Ammonia pipelines: existing networks, future deployments, and safety considerations

WEBINAR

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SUNOCO LP

AMMONIA ENERGY ASSOCIATION

Tuesday, June 3

10AM EDT (4PM CEST)

House rules

- Please post your questions for the speakers in the Q&A section. Your questions will be answered by text by the speakers or will be discussed live.
- The recording of this webinar will be shared with all registrants after the webinar, and will be available at www.ammoniaenergy.org
- An article summarizing this webinar will be posted on www.ammoniaenergy.org in the coming days.

Ammonia Trade set to Scale-up

AMMONIA ENERGY ASSOCIATION

Around 45 million tons of ammonia (22% of production) is transported via various modalities, both domesticallly and internationally.

- Most of the ammonia is transported internationally via ocean going vessels, ~17-20 million tons of ammonia.
- Inland transport occurs via barges on rivers, via pipelines, via rail tank cars (RTCs) on rail, or via trucks on highways.

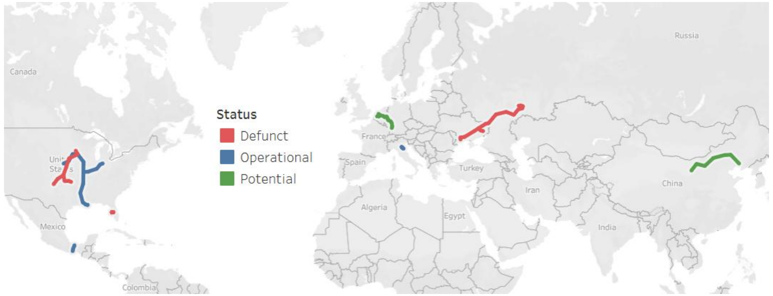
Ammonia trade is set to scale-up, because ammonia supply is decarbonized and ammonia is adopted as zero-carbon fuel and hydrogen carrier.

Modality	Medium	Distance	Ammonia capacity	Transport cost
Vessel (ocean going)	Ocean	○●●	○●●	€
Barges	River	●●○	○●○	€ €
Pipeline	Land	●●●	○●●	€ €
Rail tank cars	Rail (Land)	●●○	●●○	€ € €
Truck	Road (Land)	●○○	●○○	€ € € €

Ammonia Pipelines

Large volume, long-distance inland ammonia transportation can be performed by liquid pipelines. Ammonia is typically pressurized and transported in low alloy carbon steel pipelines.

- The **United States** has one operational ammonia pipeline, connecting 7 states in the US Mid-West (1.5 MTPA). Ammonia is used directly as a fertilizer in the US Mid-West. Two other ammonia pipelines have ceased operation.
- **Mexico** also operates one ammonia pipeline, to connect the Gulf of Mexico and the Pacific Ocean.
- Europe has various short-distance ammonia pipelines. The longest ammonia pipeline is 74 km, located in Italy (0.3 MTPA). A long-distance ammonia pipeline may be constructed from **The Netherlands** to **Germany** for energy uses and industrial uses.
- Inner Mongolia in **China** is a potential inland location for export-focused ammonia production via Water electrolysis coupled to renewables. In 2025, a 300 km pipeline was announced between Chifeng City and Jinzhou Port in North-East of China.



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H2 IMPORT
HYXCHANGE
LIQUID H2 STORAGE
ACE TERMINAL
AMMONIA CRACKERS
H-VISION
PORTHOS
CONDOR
NESTE 2
NESTE 1
MULTIPLHY
ENECO ELECTROLYSER
UNIPER
AIR PRODUCTS
GLOBAL ENERGY STORAGE
OCI
SAPPHIRE
BP
VTTI AMPLIPHY
VOPAK
UPM
CONVERSION PARK 2
MAAS H2
ZEEVONK
CONVERSION PARK 1
HOLLAND HYDROGEN 1
ELYGATOR
HYCC
HYNETWORK
AIR LIQUIDE
ADVARIO POWER2X
EXXON MOBIL
AIR PRODUCTS
CHANE
SHELL
HYTRUCKS
LOW EMISSION SHIPPING
WATERTAXI
SMART HYDROGEN HUB
BATTOLYSER
Design and Safety Aspects for large-scale Clean Ammonia Pipelines

