# 02-035 – Analysis of the adaptation of BIM tools used in construction for the electrical sector – Análisis de la adaptación de herramientas BIM utilizadas en construcción para el sector eléctrico

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In today's context of increasing energy demand, technological development requires high levels of electrical energy and is becoming increasingly integrated into everyday life. To optimize the use of materials and resources, it is essential to design electrical distribution systems that allow the traditional grid to adapt to current needs, promoting more efficient and sustainable solutions. In this regard, the use of digital tools that facilitate data organization, management, and analysis is key to improving the planning and operation of electrical infrastructures. One of the most promising methodologies in this field is Building Information Modeling (BIM), originally developed for the construction sector. BIM enables the three-dimensional modeling of projects, interference detection, and the integration of various disciplines, optimizing costs, time, and resources. Due to its success in construction, BIM has started to expand into other sectors, including the electrical industry. However, challenges remain in its adaptation. This study analyzes the different BIM tools used in construction and evaluates their feasibility for implementation in the electrical sector, identifying advantages, limitations, and opportunities for improvement.

**Keywords:** *BIM; Electrical sector; Digital modelling; Resources optimization*

En el contexto actual de creciente demanda energética, el desarrollo tecnológico requiere altos niveles de energía eléctrica y está cada vez más integrado en la vida cotidiana. Para optimizar el uso de materiales y recursos, es fundamental diseñar sistemas de distribución de energía eléctrica que permitan adaptar la red tradicional a las necesidades actuales, promoviendo soluciones más eficientes y sostenibles. En este sentido, el uso de herramientas digitales que faciliten la organización, gestión y análisis de datos es clave para mejorar la planificación y operación de infraestructuras eléctricas. Una de las metodologías con mayor potencial en este ámbito es Building Information Modeling (BIM), inicialmente desarrollada para el sector de la construcción. BIM permite la modelización tridimensional de proyectos, la detección de interferencias y la integración de distintas disciplinas, lo que optimiza costos, tiempos y recursos. Dado su éxito en la construcción, BIM ha comenzado a extenderse a otros sectores, incluido el eléctrico. Sin embargo, aún existen desafíos para su adaptación. Este trabajo analiza las distintas herramientas BIM utilizadas en construcción y evalúa su viabilidad para su implementación en el sector eléctrico, identificando ventajas, limitaciones y oportunidades de mejora.

**Palabras claves:** *BIM; Sector eléctrico; Modelado digital; Optimización de recursos*

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## 1. Introduction

The constant evolution of the energy sector, driven by the growth in electricity demand and the rise of technologies such as renewable energy, domestic storage, and electric mobility, has posed new challenges for power distribution infrastructures (International Energy Agency [IEA], 2022).

The electricity sector, particularly in its distribution branch, has a set of characteristics that distinguish it from other infrastructure sectors. It is a highly regulated technical environment, where distribution companies must operate under strict regulatory frameworks, with high requirements for reliability, safety, and sustainability (CNMC, 2023).

In Spain, the electricity distribution system is responsible for transporting energy from transmission networks to end users, through medium and low voltage networks. This infrastructure must be capable of responding to new demands such as distributed generation, the electrification of transport, and the digitalization of energy management through smart grids (Red Eléctrica de España [REE], 2022).

One of the main challenges of the sector is the need to modernize existing networks, many of which are decades old, and to adapt them to emerging phenomena such as the variability of renewable energies or load peaks derived from electric vehicles (IEA, 2022). Furthermore, greater resilience is required against extreme weather events, which compels planning, operation, and maintenance with more precise and proactive tools.

In this context, distribution companies must not only maintain high levels of reliability but also adapt to an increasingly digitalized, complex, and regulated environment (Comisión Nacional de los Mercados y la Competencia [CNMC], 2023).

To achieve this, it is essential to incorporate digital tools that optimize the planning, design, execution, and maintenance of networks. In this regard, Building Information Modeling (BIM) methodology has shown high potential in sectors such as architecture, engineering, and construction (AEC), thanks to its ability to integrate geometric, technical, and operational data into a single digital model (Eastman et al., 2011).

