VIONX ENERGY™

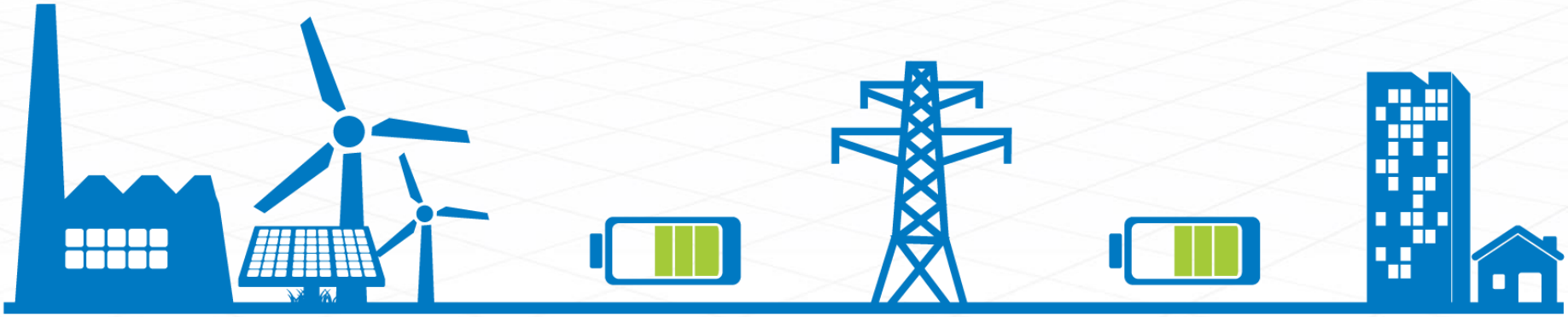
GRID STORAGE FOR THE LONG RUN

Vionx Energy Overview – CPES e3 Conference

9 March 2016

The Energy Storage Challenge

THE GRID IS BUILT TO LAST MORE THAN 20 YEARS – TRADITIONAL BATTERIES AREN'T



Grid assets: Traditional generation, transformers, wind and solar all have asset lifetimes greater than 20 years.

Storage: Traditional batteries like lead acid and lithium ion gradually lose energy storage capacity when cycling and need to be replaced every 5-10 years.

The Grid Battery for the Long Run

VIONX ENERGY'S VANADIUM REDOX FLOW BATTERY

20-Year Lifetime

Our technology has a life-span matching the rest of the sector's without the need for replacement of the system or its components.

Long Duration

Our storage solution offers 6 – 10 hour continuous runtimes, enough to match peak load duration and to meet capacity market runtime criteria.

Maintains Capacity

Unlike conventional long term batteries, our system capacity does not degrade over time and does not need replacement due to cycling.

VIONX™ ENERGY

Utilizing Breakthrough Technology

Leveraging Strategic Partners

CREATED AT UNITED TECHNOLOGIES, VIONX ENERGY HAS COMMERCIALIZED A DURABLE 20-YEAR BATTERY ENERGY STORAGE SYSTEM INDUSTRY PARTNERS

Contracts with & supported by:

Corporate Video Link

United Technologies

Exclusive Technology License, R&D, Equity Partner

3M

Advanced Membrane Technology Partner

SIEMENS

EPC & PCS Equipment Partner

JABIL

Manufacturing Partner

Investment Partners:

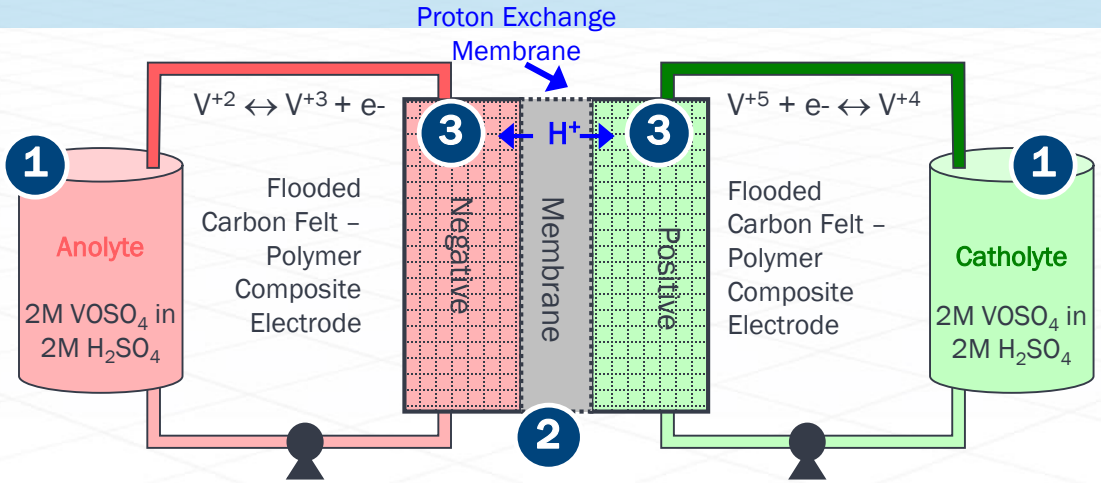
VANTAGE POINT CAPITAL PARTNERS

STARWOOD ENERGY GROUP

VIONX ENERGY

Vanadium Redox Flow Batteries

FLOW TECHNOLOGY & BENEFITS



1. Positive and negative charged solutions (electrolyte) are pumped from a tank on each side of the battery through a cell-stack.
2. A thin membrane between the cell stack keeps the two solutions from mixing together
3. Electrons are transferred from solution for charging & discharging through an electrodes

Product Animation Video Link

Energy scales independently of **Capacity** with liquid electrolyte and no added system complexity.

Stores Energy in the vanadium ion with no destruction or consumption of electrodes over time like in traditional batteries.

Safety is assured by the physical separation of reactants. Aqueous, non-flammable electrolyte operates at a low temperature.

Vanadium is fully recoverable & reusable at the end of system life.

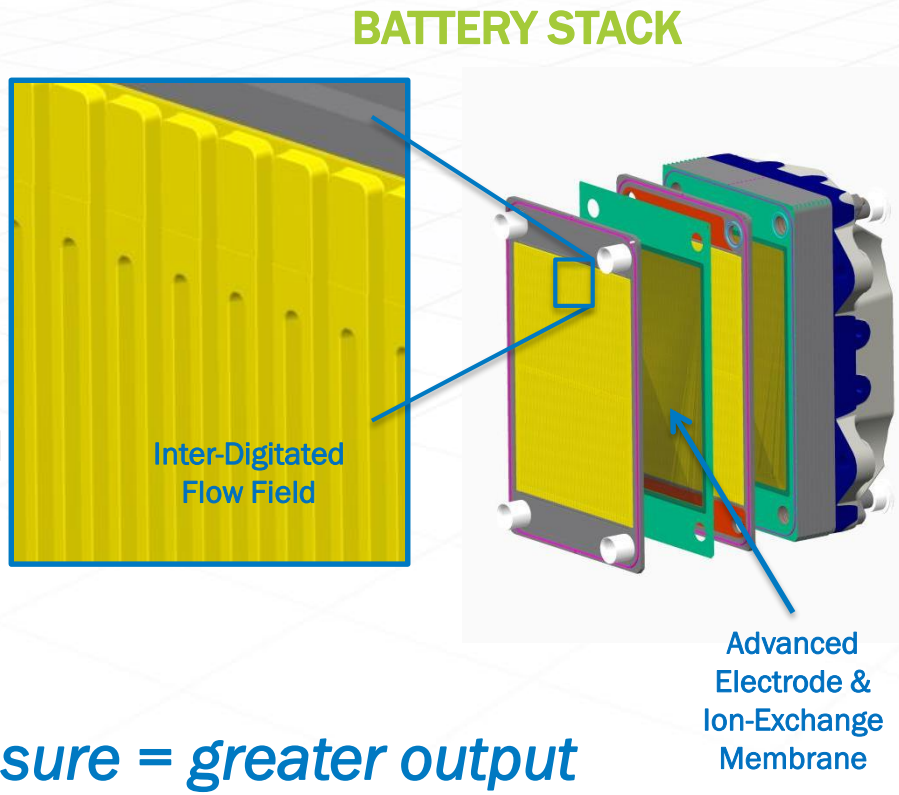
Vionx & United Technologies' Advantage

ENABLED BY THE INNOVATION OF *X-FLOW™ TECHNOLOGY*

Twice the power density from unique flow field with advanced electrode and membrane in a low pressure flow field

