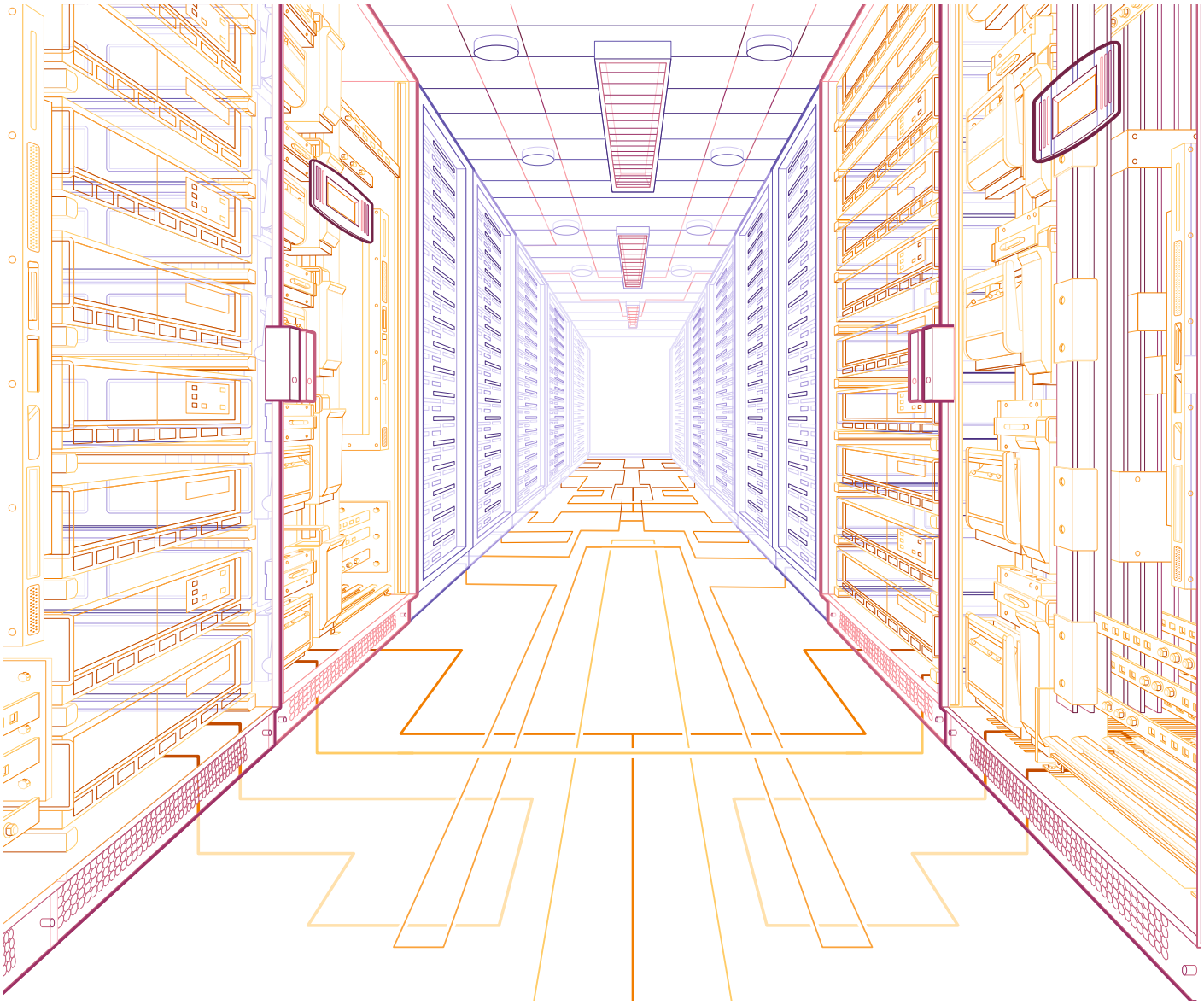
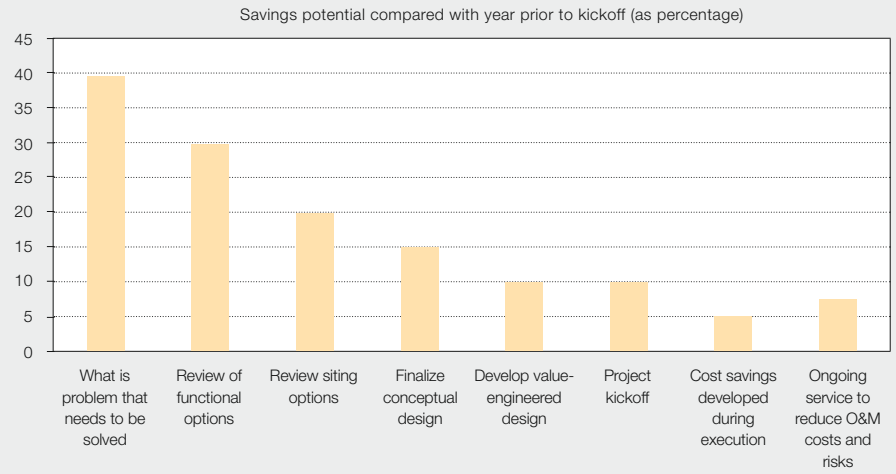


