That’s Cool! – Exciting Innovations in Nat Gas Markets

CB&I Storage Solutions





MCDERMOTT | CB&I STORAGE SOLUTIONS

CB&I Storage Solutions at a Glance

McDermott's CB&I Storage Solutions is the world's most experienced designer and builder of industrial storage facilities around the world.

200+
Active Contracts

59,000+
Storage Structures Built

~$18.5 million
Average Contract Size

~4,000
Employees Worldwide

$19.5 billion
Tracked Market

30+
Locations Worldwide

650
Tracked Opportunities

~100
Countries Served

UNMATCHED BREADTH OF PRODUCTS

CB&I STORAGE SOLUTIONS

Low Temperature & Cryogenic Storage

Providing industry-leading tanks, vessels and spheres that safely store refrigerated gas liquids.

Energy Transition

Leveraging more than a century of engineering and construction experience to deliver solutions that help our customers achieve their net zero goals.

High Pressure Storage

Designing economical and reliable storage for liquids and gases under a wide range of pressure and temperature conditions.

Storage Terminals & Process Facilities

Specializing in the design and construction of terminals that store crude oil and refined products, liquefied gases, petrochemicals and specialty chemical products.

Specialty Steel Plate Structures

Combining our expertise in low temperature and cryogenic systems, nuclear design and high-pressure vessel design to develop storage solutions for almost any type of steel plate structure.

Atmospheric Storage

Offering standard storage configurations or custom-designed systems for storing a variety of liquid products under ambient conditions.

Water Storage

Leading the design and construction of ground-level and elevated water storage tanks.

MOVE FORWARD WITH CONFIDENCE

CB&I STORAGE SOLUTIONS

CB&I's phased project delivery model offers cost and schedule certainty at low levels of risk to our customers

- Early engagement with phased contracting shortens the overall project schedule
- Also allows CB&I and our customer to budget price design options early, supporting LTIC (systems thinking)

PHASE I · (Pre-FEED)

>>>>>

Consists of early engagement and preliminary design activities:

- Early engagement with all stakeholders
- Critical design decisions optimize performance, price and initial design documents
- High-level execution plan for long-lead activities and equipment, high-level project schedule
- Review jurisdictional regulations
- Facility budget

PHASE II · (FEED)

>>>>>

Localizing and optimizing a baseline design to achieve project execution and plant performance targets:

- Supply chain development, including subcontractors and key equipment suppliers
- Front-End Engineering Design (FEED) including site geotechnical and seismic surveys
- Project scheduling
- Regulatory approvals and supporting documents; support for permit applications
- EPC pricing

PHASE III · (EPC)

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Represents EPC including plant startup and operator training:

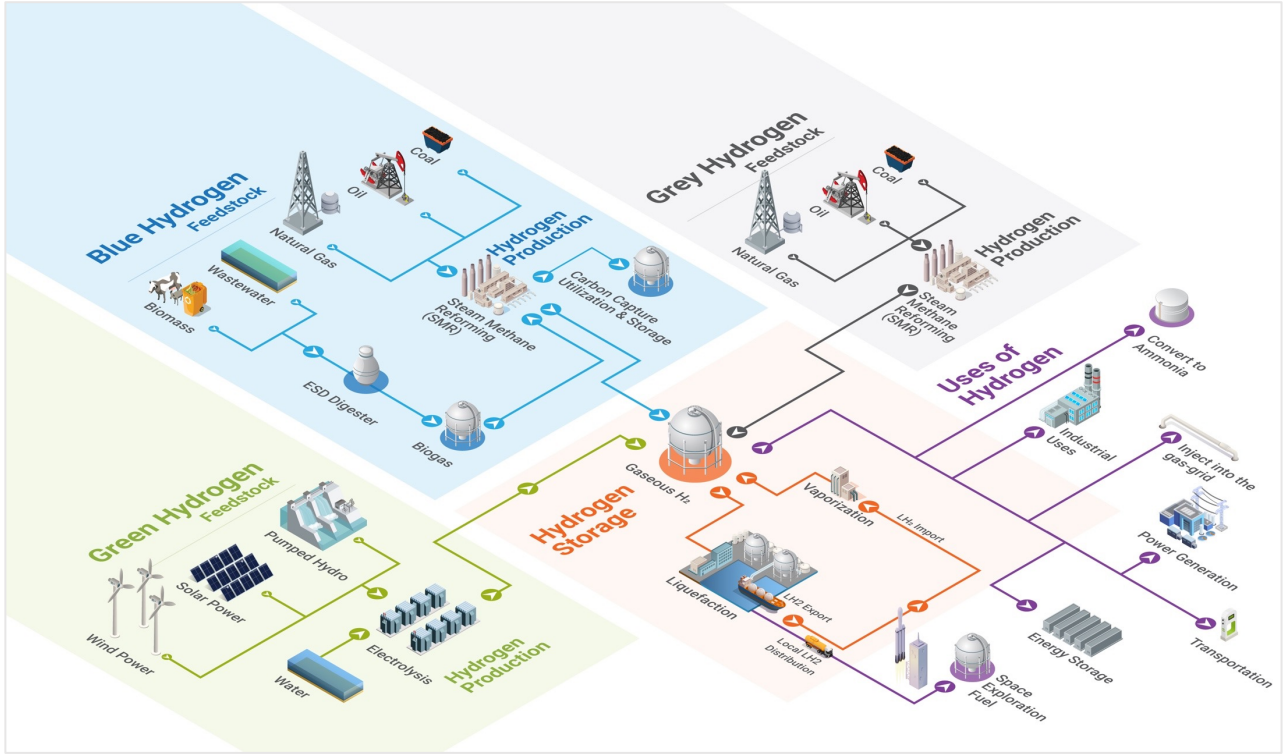
- End-to-end EPC responsibility from early engineering through commissioning, performance testing and startup

BUILDING A SUSTAINABLE FUTURE

CB&I STORAGE SOLUTIONS

Our sustainable storage solutions include:

- **Green hydrogen** production, blending, liquefaction, storage and terminals
- Refrigerated, high-pressure storage of carbon dioxide (CO_2) for **carbon capture** utilization and storage facilities
- **Renewable natural gas** (RNG) generation through anaerobic digesters and associated systems
- **Blue and green ammonia** storage and terminals
- **Stored energy** through thermal energy storage (TES) tanks, liquid hydrogen (LH_2), blue and green ammonia, liquefied air energy storage (LAES) and compressed air energy storage (CAES)



More Capabilities at Your Service

CB&I Storage Solutions has the in-house capabilities to take any project from the Feasibility Study on to FEED stage and through commissioning. Project delivery is expedited through our phased contracting approach, and we draw on decades of experience in adjacent markets to ensure optimal results.

