US DOE Webinar Series

Fuel Cell Technologies Office

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

EERE Fuel Cell Technologies Office

14 January 2014

2013 and 2014 Hydrogen Student Design Contests

Webinar Overview

1. **Introduction**
   Greg Kleen, U.S. DOE Fuel Cell Technologies Office
2. **2013 Contest Introduction**
   Development of Hydrogen Fueling Infrastructure in the Northeastern U.S.
   Emanuel Wagner, Hydrogen Education Foundation
3. **Honorable Mention Presentation**
   University of Birmingham
4. **Winning Design Summary (University of Kyushu)**
5. **2014 Contest – Industry View**
   Jacob Krogsgaard, H2 Logic
6. **2014 Contest Theme, Rules & Guidelines Introduction - Design a Drop-in H2 Fueling Station**
   Emanuel Wagner, Hydrogen Education Foundation
7. **Q&A**

2013 Contest Overview

- Emanuel Wagner, Hydrogen Education Foundation

HEF Contest Manager

Hydrogen Education Foundation

- Promotes clean hydrogen energy technologies through educational programs to encourage environmental stewardship, improve energy security, and create green jobs. More info: www.hydrogeneducationfoundation.org

- Programs include:
  - H-Prize
  - H_2andYou
  - Hydrogen Student Design Contest
  - Washington Fuel Cell Summit

- For timely updates:

Like us at: www.facebook.com/Hydrogen.Education.Foundation

Follow us at: @h2andyou

What is the Contest?

- The annual Hydrogen Student Design Contest challenges university students to design hydrogen energy applications for real-world use.
- Supported by the U.S. Department of Energy
- Technical, multidisciplinary competition
  - Engineering
  - Architecture/planning
  - Industrial design
  - Economics
  - Business/marketing
  - Environmental science
  - Political science
  - Chemistry

History of Contest

- Began in 2004
- Past themes:
  - Residential Fueling
  - Designing a Hydrogen Community
  - Green Buildings with Hydrogen
  - Hydrogen Applications for Airports
  - Hydrogen Power Park
  - Hydrogen Fueling Station
- Several winning designs were built, e.g. the 2005 winning design is now an active hydrogen fueling station at Humboldt State University

HYDROGEN EDUCATION FOUNDATION

The Hydrogen Education Foundation's Hydrogen Student Design Contest
www.HydrogenContest.org

2012-2013 Contest Sponsors and Supporters

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

NREL

TOYOTA

Mercedes-Benz

Connecticut Center for Advanced Technology, Inc.

RENEWABLE ENERGY WORLD.COM

FUEL CELLS 2000
www.fuelcells.org

energy storage

2012-2013 Theme:

Development of Hydrogen Fueling Infrastructure in the Northeastern U.S.

Theme Details

- Create a feasible plan for the implementation of a hydrogen infrastructure
- Use only commercially available technology
- Design to facilitate fuel cell vehicle travel within and between major urban areas in the Northeast and Mid-Atlantic

Why Infrastructure Development?

- Several major car manufacturers announced plans to commercially introduce fuel cell vehicles by 2015
- Challenge of infrastructure development remains a critical unresolved issue to advancing hydrogen as a fuel
- In the Northeast, home to over 50 million people, only half a dozen fueling stations currently exist, and few are publically accessible
- → Hydrogen sourcing and fueling infrastructures must be planned and developed across the United States

2012-2013 Contest Sections

1. Identifying the Hydrogen Production and Fueling Station Locales
2. Rollout Scheme
3. Cost and Economic Analysis
4. Hydrogen Storage and Fueling Station Regulations
5. Marketing and Public Education

Who Participated?

- 15 teams from 6 countries submitted Abstracts for the 2012-2013 Contest
- Top Teams:

University	Award	Score
Kyushu University	**Grand Prize**	**85%**
University of Birmingham	**Honorable Mention**	**85%**
Mingdao University	Top Five Finisher	73%
Missouri University of Science and Technology	Top Five Finisher	72%
UCT Bulgaria	Top Five Finisher	71%

Honorable Mention Design

- University of Birmingham

- Presenters:
  - James Courtney
  - Daniel Symes
  - James Watton
  - Amrit Singh Chandan
  - Tony Meadowcroft

Report is available at:
http://www.hydrogencontest.org/pdf/2013/7%20University%20of%20Birmingham%20-%20Final%20Report.pdf

Development of a Hydrogen Fuelling Infrastructure in the Northeast United States

A transitioned development plan from the Centre for Hydrogen and Fuel Cell Research

The Centre for Hydrogen and Fuel Cell Research – Fundamentals to Infrastructure

Today's Presentation team,

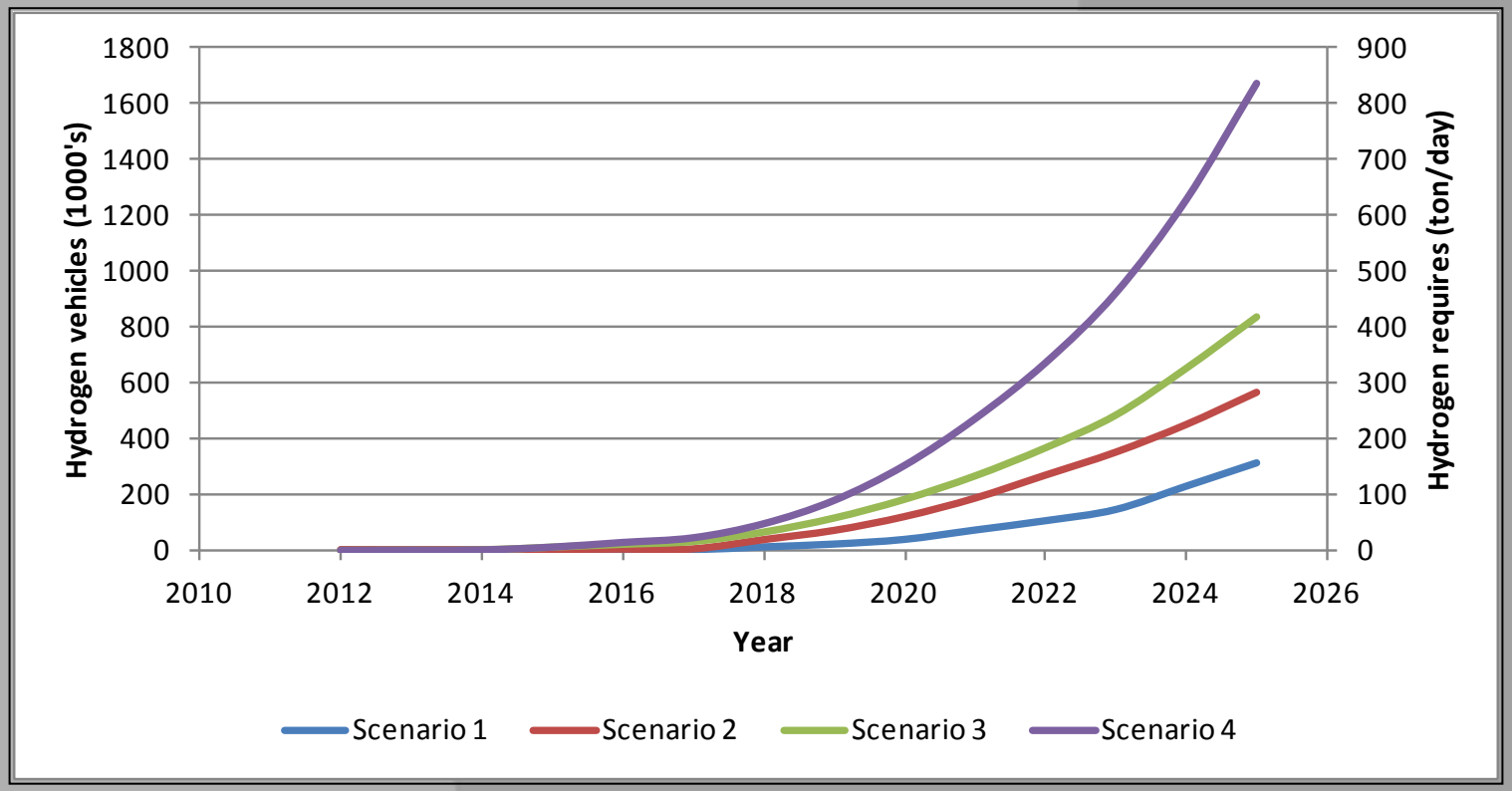
James Courtney
Daniel Symes
James Watton
Amrit Singh Chandan
Tony Meadowcroft

