AGACAD

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DELIVERING TOMORROW'S AEC

AGACAD WHITE PAPER

Accelerating the Digital Transformation of Architecture, Engineering and Construction (AEC):

A KEY TO MORE SUSTAINABLE DEVELOPMENT

By AGACAD Team

8 October 2021

Introduction

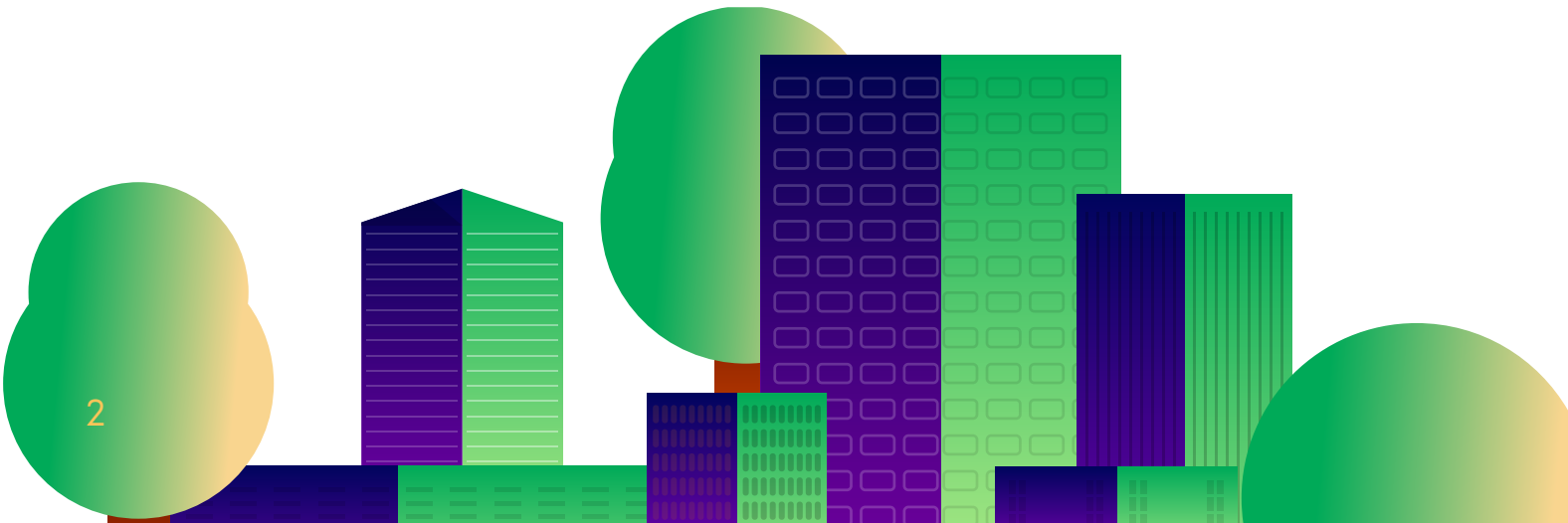
The increasingly rapid growth and development of communities and economies around the world has greatly benefited human life and society. But it has also taken a heavy toll on planet Earth – the common home which we share and must pass on to future generations. We have **carbon-dioxide emissions** on a scale that is causing climate change, mountains of **waste** clogging sea and land, and other **depletion or destruction** of nature's resources. Hence today's global goals for avoiding environmental disaster and making further human progress sustainable again, embodied in international commitments like the Paris Agreement and the UN Sustainable Development Goals. They include sharp reduction of carbon emissions and waste along with a shift to more renewable resources.

A major part of the problem is **the built environment**. The construction, operation and eventual demolition of buildings and infrastructure accounts for an estimated **one-third or more of all carbon emissions and waste**. Moreover, with rapid urbanization continuing in many parts of the world, we will need and see more and more construction.

Clearly, then, the fields of architecture, engineering and construction (AEC) play a vital role in sustainable development. This White Paper discusses how the **digital transformation of AEC** is a powerful promoter of progress toward environmental goals. And accelerating the digitalization of construction is what AGACAD is all about.