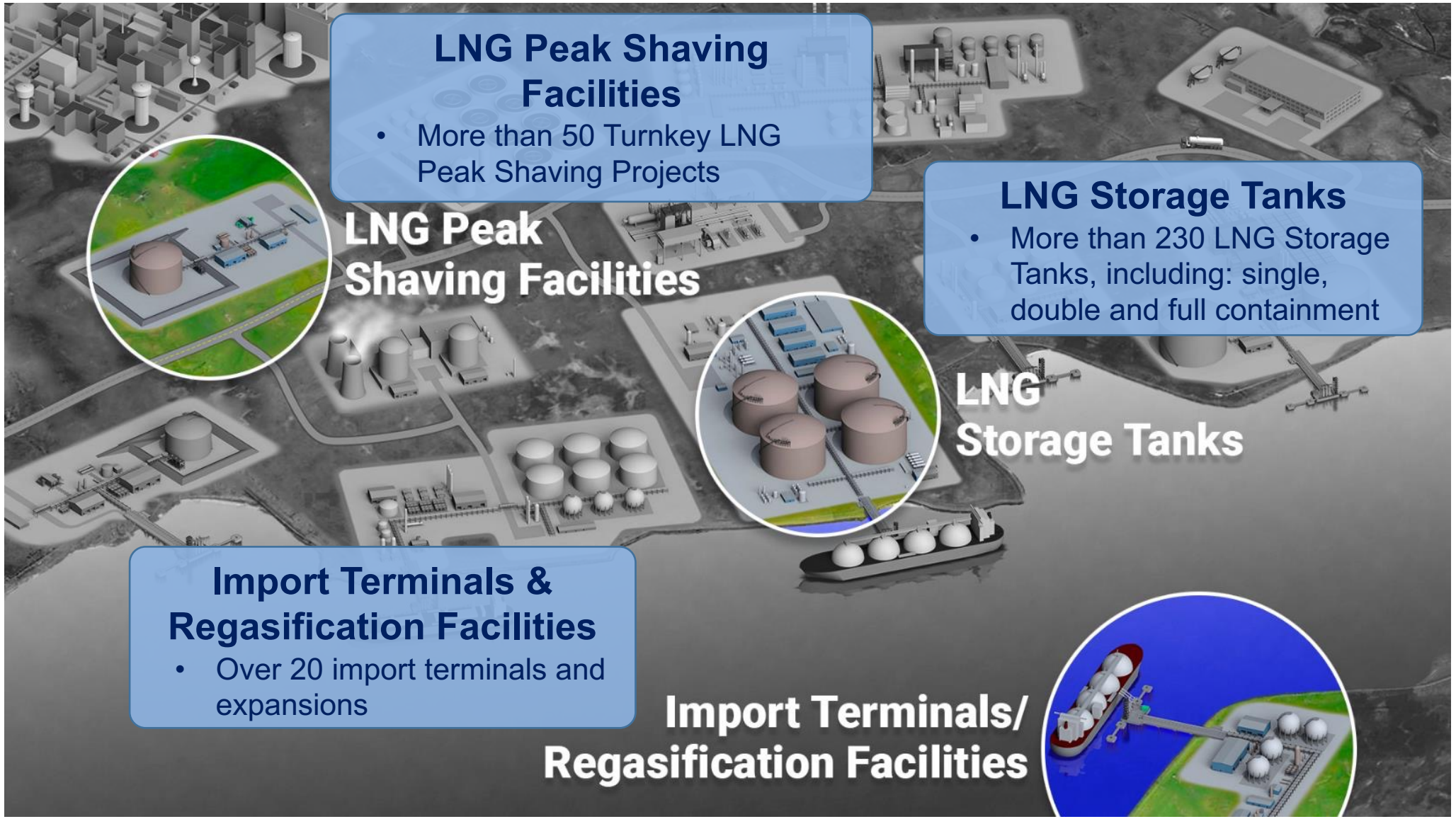
Small Scale LNG

SSLNG and Peak Shaving Highlights

CB&I STORAGE SOLUTIONS

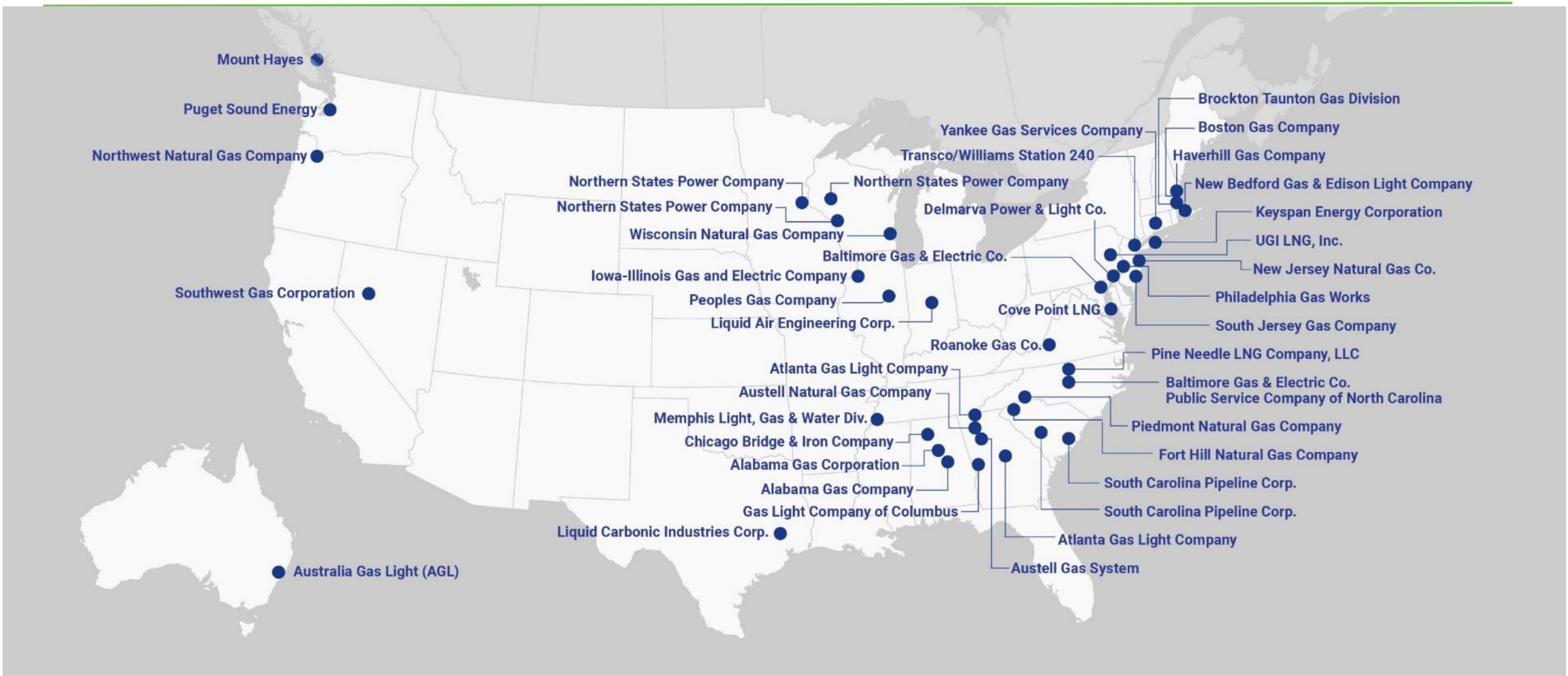
CB&I STORAGE LNG FACILITIES OVERVIEW

CB&I STORAGE SOLUTIONS



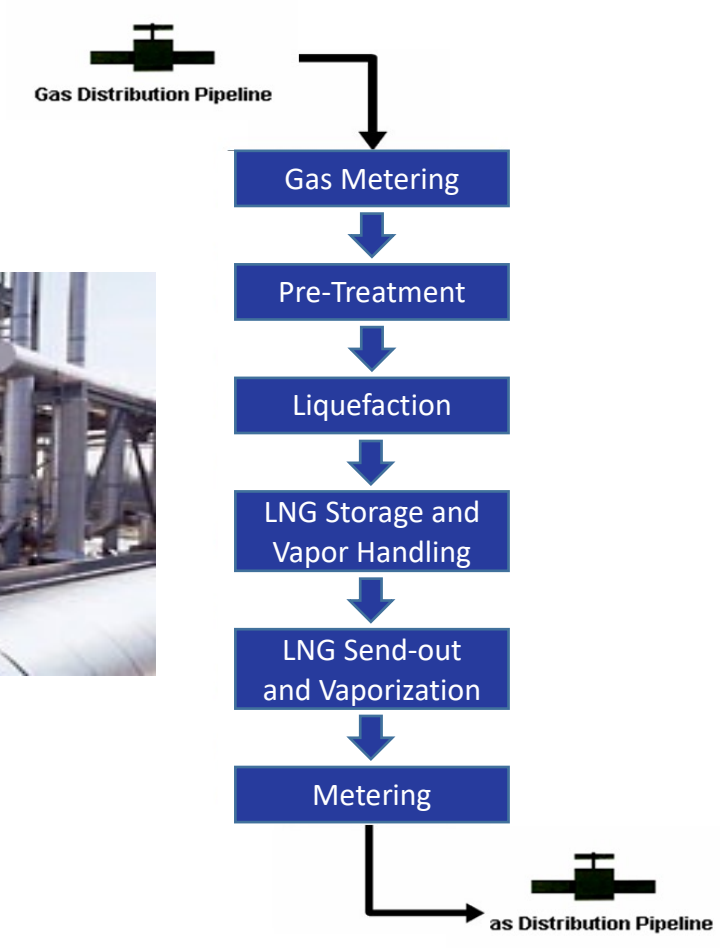
CB&I STORAGE - SMALL SCALE LNG OVERVIEW

CB&I STORAGE SOLUTIONS



Peak Shaving Facilities built by CB&I Storage Solutions 1965 to Present

CB&I STORAGE - SMALL SCALE LNG OVERVIEW



- Soil Conditioning and Remediation
- Site assessment studies
- Cost effective site layout
- Assessment of pre-treatment options and gas conditioning
