



Title: Concept of making cities glow with genetically engineered bioluminescent plants

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Abstract: Biotechnology has opened a door of plant modification through genes for modern science. Bioluminescent plant technologies are some of the latest results of this. According to this study bioluminescent plant technologies are very Prospective for future development of human civilization. People rely heavily on electricity to illuminate their homes, and their town also relies on it to illuminate its streets, parks etc. but the source of that electricity is fossil fuel which is coming to an end in the near future. So humans do not have the luxury to use electricity whenever they want and wherever they want. But for room or home illumination, bioluminescent plants may be a good option in future. If enough research can be conducted and developed versions of bioluminescent plants can be invented, even urban illumination with these plants may be practical. Bioluminescent plants produce light through biological processes. They do not depend on any external source of energy like a battery for that. Some of them do not need any external substrate to be submitted to glow. Basically they are autonomous. Also bioluminescent plants do not depend on the sun directly to glow up like solar energy based bulbs [1].

Keywords: Bioluminescent plants, genetic engineering, fungal bioluminescence pathway, TAL tyrosine pathway, Nano-lantern, plant biotechnology, urban illumination, landscape lighting.

Introduction: Some of the bioluminescent plants technologies allow plants to produce light autonomously without any external substrate [1]. That makes them a potential solution for illumination of rooms, yards, gardens, parks, streets etc in the future. Also these plants can be used as decors. If these plants can be used as decors on a mass scale, usage of electricity for decoration can be reduced substantially. Already people are buying these plants commercially as ornaments [2].



Image: Urban illumination (Imagined), **Source: AI.**

Companies like Magic Pen Bio and LEP's recently developed and upgraded Bioluminescent plant technologies along with Light Bio's commercialization of FBP based bioluminescent plants are proving that there is a lot to discover in this sector [3, 4, 2] and the sector demands more and more research. According to this study, if enough research can be conducted to develop a superior biological autonomous plant glowing system, the concept of urban illumination can be practical.

The study discusses Magic Pen Bio and LEP's technologies along with FBP technology and its commercial usage below.

Fungal Bioluminescence Pathway (FBP) technology used by Light

Bio: It is a genetically encoded metabolic pathway derived from luminous fungi. It can be integrated with plant metabolism without requiring the plant to be supplied with luciferin from outside. It uses caffeic acid which is naturally produced by plants as part of a self-sustaining cycle that produces the luciferin. Tobacco plants with self-sustained visible luminescence is a big example of FBP [5]. In 2025 a review says that scientists have used metabolic engineering and improved proteins to make the plants much brighter than before. For example, early FBP tobacco flowers' intensity of glowing was 10^{10} photons/minute. Later that was increased significantly by new variants. The eFBP2 variant produced enough luminescence to illuminate standard-font text. The review also says that the pathway was successfully implemented in several plant species including *Arabidopsis*, dahlias, roses, *Catharanthus* and petunias along with tobacco [6]. Light Bio commercial company has taken the research technology and developed an ornamental plant product [2]. An image link of Light Bio's bioluminescent firefly petunia plant product is given here: <https://light.bio/products/light-bio-firefly-petunia>.

Magic Pen Bio's high brightness TAL pathway system: Magic Pen Bio has developed TAL tyrosine pathway using an efficient genetic system [7]. It uses tyrosine to produce caffeic acid [8]. TAL tyrosine is a dual-gene system based pathway [7]. Magic Pen Bio says it has invented a high brightness system for bioluminescent plants. The pathway has more than 30x higher substrate conversion than the traditional phenylalanine metabolism pathway. The luminescence system has been applied to more than 20 plant types including sunflowers, dahlias, pentases, begonias etc. Magic Pen Bio is exploring the use of bioluminescent plants for urban nightscapes and ecological lighting applications [3]. An image link of Magic Pen Bio's high brightness bioluminescent plants is given here:

https://www.magicpenbio.com/uploadfile/202601/2daa8d795c03a4b.jpeg?utm_source=chatgpt.com. Also an image link of increased luminescence plant compared with early-generation low luminescence plant by Magic Pen Bio is given here:

<https://www.magicpenbio.com/uploadfile/202601/85d581ffa7b4b59.png>.

LEP's upgraded nano-lantern/hybrid optical technology: LEP goes beyond simply making a plant glow [4]. Nano-lantern is a fusion of a bioluminescent protein and a fluorescent protein. The system uses bioluminescent resonance energy transfer (BRET) to modify the characteristics of the emitted light. It has also achieved increased luminescence than earlier systems [9]. LEP's upgraded nano-lantern can produce 20× brightness compared to conventional methods. LEP has also achieved 20 color variations of light in luminescent proteins by controlling emission wavelengths. LEP is exploring the future use of bioluminescent plants for glowing roadside trees, park lighting and landscape illumination [4]. An image link of luminescent protein solutions emitting different colors of light, from blue to red in tubes by LEP is given here:

https://www.start-lep.jp/_next/image?url=%2Fimages%2Fcoretech03_2100.webp&w=1200&q=75.

Major findings from these technologies:

1. Autonomous and continuous biological luminescence system in plants.
2. The bioluminescent plant's glowing brightness can be increased.
3. The color of emitting light can be controlled.

Limitation of these technologies: Lack of enough brightness in bioluminescent plants is the main limitation of these technologies for now. This restricts bioluminescent plants to be implemented in sectors like park illumination, street illumination etc [1, 3, 4].

Concept of future urban illumination with bioluminescent plants: If

this concept of illumination with plants can be taken seriously and enough research can be conducted to develop more advanced bioluminescent plant technologies, those plants can be implemented in-

- Room decoration.
- House decoration.
- House illumination.
- Garden decoration.
- Park decoration.
- Natural park illumination.
- Natural street illumination etc.

If the way of making big trees glow sufficiently in a mass scale can be discovered, the concept of urban illumination can become practical. Also big and small trees can be used to light up those areas where it is difficult to provide continuous electricity. But to make all these possible more and more research is required.

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