Hydraulic- Magnetic Circuit Breakers

Prepared for [Client]

April 2023

Project Summary

The following report prepared for [Client] Technologies summarizes research conducted by an independent consultant and [Client]. A total of four participants in the circuit breaker industry were interviewed about their experiences. The following report captures their sentiments, aggregates themes across interviews, and presents patterns. This report does not provide strategic recommendations or advice.

Methodology

- Phone interviews lasting 45-60 minutes conducted by independent consultant, executed with the support of the pre-aligned interview guide
- Conducted between: **March 20 – April 7, 2023**

Interviewees

4 professionals with direct experience in marketing, managment, or engineering of circuit breakers and involved in the selection of circuit breaker technologies

- Roles: 1 marketing professional, 2 managers, 1 engineer
- *Full interview list on a following slide*

Key Research Questions

1. What are the key megatrends in the industry?
2. What markets are more attractive for HMCB?
3. How are product requirments changing?
4. Who are the key players?
5. How are products chosen?

Project Summary

Key Takeaways

- The key megatrends of renewables and electrification, as well as high growth in segments such as data and telecom will drive high demand for circuit breakers

- Increased applications in harsh environments, requirements for design flexibility, and ease of maintenance will drive specific innovations in technology

- Hydraulic-magnetic circuit breakers are most applicable in harsh environments such as high heat or vibration, and viable for growing market segments

- Technologies are selected primarily on meeting mission profiles, ability to meet specifications and reliability

- Vendors are selected based on ability to meet requirements, capacity, channel, price/cost and reliability

Interviewee List

	Market	Employee's Title
1	Circuit Breaker Manufacturer	Former Marketing Director
2	Sensor/Connector Manufacturer	Former Managing Director
3	Electronics Distribution	Former Vice President Supply Chain Solutions
4	Energy Management	Former Vice President, Secure Power

Expert Screening Criteria:

- What are the megatrends impacting the requirements of circuit breakers?
- What segment markets are HMCB technologies able to apply more value against other circuit breaker technologies?
- What are the changes in product needs for a power supply and distribution system in different applications?
- Is there a geographic difference in the needs of product function, features, performance, or form factor for the same segmentation?
- Investigation of top players of each type of circuit breaker technology. Scope: HMCB, MCCB, Thermal CB, GFCI, ELCI

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Trends

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Circuit Breaker Technologies

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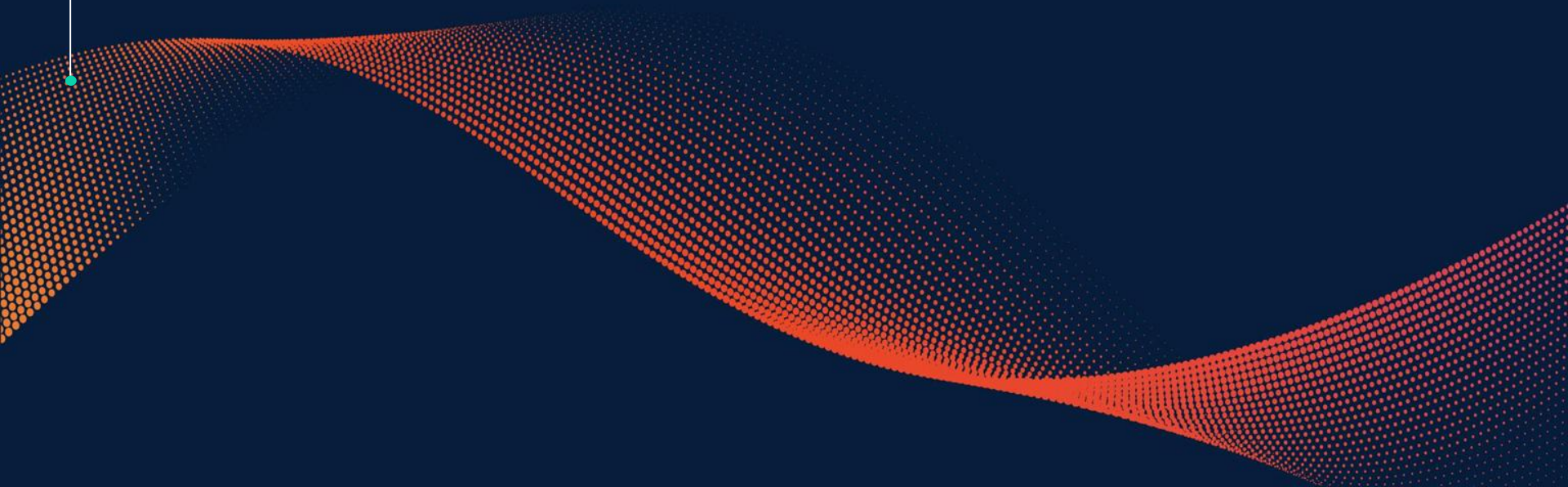
Selection & Buying Process

01

Trends



General Industry Megatrends

Overall increase in demand is common across all industry drivers

Renewables

- Solar and wind power are growing at very rapid rates
- Renewables will be split between large sources, such as solar farms, and distributed sources, requiring adaptations to power distribution
- Renewables will also drive power going both ways – some consumers will both use and produce electricity

Electrification

- Electric vehicles and required charging stations are the largest part of electrification
- Home uses – stove, HVAC, etc. – will also be increasingly electric

Data and Telecom

- Data storage and distribution growth will continue to outpace overall economic growth, requiring large amounts of electricity
- Wireless telecom is also expected to continue rapid growth

Megatrends

Experts were fairly consistent in assessment of megatrends

"When I was working with hydraulic magnetic breakers, the three main leading industries were renewable energy, electrical vehicles and data centers."