For over 30 years, we have been developing innovative technologies for AEC, working closely with top practitioners, whom we also help train and consult. Today we offer a large portfolio of solutions for efficient **building information modelling and management** (BIM). They lead not only to cost savings and new capabilities for our clients around the world, but also to important reductions in emissions, waste and the use of energy resources.

AGACAD is part of the Arkance Group, a European leader in the digital transformation of construction and manufacturing. Arkance actively supports **the Paris Agreement goal of cutting construction's carbon impact in half by 2030**. For buildings, we do so by providing cutting-edge technology to control and reduce not just costs but also emissions throughout the design-build-operate project life cycle.



Ecology and digital AEC

In recent years, automation, robotization and more have brought manufacturers big productivity gains. Meanwhile, **construction has been slow to go digital** and lags in efficiency. We will see that this means more waste and carbon emissions than are needed. As participants of AGACAD's ongoing Global BIM Survey have stressed, there is a need for specific tools, training, and education to speed up the digital transformation of the built environment.

> "Digital technology can cut global emissions by 15 percent."
>
> World Economic Forum

A great deal depends on **pre-construction activities** – the work of architects and engineers. Design decisions have a major impact on costs, quality and the environment over the entire life of a building. Moreover, digital work at this stage is key for being able to use digital solutions later: for off-site fabrication, at the construction site, and in facilities management.

The foundation for the digitalization of architecture, engineering and construction is **the BIM method** for modelling and managing building information. BIM involves collaborative processes by which actors create, update and store 3D representations and all relevant data about a building throughout its life. The purpose of BIM is to give each actor the information they need at just the right time to support the building's effective design, creation and use.

What are the main ecological benefits of BIM?

- **Design optimization (including for green objectives)**

  BIM software, like the Autodesk Revit platform and related extensions, makes it possible to simulate and analyse all aspects of an asset in virtual space to make better design choices, also in environmental terms, as regards **materials, energy efficiency, resilience/longevity, reuse plans, and so on**. Pooling technical, operational, construction and manufacturing knowledge enables design to be value engineered and optimized for every stage of delivery and operation.

> With BIM, "the whole life carbon emissions of a project can be modelled and assessed [and] the data can then be used to drive specifications, bringing about the lowest possible emissions (or highest possible sequestration) at the outset as well as throughout the life of the asset."
>
> Report by Norway's Vestre

- **Much less rework (meaning much less construction waste)**

  The need for rework, which creates a lot of waste, is sharply reduced because:

  - BIM enables early clash detection and resolution in a virtual environment.
  - Collaboration, data sharing, and 3D visualizations mean a project's various stakeholders are more likely to notice errors or inefficiencies and question poor design decisions early, so changes can be made before waste occurs.

- **Better planning (making construction less carbon-intensive)**

  BIM enables better sequencing of building processes and provides more accurate take-offs to ensure **delivery of just the materials that are needed when they are needed**. This eliminates unnecessary transport of materials (and potential waste) and delays that extend work on site (with energy and other types of impact).

- **Access to other environmentally friendly technologies**

  BIM provides the data which is needed to drive other building solutions with significant potential to reduce emissions, resource use and waste: off-site fabrication (CNC machines), robotization of construction tasks and 3D printing, digital twins and specific systems for smart facilities management (buildings with artificial intelligence), and so on. BIM also makes it easier to integrate ecological materials (like wood products) and intelligent façade solutions into a project.

As Frost & Sullivan wrote in a recent report on Digital Sustainability: "The evolution of

With BIM, "AEC professionals are designing net-zero buildings that produce as much energy as they consume, zero-emission transportation systems, resilient infrastructure, and net-positive products, among countless other climate solutions."

Emmanuel Di Giacomo writing for Autodesk University

BIM [...] enables sustainable construction by incorporating economic efficiency, energy and resource efficiency, and environmental performance in different stages of construction."

Accelerating the digitalization of AEC activities clearly offers a significant opportunity for the sustainable development agenda. Holding the sector back, though, is a slowness to adopt the BIM methodology, whether for perceived lack of expertise, inertia and general dislike of change, or enduring scepticism about the relative costs and benefits of doing BIM.

