THE ERA OF PREFABRICATED MODULAR SOLUTIONS IN DATA CENTRES

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The technology sector has experienced exponential growth in recent years, which is set to continue. As a result, developers have turned to prefabricated modular solutions, and in certain countries, an element of prefabrication is even mandated, with the aim to reduce construction programs and costs while improving quality.

At Black & White, we have just surpassed 500 employees globally, working in 25 different countries, delivering well over 4GW of critical IT capacity. A significant proportion of the developments we design incorporate various forms of prefabrication.

ENHANCED QUALITY CONTROL THROUGH PREFABRICATED SOLUTIONS

Prefabricated or modularised solutions in construction encompass four primary types. Firstly, there are turnkey data centre solutions, followed by MEP modules such as power centres. The third type includes skid-mounted MEP equipment, such as metal racks for mounting and connecting mechanical and electrical systems. Finally, prefabricated structural or architectural components form the fourth category, encompassing elements such as concrete beams, walls, slabs, facades, and precast underground service corridors.

These pre-engineered solutions are built with standardised installation procedures. Each module is constructed in a factory and delivered to the site. This process allows greater control over the quality of the product, with rigorous testing undertaken in the factory. The factory environment also allows enhanced quality control from an installation perspective. Construction and integration can be performed under tightly controlled factory conditions by trained specialists while on-site preparation continues, compressing construction timelines, and subsequently lowering engineering and construction costs.

Implementing prefab or modular solutions within data centres presents significant construction program improvements. Ultimately, one of the key selling points of prefab is that they can be delivered much quicker than a traditional data centre, subject to the extent it can represent circa 40% improvement in comparison to traditional methods.

As the sector continues to accelerate, clients are leaning on innovative ways to deal with the demands of the growing digital economy. The traditional approach is arguably a thing of the past as clients look to avoid risk, expense, and lengthy delivery programs. Speed to market is key.

Clients are seeking to avoid permitting delays, supply chain constraints, delays due to availability – manufacturing backlog

and to minimise installation risk due to local expertise – subject to capability in certain markets. Factoring in these risks, the shift was predictable, and market research from key vendors in the space suggests as much, plus continued growth as operators lean towards the approach.

The improvements within the space are visible. Modern solutions are spatially efficient building blocks and fully integrated, meaning not only a choice for new data centres but a go-to for existing facility modifications and additions. The flexibility in options from small components, integrated racks, aisles built in the factory with servers and infrastructure, to integrated modules, including critical power distribution, critical cooling systems, and IT.

Our market exposure is aligned with the hybrid approach, which has emerged as a common concept within the industry. Power modules are arguably the most common, a prefabricated module that can include both medium voltage equipment, typically, a ring main unit, transformer, and cooling, and LV system components such as a main switchboard, UPS, batteries, and static transfer switches, subject to the system topology specified. Equivalent cooling and IT modules are also available and can be supplied in an enclosed unit or skid-mounted. This type of deployment can require early engagement to establish

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local compliance to ensure modules are configured to allow no permitting delays at a later stage.

These modules or skids can be installed in retrofits of existing data centres or new builds. As referenced, they can reduce the traditional building footprint by as much as 30%, depending on design efficiency. This can free up space for revenue-generating customer space.

In some countries, the modules can be considered as equipment as opposed to an internal building area, which can be beneficial when designing sites with strict gross floor area caps on which compliance is mandatory for planning. In addition, it can help where applicable when seeking compliance with local codes, subject to the country in which the module will be deployed.

Traditionally, we collaborate with clients aiming to develop regionally specific prototypes that adhere to applied standards. In addition, and using power modules as an example, modules with enhanced thermal properties can improve the overall thermal profile of the facility and subsequently reduce energy and costs dedicated to cooling.

Furthermore, almost all operators now recognise the value of 'reference designs' that implement standardised products, system topologies, and building designs. A consistent approach to design, offering an equivalent product, provides a host of benefits, not least the ability to develop a standard product specification, which can be specified, subject to localisation, globally. We work with operators who liaise directly with vendors and others who have a prototype design that is compliant with the offering of multiple vendors, appreciating the value of infrastructure repetition.