Institute for Sustainable Process Technology

Ammonia Pipeline Safety

AEA Webinar 3 June 2025

Hans van ‘t Noordende

ISPT Mission

By 2050, we will have transformed to a circular and carbon neutral process industry. **Together.**

Institute for Sustainable Process Technology

Our strategy and impact

By creating a **trust-based** environment
we **connect** parties
and facilitate **sharing** of expertise and know-how in **joint projects**

12 programs

80+ projects

180+ partners

The project

Ammonia Pipeline Safety Project is a study of a virtual trajectory from Rotterdam to Germany.

Follow-up a ISPT Roadmap report: 7 mtpa NH3

Clean ammonia import and transport is needed in energy transition and decarbonisation

The aim is assessing if and how ammonia transport of large volumes over long distances in densely populated areas can be done safely.

Worst case scenario is full bore rupture and toxic gas cloud leading to disruption and fatalities

400 m
120m

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Methods and tools

Starting points → Design → Safety studies → Economics

Design:

- System design incl. pump and ESD valve stations, trench with single ammonia pipeline
- Design codes ISO 13623, NEN 3650-series, TRFL, (optional ASME B31.4)
- Cost estimate (Level V)
- QGIS for trajectory and elevations
- Steady state hydraulic simulations using UNISIM R480 for wall thickness
- Design factor 0.67, 1.4 MAOP
- No location classes, safety distances incl. risk reduction
- State of the art, next level

Safety studies:

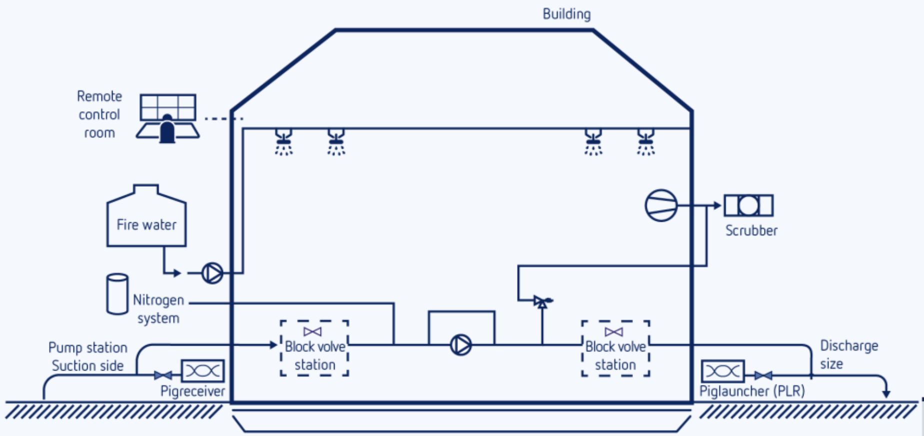
- Inherent safer design, prevention-mitigation, ER
- Bow tie, HAZID
- LOC scenarios: full bore rupture and leakage 20mm hole)
- Minimising Maximum Effect (Focus areas) (1100ppm/1h) for spatial planning and emergency response
- Location Specific Individual Risk (LSIR)<5m
- QRA dispersion model (SAFETI.NL 8.1)
- Avoidance principle and state of the art design (DE)
- Calculation Model V for reduction measures, failure frequencies and reduction factors (NL)

Pipeline design - Hydraulic analysis

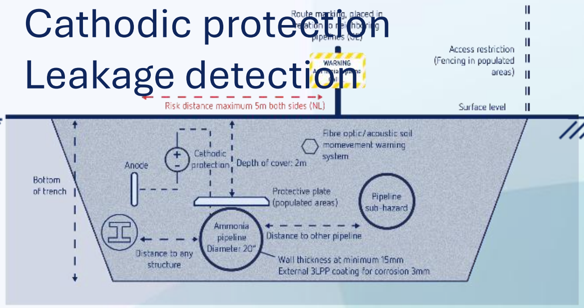
- Hydraulic analysis (UNISIM) performed to find the optimum pipeline diameter
- Single 32" pipeline at 50 barg design pressure, no intermediate pumping stations
- Proposed line size 20" at 50 barg, full length, 3 intermedeate pumping stations
- Alternatively, 18" at 100barg would require one intermediate pumping station less
- Line inventory reduces by factor 3

