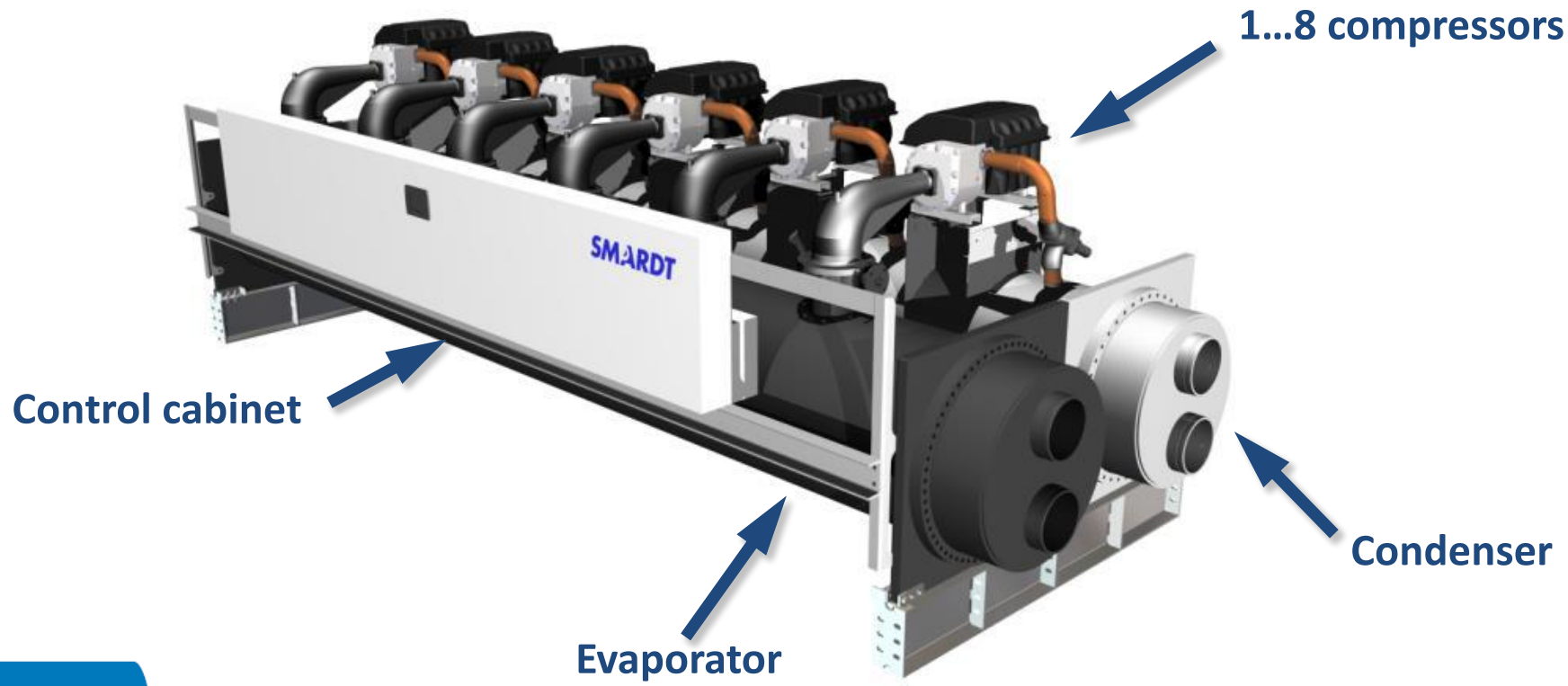
Smardt Water Cooled Chillers

60-1140tonR(200-4,000kWr)



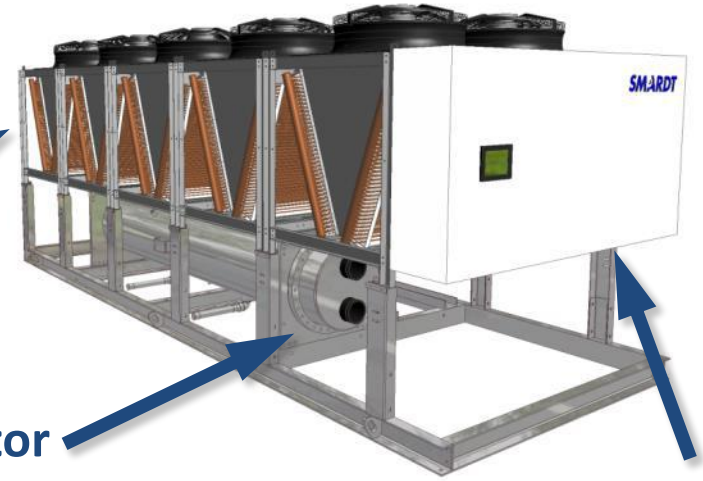
AHRI CERTIFIED™
www.ahridirectory.org
Water-Cooled Chillers
AHRI Standard 550/590
C

SMARDT

Smardt Air Cooled Chillers

60-430TR (200-1500kWr)

1…4 compressors



Condenser with EC-fans

Evaporator

Control cabinet

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Air-Cooled Chillers
AHRI Standard 550/590
C

SMARDT

Advantages of Smardt

- Exclusively oil-free chiller technology
- Largest oil-free R&D facilities anywhere in the world
- Designing and Manufacturing oil-free chillers since 2000
- Certified Chiller Test Facilities in Australia, Canada, Germany and China
- Large number of Smardt staff are former Turbocor Inc. employees
- Close relationship with Danfoss Turbocor Compressors Inc.
- Smardt is the largest user of DTC oil-free compressors (>30% of total world-wide production)
- **Smardt has the only Danfoss Turbocor certified compressor repair center in the world.**
- Smardt has over 4,000 chillers installed world wide, with chillers operating in diverse climates.
- Fully AHRI Certified Product Range

AHRI CERTIFIED™ www.ahridirectory.org

SMARDT

Question:
Why should you choose a Smardt oil-free chiller?

Answer:

They provide the highest efficiencies and lowest cost of ownership, whilst also increasing reliability by eliminating conventional chiller issues.

SMARDT

Conventional Chiller Issues

- Inefficiency – particularly at part load
- Inability to run continuously at part loads
- Noise and Vibration
- Unreliability and High Maintenance
- Electrical constraints
- Physical constraints - size, weight and cost of replacements
- Cost of Maintenance, Parts, Filters, and Oil
- Oil Related Problems
  - Oil Return Issues
  - Reductions in Heat Transfer
  - Contaminated Waste Disposal

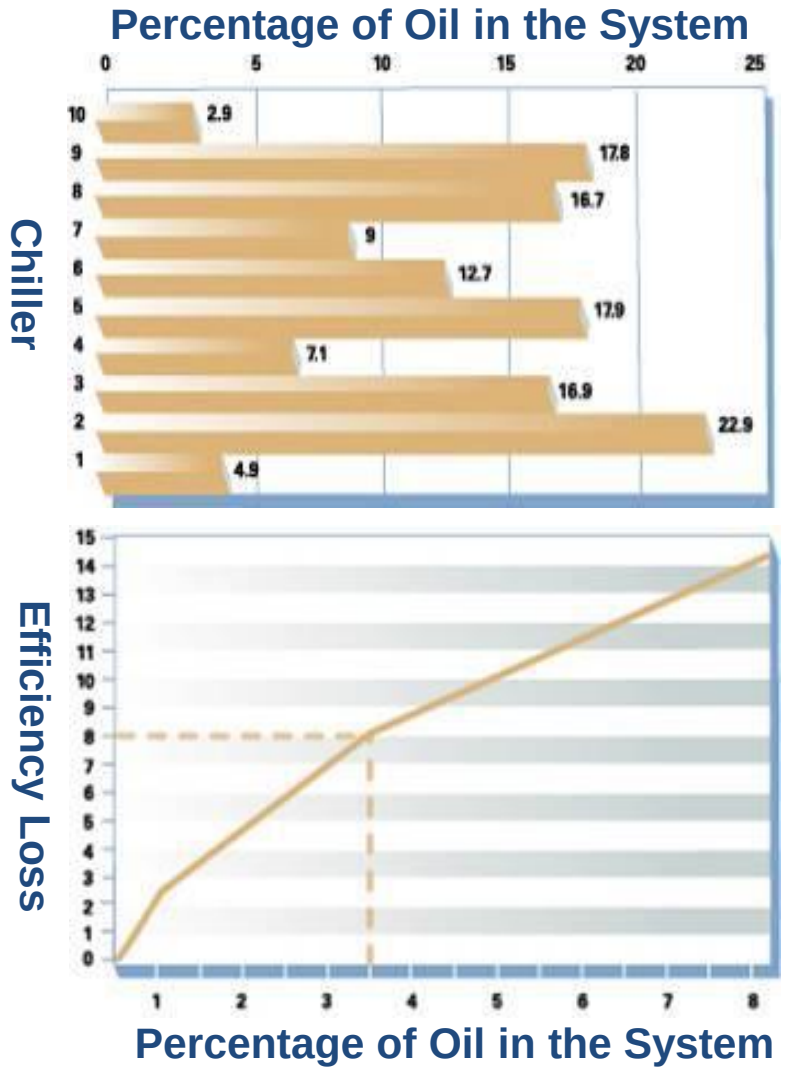
SMARDT

Conventional Chiller Issues – One Source

- Compressor Technology is the major source of chiller issues and affects a chillers ability to;
  - reduce energy consumption
  - Accurately match operating conditions
  - Offer more environmentally friendly solutions
  - Reduce operating costs over a chillers lifetime
- Today's dominant 'solution':
  - Combine old compressor technologies, such as screw compressors, with variable speed technologies to reduce energy consumption.
  - This may improves efficiency, but accentuates oil-related issues