– Former Marketing Director, **Circuit Breaker Manufacturer**

"Renewables are huge. They are shifting the whole landscape from a centralized landscape of power generation, power distribution, power protection, and so on. They're shifting that from a centralized landscape to a more distributed landscape.."

– Former Managing Director, **Connector Manufacturer**

"As the world becomes more electrified, digified, whatever you want to call it, the need for infrastructure grows geometrically because they just need more of it."

– Former Vice President Supply Chain Solutions, **Electronics Distributor**

"There is pretty broadly an active electrification of everything going on I would say right now. Different things are electrifying at different rates. Some of them will take a while but it does appear that we are in a pretty long-term trend of electrifying of a lot of things."

– Former Vice President, **Energy Management**

Circuit Breaker Technology Drivers

Industry megatrends will drive changes in circuit breaker demand

Overall Growth

- The biggest change will be an increase in total demand for circuit breakers
- Most current technologies will continue to be used, but in greater quantities

Harsh Environments

- Many areas for growth will require circuit breakers that can operate in harsh environments
- Renewables will need to operate in extreme weather environments
- Breakers will need to operate in heat and vibrations

Flexibility

- Standard power grid structures will continue to evolve
- Breakers will need to work with power going in both directions
- New power structures will require customization for individual applications

Ease of Maintenance

- Many applications will be at sites without technical personnel, requiring simple maintenance (retail, residential, etc.)
- High value operations will require short repair times

Growing Markets for Circuit Breakers

Opportunities are in growing markets, with no emerging markets identified

Renewable Energy

Fastest growing segment

Residential market is largest market – due to higher energy costs

Industrial market will also be substantial

Data

Server farms require protection at all levels: card, module, rack, bay

Data is a large user of electricity, generate heat, and size of breakers is critical

Telecom

Growth is technology driven in developed markets – 5G/6G

Developing markets are less penetrated and growth is driven by economics

Growing Markets for Circuit Breakers

Experts varied on most attractive markets

"If you have a battery, there's a circuit breaker on it. If you have an EV charger, there's a circuit breaker on that. Think of the circuit breaker as basically the connection point. Every time you have a connection point, you have a circuit breaker."

– Former Vice President, **Energy Management**

"There is a tremendous need for information and that information is always going through a server farm, and these server farms are a hog for not just information, but for power."

– Former Managing Director, **Connector Manufacturer**

"A lot of my experience in leading technology changes had to do with renewable energy and electric vehicles and also with the data com and telecom environment."

– Former Marketing Director, **Circuit Breaker Manufacturer**

"I think the need for circuit breakers in general is going to continue to outpace the general market just because of all of the things that are going on in the electrical and the powering thing."

– Former Vice President Supply Chain Solutions, **Electronics Distributor**

Changes in Safety Regulations

Safety regulations are important in all industries

Key Topics

- Human Life
- Explosion Prevention
- Variations

Discussion

- Protection of human life has been paramount for decades
- Signal interference around airports is an increasing concern

- Explosion prevention is important in volatile environments
- Circuit breakers are required to eliminate sparks and heat

- Majority of safety regulations set in Europe and North America
- Regulations are continually tweaked, but major changes not expected

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Circuit Breaker Technologies

Most Attractive Segments for HMCB

Suitability of technology and growth drive attractiveness

Renewable

- Residential applications, including EV charging at home – largest segment
- Industrial applications, especially in main systems for solar – customized into systems by OEMS

Infrastructure

- Building infrastructure, with somewhat harsh environments
- Industrial automation – rapid shutdown of factory required
- Data/Telecom – large and growing markets

Locomotive

- Ideally suited to HMCB technology
- Durability in heat in vibration have made HMCB the standard
- Market and growth are limited

Changes in Product Requirements

Technology changes are tied to overall trends

Size

- More need for medium size breakers as grid evolves
- Increased size in residential applications as home loads double
- Smaller designs in certain applications such as data centers

Customization

- Large customers will require customization to fit OEM designs
- Required designs will be very application specific
- Successful designers will focus on specific niches versus broad designs

Control

- Smart designs will continue to grow in residential applications
- Industrial applications will be tied to overall control systems

Innovation

- Regulations will be driven by innovations
- Successful companies will drive innovation to stay ahead of regulations
- Features such as time to trip, vibration requirements, ease of installation/replacement will continue to evolve