Some European countries, like the UK and Norway, now have BIM mandates in place and others, too, actively encourage BIM implementation in public sector projects.

We at AGACAD, for our part, provide training and consulting services for AEC professionals while continually developing software solutions to make doing BIM as easy, attractive and advantageous as possible. Those tools generally take the form of add-ins for Revit and are now used by more than 13,000 BIM professionals in 130 countries. In the next section we examine some of them which have specific relevance for sustainability goals.

Benefits of specific BIM solutions

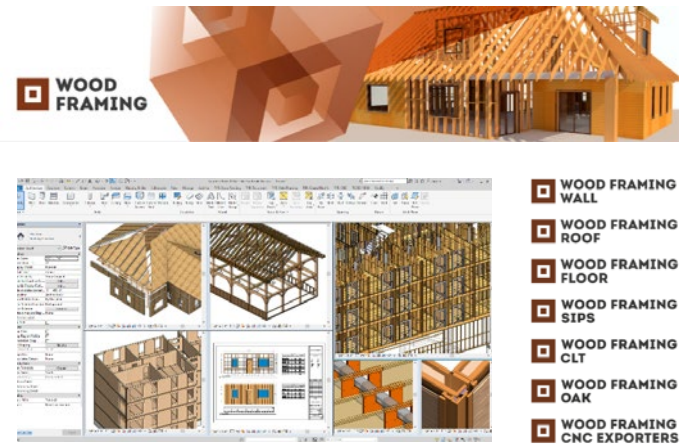
As we have seen, BIM in general offers broad opportunities for reducing emissions, waste and resource depletion in the context of the built environment. Within specific areas of pre-construction and construction activities, however, BIM use and specialized BIM applications offer particularly relevant benefits. Here we examine some of those cases.

BIM and wood

In the move to more environmentally friendly construction materials, wood is very much in the spotlight. Abundant, natural, renewable and recyclable, it has great tensile strength and is relatively lightweight. And where making 1 cubic meter of concrete or steel releases hundreds of kilograms of greenhouse gases into the air, growing the same quantity of wood actually absorbs 900 kg of CO_2 from the air.
So, using wood to build a 125-metre skyscraper could reduce its carbon footprint by up to 75 percent.

But is this ages-old, simple material suited to contemporary building needs? As a matter of fact, wood is being rediscovered as a versatile component for even very modern projects.
In some cases, it is **helping make buildings carbon neutral or even carbon negative**.
And that is in large part thanks to technological advances including digital solutions for AEC.

BIM tools – like those in the AGACAD WOOD FRAMING SUITE – are facilitating architectural design, structural engineering and automated fabrication with wood and engineered wood products (like CLT, GLULAM, LVL, and SIPS). That is helping to fuel the renaissance of wood, with a major positive impact on the environment and the construction sector.



AGACAD's Wood Framing software for Revit, an Autodesk AEC Industry Partner Solution, automates the design-to-detail process for timber-framed floors, walls, and roofs, with integrated structural analysis, estimation, documentation, shop deliverables, and export to CAD/CAM production. It also includes advanced solutions for the specialized workflows that are part of SIP, CLT, and heavy timber design. The suite lets architects make key project decisions easily and early, and it automates time-consuming processes for structural engineers, from building up a model to generating shop tickets and exporting to CNC.

Some key sustainability benefits of AGACAD Wood Framing tools:

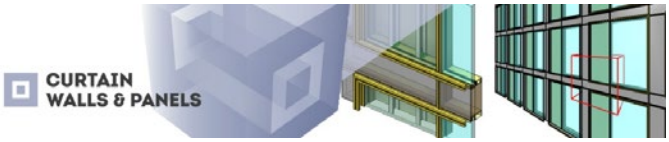
- 3D modelling helps to see more design options and achieve **better efficiency**. As an example, effectively arranging sheathing panels in the design of a wood frame building can notably **reduce the amount of construction materials** needed.
- Precise geometry ensures **accurate bills of materials**, so only what is needed is procured, helping **save resources and avoid waste**.
- Model accuracy ensures quality documentation and helps identify errors during the design phase, which means **fewer mistakes and less rework** during construction.
- Much better management of project information means that for any design changes, take-offs update automatically, **avoiding rework and orders of unneeded materials**.

