Ammonia Transportation, Distribution & Logistics

Argonne National Laboratory

October 14, 2005

Greg Hutchison
Managing Director Logistics

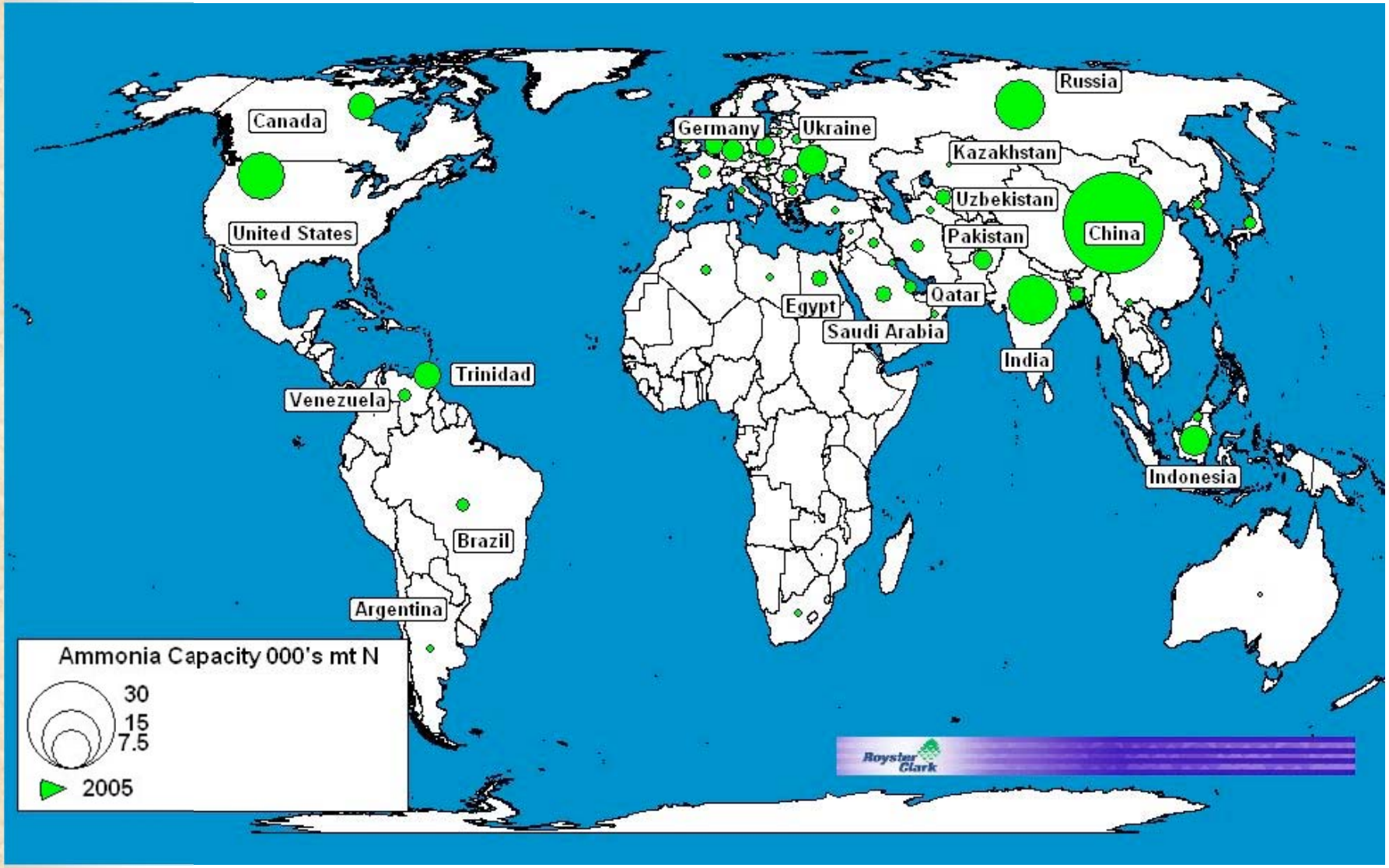
Agenda

- World Supply > Growth > Trade Flows
- Economic Issues Trade Ammonia
- North American Industry
- North American Transportation, Distribution, and Logistics
- What is NH3?
- How is NH3 transported & stored? By mode

Ammonia World Capacity Key Producing Areas

- China
- Russia Ukraine
- EEC
- USA
- Canada
- Middle East
- Indonesia
- Trinidad

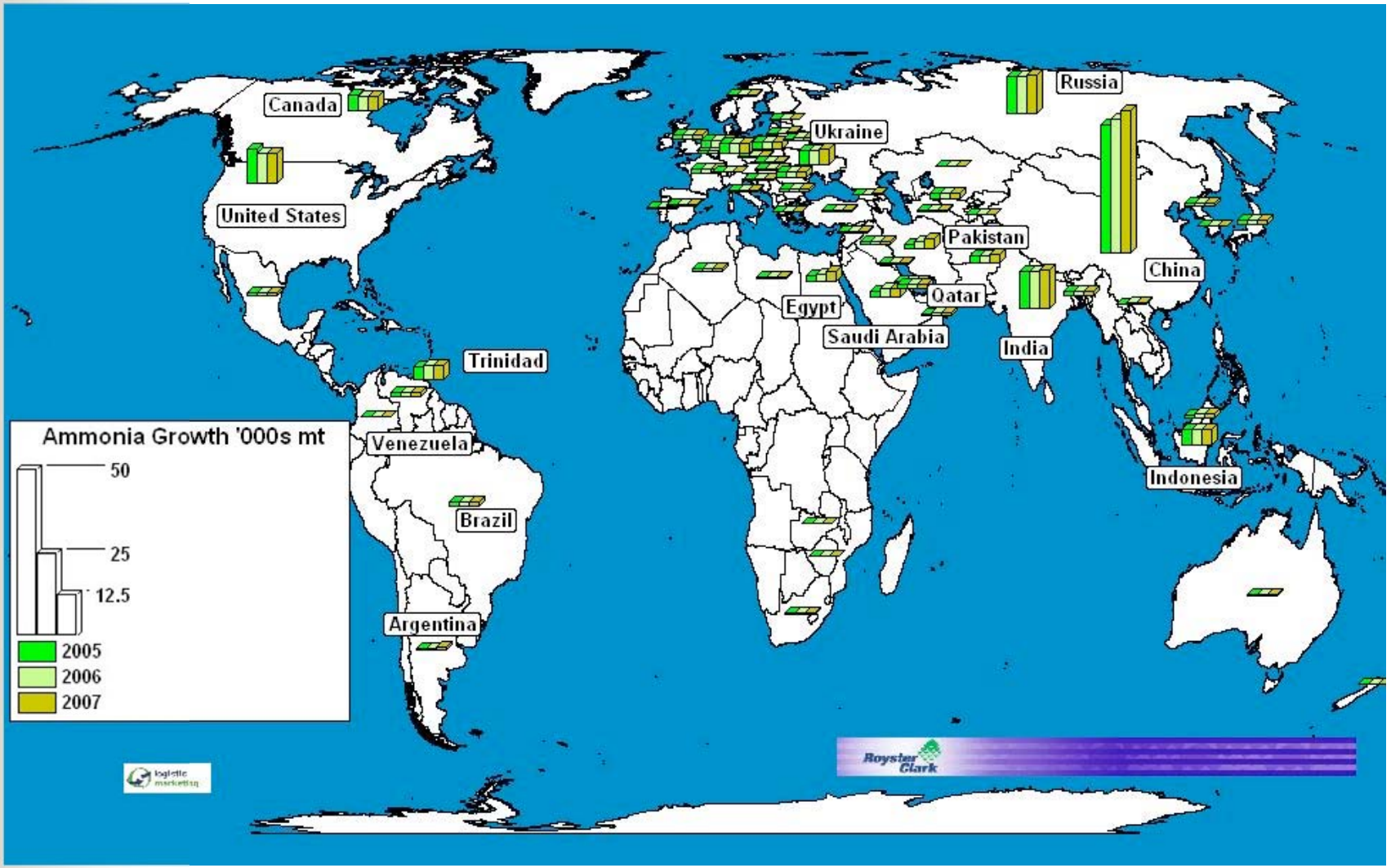
World Capacity



Forecast World Growth

- Production Dependent Upon Gas Costs
  - Middle East, Indonesia, Trinidad
- Developing Economies
  - China, Russia, India

