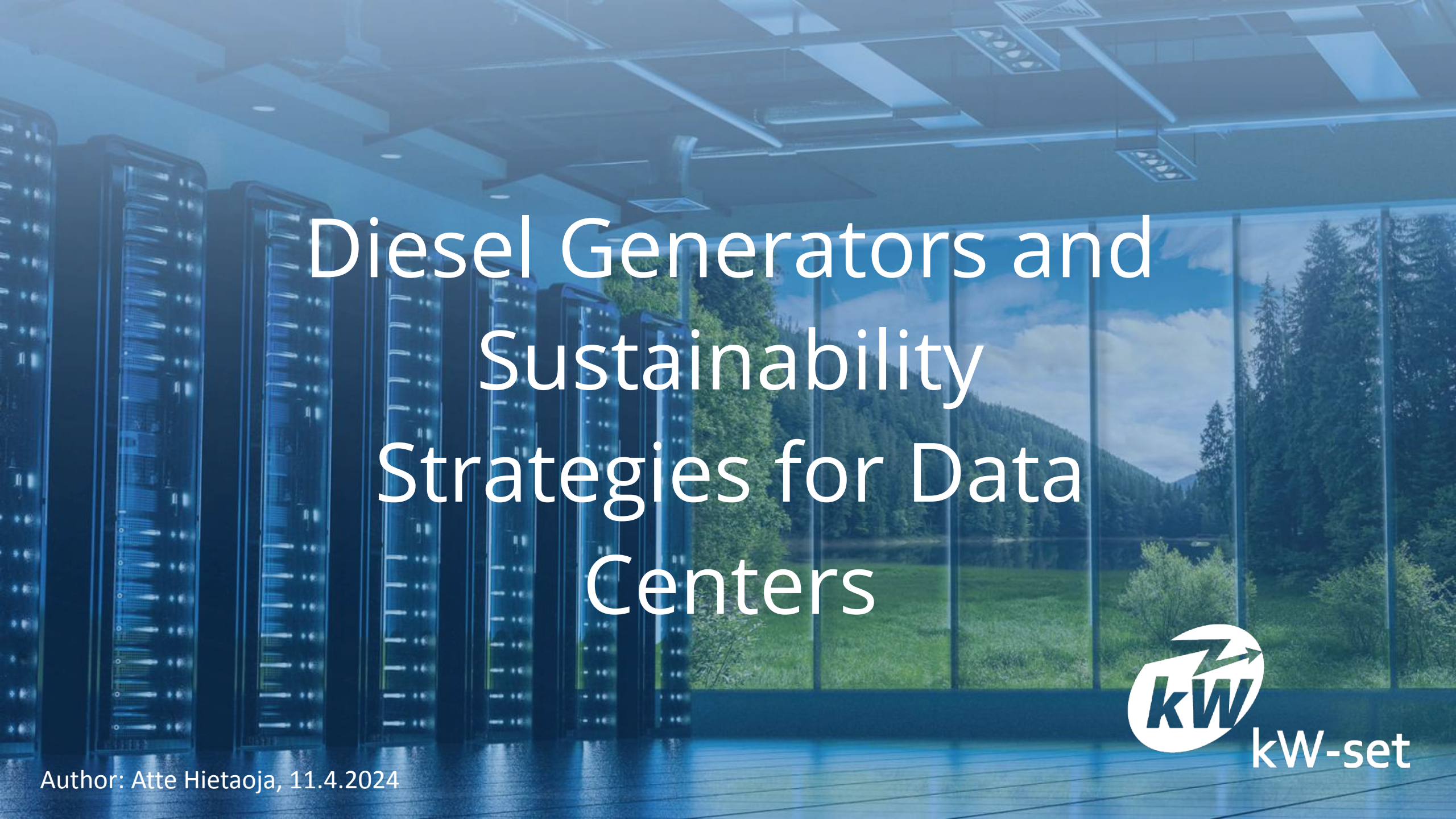

# Diesel Generators and Sustainability Strategies for Data Centers

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Author: Atte Hietaoja, 11.4.2024

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# Data Center Sustainability

Data centers

- Significant impact due to their energy-intensive nature
- Accounts for 1.8-2.6% of total EU electricity consumption (1.)