SMARDT

The Effects of Oil

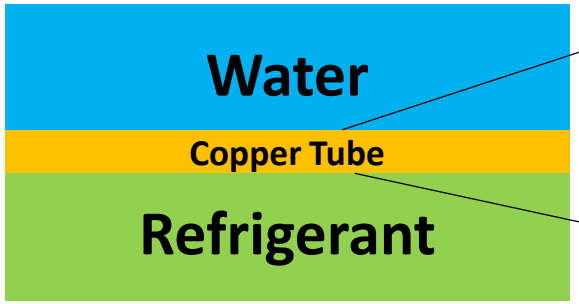


- The top ASHRAE study determined the average quantity of oil as a percentage in older chillers.
  The average is 12.88%.
- The bottom study equated presence of oil to efficiency loss.
  3.5% of oil = 8% efficiency loss.
- **Smardt Chillers have been designed around the oil-free Turbocor compressor and as such do not use any oil.**

SMARDT

The Effects of Oil

Drop of heat exchanger efficiency because of oil slick / coating

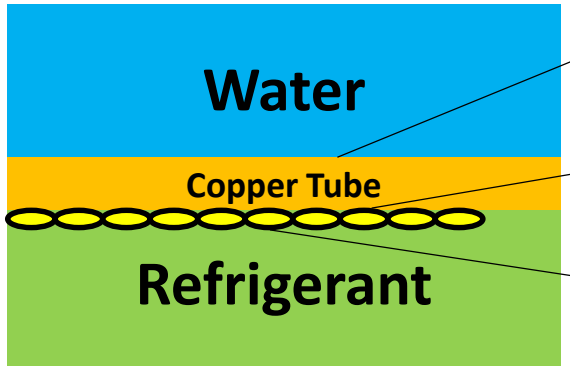


Leaving Chilled water temperature @ 7C

Refrigerant Saturated Temperature @ 6C

- A healthy approach of 1C

A brand new heat exchanger



Leaving chilled water temperature @ 7F

Sticky oil particles on the heat exchanger

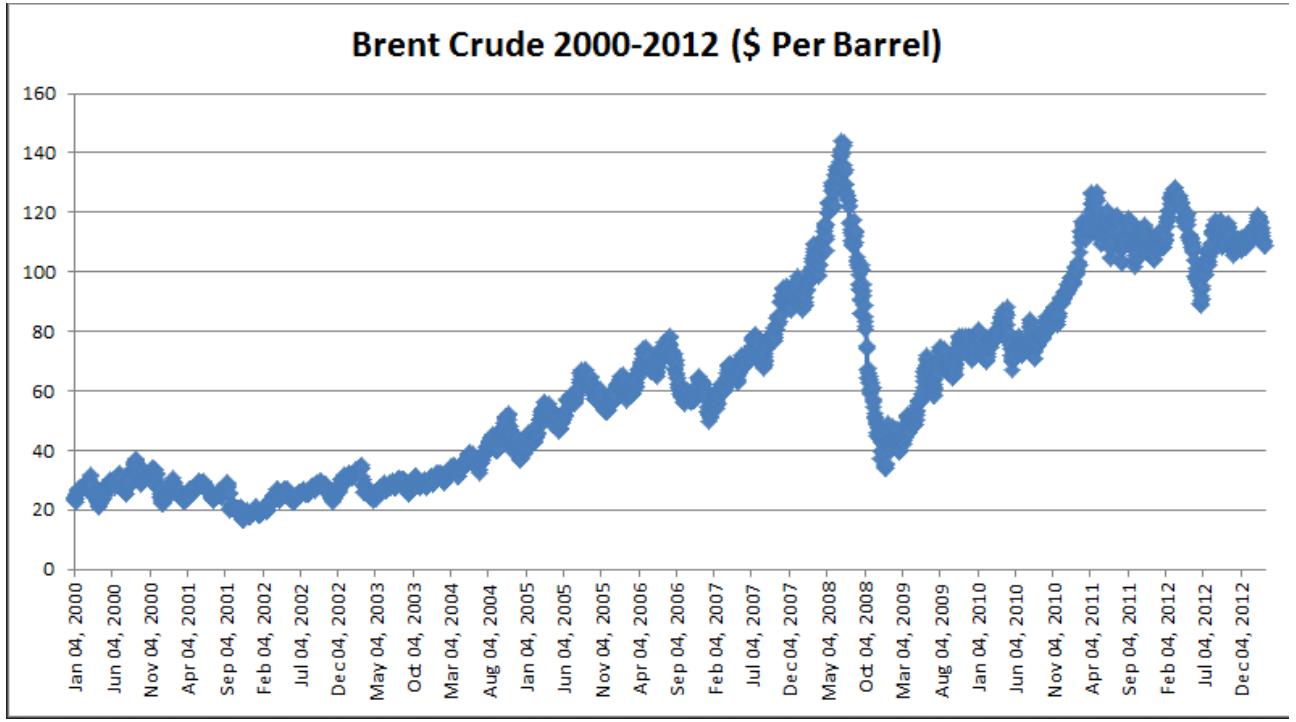
Refrigerant Saturated Temperature @ 4C

- Accumulation of oil increase the approach to 3C
- Additional 2C will reduce efficiency by approx. 20% (based on 5C ΔT)

The effect of prolonged oil in the system

The Direct Cost of Oil

Ever increasing price of oil and its by-products



- Price of petroleum by-products linked to crude oil
- Annual increase of 15% on the price of oil
- For a chiller plant room with 3 x 500RT, estimated annual oil consumption *USD10,000

(*assume each chiller required 15 gal and oil price @ USD200/gal)

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The In-Direct Cost of Oil

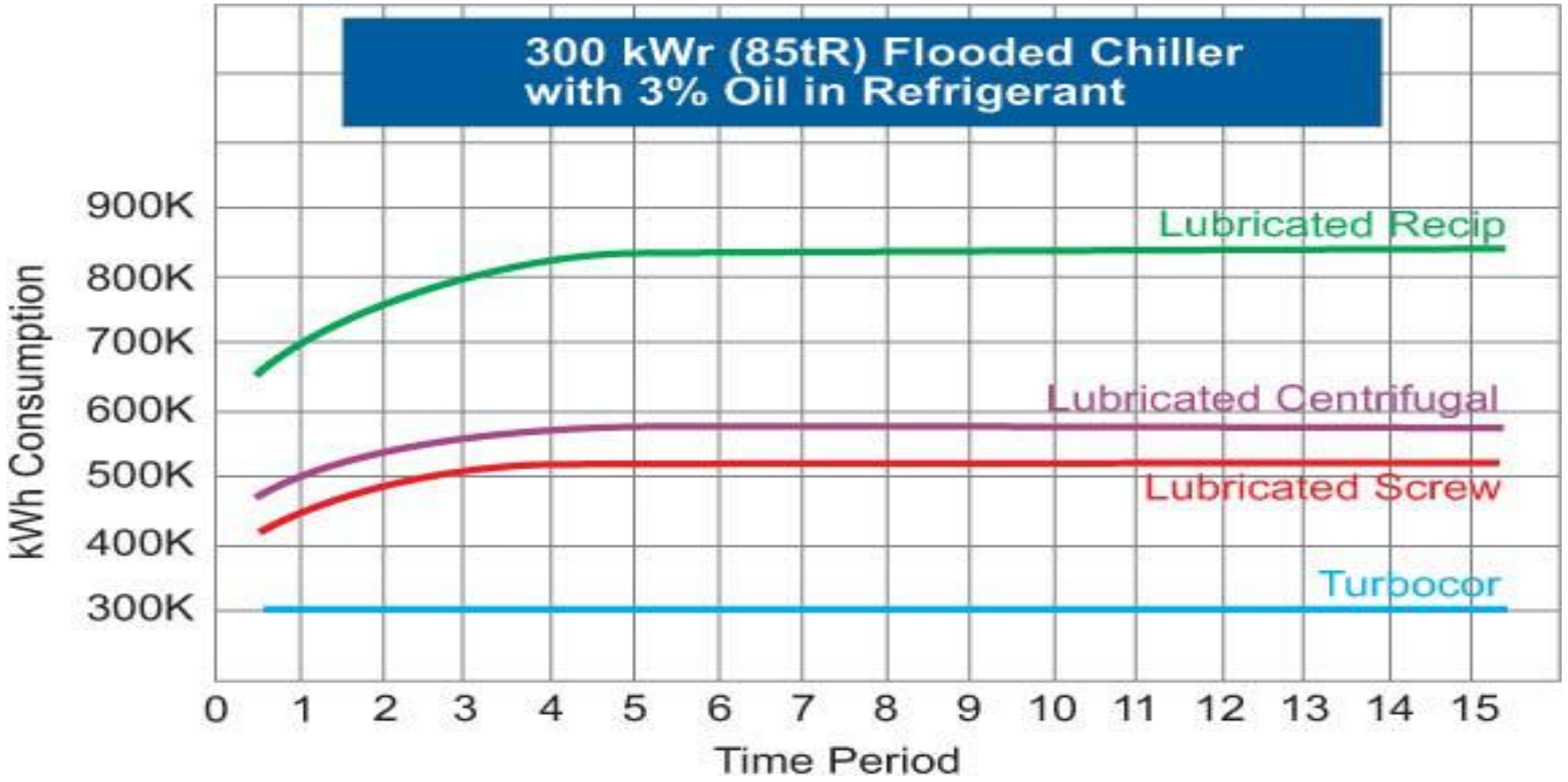


Diagram: as this comparative study showed, over 20% of lubricated chiller's operating efficiency is routinely lost in the early years as a result of oil clogging of heat transfer surfaces.