No capacity degradation & no cycling limitation over 20 year life eliminates the need to oversize or de-rate the system

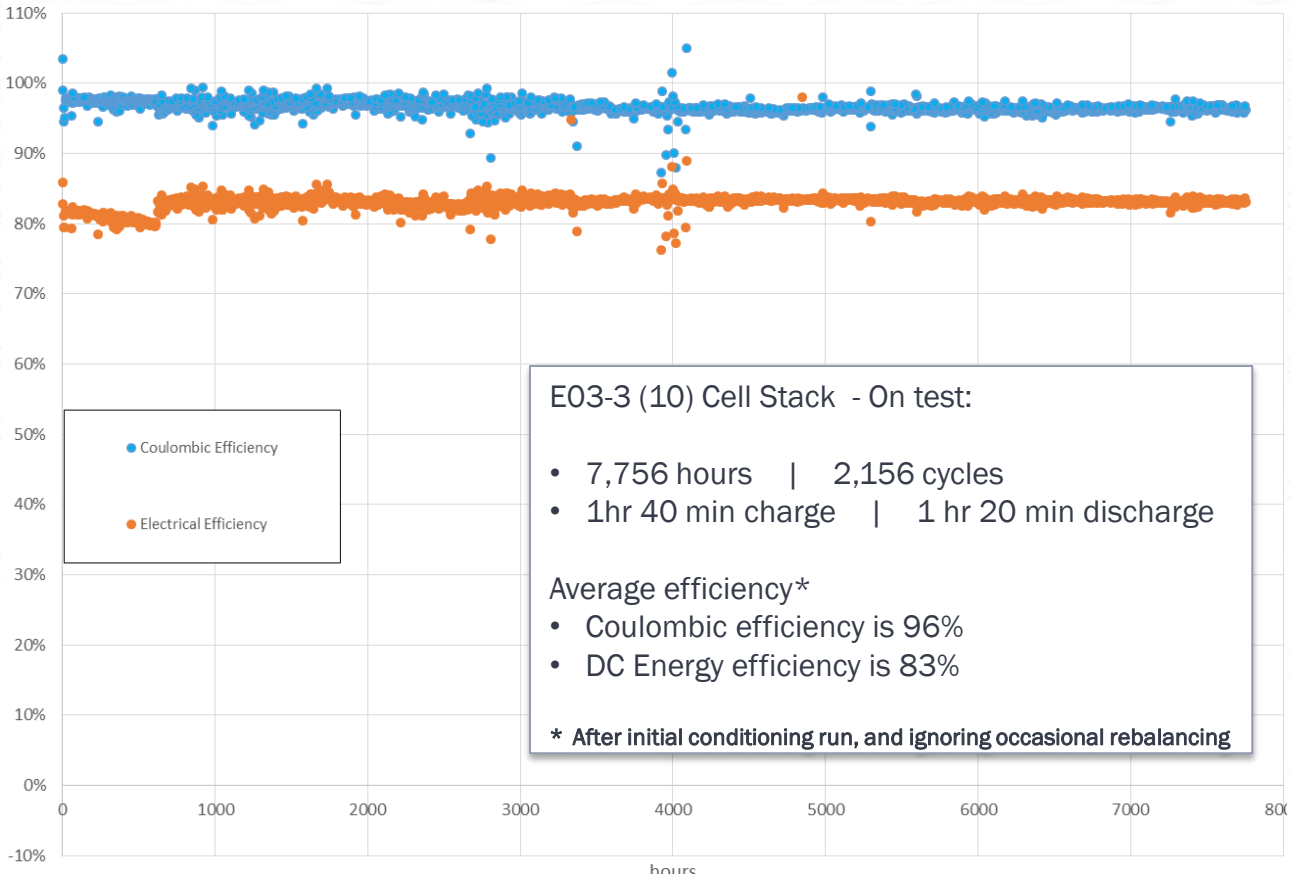
Patented Technology from UTC and quality materials from 3M enables 20-year life and reliable operation.



Higher power density + low pressure = greater output

No Capacity Fade With Cycling or Time

LONG LIFE LEADS TO SIGNIFICANT LCOE ADVANTAGE OVER LI-ION



E03-3 (10) Cell Stack - On test:

- 7,756 hours | 2,156 cycles
- 1hr 40 min charge | 1 hr 20 min discharge

Average efficiency*

- Coulombic efficiency is 96%
- DC Energy efficiency is 83%

* After initial conditioning run, and ignoring occasional rebalancing

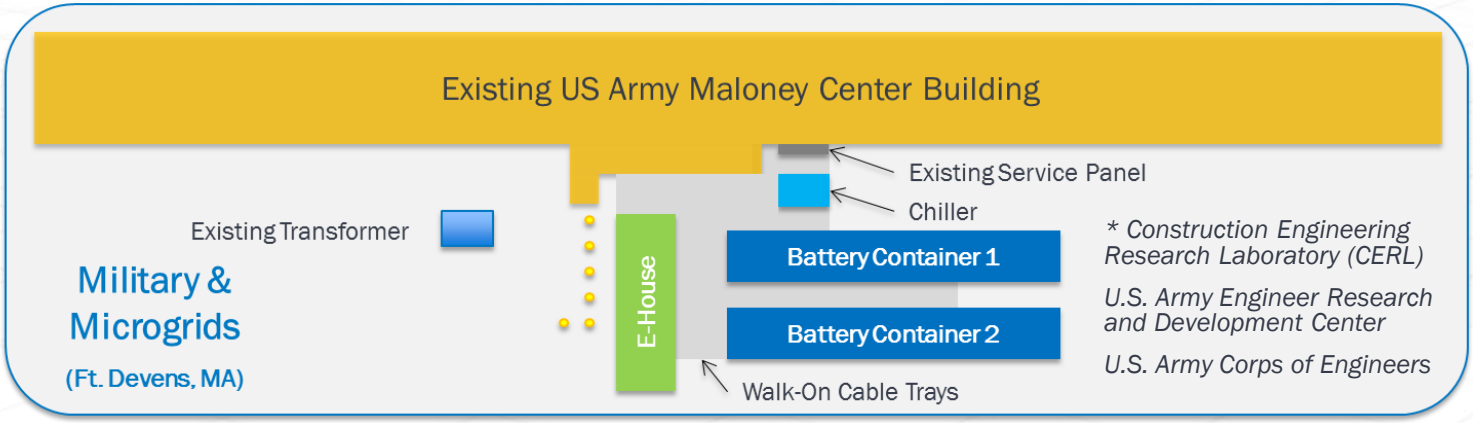
Ft Devens “CERL” Commercial Demonstration

160KW 4 HOUR AC SYSTEM INSTALLED & OPERATIONAL 2015

96.5%

Availability

(2/3/16)



Grid-Scale Projects Underway

DELIVERIES → Q3 2015 US ARMY | Q1 & Q2 2016 NATIONAL GRID

✓ **Military & Microgrids** (Ft. Devens, MA)

160kW 4-hour VNX-C Series

- ✓ Micro-Grid Control Compatibility
- ✓ Time-of-Use Rate Reduction
- ✓ Demand Charge Reduction

Q1 2016 — **Wind Integration** (Worcester, MA)