Design decisions

What does ABB contribute to the design of data centers?

PATRICK KOMISCHKE – Design should always be driven by the purpose of the end product, and this should be reflected in the requirements of the customer or end-user. These requirements, including codes and industrial standards, are combined with the capabilities and competences of the supplier to create the product. The design of the electrification of data centers occurs in a very dynamic environment. It is not a completely new field of engineering, but the range of design approaches and the rapid development of technologies and customer requests create numerous challenges. This is reflected in the fact that various standards for data center design exist.

1 Advantages of ABB's systems approach



- Lower project risks.
- ABB systems project awarded on a firm lump-sum basis (ABB paid for results, not effort).
- One integrated project schedule coordinated with customer and owner engineers.
- ABB system model reduces the number of companies involved in the project, hence fewer interfaces to coordinate.
- ABB experts support the project organization in all disciplines.
- ABB projects feature direct involvement of ABB factory personnel.
- An ABB Manager at each ABB factory is responsible for equipment to be delivered.
- ABB system approach reduces delivery challenges by securing priority production slots from its factories.
- ABB system projects reduce emergent technology risks by accessing factory experts on a real-time basis.
- Lower awarded costs.

ABB provides a mix of global equipment technology, project execution expertise, project/discipline/product engineering along with the expertise of integrating third-party contractors to deliver the optimum mix of technology, project engineering, project management, and local expertise for the most cost effective solution.

- Lower customer project management costs.
- Lower project execution costs.
- Lower customer warranty, operations and maintenance costs.
- ABB has expertise in a broad range of fields.
- ABB has global expertise in the data center industry.
- Technical experts from different disciplines and factories. ensure the best solution from a single source.
- Lower cost of ownership (see inset graphic).

At the beginning of the design process of a data center are the identification of the load requirements that the center will need to handle and the required reliability. The reliability definition is interpreted in the context of the Tier concept. Additional parameters to taken into account are geographical and physical locations as well as security aspects and required compatibility with other systems.

A typical design starts at the high-voltage (HV) connection where the power is drawn from independent sources. Power sources can be utilities or independent energy suppliers. From here, the power passes through the medium- and low-voltage (MV and LV) distribution, which connects and combines different sources while feeding and supplying the energy to the points where it is required: primarily the server racks but also all the auxiliary systems supporting the reliable and safe operation of a data center. These are mainly hardware implementations, but to ensure a smooth integration and cooperation, several control systems based on different software platforms are used to combine these components.

The handling of this huge span of disciplines and technologies requires an organization covering a broad palette of engineering resources and the associated expertise under one umbrella. It is furthermore important to work closely with the customer in the selection of the optimal design.

Why is the ABB approach different?