- NG liquefaction with a variety of technologies
- LNG Storage configuration
- Vapor handling
- LNG Sendout options / Regasification / Truck Loading / ISO-container Loading / Trailer Loading / Marine Loading
- Cryogenic Piping Systems
- Plant Utilities & Infrastructure
- E&I / Process Controls / DCS
- Commissioning / Training

Full Range of LNG Capabilities

Anaerobic Digestion and RNG Production

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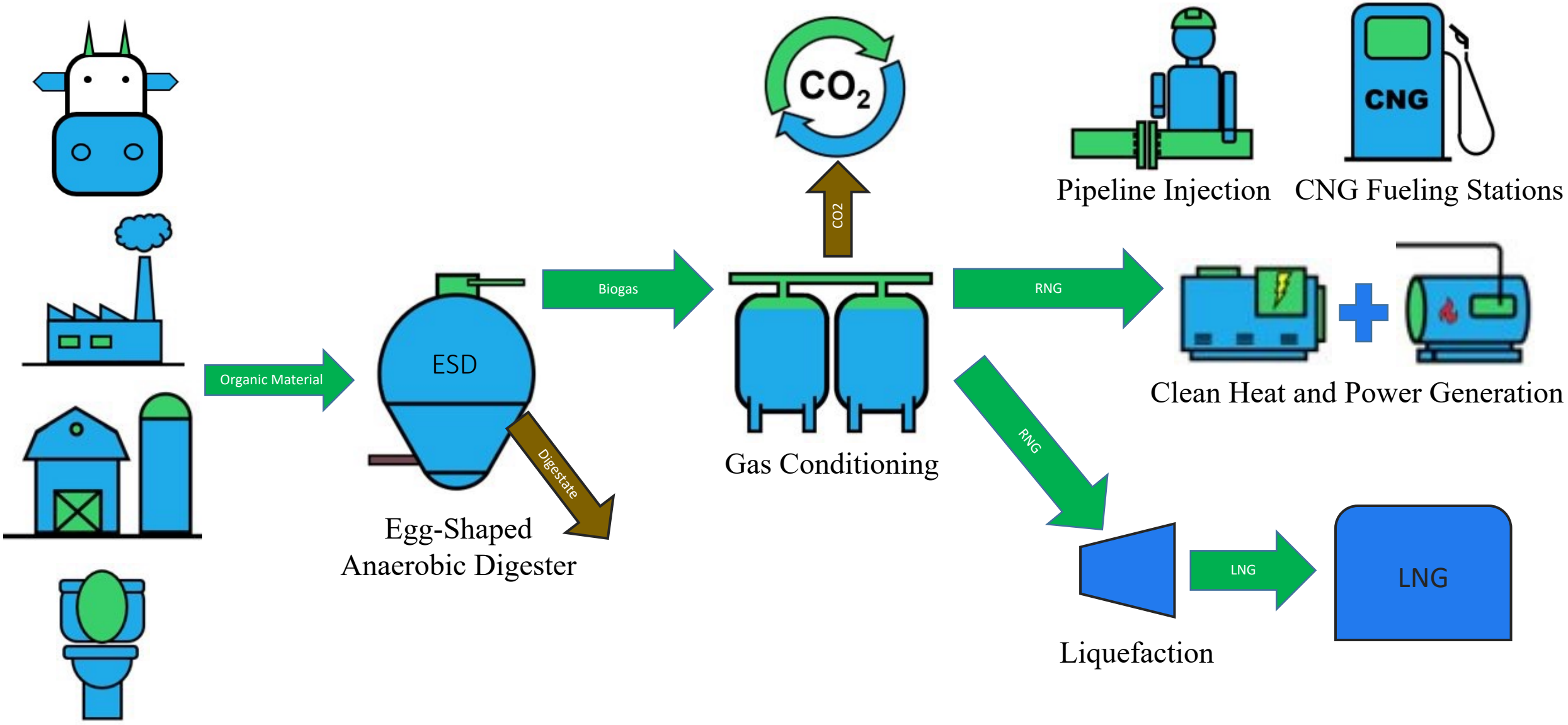
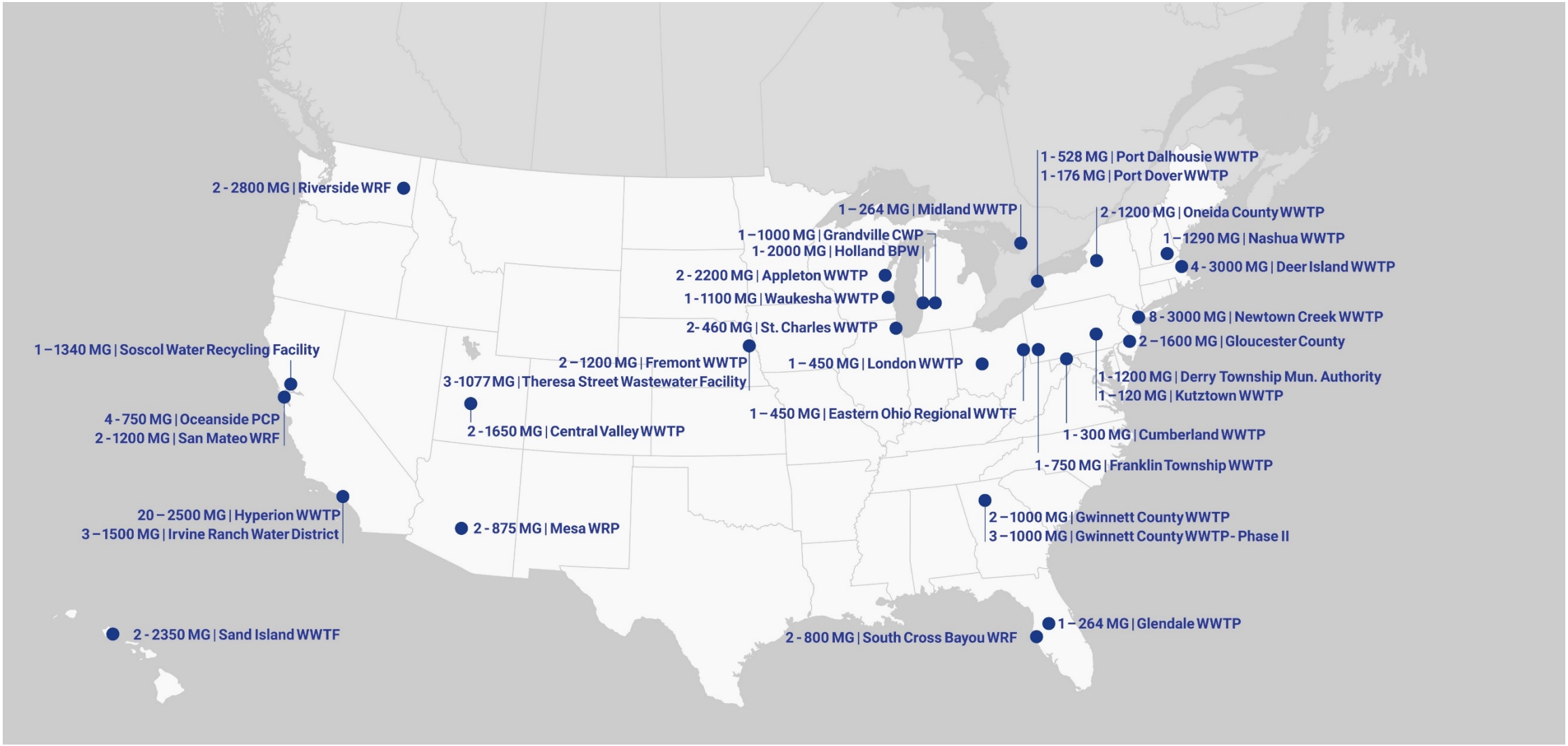
BASICS OF ANAEROBIC DIGESTION AND USES



