Hydrogen Technology Overview

Arizona Tribal Energy Association

Hank Courtright, SRP | May 11, 2023

Agenda

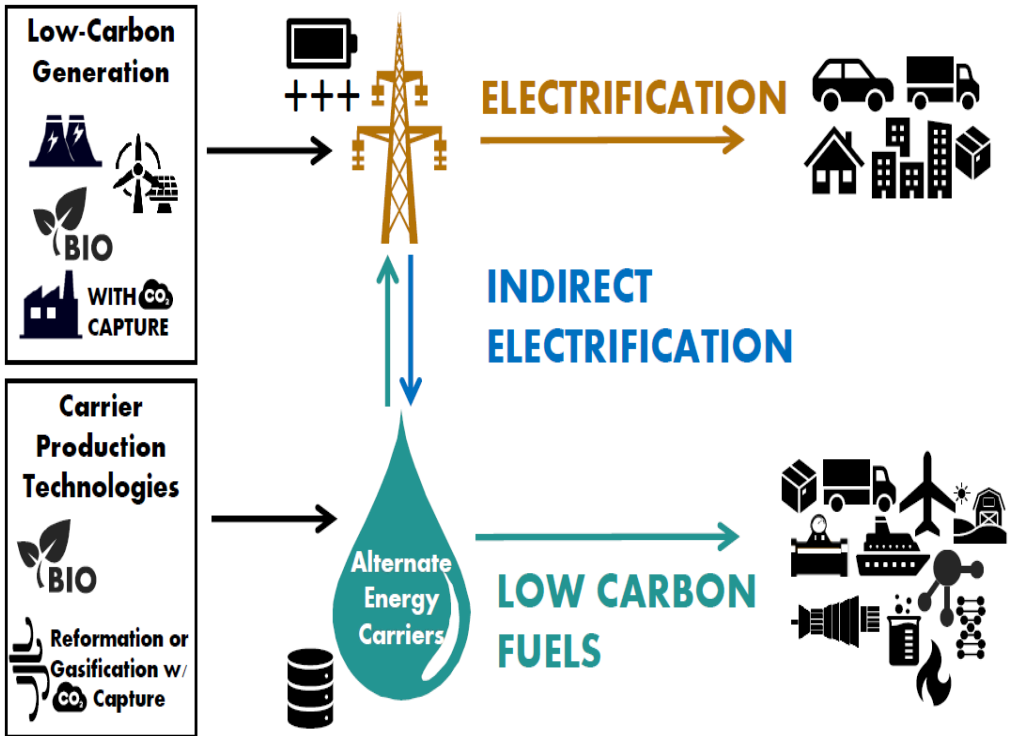
- Why Hydrogen?
- Hydrogen Fundamentals
  - The Colors of Hydrogen
  - Production / Delivery / Storage
- Applications for Hydrogen Use
- DOE Hydrogen Hub Application
  - The Center for an AZ Carbon-Neutral Economy (AZCaNE)
  - Southwest clean Hydrogen Innovation Network (SHINe)
  - Proposed Projects in AZ and NV

Why Hydrogen? Carbon Reduction Role?

Petroleum replacement in transportation – to power fuel cells with electric drive

Natural Gas replacement – as a primary fuel, or blended fuel, for power generation, building heating and industrial processes

Energy storage – seasonal storage at large scale for multiple applications



Graphic Source: EPRI/GTI

The Colors of Hydrogen

Gray – natural gas steam methane reforming (SMR)

Brown – coal gasification

Blue – natural gas or coal with carbon capture sequestration/utilization

Green – water electrolysis with renewable electricity (or bioresources based)