ABB draws on a comprehensive and long experience as a product supplier for data center applications. In recent years increasing efforts were made to package these products and to offer customers a broader product portfolio from a single supplier. The real potential and advantage of ABB's offering, however, lies is in the OEM (original equipment manufacturer) systems approach. Here, the full strength of the company's wide product portfolio is paired with the competence of an OEM system integrator. This means that the products do not only come from a single company, but are integrated into one system and supplied to customers from a single source.

The acquisitions ABB made over recent years have expanded the company's product portfolio further, meaning the company can now cover almost the full spectrum of data center electrification. Indeed if there is a gap, the systems approach ensures that a third party product can be selected and seamlessly integrated with ABB's offering.

The systems approach, which is equal to an EPC (engineering, procurement, construction), offers significant advantages to customers or investors in the data center industry → 1–2.

Title picture
The design of a data center is not only about choosing between myriad competing suppliers and their products, but also between different design and operational philosophies. Decisions made at an early stage will have implications and repercussions throughout the life of the data center. So what is the best way through this labyrinth of decisions?

2 Traditional outsourcing options

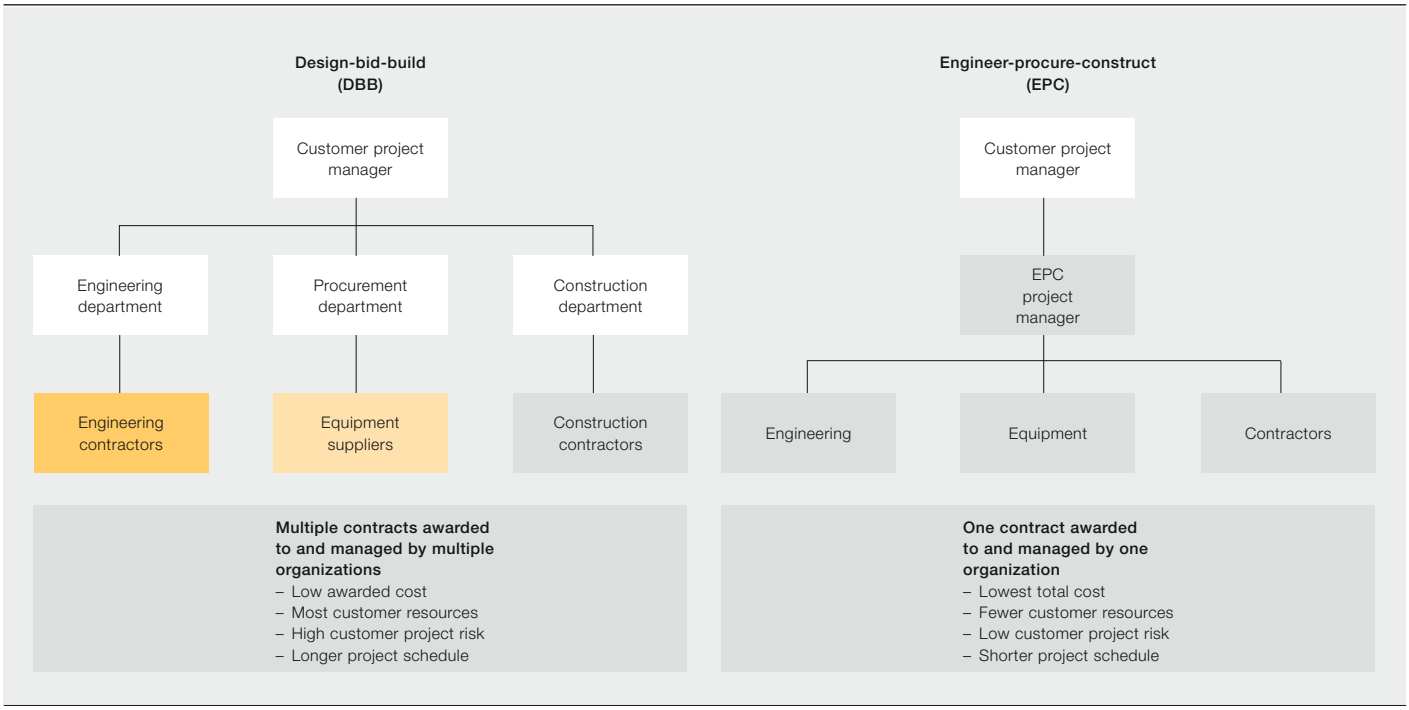


ABB can now cover almost the full spectrum of data center electrification.

