



Natural Refrigerants – U.S. Considerations

*Caleb Nelson, PE, LEED AP
CTA Refrigeration Group*

Overview:



- US Demand
- Climate Consideration
- CO2 Integration
- NH3/CO2 experience

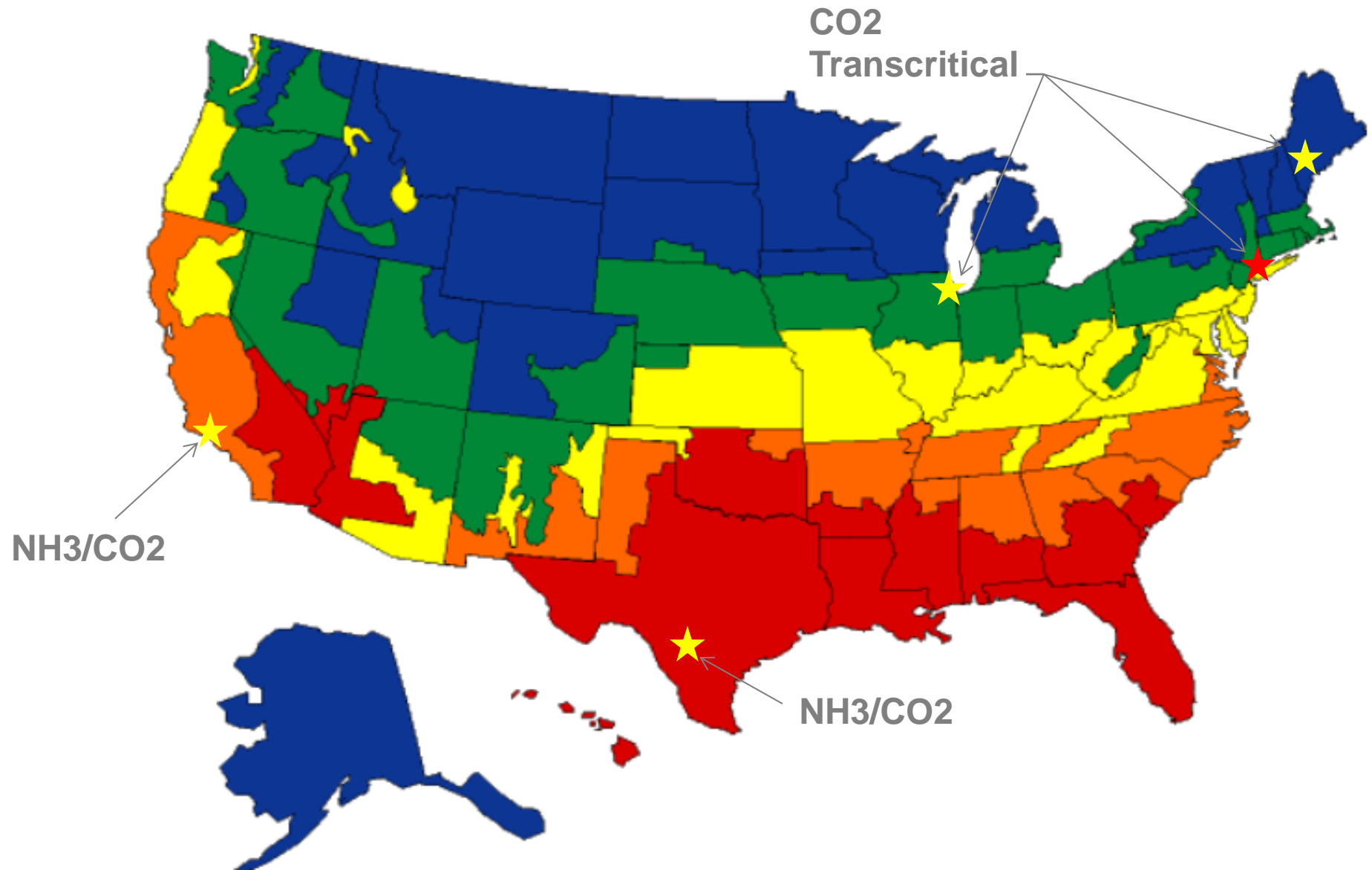


U.S. Demand



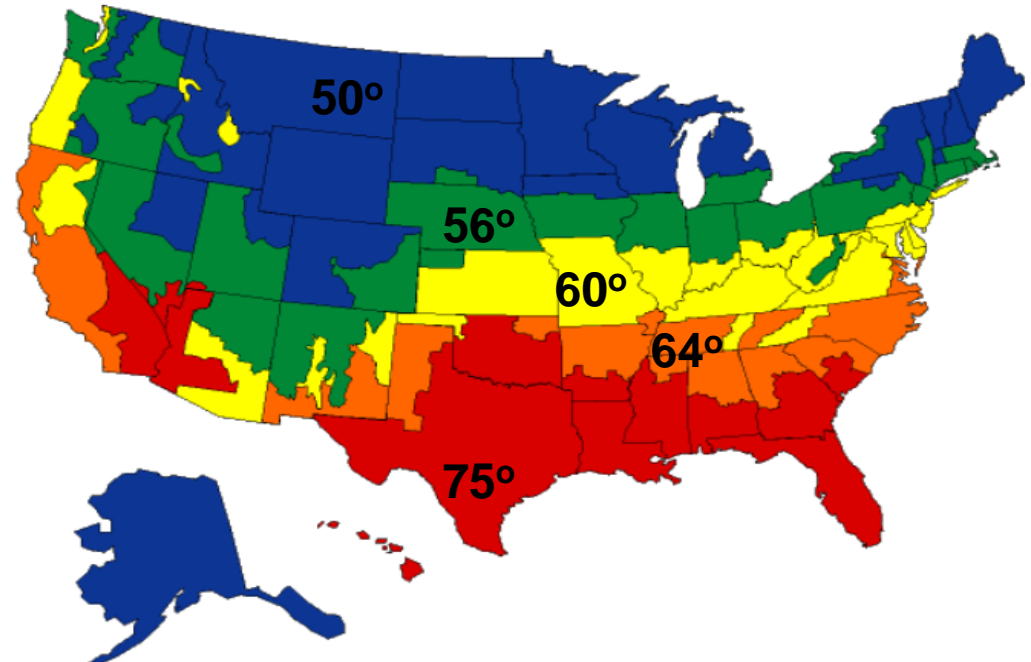
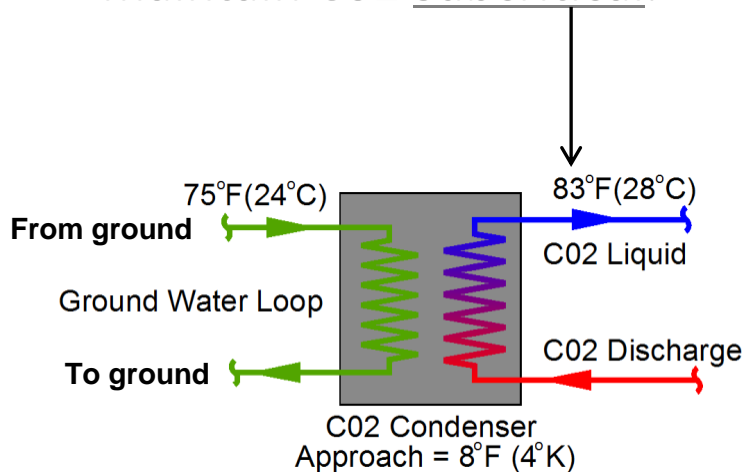
- C02 is becoming very common (w/HFCs)
 - Cost and performance benefits already realized
- No HFC legislation, tax, or production quotas in U.S. currently
 - Reducing TEWI (GWP) continues to be focus for many
- Consumer Goods Forum reaches U.S.
 - Begin HFC phase-out by 2015.

U.S. Climate



CO₂ transcritical integration

- Currently, no 100% CO₂ systems planned outside of “Blue/Green” zones
- Moving further toward the “Red” will require significant integration with heating systems
- If facility does not have enough heating demand, look to possibly integrate with neighboring facilities if possible/feasible.
- Use of ground water also provides a possible solution to use as condensing water—to maintain CO₂ subcritical.