Pink – water electrolysis using nuclear electricity

White – water electrolysis using grid power

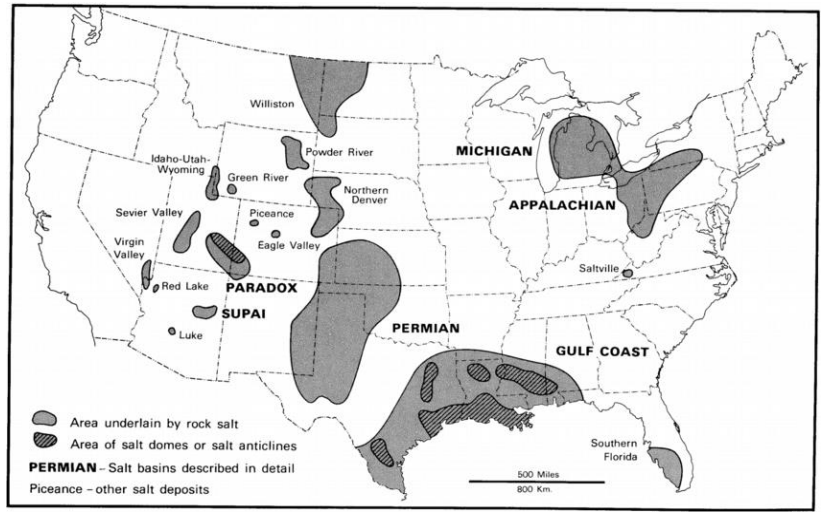
Clean H_2 Standard < 4.0 Kg CO_2 / Kg H_2

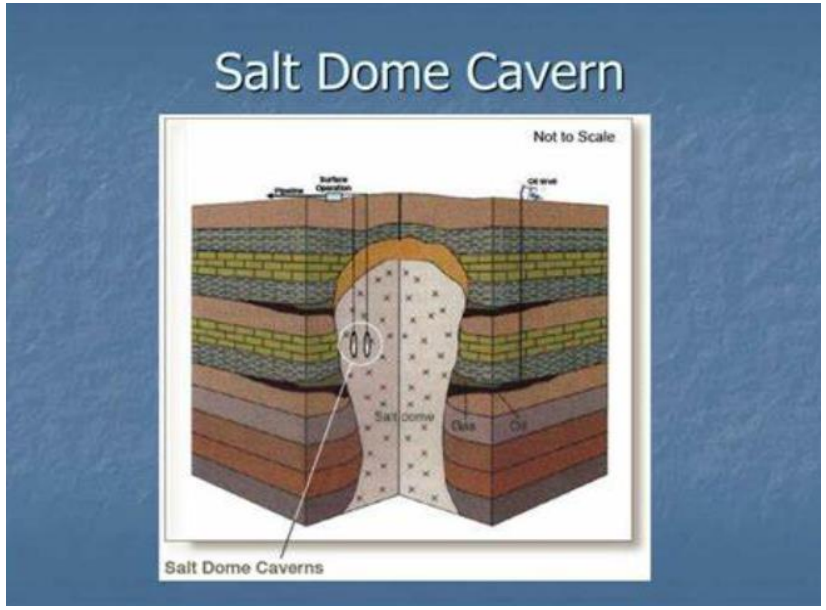
	Hydrogen Production Methodology	Carbon Impact (kg CO_2/kg H_2)
CARBON IMPACT OF HYDROGEN PRODUCTION	Gray: Natual gas SMR	8-12
	Brown: Coal Gasification + SMR	18 -20
	Blue: Natural Gas SMR + Carbon Capture	0.6 - 3.5
	Green: Electrolysis with Renewable Electricitys	0