Tightening EU regulations

- Recent new legislation mandates energy efficiency reporting (2.)
- EU Emissions Trading System (EU ETS)

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# Diesel Generators' Role as Backup Power

## Critical Role

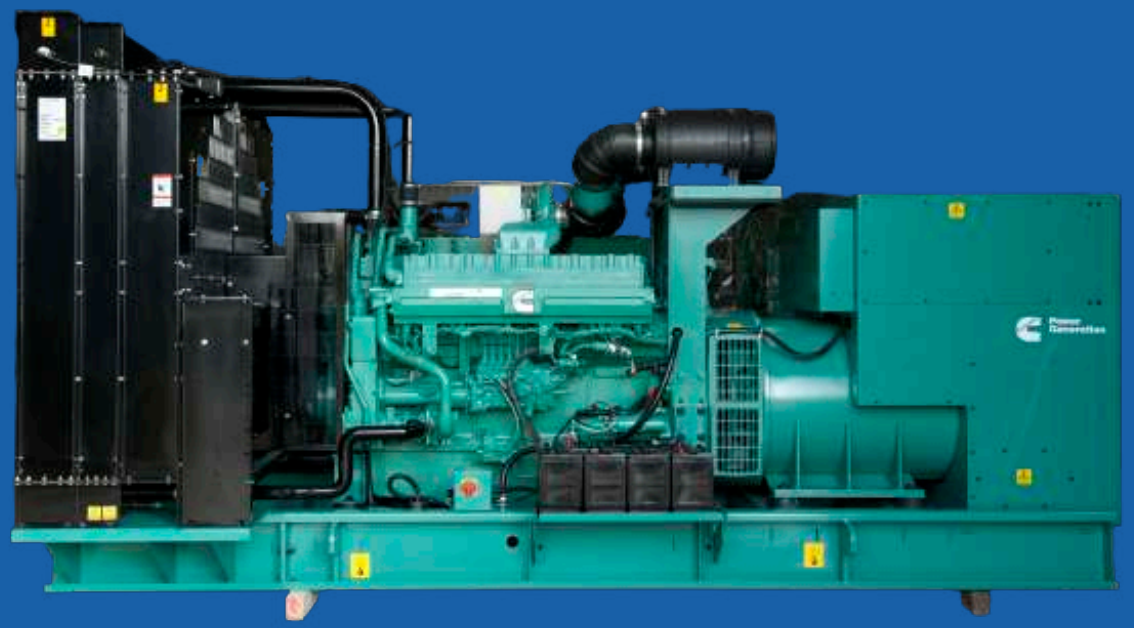
- Diesel generators provide essential and reliable backup power

## Efficiency vs. Emissions

- Highly reliable but a major source of harmful emissions: NOx, PM, CO, and CO2

## Sustainability Mandate

- Environmental concerns drive the demand for greener alternatives



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# Strategies for Reducing Diesel Generator Emissions

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# Impact of Engine Selection

Leverage advanced engine technologies and electronic control systems for improved emissions

Prioritize EPA Tier compliance to ensure regulatory adherence and lower environmental impact

Choose engines with superior power-to-displacement ratios for better power density and efficiency

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# Impact of Engine Selection

| Comparative Emissions and Performance Metrics of Cummins High Horsepower Engines | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Engine Model** | **Displacement (liters)** | **Standby Power (BHP)** | **Fuel consumption (l/BHP·h)** | **NOx (g/BHP·h)** | **CO (g/BHP·h)** | **PM (g/BHP·h)** | **EPA Tier 2 Compliance** |
| KTA50-G8 | 50,30 | 1915,00 | 0,18 | 6,80 | 2,20 | 0,26 | No |
| QSK60-G8 | 60,20 | 2875,00 | 0,17 | 6,97 | 0,57 | 0,03 | No |
| QSK60-G23 | 60,00 | 3202,00 | 0,17 | 6,13 | 0,13 | 0,02 | Yes |
| QSK95-G4 | 95,30 | 4332,00 | 0,17 | 7,52 | 0,12 | NA | No |
| QSK95-G10 | 95,30 | 4377,00 | 0,17 | 6,46 | 0,14 | 0,01 | Yes |

# Fuel Selection: HVO Benefits

HVO

Using Hydrotreated Vegetable Oil (HVO):

- Lowers greenhouse gas emissions by 40-90% (3.)
- Reduces NOx, PM, CO, THC emissions
- Decreases engine smoke
- Can be blended with conventional diesel
- No engine or control modifications required

| Average Emissions Reductions for HVO (4. Erkkilä, et al. 2011) | | | | |
|---|---|---|---|---|
| NOx | PM | CO | THC | Smoke |
| -10 % | -30 % | -29 % | -39 % | -35 % |

