Exceptional service in the national interest

Sandia National Laboratories

Hydrogen Station Infrastructure: Opportunities for Cost Reduction and Improved Customer Experience

IEPR Transportation Workshop No. 2

Daniel E. Dedrick

April 10th, 2014

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND 2010-5138P.

CA is providing leadership in the development of hydrogen fueling infrastructure

Sandia National Laboratories

US

U.S. DEPARTMENT OF ENERGY

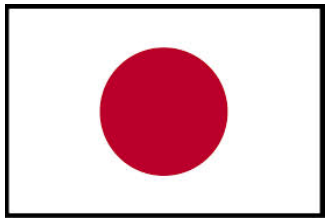
H_2 USA

California Fuel Cell Partnership

State of California Energy Commission

California Environmental Protection Agency Air Resources Board

Asia/Japan



HySUT

EU/Germany

H_2 Mobility

New Energy World JU

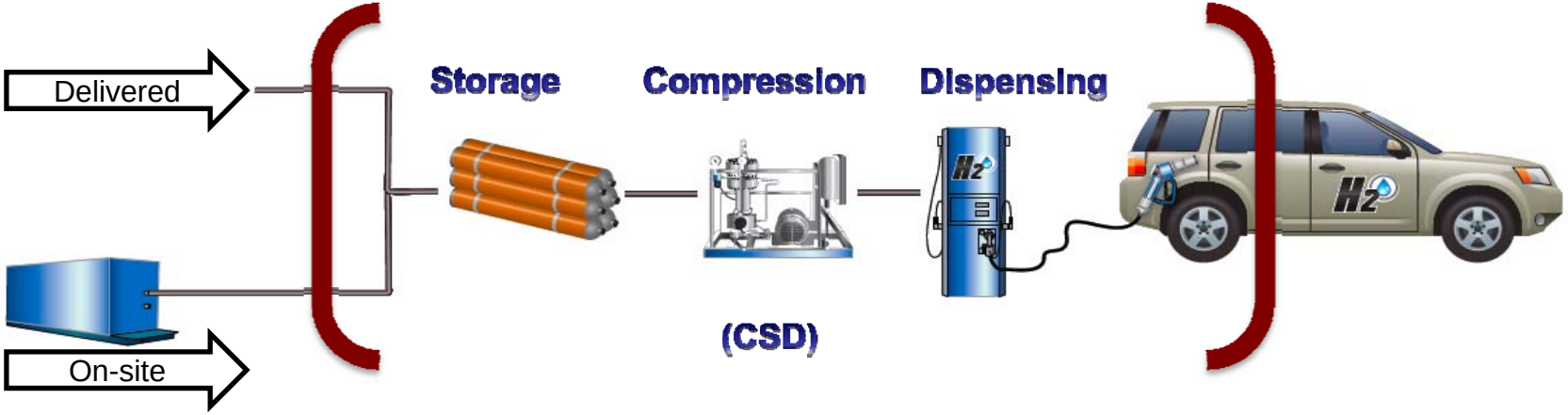
fuel cells & hydrogen for sustainability