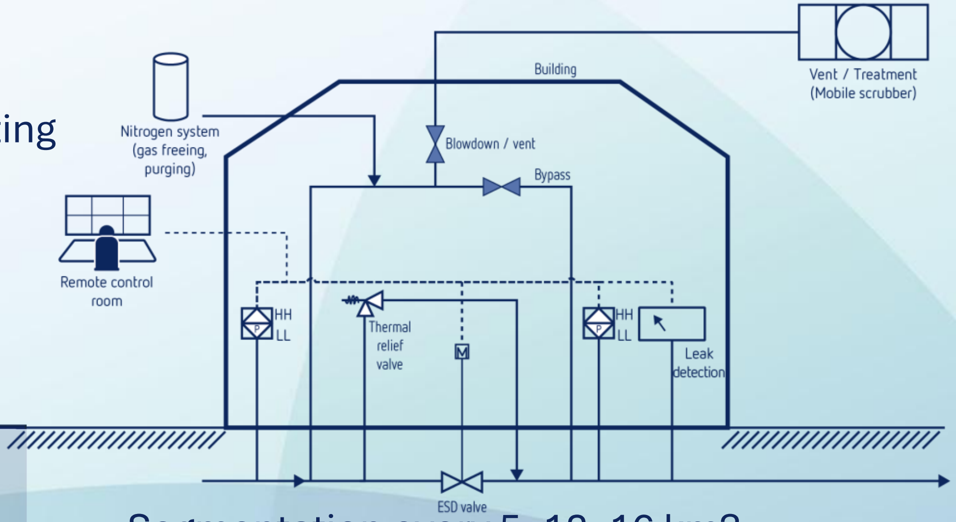
Line size [inch]	Design pressure [barg]	Velocity [m/s]	Wall thickness [mm]	# interm. pumping stations	Pumping power [MW]	Line inventory [mt NH3 /km]
32	50	0,75	15	0	-	298
20	**50**	**1,99**	**15**	**3**	**3**	**111**
18	100	2,57	19	2	3.3	86

PFD Ammonia Pipeline

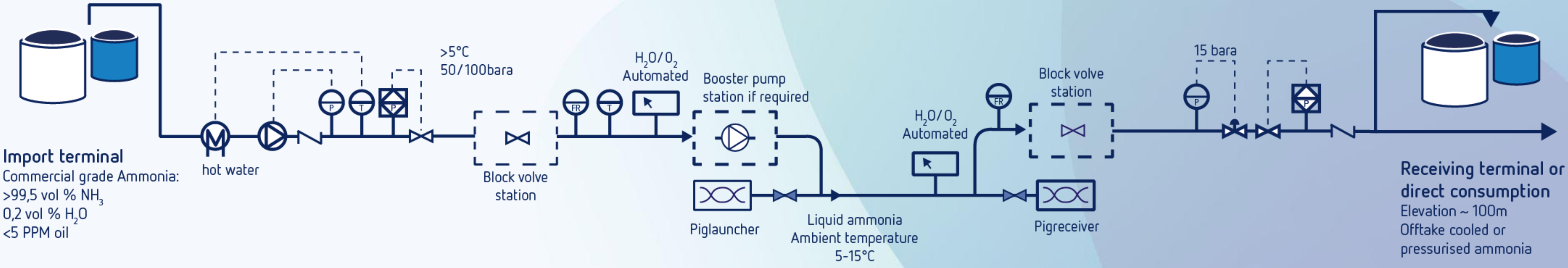


2m burial depth
No drilling/ digging, Sign posting
Fences or protection plates
Corrosion resistant, coatings
>=15mm wall thickness
Cathodic protection
Leakage detection