BIM represents a profound transformation in the way projects are approached, allowing for more efficient collaboration between disciplines, greater asset traceability, and better lifecycle management of infrastructures (Succar, 2009). These features position it as a possible solution to the challenges of the electricity sector. However, its application in this field is still in early stages and faces barriers such as the lack of electrical object libraries, the need to adapt workflows, and interoperability with existing management systems (Volk et al., 2014).

This study aims to analyze the degree of potential adaptation of well-established BIM tools currently used in the construction sector to the electricity sector. The objective is to identify their technical and operational feasibility in the electrical domain, particularly in the distribution segment.

From a technical point of view, the electricity sector includes specialized elements (transformer stations, substations, protections, underground and overhead cabling) that require a very high level of technical detail and exhaustive documentation throughout the entire lifecycle of installations. This makes information management a key aspect.

The possibility of modelling electrical infrastructures in digital environments, with integrated and traceable data, is strategic for optimizing processes such as construction planning, interference analysis with other infrastructures, or predictive maintenance. However, this potential can only be fully leveraged if the tools used are correctly adapted to the operational logic of the electricity sector.

Therefore, before implementing methodologies like BIM in this sector, it is necessary to understand its specific characteristics in order to accurately assess which tools, workflows, and development levels are viable and useful.

## 2. Objectives

The implementation of BIM methodology in the electricity sector represents an opportunity to significantly improve the efficiency of planning, execution, and maintenance of distribution networks. However, its adoption cannot be a simple transposition from the construction sector; it must respond to the technical and operational features of the electrical environment (Volk et al., 2014).

This work sets out the general objective of analyzing the feasibility of adapting BIM tools used in construction to the electricity sector, with particular focus on distribution. To this end, the following specific objectives are proposed:

1. Identify the main BIM tools currently used in the construction sector, both in the field of modelling and in data integration (CDE).
2. Evaluate the functionalities, advantages, and limitations of these tools from the perspective of their applicability to the design, operation, and maintenance of electrical networks.
3. Apply a multicriteria evaluation methodology (scoring) that allows objective comparison of these tools based on key criteria for the electricity sector.
4. Propose recommendations on which tools show the greatest adaptation potential and what aspects should be improved for effective implementation.

With these objectives, the aim is to provide a solid foundation for decision-making in pilot projects or digitalization strategies within energy distribution companies, as well as to contribute to research on the use of BIM in sectors beyond traditional building construction.

## 3. Methodology

To address the proposed objectives, a structured methodology has been developed in four main stages, based on an analytical-comparative approach. The process combines documentary review, technical characterization of BIM tools, and the application of a multicriteria evaluation system adapted to the context of the electricity sector.

### 3.1. Review and classification of BIM tools

First, a representative set of BIM tools widely used in the construction sector is identified and classified. These are divided into two fundamental categories:

- Integration tools, which allow coordination and information management in a Common Data Environment (CDE).
- Three-dimensional modelling tools, used to design and document the physical elements of an infrastructure in high detail.

The selected tools were analyzed in depth, collecting technical information on their functionalities, advantages, limitations, BIM maturity level, and known use cases.

The selection of the BIM tools analysed in this study was based on a combination of technical, practical, and sector-relevant criteria. First, priority was given to platforms with wide adoption in the construction sector, both in design environments and collaborative project management, ensuring a sufficient level of BIM maturity for meaningful analysis. Second, their compatibility with open standards such as IFC and COBie was considered essential for potential adaptation to the electrical sector. Additional factors included the availability of technical documentation, validated use cases, integration with other systems (e.g. GIS, SCADA, ERP), and the ability to represent electrical infrastructure components using customisable object libraries. Finally, the selection aimed to include both well-established commercial solutions and emerging platforms, in order to offer a balanced and representative comparison of the current market.

### 3.2. Definition of evaluation criteria

In the second phase, key criteria were defined to assess the applicability of these tools to the electricity sector, considering technical, operational, and functional aspects. The criteria were organized into two groups, according to the type of tool (integration or modelling).

This step defined all the key factors for applying BIM in the electrical sector.