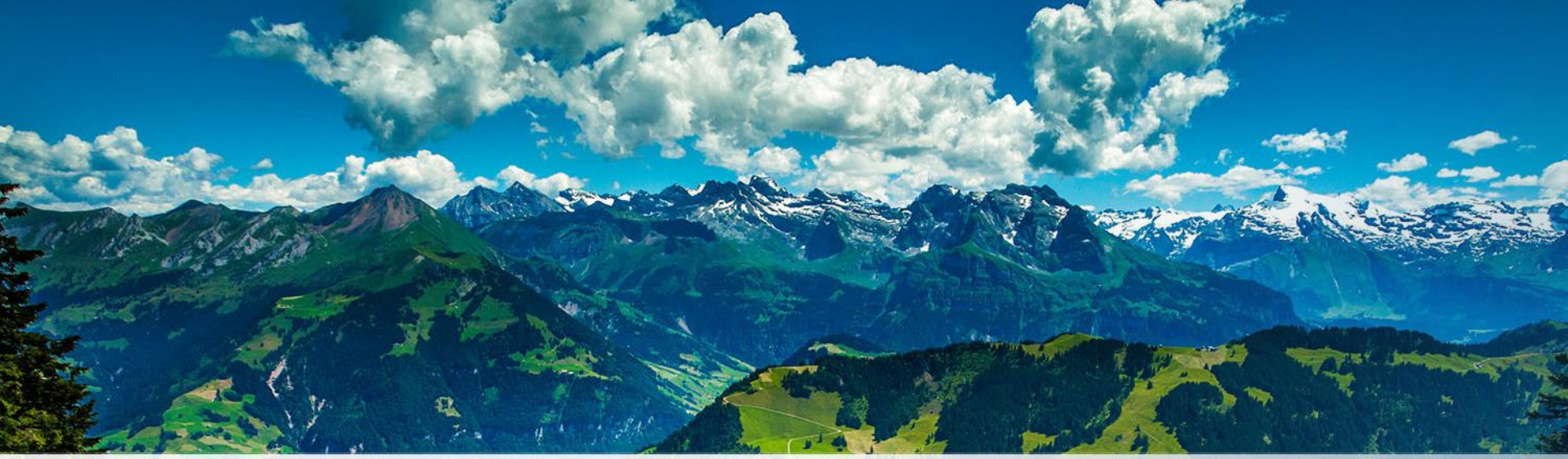
500kW 6-hour VNX-C Series

- ✓ Wind Integration (600kW Wind)
- ✓ Time-of-Use Rate Reduction
- ✓ Demand Charge Reduction

Q2 2016 — **Solar Integration** (Everett, MA)

500kW 6-hour VNX-C Series

- ✓ PV Integration (605kW Solar)
- ✓ Voltage Support
- ✓ Load Following



VIONX™
ENERGY

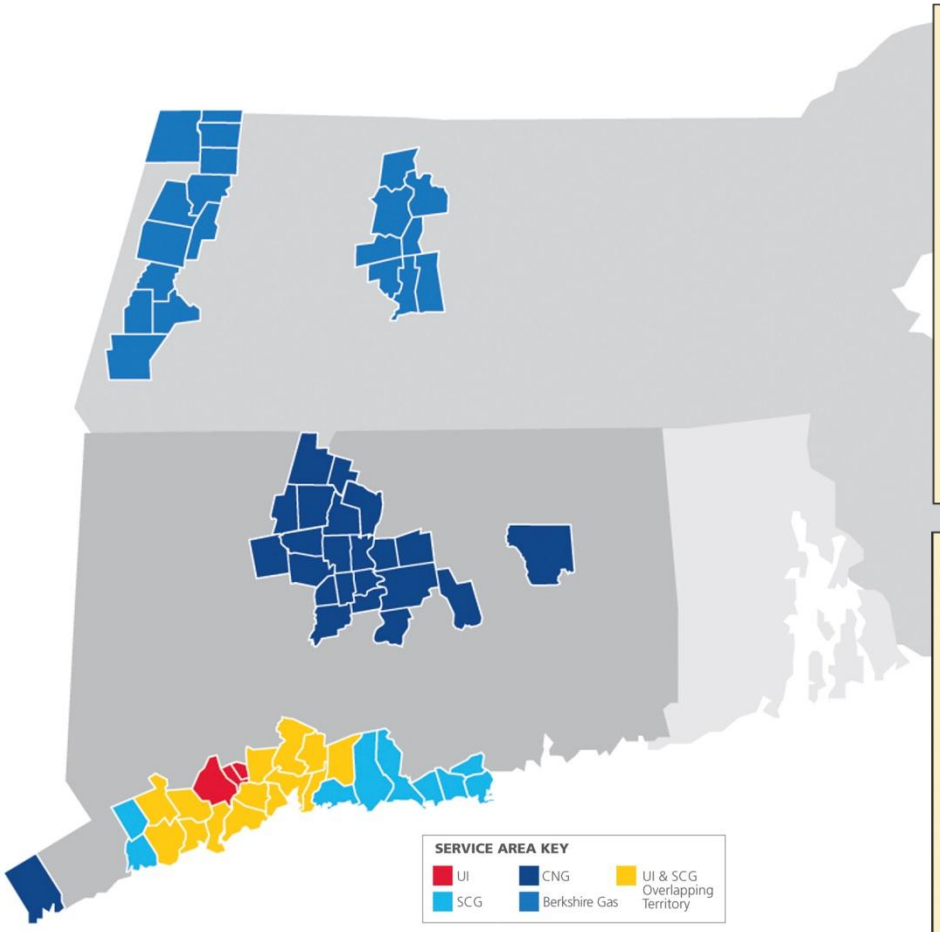
The United Illuminating Company

March 9, 2016

Panel 2: Advanced Technology in Energy Storage

Energy, Environment & Economic Development Conference, Connecticut Power and Energy Society

UIL companies at a glance



THE UNITED ILLUMINATING COMPANY (UI)

- Area: 335 sq miles
- ~328,000 customers

THE SOUTHERN CONNECTICUT GAS COMPANY (SCG)

- Service territory: 522 sq miles from Westport, CT to Essex, CT
- ~190,000 customers

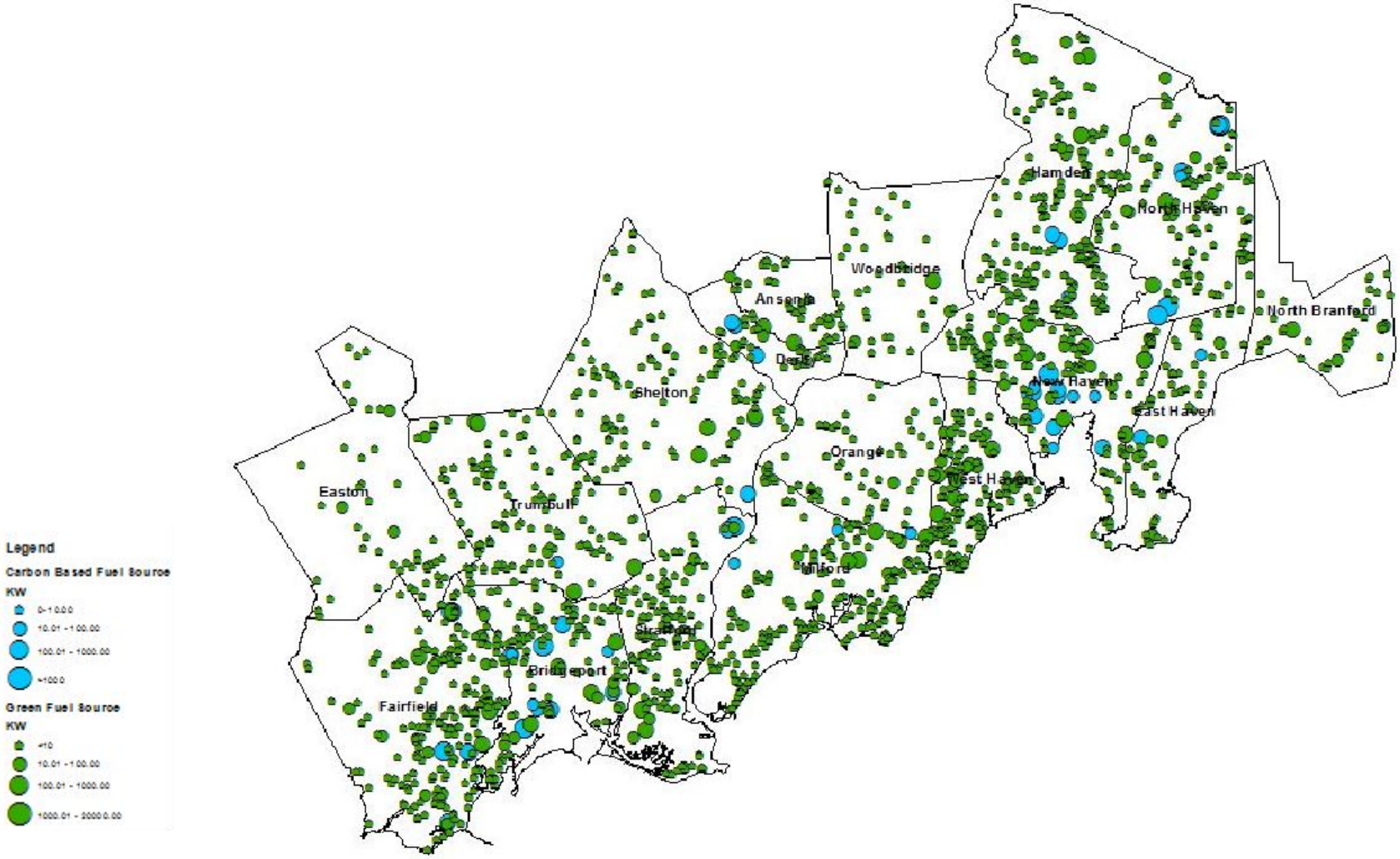
CONNECTICUT NATURAL GAS CORPORATION (CNG)