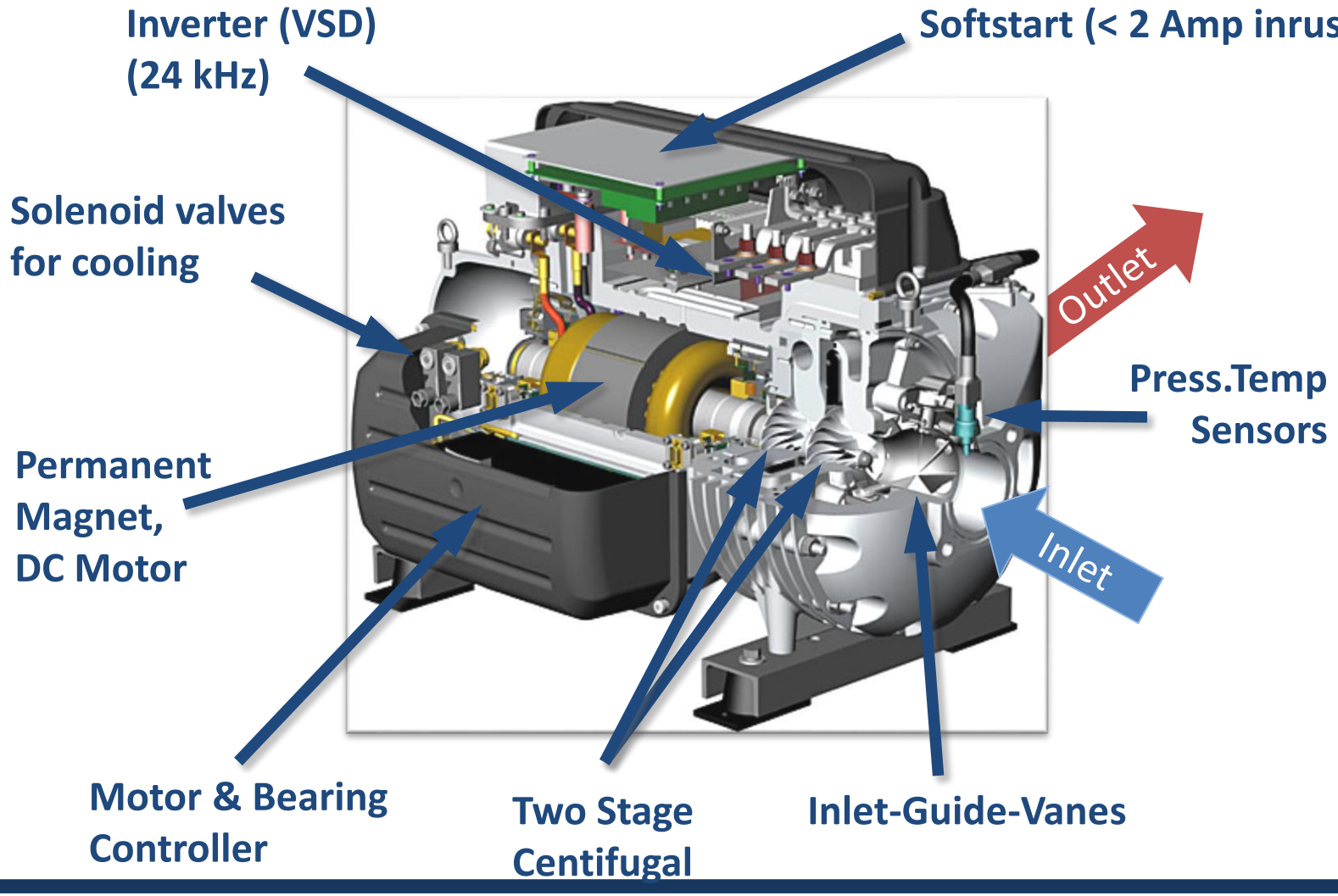
SMARDT

The Smardt-er Alternative - One Solution

- A Magnetic Bearing, Oil-Free, Centrifugal Compressor.
- Designed from the “ground up” to address the issues and the need for environmental responsibility.
- This revolutionary compressor provides:
  - Increased Energy Efficiency
  - Elimination of Oil Related Issues
  - Noise Reductions
  - Reduced Maintenance Requirements
  - Weight and space reductions
  - Increased Chiller Capabilities

SMARDT

Revolutionary compressor technology



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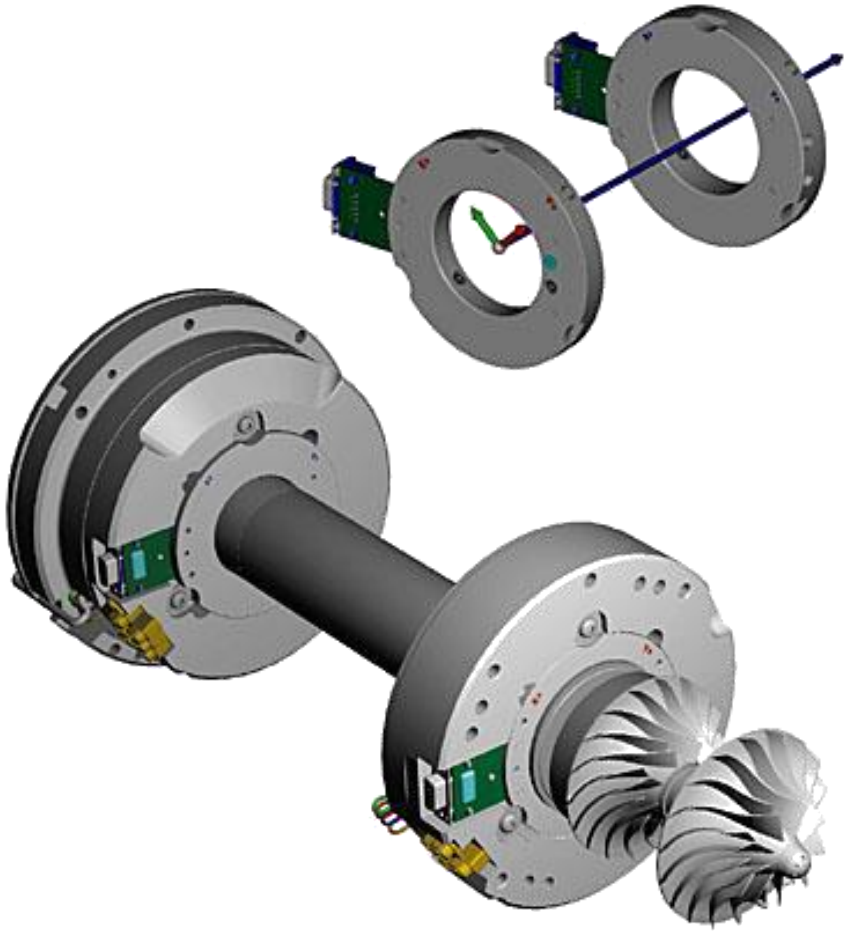
Key Technologies - Magnetic Bearings

- Magnetic Bearings
  - Eliminate high mechanical friction losses
  - Increase equipment life through elimination of wear surfaces
  - Eliminate oil-related heat transfer losses
  - Eliminate complex oil management systems (controls and hardware)