BIM and facades

Facade engineering is another important area for sustainability advances in construction. Facades not only serve as the face of a building but can also be used to control the effects of the outer environment and make interiors more energy efficient.

The use of louvres, smart facades, etc. can make a huge impact on the amount of energy used by a building. Dynamic systems are developing that interact with and automatically respond to environmental conditions, with technologies such as nano-coatings, electronic tinting, and solar generation. Among new technologies whose use could be revolutionary is photovoltaic glass – transparent solar panels that can generate electricity from windows.

Specialised advanced BIM tools are playing an important role as well. Examples are the Revit add-ons for curtain walls and panels and for ventilated facades developed by AGACAD, which are stand-alone solutions. They facilitate communication and coordination in building projects, as well as integration of a building's skin with other building systems.



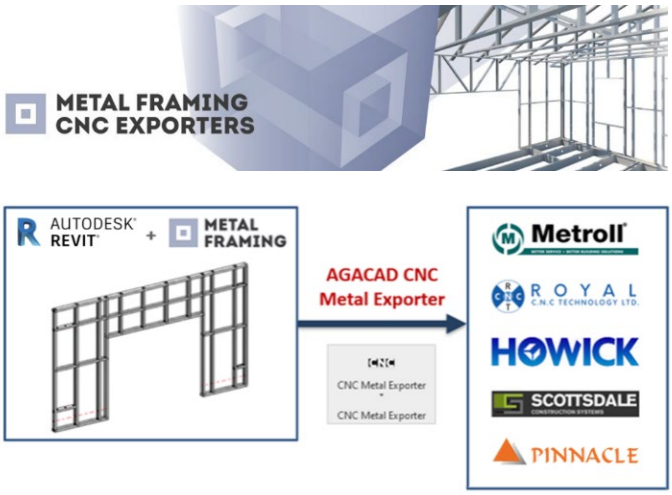
Some key sustainability benefits of AGACAD's tools for facades:

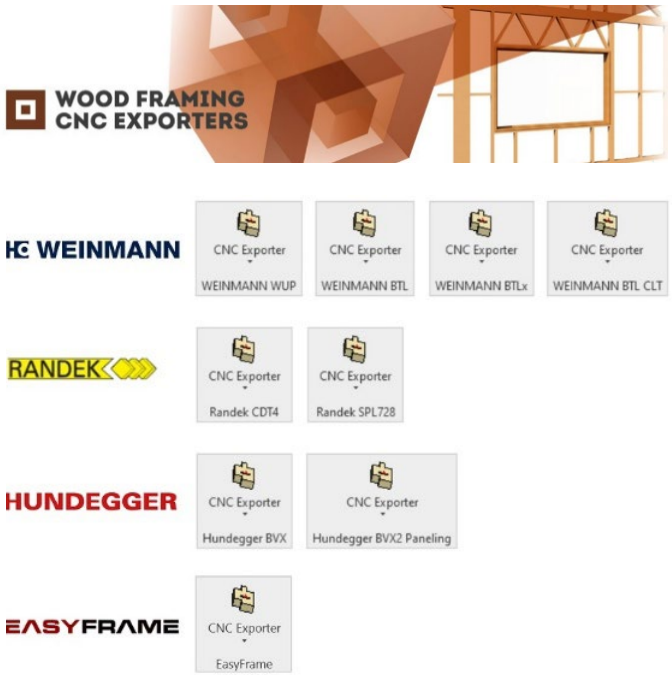
- 3D modelling helps to see more design options and achieve **better efficiency**.
- Precise geometry ensures accurate bills of materials, so only what is needed is procured, helping **save resources and avoid waste**.
- Model accuracy ensures quality documentation and helps identify errors during the design phase, which means **fewer mistakes and less rework** during construction.
- Much better management of project information means that for any design changes, take-offs update automatically, **avoiding rework and orders of unneeded materials**.
- Models enable **a paperless building process** and the use of augmented and virtual reality on site, with drawings no longer needed for control or as-built deliverables.