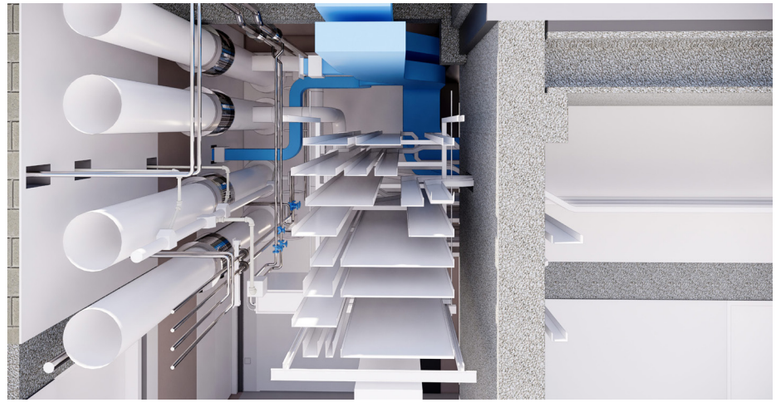
Modular roof installation

The transition to cloud computing, increased adoption of IoT, and advancements in technology like artificial intelligence (AI) necessitate operators to continually expand their operations to sustain their business. Universally, everyone within the sector acknowledges that sustainable working practices are a necessity. The significant power required to run these facilities and their carbon footprint are well understood. Operators continue to face growing pressure from governments worldwide due to increasing regulatory compliance requirements.

BENEFITS OF PREFABRICATED MODULAR DESIGN AND CONSTRUCTION

In terms of design, undoubtedly sustainability is one of the challenges alongside flexibility and scalability. Therefore, prefabricated modular design and construction provide the foundation, and the benefits are summarised as follows:

- **Speed:** Deployed much faster than traditional construction methods. The modular aspect supports operators to match the supply of needed capacity to the demand. The build process allows for system interface and testing prior to on-site installation, streamlining the commissioning and minimising the potential for issues on-site.
- **Scalability:** For providers trying to meet demand, prefabricated modules are inherently scalable, allowing for planned expansion with staged capital outlays that maximise capex and lower total cost of ownership. However, it should be noted that cost at scale for a complete modular data centre is prohibitive; there is a tipping point.
- **Performance:** For remote locations with no local technical or service support, common global platforms that have been factory-built, tested, and offer remote management and vendor support.
- **Financial:** In certain countries, the classification of equipment as opposed to a 'building' offers the opportunity for financing incentives and tax benefits.
- **Health & Safety:** The bulk of the installation within the modules carried out in a controlled factory environment, reducing the labour required on-site, and thus reducing the risk of accidents.
- **Reduction in waste:** The construction of prefabricated modules can be carried out as a repeatable production line process, therefore reducing the number of waste/offcuts compared to an equivalent on-site installation.
- **Global consistency:** For operators exploring multiple expansions, either regionally or globally, prefabricated modular designs can be specified to meet operators' requirements. The opportunity is then to replicate with modifications to meet regional or geographic differences. It can also reduce vendor and procurement complexity.
- **Simplified Design:** Prefabricated solutions can be standardised to fit general requirements and adjusted for different environments, simplifying the overall design complexity.

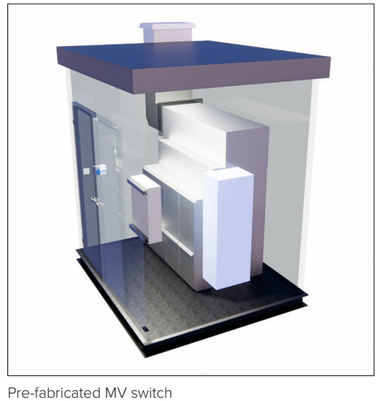


Modular service corridor

CHALLENGES ASSOCIATED WITH PREFABRICATED MODULES

Ultimately, prefabricated module technology makes a lot of sense. The demand for agile and globally consistent sites suggests that this is now the industry's default option. While prefabricated modules offer flexibility, quicker deployment times, and cost advantages, they might not suit every situation.

To present a balanced view, we should be mindful of some of the drawbacks, such as the dependency on vendors, which in some instances can limit flexibility for those operators whose requirements are fully aligned with a specific product range. This can present challenges in relation to support and maintenance.



Pre-fabricated MV switch

Previously referencing the necessity for early engagement for local compliance verification, it should be reiterated that the location can introduce challenges related to environmental conditions, security, and access to resources. Also, in certain countries, local municipalities may not yet have established guidelines for restrictions on modules.

Inconsistencies do exist regarding the approach municipalities apply when classifying power, cooling, and IT modules. Local codes, therefore, impact the level of module engineering and equipment specifications.

Operators will also naturally have concerns regarding technology development and the potential challenges around upgrading or replacing components to maintain the ever-evolving market trends. This is closely linked to reservations on some modular designs which have limitations on power density.

One of the key data centre trends is artificial intelligence, alongside other modern tech, for example, smart cities, which is widely anticipated in the UAE. Anticipated rapid growth will continue to drive the demand. Operators, therefore, need to deliver capacity which realises the increased power density requirements for high-performance computing, and questions remain regarding the modular capability to realise this.

In addition to power density, cooling efficiency is also widely debated. The implication on energy consumption is questioned because of the limitation pre-engineered solutions have on the implementation of efficient cooling strategies and optimal airflow. Further from this integration, scalability, cost, and general perception of the change are all topics that require careful consideration at the outset.

Despite the drawbacks, the market is transitioning to prefabricated modular components and data centres for the reasons identified. ■