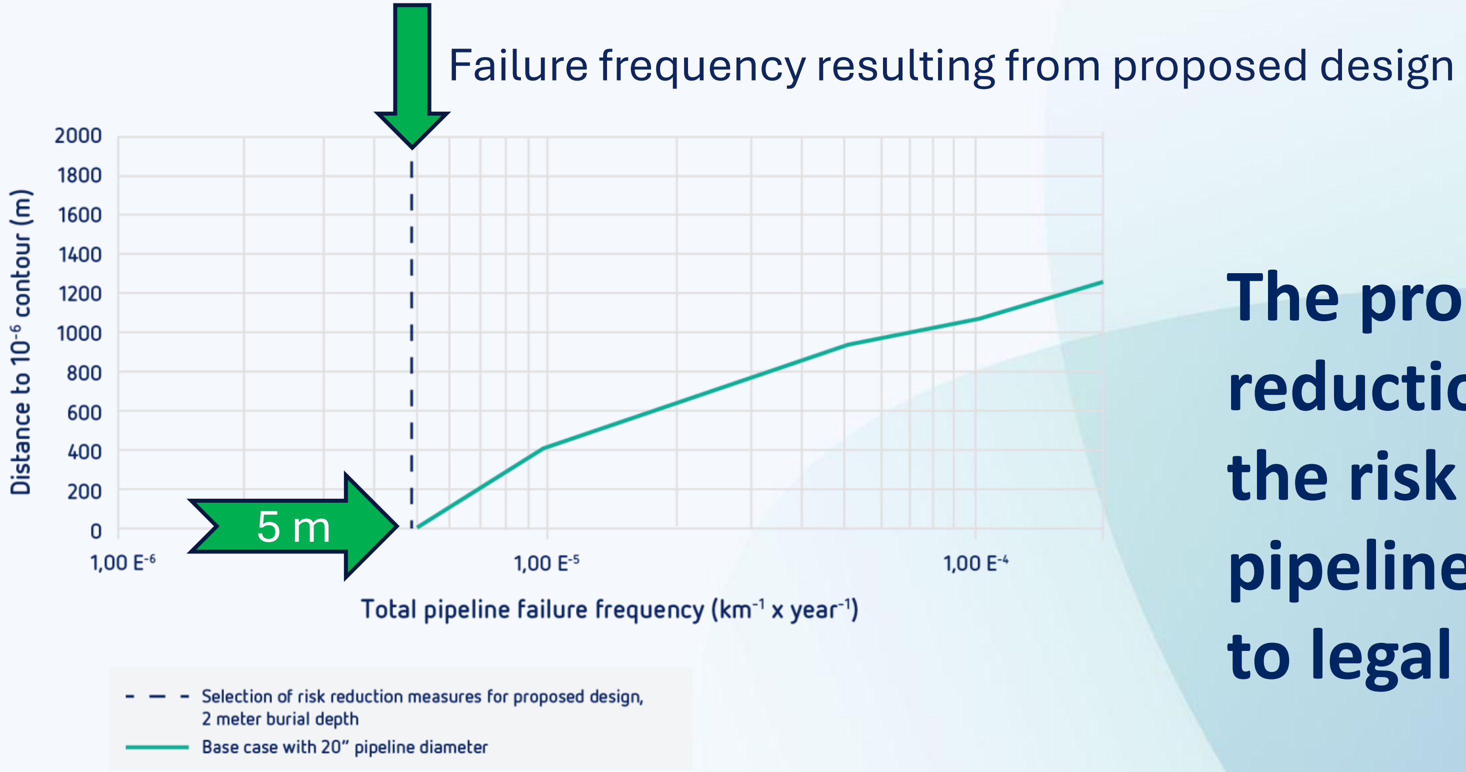




Segmentation every 5, 12, 16 km?
ESD response time, closing time?