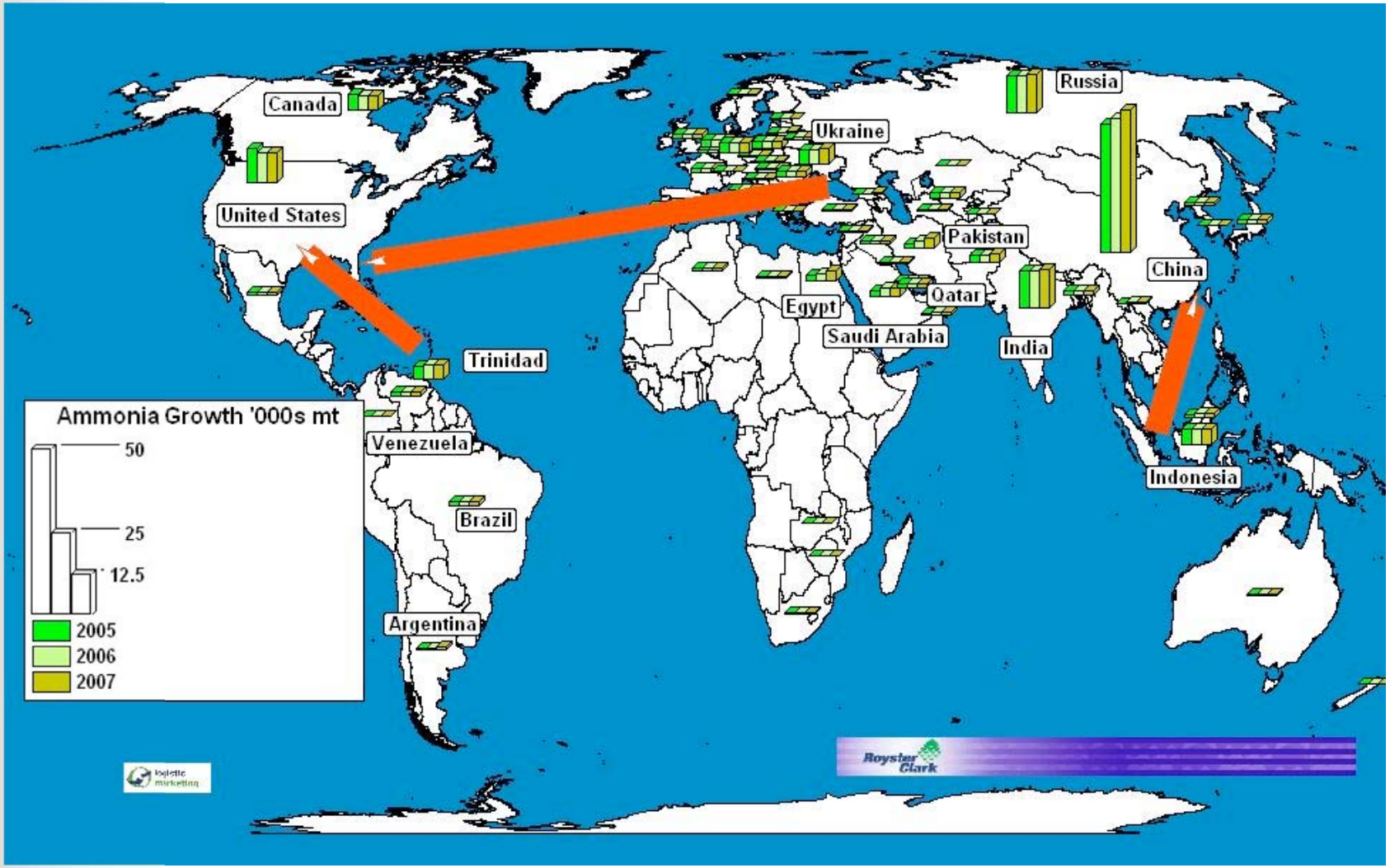
World Growth



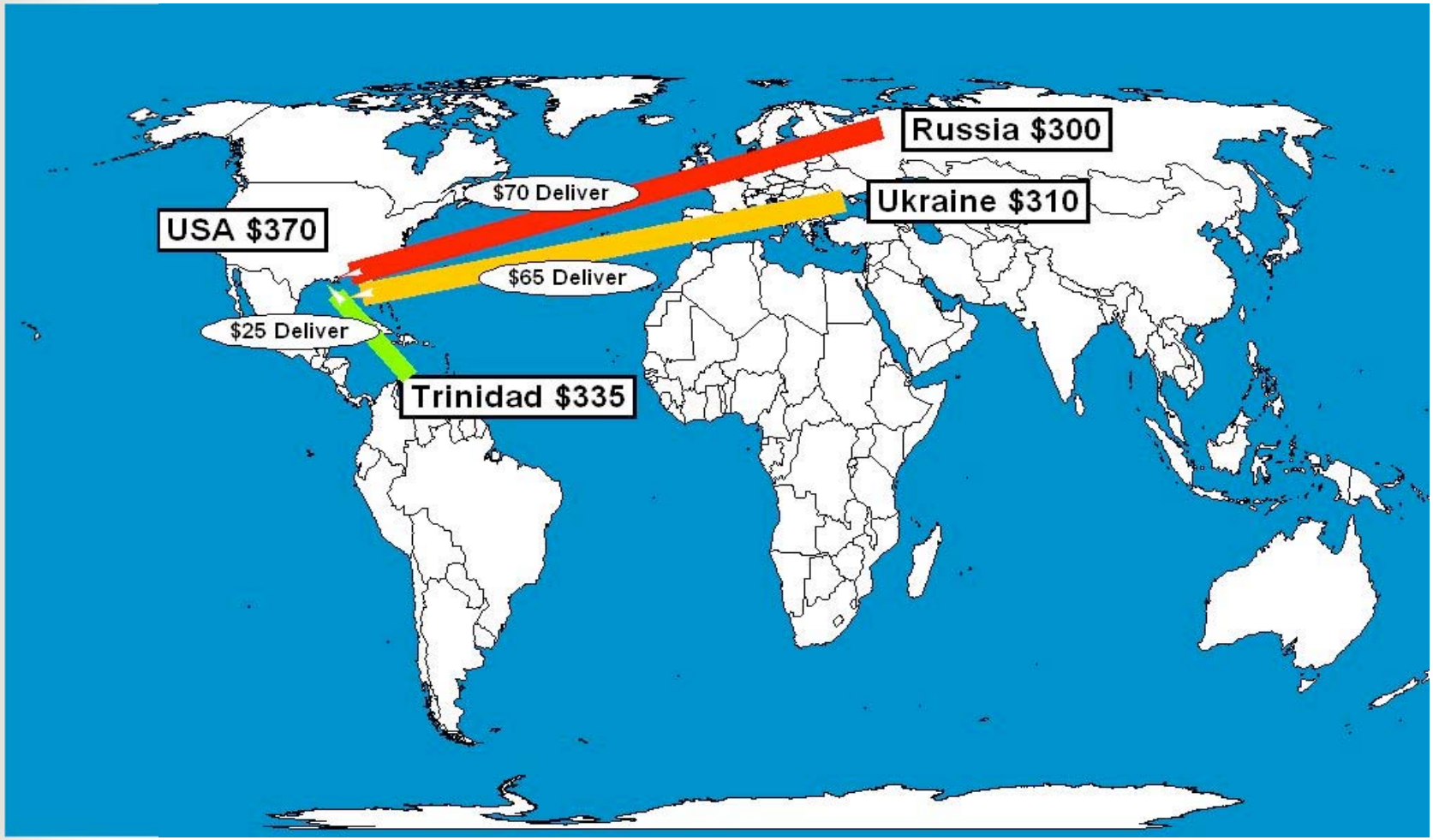
Trade Flow Issues

- Supply : lower gas production costs
- Demand : agriculture, industrial
- Gas price regional
- Storage terminals compressed gas
- Hazardous material
- Expensive to handle

