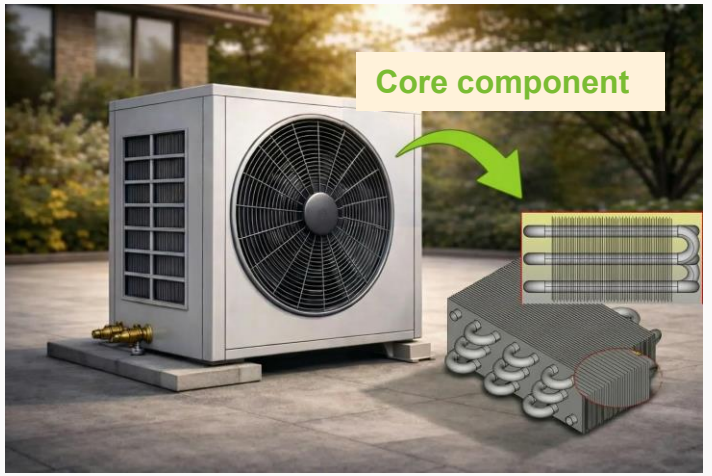
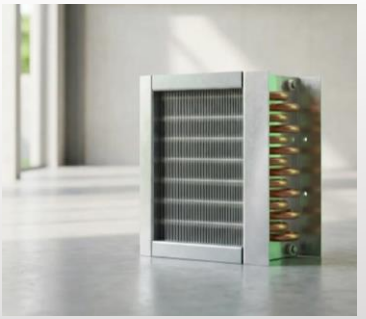
# Finned-Tube Heat Exchanger with 20% Efficiency Increase- Licensing Opportunity for OEM Manufacturers

## Patented Fin Offset – Integrable Without Production Changes

**The Next Efficiency Leap for Heat Exchangers**

- ✓ Up to 20% energy savings
- ✓ Improved frosting behavior with delayed ice bridge formation
- ✓ Applicable to existing sizes and variants
- ✓ ≥ 25% reduction in tube share
- ✓ approx. 14% fin material savings



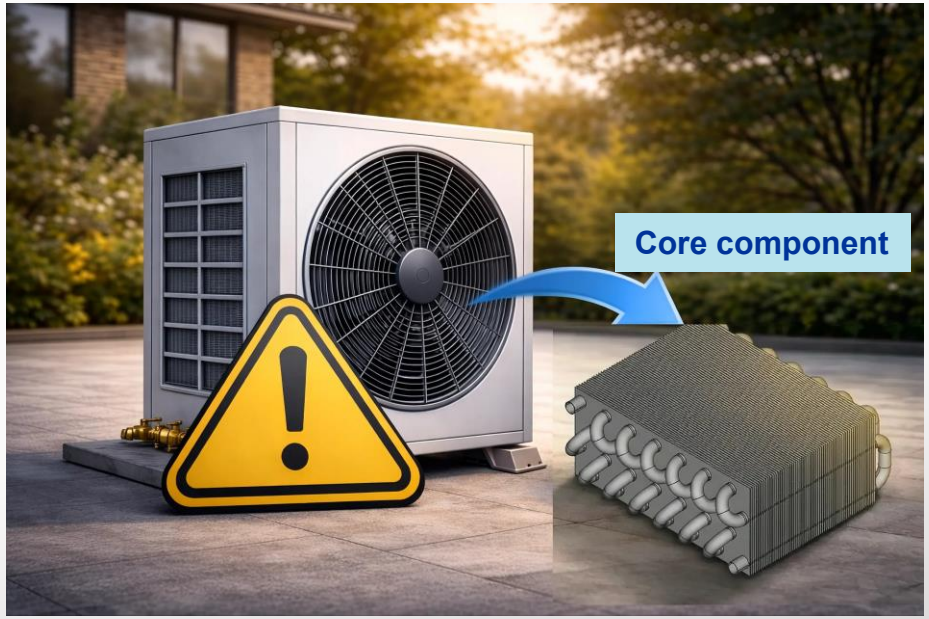
Patent portfolio: DE102012007570B4

Market Problem

# Growing Performance Requirements – An Inefficient System

## OEM Challenges

- Increasing efficiency requirements (Ecodesign, F-Gas)
- Higher fan power demand with increasing performance
- Rising energy prices
- Noise limits in residential areas