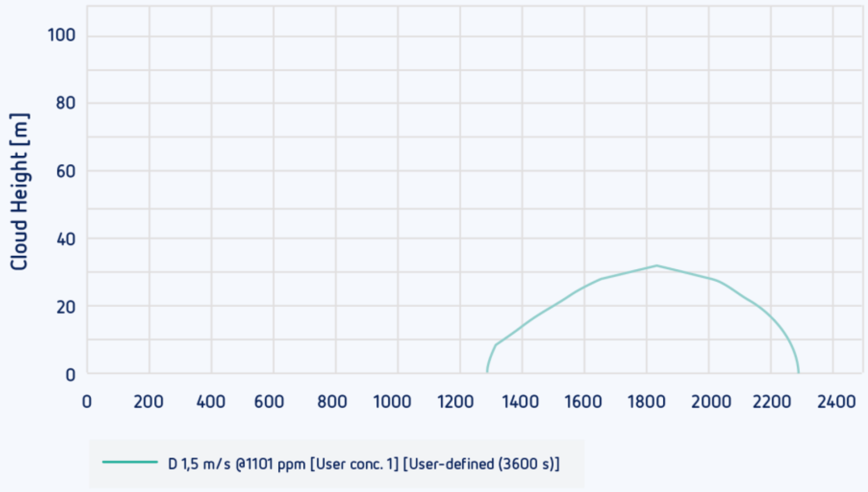


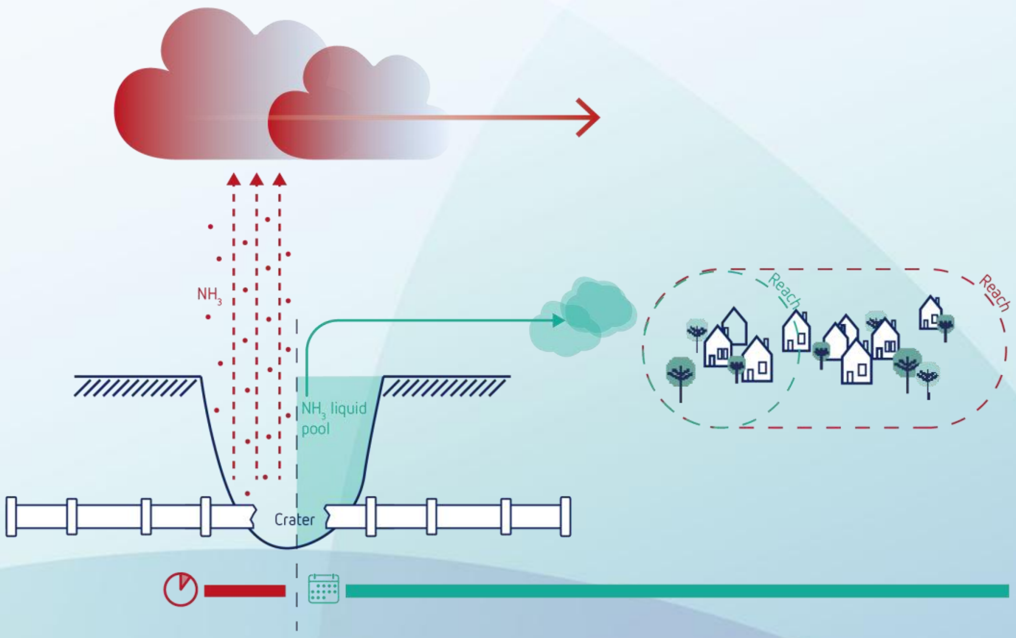
Impact failure frequency with regard to risk contour (LSIR) based on risk reduction measures



The proposed design and risk reduction measures enables the risk contour of a 20" pipeline < 5 metres according to legal requirements.

Thresholds and gas cloud





VBR Dutch intervention value

Alarm threshold value (Alarmeringsgrenswaarde AGW)

Dutch intervention values: LBW (lethal)

PGW/LOA 2 ppm	VBR 30 ppm	PEL 50 ppm	AGW 280 ppm	IDLH 300 ppm	LBW (8h) 400 ppm	LBW (1h) 1100 ppm	LBW (30 min) 1500 ppm

Level Odour Awareness (LOA) or publieke grenswaarde (PGW)

Permissible Exposure Limit (8h) PEL: 50 ppm

Immediately Dangerous To Life or Health (IDLH) Value

Focus areas

Max. effect as a function of segmentation distances, due to full bore rupture (20”)