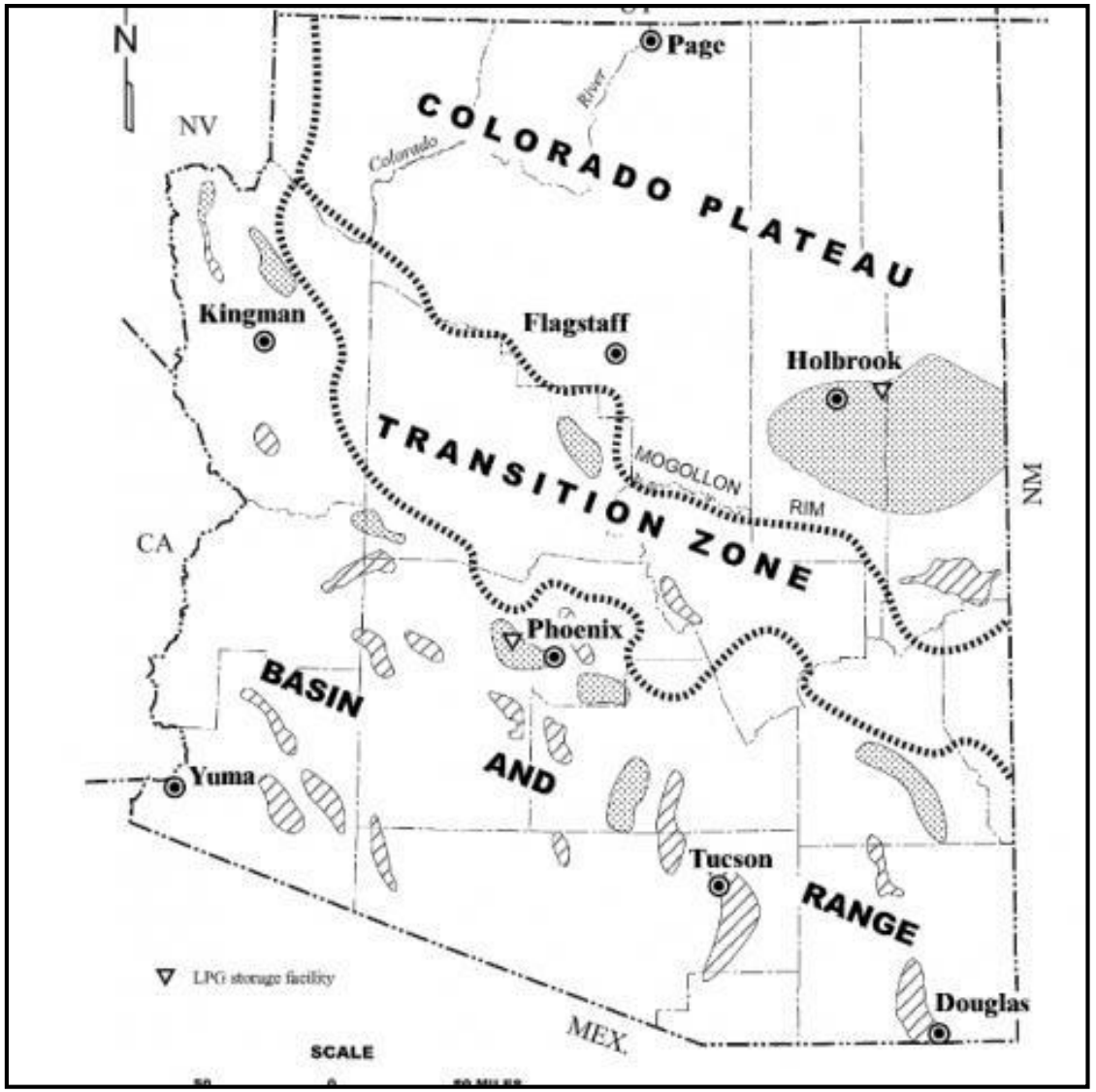
Source: GREEN HYDROGEN GUIDEBOOK

Heavy Duty Transportation

H_2 Storage – Underground Options in AZ







Infrastructure Investment and Jobs Act – Hydrogen

Includes $9.5B for clean hydrogen

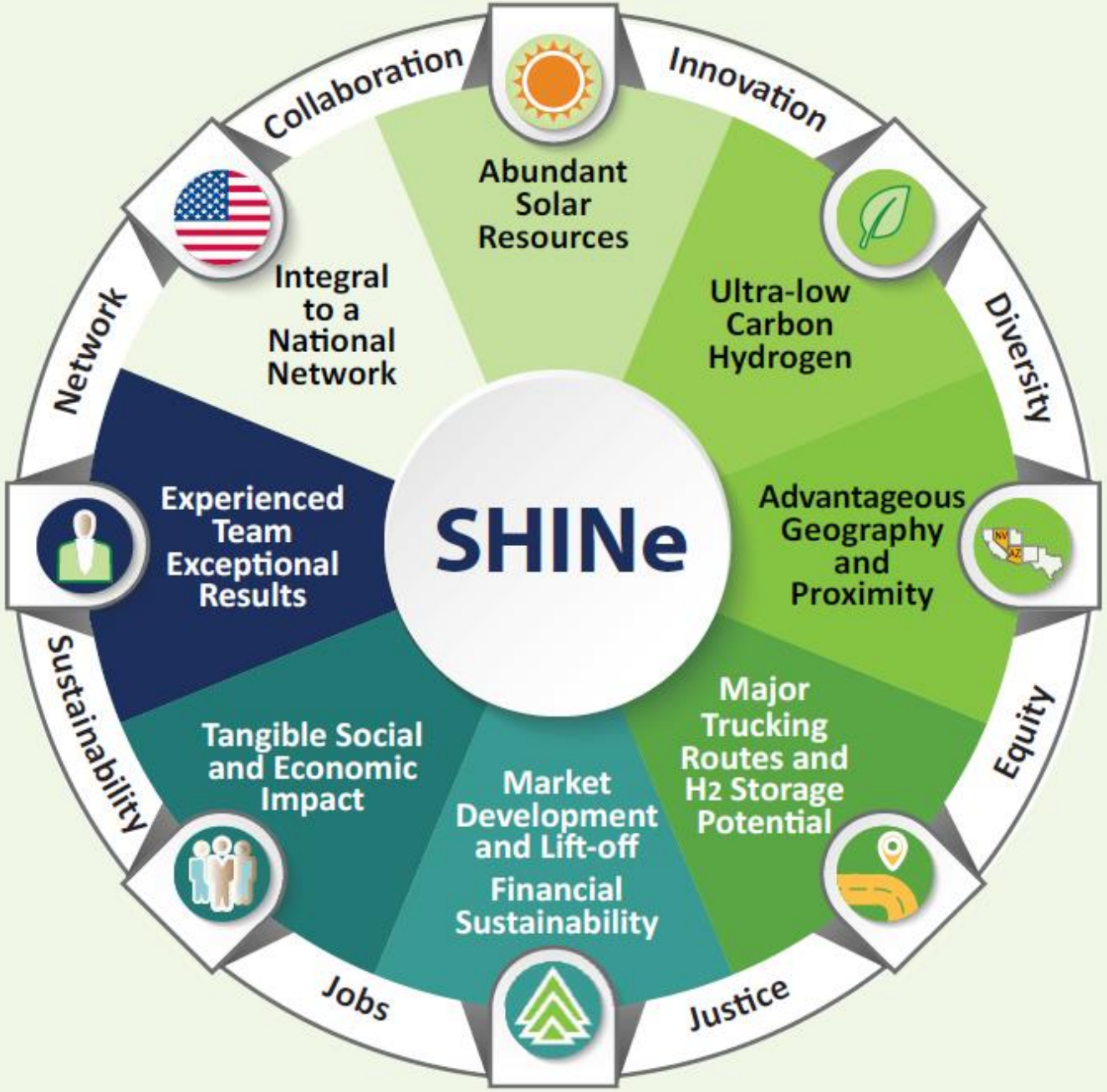
- $1B for electrolysis RD&D
- $500M manufacturing and recycling R&D
- $7B for 6 to 10 regional clean hydrogen hubs across US

THE CENTER FOR AN ARIZONA CARBON-NEUTRAL ECONOMY AT ASU

Southwest clean Hydrogen Innovation Network

SHINe

SHINe is a unique consortium of public, private, and tribal organizations working across Arizona and Nevada to produce, store, deliver, and use clean hydrogen (H_2), with connectivity to the Southwest and the broader U.S. clean H_2 ecosystem.