CB&I STORAGE – DECADES OF RNG EXPERIENCE

CB&I STORAGE SOLUTIONS



Egg-Shaped Digesters 1989 to Present

EGG SHAPED DIGESTER BENEFITS

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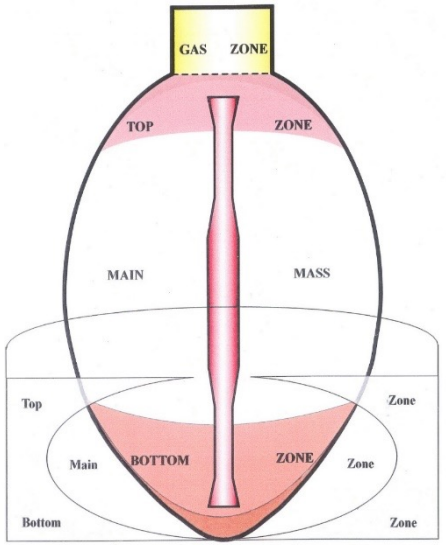
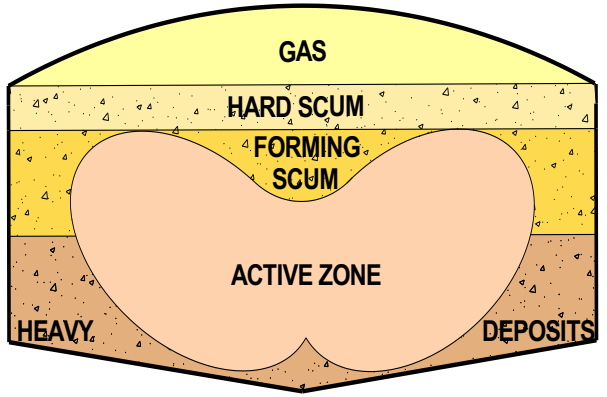
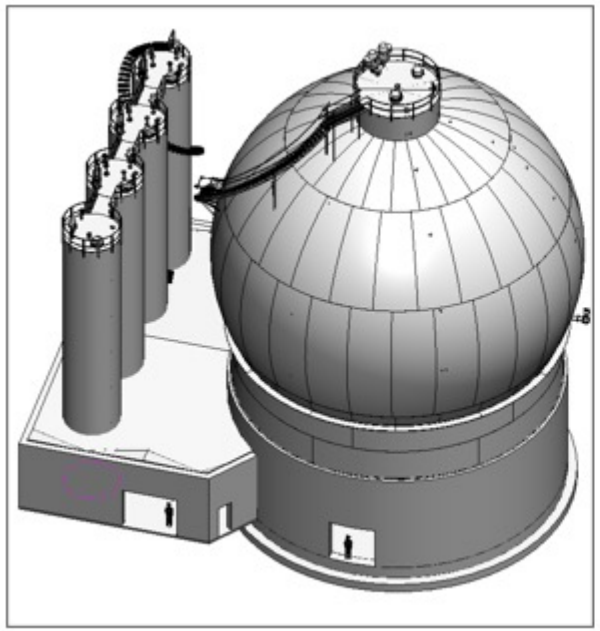
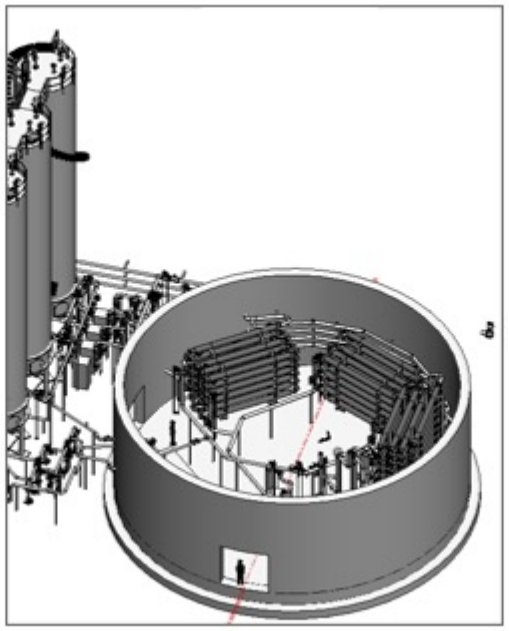
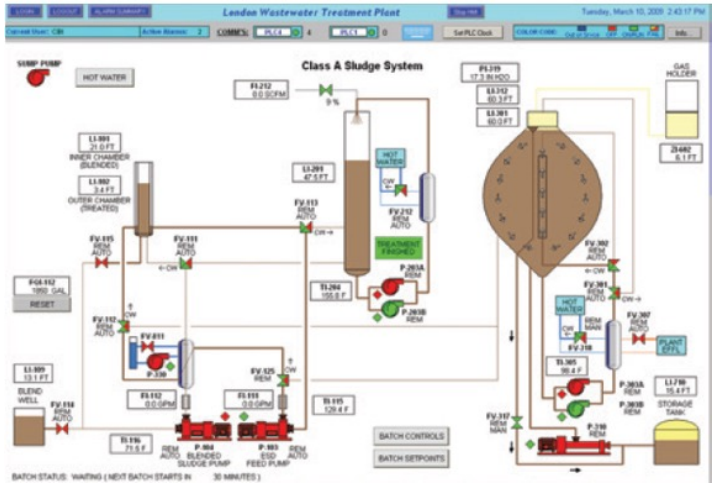
- Automated system
- Efficient Mixing
- Minimal Footprint