ESD valve distance [km]	Max distance (at 1100ppm/1h) [km]	Duration for cloud concentration [s]	NH3 left >1800 s [tonnes)] (% of inventory)
5	1.9	2300	0
12	2.0	2800	720 (47%)
16	2.0	2900	1,200 (60%)

For the large scale ammonia service in this project it is suggested that protecting the population from a toxic ammonia cloud resulting from a pipeline rupture can best be achieved by reducing pipeline inventory, through:

- **reducing pipe diameters, in this study from 32” to 20”;**
- **utilising shorter, for example 5 km, segments between ESD valve stations combined with pumping stations.**

Economics

Table 8: Total CAPEX and OPEX [5]

Costs in Mio Euro (+100/-50% accuracy) for 18"/20" pipeline	Basic design, only standard measures, 1.2 m depth, 16 km distance ESD valve stations	Proposed design with all reduction measures (incl. additional) and 5 km distance ESD valve stations	Difference ~30%
Total CAPEX	1,600	2,100	500
Total annual costs	240	310	70

Table 9: Indicative Cost Breakdown [59]

Costs in Mio Euro	This project, proposed design and risk reduction measures
Pipeline	71%
Valve stations	21%
Pumping stations	2%
Protective plates	3%
Other	3%

Based on these figures, the transport costs are estimated at 0.50 EUR /ton H2 equivalent/km.

According to a European hydrogen backbone study (2021), and corrected for inflation and escalation, the transport costs for hydrogen today would also be around this figure of 0.5 EUR/ton H2/km.

Download

[Report: Clean Ammonia Pipeline Safety Study]

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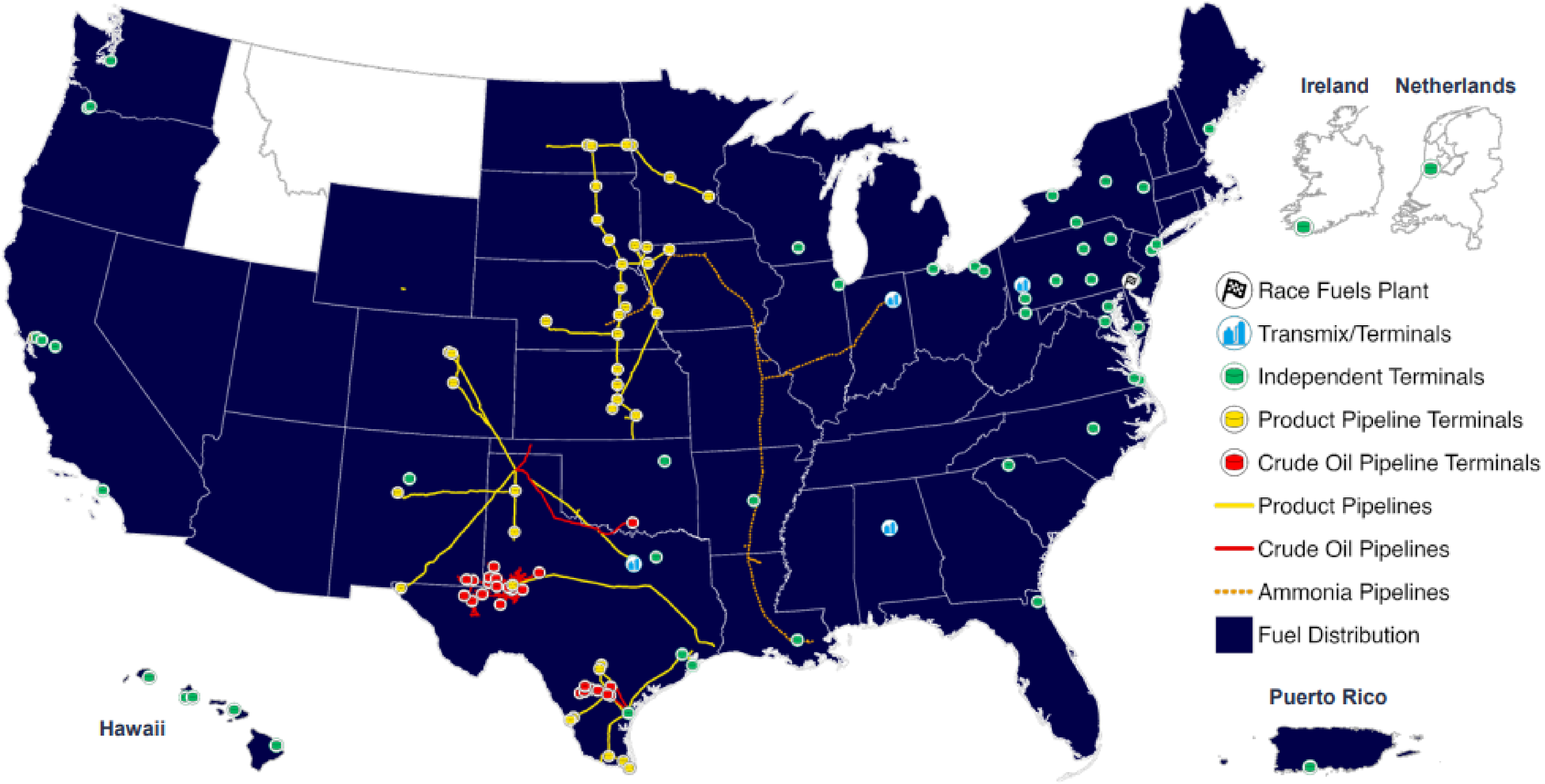
Thank you

