

PowerPlant Lighting Systems AS - Photosynthesis done bright

PowerPlant is an intelligent plant lighting system that combines data science with plant science in order to enable a next generation light sensor module for individual plant health. The core technology being data modelling approach in combination with innovative LED light module that as been tested and sold to Bama and Gartnerhallen w



With PowerPlant the aim is to bring a durable, sustainable and efficient light systems and growing solutions to the consumer market. Meeting the demands of the rapidly increasing home-growing- and urban vertical farming market segments with products that do what they are supposed to do: Make photosynthesis happen – efficient, according to the plant’s capacity and needs.

The project that the student team desire to conduct within the STUD-ENT application is to productize and commercialize lighting systems for the home growing market based on technological and plant science expertise and experience through previous and ongoing prototyping and testing.

1 Research and innovation

Research and knowledge - The idea of PowerPlant has its source in people and projects associated to Eik Ideverksted at the Norwegian university of life sciences (NMBU). Based on the combinations of knowledge in plant science, technology and innovation processes, an entrepreneurial environment and infrastructure for prototyping and electronical engineering; The team behind PowerPlant have been working on multiple projects with research institutions and industry as collaborators and demanding costumers.

Among the projects demonstrating the team’s ability to deliver state-of-the-art solutions:

- Design and production of custom made LED light system for NIBIO research project on intensive indoor vertical farming of ruccola in aquaponics. Norsk institutt for bioøkonomi (NIBIO, Landvik, built and delivered 2017. Research project 2018). Financed by Grofondet)¹
- Delivery of significantly improved light system for the tissue culture lab at Senter for klimaregulert planteforskning (SKP, NMBU) Own design, and production.
- Demonstration facility for vertical farming. Student project at Eik Ideverksted, Faculty of Science and technology, NMBU.



FIGURE 1 THE PLANT LAB AND DEMONSTRATION FACILITY AT EIK IDEVERKSTED

¹ <https://www.nibio.no/prosjekter/norsk-helarsproduksjon-av-ruccola-i-aquaponisk-dyrkingssystem-i-veksthus>

In these projects, there has been conducted development of innovative customized lighting products based on the most suitable electronic components available. During these projects on matching technology with biology – the team has achieved a very high level of expertise in the field of plant lighting and indoor farming. Leading to this idea to productize on the knowledge into filling a market gap of easy to use, but still flexible plant lights of the highest quality.

Level of innovation - Among scientists, home-growers and the industry it's a known truth that sufficient light is the first bottle neck in plant production. Nutrition and water is of course essential, but in most relevant cases easy to handle. In the more intensive forms of indoor plant production, factors like Co₂-levels, humidity and airflow are relevant – depending on the amount of light pushing photosynthesis.

The problem - today's solutions for home growers - To achieve the joy and satisfaction of growing your own greens at home, there are plenty of alternative products and set/ups available in the market. Everything from do-it-yourself components to plug-and-play capsules plant machines.

Our hypothesis based on initial customer research and our own experience is that the existing solutions do not fit the typical enlightened (!) customer's needs: To succeed with indoor growing.

A kind of costumer that want flexibility, capacity and personal adjustments without building everything from scratch. Without the need of doing the production very technical or complicated.

Solution - PowerPlant seeks the segment of "semi-intensive" production – high photosynthesis, bud without the need for technological control of humidity, airflow and co₂ to avoid stress and unhealthy plants.

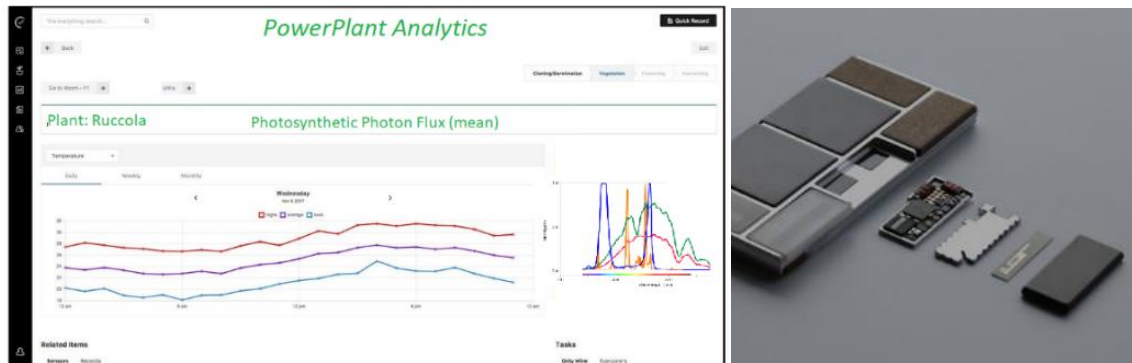
With the sensor data the light system will adjust the amount of light to the plants depending of other sources of light. Like daylight and other light sources. Resulting in optimal lighting for the type of plant and the growing stage of the plant to ensure fast growth and good plant health with a minimum of effort from the costumer.

The PowerPlant consist of a

- PlantPal – For that purpose PowerPlants plug and play LED-light-boards will have an integrated "photosensitivity sensor" which provides overview of the total photosynthetic photon flux (PPF).
- PlantBank – Microcontroller unit (MCU) board with embedded models that have recommended PPF values on different plants.