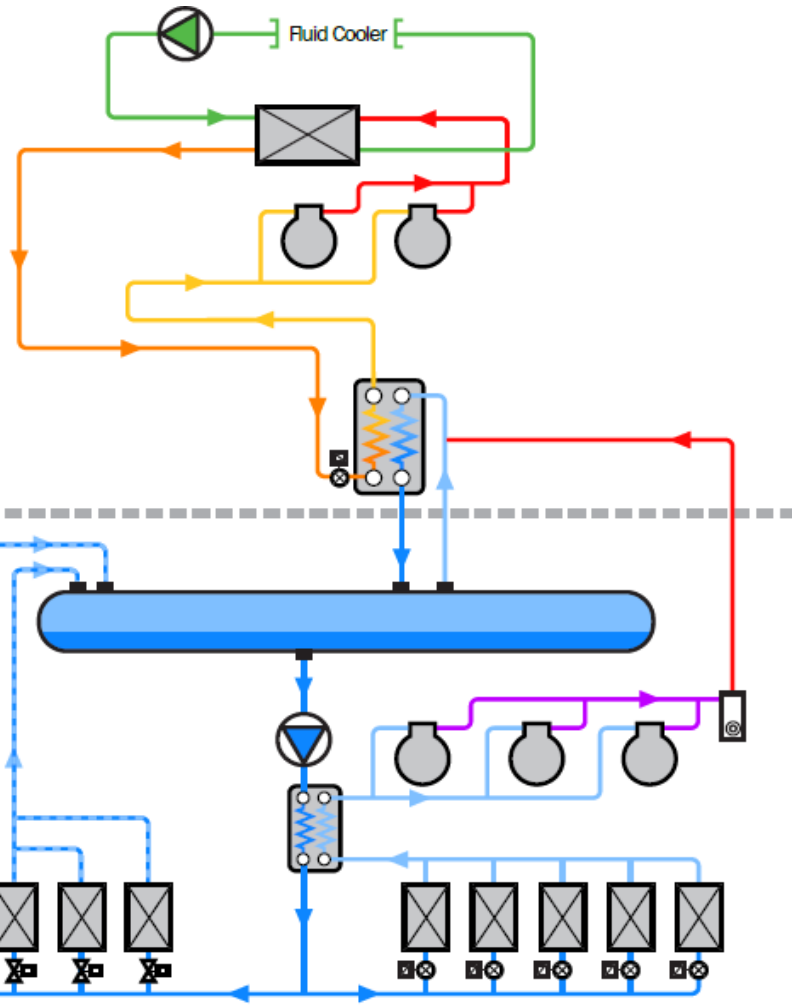


NH₃/CO₂ (Orange Zone)



*Images from CTA presentation for Greenchill—publicly available in EPA webinar archives (next 3 slides also):
http://www2.epa.gov/sites/production/files/documents/GC_Webinar_AmmoniaCascade_2012.11.15.pdf

System Layout:



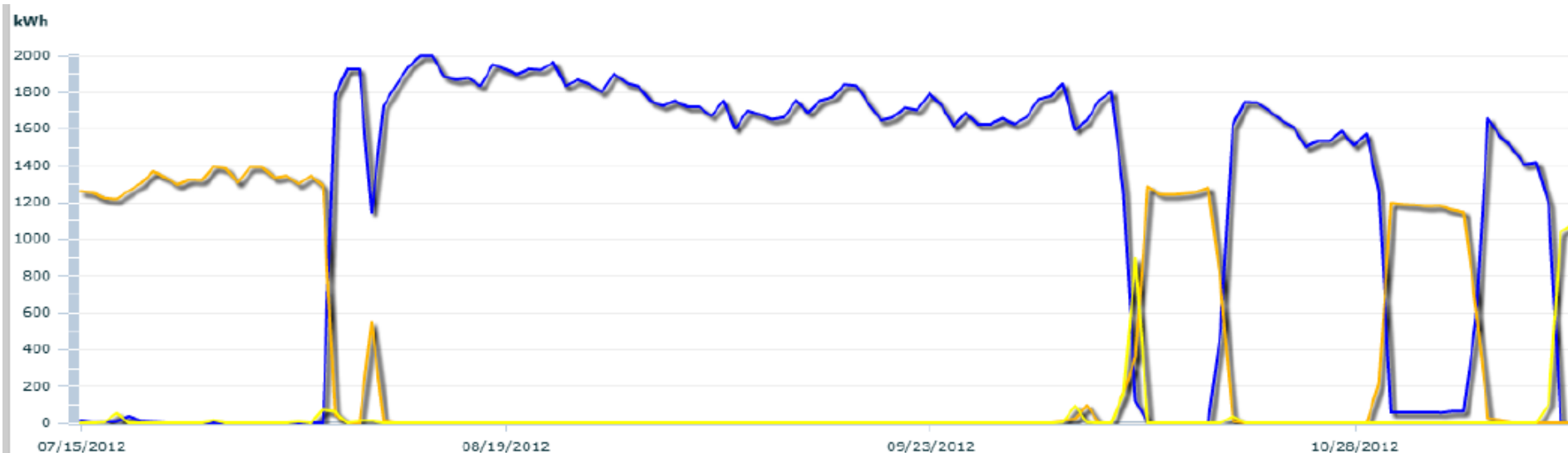
Design Approach:

- Simple/Proven/Efficient.
 - “Off the shelf” (Industrial) NH₃ components
 - Open-Drive Reciprocating Compressors
 - Flooded Cascade HX
 - Mineral Oil
- Low Charge
 - No High-Pressure Receiver
 - Approx. 3.6 lbs/TR (0.46kg/kW)



