Low Charge, Packaged Ammonia Solutions For Small Industrial Refrigeration Applications

Dr Robert Lamb
Group Sales & Marketing Director
Star Refrigeration Ltd

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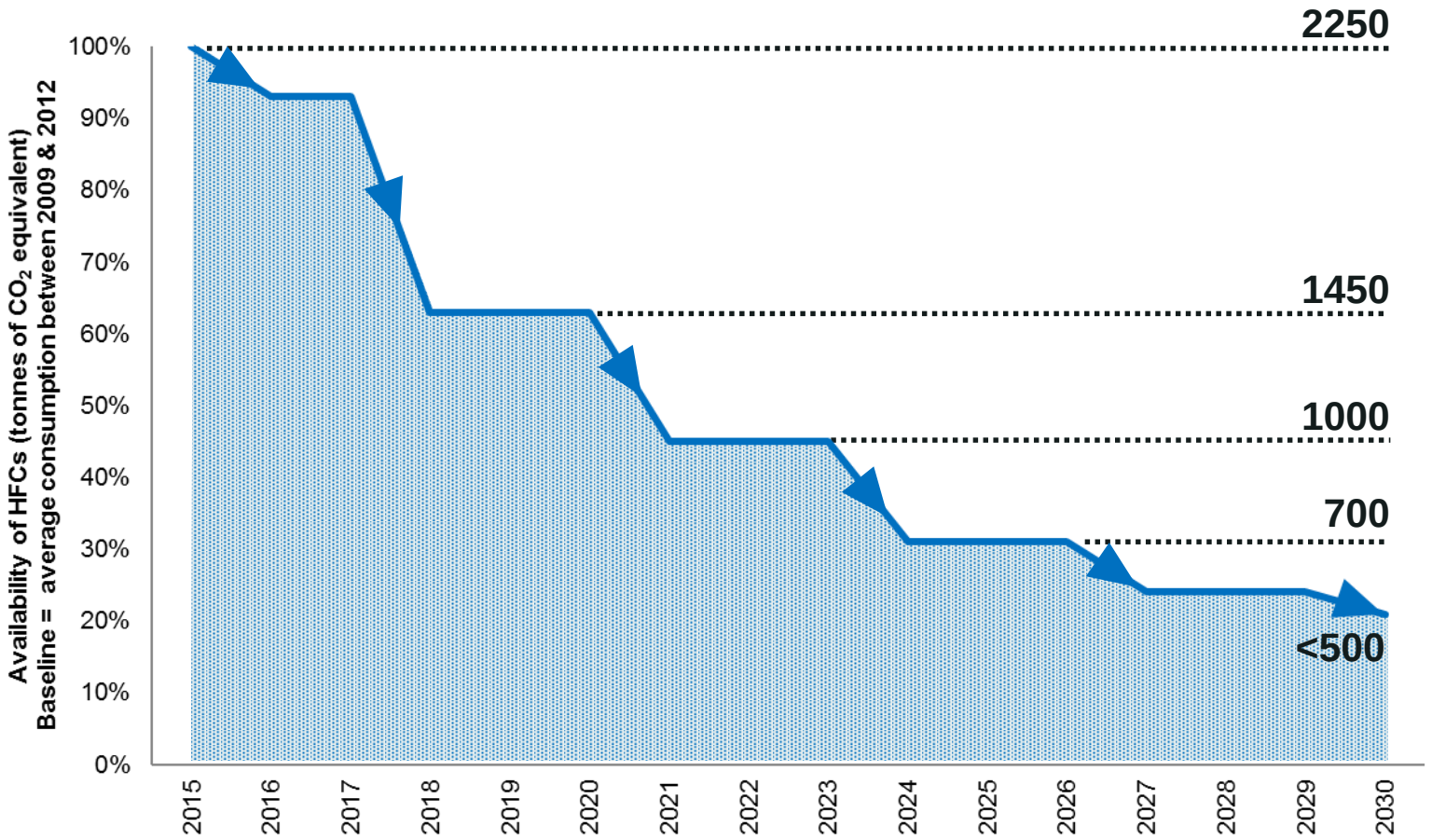
Definition of ‚Small Industrial Refrigeration Applications‘

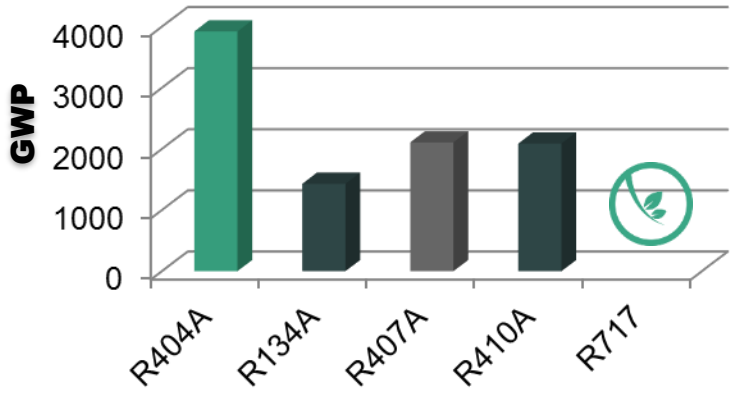
- Capacities from 100kW to 500kW
- Applications including
  - Temperature controlled storage
  - Food processing
  - Leisure and ice
  - Data centres

F-gas Phase Down Timeline



F-gas Phase Down Timeline

- Reduced availability of HFCs driven by F-Gas Regulation
- Escalating HFC costs
- Ammonia unaffected by F-Gas Regulation (GWP=0)



Why Operators Select Packaged Ammonia Systems

Natural

Ammonia is not subject to the F-Gas Regulation

Efficiency

Exceeds Ecodesign energy efficiency requirements

Safety

80%+ reduction in refrigerant charge

Robust

Industrial build quality using high quality components. Designed to maintain performance throughout the entire 20+ year life expectancy

Flexible

Packaged unit allows future relocation if required

Defining Low Charge Ammonia

- ‘Any ammonia system which requires a specific system charge of less than 10 lb/TR (1.3kg/kW) of refrigerant.’