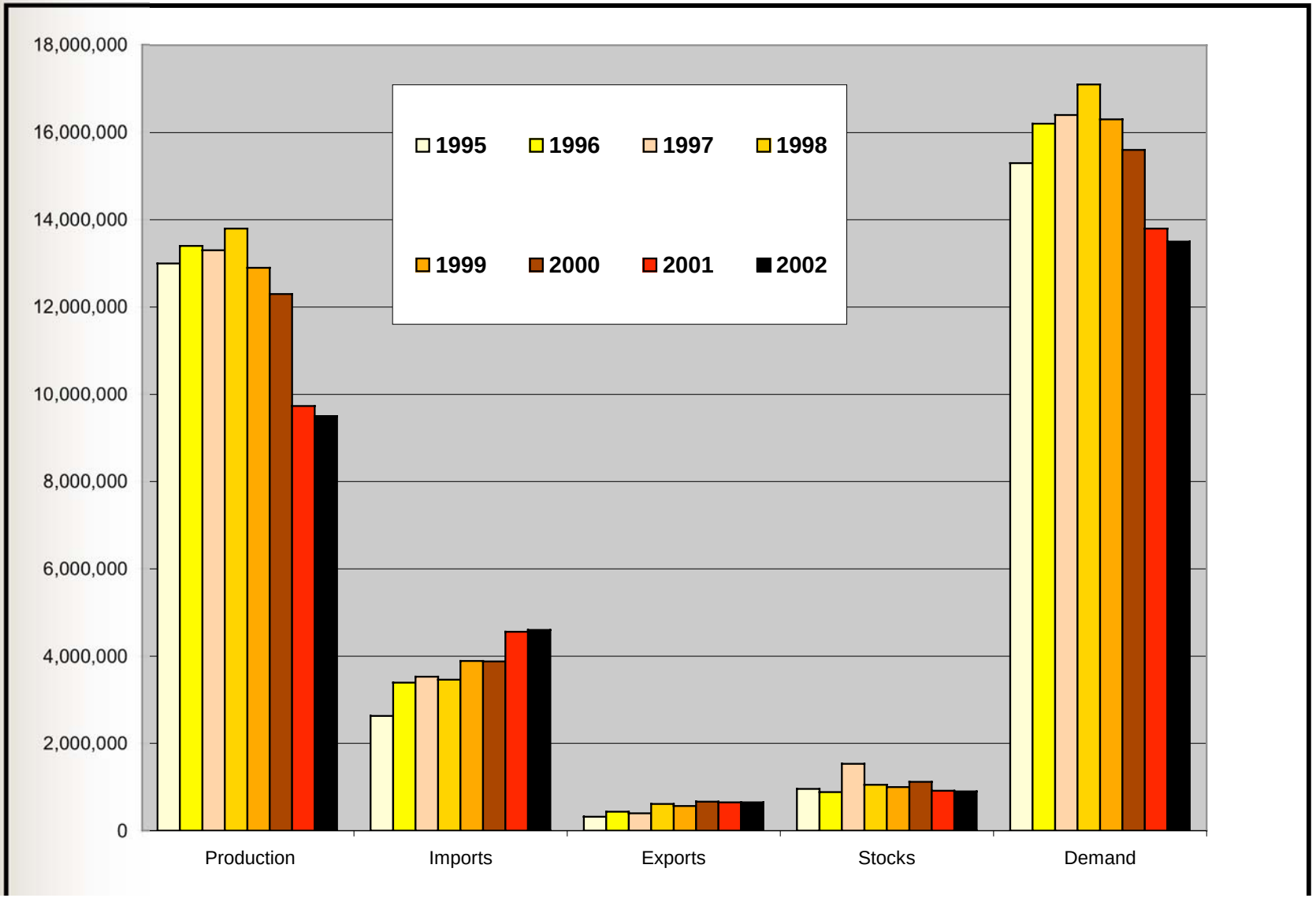
World Trade Flows



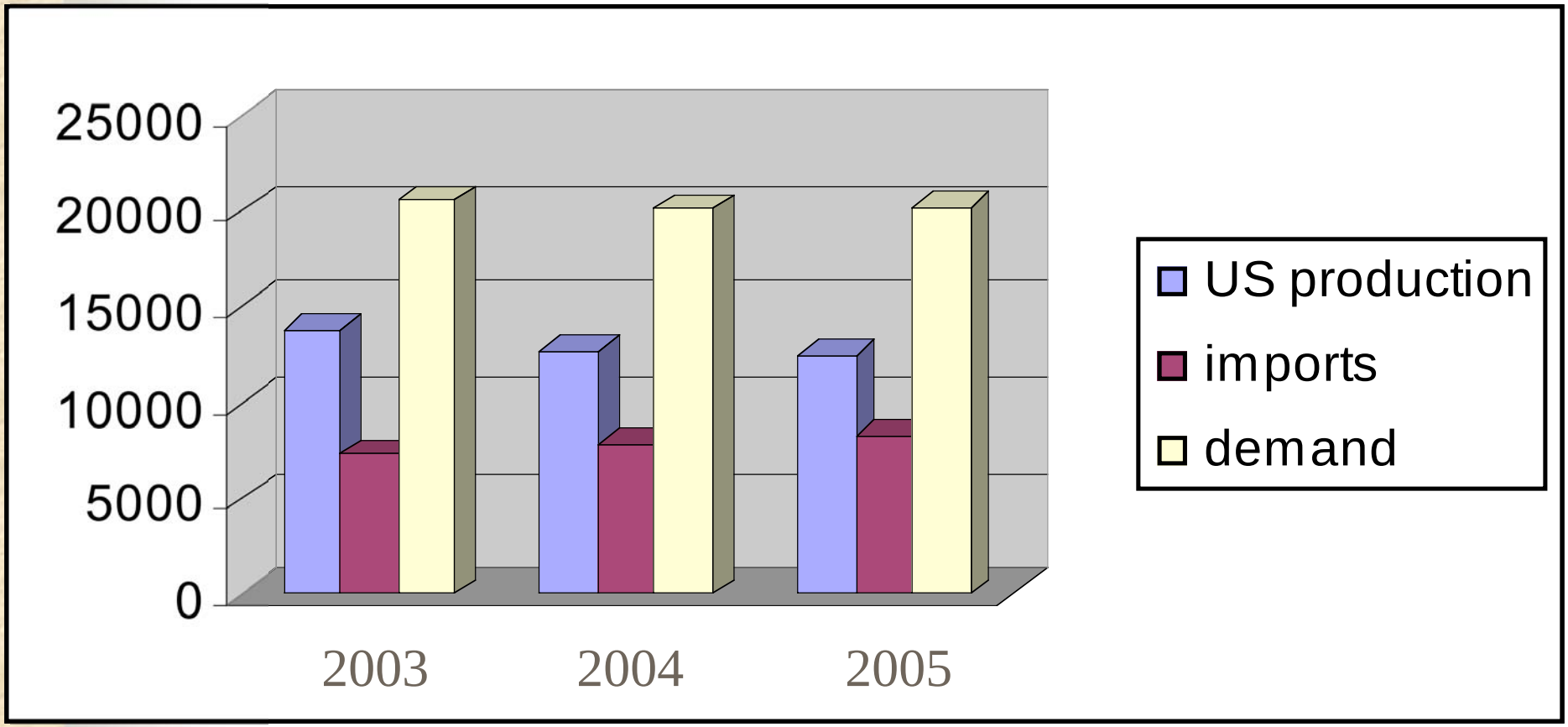
Estimated Ammonia Costs Delivered to Mississippi River



USA Ag Ammonia Supply - Demand



USA Ammonia Supply - Demand

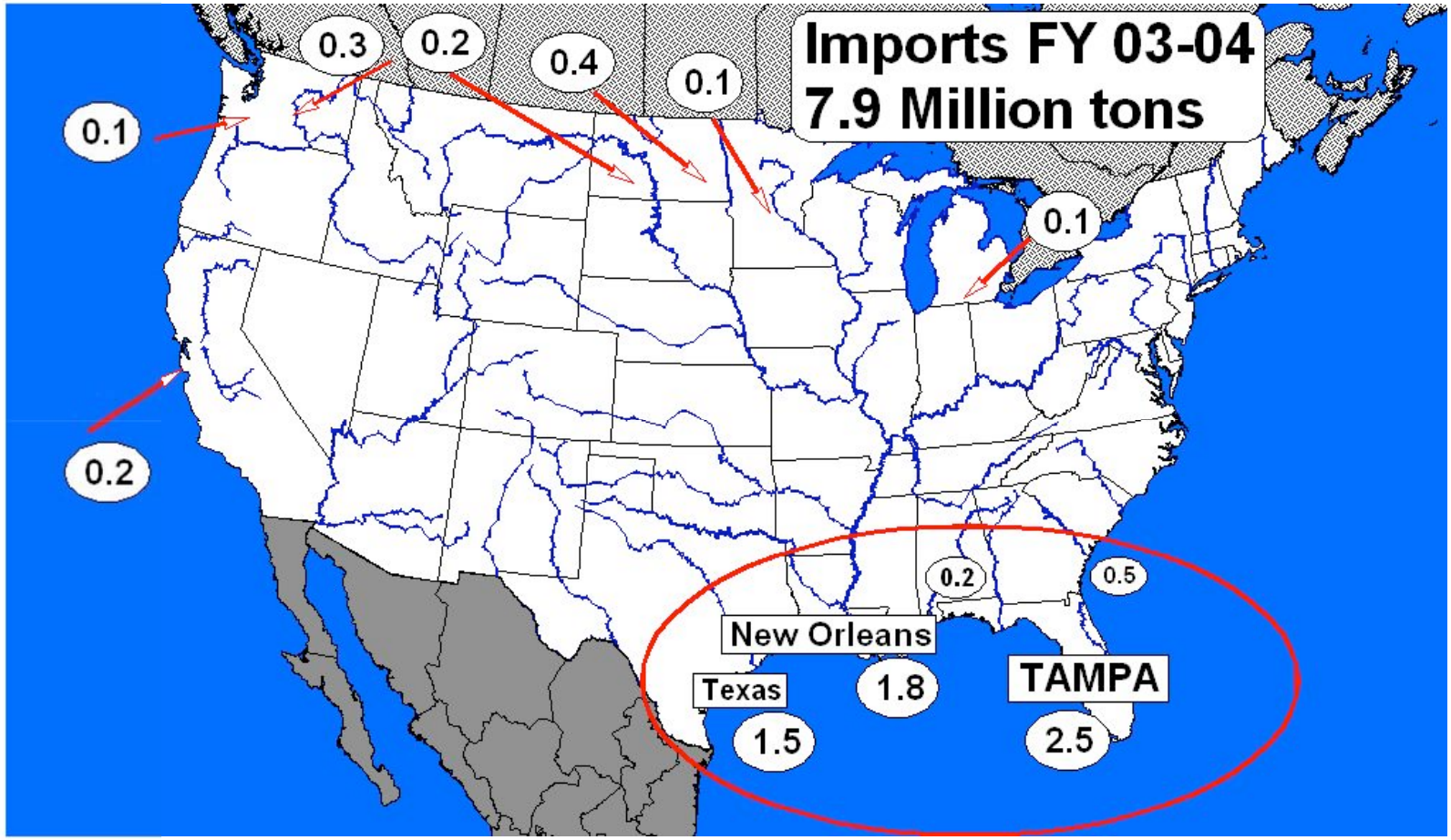


US Ammonia Imports

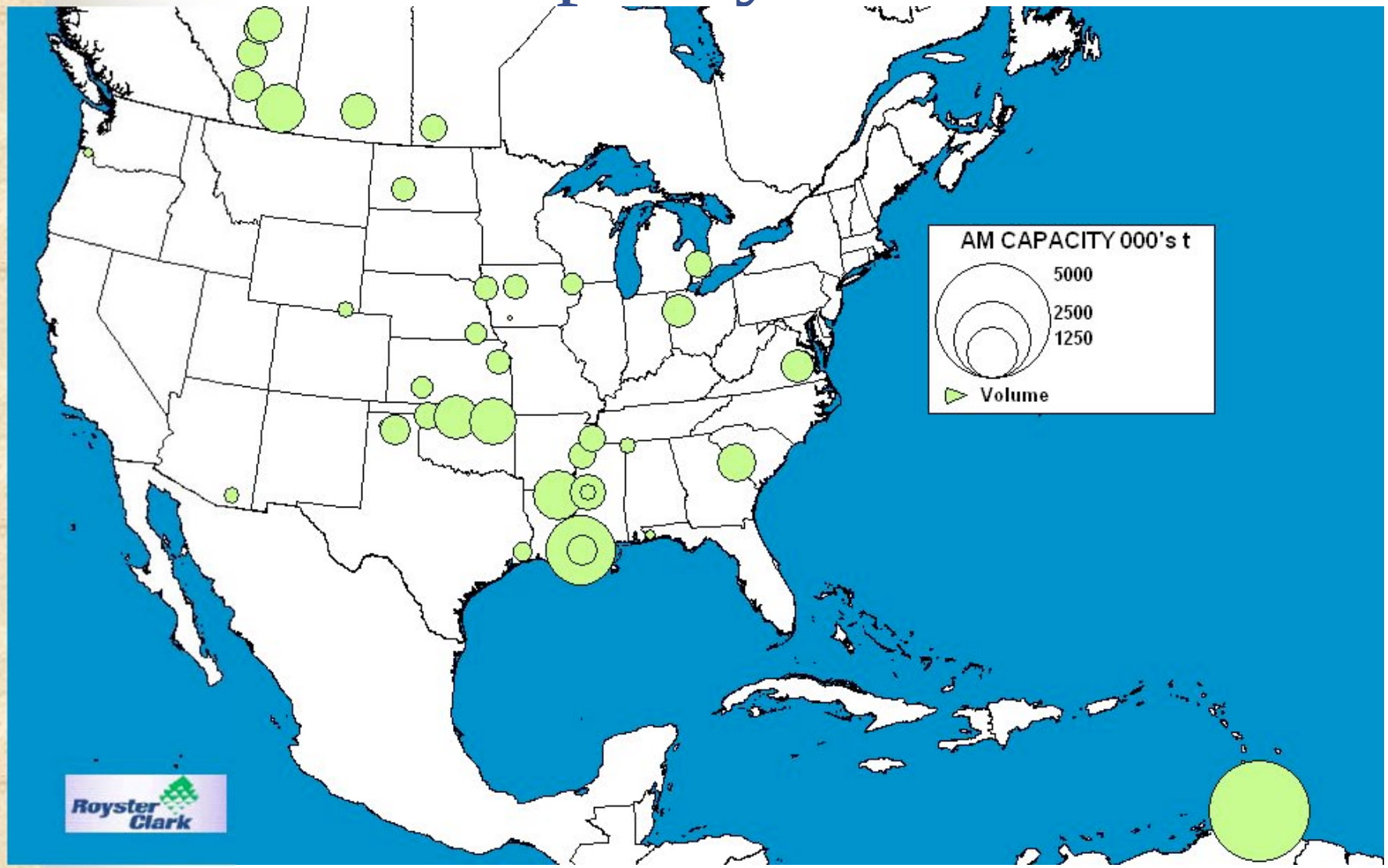
(million's of tons of ammonia)