The University of Nottingham
Loughborough University
UNIVERSITY OF BIRMINGHAM

Content

- Overall aims and Objectives
- Split Development Periods
- Phase I
- Phase II
- Phase III
- Special Regulatory Notes
- Economic Considerations
- Marketing and Outreach

Aims and Objectives

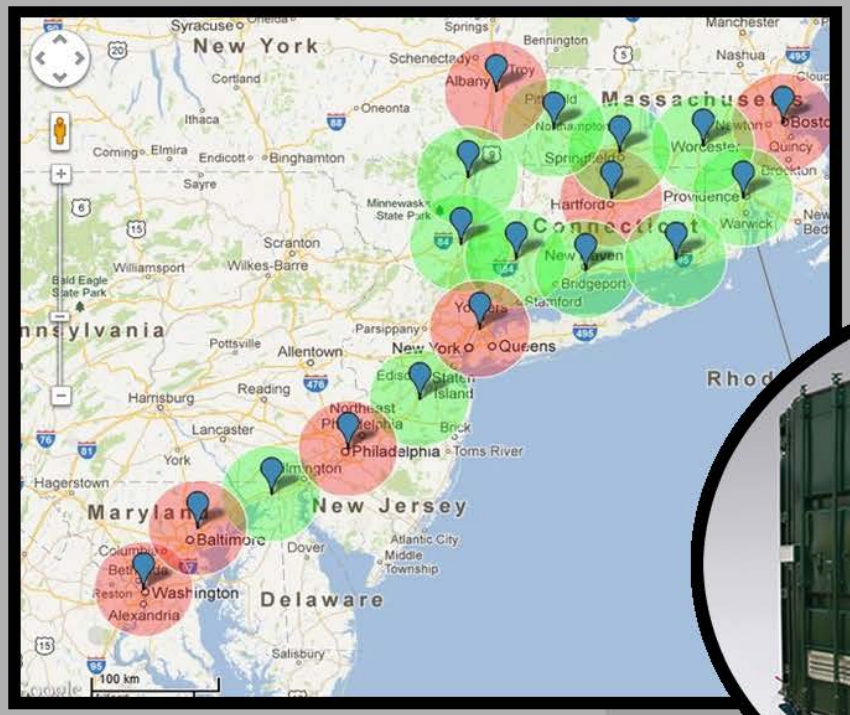


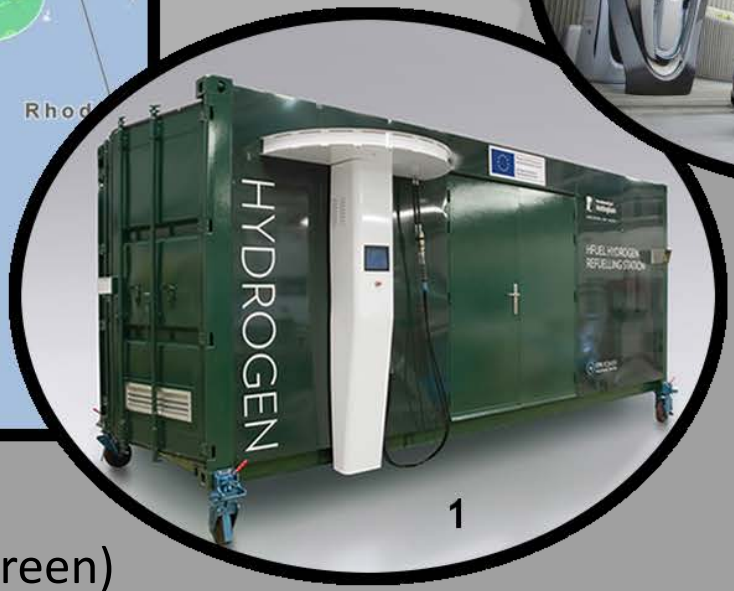
- To create a planned transitioned development strategy to implement a hydrogen refuelling network in the north east coast of the United States between 2013-2025 facilitating and engaging demand for hydrogen products.

Split Development Periods

- Phase I
  - 2013-2015
    - Minimum Requirement for a functional Corridor
- Phase II
  - 2015-2020
    - Targeted Deployment for Early Markets
- Phase II
  - 2020-2025
    - Transition to Consumer Convenience
- Phase IV
  - 2025 +
    - Legacy to facilitate free market Economics

Phase I – Station Locations





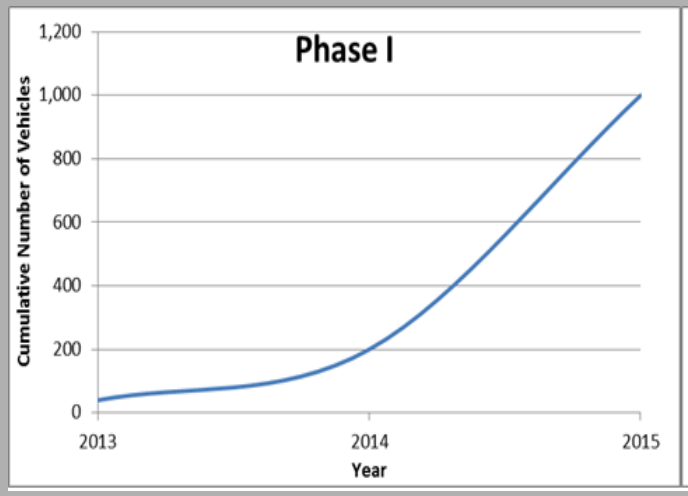
- Tier 1 (red), Tiers 2 and 3 (green)
- Locations Chosen on physical range of FCEV and Geographical considerations alone
- Utilisation of Portable (1) to Stationary Refuelling (2) implementation to create instant impact

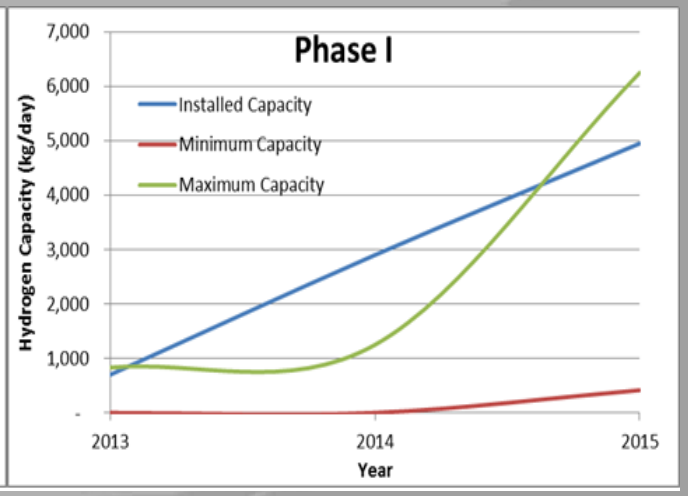
1- http://www.thegreencarwebsite.co.uk/blog/index.php/2012/09/21/university-of-nottingham-installs-own-hydrogen-fuelling-station/

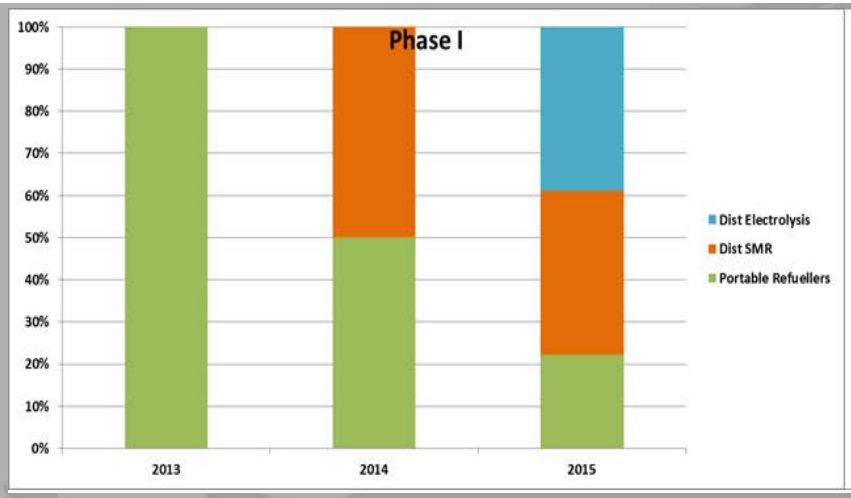
2- http://www.gizmag.com/honda-solar-hydrogen-fuel-cell-refueller-electric-vehicle/14049/