**Fact:**

⚠ 2× air flow → up to 5× fan power demand (+500 %)

→ A system that does not scale efficiently

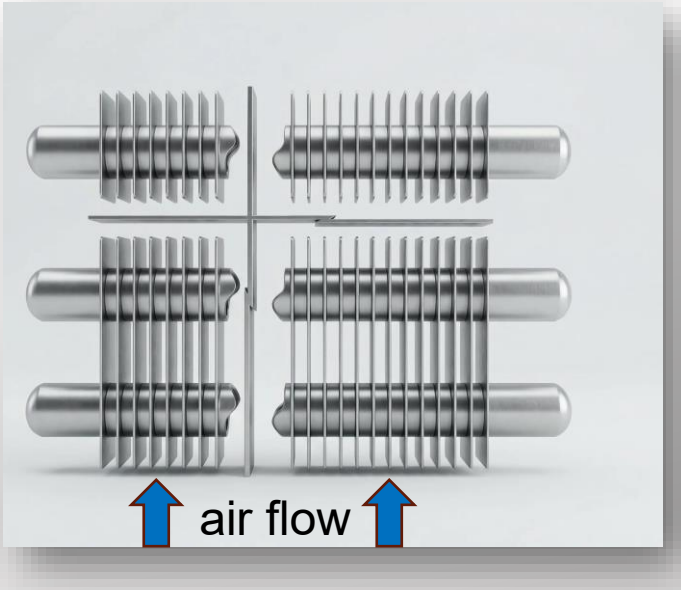
Market Problem

# High-Tech Systems with Outdated Core Technology

**The leverage lies in the heat exchanger**


The fin-and-tube heat exchanger significantly determines system efficiency:

- **Direct impact on COP/EER**
- **Determines fan power**
- **Influences noise development**
- **Significant share of material usage**
- **Scaling today mainly happens through:**
  - More air
  - More material
  - More volume