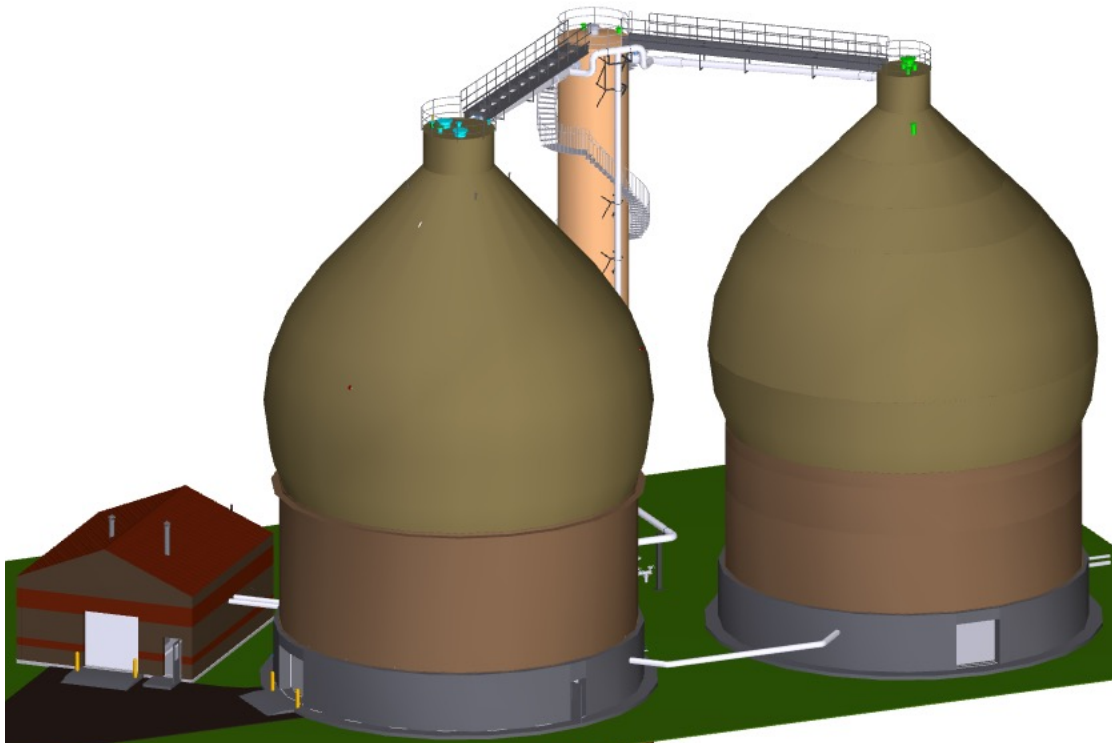






FREMONT NEBRASKA PROJECT PROFILE

CB&I increased the WWTP capacity to treat additional feedstock and enhance biogas production



CB&I Storage Solutions was the general contractor for this multi-discipline design build, materials and equipment procurement, construction, startup and commissioning project at the Fremont Nebraska Wastewater Treatment Plant (WWTP)

Features

- The original 1.2 MMG Egg Shaped Digester was built by CB&I in late 1990's.
- The second 1.2 MMG ESD was added in 2020 to handle additional agricultural waste.

FREMONT, NEBRASKA

Hydrogen

CB&I Hydrogen Expertise

Liquid Hydrogen Storage Spheres

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HYDROGEN GENERATION AND INFRASTRUCTURE

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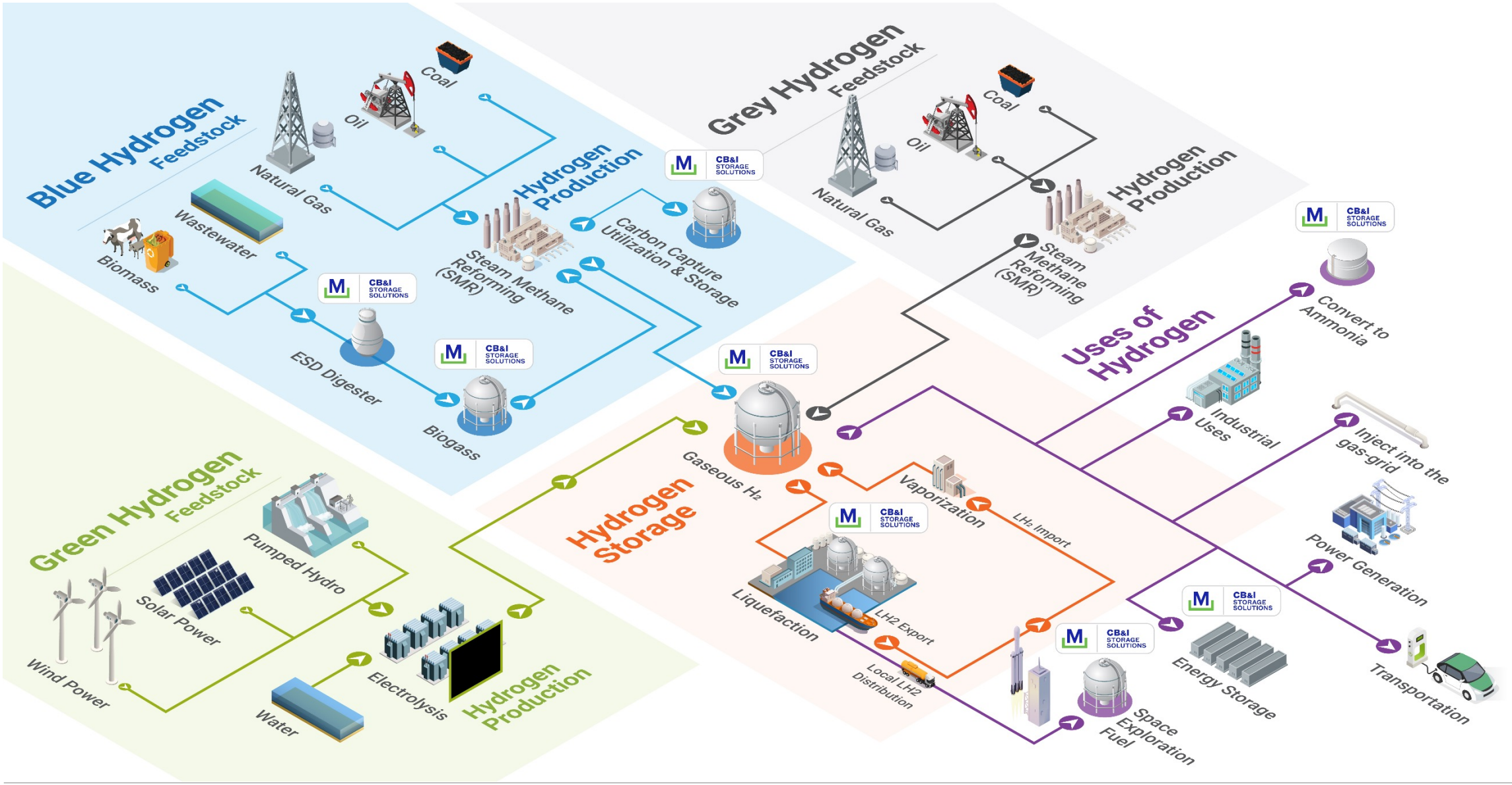
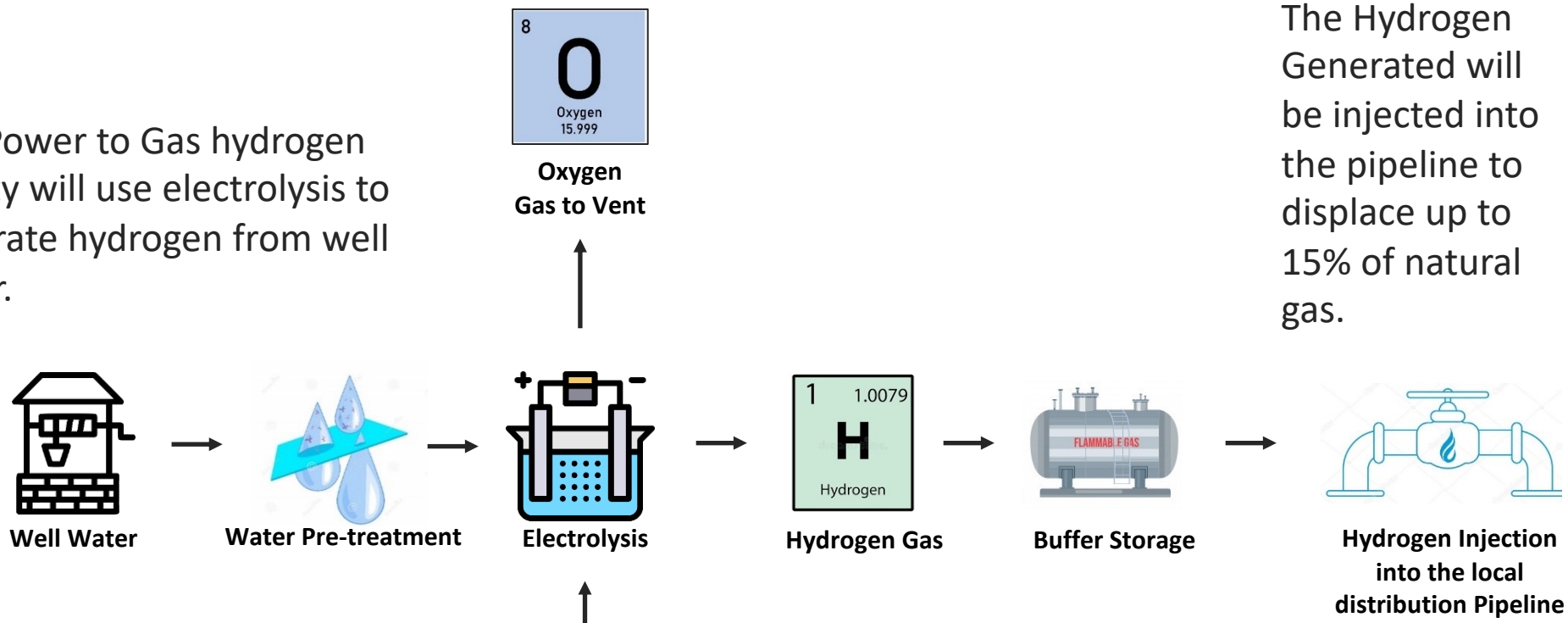