### 3.3. Application of the scoring method

In the third phase, the scoring or weighted rating method (Pugh, 1990) was applied, a multicriteria technique that allows alternatives to be compared through a decision matrix. Each tool was assigned a score (from 1 to 9) for each criterion, multiplied by a relative weight defined according to its importance for the electricity sector. The weighted sum resulted in a total score for each tool.

This method is particularly useful when the alternatives to be compared present different characteristics and when a more objective decision-making process is sought (Triantaphyllou, 2000).

The weighting of each criterion was established based on its perceived criticality in real-world electrical projects, informed by both literature and expert judgment. The score for each tool was determined through a qualitative-quantitative review using a 1–9 Likert-type scale, where 1 represents poor performance and 9 represents optimal alignment with sector needs. This approach ensures the methodology is reproducible and adaptable to similar comparative analyses.

### 3.4. Analysis of results and discussion

Finally, the results obtained were interpreted, identifying the tools that show the highest level of compatibility with the needs of the electricity sector. Furthermore, improvement opportunities, current barriers, and recommendations for future implementations or pilot tests were discussed.

## 4. Theoretical Framework: BIM methodology

Building Information Modeling (BIM) is a collaborative working methodology based on the creation and management of digital models containing geometric and technical information of a project throughout its entire lifecycle (Eastman et al., 2011). Unlike traditional 2D drawing systems, BIM allows the development of intelligent three-dimensional representations that integrate structural, electrical, mechanical, temporal (4D), financial (5D), sustainability (6D), and operational (7D) data, among others (Succar, 2009).

### 4.1. Advantages of BIM

The implementation of BIM has had a positive impact on sectors such as building, civil engineering, and architecture, mainly due to the following:

- Improved interdisciplinary coordination: BIM enables simultaneous and collaborative work among multidisciplinary teams, reducing conflicts and interpretation errors (Hardin & McCool, 2015).

- Early clash detection: 3D models help identify conflicts between elements before construction begins, avoiding costly rework.
- Efficient lifecycle management: The traceability of elements and their technical data facilitates operation, maintenance, and decision-making regarding future interventions (Volk et al., 2014).
- Simulation and analysis: BIM allows for energy simulations, structural analysis, and cost and time estimates from early project stages.
- Productivity gains: According to Dodge Data & Analytics (2020), BIM-enabled projects reduce total lifecycle time by an average of 7%.

### 4.2. Limitations of BIM

However, BIM adoption also faces several limitations and barriers:

- High initial cost: The investment in software, hardware, and training can be a barrier, especially for SMEs (Khosrowshahi & Arayici, 2012).
- Learning curve: BIM requires advanced technical skills and specific experience.
- Incomplete standardization: Despite the existence of international standards like ISO 19650, implementation varies across regions and companies.
- Limited interoperability: Some software tools struggle to exchange information across platforms, especially when using proprietary formats.

### 4.3. Challanges of implementation in new sectors

Extending BIM to sectors beyond construction —such as the electricity sector— involves new challenges, including:

- Developing specific object libraries (transformers, cells, substations, lines) aligned with electrical standards.
- Integration with SCADA, GIS, or ERP systems, essential for network operation.
- Adapting workflows to ongoing maintenance and work on live installations.
- Training technical teams in both BIM and complex electrical systems.

In summary, BIM provides a powerful framework for infrastructure digitalization, but effective application in sectors like electricity requires specific adaptations.