SUNOCO LP

Ammonia Pipeline

June 2025

North America's Largest Independent Fuel Distributor and Leading Operator of Critical Energy Infrastructure



~9 billion	~7,400	~800	124	4	~14,000
Gallons Distributed	Branded Locations	Real Estate Assets	Terminals	Transmix Facilities	Miles of Pipeline

Sunoco LP Ammonia Pipeline

- Only interstate ammonia pipeline in the United States
- Approximately 2,000 miles long
- Construction completed in 1971
- Main trunk lines are 6", 8" and 10" diameter
- Common Carrier Pipeline regulated by Surface Transportation Board (STB)
- Construction and Operations adheres to U.S. Department of Transportaion Pipeline and Hazardous Materials Safety Administration (DOT-PHMSA) Code of Federal Regulations
- Transports approximately 1.5 million tons of anhydrous ammonia per year
- Currently connected to 5 origination locations and 28 destinations, which are all owned by third parties

Sunoco LP Ammonia Pipeline

- Ammonia transported as a liquid with maximum operating pressure of 1,340 psig

Ammonia Acceptance Specifications	
Temperature:	Not less than 35 degrees Fahrenheit, nor more than 85 degrees Fahrenheit
Ammonia (NH3) Content:	99.5 % minimum by weight
Water Content:	0.2 % minimum by weight
Oil Content by Weight:	5 parts per million maximum
Inerts:	0.5cc per gram maximum

- Utilizes Supervisory Control and Data Acquistion ("SCADA") System which is a control system that uses satellite communication to remotely operate the pipeline
- Control Center located in San Antonio, Texas is manned 24/7
- Integrity Management Program includes:
  - In-line inspections with smart tools
  - Valve and pump visual inspections
  - Cathodic Protection
  - Aerial Patrols
  - Pipeline replacement program