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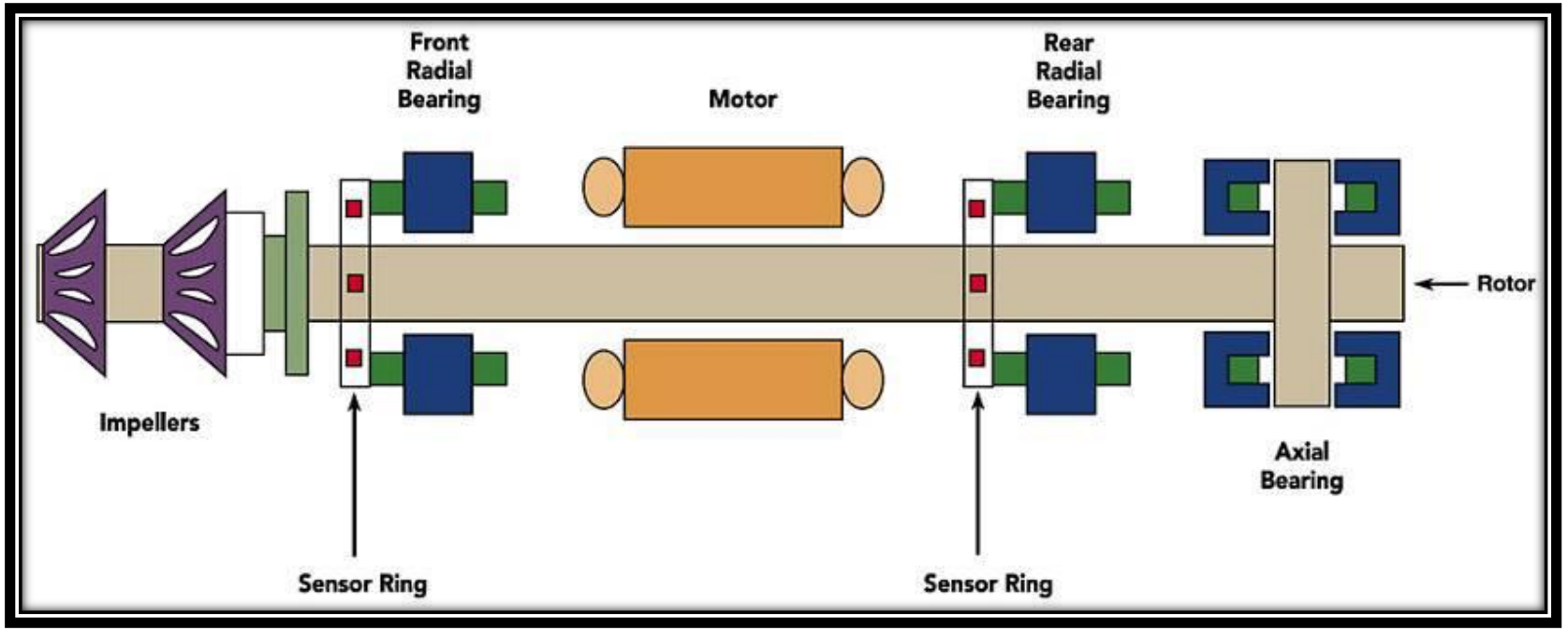
Magnetic Bearing System



- Active re-centering of the shaft at 100,000/second.
- Movements measured and actively adjusted in mere microns.
- Shaft kept controlled and centered to within 7micron. (1/10th of the diameter of a human hair.)
- Back up bearings are included to prevent damage to the shaft should a control or bearing failure occur.

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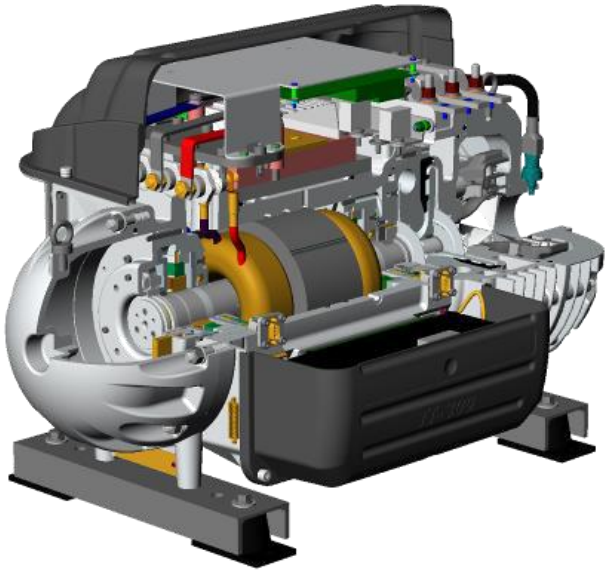
Power Outage?

- Within 0.5 of a micro-second, the motor becomes a generator, feeding power to the various controls and bearing actuators during a controlled coast-down.
- The onboard capacitors have enough power to fully support the bearing system during the switch from motor to generator mode.
- After the compressor comes to a complete stop, the rotor de-levitates normally onto touchdown bearings.
- Smardt Chillers can be rapidly restarted without concern as there is almost no inrush current to the motor and there are no oil based constraints.



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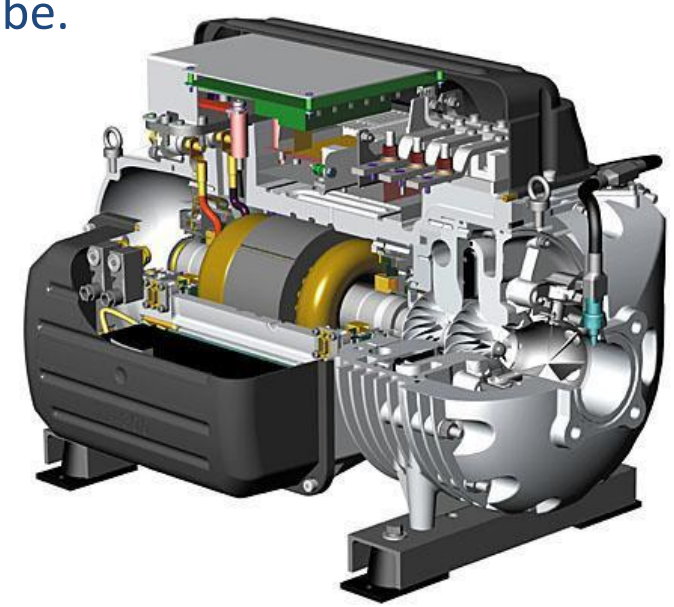
Variable Speed Drive

- The Compressors speed adjusts automatically to match the load and current operating conditions so that optimum efficiency is gained.
- We vary the speed for most of our capacity control, and only use the Inlet Guide Vanes when beyond the range of solely relying on speed.
- The slower the compressors, the greater the efficiency. As speeds is reduced, energy consumption is reduced by the cube.
  - Speed $\propto$ Energy^3
- Speed range of 12,000 – 45,000 r.p.m.



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Simplest Centrifugal Compressor

- This oil-free compressor has essentially only **a single moving part**
- The compressor's high speed capability, reduces its overall size
- Centrifugals offer the highest aerodynamic compression efficiency at full load and with an integrated VSD, they also provide the best part load efficiencies

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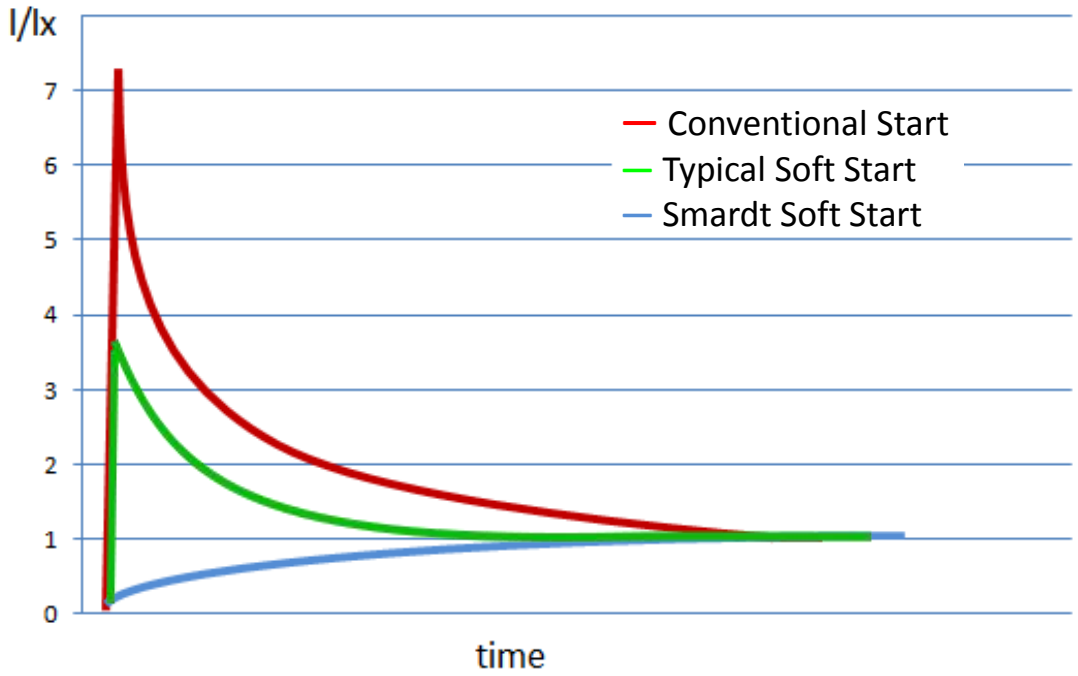
Smardt-Chiller – True Soft Start



Starter Type	Starting Current (% of FLA)
VSD	100%
Solid State	300%
Auto Transformer	400-500%
Part Winding	400-500%
Wye-Delta	200-275%
Across the Line	600-800%

Diagram: Smardt chillers, require only 2 amps for start-up, compared with 1200-1400 amps in conventional machines.

- Low in rush current, ideal for replacement and retrofit projects - 1:1 ratio generator sizing

→Further savings for owners, who can reduce maximum power loads and reduce backup generator size.

SMARDT

Lowest Sound and Vibration Levels

- “Best in Class” lowest sound levels. No moving mechanical part touches any part of the housing or frame to transmit acoustic energy.
- Compressor tested at 72 dBa at 1 meter with no sound attenuation. Screw compressors, by comparison, are approximately 80 dBa or higher.
- A Smardt Chiller with 5 compressors operating at full speed only produces 75 DB of sound at 3m, about the sound level of your television.
- Vibration is essentially non-existent.