Internal ABB project

To test and cement the systems approach, ABB began an internal project in 2012 with the goal of designing a 20 MW Tier III data center design with maximum ABB content, while remaining as close as possible to market typical solutions.

Technical experts from different disciplines and factories. ensure the best solution out of one hand.

The target was to ensure the systems approach by using ABB products as well as products from the recently acquired companies, Baldor and Thomas & Betts, and integrate them into an ABB data center solution.

The project's specified deliverables were single line diagrams, physical layouts, specifications and other supporting material that could be used as a basis to deliver both data center equipment and integration out of one hand (the system approach) while being closely attuned to customer and market requirements. This internal project led to a successful market introduction of the defined system approach.

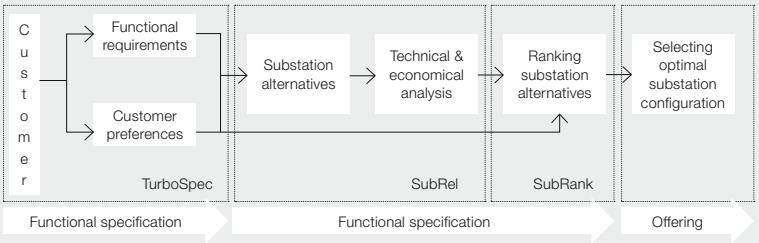
Design approach in detail

Starting on the HV side, the design had to consider different solutions such as air- and gas-insulated switchgear (AIS and GIS) → 5, different transformer types, and control systems – to ensure reliability but also correct connection and grid integration on the utility side. The AIS vs. GIS comparison is a widely discussed topic and a very good example for demonstrating the advantage of a system approach. Before committing to a decision, ABB is able to look at the grid where the data center should be integrated and make a recommendation in collaboration with the customer and the related utility. An example of the evaluation process is shown in → 3. Conclusions of this evaluation are shown in → 4.

In addition to the system/grid analysis, other factors such as physical location and safety requirements can play a role. An example of a physical AIS vs. GIS comparison (showing significant space savings) is shown in → 5.

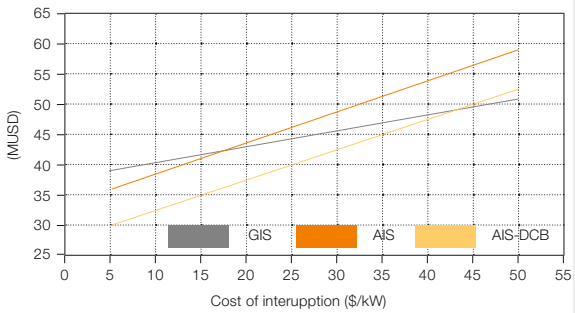
The same design steps and analysis are also applicable for the MV side, but in addition, the integration of loads and subsystems such as generator sets, needed to be