GCCA White Paper on Low Charge Systems

- ‘The lowest possible charge required for stable operation of the unit over the full range of possible operating conditions while maintaining the system’s rated capacity’

Refrigerant Charge Reduction in Refrigerating Systems – IIR Informatory Note

Designing Low Charge Packaged Ammonia Chillers

Short pipe runs for low refrigerant volume

No high side receiver

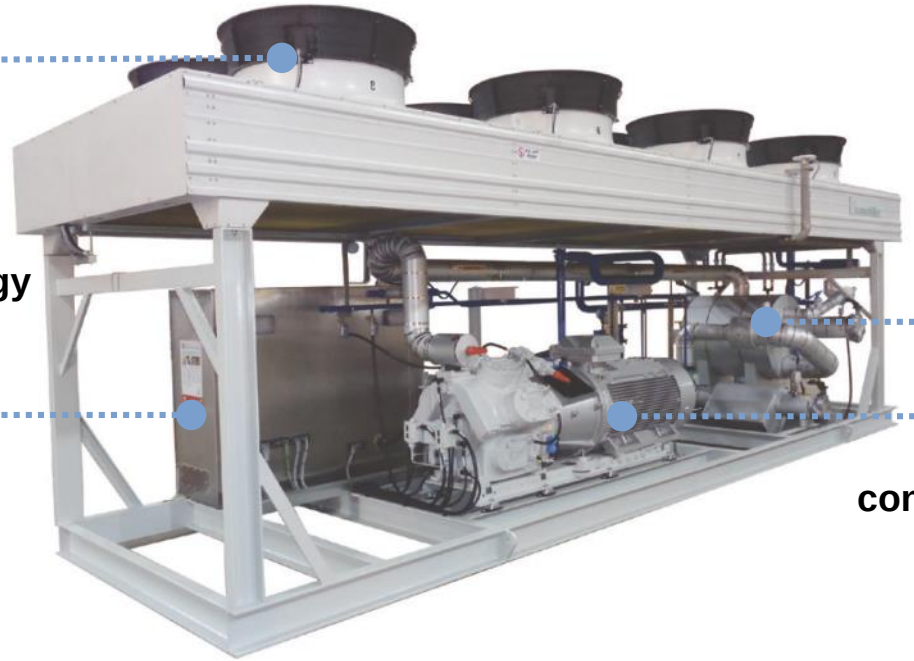
Plate and shell evaporator with combined suction separator

Refrigerant charges as low as 0.18kg/kW

Designing Packaged Ammonia Chillers for Optimum Efficiency

EC fans and floating head pressure for efficient operation in low ambient and part load

PLC controls integrate energy saving features for optimum efficiency



Large heat exchangers surface ensuring close approaches on evaporating and condensing temperatures.

Variable speed capacity control on compressors, for optimal load matching

Possible to exceed 2018 Ecodesign efficiency by > 100%

Case Study 1 – Meat Processing Facility

- Boston, England
- Family owned business
- Supplier of ambient and temperature controlled products to the foodservice industry
- Extension to existing warehouse
- New meat processing facility and chill extension

Case Study 1 – Meat Processing Facility

- Room temperatures
  - +2°C to + 4°C chill
  - +0°C to +12°C processing rooms
  - -20°C freezer
- Cooling loads
  - 383kW chill and process areas
  - 40kW freezer loads

Case Study 1 – Meat Processing Facility

- 3 system designs assessed
  - HFC
  - CO_2
  - Ammonia/glycol
- Criteria
  - Longevity
  - Energy
  - Reliability
  - Cost

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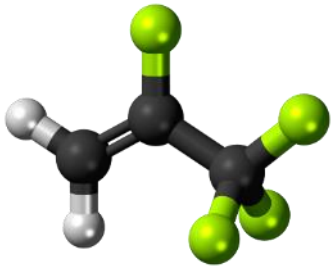

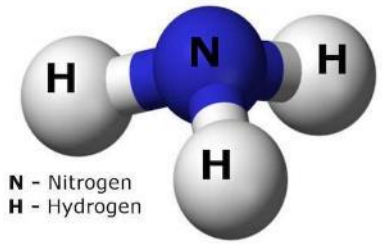

Case Study 1 – Meat Processing Facility

HFC – R134a

- Advantages
  - Lowest capital cost
  - Lower equipment weight
- Disadvantages
  - HFC phase down
  - Refrigerant cost
  - Energy costs (e.g. electric defrost)
  - System life (10 to 15 years)
  - Recent experience with HFCs