## 5. Analysis of BIM tools

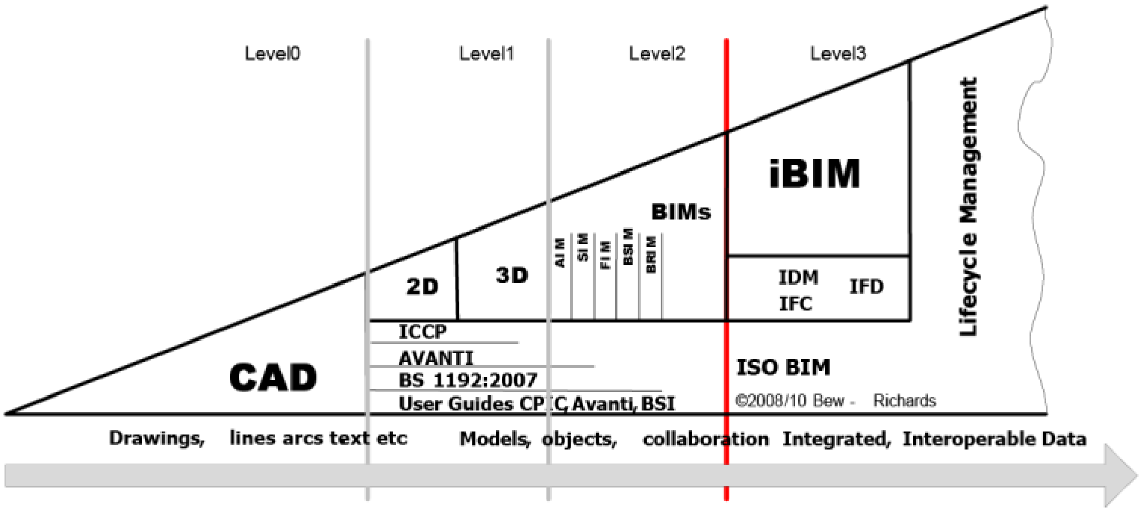
To assess the feasibility of BIM implementation in the electricity sector, tools widely used in construction were evaluated. These were grouped into two main categories according to their BIM environment role:

- Integration tools (CDE): Focused on collaboration, document management, and multidisciplinary coordination.
- 3D modelling tools: Used for the design, representation, and technical documentation of construction elements or infrastructure.

### 5.1. Characterization of tools to be applied in the electrical sector

Before a detailed analysis, it is essential to understand each tool's maturity level. The concept of maturity is defined as the progressive and continuous improvement of quality, enabling repeatable and predictable results within the available BIM capacity. The model by Mark Bew and Mervyn Richards (2008) introduces four levels of BIM maturity.

**Figure 1: Maturity levels.**




Each tool presented below is assessed using key criteria to be later applied in the scoring method. These tools allow to stablish a common space to save the data (CDE) in which different roles in the project can collaborate and share models, plans and documentation in real time. Some tools analyzed:

- **<u>Integration tools</u>**

In the following table is shown an analysis of the main key points to compare the different tools selected to the study.

**Table 1: Characterization of integration tools.**

| | Autodesk Construction Cloud | Trimble | Revitzo | Vircore | BimPlus |
|---|---|---|---|---|---|
| Description | Comprehensive platform designed to support construction project management through cloud-based data and collaboration tools | Cloud-based collaboration platform designed to connect project teams with the right data at the right time | Advanced platform for collaboration and information management in construction projects | Developed to enhance coordination among multidisciplinary teams and improve efficiency in managing data and 3D models | Collaboration and BIM model management platform aimed at improving coordination, communication, and project control in the construction industry |
| Use | Project management and collaboration | Data collaboration and management | BIM model visualisation and coordination | Project data management and visualisation | BIM project management and visualisation |
| BIM Maturity Level | Level 2 and 3 | Level 2 and 3 | Level 1, 2, and 3 | Level 2 and 3 | Level 2 and 3 |
| Advantages | Data integration, real-time | High interoperability, | Easy to use, supports | 2D/3D model synergy, GIS | Real-time collaboration, |

| | Autodesk Construction Cloud | Trimble | Revitzo | Vircore | BimPlus |
|---|---|---|---|---|---|
| | collaboration, process traceability | 3D visualisation, project tracking tools | multiple formats, real-time collaboration | integration, advanced analysis, easy to use | compatibility with multiple BIM tools, open BIM principles |
| Limitations | Expensive, steep learning curve | Fewer advanced functionalities compared to competitors, steep learning curve | fewer advanced features | Less market presence, steep learning curve | Internet-dependent, learning curve |
| Applicability in the electrical sector | High | Medium | Medium | Medium | High |

- **<u>3 dimensional modeling tools</u>**:

The same comparative carried out in the integration tools chapter is done for the modeling. The comparative is shown in the following table.