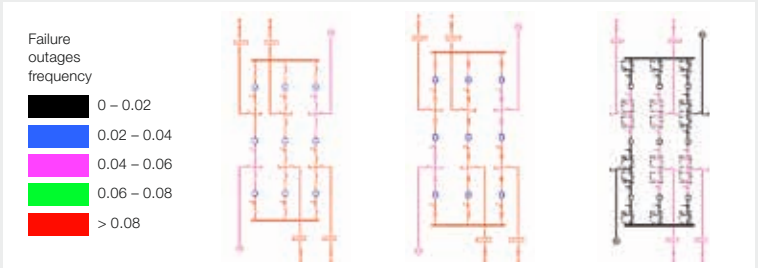
3 Substation optimization process

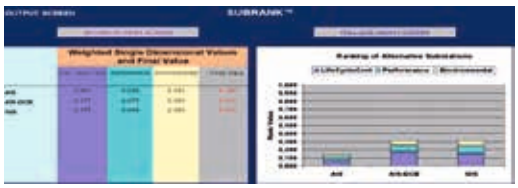


Methodology major pillars

1 Collecting S/S functional requirements
2 Identifying S/S alternatives
3 Reliability analysis
4 Economic analysis
5 Ranking S/S alternatives
6 Selecting optimal S/S solution







Configuration Type	Total OF /yr	Total OD hr/yr	Failure OF /yr	Failure OD hr/yr	Maint. OF /yr	Maint. OD hr/yr
AIS	0.94748	14.57	0.09748	3.17	0.85	11.40
AIS-DCB	0.54136	13.01	0.09136	3.21	0.45	9.80
GIS	0.36770	12.69	0.05100	3.16	0.32	9.53

4 Assessment process tools

Captures customer objectives

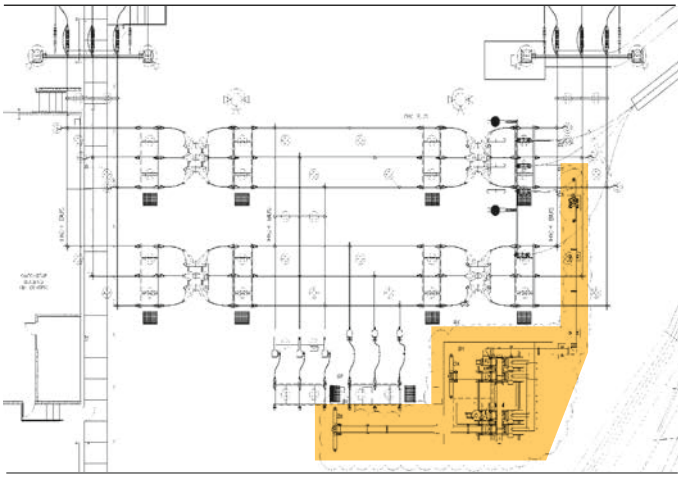
Life cyle cost
- Initial capital costs
- Reliability cost
- O&M cost

Performance
- Flexibility
- Safety
- Automation level
- Technology vintage

Environmental factors
- Ecological impact
- Air pollution tolerance
- Appearance/aesthetics
- Audible noise generated
- EMF fenerated
- Radio/television
- Interference generated
- Disposal concerns

Ranks power system alternatives

5 ABB high-voltage gas-insulated switchgear (actual AIS footprint vs. GIS footprint)



GIS substations cover approximately 15 percent of comparable conventional substation footprint while delivering increased reliability.

considered as options. Decisions such as indoor vs. outdoor, physically together with the data center or not, noise, safety etc. must be reviewed and answered. ABB also provides the full expertise to integrate this part into the optimal solution.

The numerically most significant selection of ABB products and variants considered in this internal project were those on the LV level and the interface to the server structure (where ABB offers vast experience in the data center industry). There remain, however some gaps where ABB has no products to cover a given function or a product exists that would be difficult to integrate. Here again, the systems approach displays its value as ABB can support decisions on integrating a third party product or launch an internal development effort.

Beyond the traditional HV/MV/LV disciplines, ABB's portfolio includes other products and software solutions that fit in the data center landscape and can be used to combine, connect or extend the above solutions. A notable part of this category is ABB's systems integration expertise that can combine products to a system. By focusing on the systems approach and drawing on the full knowledge from across the company, an optimal solution can be delivered to every customer.

Looking forward

Facing the constraints in the electrical infrastructure sector, such as limited qualified in-house resources, customers are increasingly seeing the value offered by ABB's systems approach. Opportunities, however, will still remain for customers interested in ABB's products and seeking to combine them with solutions in-house.

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