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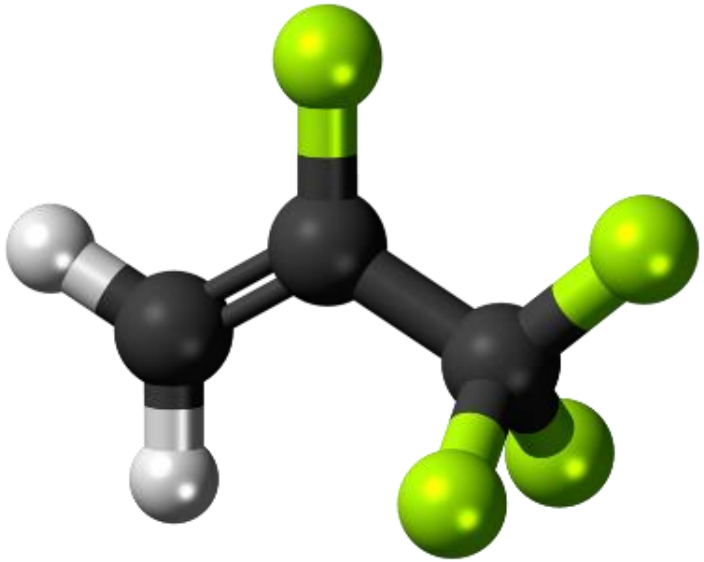

Case Study 1 – Meat Processing Facility

Carbon Dioxide - CO_2

- Advantages
  - Lower capital cost than NH_3
  - Equipment weights similar to HFC
  - Future proof refrigerant
- Disadvantages
  - System life (10 to 15 years)
  - No widely used for application
  - Energy costs (e.g. transcritical operation)

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Case Study 1 – Meat Processing Facility

Ammonia - NH_3 / Glycol

- Advantages
  - Most efficient
  - Future proof refrigerant
  - Heat recovery for defrost
  - No plantroom required
- Disadvantages
  - Capital cost
  - Heavier equipment

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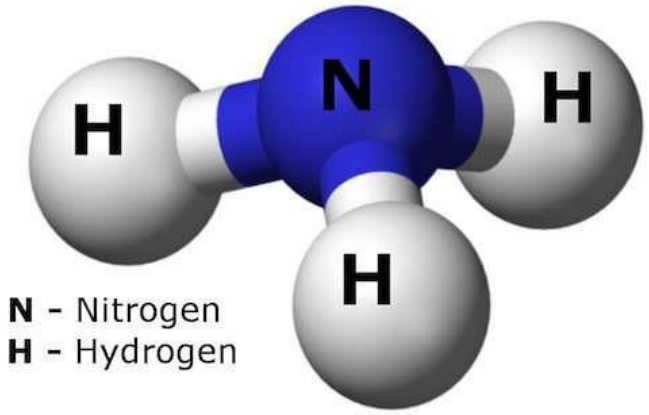

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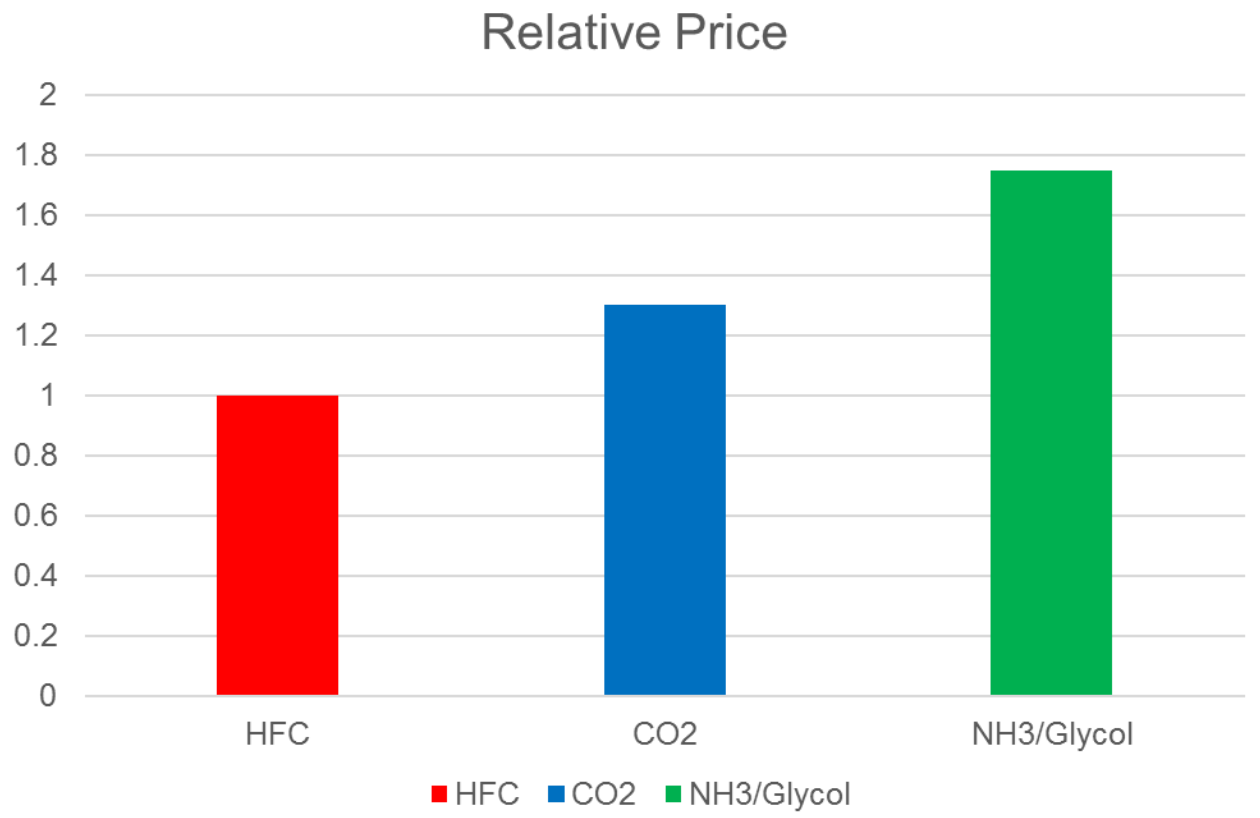