BIM and off-site work

BIM is also fuelling (and enabling) a surge in modular and prefabricated construction, including off-site manufacturing and automation, employing the latest industry technologies to fully or partially fabricate building modules and components. Energy use and waste can be significantly reduced in a controlled production environment. Construction time on site is also shortened notably. And the better quality control in a factory improves the longevity and life-time energy efficiency of assets.

BIM makes it possible to provide design and construction information of building components to offsite manufacturers in a machine-readable format. Computer aided manufacturing (CAM) software uses the models created in a computer aided design (CAD) application like Revit to drive machine tools to turn designs into physical components.





AGACAD's CNC Exporters for Wood and for Metal automatically assemble framing members as modelled in Revit and send the necessary data to CNC machines and CAD/CAM production lines for flexible manufacturing of wood structures and light-gauge steel frames. We offer exporters for the most popular CNC machines and can adapt them for others.

Some key sustainability benefits of AGACAD's CAD/CAM and CNC solutions:

- Sharp reduction of the margin of error: highly precise data is sent to machines for very accurate production, thus **saving resources and avoiding waste**.
- A **paperless building process** is made possible as direct transmission of production data to CNC machines means there is no need to print drawings, saving resources.
- Enhanced quality control improves longevity and **life-time energy efficiency**.
- Solutions for efficient packing and transport planning **reduce both emissions and the depletion of energy resources**.

BIM and precast concrete

Concrete holds a very significant place in the built environment. As such, the general environmental benefits of using the BIM methodology very much apply here and offer important potential for gains in terms of carbon emissions, waste, and so on. It is also true that precast concrete is more sustainable than cast-in-place concrete.

Reviewing some of the applicable BIM benefits, accurate modelling and fewer mistakes means less redo needed on the construction site, which would involve additional transport of elements, additional cutting, drilling, etc.

AGACAD promotes the use of precast over cast-in-place concrete and supports more ecological precast solutions through its PRECAST CONCRETE suite of Revit tools.

Some key sustainability benefits of AGACAD's tools for precast concrete:

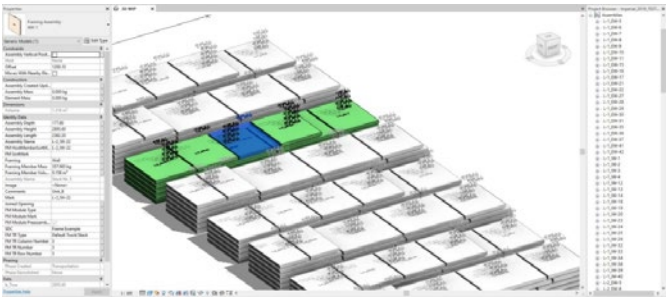
- 3D modelling helps to see more design options and achieve **better efficiency**.
- Precise geometry means accurate bills of materials, for example for concrete and reinforcement bar, so only what is needed is procured, **reducing waste to a minimum**.
- Model accuracy ensures quality documentation and helps identify errors during the design phase, which means there will be **fewer mistakes and less rework** during construction.
- Much better management of project information means that for any design changes, take-offs update automatically, **avoiding rework and orders of unneeded materials**.
- Models enable **a paperless building process** and the use of augmented and virtual reality on site, with drawings no longer needed for control or as-built deliverables.
- Solutions for efficient packing and transport planning **reduce both emissions and the depletion of energy resources**.

BIM and logistics

A central part to off-site production is the ability to transport what has been manufactured to the construction site. That means planning all aspects of storage and logistics. At stake is the efficiency of transportation and logistics, which have an important emissions dimension.

For maximum performance in this area too, AGACAD has developed a BIM solution for Revit known as Panel Packer. This is a powerful toolbox for sorting, packing and loading prefabricated building components. Colour coding, unique identifications and even QR codes can easily be used. Packing calculations are accurate to a precision of 1 mm. Panel Packer, a stand-alone product, is a perfect complement to AGACAD's framing packages and its precast suite, enabling users of those design solutions to save time and costs on the logistics side of their work as well.