**Table 2: Characterization of 3D modelling tools.**

| | Revit | ArchiCAD | BricsCAD | Open Buildings | Allplan |
|---|---|---|---|---|---|
| Description | Platform for designing, visualising, and managing buildings and infrastructure in an integrated 3D environment | Allows users to create detailed 3D models, generate 2D plans, and manage project information in a collaborative and efficient environment | Known for working in a direct and parametric modelling environment, facilitating creation and editing of BIM models | Offers advanced tools for the design, analysis, and visualization of buildings and structures | Integrated platform for creating detailed 3D models, generating plans, and managing construction data in a collaborative environment |
| Use | Building information modelling (BIM) | Building information modelling | Building information modelling | BIM modelling and analysis | Building information modelling |
| BIM Maturity Level | Level 1, 2, and 3 | Level 1, 2, and 3 | Level 2 and 3 | Level 2 and 3 | Level 2 and 3 |
| Advantages | Broad functionality, Autodesk ecosystem integration | Easy to use, supports multiple formats | Competitive cost, DWG integration, task automation | Advanced analysis tools, integration with infrastructure workflows, tools for advanced modelling and automatization of tasks | High modelling precision, advance tools for modelling |

| | Revit | ArchiCAD | BricsCAD | Open Buildings | Allplan |
|---|---|---|---|---|---|
| Limitations | Expensive, requires high-performance hardware | Fewer advanced features compared to Revit | Less widely known, fewer available resources, high specifications of hardware | Complex interface, requires powerful hardware, expensive | Expensive, steep learning curve |
| Applicability in the electrical sector | High | Medium | Medium | High | Medium |

Once the 5 most relevant tools related to integration elements and the 5 most relevant tools related to modeling have been analyzed, a comparison will be made using the scoring method.

## 6. Evaluation of Tools Using the Scoring Method

To identify the most suitable BIM tools for implementation in the electricity sector, a scoring method or weighted rating technique was applied. This multicriteria approach enables objective comparison of alternatives, assessing them based on a set of relevant criteria and assigning weights proportional to their importance (Triantaphyllou, 2000).

### 6.1. Evaluation criteria

The following criteria were defined for comparing integration and 3D modelling tools, including their respective weightings represented in the first columns of the following tables.

Each tool was scored from 1 (very low) to 9 (very high) in each criterion. The total weighted score was calculated to enable comparison.

**Table 3: Evaluation results – Integration tools.**

| Criteria | BimPlus | Revizto | Vircore | Autodesk Construction Cloud ACC/BIM 360 | Trimble Connect |
|---|---|---|---|---|---|
| Information security (5) | 9 | 7 | 9 | 8 | 8 |
| Real-time information Exchange (3) | 9 | 9 | 9 | 9 | 9 |
| Process traceability (4) | 9 | 8 | 8 | 9 | 8 |
| Data interoperability (5) | 9 | 9 | 8 | 9 | 5 |
| Workflow coordination (3) | 9 | 8 | 8 | 8 | 9 |
| User-friendly environment (4) | 7 | 8 | 9 | 6 | 5 |
| Implementation cost (2) | 5 | 6 | 1 | 2 | 7 |

| | | | | | |
|---|---|---|---|---|---|
| **Score (max 234)** | **218** | **207** | **206** | **200** | **185** |

**Tabla 4.- Evaluation results – 3D modelling tools**

| Criteria | Revit | ArchiCAD | BricsCAD BIM | Allplan | OpenBuildings Designer |
|---|---|---|---|---|---|
| Data interoperability (5) | 9 | 9 | 8 | 8 | 9 |
| Model coordination (4) | 9 | 9 | 8 | 8 | 9 |
| Visualisation ease (4) | 8 | 8 | 8 | 7 | 7 |
| Learning curve (3) | 5 | 8 | 5 | 3 | 3 |
| Hardware requirements (4) | 2 | 2 | 3 | 3 | 2 |
| User-friendly environment (4) | 8 | 8 | 8 | 8 | 7 |
| Implementation cost (2) | 2 | 3 | 4 | 2 | 1 |
| Projected network connectivity (5) | 7 | 4 | 6 | 7 | 7 |
| **Score (max 279)** | **207** | **203** | **201** | **192** | **191** |

Conclusion: Bimplus (integration) and Revit (3D modelling) achieved the highest scores and are thus considered the BIM tools with the greatest applicability to the electricity sector according to this scoring method.