- Service territory: 716 sq miles - Greater Hartford-New Britain & Greenwich
- ~170,000 customers

BERKSHIRE GAS COMPANY (BERKSHIRE)

- Service territory: 738 sq miles in Western MA
- ~39,000 customers

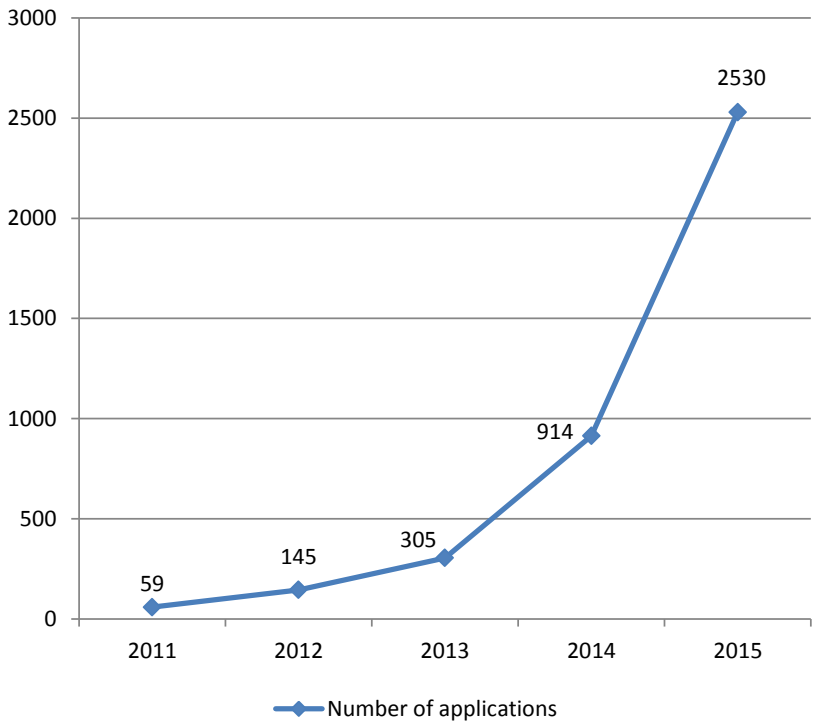
UI Service Territory Geographic Distribution of DG



5 to 6X Solar pv 4-yr growth, and rising…

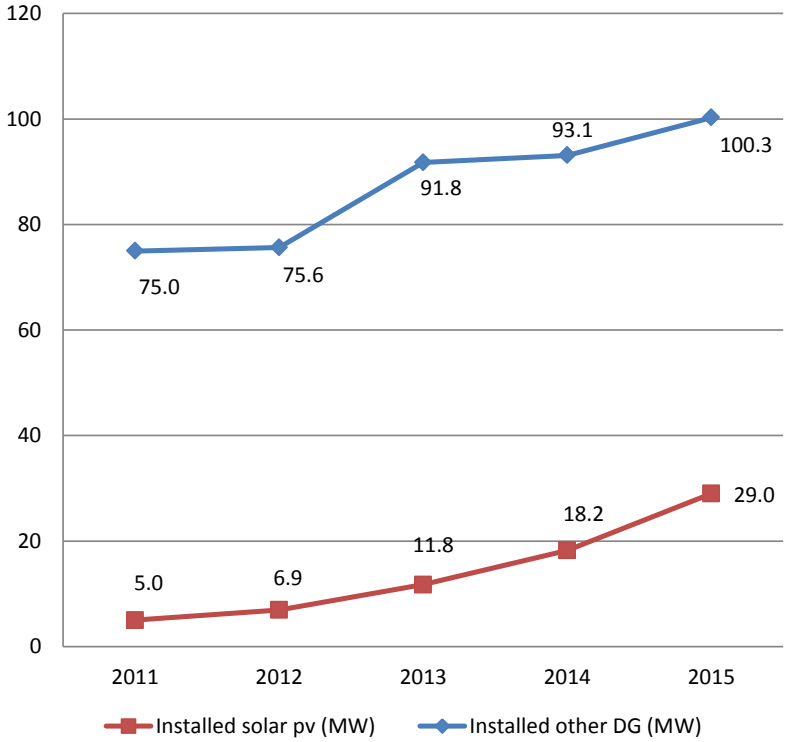
Parallel DG Interconnection Activity

of applications per year 2011-2015



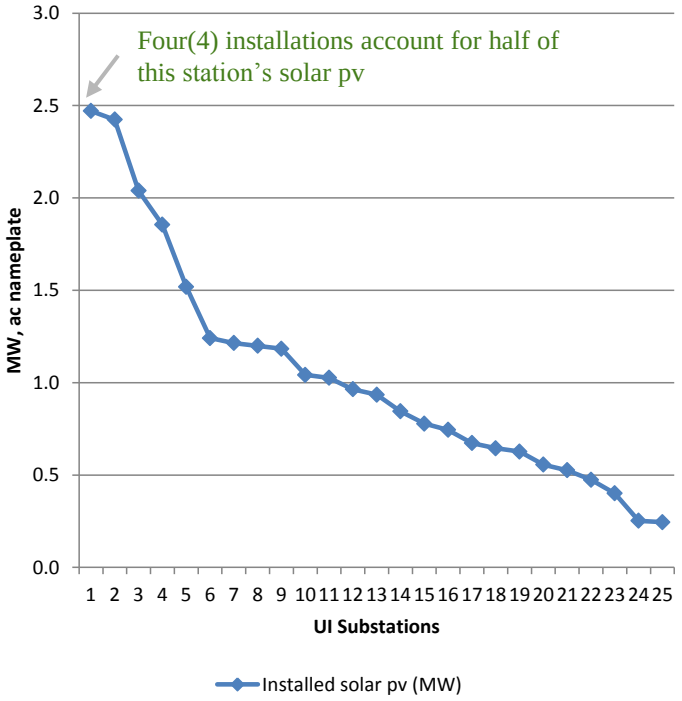
Installed Parallel DG

in cumulative MW, ac nameplate, 2011-2015 (end of year, 2015)