Key sustainability benefits of AGACAD's Panel Packer solution are **reduced use of energy resources and reduced emissions** due to better planning of transport and storage of construction materials and prefabricated modules or elements.



Conclusions

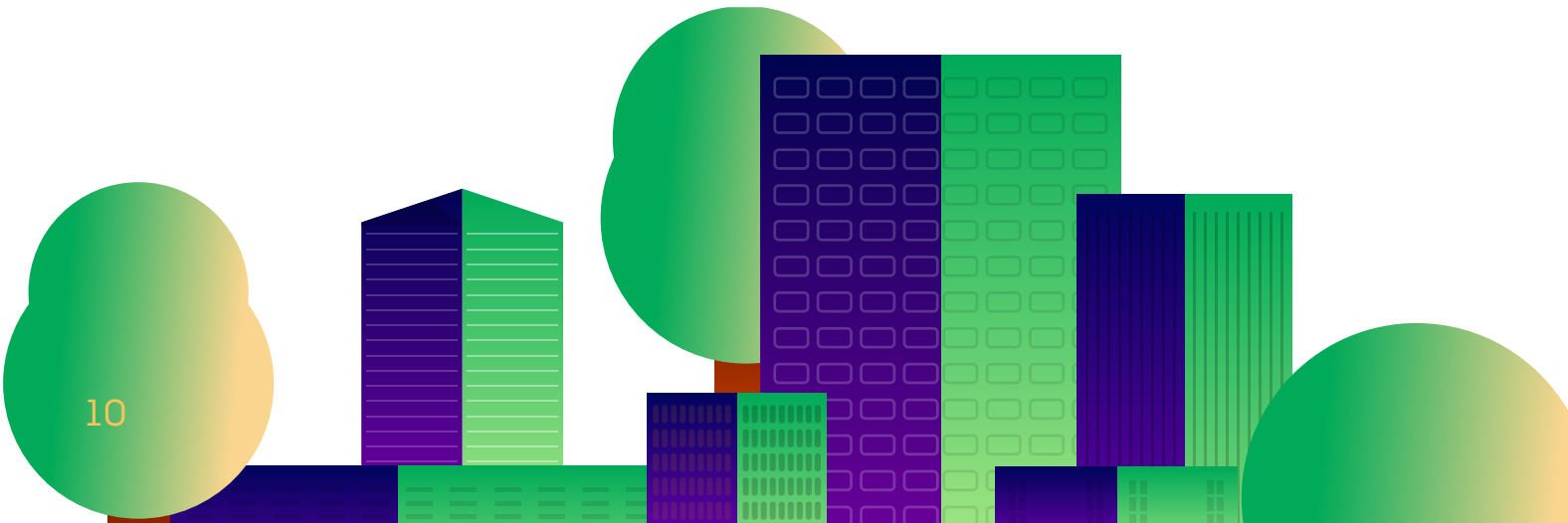
This paper has sought to illustrate:

- that the fields of architecture, engineering and construction play a vital role in sustainable development;
- that promoting the digital transformation of AEC is key for progress toward environmental goals;
- and that AGACAD, along with the Arkance Group of which it is part, is focused on accelerating the digitalization of construction through innovative technology solutions, including an existing portfolio of advanced BIM tools for Revit.

> "Making our buildings climate-proof is not only about reducing the 36 percent of CO_2 emissions they are responsible for, but about doing so while caring for the people that live in them."
>
> **The European Green Deal policy initiative**

At AGACAD, we have always been committed to fully realising all the benefits of BIM. Those benefits also include progress toward the sustainable development goals on which the world's future depends. AGACAD tools enable Revit users to work fast and accurately during the design and documentation phases. They reduce human error by automatically placing elements within models, assigning specific complex data for documentation and manufacturing purposes, and ensuring real-time updates for any design changes. As a result, the tools not only save project teams time and money during design and documentation but also cut material waste during manufacturing and construction.

We continue closely collaborating with top BIM professionals worldwide to further develop new and existing digital technologies for AEC based on their insights, best practices, and real-life practical needs.