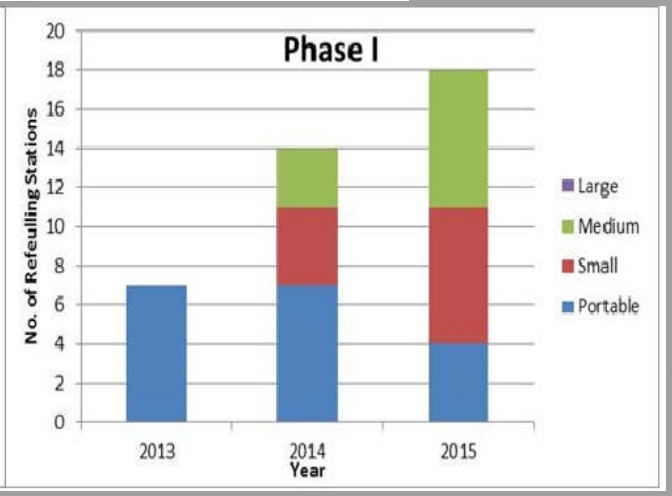
The University of Nottingham | Loughborough University | UNIVERSITY OF BIRMINGHAM

Phase I – Capacity and Production



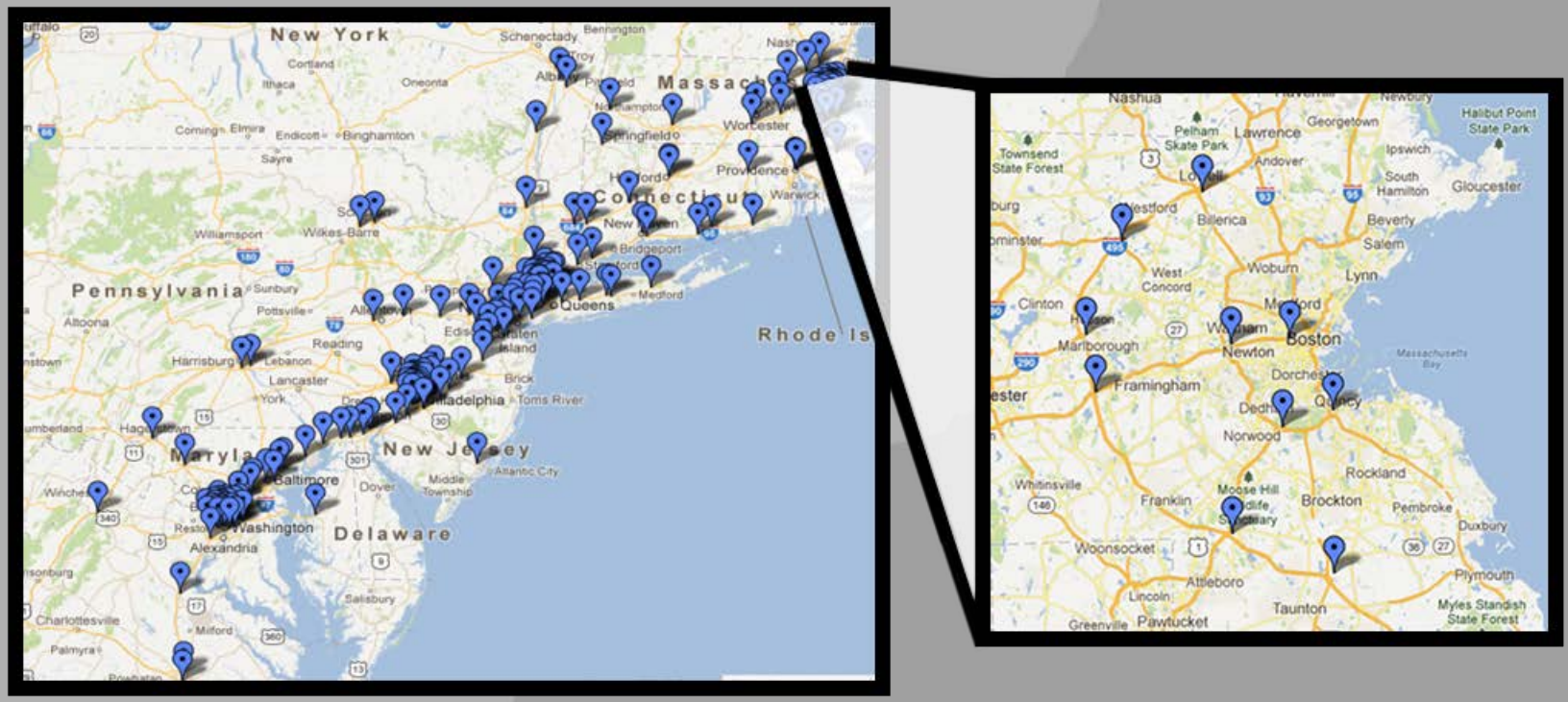






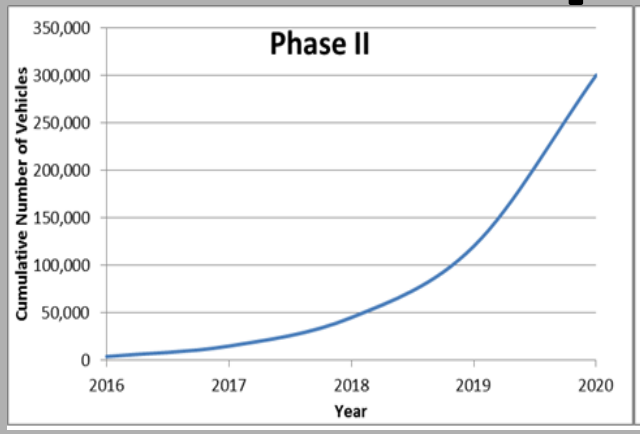
- Simplicity key – portable stations to stationary methodology and on-site hydrogen production

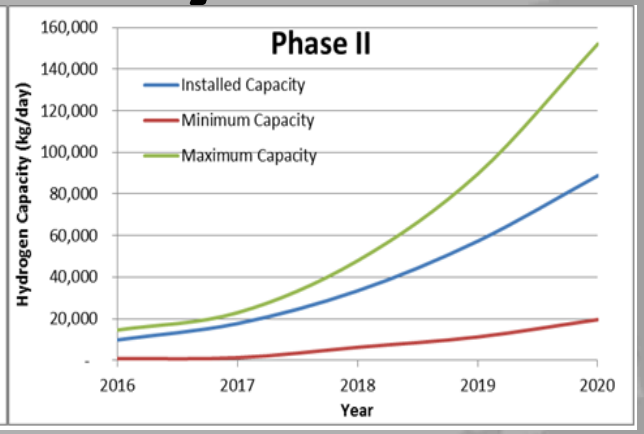
Phase II – refuelling locations

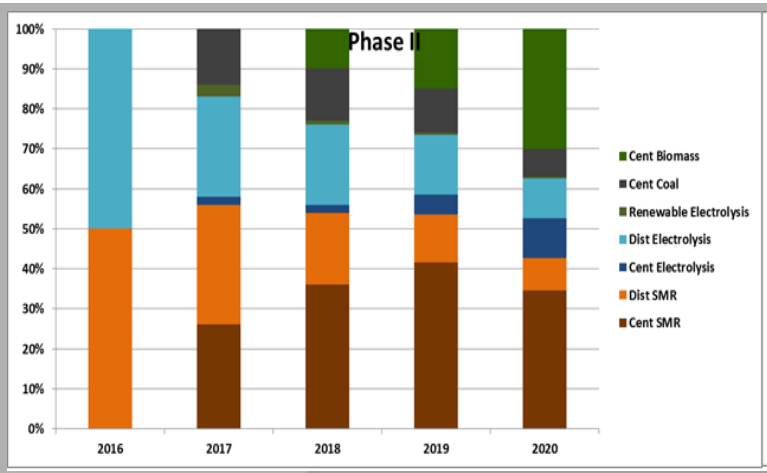


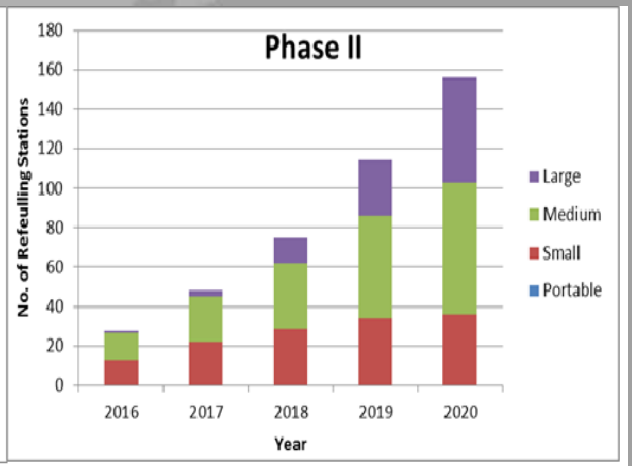
- Skeleton network transitioning to early adopter market.
- Three tiers of priority targeting specific market formation