Produce

174 Power Global Corp.
Air Liquide · Ameresco
Avangrid
Element Resources
Heliogen · Hyve 1
Intelligent Energy
Libertad Power
Linde Inc.
NextEra Energy Resources LLC
Nikola Corporation
Origis Energy

Liquefy, Store, and Deliver

174 Power Global Corp.
Air Liquide
EDF Renewable Energy
Element Resources
Linde Inc.
Nikola Corporation
Origis Energy
Phoenix Hydrogen
Tallgrass Greenview
Vopak New Energies

Refuel and Use

American Airlines
Artemix · First Mode
GE Gas Power
Hyundai Global · Komatsu
Nevada Gold Mines
Nikola Corporation
PACCAR/Kenworth
Pilot · RTC South Nevada
Tallgrass Greenview
Toyota · Trillium

Workforce and Training

SciTech Institute
National Council Workforce Education
Learn Fresh
Estrelle MtComm College
Center for Entrepreneurial Innovation
Arbor Day Foundation

SHINETECH_007f

Federal, State, and Tribal

US Senators Cortez Masto & Rosen (NV)
US Senators Kelly & Sinema (AZ)
Governor Hobbs (AZ)
Governor's Office of Energy (NV)
US House Rep. Lesko, Stanton (AZ)
US House Rep. Lee, Titus, Amodei, Horsford (NV)
AZ House Majority Leader - Biasiucci
Baja California, Governor
Department of Transportation (NV)
Navajo Nation
InterTribal Council of AZ

Utilities and Universities

Arizona Public Service
Arizona State University
Northern Arizona University
Salt River Project
Southwest Gas
Tucson Electric Power
University of Arizona
University of Nevada Las Vegas

Unions, Investors, and Connectors

Aegon Asset Management
AZ Commerce Authority
Boilermakers Local 627
Electric Power Research Institute
Greater Phoenix Economic Council
Las Vegas Global Economic Alliance
SidePorch Consulting LLC
Starstone Ventures
Teamsters Local 848