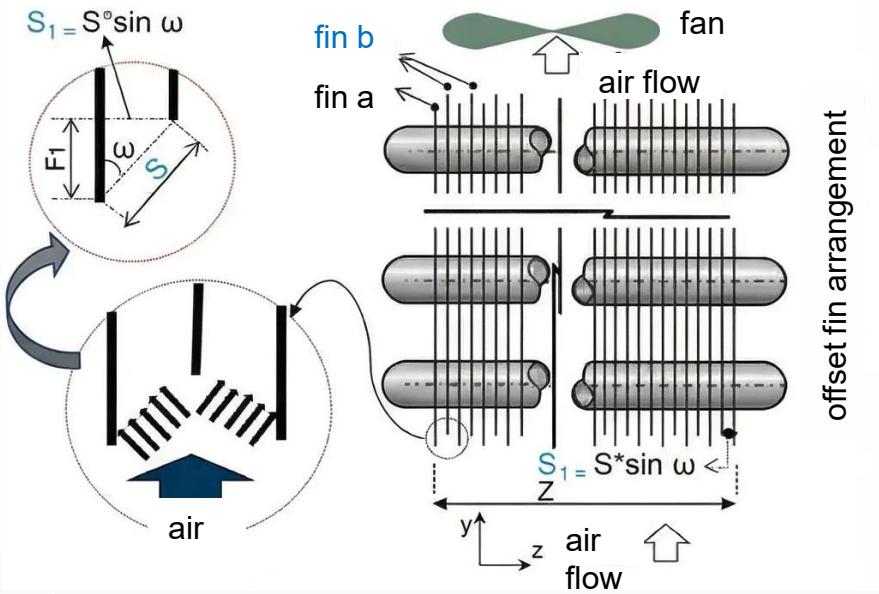

**Higher costs per additional kW**

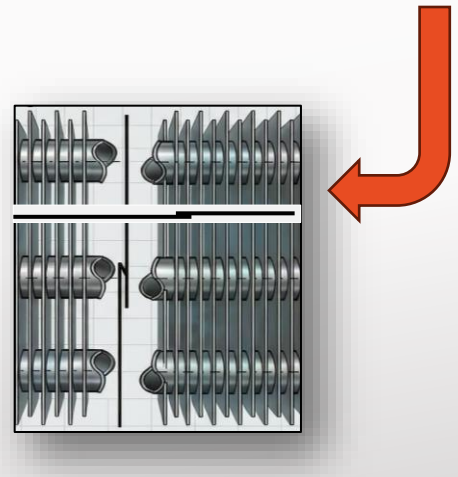
# The Innovation – Patented Fin Offset

The Invention "Fin Offset"

## Fin arrangement with alternating offset

- **Air no longer flows parallel to the fins**
  → increased turbulence
- **Air inlet areas larger than the spaces between fins**
  → increased air velocity
- **Higher number of fins within the same or smaller space**
  → lower fin height and fewer tube rows
  → higher efficiency
  → higher performance **without increasing fin surface area**
  → more surface area where it is effective (air inlet area) – less where it contributes little (air outlet region)



**More effect per m³ of air**

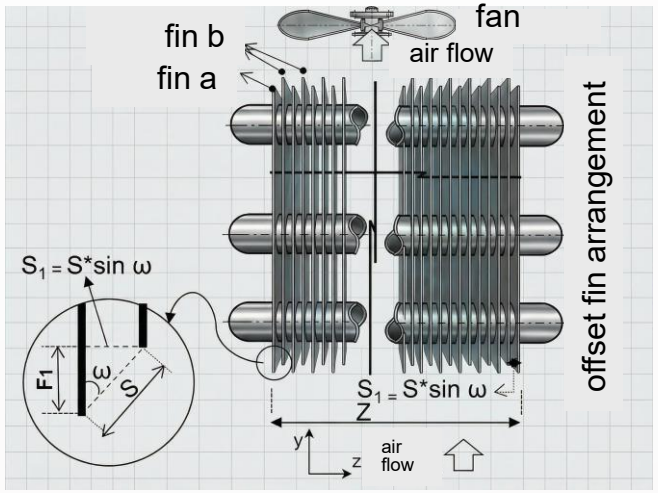
The Invention “Fin Offset”

# Geometric Influence on Heat Transfer and Pressure Drop

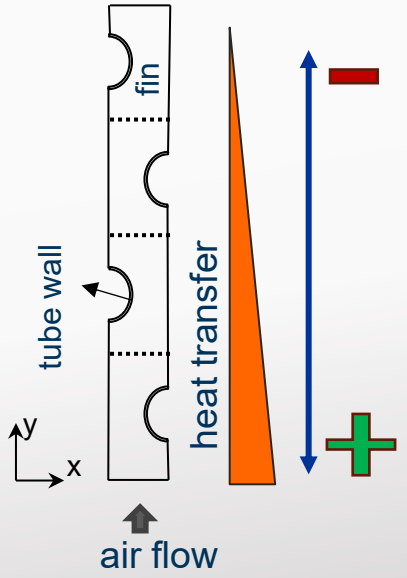
**Optimized flow instead of pure surface enlargement**

## The technology enables:

- Larger effective inlet area
- Increased local turbulence
- Increased local heat transfer
- Lower air resistance
- Reduced pressure drop
- Better material utilization
- **Same manufacturing processes**
- **More compact design (also for end devices)**