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Smardt-Chiller - Efficiency

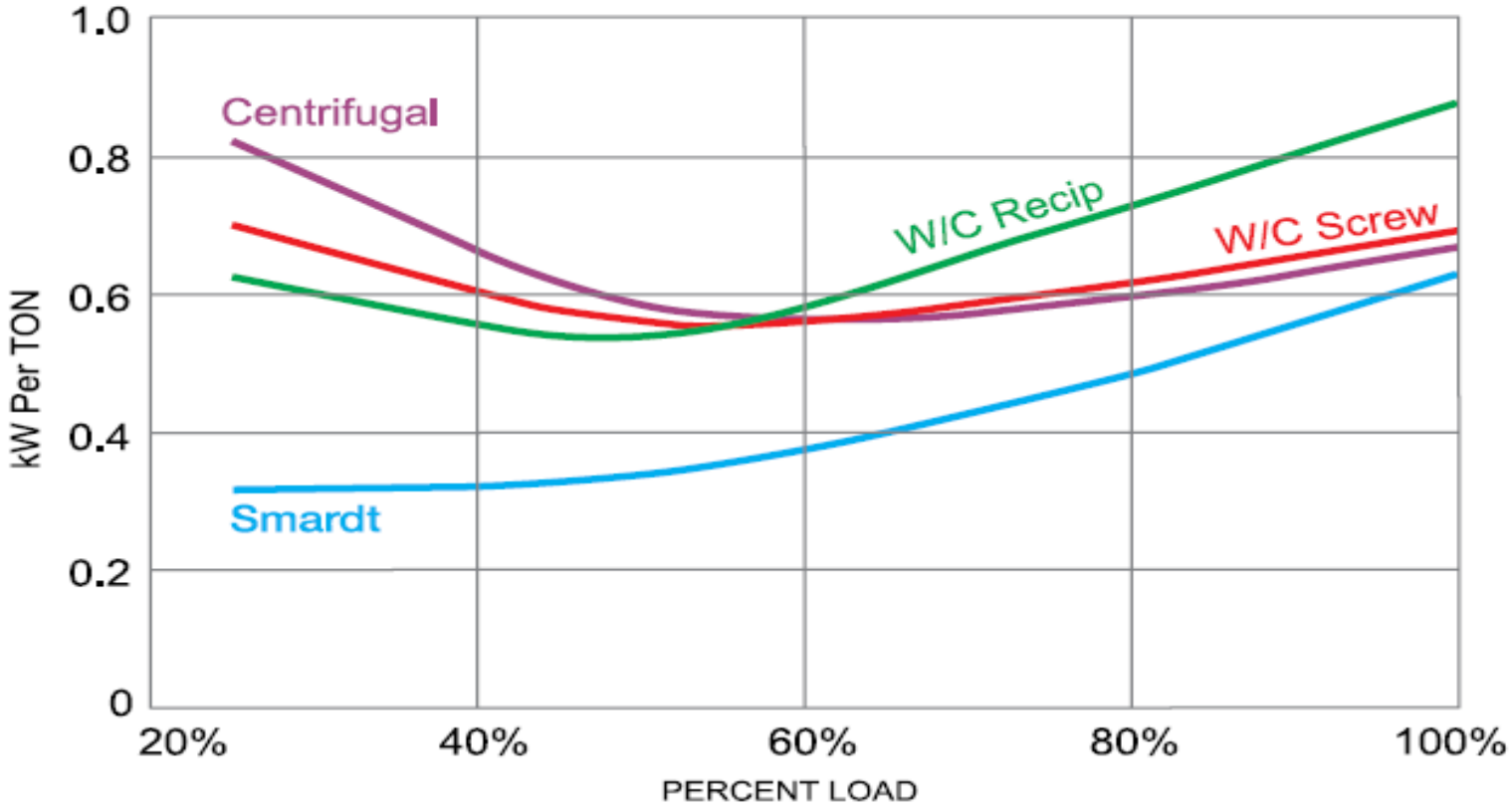

Diagram: Comparison uses generic industry performance data for 250TR water-cooled chillers (data source AHRI) with cooling tower relief

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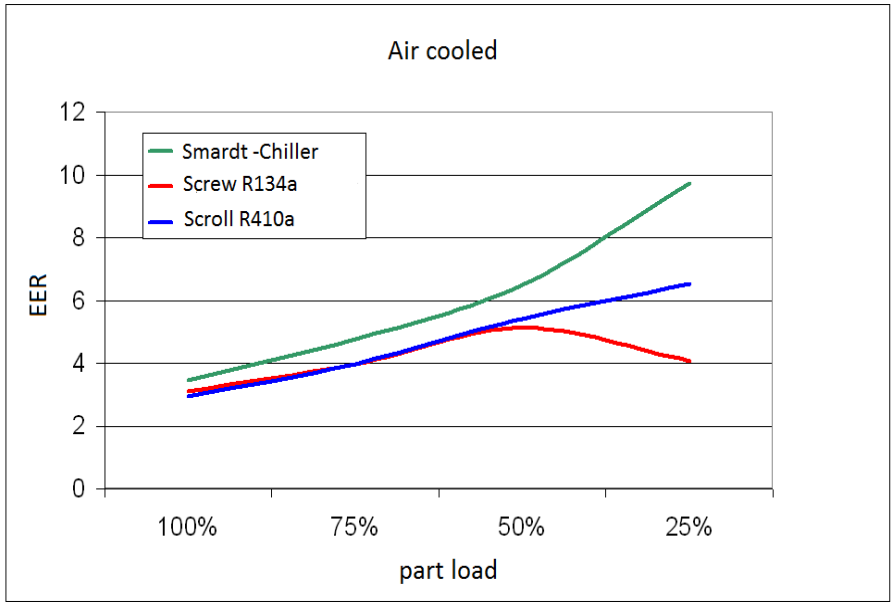
Smardt-Chiller - EER Characteristic



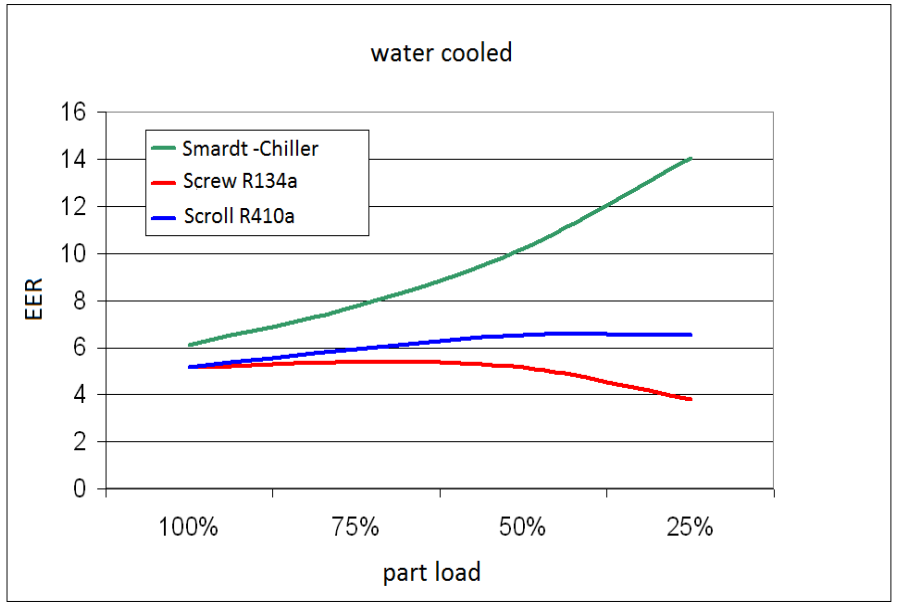
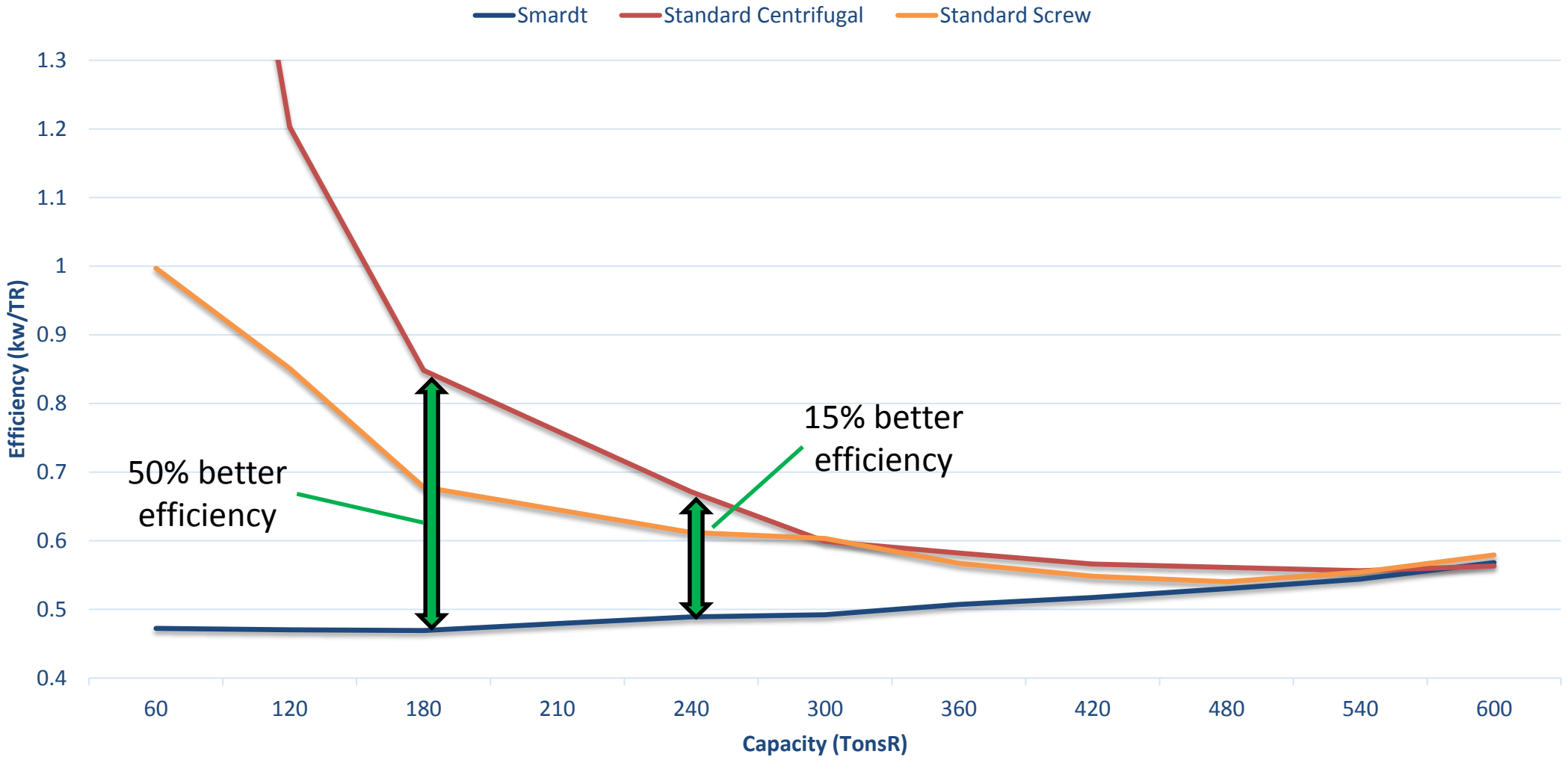