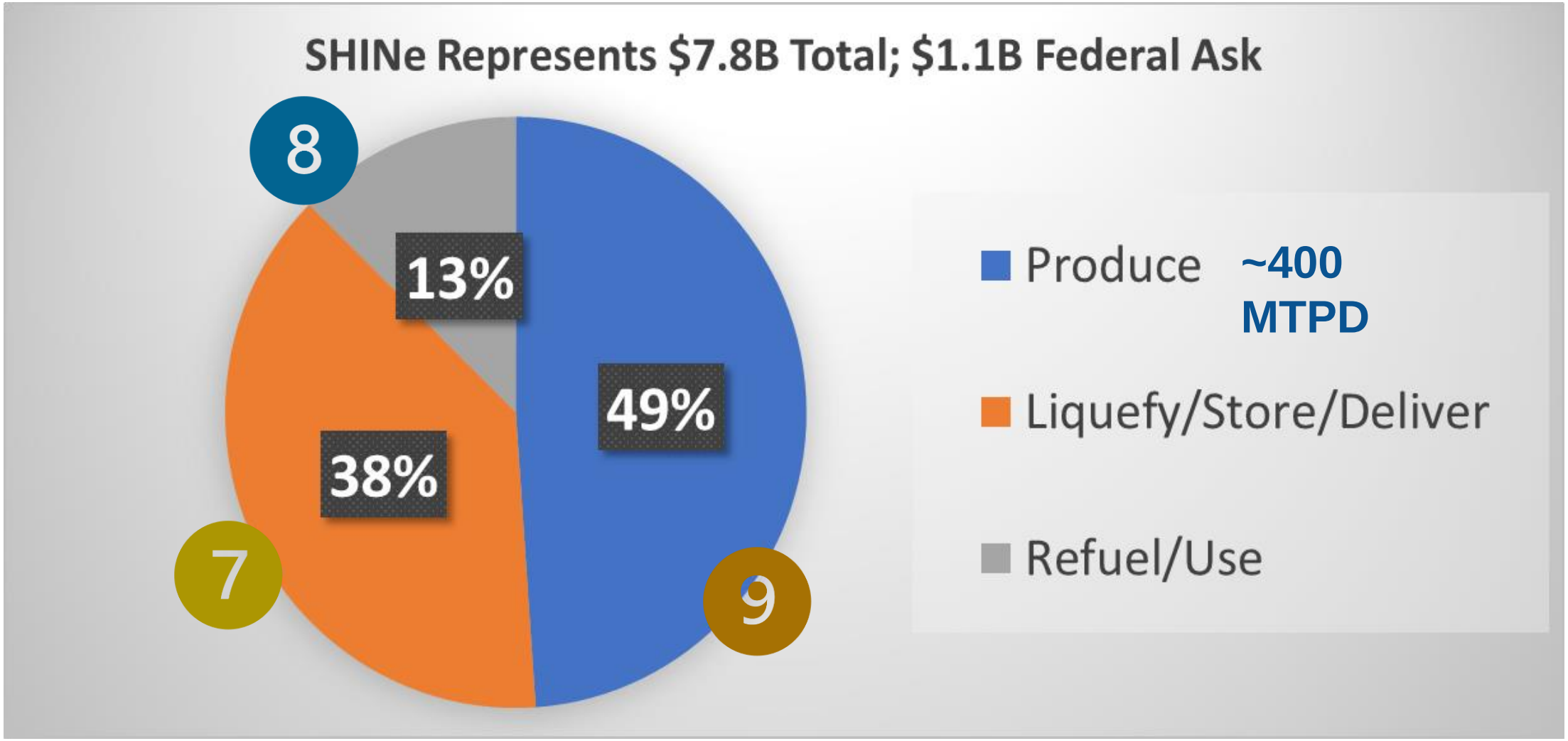
Advocacy Organizations

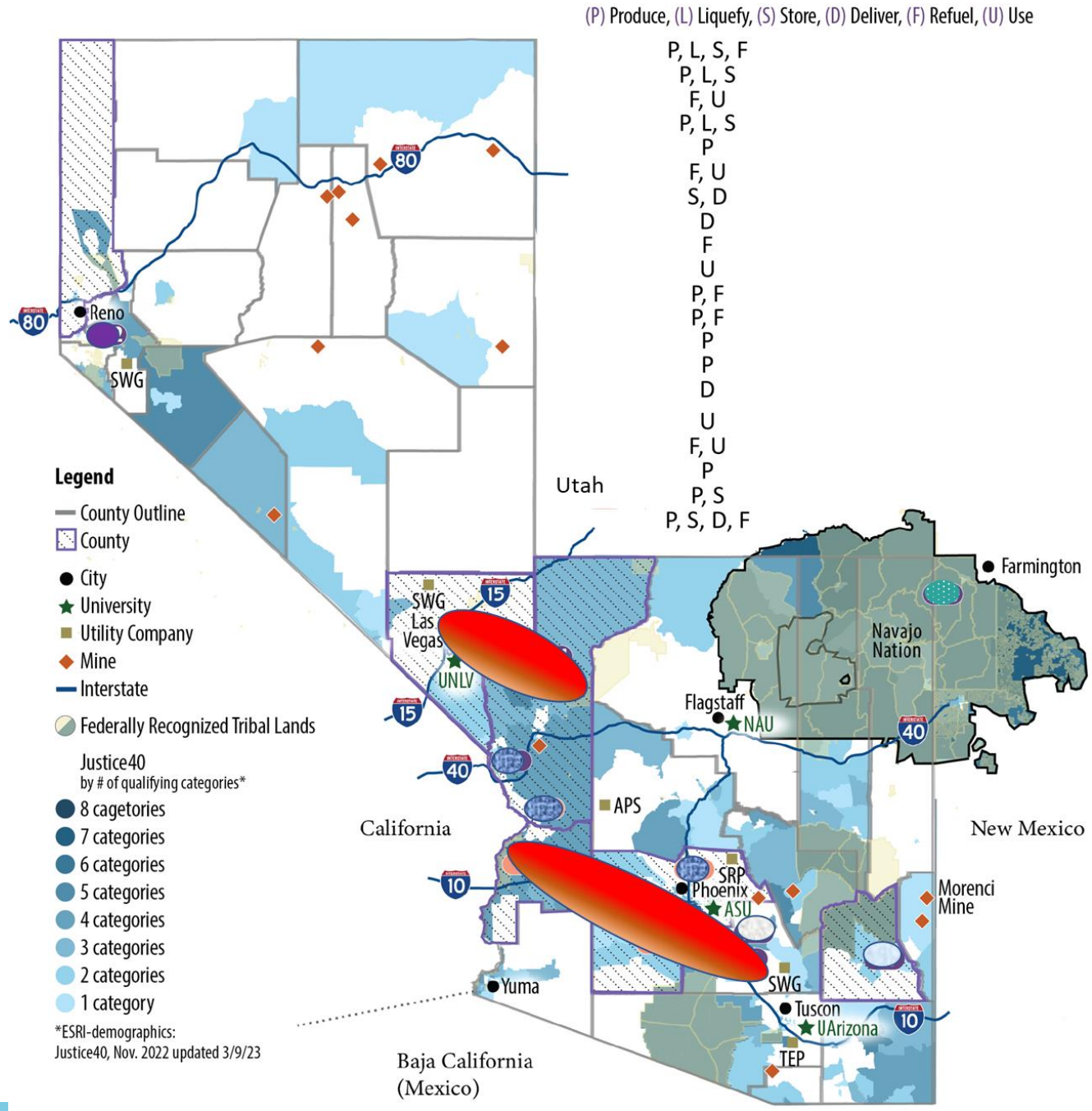
Green Our Planet
Peaks Advocacy Group
Read Better Be Better
The Nature Conservancy - Arizona
The Nature Conservancy - Nevada
Truckers Against Trafficking
United Way - Valley of the Sunv