Source	2002/03	2003/04	2003/04 Share %
Trinidad	3.8	4.2	53%
FSU	1.7	1.7	21%
Canada	1.3	1.3	17%
Venezuela	0.3	0.3	4%
Middle East	0.1	0.1	1%
Others	0.1	0.3	4%
Total	**7.3**	**7.9**	**100%**

Ammonia Imports by Region



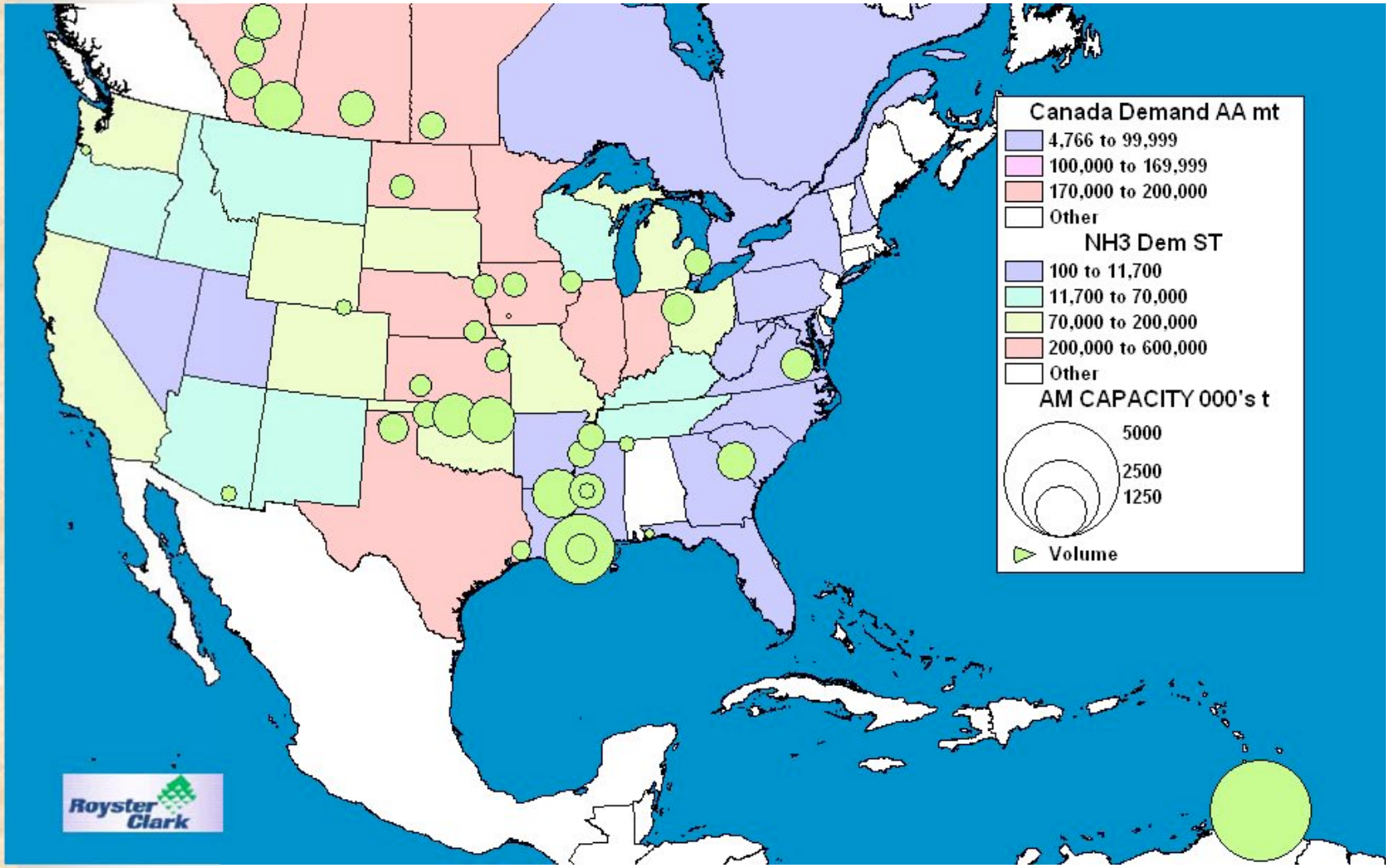
NA Base Capacity



NA Capacity Shutdown

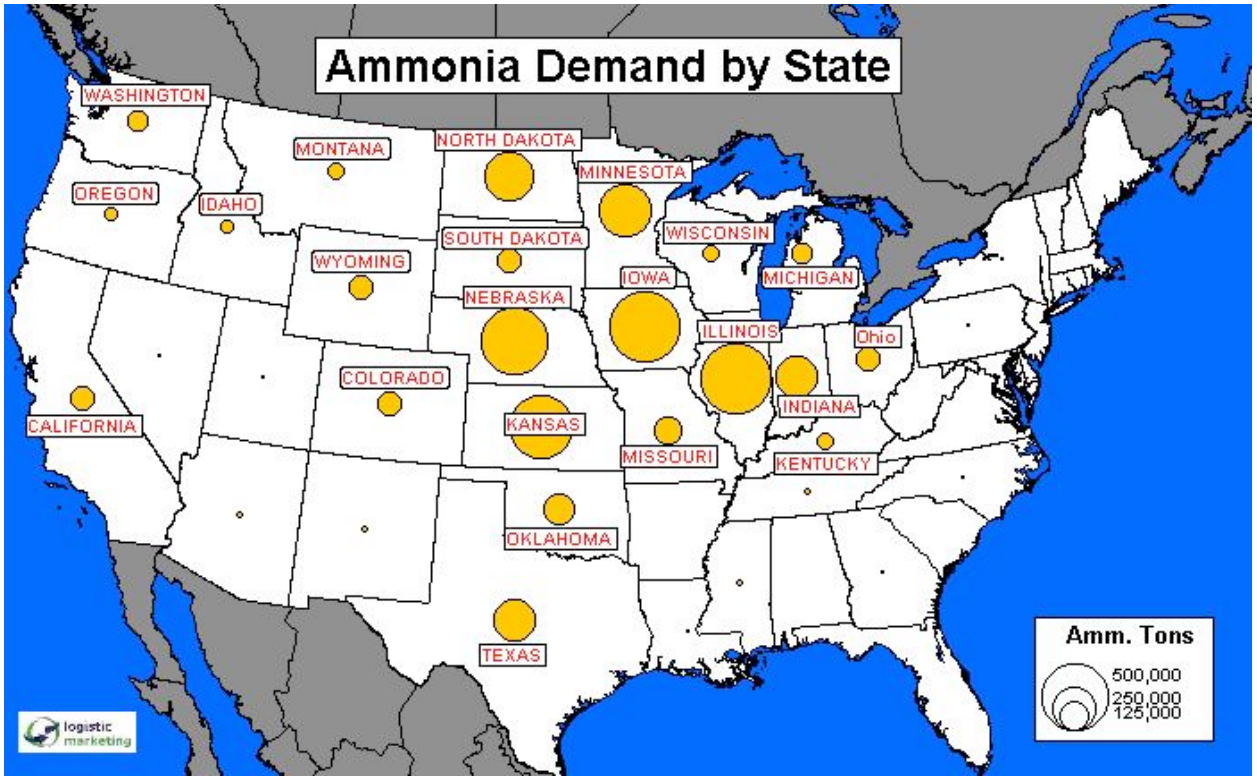
- NG prices above $5 - 10
- 1.7 million N tons of 16.99 million capacity has closed
- Currently plants closed
  - Put names here
  - Total Capacity
  - Increased Imports Pipeline NOLA