POWER TO GAS FACILITY SCHEMATIC – H2 INJECTION

The Power to Gas hydrogen facility will use electrolysis to generate hydrogen from well water.



The Hydrogen Generated will be injected into the pipeline to displace up to 15% of natural gas.

Some of the power required for hydrogen generation will be supplied by a new onsite photovoltaic system.

This facility is currently under construction for a Gas Utility Company in New Jersey. Commissioning is planned to begin shortly. Full operation this Fall.

SCHEMATIC OF GREEN HYDROGEN FUELED POWER PLANT

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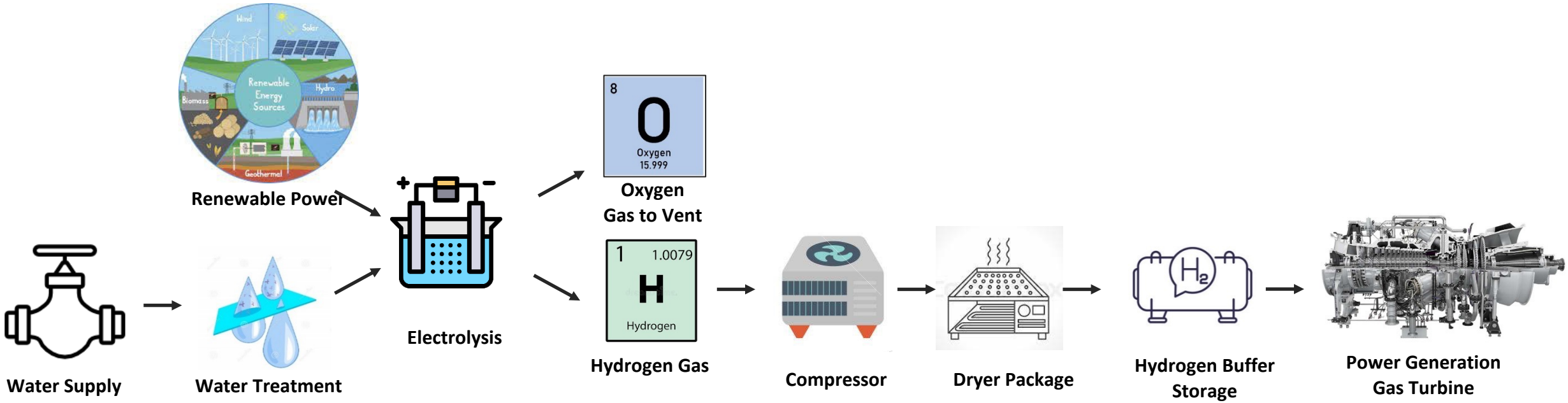
The facility will utilize renewable power to produce gaseous hydrogen for green fuel to produce electricity.

This conceptual facility is designed to produce nearly 24,000 kilograms per day of **green hydrogen**

- Other possible end products include hydrogen blending into natural gas grids, energy storage, liquid hydrogen for overseas shipment, etc.

The modular nature of the facility configuration allows for a wide range of scaling of the **green hydrogen** production, hydrogen storage and power generation to meet specific project needs

- Scalability long term allows for incremental 15 megawatts of 100 percent **green hydrogen**-fueled power generation to support grid-scale energy storage applications



GREEN HYDROGEN FUELED POWER PLANT CONCEPT

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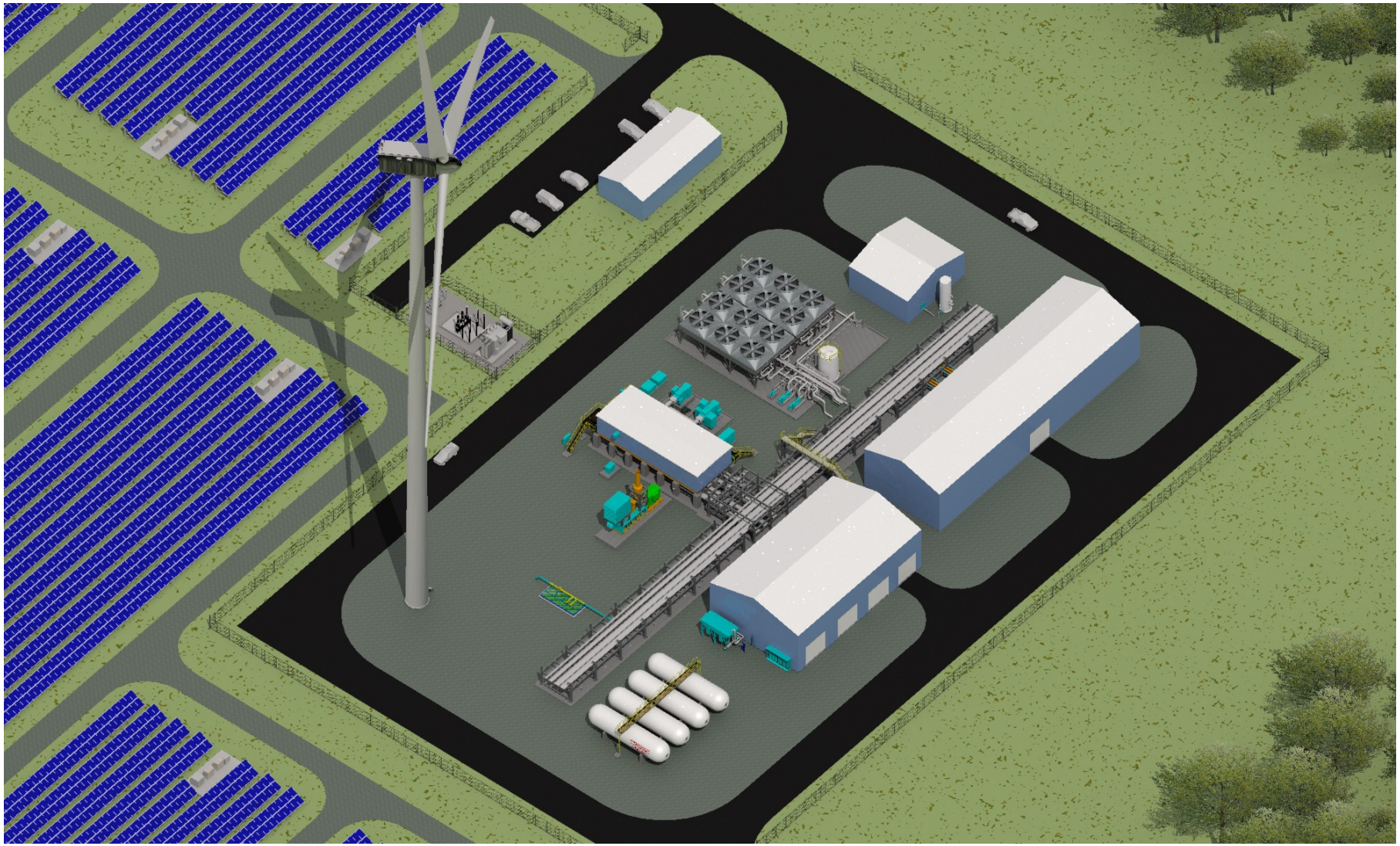