Phase II - Capacity and Production





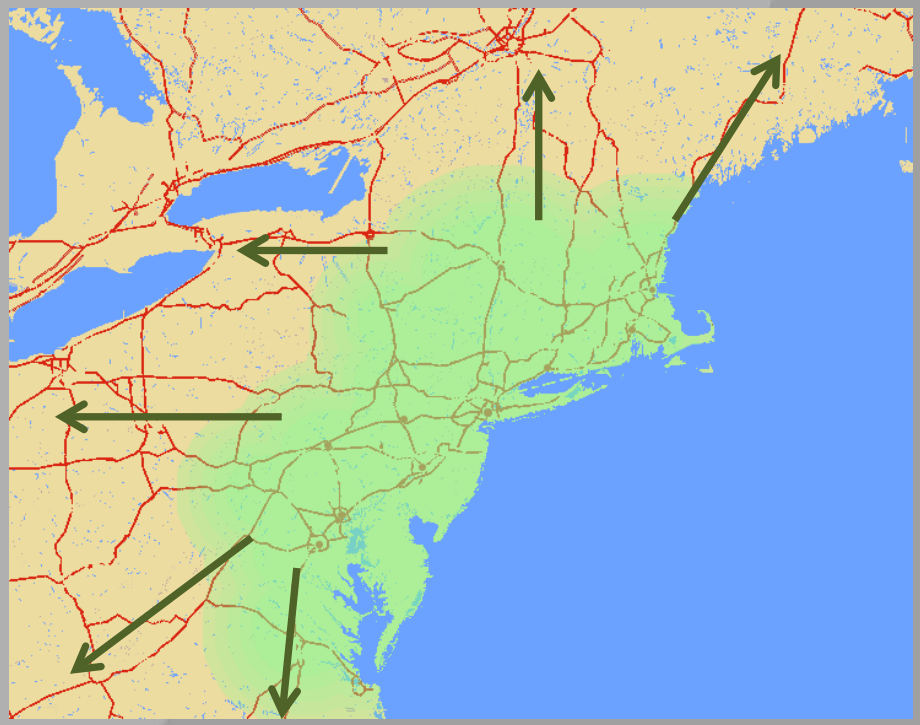




- Dramatic increase in supply capacity to functionalise a true market

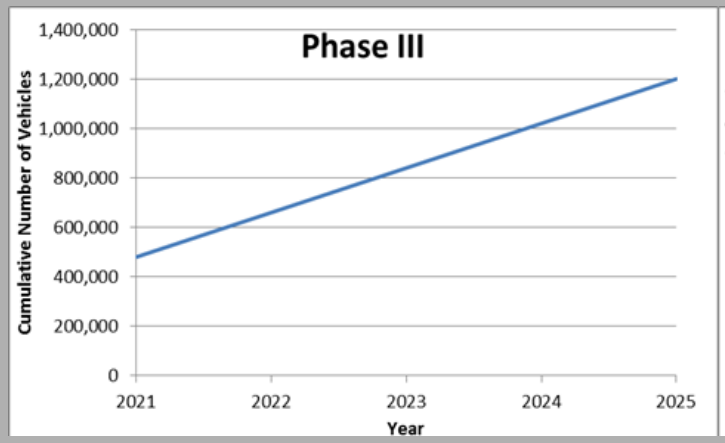
- Nature of hydrogen supply transitions to use multiple supply methods to facilitate growth and strengthen supply market

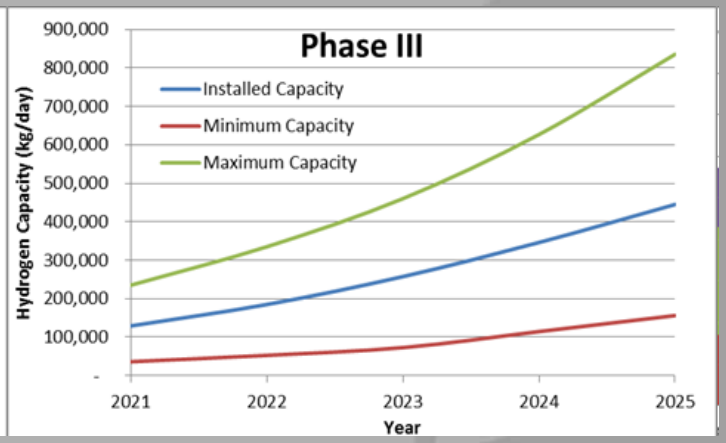
Phase III

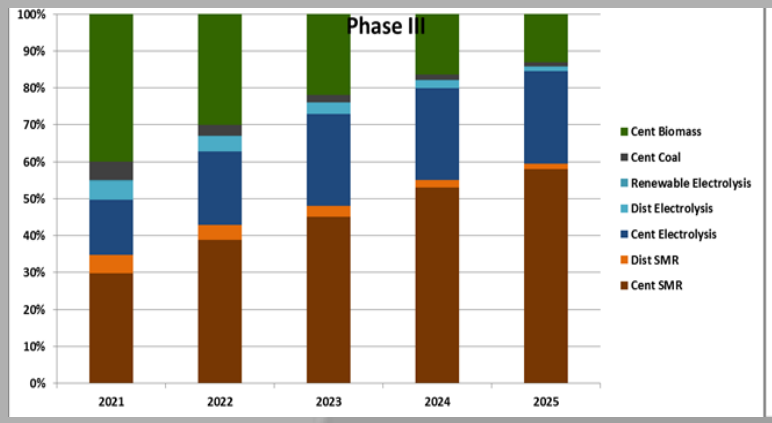


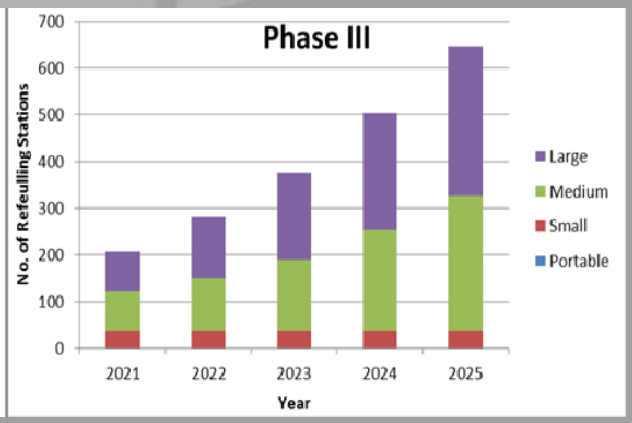
- Transition from directed markets to consumer market with a view to consumer convenience
- Integration into full market
- Penetration away from initial ‘protected’ market