Cities and Counties

City of Phoenix, AZ
Kingman, AZ
Las Vegas, NV
Mesa, AZ
Tempe, AZ
Tucson, AZ
Clark County, NV
La Paz County, AZ
Maricopa County, AZ
Mojave County, AZ
Pima County, AZ
Yuma County, AZ
Sustainable Cities Network, AZ

H_2 Value Chain for SHINe




(P) Produce, (L) Liquefy, (S) Store, (D) Deliver, (F) Refuel, (U) Use
P, L, S, F
P, L, S
F, U
P, L, S
P
F, U
S, D
D
F
U
P, F
P, F
P
P
D
U
F, U
P
P, S
P, S, D, F
Legend
County Outline
County
City
University
Utility Company
Mine
Interstate
Federally Recognized Tribal Lands
Justice40
by # of qualifying categories*
8 cagetories
7 categories
6 categories
5 categories
4 categories
3 categories
2 categories
1 category
*ESRI-demographics:
Justice40, Nov. 2022 updated 3/9/23
Utah
Reno
SWG
SWG
Las
Vegas
UNLV
Farmington
Navajo
Nation
Flagstaff
NAU
APS
California
New Mexico
SRP
Phoenix
ASU
Morenci
Mine
Yuma
SWG
Tuscon
UArizona
TEP
Baja California
(Mexico)
80
15
40
10

Key Takeaways

- SHINe Hydrogen Hub is the start of a hydrogen ecosystem for the Southwest region and neighboring states.
- DOE Hydrogen Hub funding will “jump-start” a national hydrogen ecosystem and infrastructure.
- Transportation of heavy vehicles will be the initial H_2 applications.
- SRP and other utilities will be engaged with SHINe to assess and guide H_2 for power generation.

Thank you for your time

Contact Information

Hank Courtright, SRP, hank.courtright@srpnet.com

Ellen B. Stechel
Executive Director, Center for an Arizona Carbon-Neutral Economy
Ellen.Stechel@asu.edu
480-965-1657 or cell: 505-400-4299

Connie Gardiola
Senior Program Manager, Center for an Arizona Carbon-Neutral Economy
Connie.Gardiola@asu.edu
480-965-0183