Diagram: EER comparison under various capacities between conventional Screw, Scroll and the Smardt – Chiller. Based on Eurovent

→ **Lowest lifetime operating costs**

Smardt vs. Centrifugal vs. Screw

Constant Condenser Water Temp (6.7C/ 12.2C and 29.5C/35C, based on 600RT)



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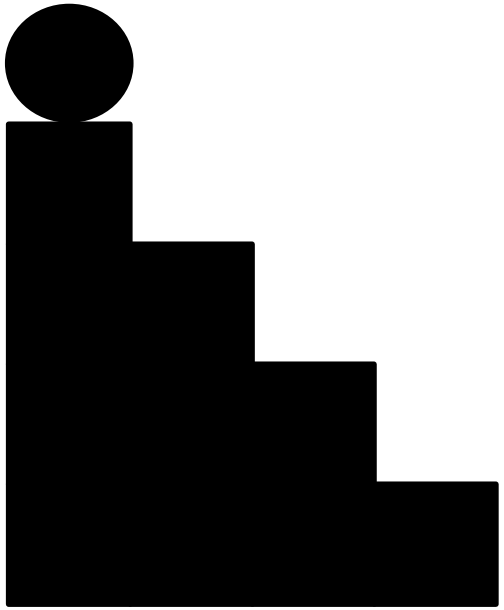
Conventional Centrifugal VS Smardt Centrifugal

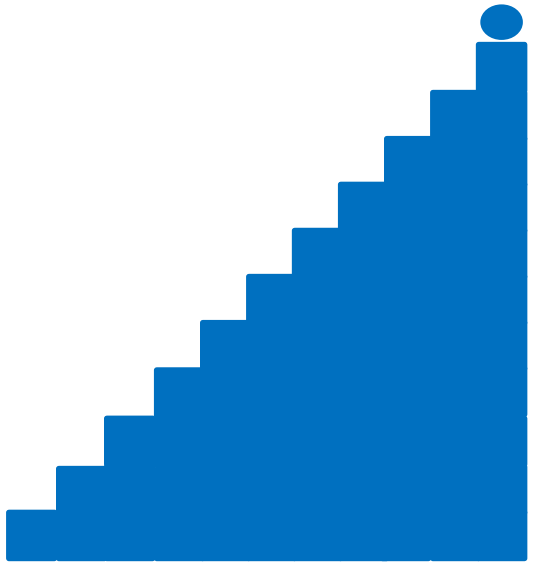
Conventional Centrifugal with VSD

- Direct Drive AC Motor
- Running on max 3000RPM = 50 Hz
- Therefore only 50 steps in a cycle
- Less resolution and precision capacity control



Smardt Chiller with integrated VFD

- Built in DC, PWM converter to vary speed
- RPM range from 12000RPM to 45000RPM
- Up to 750 steps in a cycle
- Higher resolution and precision



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Part Load Optimisation

- To achieve the best efficiency when operating the chiller, the maximum number of compressors run in parallel.
- This is controlled by propietary logic developed by Smardt and managed by Smardt‘s own chiller controller

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Smardt Chillers – Reliability

Redundancy in HVAC or Process cooling is critical

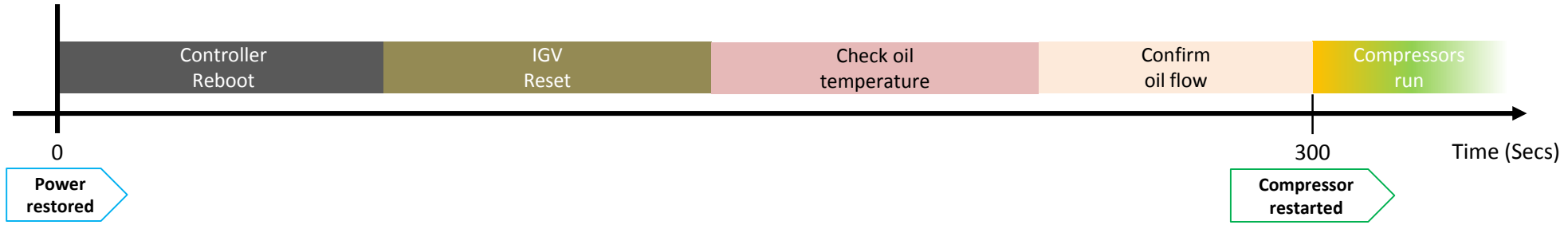
A compressor issue reduces chiller capacity to 0%

A compressor issue reduces chiller capacity to 75%

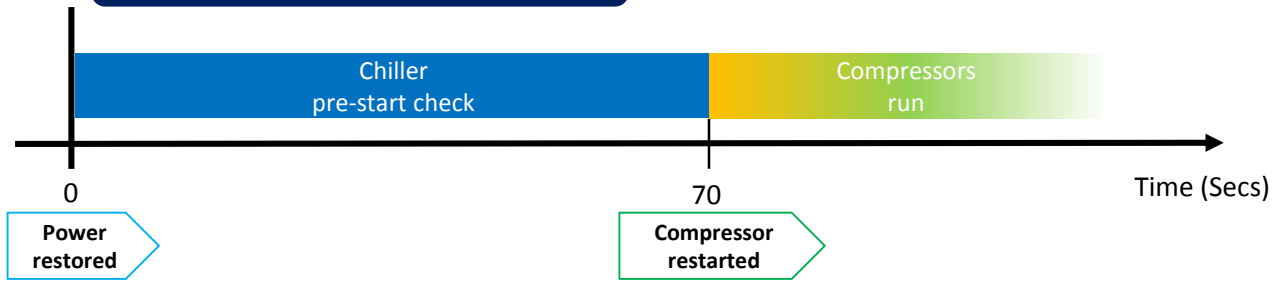
SMARDT

Smardt Restart

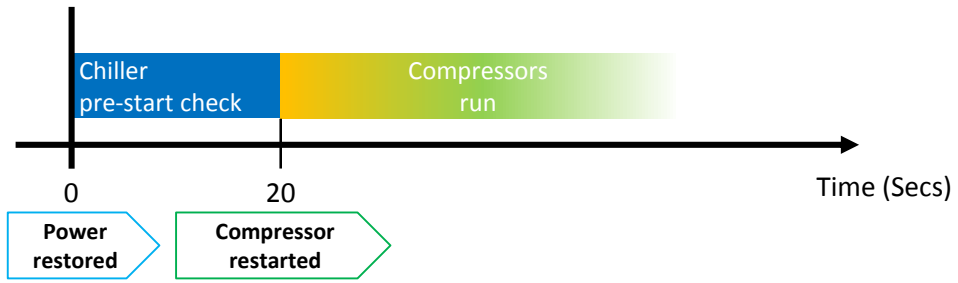
Conventional oil base chiller @ short power failure