Heat Exchanger with Offset Fins



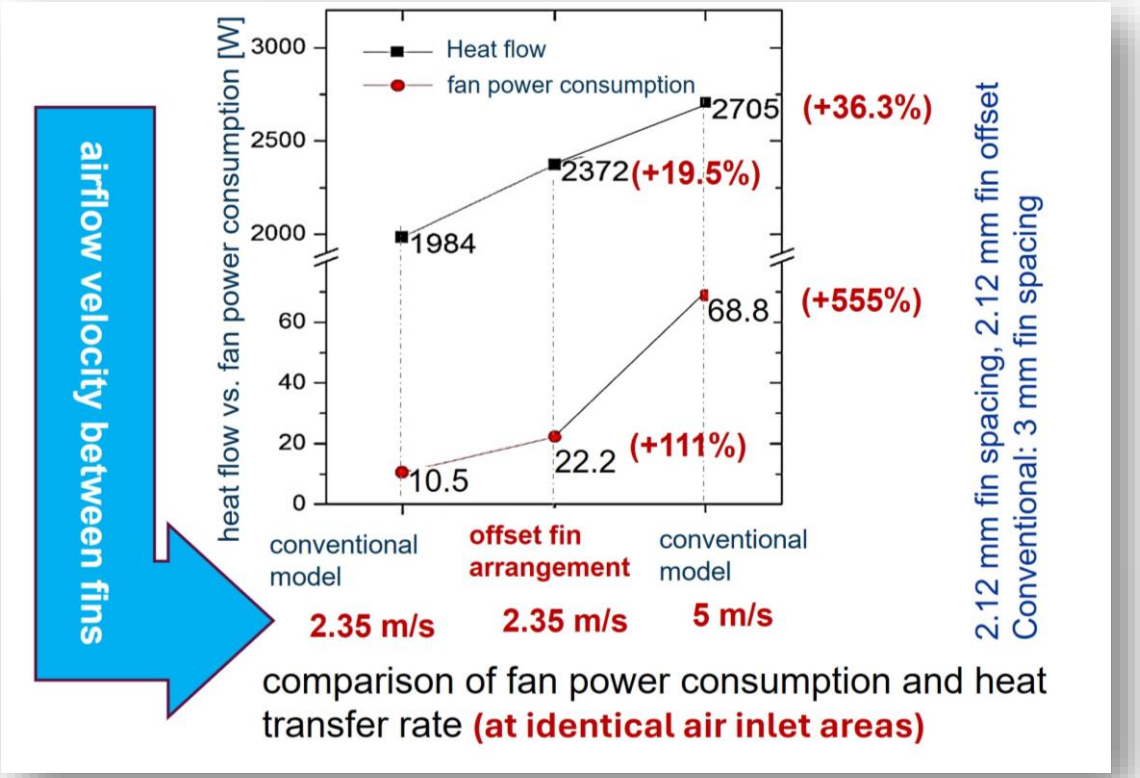

heat transfer distribution

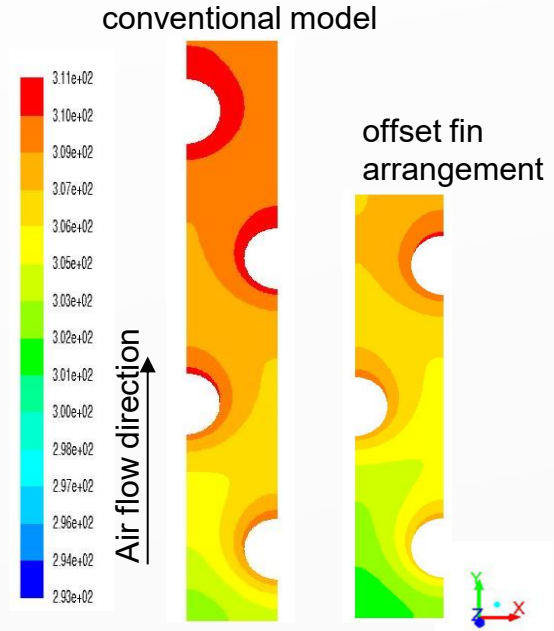
**More efficiency in the same installation space**