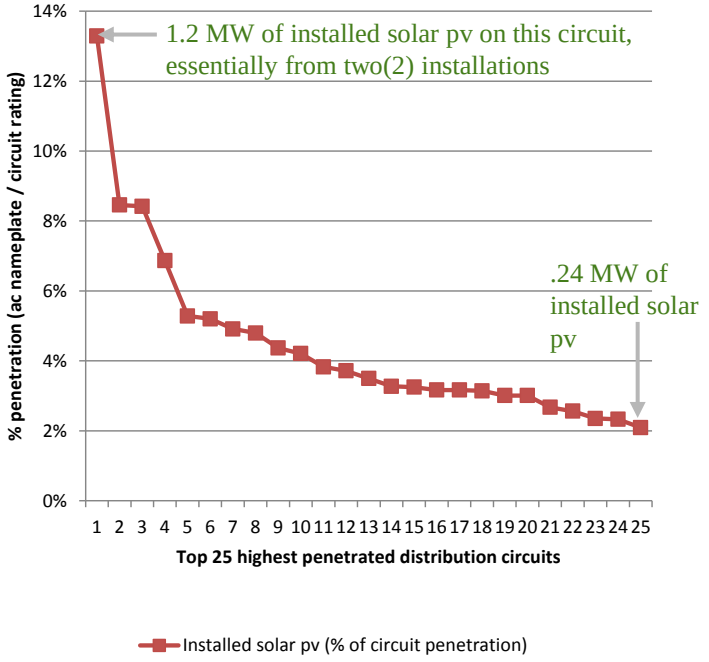


…though penetration is still relatively low

Solar pv at UI substations
Highest to lowest penetration
(through mid-Sept 2015)



Solar pv
Top 25 highest penetrated circuits
(through mid-Sept 2015)



How about energy storage?

Customer choice requires supporting adoption of new technologies while …

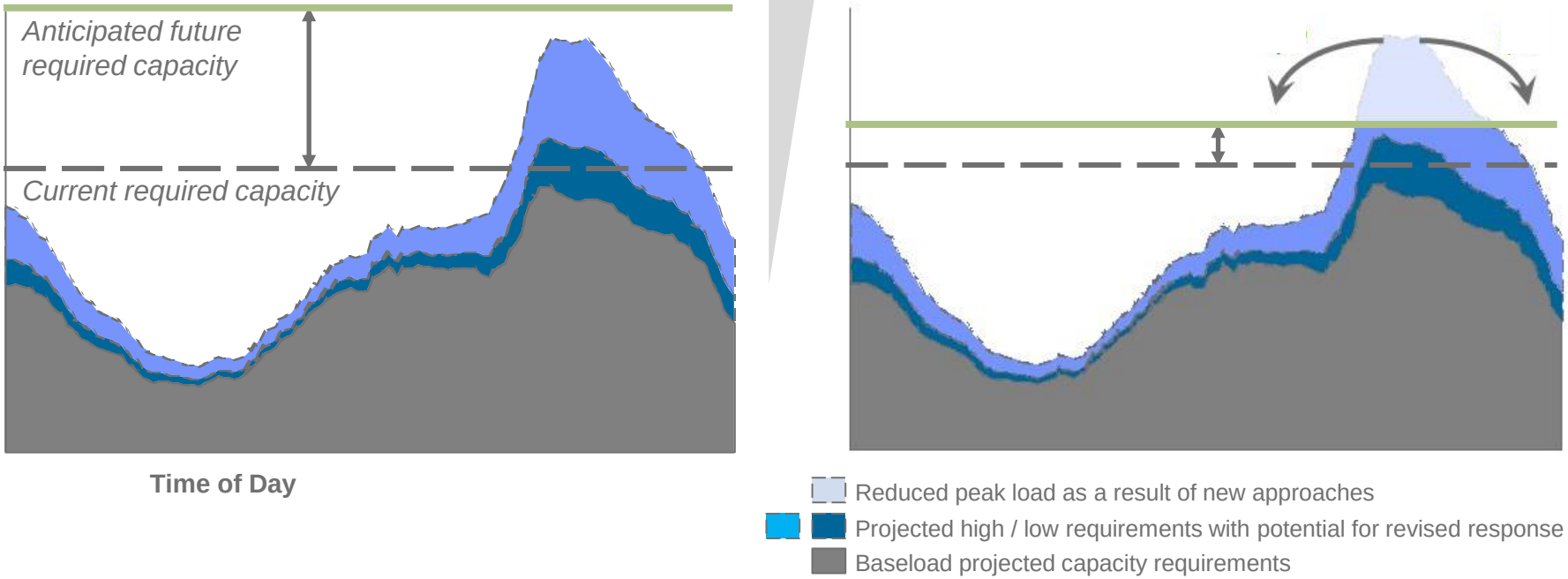
… moving from an "obligation to serve" to a "commitment to optimize"

Capacity, Reliability, & Risk

Capacity, Reliability & Resiliency

Demand Integration (EE, DR, DER, Interop)

Flexibility (Storage, control, automation)



Reduced peak load as a result of new approaches

Projected high / low requirements with potential for revised response

Baseload projected capacity requirements

Energy Storage is an important part of UI's Demonstration Project Concept Proposals

CT Public Act 15-5, Section 103 - Demonstration Project Concepts for Grid-Side System Enhancements to Integrate Distributed Energy Resources

#	UI Demonstration Project Name	Meets DEEP's goals & objectives								
		Innovative Marketing	Deferred Costs	Proactive Planning	Energy Storage	Transparency	Procurement	Policy Changes	Existing Pgm Synergies	Other
1	Battery Storage to Defer Capacity Need		X	X	X	X		X		X
2	Localized Targeting and Integration of DERs	X	X	X	X	X	X	X	X	X
3	Hosting Capacity Analysis and Mapping			X		X				X
4	Solar Adoption Forecast			X		X				X
5	Base Load DG Integration			X	X	X				X

PROTON
THE LEADER IN ON SITE GAS GENERATION.

CT Power & Energy Society

Presented by:
Robert Friedland
President and CEO

March 9, 2016

Proton OnSite

- Manufacturer of Proton Exchange Membrane (PEM) hydrogen generators using electrolysis as well as nitrogen and zero air products.
- Founded in 1996 as Proton Energy Systems
  - d/b/a Proton OnSite since April 2011.
- Headquarters in Wallingford, Connecticut.
- Over 2,500 installations operating in 75+ different countries.

Certified to
ISO 9001:2008

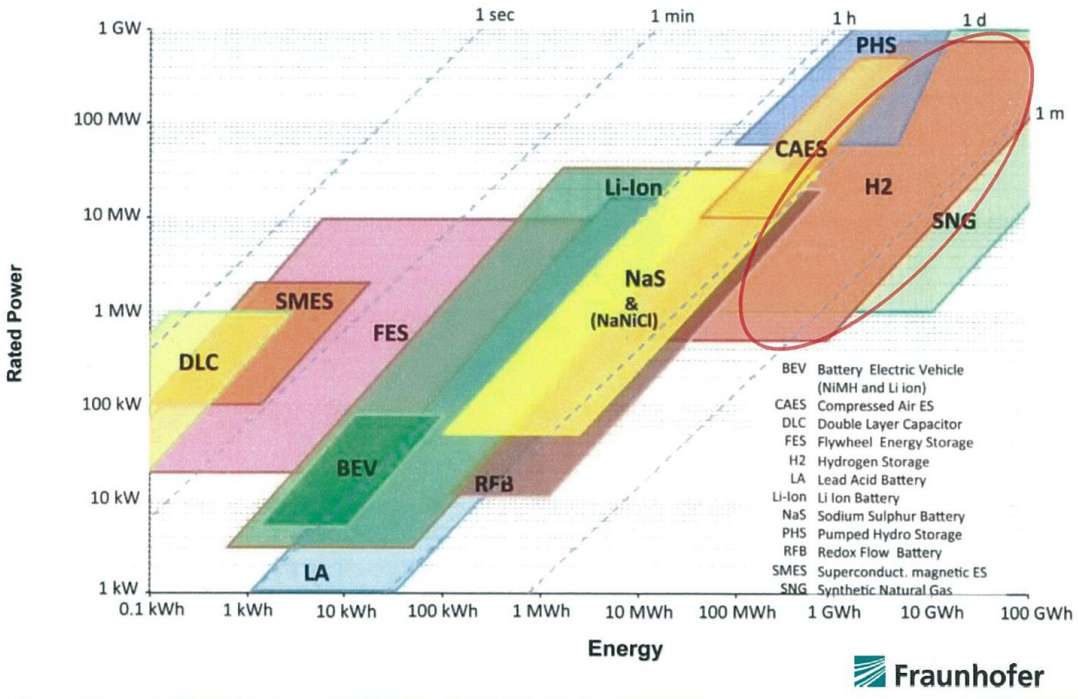
TÜVRheinland®

Precisely Right.