NA Demand to Production

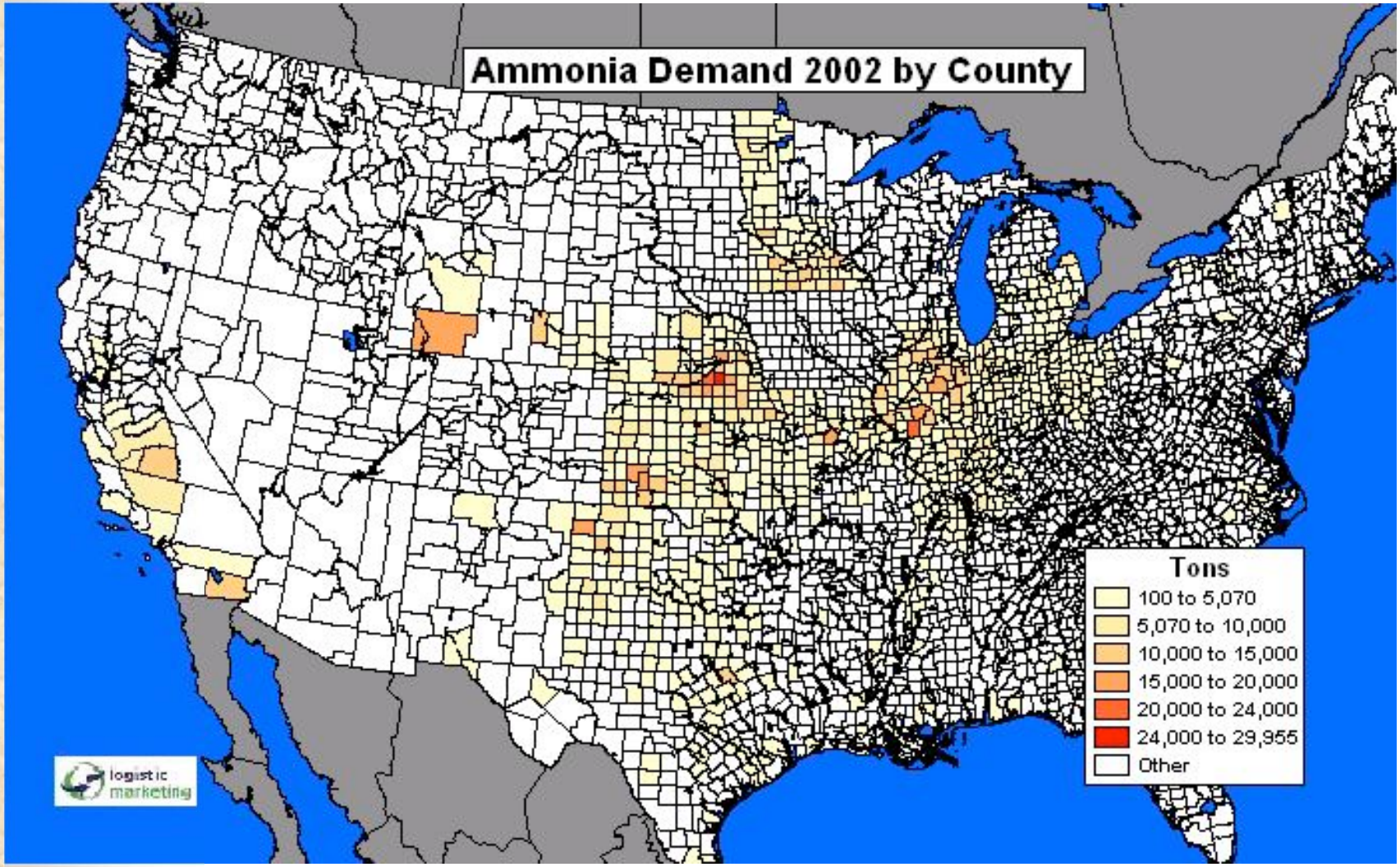


USA Demand - 20.1 million tons

- Agriculture : 17.9 million tons
- Industrial : 2.2 million tons

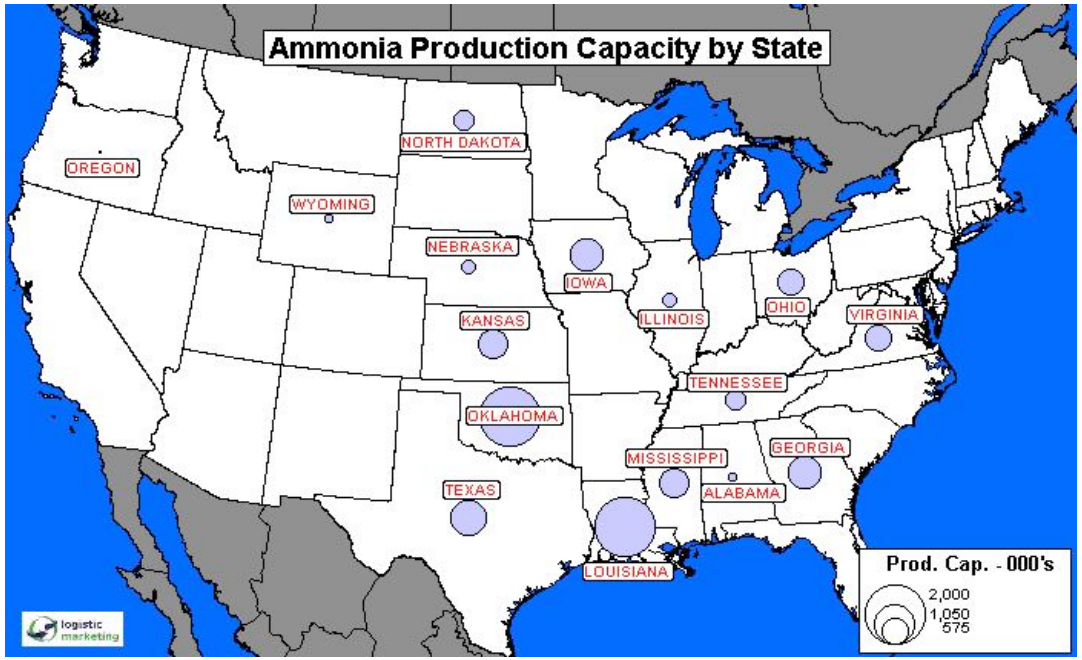


Agriculture County Demand

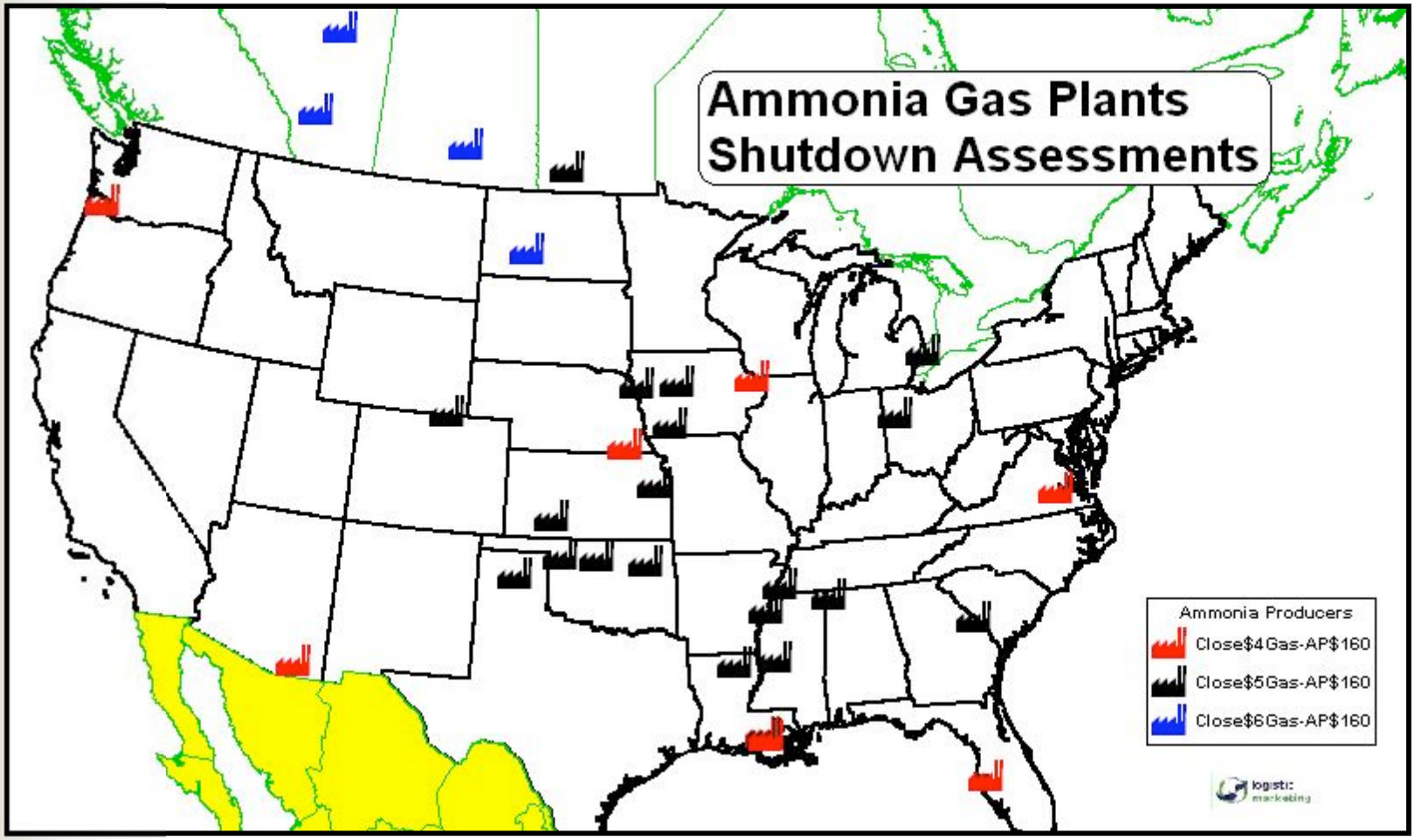


State Production Capacity

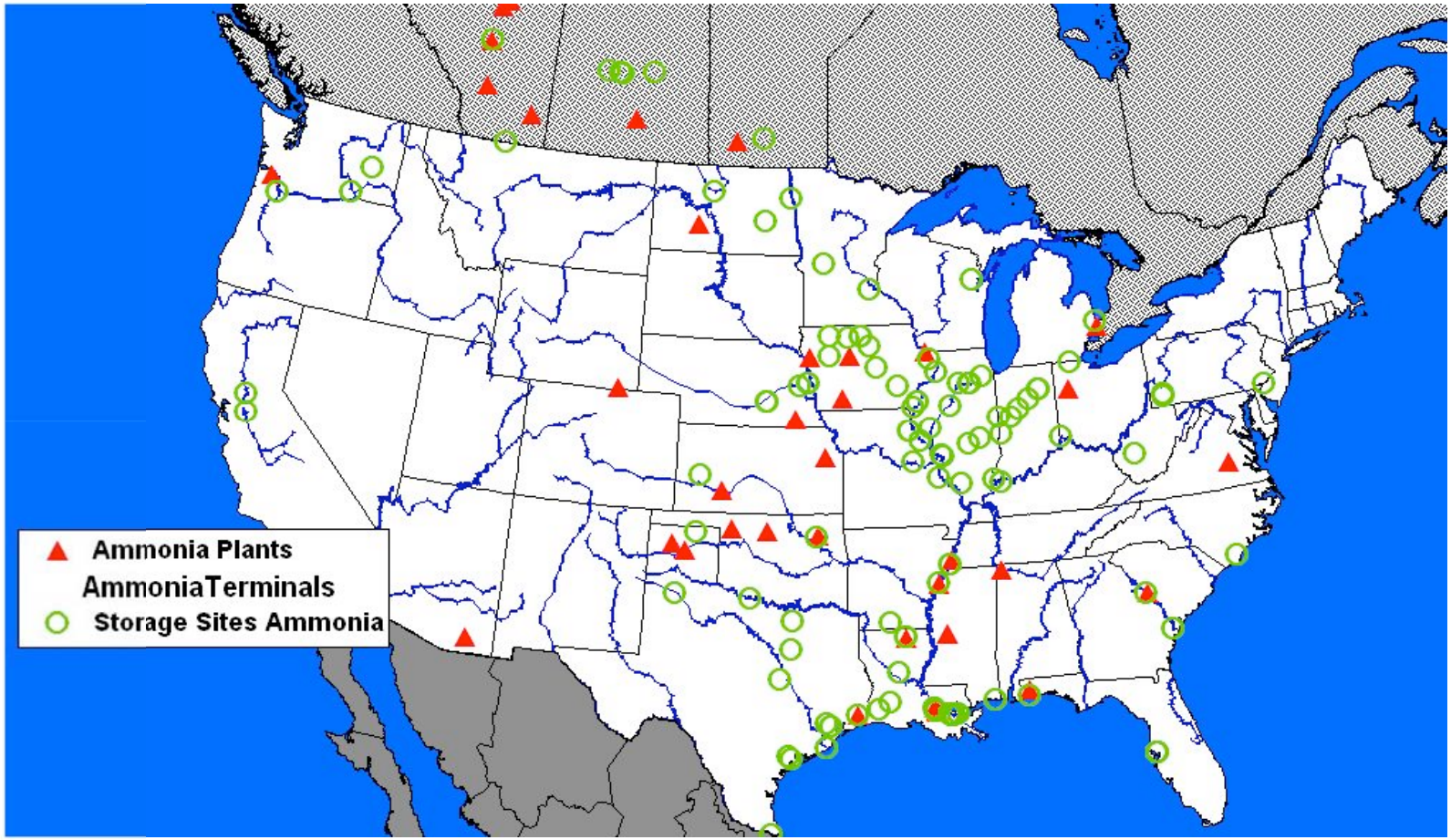