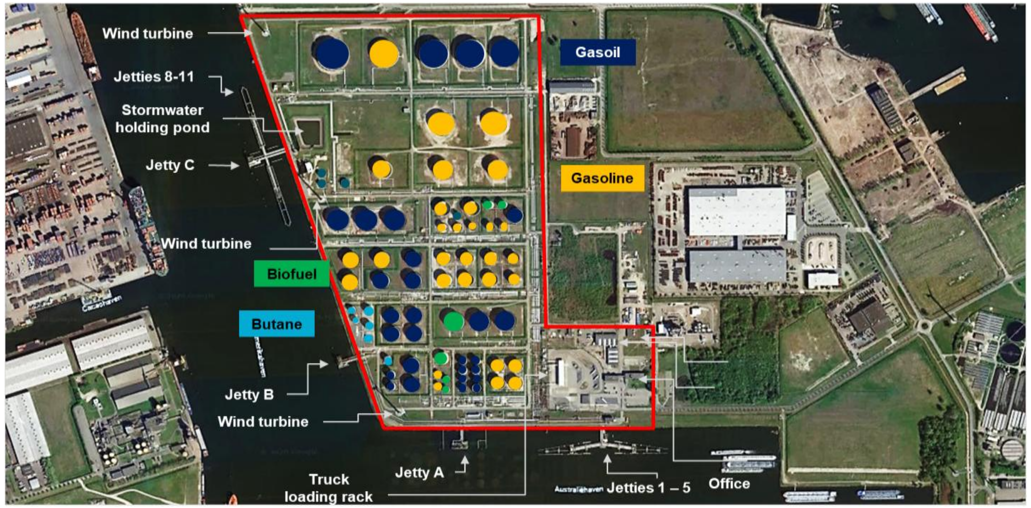
Sunoco Europe Terminals

Sunoco Amsterdam, Amsterdam, Netherlands

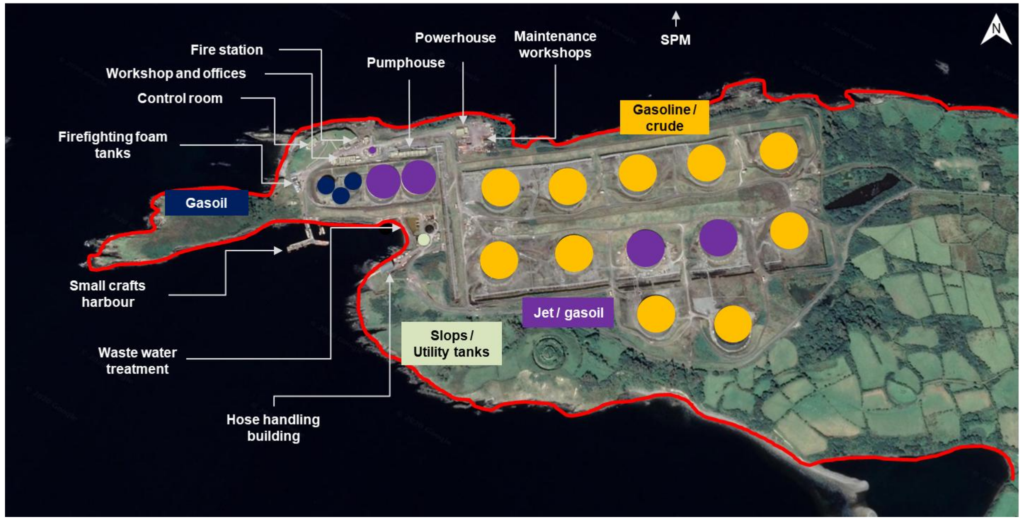
Sunoco Bantry Bay, Bantry Bay, Ireland

Sunoco Europe

- **Amsterdam Terminal Overview**
  - Located in the Port of Amsterdam, Netherlands
  - 73 hectares of leased land
  - 1.099 million m^3 of shell capacity
  - 69 tanks and 6 butane spheres
  - 3 sea-going vessel and 9 barge jetties
  - Well positioned for Ammonia placement or Ammonia to Hydrogen conversion/distribution
  - Co-located with Dutch & German HyNetwork, Dutch Firan Hydrogen System, & Linde OCAP Co2 Line for future connection
- **Bantry Bay Terminal Overview**
  - Port of Bantry Bay, Ireland
  - Capable of handling VLCC tankers
  - 142 hectares with room for expansion
  - 1.4 million m^3 of shell capacity
  - Number of Tanks: 17
  - Well positioned for Ammonia "break-bulk" into Europe
- **TanQuid Terminals Acquisition**
  - Sunoco is acquiring the largest storage operator in Germany, adding 15 terminals in Germany and 1 in Poland- many with river access for potential ammonia distribution.



Amsterdam Terminal



Bantry Bay Terminal