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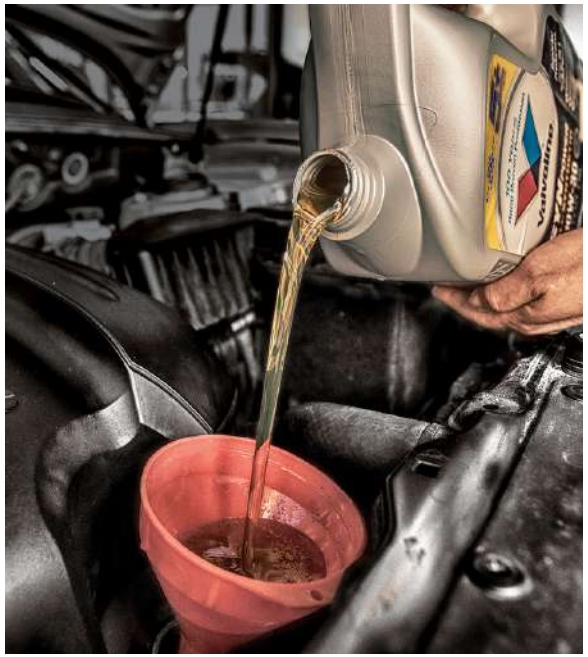
# Maintenance Protocols

- Recommended interval for oil replacement: annually
- Extend intervals with oil sample testing
- Save 350-650 liters of lubricating oil per generator annually
- Also applicable to cooling systems



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# Controlled Testing

Strategic Testing Schedule:

- Weekly 10-minute off-load tests ensure readiness
- Monthly 30-minute on-load to assess full operational capacity

Optimal Operating Conditions:

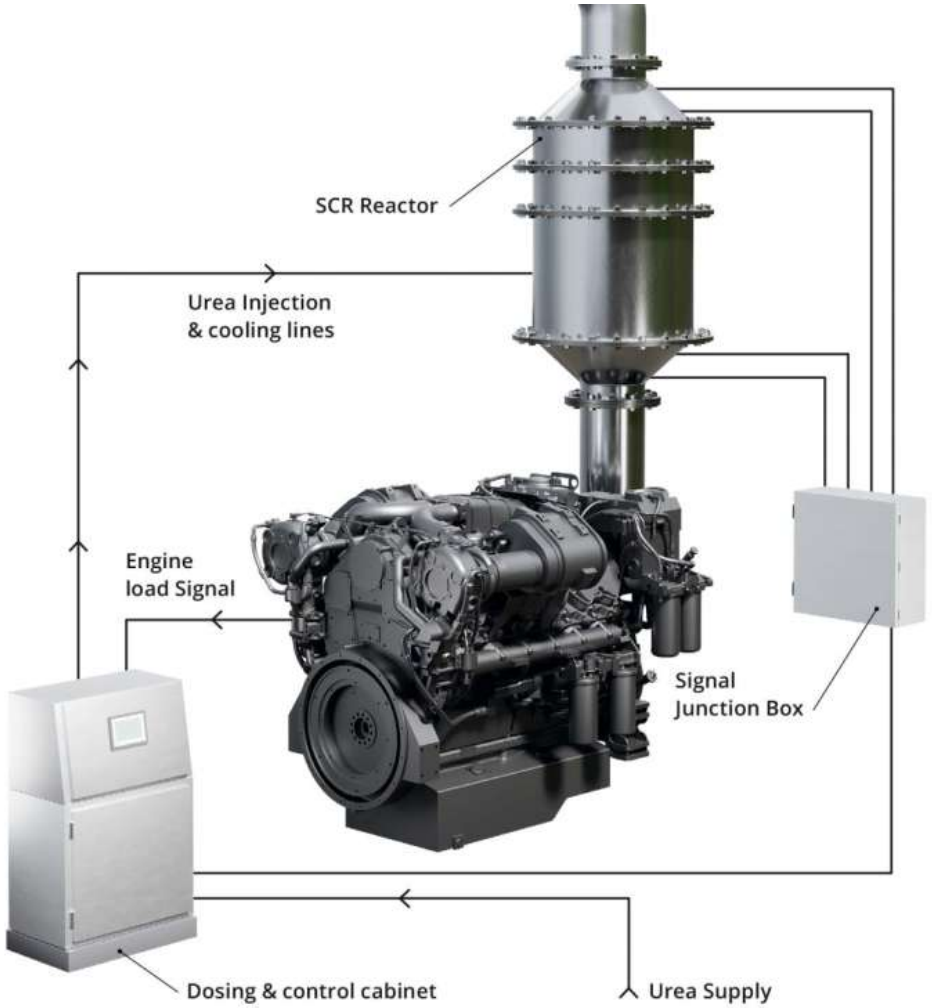
- Aim for 82-96°C engine temperature for optimal efficiency and emissions reduction