State	Capacity Tons	Rank
LA	4,514,000	1
OK	2,515,000	2
AK	1,416,000	3
IA	791,000	4
GA	758,000	5
KS	695,000	6
TX	680,000	7
MS	669,000	8
OH	598,000	9
VA	584,000	10
TN	409,000	11
ND	400,000	12
IL	306,000	13
NE	292,000	14
AL	193,000	15
WY	192,000	16
OR	111,000	17
FL	86,000	18



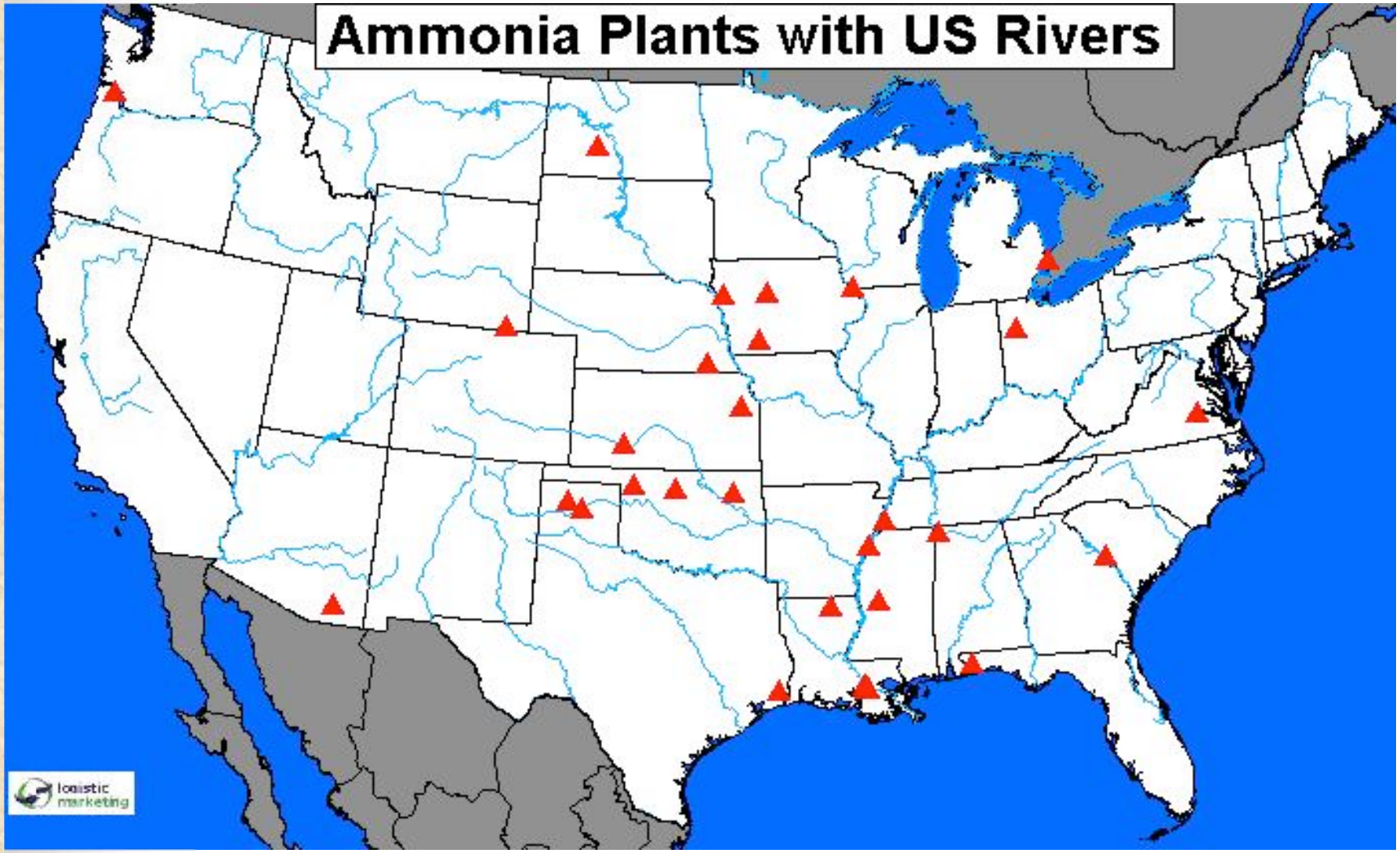
Plant Closures Gas to NOLA Ammonia Price