Phase III





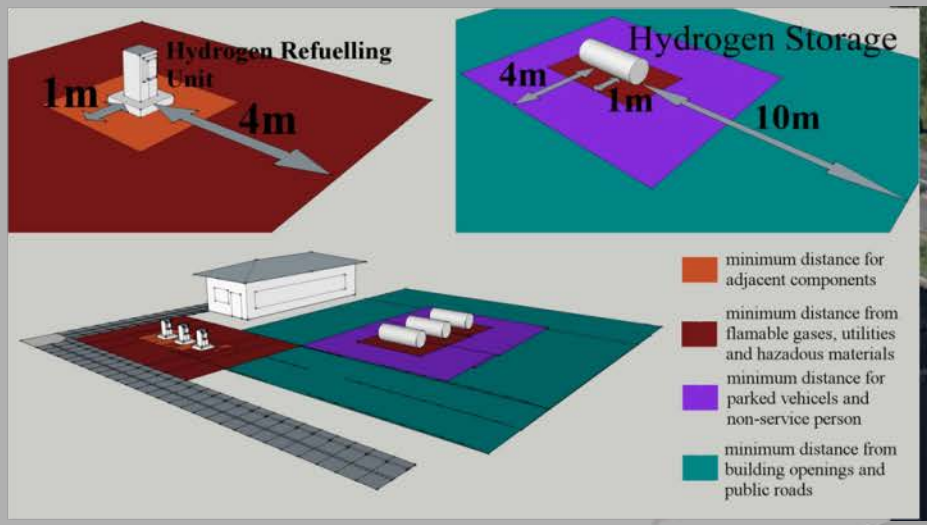


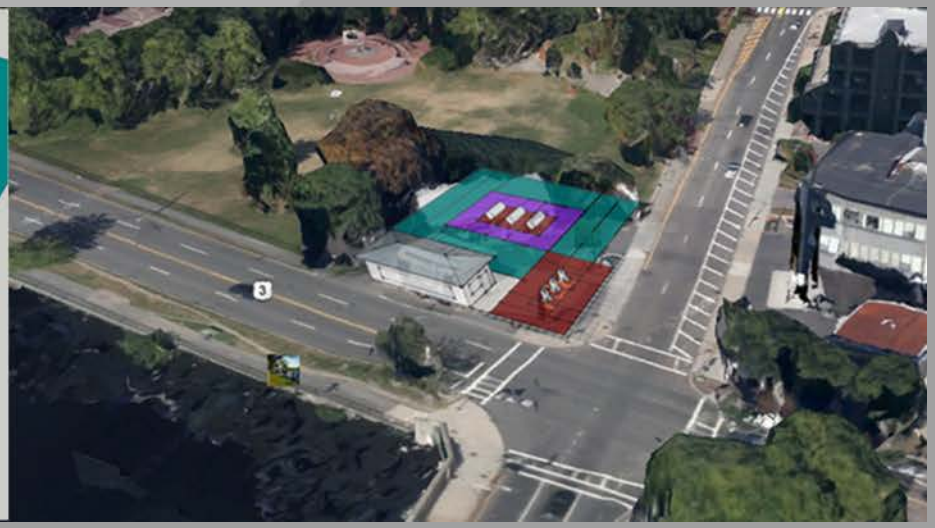


- Transition to full market able to compete naturally with competitive industries

- Hydrogen supply market stable and fully functional, production technology dominated by macro not local economics.

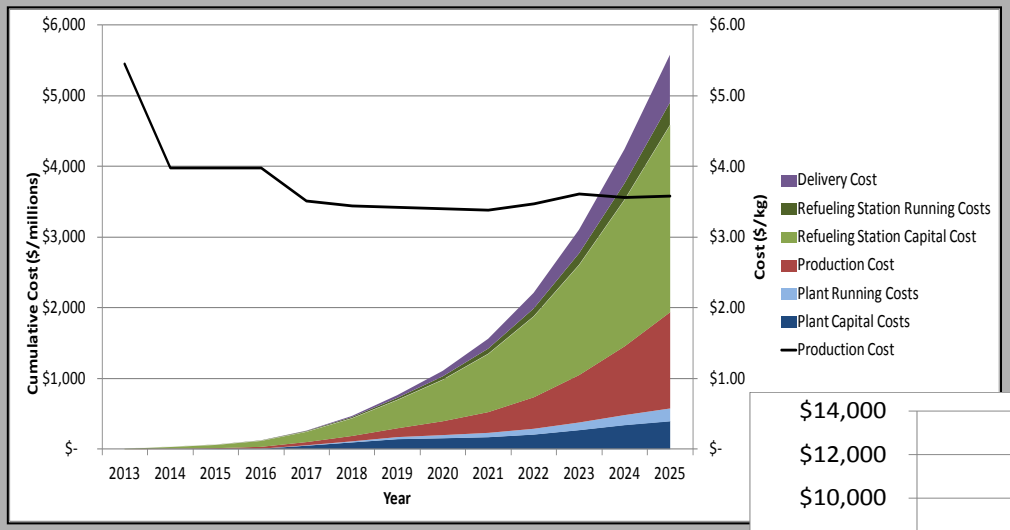
Special Regulatory Notes

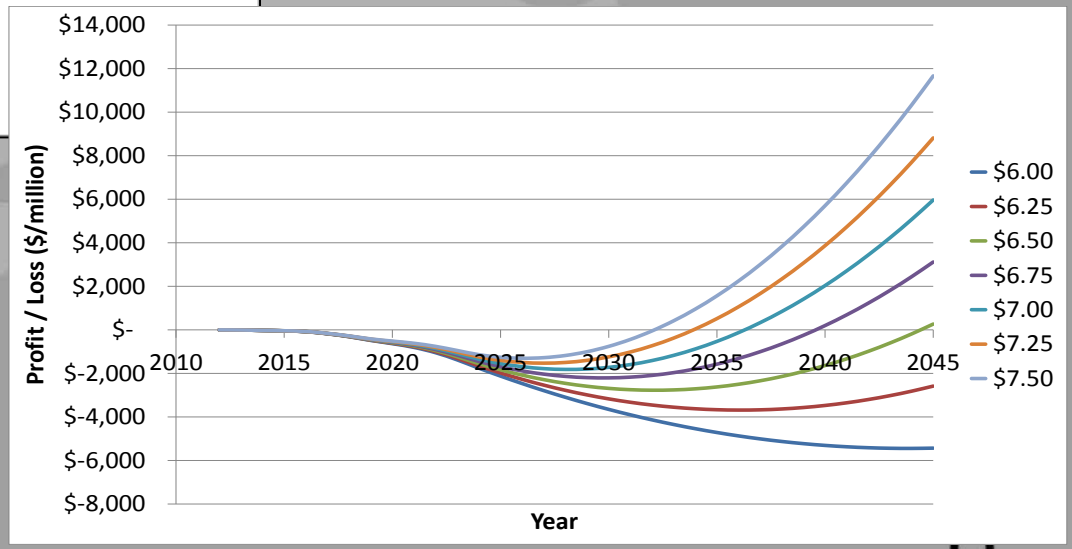




- Hydrogen has been a commercial product for over a century
- Still complicated barriers to entry caused by regulation
- Regulations Navigable but need simplifying

Economic Considerations

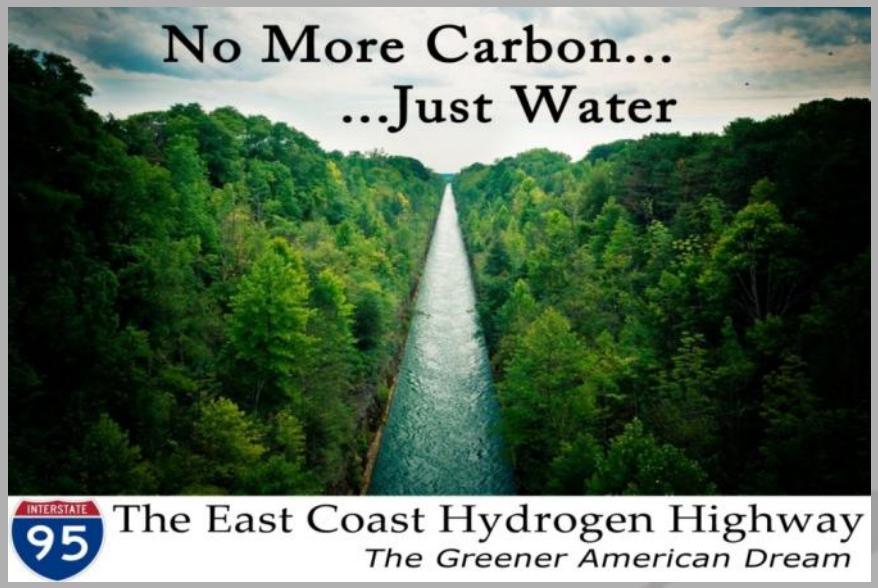




- True economic analysis difficult, ‘futurology’ in a highly changeable market place

- However, Economically Viable!

Marketing and Outreach



- Strong education program
- High level direction needed to implement public engagement effectively
- Individual marketing strategy is the role of individual companies
- Education drive is most essential aspect

Conclusions

- The North East Coast of the United States is suitable geographically and economically to implement a hydrogen refuelling infrastructure

- Strong Leadership needed by federal and local Governance
  - to direct refuelling locations
  - to stabilise hydrogen supply market
  - to decrease regulatory complexity
  - and to lead education

- A viable Hydrogen Refuelling market and supply infrastructure is possible...

...Action needed now!