Case Study 1 – Meat Processing Facility

- Customer opted for ammonia/glycol for chill and production areas
- Reasons for this were:
  - Longevity
  - Reliability
  - Efficiency
  - Proven technology for application

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Case Study 1 – Meat Processing Facility

- 2 x 315kW ammonia chillers
- -8°C cold glycol temperature
- +20°C warm temperature
- Energy enhancements
  - EC evaporator fans with automatic speed control
  - Warm glycol defrost
  - Partial condenser
  - Defrost on demand
  - VSD cold and warm glycol pumps

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Case Study 2 – Snozone

- Milton Keynes, England
- 170m long indoor ski slope
- Existing 2 x R404A chillers
- 376kW capacity each
- Issues with:
  - Temperature control
  - Reliability – both chillers were out of operation
  - Energy costs

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Case Study 2 – Snozone

- Glycol system design:
  - 45% glycol concentration
  - Circuit design
    - 50% of flow through chillers
    - 50% bypass
    - -10°C return temperature
    - -16°C off chiller
    - -13°C mixed temperature
- Hire equipment on site and piped without bypass

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Case Study 2 – Snozone

- New chillers required
- Cooling capacity to match existing
- Capital not available for purchase of new equipment
- Experience with ammonia at other facilities
- Existing plant room not suitable for ammonia

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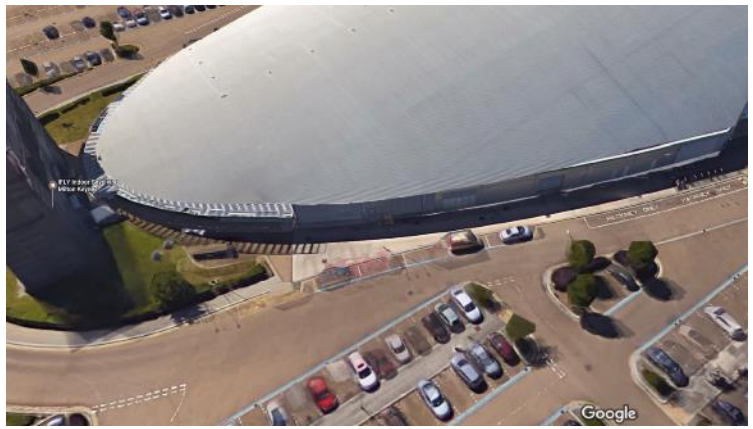
Case Study 2 – Snozone

- Ammonia Hazard Assessment
  - Understand regulations, standards and good practice
  - Highlight immediate and ongoing actions
  - Dispersion model identifies risks in event of leakage
  - Action can be taken to mitigate risks
    - Compressor housing
    - Ammonia scrubber system
    - Security fencing