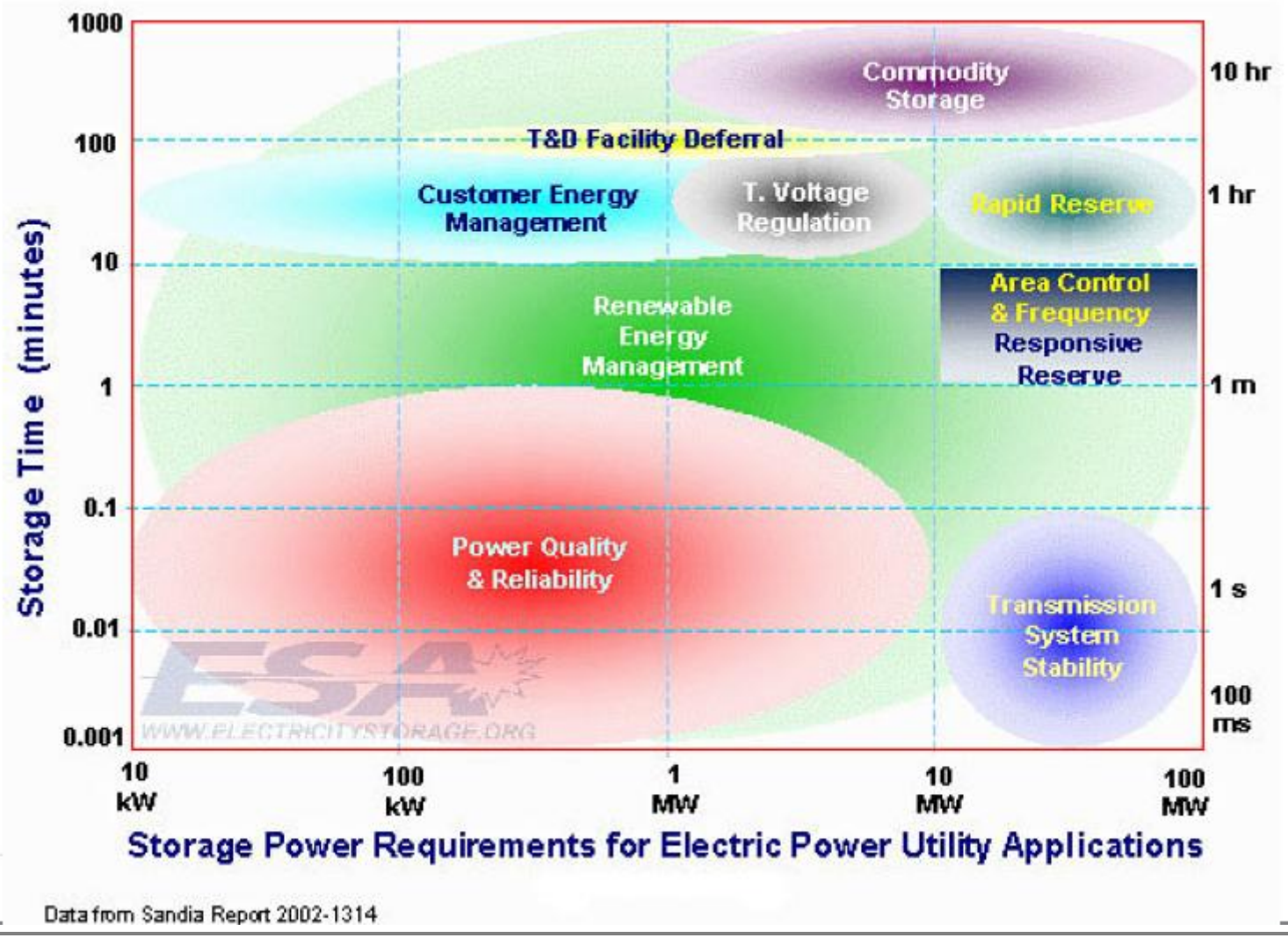
PROTON
THE LEADER IN ON SITE GAS GENERATION.

Hydrogen Enables Long Duration and High Power Energy Storage

- Needed to balance the fluctuating renewable energy and provide stability to grid.
- Excess or stranded renewable energy can be as high as 20-40% of rated capacity at times.
- Hydrogen can play an interesting role.

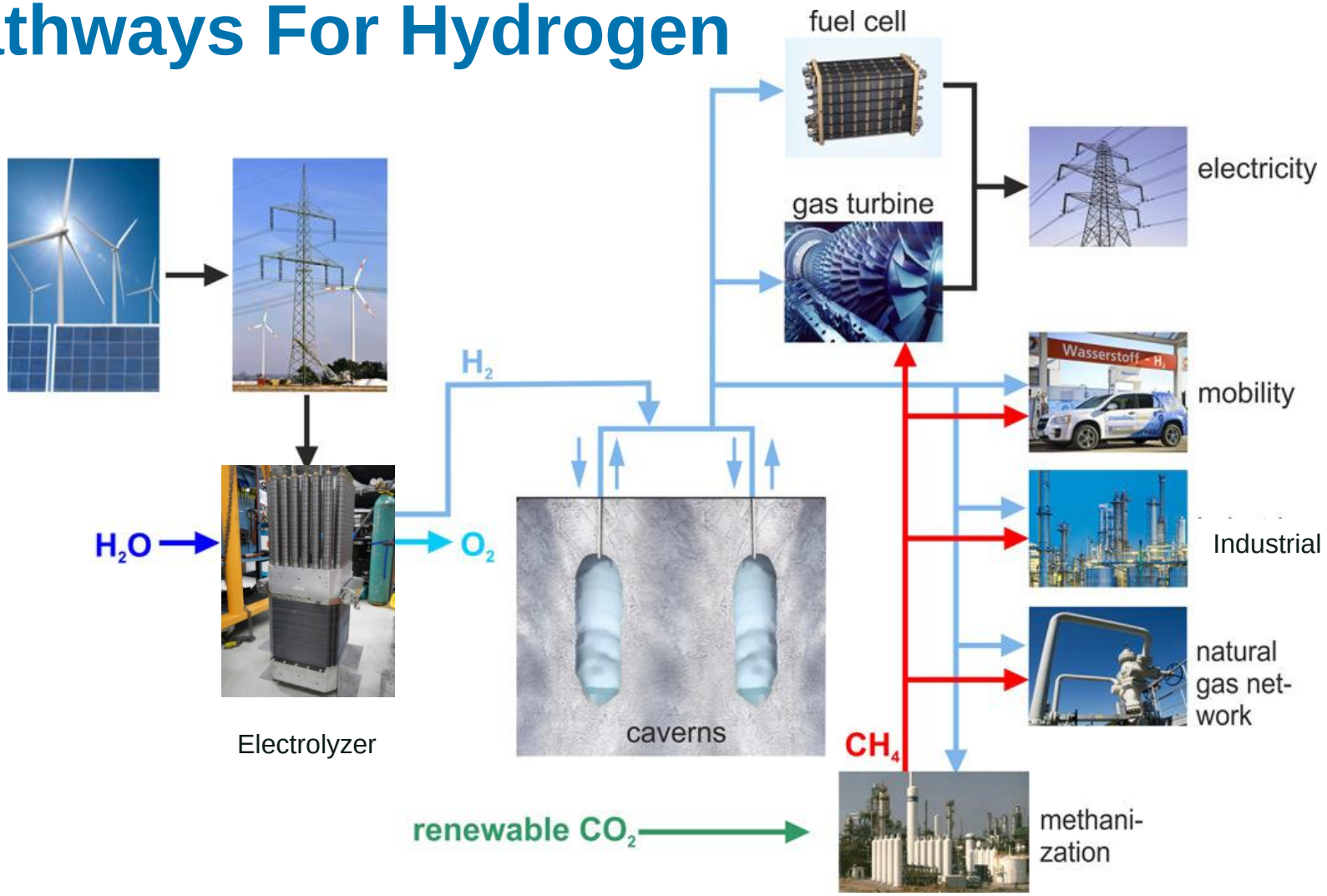


Utility Applications for Storage



Data from Sandia Report 2002-1314

Pathways For Hydrogen



Connecticut Power and Energy Society Meeting
Cromwell, CT, March 9, 2016

based in

A portfolio of innovative products thanks to 13 years of R&D…

H_2 production units


A full range:
Small, medium and large-scale hydrogen production units (electrolyzers)