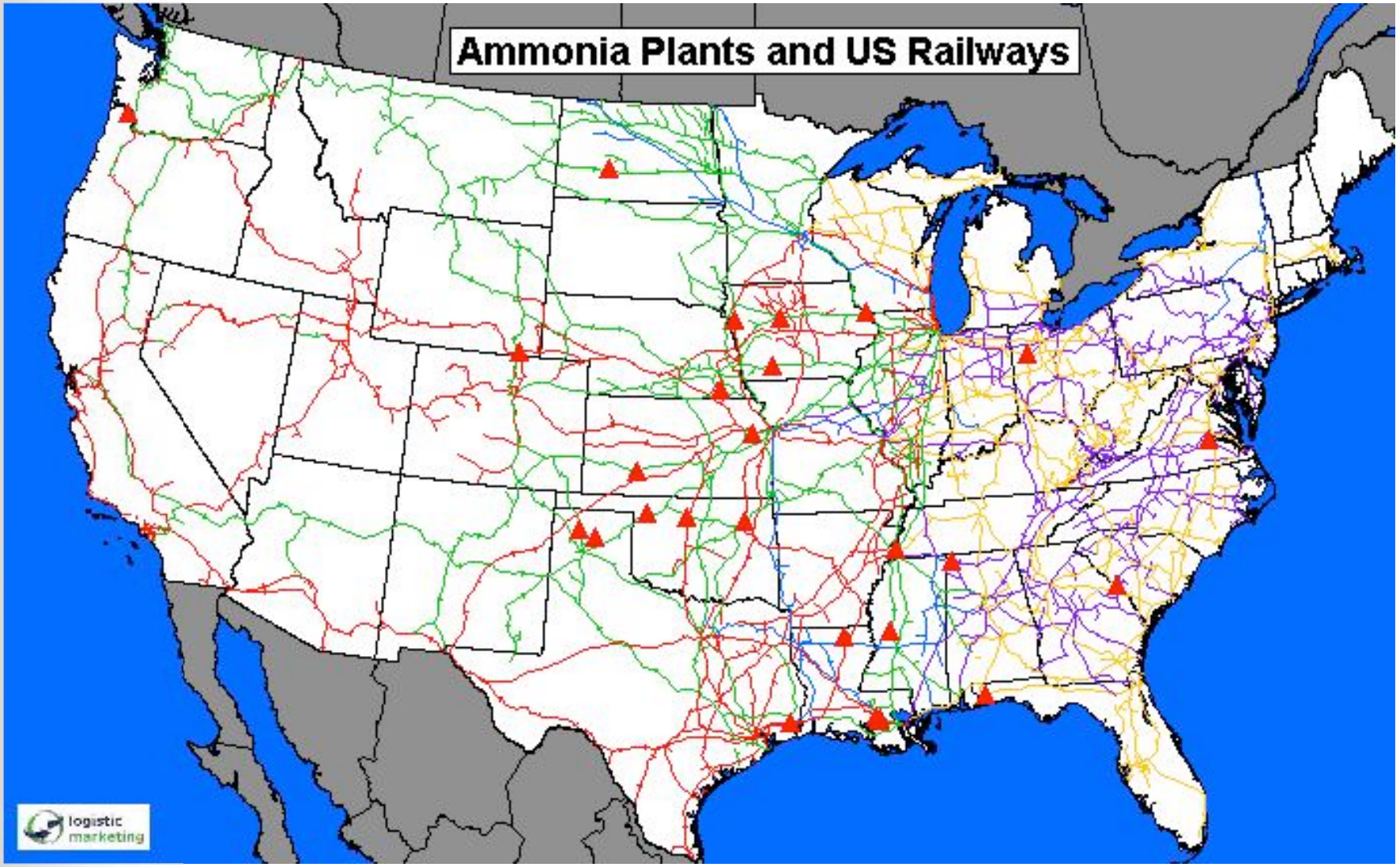
Ammonia Plants and Terminals



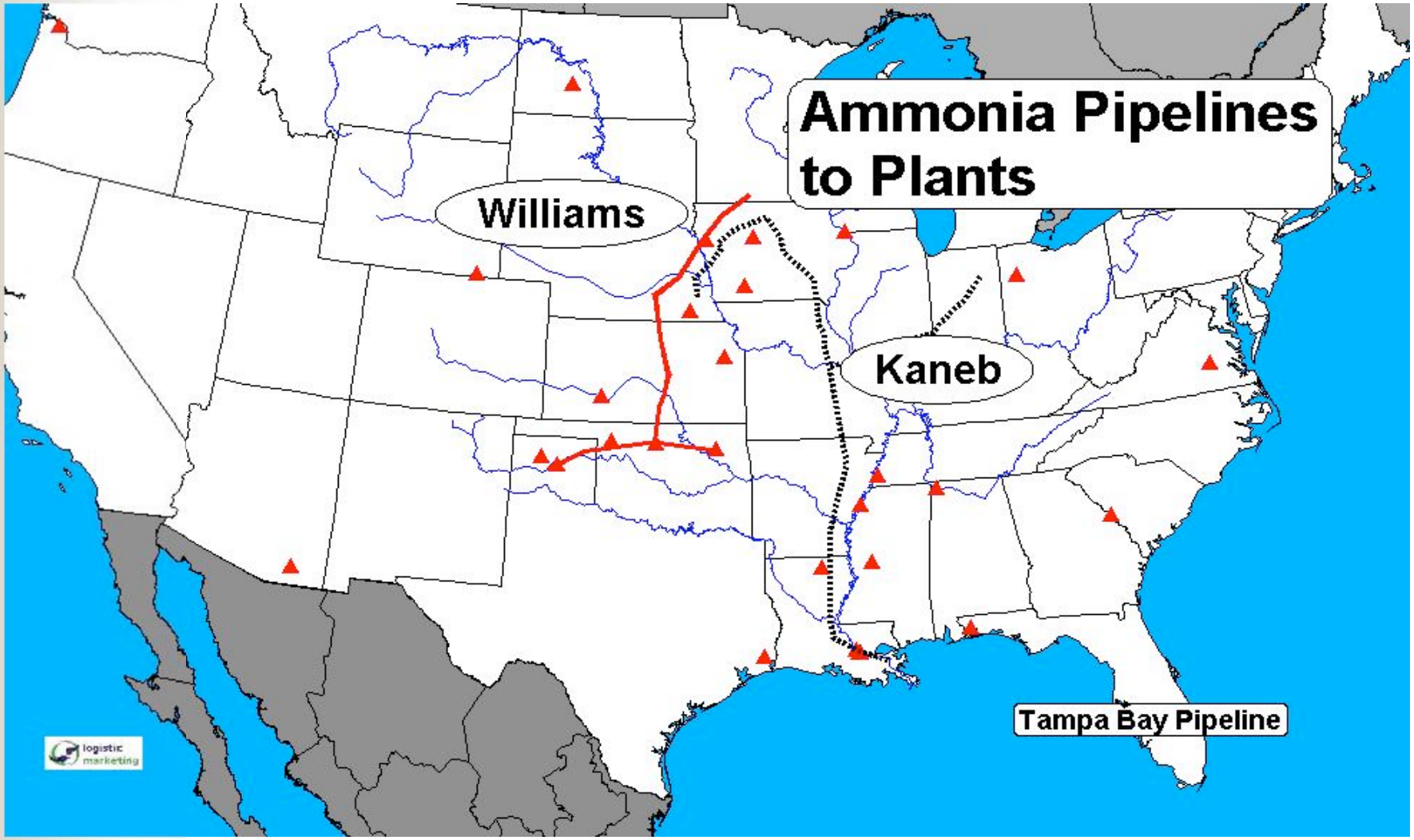
Distribution



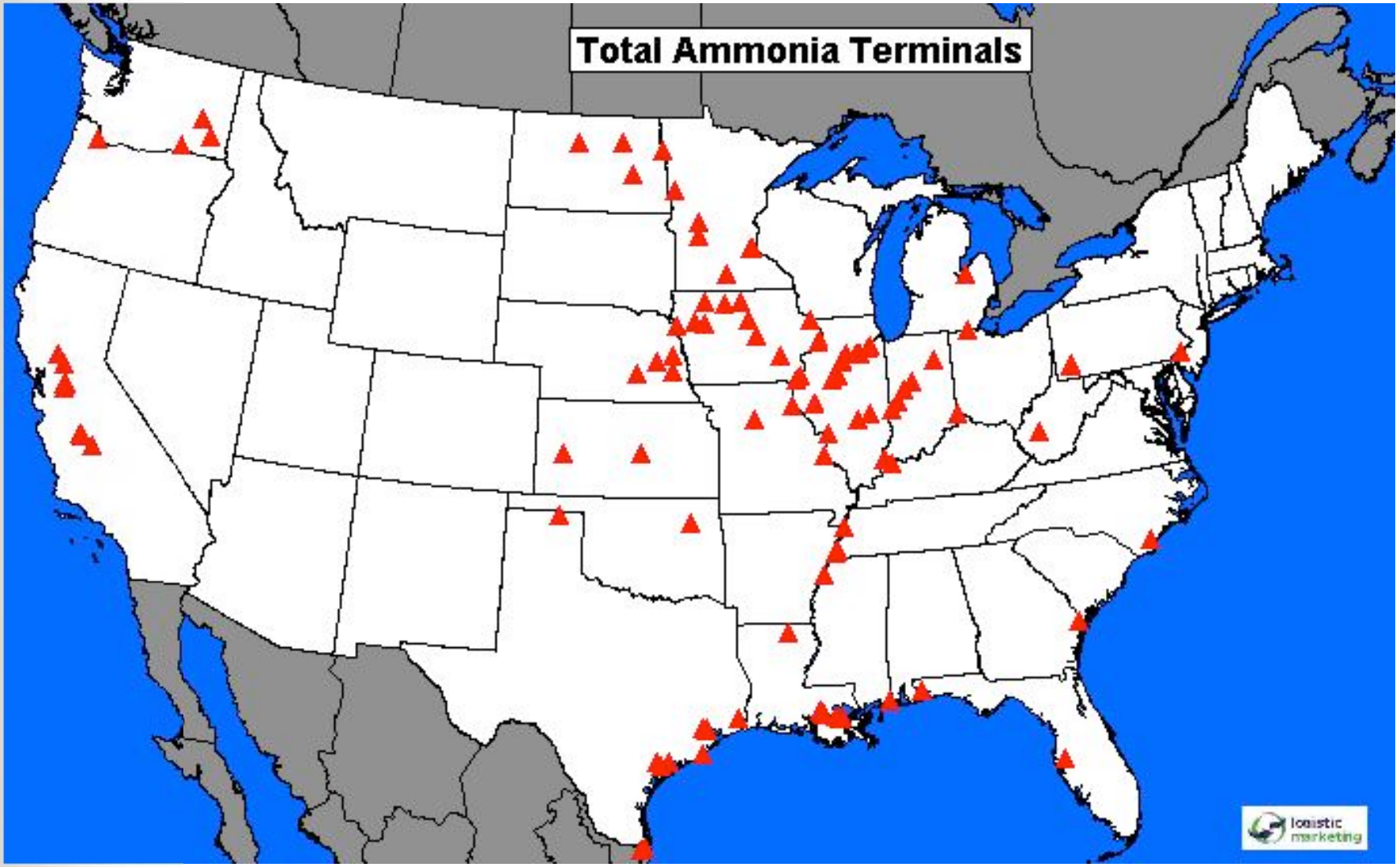
Distribution



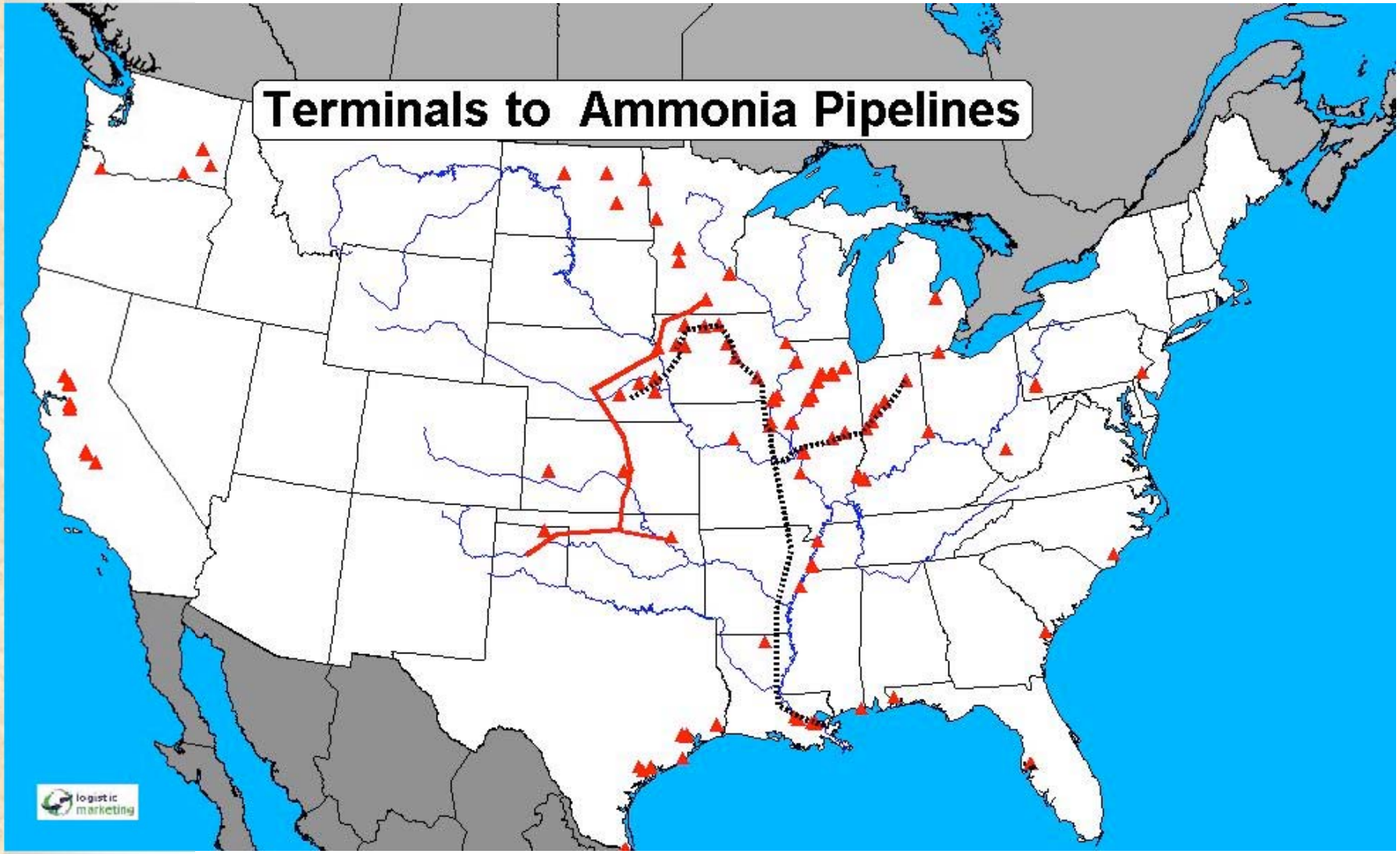
Distribution



Distribution



Distribution



Supply Chain Logistics

Production to Demand

- Vessel to Terminal
- Pipeline to Terminal
- Barge to Terminal
- Rail to Terminal
- Truck from Production

Truck delivery common mode end delivery agriculture

Anhydrous ammonia (*NH3*) exists naturally in a gaseous state under atmospheric pressure and temperature. Under moderate pressure it changes easily to a liquid, becoming a gas again when the pressure is reduced. Industries take advantage of this characteristic by shipping and storing liquefied ammonia in pressurized railway cars, tank trucks and cylinders of various sizes.

Ocean going vessel to terminal

Barge to terminal

Rail to terminal

Pipeline to terminal

SUPPLY-production

Storage tanks

- NH3 is stored in a liquefied state at approximately -28° F
- This is accomplished with refrigeration compressors
- NH3 is loaded into trucks or rail cars using a heater

production to ocean going vessel

ocean going vessel to deep water terminal

Ship

- NH3 is liquefied by being cooled to approximately -28° F
- Ships keep cargo cool via refrigeration compressors
- Ships are also in LPG trade

deep water terminal or production to barge

barge to river terminal

Barge

- NH3 is liquefied and transported at approx. -28° F

- Barges use refrigeration compressors to cool cargo
- Typical NH3 tow is 5,000 st
- Age of barge fleet in US averages 40 years