Winning Design: Kyushu University

Kazuto Tsuda
Naoya Kobayashi
Kosuke Shinto
Yohei Nagamatsu
Liana Christiani
Shingo Baba

Yasuhiro Toyofuku
Takahiro Takaki
Keisuke Adaniya
Masaru Takada
Kota Miyoshi
Kyohei Hirata

*Department of Hydrogen Energy System, Faculty of Engineering

<Faculty Advisors>

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*Department of Business and Technology Management, Faculty of Economics

Prof. Yusuke Shiratori
*Department of Mechanical Engineering, Faculty of Engineering

<Special Thanks to>

Seiichiro Kimura
*International Institute for Carbon-Neutral Energy Research (I^2CNER)
*Next-to-last Team Leader

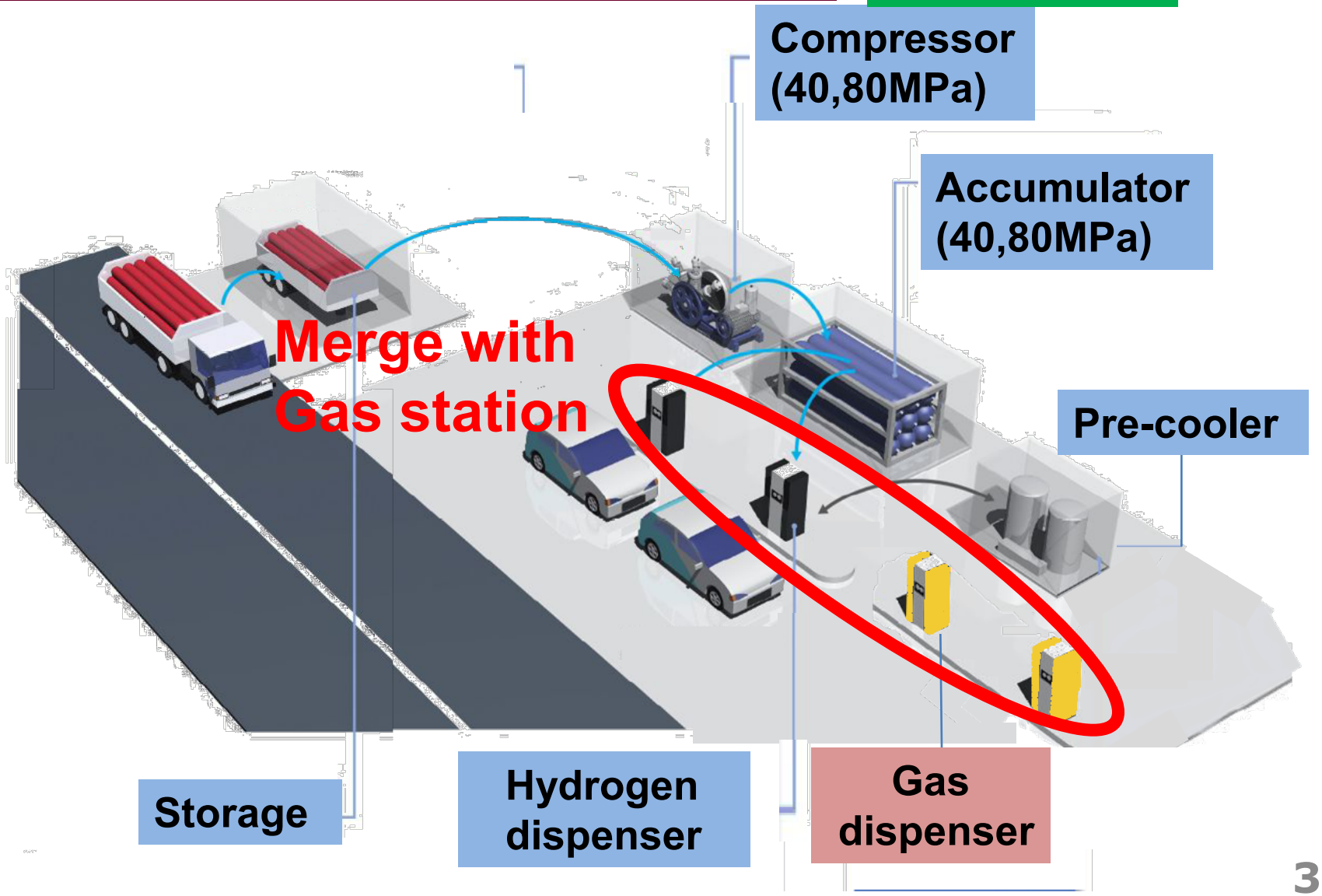
Soichiro Murakami
*Mitsubishi Corporation
*Last Team Leader

http://www.hydrogencontest.org/pdf/2013/6%20Kyushu%20University%20-%20Final%20report.pdf

Merged with existing gas station

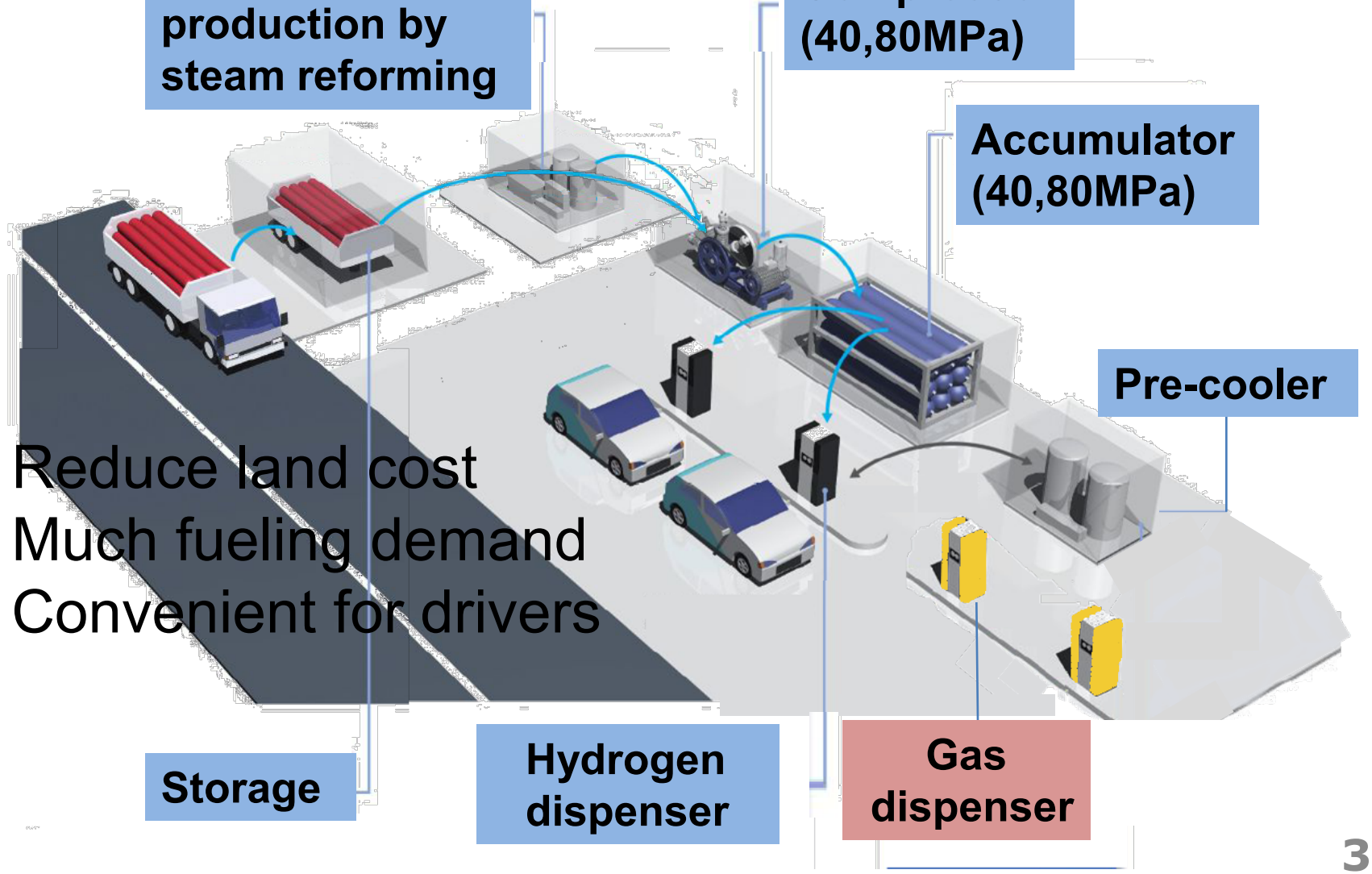
Off-site station(400kgH_2/day)