Smardt Restart @ long power failure



Smardt Restart @ short power failure

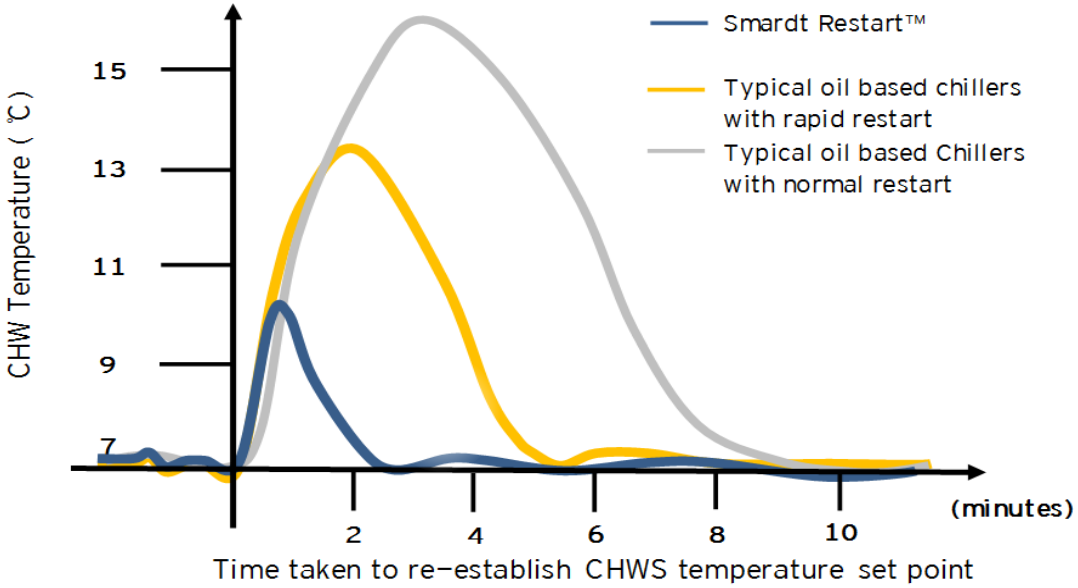


SMARDT

Smardt Restart

How Smardt Restart works

- The advanced Smardt controls see the power failure and switch to a fast restart mode, which alters the chiller's compressors start logic.
- On the compressors the fast-start function will skip the IGV and bearing calibration.
- Once the power is restored, the shaft will levitate and the motor will ramp up at approx. 1000 rpm per second to satisfy the cooling load



Fast-start benefits

- Chiller back on line within 20seconds.
- Fluctuation in chilled water loop temperature limited
- Applications where chilled water supply is critical will not be impacted by a intermittent power loss
- Flexible start up times
- Eliminate additional thermal storage

Protection

- All power losses are logged and recorded.
- The start-up mode has additional motor and surge protection

SMARDT

Smardt Restart Advantages

- No pre/post lube required (conventional oil-lubricated compressors takes around 60 seconds to do pre/post lube)
- No oil heater; smaller UPS required
- No oil temperature checks required
- No mechanical stress on compressors during restart
- No thermal stress on motor during multiple restarts
- No IGV calibration required
- No power surge on restart – 2 Amps starting current
- No coast down cycle
- No hours based limitation on number of restarts (open drive compressors should only be restarted twice an hour)
- Controller remains powered up and communicating
- Fast chilled water recovery with Smardt's proprietary programme
- Eliminate the need for additional thermal storage

SMARDT

Integrated Redundancy

"Integrated redundancy is a design concept that increases operational availability, whilst reducing operating and infrastructure costs…"

Conventional oil based chiller configuration with single compressor (2000RT+1000RT)

1000RT + 1000RT = 2000RT (N)

500RT + 500RT = 1000RT (+1)

Peak load at 1800RT
Night load @ 300RT

Smardt chiller configuration with multiple compressors (2000RT) (140RT x 14)

1000RT + 1000RT = 2000RT (N)

SMARDT

Integrated Redundancy

Conventional oil based chiller with single compressor

Total capacity = 2000RT + 1000RT

Chiller 1 | Chiller 2 | Standby Chillers

Peak load at 1800RT
Night load @ 300RT

Smardt chiller with multiple compressors

Total capacity = 2000RT

Chiller 1

Chiller 2

Each compressor is about 7%

2000RT * 93% = **1860RT**

- Low initial cost
- Low maintenance cost
- Space saving
- No fluctuation of chiller water supply temperature

SMARDT

Active Redundancy

Peak load at 1800RT
Night load @ 300RT

Conventional oil based chiller with single compressor

1000RT 1000RT

2x 500RT (Standby)

Conventional chiller efficiency
@ 90% load = 0.56 kW/ton

Smardt chiller with multiple compressors

1000RT 1000RT

1000RT (Standby)

Oil-free chiller efficiency
@ 60% load = **0.47kW/ton**
20% saving!

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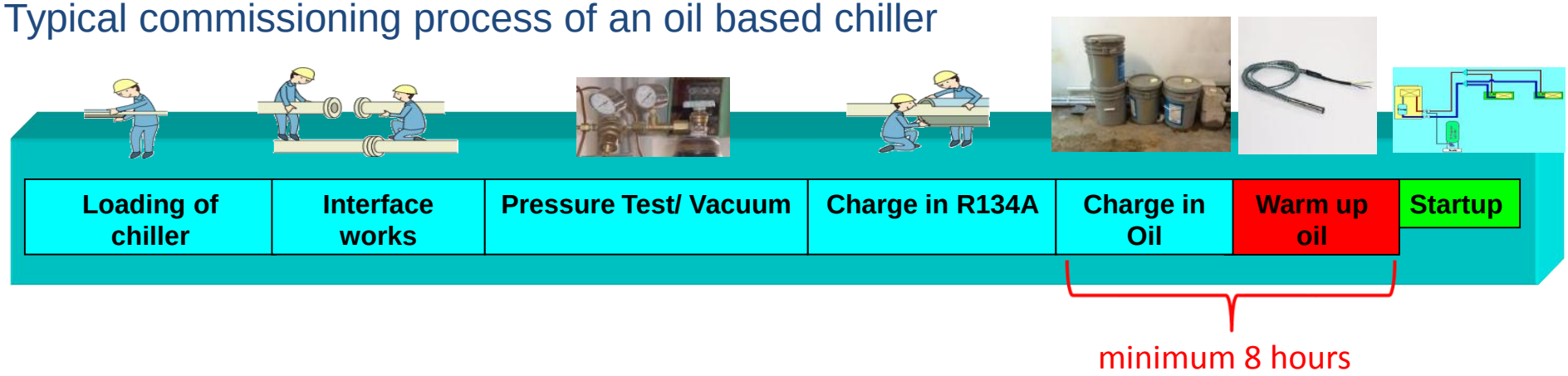
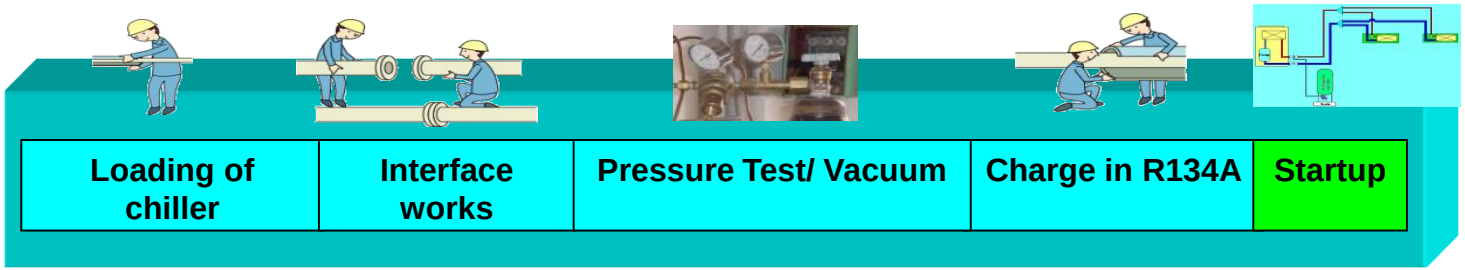
Service Convenience

Typical commissioning process of an oil based chiller



Typical commissioning process of a **SMARDT** chiller



Maintenance Reductions

- Over 70% of chiller field costs are due to problems with compressor oil return (Sources: Emerson Electric, AHRI)
- This compressor is **virtually maintenance free**, as the Magnetic Bearings have eliminated wearing surfaces – irrespective of the running hours on the compressor.
- Unique anti corrosion options available on AC and WC
- Smardt chillers have less maintenance as they do not contain any oil, or oil management hardware.
  - No Oil Changes or Oil Filter replacements
  - No Oil and Refrigerant Testing Required
  - No Filter Dryer Replacements Required
  - No Oil Migration at Part Load
  - No Oil Fouling
- Reported reductions in Maintenance costs of around 50%.