### 6.2. Analysis of results

The results suggest that combining platforms like Bimplus (integration) and Revit (modelling) may represent a solid strategy for initial BIM implementation in the electricity sector. However, their effectiveness will depend on customizing electrical components, integrating with existing management systems, and training technical staff.

## 7. Discussion

The scoring results allow reflection on several key aspects for implementing BIM methodology in the electricity sector. This discussion is structured around three axes: technical viability, organizational challenges, and improvement opportunities.

### 7.1. Technical viability

The evaluation shows that there are mature BIM tools that can be adapted to the electrical distribution context. Platforms like Autodesk Construction Cloud and Revit offer robust capabilities for document management, MEP modelling, interoperability, and multidisciplinary collaboration. Likewise, Bimplus and OpenBuildings Designer provide strong alternatives, especially for complex environments such as substations or urban infrastructure.

Although these tools were originally designed for building or civil engineering, many of their features are transferable to the electricity domain, provided specific libraries are implemented, processes are adapted, and technical training is provided.

### 7.2. Organisational Challenges

One of the main challenges identified is organizational and cultural. BIM implementation requires a transformation from traditional 2D, document-based workflows to a collaborative, digital model approach. This implies:

- Technical training of electrical engineering personnel in BIM modelling, interoperability, and data management.
- Workflow adaptation to align with model-based processes.
- Cultural change within organizations, particularly those with hierarchical or traditional structures, which may resist technological adoption (Khosrowshahi & Arayici, 2012).

In addition, a lack of standardization specifically for BIM in the electrical sector is observed. While the building industry has developed advanced standards, the electrical environment is still in early regulatory stages.

### 7.3. Improvement Opportunities

Digitalization in the electricity sector is a strategic priority in many countries, and BIM adoption could be a key driver in this transition. Opportunities include:

- Development of standardized electrical BIM objects for reuse in networks, transformer centres, substations, etc.
- Integration of BIM with GIS, SCADA, and ERP systems to connect 3D models with real-time operational data.
- Cross-sector collaboration among utilities, software vendors, and regulators to establish adapted frameworks.
- Pilot projects to validate BIM's utility in real scenarios and adapt it to local operational and regulatory conditions.

In summary, although a full BIM implementation in the electricity sector faces important challenges, the potential benefits in efficiency, traceability, and sustainability justify continued investment and development.

## 8. Conclusions

The digital transformation of the electricity sector is an ongoing process that demands tools capable of managing the technical and operational complexity of modern infrastructures. In this context, BIM represents a significant opportunity to optimize the design, construction, and maintenance of electrical networks, providing more efficient, collaborative, and traceable management.

From the analysis conducted in this study, the following conclusions can be drawn:

- BIM tools developed for the construction sector are largely feasible for adaptation to the electricity sector, particularly those focused on collaboration and integration (e.g. Autodesk Construction Cloud) and MEP modelling (e.g. Revit).
- The multicriteria scoring evaluation enabled an objective determination of which tools demonstrate the strongest alignment with the needs of the electricity environment highlighting interoperability, technical modelling capability, and documentation management.
- BIM adoption in the electricity sector still faces significant barriers, particularly regarding the lack of electrical libraries, organizational resistance, and low regulatory standardization.

- Clear improvement opportunities exist, including developing electrical BIM components, integrating with digital systems (GIS, SCADA, ERP), and launching pilot projects as reference cases.

Ultimately, while BIM implementation requires an initial investment in time, training, and resources, its medium- and long-term benefits strongly justify its advancement. This study lays the groundwork for moving forward and aims to contribute to the dialogue and action toward a smarter, more efficient, and sustainable electrical infrastructure.

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### Use of Generative Artificial Intelligence

Language refinement and structural editing were supported by an AI-based language model (ChatGPT). All content has been verified and approved by the author.

### Communication aligned with the Sustainable Development Goals