LIQUID HYDROGEN STORAGE EXPERIENCE

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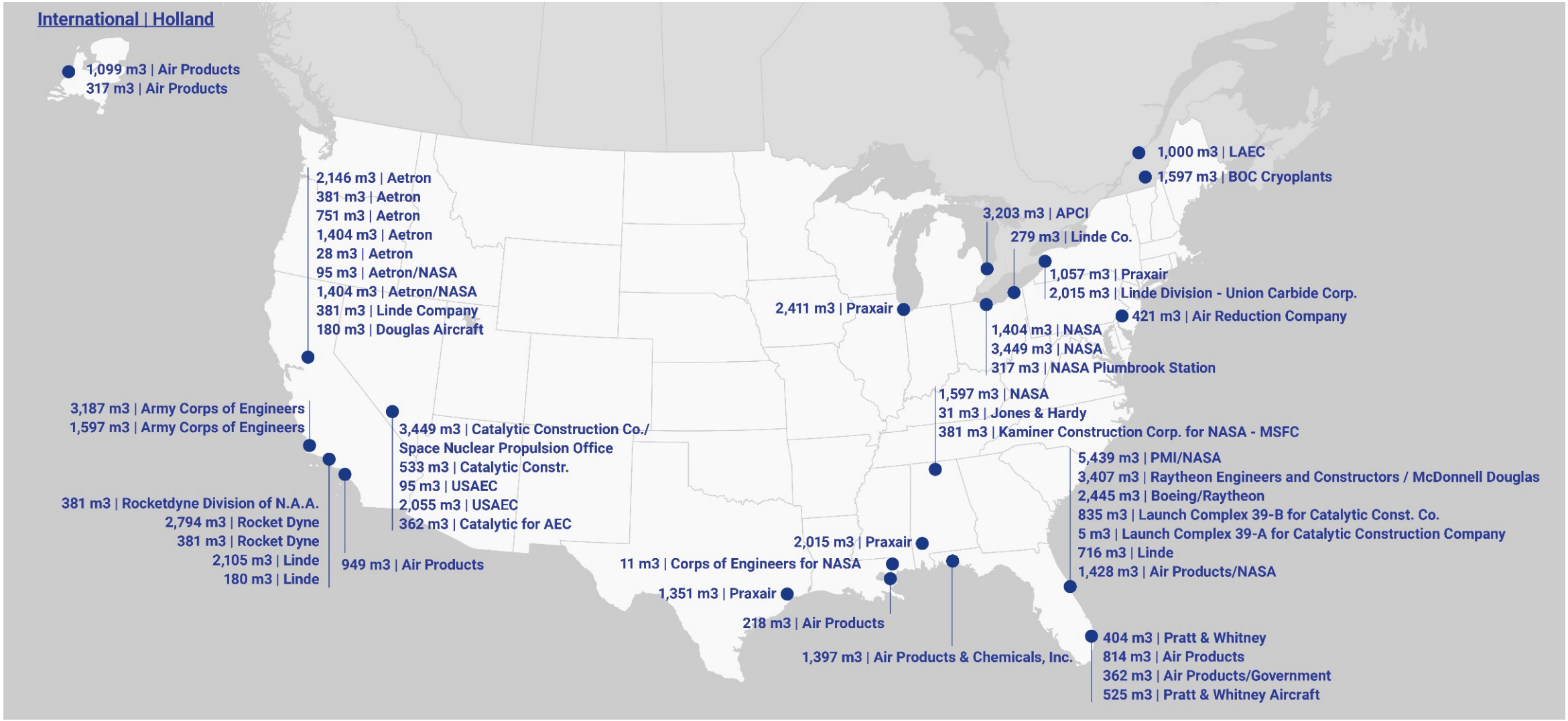

Liquid hydrogen storage built by CB&I Storage Solutions 1960's to Present

LH_2 Storage for NASA, Cape Canaveral, FL

CB&I STORAGE SOLUTIONS

Client: Precision Mechanical, Inc.
Location: Cape Canaveral, Florida
Services: Design, Fabrication & Construction
Size: 1.25 Million Gallons
Schedule: Summer 2021

Technological Advancements

- *Use of glass bubble bulk fill insulation instead of perlite to reduce boil-off*
- *Internal Integrated Refrigeration and Storage heat exchanger to keep hydrogen liquefied and minimize boil-off*

CB&I LIQUID H2 STORAGE STATE OF THE ART - 2021

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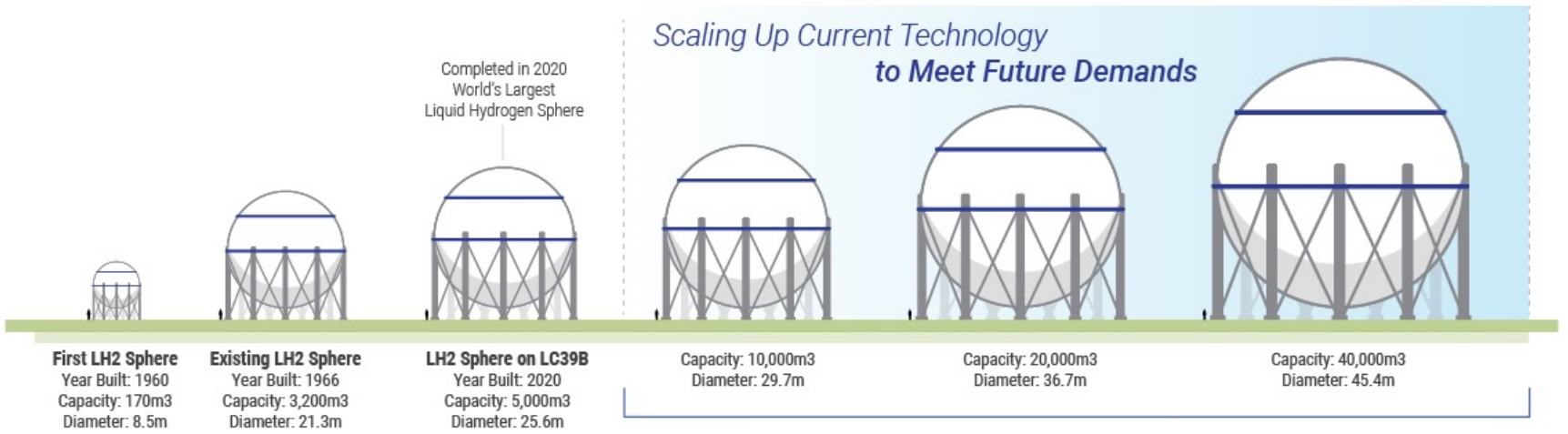

100,000m3
future capacity

Industry partners to develop feasible materials

Next generation insulation systems

Remove requirement for vacuum annular space

Build demonstration vessel to prove the technology

Extended Capacity Range We Can Now Offer

- CB&I Engineering performed a customer study to scale up existing liquid hydrogen storage technology (5,000 m^3) currently being used for NASA at Cape Canaveral.
- We developed special design techniques to scale up the 5,000 m^3 design up to 40,000 m^3
- CB&I Storage Solutions can now offer customers LH2 storage capacity up to 40,000 m^3
- CB&I has ongoing development for storage capacity above 40,000 m^3 under in-house R&D contracts
- An additional step is to develop up to 100,000 m^3 storage under the Shell/NASA/DOE 3-year development project 2021-23