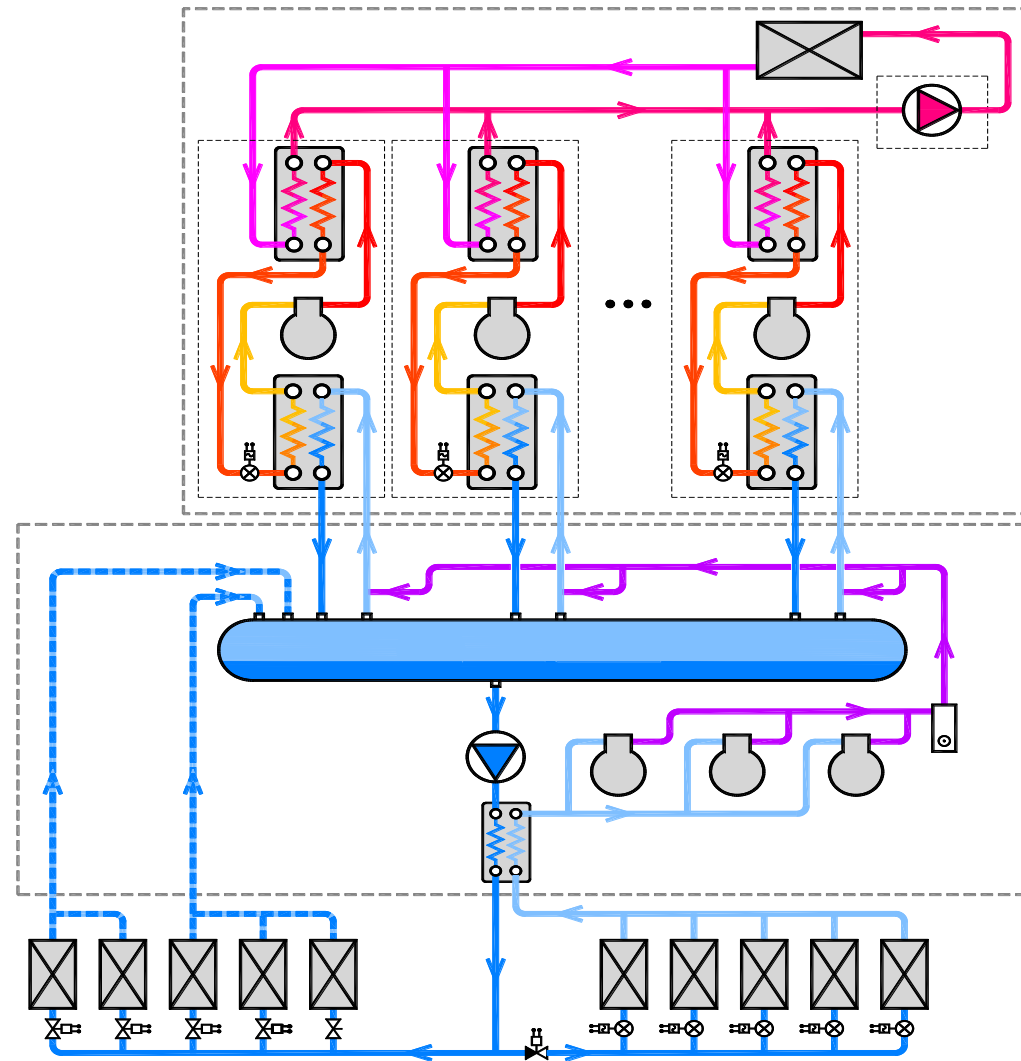
Results:

- NH3: 25% less energy than R407a
- 18% total first cost increase (NH3/CO2 vs R407a/CO2)
 - Cost wasn't a priority for this demonstration
 - Cost expected to drop with iterations



NH3/CO2 (Red Zone)

- CO2 system—same
- NH3 system—modularized
- Dry expansion
- Expected further reduced charge: 0.88 lbs/TR (0.11kg/kW)
- Expected 10% efficiency benefit (vs R134A/CO2)
- Projected 35% total first cost increase (NH3/CO2 vs R134a/CO2)



Conclusions:



- 100% Natural Systems are coming to the U.S.— despite the lack of government “push”
- NH₃/CO₂ is an efficient option to obtain 100% natural—virtually in any country/climate
- Simple/proven NH₃ components already being used in developing countries are applicable in smaller commercial systems
- CO₂ transcritical use in warmer developing countries can expand— where waste heat is usable.



 **ATMO**
sphere
UN
technology summit
natural solutions
3 - 4 June 2013 in Vienna



Thank you very much for your attention

Caleb Nelson, PE, LEED AP
CTA Refrigeration Group
calebn@ctagroup.com

+011.406.728.9522
www.ctagroup.com