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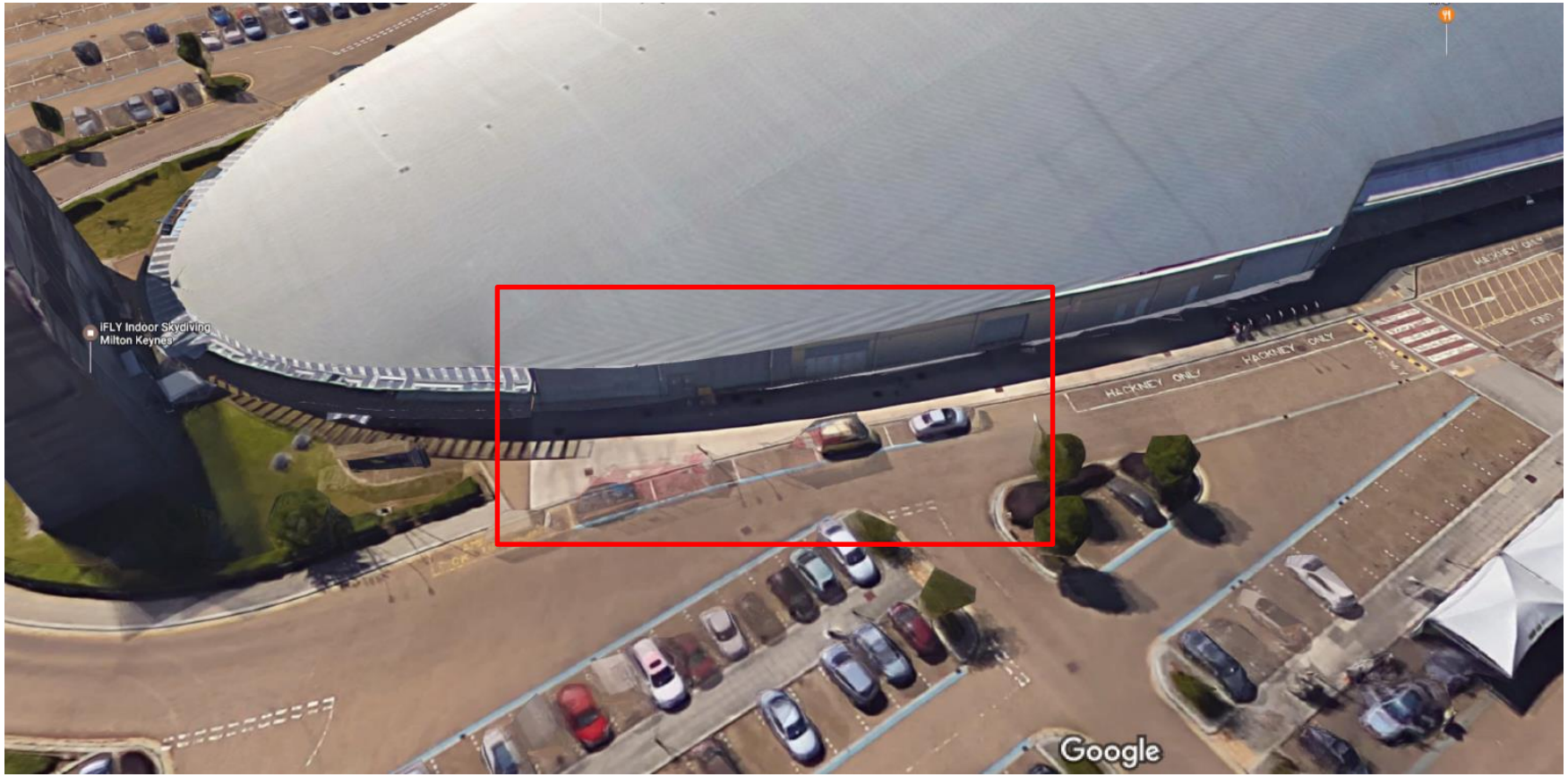

Case Study 2 – Snozone

- New solution
  - 2 x 360kW ammonia chillers
  - 85kg of ammonia per chiller
  - Glycol concentration reduced to 35%
  - Glycol supplier temperature raised to -13°C
  - Bypass arrangement removed
  - Scrubber system fitted
  - Security fence installed
  - Noise attenuation to compressors

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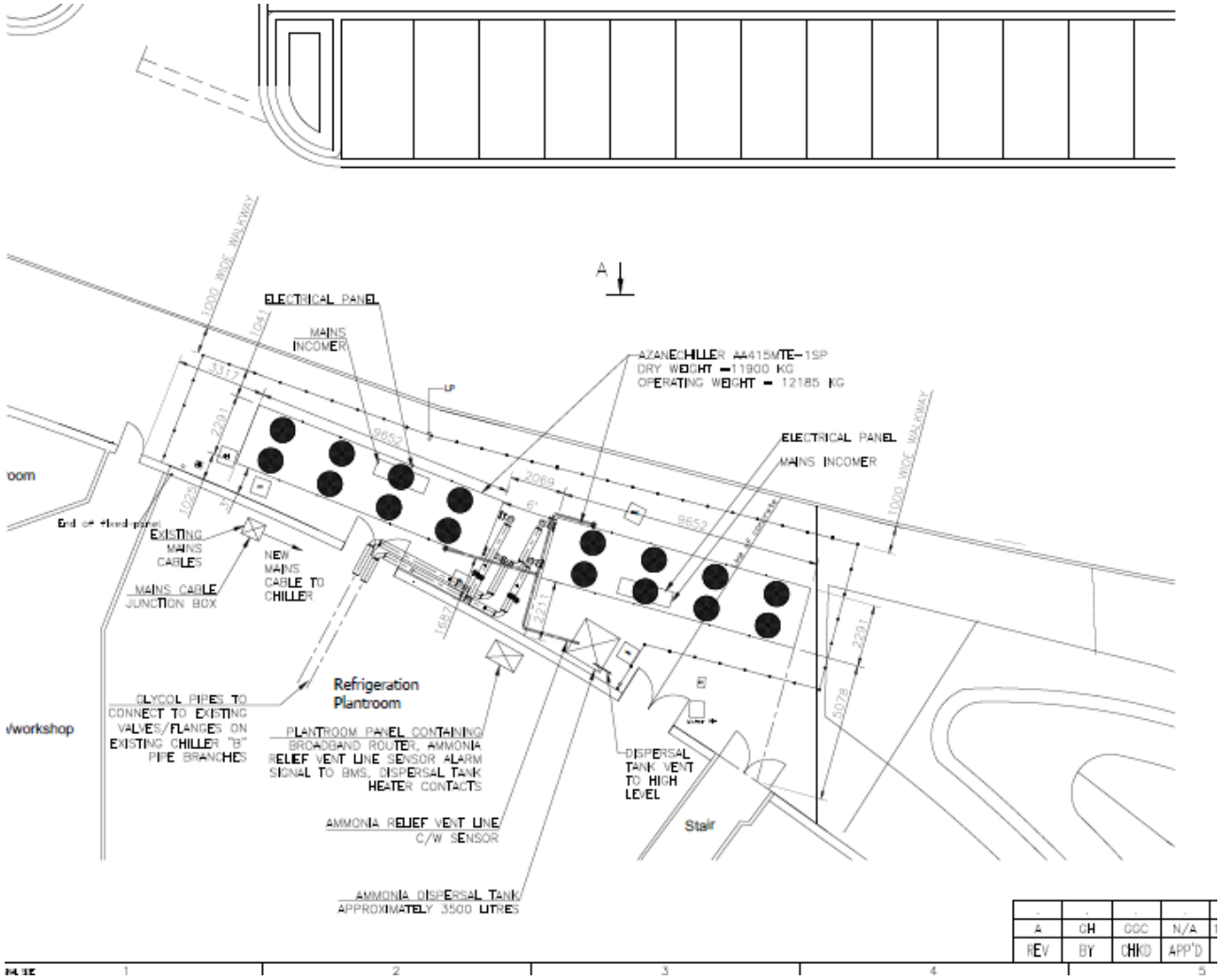
Case Study 2 – Snozone