Hydrogen fueling stations look similar to gasoline stations, yet cost much more

Sandia National Laboratories

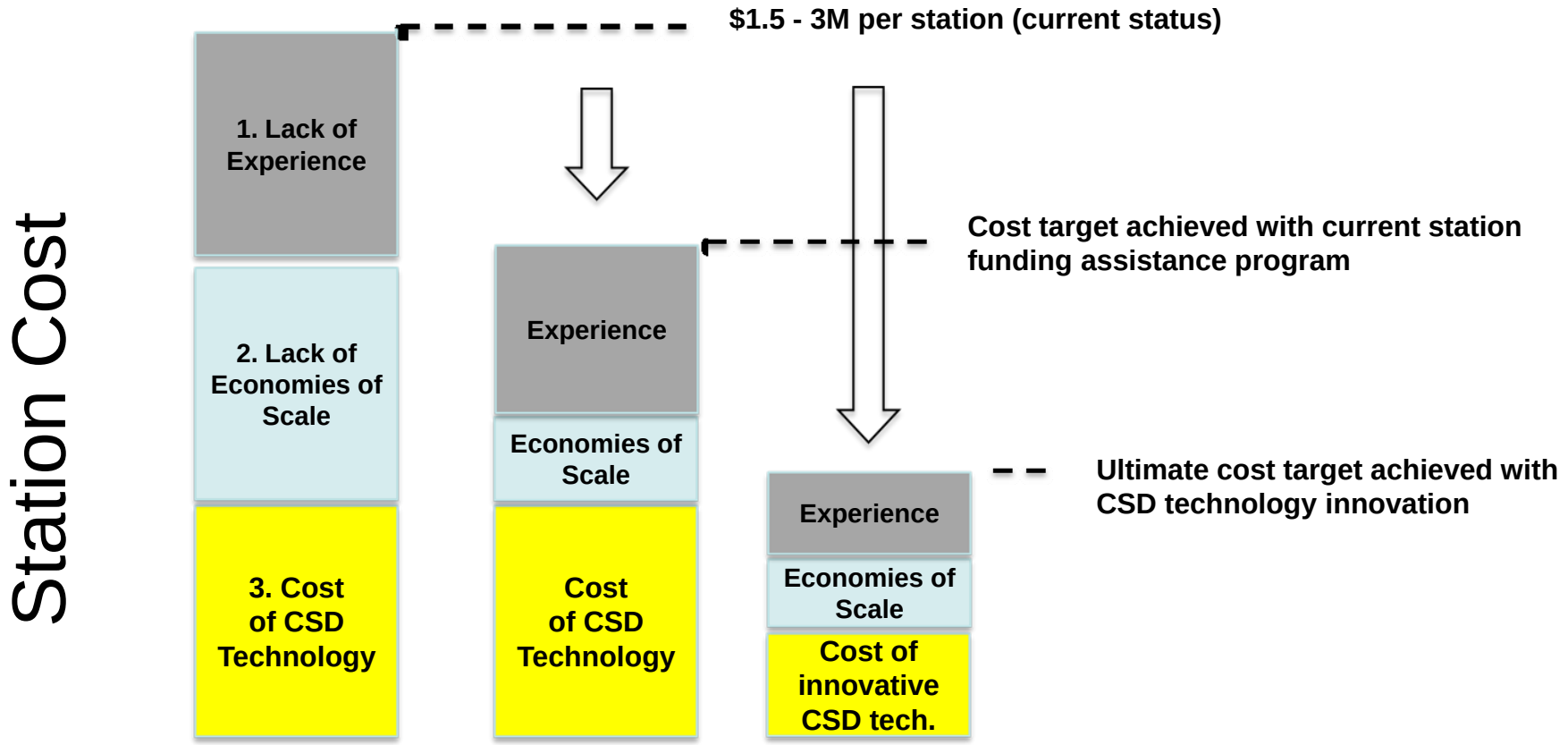
Hydrogen fueling station

“Conventional” fueling station



Hydrogen CSD systems are successful commercial technologies that are new to the retail environment

Three factors to reduce the cost of hydrogen fueling stations



SNL and NREL are coordinating to accelerate innovative station technology

Sandia National Laboratories

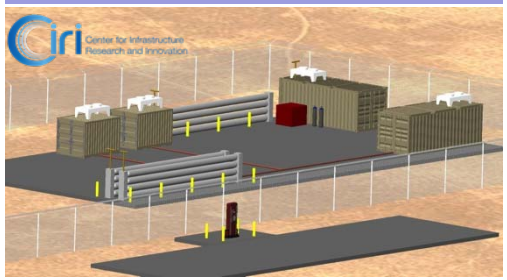
NREL and SNL provide:

- Technical expertise
- Facilities
- Objectivity

DOE National Lab network

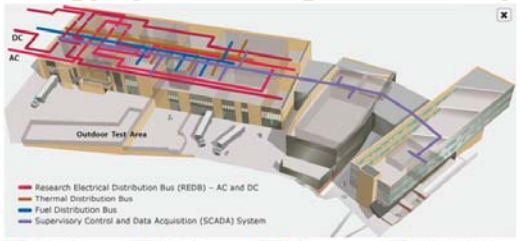
The image part with relationship ID rId9 was not found in the file.