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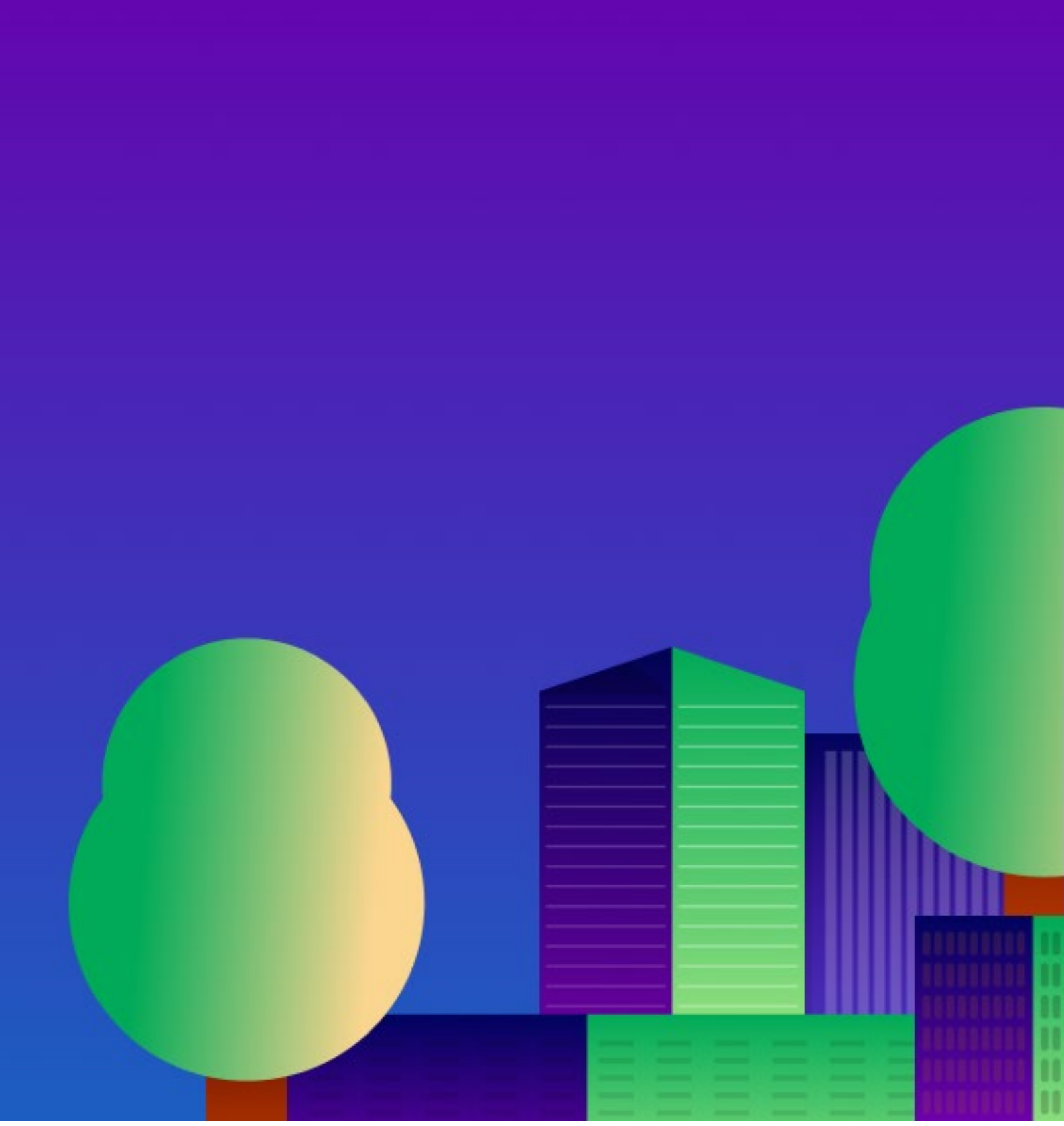

AGA CAD Ltd.
TOOLS 4 BIM Developer

Phone: +370 618 55 671
Email: info@agacad.com

Žalgirio g. 94, LT-09300 Vilnius
Lithuania – European Union
Northern Europe

www.agacad.com

AGACAD