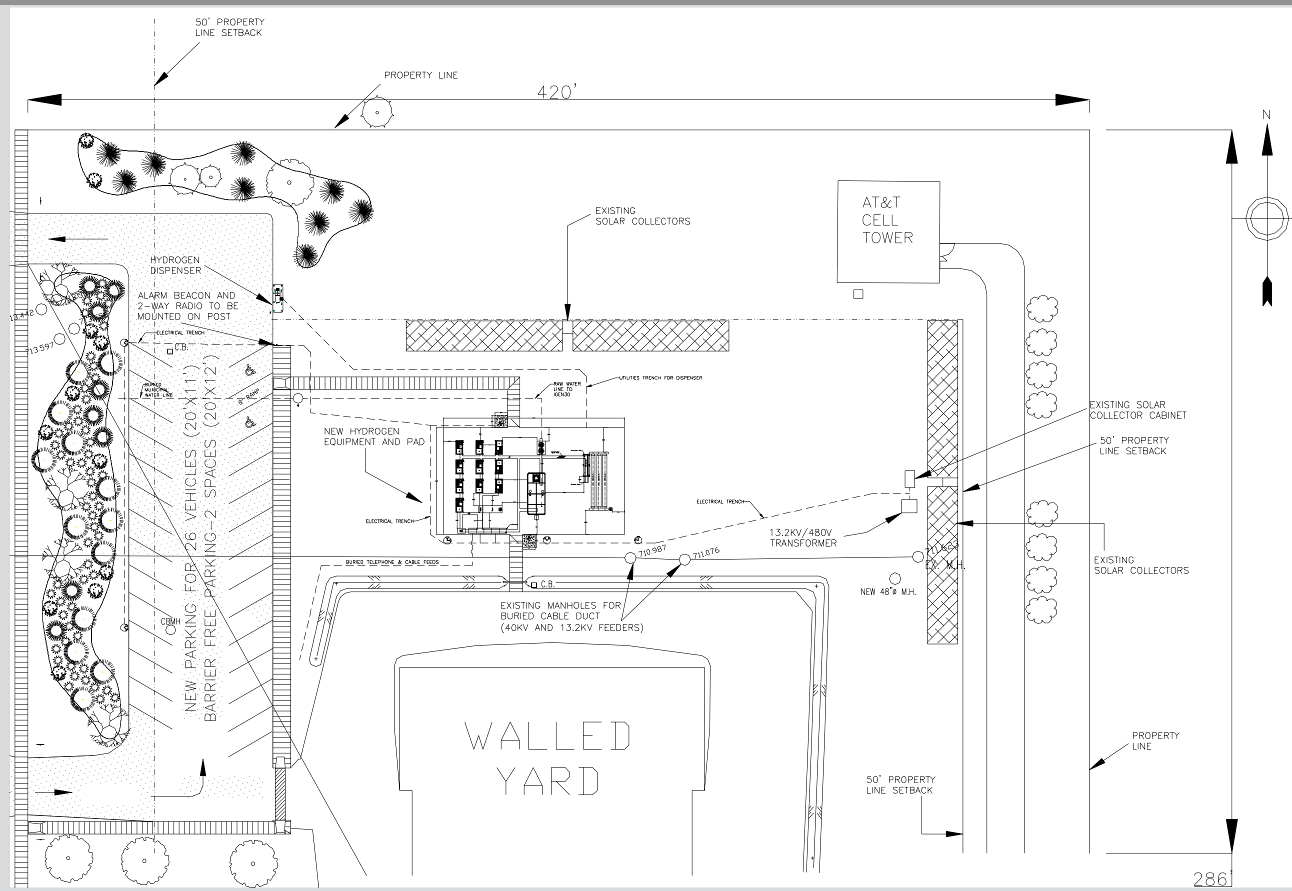
Potential follow-on DOE project '05 – '08

*Project placed on hold for first three months of FY04 due to award pass-through issues