$2.7M/site



Combination of off-site & on-site station

On-site station(1000kgH_2/day) **$5.0M/site**

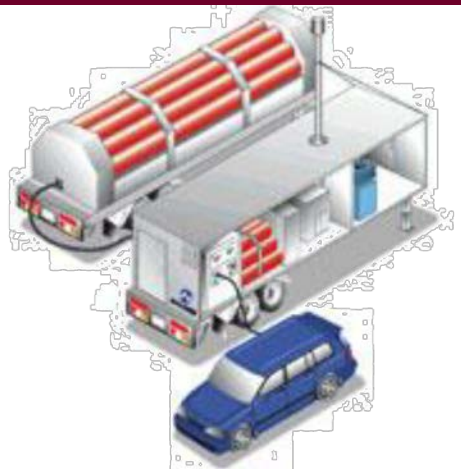


- Reduce land cost
- Much fueling demand
- Convenient for drivers

Station design

Portable station(40kgH_2/day)

$ 0.7M/site

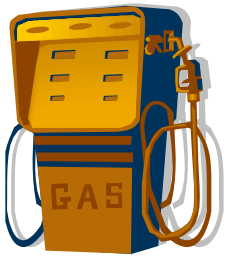


Compact size
Low cost
Movability

Fit with early phase

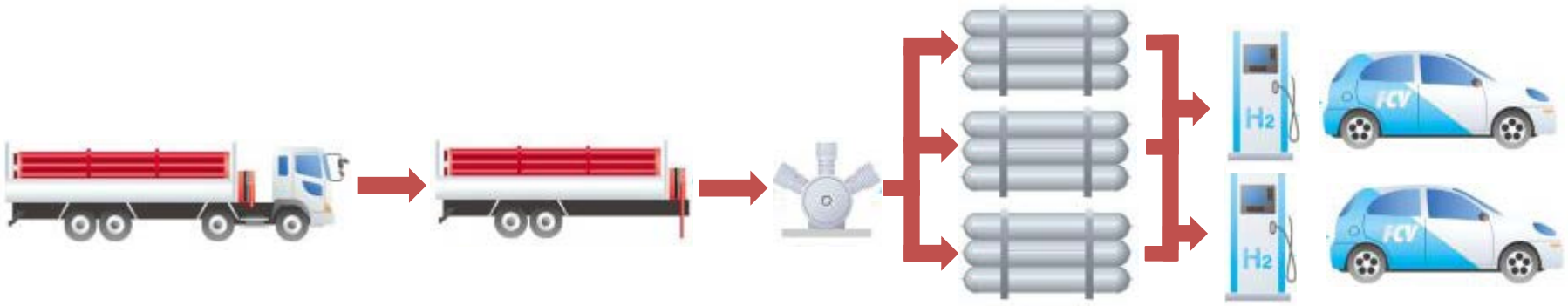
Gas station

Portable station
(40kgH_2/day)



Station design

Modular design (off-site station)



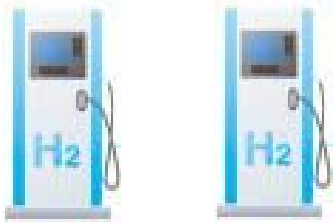
$2.7M | **+ $0.67M** | **+ $0.28M /site**

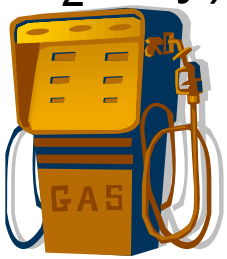
New place

Portable station
(40kgH_2/day)

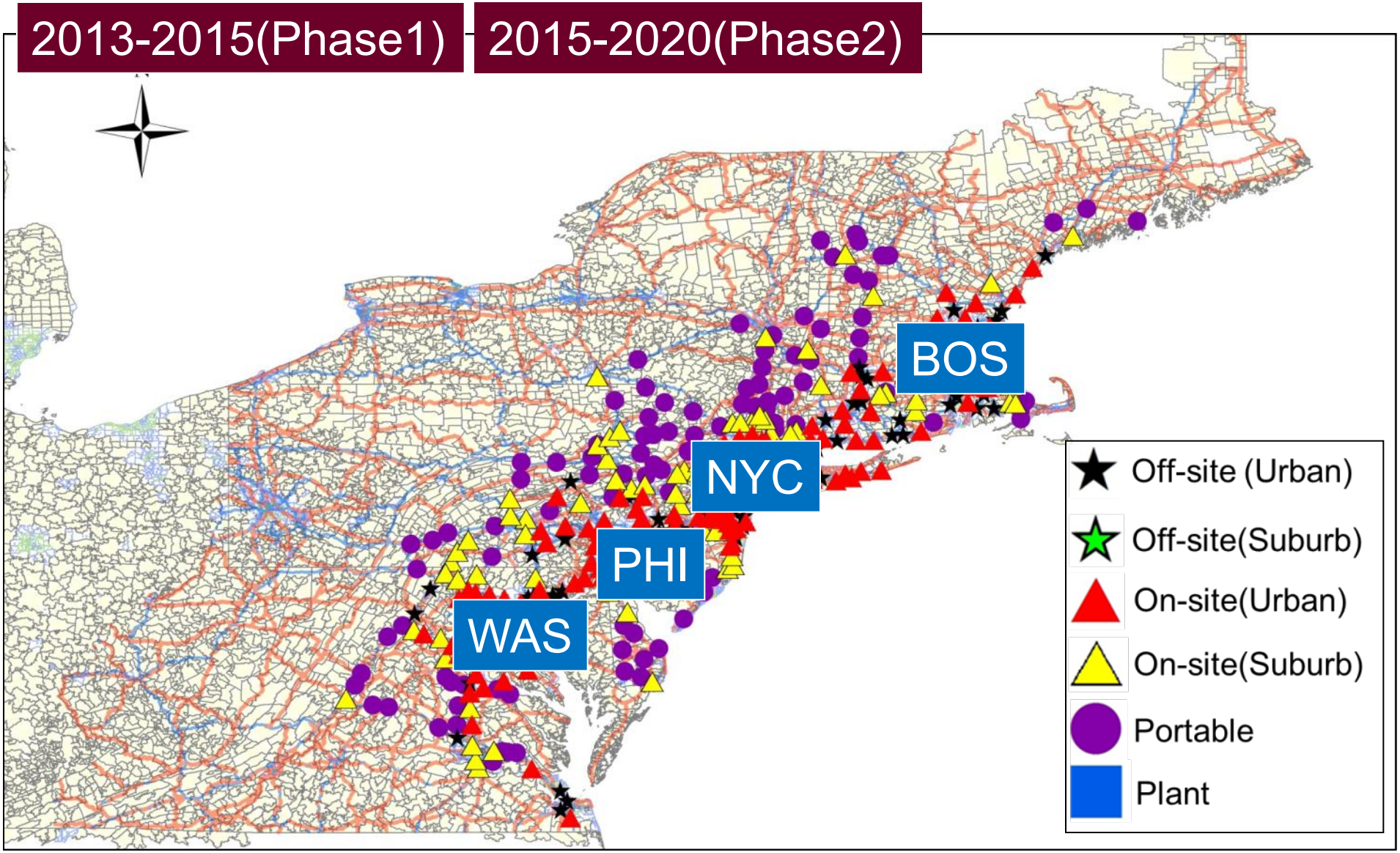
Gas station

Off-site station (1200 kg H_2/day)