- Cost of replacement approximately $5mm per barge

deep water terminal or production to rail

rail to inland terminal or end user

Rail

- NH3 is shipped in a liquefied state under pressure, not refrigeration.
- NH3 is actually heated from -28° F to between 30° & 40° F for loading dependent upon outside temperature
- Cars are insulated and pressurized

deep water terminal or production to pipeline

pipeline to inland terminal

Pipeline

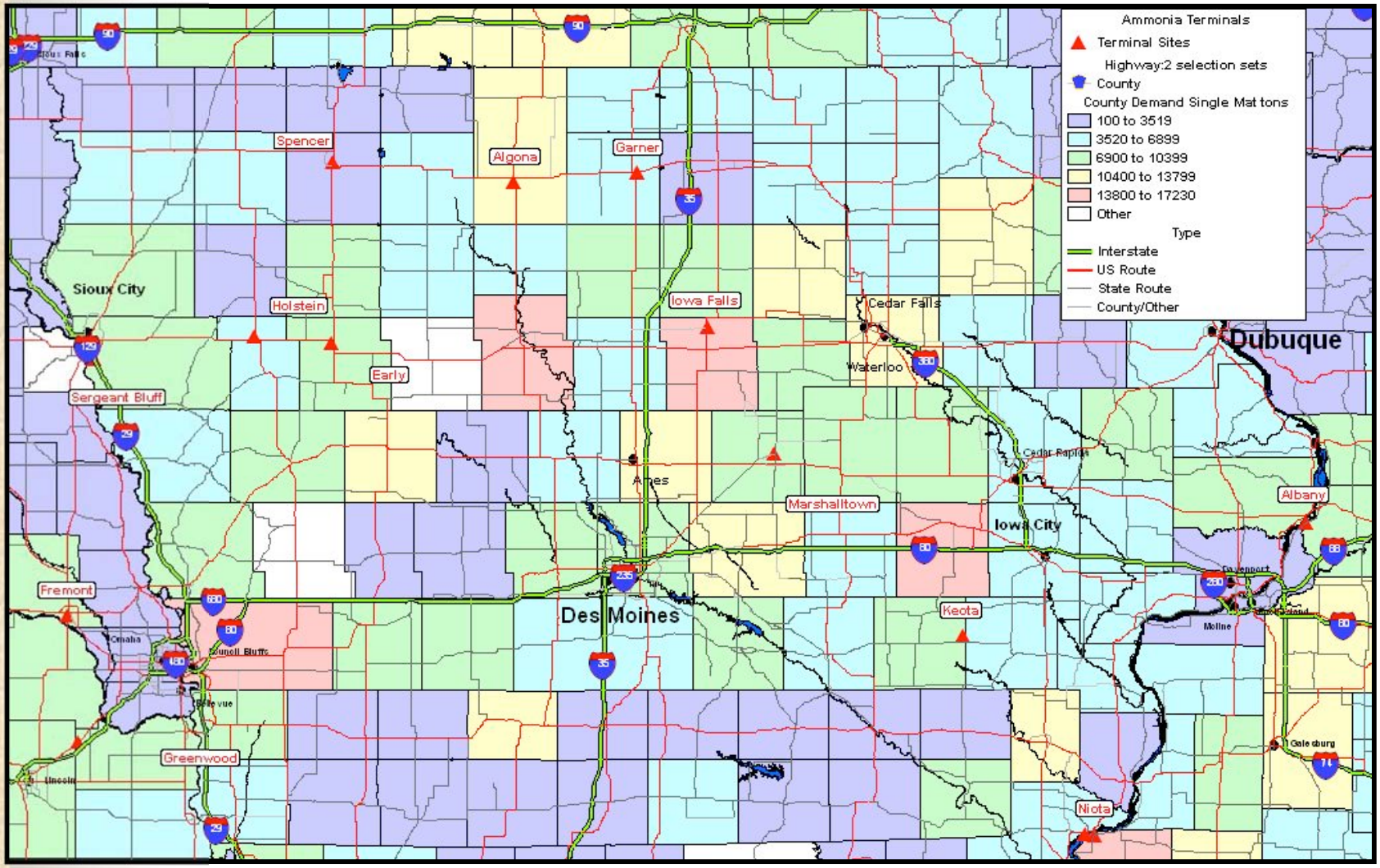
- NH3 is injected into the pipeline in a liquefied state under pressure, not refrigeration.
- NH3 is actually heated from -28° F to between 30° & 40° F for injection dependent upon pipeline temperature
- Pipeline is naturally insulated (underground)
- Pipeline is pressurized

terminal to truck

Trucks

- NH3 is actually heated from -28° F to between 30° & 40° F for loading dependent upon outside temperature
- NH3 is shipped in a liquefied state under pressure, not refrigeration.

IOWA


Ammonia Terminals
Terminal Sites
Highway:2 selection sets
County
County Demand Single Mat tons
100 to 3519
3520 to 6899
6900 to 10399
10400 to 13799
13800 to 17230
Other
Type
Interstate
US Route
State Route
County/Other
Spencer
Algona
Garner
Sioux City
Holstein
Iowa Falls
Cedar Falls
Dubuque
Waterloo
Early
Sergeant Bluff
Ames
Marshalltown
Cedar Rapids
Albany
Iowa City
Fremont
Des Moines
Keota
Greenwood
Niota

Closing Statements

- Ammonia and gas prices
- Further closing of NA plants
- Higher degree of imports
- Cost sensitive
- Current foot print of NH3 distribution

Questions????

Royster Clark

Royster Clark

Royster Clark

Royster Clark

Royster Clark