Customer Benefits

# Quantitative effects (experimental results)

**Heat transfer vs. fan power**




temperature distribution on fin surface

**Conventional design**:**

**+36 %** heat transfer | **+555 %** fan power

→ **doubled airflow**

**Patented geometry:**

**+19.5 %** heat transfer | **+111 %** fan power

→ **same airflow level**

| noise | efficiency |
|---|---|
| ↑ | ↗ |
| ↗ | ↑ |

***The study focused on comparing heat transfer and power demand with identical material usage.*

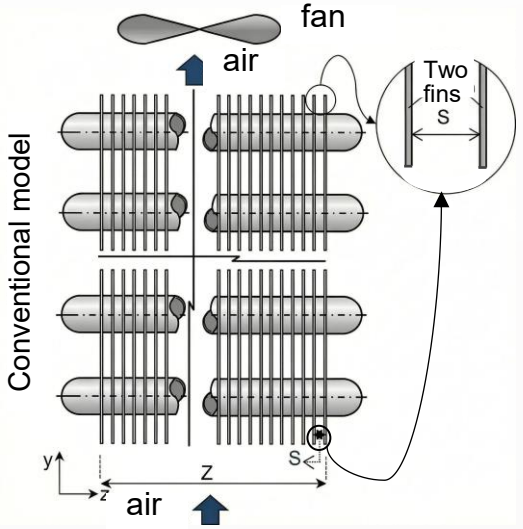
Customer Benefits

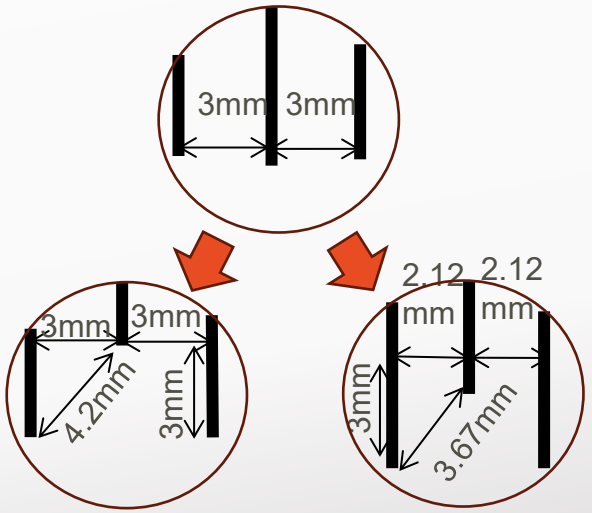
# Frosting Behavior: Conventional Fins vs. Staggered Fin Arrangement

## Further considerations for reducing frost formation in finned heat exchangers

- **Conventional Heat Exchanger**
  - Uniform frost formation on both fin surfaces, especially at the edges
  - Rapid formation of ice bridges between adjacent fins
  - Early channel blockage increases pressure drop and defrost frequency
- **Offset Fin Arrangement:**
  - Increased effective distance between critical fin edges can delay direct ice bridge formation
  - Non-uniform airflow over adjacent fins allows more frost growth on the longer fin edge (fin A) without early blockage of the flow channel
  - Higher heat transfer at lower airflow demand enables the same performance with reduced air volume flow and potentially lower moisture input
  - Targeted local coatings applied only on the longer fin edges can further reduce ice adhesion.