➔ *Years of experience in producing hydrogen through water electrolysis, a mature technology*

H_2 solid storage units


A disruptive, green, safe and large scale solution

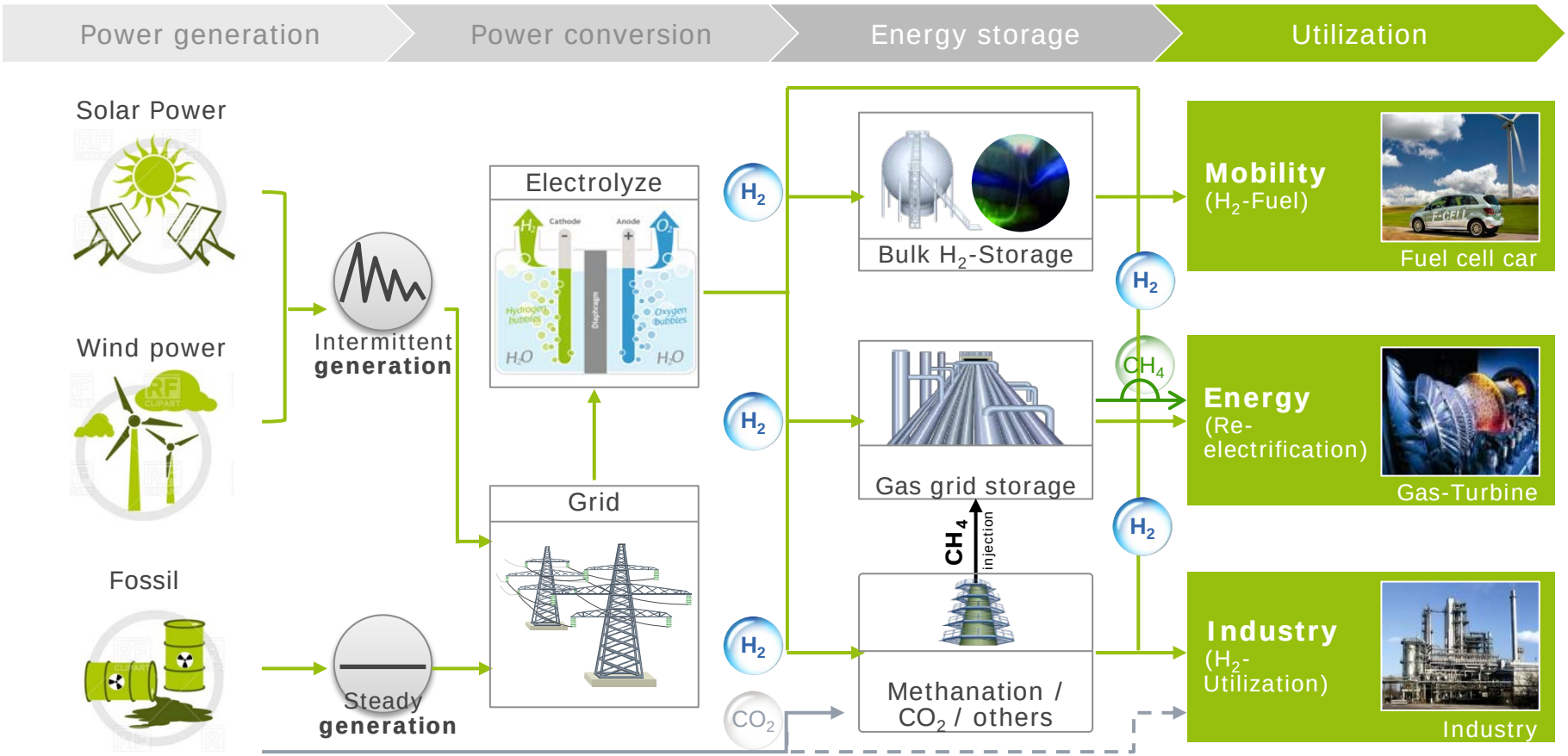
➔ *Exclusive technology for storing hydrogen in solid form*