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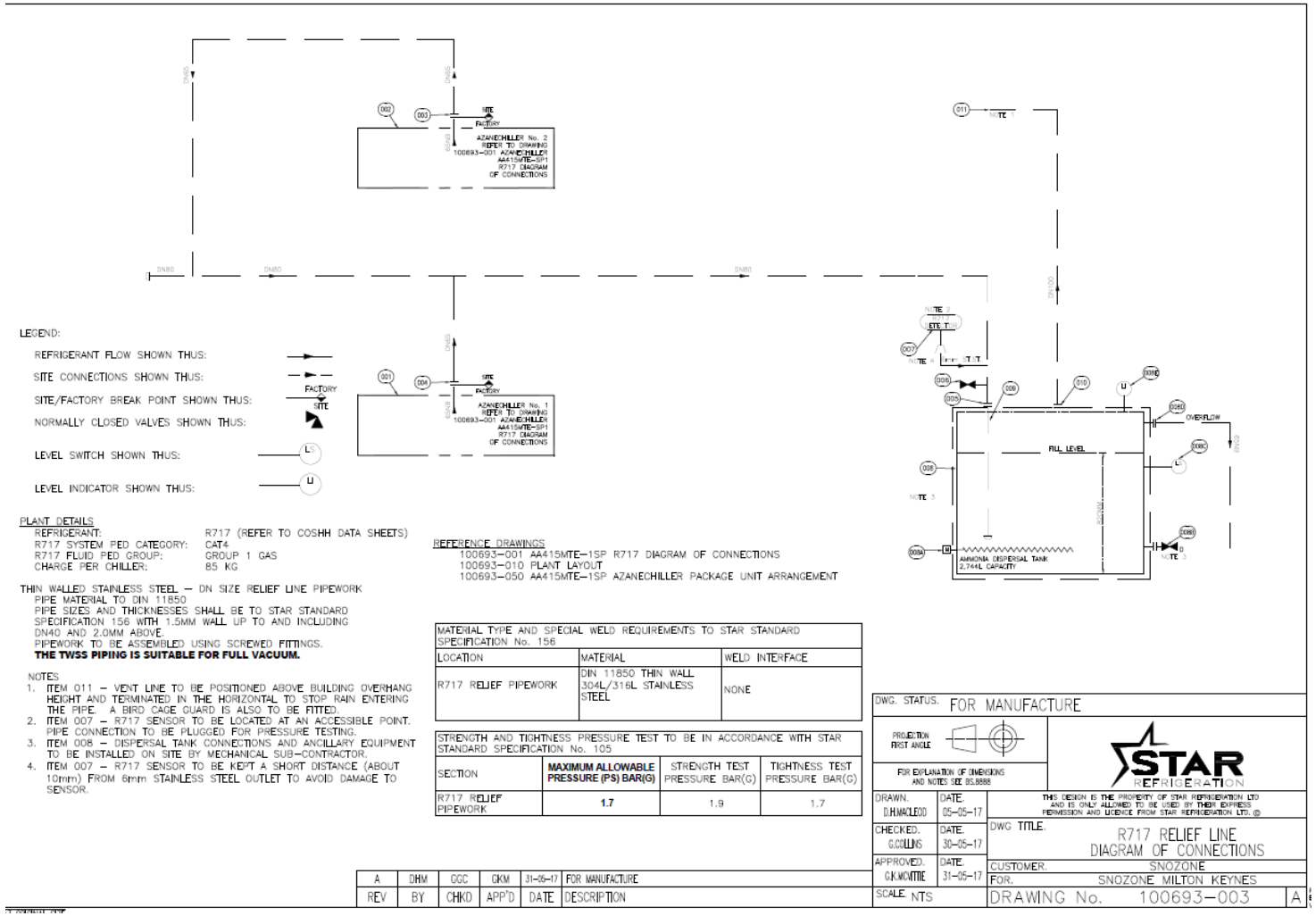