**Offset fins can delay ice bridge formation and extend the time until airflow channel blockage occurs.**



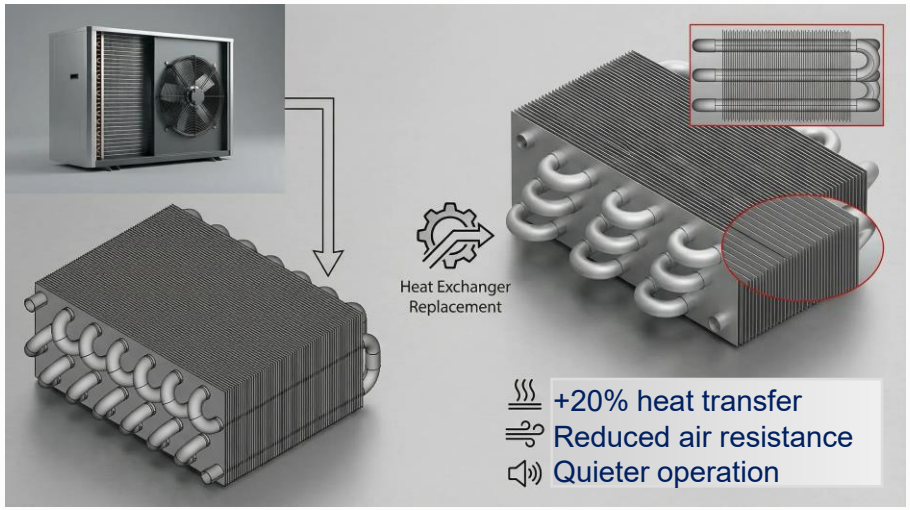




**Extended design flexibility:** Variable F1 and S1 enable increased air inlet area and larger fin spacing.

Customer Benefits

# Measurable Efficiency Gains with Minimal System Change

## Competitive Advantages

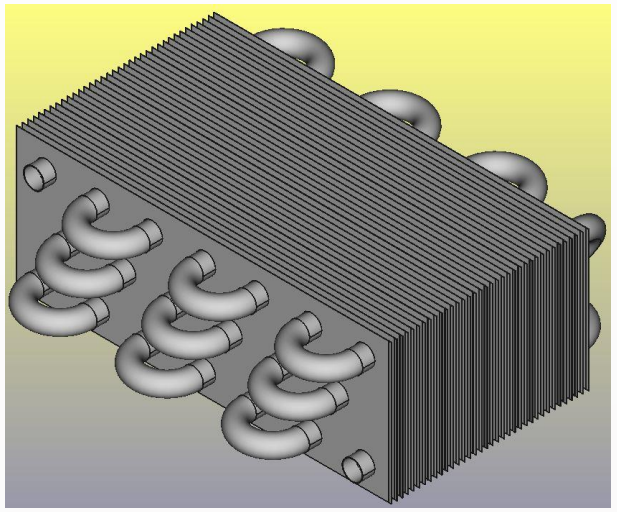



Up to **20%** energy savings

**Economic benefits for manufacturers:**

- Improved energy class
- Reduced device volume
- Smaller fan design possible
- **Additional system savings of 3–8%**

**and/or**



Up to **14% fin** material reduction and up to **38% tube** reduction

- Reduced logistics costs
- Potentially higher margins

**Example heat pump:**

**Up to 1,000 kWh savings per year**

Current Project Status

# From idea to granted patent – ready for market

## Patent development

- **Granted German patent**
  - DE102012007570B4 "*Finned-tube heat exchanger with improved heat transfer through fin offset*" (German: Lamellen-Rohr-Wärmetauscher mit verbesserter Wärmeübertragung durch Lamellenversatz); Granted in 2022
  - Current patent holders (inventors): Dr.-Ing. Diala Karmo & Dr.-Ing. Ayman Al Khateeb (since 2023)
- Original patent applicant: Technische Universität Ilmenau, Germany (April 2012)
- Professional patent drafting with PATON | State Patent Center Thuringia
- **Licensing model individually negotiable**

Scientific Background

# Scientifically founded – technically validated

## Research-driven Technology Development

- Developed during several years of scientific research at Technische Universität Ilmenau (Department of Thermo- and Magnetofluiddynamics)
- **Dissertation** “Contributions to Increasing the Effectiveness of Finned-Tube Heat Exchangers” University Press Ilmenau, 2016
- **Prototype and multiple design variants developed**
- Energy efficiency scientifically demonstrated
- More information: **https://www.innovative-heat-exchanger.de**
- **Patent reference DE102012007570B4:**
  https://worldwide.espacenet.com/patent/search/family/049231983/publication/DE102012007570B4?q=pn%3DDE102012007570B4

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