Geographic Difference in Requirements

Primary differences are developed versus developing markets

Developed Markets

- Developed markets are primarily North America and Europe
- Regulations stricter and market specific
- Circuit protection more important in developed markets
- Customers are more technology and reliability driven

Developing Markets

- Primary developing markets are Asia and Latin America
- Regulations more lax
- Circuit protection less important
- Overall demand is driven more my economics

Key Players

Most Major Companies are Global

Circuit Breaker Focus

Key Specialty Players

- Airpax ([Client])
- Carling/Littlefuse
- Schurter

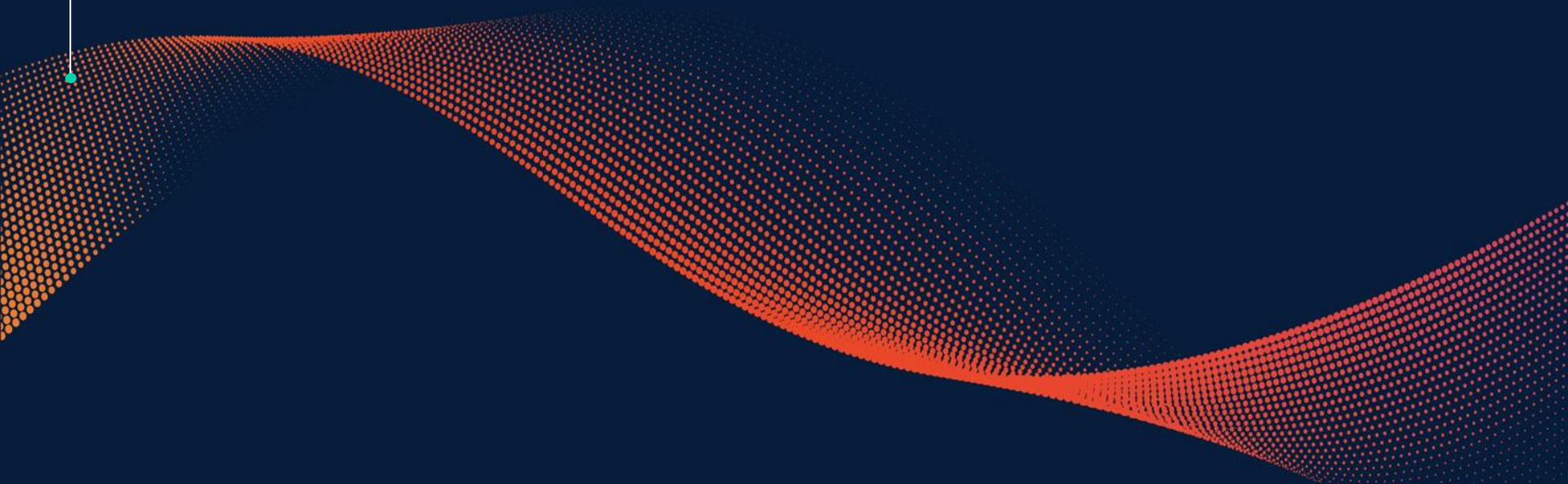
Many smaller companies, mostly in China

Broader industrial Players

- Schneider Electric
- Eaton
- ABB
- Siemens
- General

03

Selection & Buying Process



Technology Selection

Design Engineer Considerations

Determine Mission Profile

- What is the purpose?
- Requirements
  - Temperature
  - Amps
  - Lifecycles

Meet Design Requirements

- RFQs will include all required features
- Typical features will include:
  - Size
  - Performance
  - Installation (tandem, in parallel)

Reliability

- Often assessed using prototypes
- Prototypes and samples are often tested before selecting a technology
- Most designs are proprietary and IP protected
- Off-the-shelf items are assessed based on history

Technology selection will drive the selection of a limited number of vendors

Purchasing Criteria

Multiple suppliers are often selected

Meet the RFQ	Capacity/ Capability	Channel	Price/Cost	Quality/ Reliability
Able to meet the requirements in RFQ is first	Have the available capacity/capability to provide quantities required on time	Direct from manufacturer or through distributor based on quantity	Cost includes other factors beyond price such as failures	Determination based on testing or history

Selection Criteria

Selection of technologies and vendors were often closely tied

“First, when they start to do a design, the first thing is the electrical parameters. What is it that I need to do? They narrow down the technologies to the types of products that will fit. Then they just narrow it down to two or three manufacturers.”

– Former Vice President Supply Chain Solutions, **Electronics Distributor**

“The technology is first. I narrow it down to about four or five, or whatever it is, that really have the technology I’m looking for and all of the features. And then I go after the next layer which is availability and qualification testing.”

– Former Marketing Director, **Circuit Breaker Manufacturer**

“The process is defining what is the mission profile, number of cycles, vibration, design life. Then you would go and you would look and say, who has a product that can meet this requirement?”

– Former Vice President, **Energy Management**

“They’re reaching out to several manufacturers and seeing who comes up with the most cost-effective design, but also meeting the specifications, reaching out to several manufacturers and then seeing the preliminary designs and costs.”

– Former Marketing Director, **Circuit Breaker Manufacturer**

Questions?