DTE Energy

Accomplishments:
Site Design & Approval

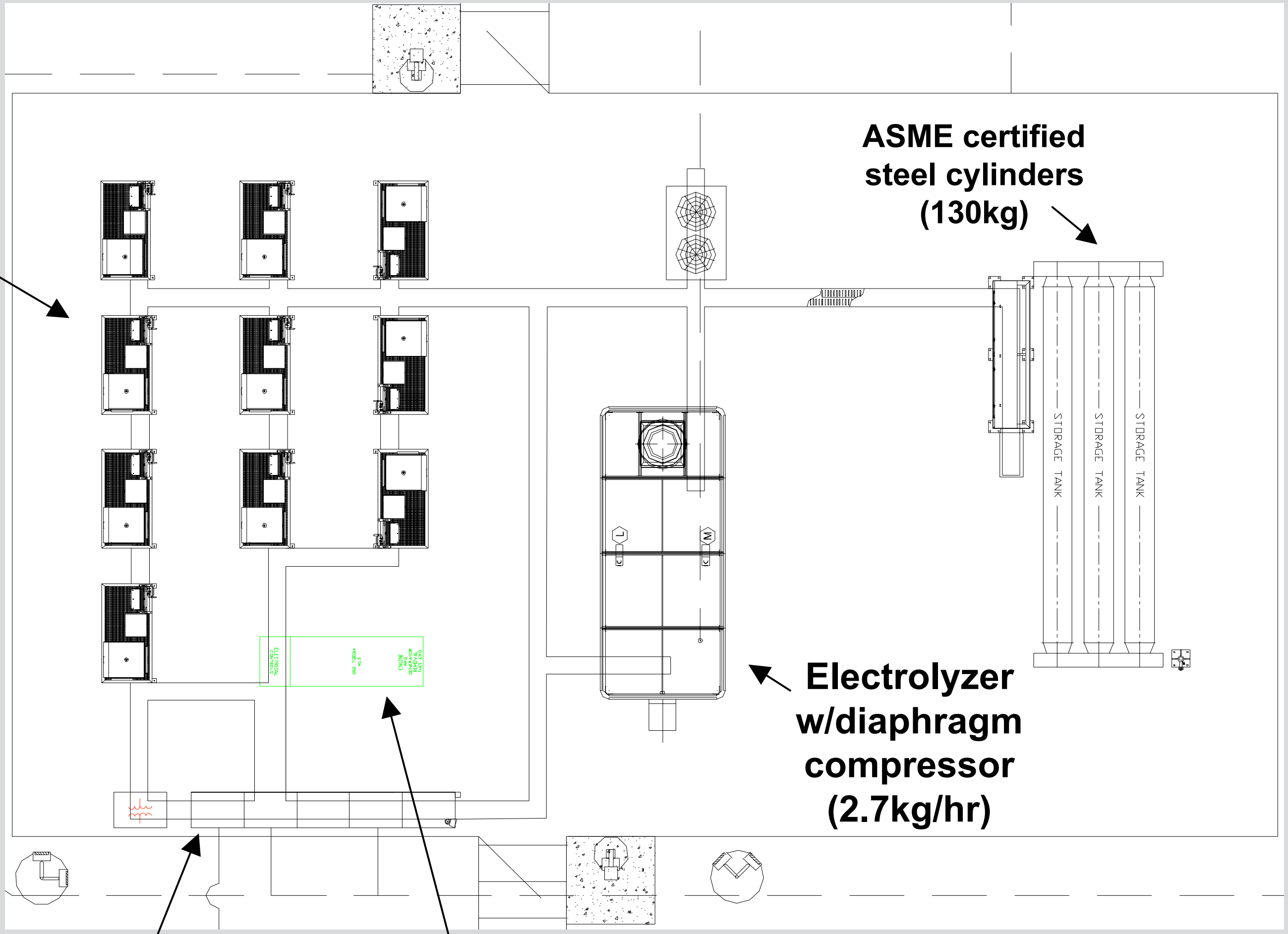
- **Site Plan approved by City of Southfield**
- **Cost reductions achieved through integrated, compact site design incl. minimal pad footprint**
- **Fully integrated w/on-site renewable energy source (solar power)**
- **Future site development supported:**
  - **Space provided for additional power generation technology**
  - **Space provided for future Visitor Center**
- **Construction permit application submitted**



Accomplishments:
System Design/Equipment Pad Layout

DTE Energy

- 10 stationary fuel cell subsystems developed to operate in tandem for AC power generation (40-50kW)
- Hydrogen purity concerns addressed through use of electrolysis and diaphragm compression
- Meets Americans with Disabilities Act (ADA) Standards for Accessible Design
- Meets all applicable safety codes & standards



Accomplishments:
Major Equipment Procured

GenCore™ 4AC fuel cell subsystems (x10)