Limit Testing Impact:

- Off-load: Total of 520 minutes annually to minimize wear
- On-load: Total of 360 minutes annually to verify performance without excess emissions

# Aftertreatment Systems

- Diesel Oxidation Catalysts (DOC)
  - Catalytic converters for CO, HC, PM reduction
  - Activation at ≥200°C
- Diesel Particulate Filters (DPF)
  - Captures up to 99% PM
  - Requires high-temperature regeneration
- Selective Catalytic Reduction (SCR)
  - Lowers NOx emissions
  - Uses ammonia or urea (AdBlue)
  - Requires high temperatures and load




SCR Typical Layout

(Copyright CatEMission & Silentor)

# Aftertreatment Systems

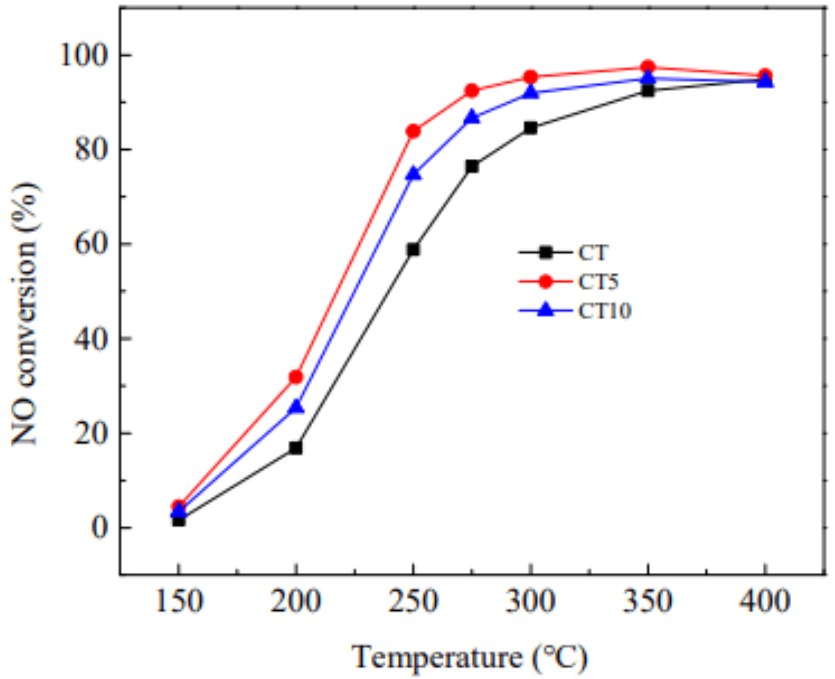
## Pros

- Emission Reduction
- Regulatory Compliance
- Proven Technology

## Cons

- Cost
- Complexity
- Maintenance requirements
- Space
- Temperature and load requirements

SCR performance as a function of temperature (5. Jiang, Ye, et al., 2019)

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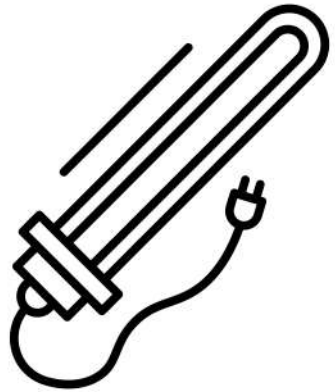
# Pre-heating Systems



Essential for Rapid Start-Up:

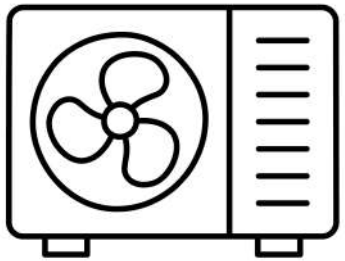
- Temperature 32°C-40°C

Energy Savings:

- Thermosiphon
- Vs. Forced circulation: -60% energy (6.)
- Vs. Heat pumps: -75% energy (7.)

Benefits:

- Energy Efficiency
- Performance
- Reliability



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# Summary

Diesel generator emissions depend on operational practices. Strategic enhancements can significantly reduce their environmental footprint.

Limited Clean Alternatives:

- Natural gas generators share comparable emissions to diesel
- Batteries cannot sustain long-term loads
- Hydrogen and Fuel Cells struggle with high initial cost and infrastructure challenges (8.)

For now, focusing on making diesel generators more efficient is a good way for data centers to be both reliable and eco-friendly.

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