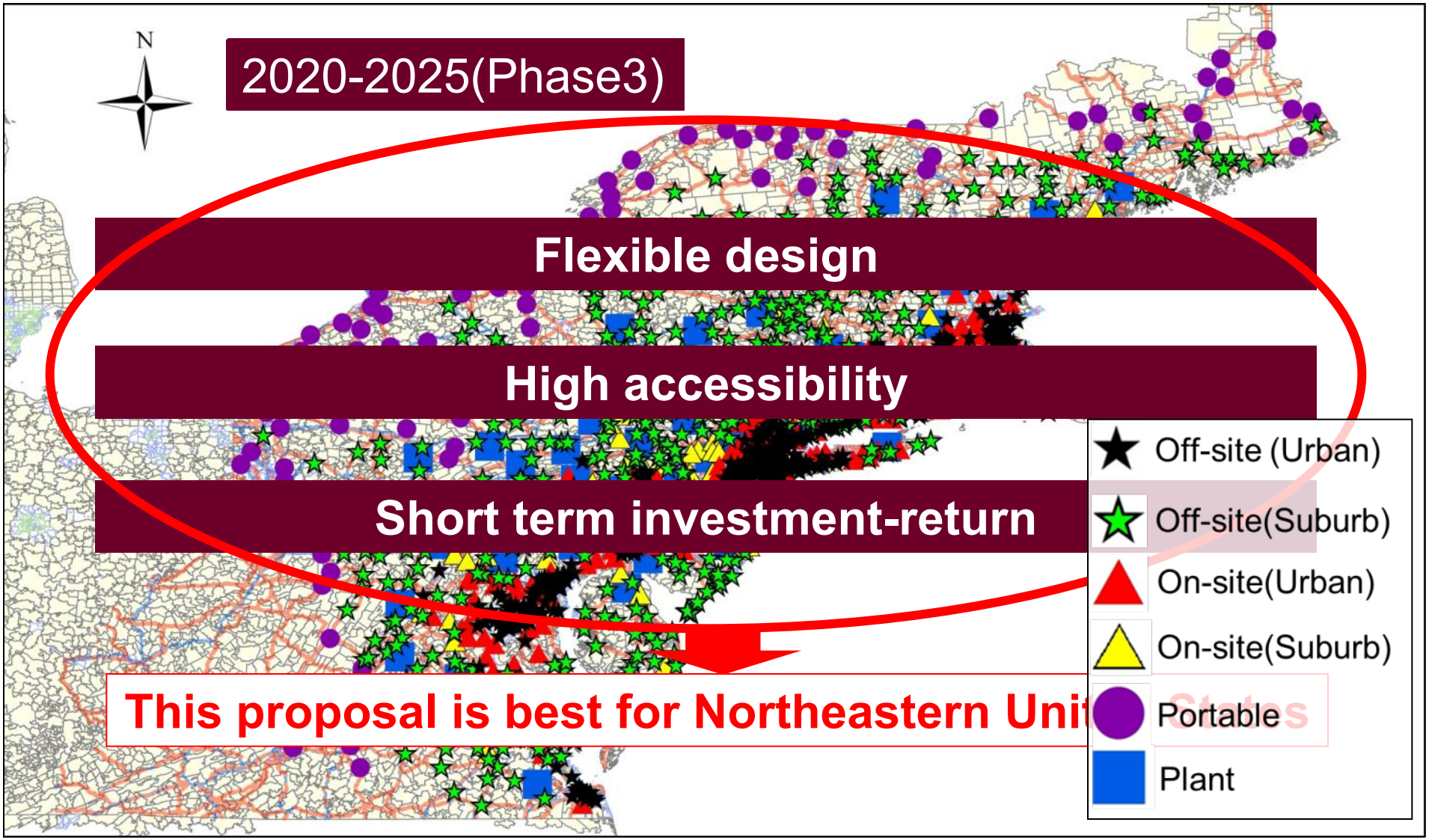




Summary


2013-2015(Phase1)
2015-2020(Phase2)
BOS
NYC
PHI
WAS
Off-site (Urban)
Off-site(Suburb)
On-site(Urban)
On-site(Suburb)
Portable
Plant

Summary


N
2020-2025(Phase3)
Flexible design
High accessibility
Short term investment-return
This proposal is best for Northeastern Unit
Off-site (Urban)
Off-site(Suburb)
On-site(Urban)
On-site(Suburb)
Portable
Plant

Award Ceremony at ACT Expo 2013 in Washington D.C.

HYDROGEN EDUCATION FOUNDATION

The Hydrogen Education Foundation's
Hydrogen Student Design Contest
2013-2014: Designing a Drop-in Hydrogen Fueling Station
www.HydrogenContest.org

2013-2014 Contest

The theme of the 2013-2014 Hydrogen Student Design Contest is **"Development of a Drop-in Hydrogen Fueling Station".**

Student teams are challenged to design a hydrogen fueling module that fulfills the requirements of

- low-cost
- easy permitting
- low-maintenance
- mass-production
- and transportability

in order to create a model for a reliable, convenient and reasonably priced refueling experience for all hydrogen fuel cell vehicle customers.

System Overview

- Jacob Krogsgaard
  Managing Director
  H2 Logic

Building a hydrogen station in 48 hours
http://www.youtube.com/watch?v=kjGaNGhz1pE

2013 - 2014 Contest

Design Data And Equipment Drawings

- All components of the system need to be described in detail, including their interconnection supported by detailed high-resolution schematics
- A blueprint and schematics of the entire systems with specs on key data, including footprint, weight, and interconnection requirements needs to be included

Cost And Economic Analysis

- Determine the costs of their proposed hydrogen fueling system
- Include all fixed costs associated with the team's station design
- Estimate the operating costs of the station as well as estimate costs for replacements of parts

Safety Analysis

- Describe how safety concerns and applicable codes and standards have been addressed for their fueling system
- Safety equipment and operational safety, as well as public perception of safety, are included

Siting

- Identify one specific site in the United States to site their fueling station

Operation and Maintenance

- Identify one specific site in the United States to site the fueling station

Environmental Analysis

- Provide a narrative of the environmental impacts of the design

Interface Design / Customer Education

- Develop an interface for the customer
- Develop a one-page high-resolution advertisement

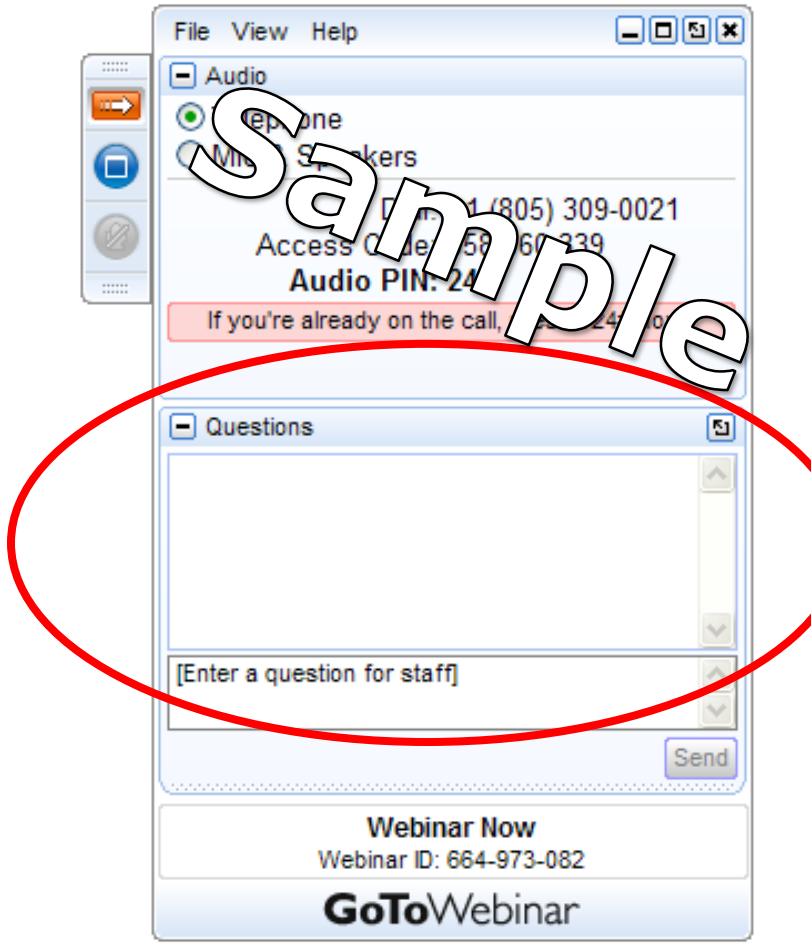
How to Register/Submit an Abstract

- Details on the Contest and team registration at www.hydrogencontest.org

- Abstract due
  - Early Deadline – January 15, 2014
  - Late Deadline – January 31, 2014

Question and Answer

- Please type your question into the question box



Thank you!

- Early Deadline to submit an abstract for the 2014 Contest is January 15, 2014
- Late Abstract Deadline is January 31, 2014

www.hydrogencontest.org

US DOE Webinar Series

Fuel Cell Technologies Office

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EERE Fuel Cell Technologies Office

14 January 2014

Thank You for Your Participation