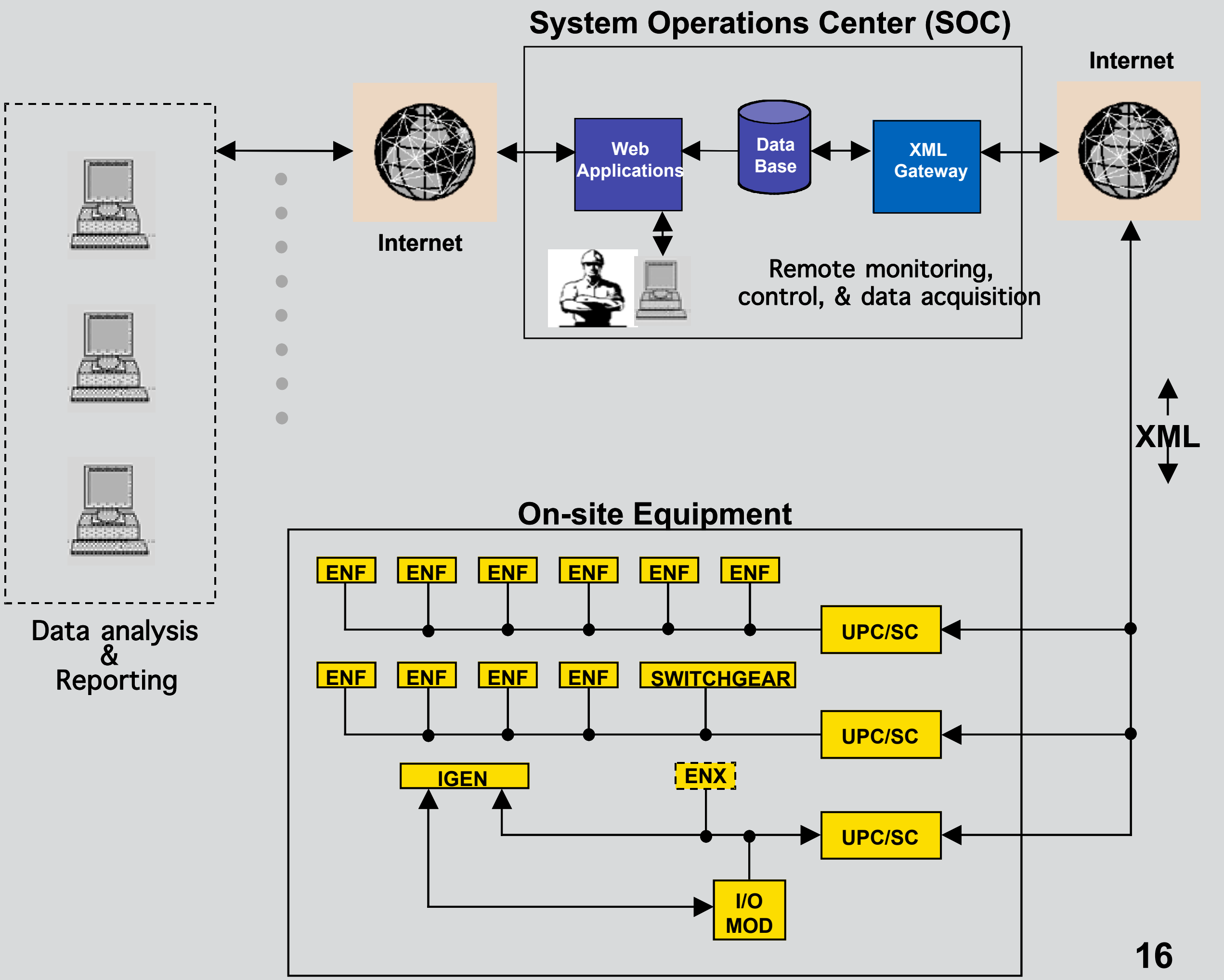
H2 IGEN® 30 with Weatherized Enclosure

SES Fuel Dispenser Module

ASME certified steel cylinders

Accomplishments:
Remote Monitoring & Control System Design

- Remote monitoring & control system designed
- System capable of remotely monitoring and recording all relevant system parameters including runtimes, power consumed, hydrogen mass produced/consumed, component & system efficiencies, and alarms & warnings
- Data collection & analysis plan drafted



Other Accomplishments

- Project safety plan developed & implemented
- Permitting
  - Received DOE certification of compliance with National Environmental Policy Act (NEPA)
  - Permitting lessons learned shared with other DOE projects
- Codes & Standards:
  - Participant in Michigan Department of Environmental Quality (MDEQ) Hydrogen Ad Hoc Committee
  - Committee developing hydrogen storage certification and licensing standards for the State of Michigan
- Education & Outreach:
  - Project featured in several public outreach activities including news stories, print articles, internet newsletters, radio spots, and TV interview
  - Project presented at the 2003 MicroGeneration to PowerParks Conference, Lansing, MI
- Participant and co-awardee in DOE's Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

Interactions & Collaborations

Lawrence Technological University:
Dr. Robert Fletcher – Mechanical Engineering
- Data collection & analysis lead
- Project to serve as 'working laboratory' in new alternative energy curriculum

BP
- Infrastructure partner for DOE Hydrogen Fleet Demonstration project
- Providing design & safety reviews for refueling portion of facility
- Providing best practices/lessons learned from EU and other hydrogen refueling installation experiences

DaimlerChrysler
- Vehicle partner for DOE Hydrogen Fleet Demonstration project

BOC
- Collaborator on gas handling, system optimization, & commercial off-take opportunities

DTE Energy

FY03 Comments & Responses

Strengths

- **The program has a variety of established partners and a workable concept design.** *Thank you*

Weaknesses

- **The details of implementation could be more thoroughly developed.** *Site & system designs are now complete with all major equipment specified and procured. Developing system operation, control & monitoring, and data collection & analysis plans*

Specific recommendations and additions or deletions to the work scope

- **It will be important to include project details and specific descriptions of the program as they are developed and implemented.** *Please see above and previous slides*

Future Work (FY04-05)

- Obtain construction permits
- Hold ground-breaking event
- Construct site
- Complete data collection & analysis plan
- Install & commission system
- Hold project dedication/site opening event
- Operate & maintain system
- Enhance education & outreach activities (e.g. Visitor Center)
- Begin data collection, analysis, optimization, and reporting work
- Integrate site into CONTROLLED HYDROGEN FLEET AND INFRASTRUCTURE DEMONSTRATION AND VALIDATION PROJECT (FY05-FY08)

Future Visitor Center (example)

DTE Energy

Questions?