Center for Infrastructure Research & Innovation



NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Energy Systems Integration Facility

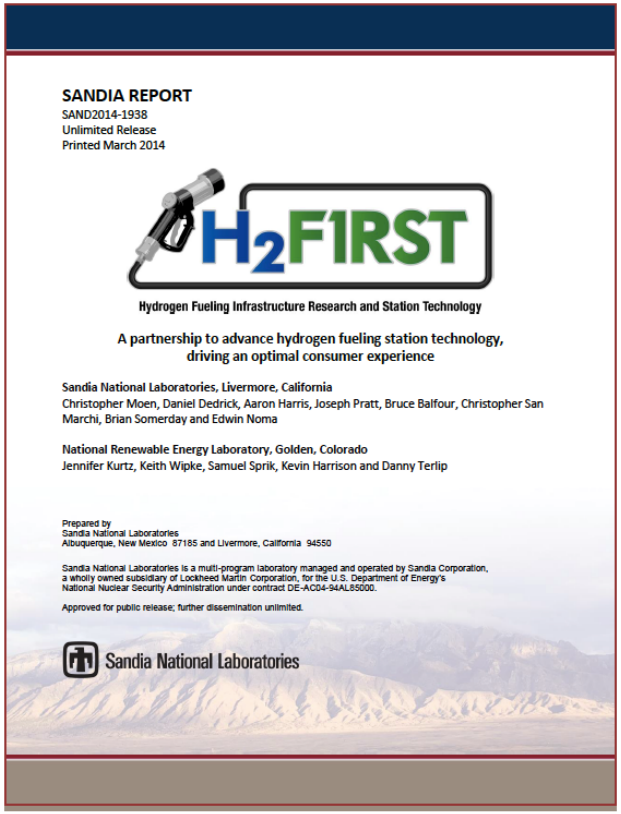


Distributed Energy Resources Test Facility

We have engaged stakeholders to provide key insight to opportunities for cost reduction

- **Collaborative agreements**
- **Collaboration MOU's**
- **Cost share proposals**
- **Candid communication**

Whitepaper published that outlines opportunities of cost reduction and performance improvement



SANDIA REPORT
SAND2014-1938
Unlimited Release
Printed March 2014

H2FIRST

Hydrogen Fueling Infrastructure Research and Station Technology

A partnership to advance hydrogen fueling station technology, driving an optimal consumer experience

Sandia National Laboratories, Livermore, California
Christopher Moen, Daniel Dedrick, Aaron Harris, Joseph Pratt, Bruce Balfour, Christopher San Marchi, Brian Somerday and Edwin Noma

National Renewable Energy Laboratory, Golden, Colorado
Jennifer Kurtz, Keith Wipke, Samuel Sprik, Kevin Harrison and Danny Terlip

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Approved for public release; further dissemination unlimited.

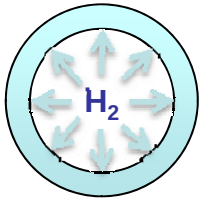
Sandia National Laboratories

Example opportunities for cost reduction:

- **Station footprint Reduction**
- **Enhanced reliability of components**
- **Hydrogen dispenser performance**
- **Eliminate unnecessary high-value materials**

Scoping analysis: significant cost reductions achievable through materials selection

Consider:
- A simple hydrogen pressure containing pipe
- Standard design equations found in ASME codes



$$t = \frac{PD}{2(SE + PY)}$$

Table A1. Estimated cost and weight factors achievable by materials selection.

Material	Yield strength (MPa)	Relative weight (R_W)	Relative material cost (R_{MC})	Cost basis	Relative component cost (R_{CC})
316L (annealed)	140	1.0	1.0	Baseline material	1.0
304L (annealed)	140	1.0	0.84	Partner estimate	0.84
304L (strain-hardened)	345	0.46	1.7	Twice the partner estimate for annealed (conservative)	0.78
XM-11 (annealed)	345	0.46	0.79	Partner estimate	0.36
XM-11 (strain-hardened)	620	0.17	1.6	Twice the partner estimate for annealed (conservative)	0.27
XM-19 (strain-hardened)	725	0.15	2.5	Twice the partner estimate for annealed (conservative)	0.38

Key point: Pressure containing component cost could be reduced by as much as 60% through research, testing, and validation of new low-cost material solutions

Thank you

Sandia National Laboratories