1960 → 1966 → 2020 → 2021 Development → 2021 and Beyond

CO_2 / Carbon Capture

Refrigerated CO_2 Storage

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Gaseous and Liquid CO_2 Storage

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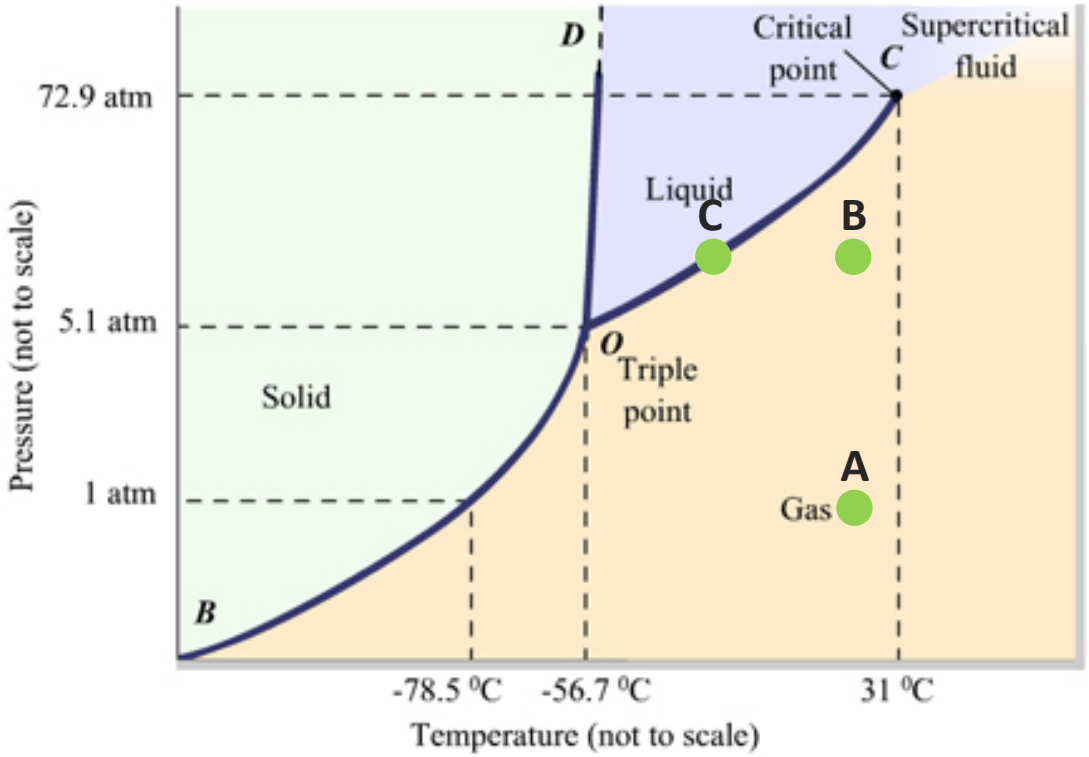
- **Sources of CO_2**
  - Captured during blue hydrogen production
  - Byproduct of ethanol & ethylene oxide production
  - Separated and captured during biogas upgrading to RNG
- **Industrial Uses**
  - Food & Beverage Industries – e.g. carbonated drinks
  - Oil & Gas – Enhanced Oil Recovery
  - Chemical Production
  - Fire Fighting Equipment

Gaseous and Liquid CO_2 Storage

CB&I STORAGE SOLUTIONS

- **Types of CO_2 Storage:**
  - Geological (Sub-surface) Storage
    - Stored in saline formations, oil & gas reservoirs, unmineable coal seams, and other underground formations
  - Storage cylinders
  - Refrigerated Pressure Vessels
    - Bullets (horizontal or vertical)
      - Double-wall, vacuum-perlite insulation in annular space
      - Single-wall, polyurethane insulation and outer casing
    - Hortonsphere® Spherical Pressure Vessels
      - Single-wall, insulated vessel

GASEOUS AND LIQUID CO_2 STORAGE



How many pressure vessels are required to store 2,800,000 cubic meters of carbon dioxide gas?

	Storage Phase	Volume (m^3)	Pressure (barg)	Temp (C)	Qty	Vessel Type	Diameter (m)	Length (m)
A	CO_2 Gas	2,800,000	0	21 C	---	---	---	---
B	CO_2 Gas	230,000	11.4	21 C	28	sphere	25 m	---
B	CO_2 Gas	230,000	11.4	21 C	800	bullet	2.4 m	60 m
C	CO_2 Liquid	4,700	11.4	-31 C	1	sphere	21.5 m	---
C	CO_2 Liquid	4,700	11.4	-31 C	16	Bullet	2.4 m	60 m

SAMPLE COMPARISON: 12,000 VS 15,000 M³

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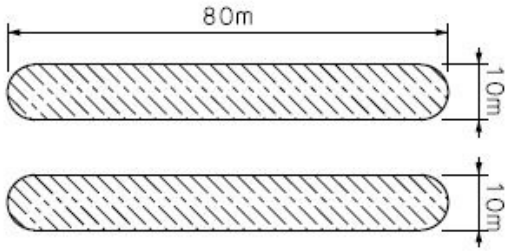
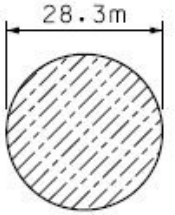
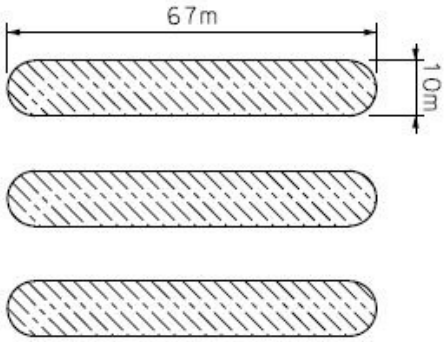
Design Conditions:

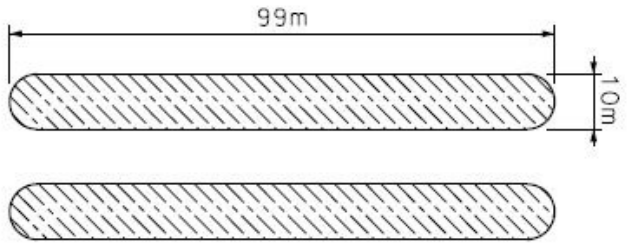
Pressure = 17.5 bar(g)
MDMT = -26° C
Steel: SA 738 Gr. B
Product = Liquid CO_2

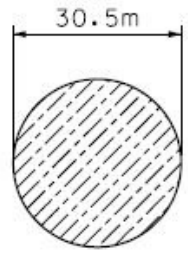




12,000 m³ STORAGE	36mm Thick Blimps w/ Hemi-Heads	50.8mm Thick Spheres
Quantity, Size, Thickness	(2) 10m dia. x 70m TL	(1) 28.3 m dia.
Total Weight of Pressure Boundary	1,321 Metric Tons	1,003 Metric Tons
Total Plot Area	90m x 30m	28.3m x 28.3m







15,000 m³ STORAGE	36mm Thick Blimps w/ Hemi-Heads		54.7mm Thick Spheres
Quantity, Size, Thickness	(3) 10m dia. x 57m TL	(2) 10m dia. x 89m TL	(1) 30.5 m dia.
Total Weight of Pressure Boundary	1,658 Metric Tons	1,643 Metric Tons	1,254 Metric Tons
Total Plot Area	77m x 50m	109m x 30m	30.5m x 30.5 m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