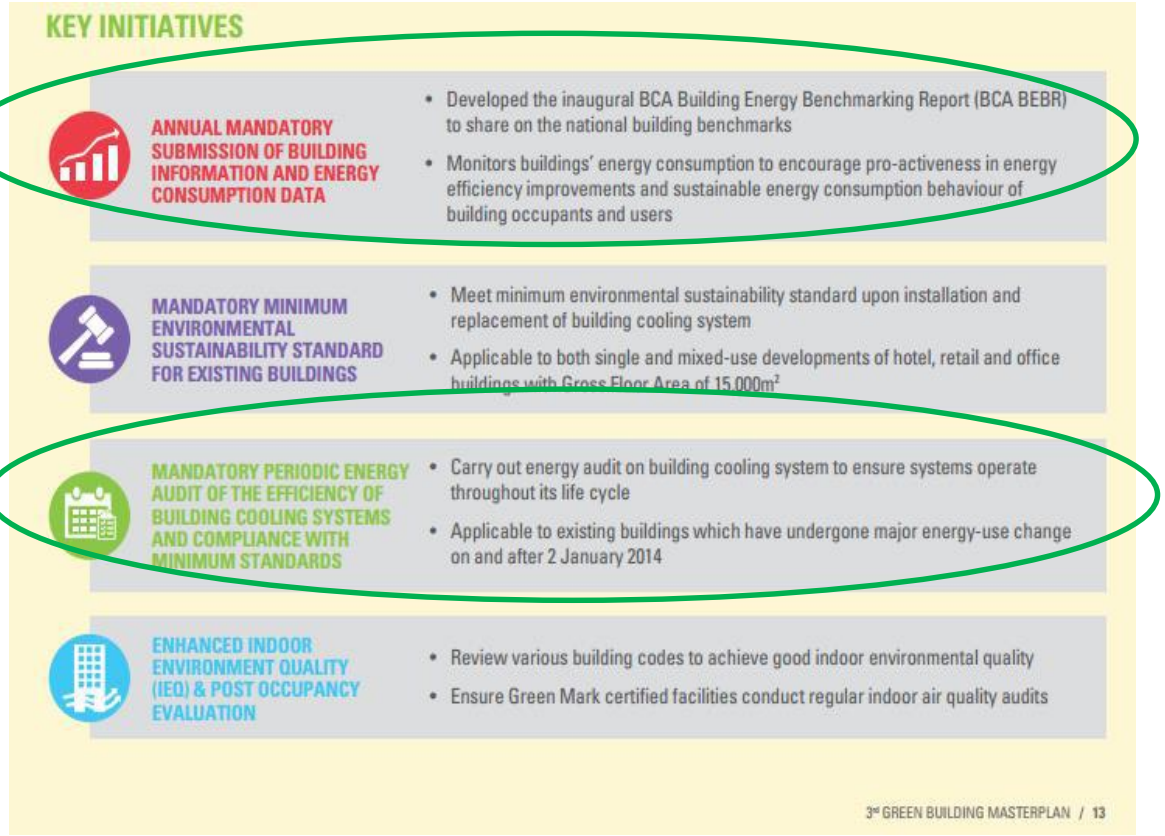
100%

OIL-FREE

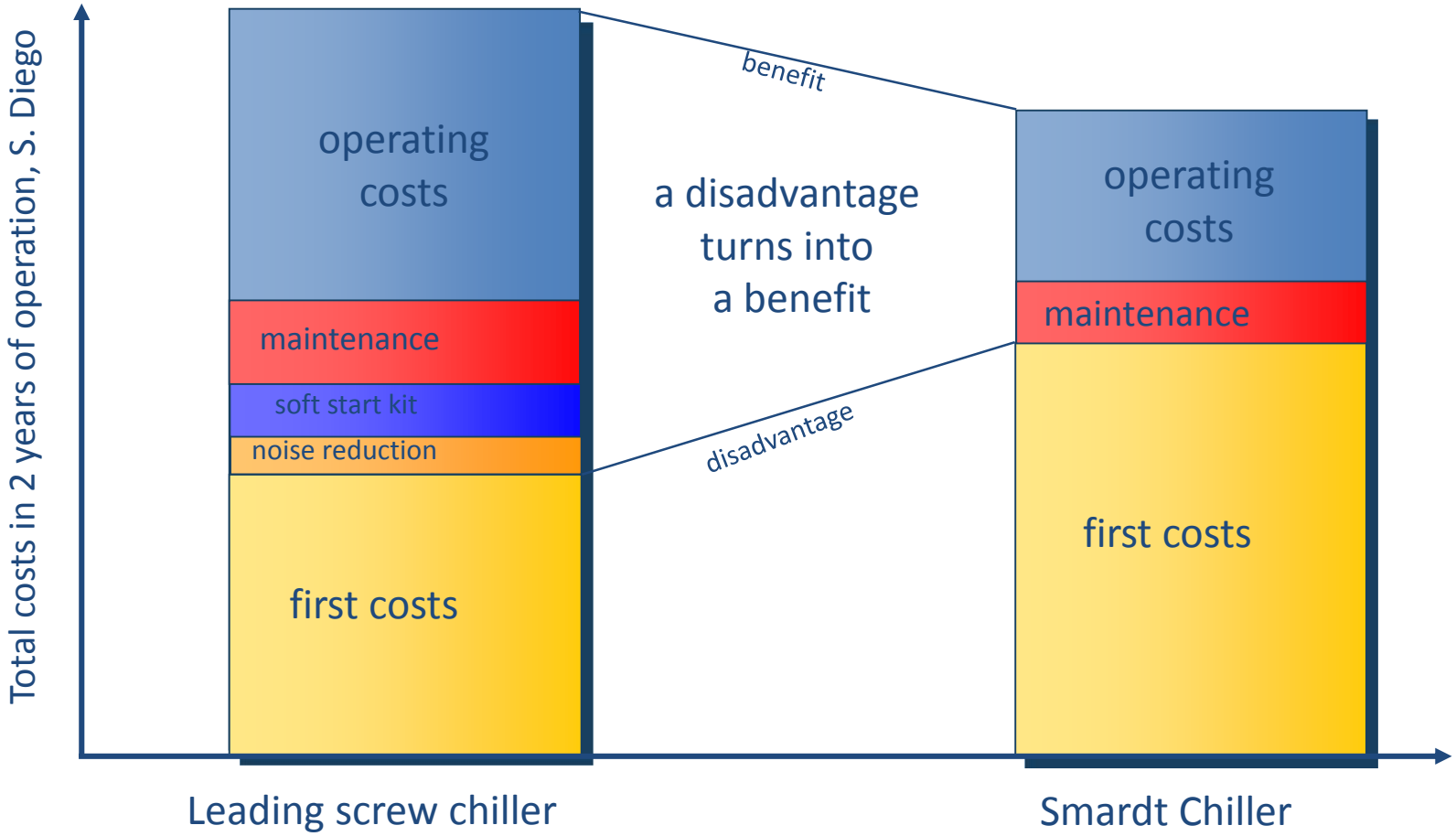
Sustainable Performance

- Virtually no loss in efficiency due to no oil in system and no wear to the compressors

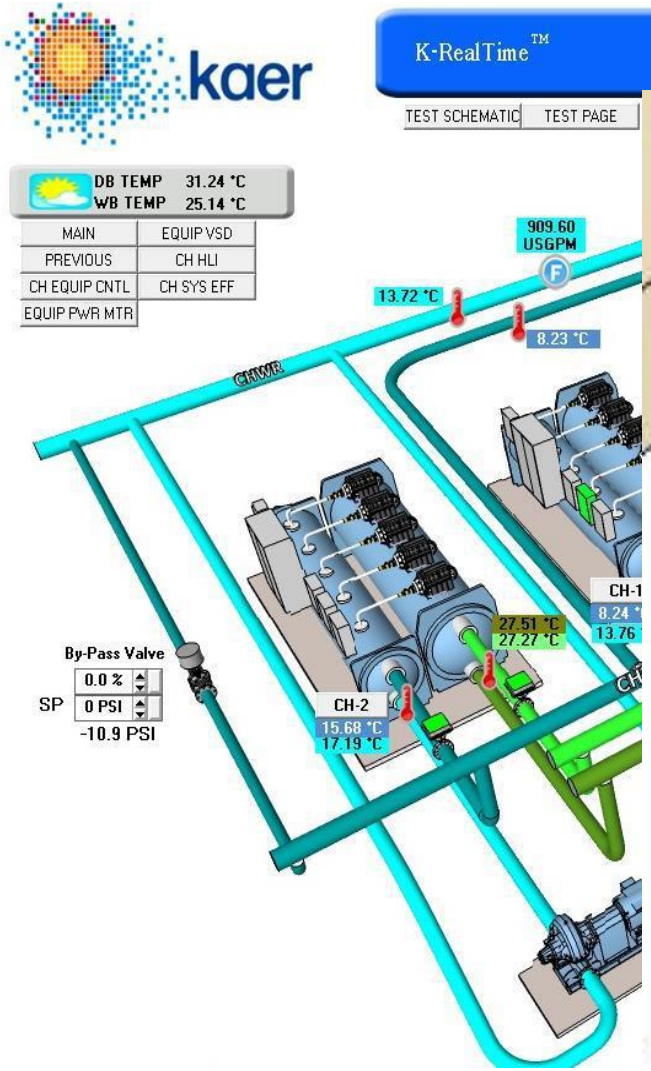
Under the 3rd Green Building Masterplan, the 3rd strategic goal is **Proven Sustainability Performance**.



The better solution often has the higher first costs



Measurement & Verification



SYSTEM EFFICIENCY	
Chiller Efficiency KW/RT	0.501 KW/RT
CHWP Efficiency KW/RT	0.032 KW/RT
CWP Efficiency KW/RT	0.032 KW/RT
CT Efficiency KW/RT	0.034 KW/RT
System Cooling Load RT	374.6 RT
System Rejected Heat RT	441.9 RT
System Power KW	224.8 KW
System Total Efficiency	0.599 KW/RT
System Heat Balance %	-3.15 %

K-RealTime to continuously track & optimize the chiller plant performance

Leading companies trust Smardt

SMARDT