… addressing 2 main high-growing markets

Industry

Energy & mobility

Power to Gas concept

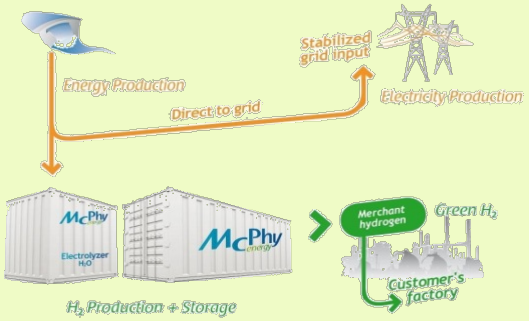


- ✓ **Power to gas = energy storage**
- ✓ **Power to gas = intermediate**

P2G & Energy Storage Projects

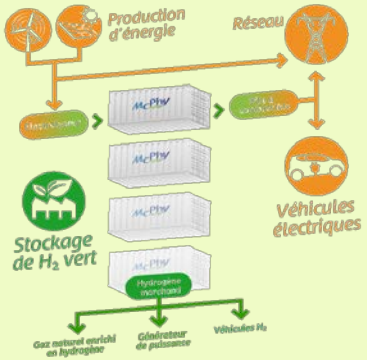
LASSY PROJECT

- 250 kg H_2
- 8.3 MWh
- Industrial green H_2
- France
- 2015

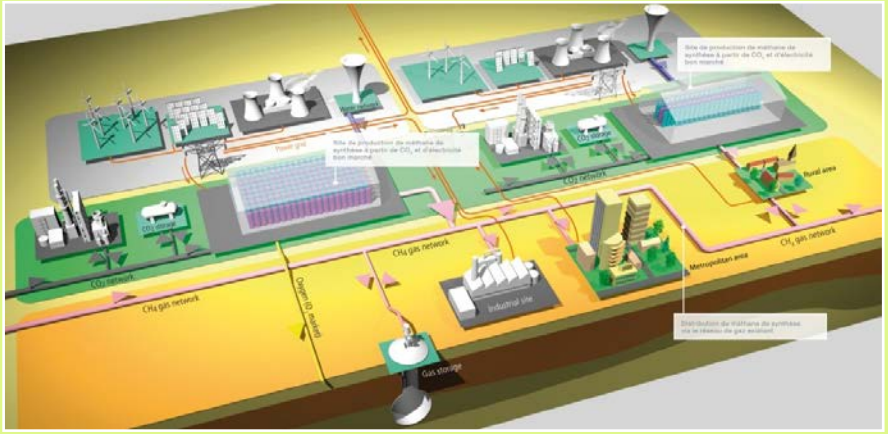


INGRID PROJECT

- 1000 kg H_2
- 33.3 MWh
- PtG & green H_2 for industry/transport
- Italy
- 2014



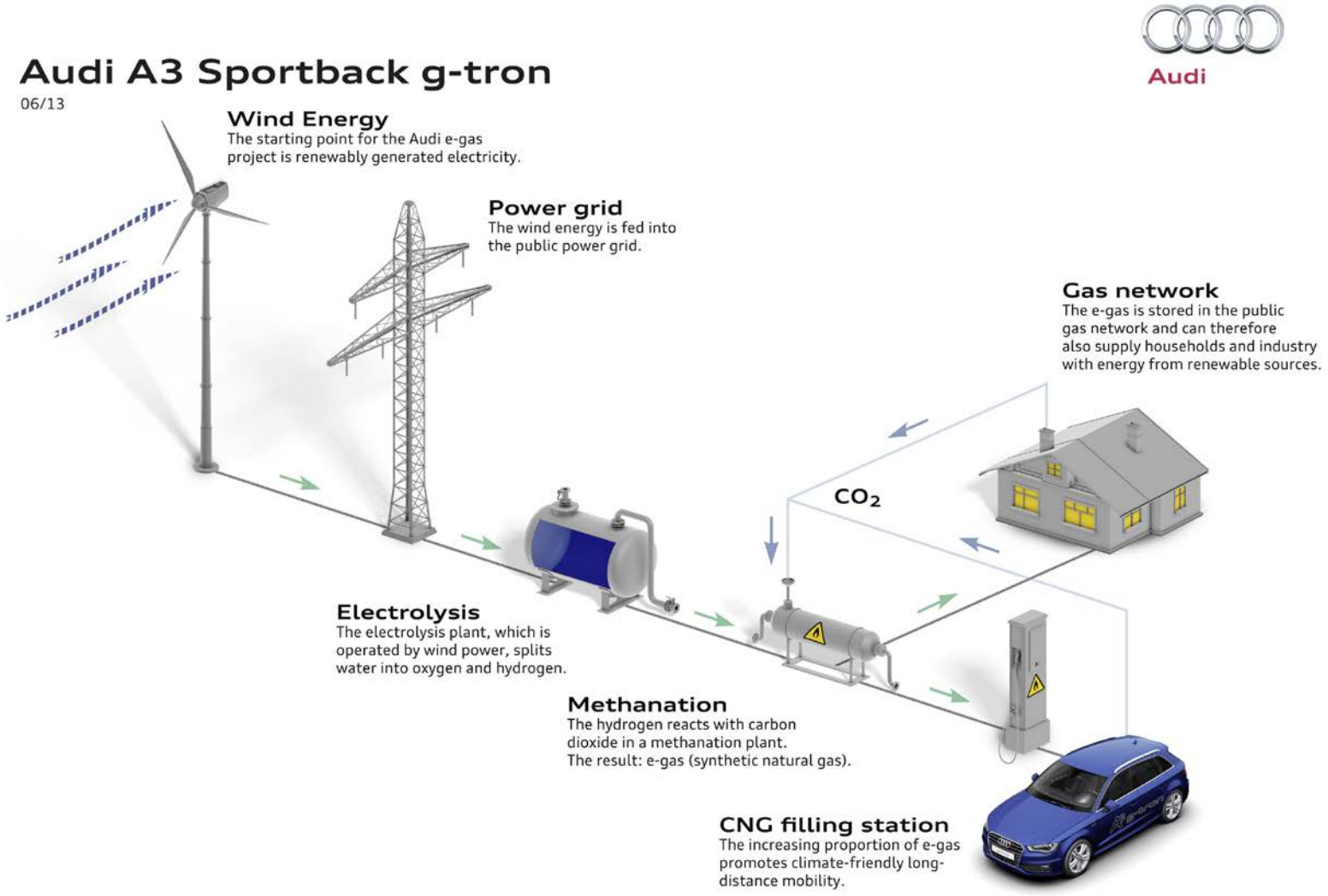
GRHYD PROJECT



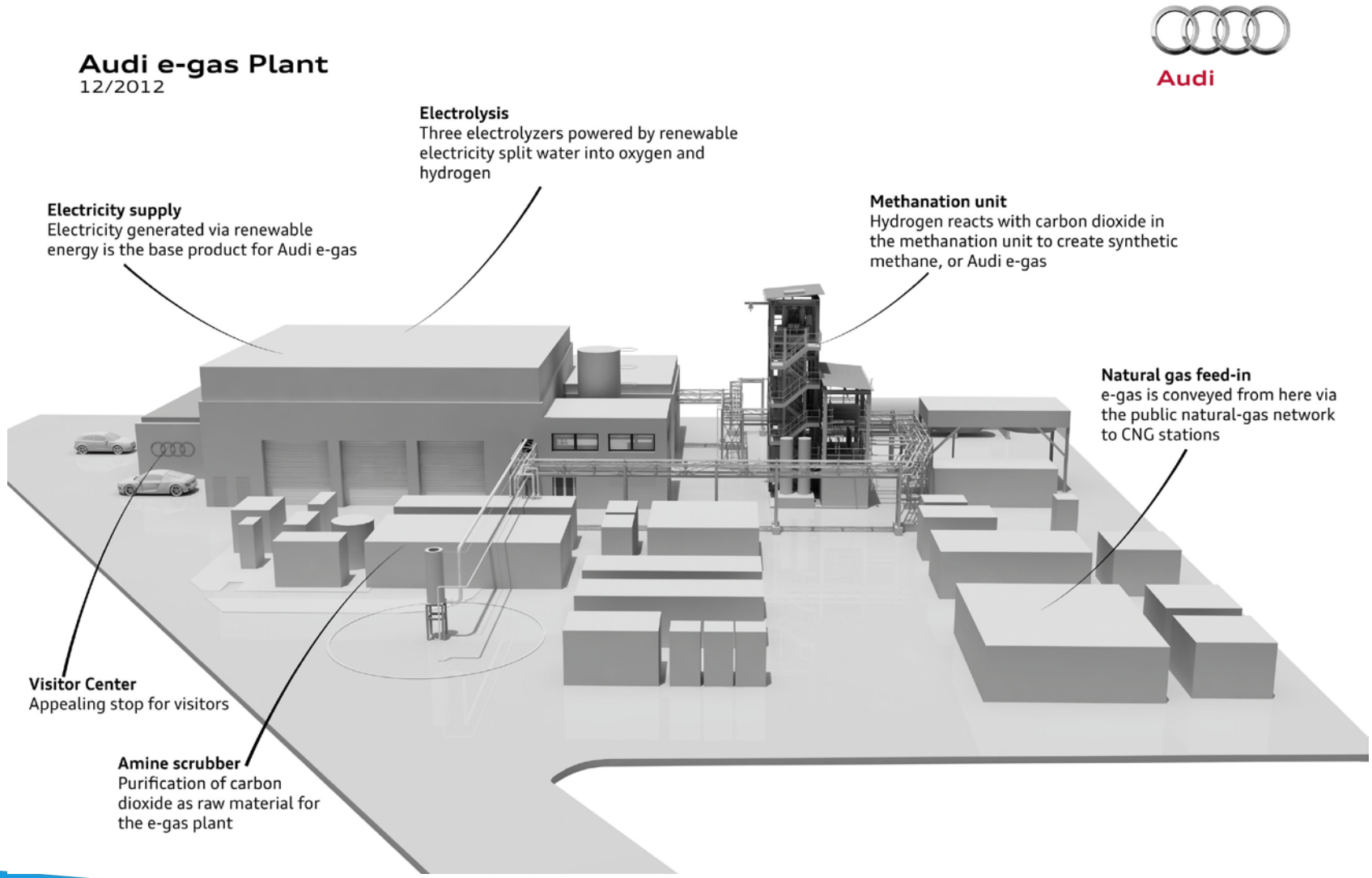
- **Power to Gas & green H_2 for industry/transport**
- **2015/2016**
- **150 kg H_2 (4.5 MWh)**
- **Leader: GDF-Suez**

Werlte, integrated facilities: Biomass – H2 – Methanation – CH4

Audi Project - Overview



Audi e-Gas Project Design



~2800 kg/day H2 production with 3 x 2 MW Electrolysers
McPhy Energy

JUPITER 1000 – un projet innovant porté par un consortium solide piloté par GRT Gaz

Consortium : 7 Partenaires Industriels, 1 Laboratoire R&D

Une plateforme innovante :
Capture de CO2, Production d'H2 (1 MW)
et de Méthane de synthèse

McPhy energy