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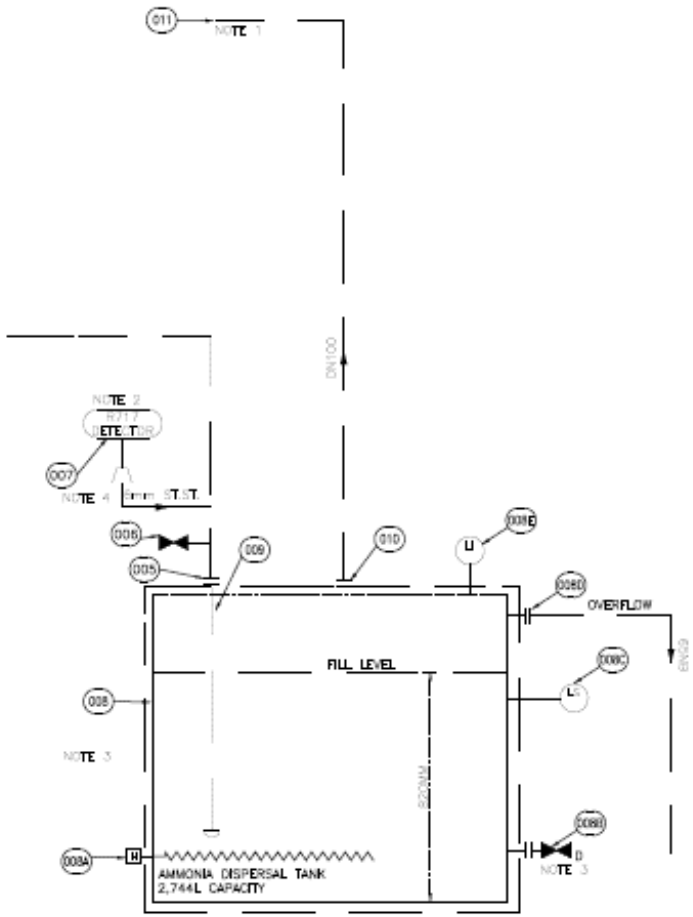

Case Study 2 – Snozone

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- Energy saving features
  - VSD compressor drives
  - EC fans
  - Floating evaporating and condensing temperature
  - Higher glycol temperature
  - Glycol bypass removed
  - Close temperature approach
  - Chillers run together
  - Good air flow to condensers
  - Ammonia refrigerant

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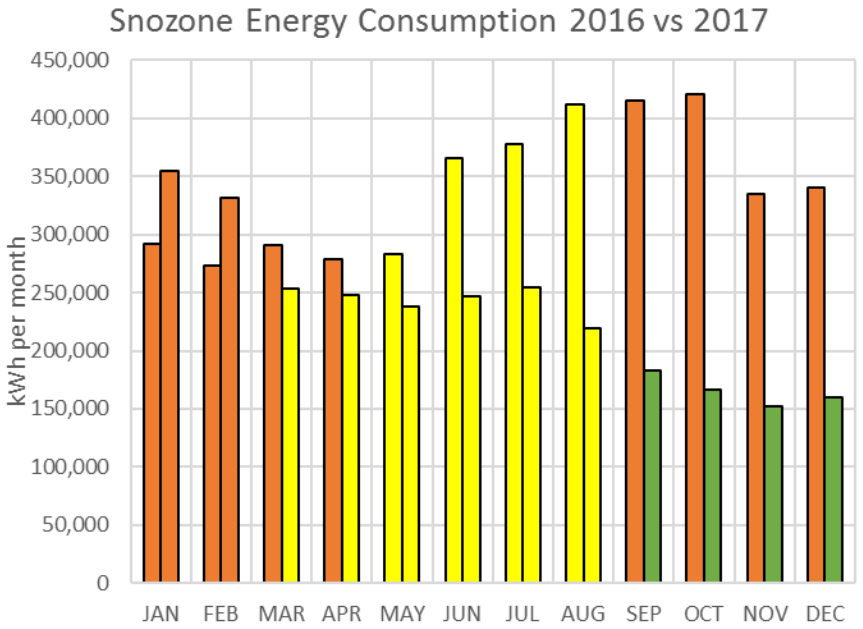

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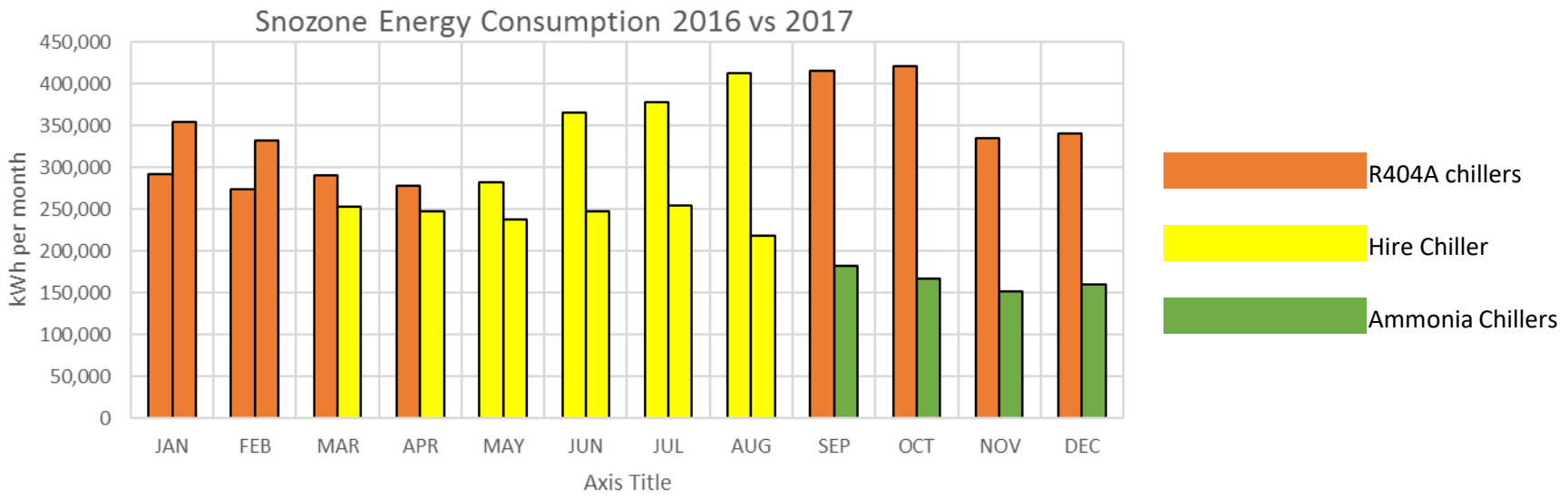

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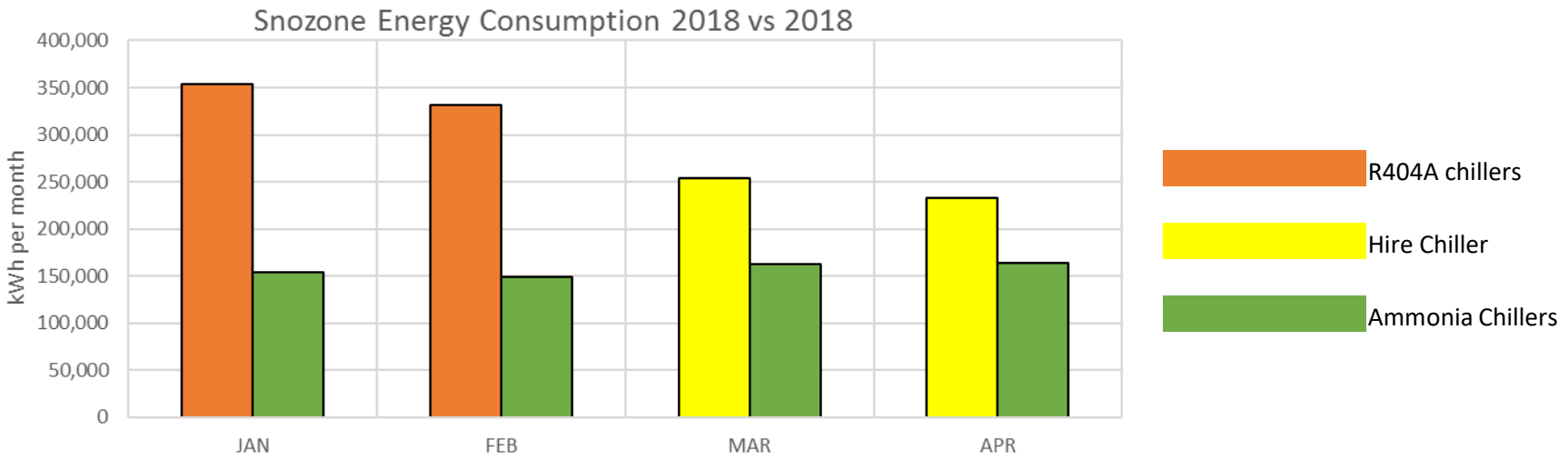
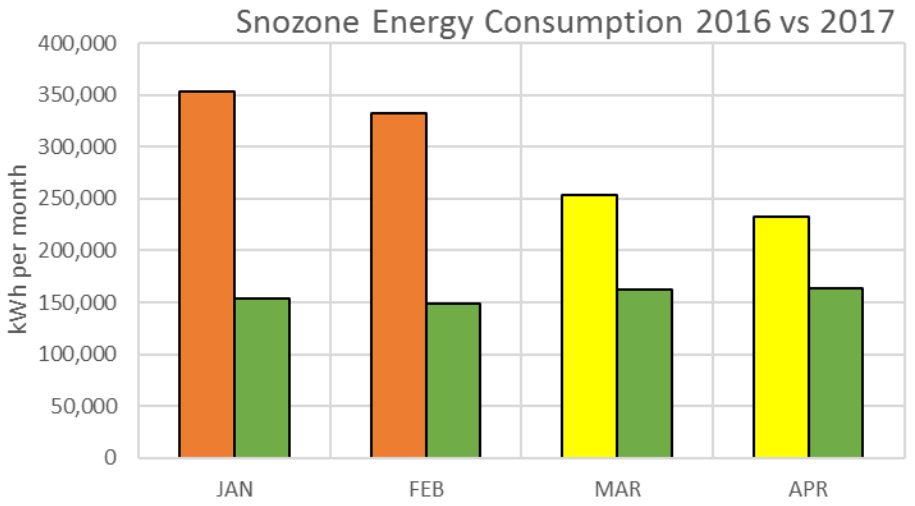


Case Study 2 – Snozone

- Ammonia energy savings
  - 56% reduction in energy in last four months of 2017 compared to 2016
  - 46% reduction in energy in first four months of 2018 compared to 2017



Conclusions

- Low charge ammonia chillers are a viable alternative to HFCs for small industrial applications
- Customer need to look at total cost of ownership
- Energy savings can yield long term financial benefits
- Important to carry out ammonia hazard assessment