- PlantMonitor – Dashboard which provide user insight to the total radiated light for the specific plant.



With the PowerPlant solution, the customer can use whatever growth medium (e.g. pot-soil, rockwool, fiber) or watering system that they want or have available. The light-boards are slim and elegant without any need for any cooling. This means it can be used in all kinds of set up. The control unit will be placed on the power supply cable.

2 Impacts and outcomes

Market insight and areas of application

We spend 90% of our time indoors. Plants make the indoor environment feel better and indoor vertical farming and urban farming among households are an anticipated trend. Smart greenhouses are a perfect example. With the global smart greenhouse market projected to grow to \$1.2 billion in 2020, IoT companies are developing new systems to help growers achieve better yield rates. According to Global Market Insights, the vertical farming market is expected to generate a sizable revenue over the next years. A report from GMI stated that vertical farming market size is expected to cross \$13 billion by 2024, with a striking CAGR of 27 percent over 2017-2024, having had a base valuation of \$2 billion in 2017. Currently, this type of farming is most prevalent in the United States and China. During the next few years, Belgium, UK, Netherlands and Germany are slated to be major revenue contributors.

Maybe especially in Norway. Where both households and professional growers have limited possibilities to grow parts of the year when the sun does not shine and we have to import most of our vegetables. The Norwegian government², Oslo municipality³ and also the greenhouse and vegetable farming associations⁴ are optimistic and enthusiastic about the future for urban agriculture made possible here in the north due to technological innovation in LED-lighting.

Competitor analysis (1)- "Smart Herb Gardens"

There are several players working on IoT solutions focusing on plant health creating "Smart Herb Garden". All of these systems are designed for ease of use. Bringing fresh and pesticide-free herbs and plants into your home takes just a small bit of space on your counter top and then:

- Adding seed pods to system
- Plugging in and connecting to your home Wifi network
- Filling growing reservoir up with water (typically need to add water once a month from then on)

² <https://www.regjeringen.no/no/aktuelt/strategi-for-urbant-landbruk/id2667619/>

³ <https://www.oslo.kommune.no/natur-kultur-og-fritid/urbant-landbruk/om-spirende-oslo/#gref>

⁴ <https://www.landbruk.no/biookonomi/norsk-gronnsaksproduksjon-skal-oke-med-nye-produksjonsmetoder/>

The device will then set an automated lighting and control schedule to grow your plant and you should have a fresh set of herbs for your next dish in a few weeks. In this analysis the project group has focused on the most popular solutions.

AUK is a Norwegian start-up that is creating a automatic plant box. Their goal is to replicate nature and create a self-sustaining system. The price is 3.990 NOK for a start kit. In addition, their business model is based on selling soil and nutrients packets has aftermarket focus.

“Click and grow” is a similar concept that is selling a self-sustaining unit and capsules. The user-logic of the Click & Grow gardens is similar to that of Nespresso and Keurig capsule coffee machines only instead of coffee pods, we offer plant capsules with a variety of seeds. Their seedpods are biodegradable and don’t contain any GMO’s, herbicides or pesticides.

The price is between 900 – 4.000 NOK.

AeroGarden another popular solution. Some of its key features are

- Efficient 45-watt LED lights that will increase your output tremendously. The lighting system is automated and turns on and off depending on the plant’s needs.
- 9-pod garden to enable you to plant variety.
- Seed kit that contains a variety of 9 herbs.
- LCD touchscreen control panel that is user-friendly.
- Guaranteed 5 times growth than an outdoor garden.
- 24-inch high adjustable lamp.

The price is around 2.500 NOK.

Competitor analysis (2) - “Standalone lightning for plants”

When it comes to other lighting products applied for plants in the market, they are either inefficient, based on older technology or demand a higher level of skills to set up and use.

Among producers of good and efficient lighting, but requires technical skills:

Horticulture Lighting Group – American Company that offers modern lighting components and systems to professional growers and semiprofessional home growers. With similar diode components and boards that the basics of the PowerPlant-design. Horticulture Lighting Group targets the greenhouse market with LED-substitutes for HPS-lamps (High Pressure Sodium Vapor) replacements. Their products are in the ultra-efficiency and high performance segment.



FIGURE 2 OVERVIEW OF EXCISTING SOLUTIONS

Price: Varies between products: Typically USD 150-250 for 100W LED-board suitable for vegetables. Additionally the customer would need to buy cooling and power supply control equipment.

The current solutions mentioned above are over-engineered or too complicated to use. The goal of PowerPlant creating a simpler solution that focuses on the key need of the plant; namely light and how to control it more efficiently.

Strategy for realization - The objective of the project period is illustrated in the Gantt chart and can be summarized as follows:

- Develop a production ready prototype with third party.
- Development of API and software.
- Development of a demonstration system for creating a plant health database.
- Presentation for customer
- Obtaining letter of intent from a retailer Hageland, Coop, Plantasjen, Felleskjøpet, Mester Grønn etc based on the presentation.

Position in the valuechain - At each tier in the value chain there will be a supplier that assists the respective parts of the value chain with services and supplies of equipment. Below is overview of the present value chain of plants, seeds and equipment in Norway. In addition to the value chain in the overview retailers like Clas Ohlson, Jernia, IKEA, Maxbo or suppliers to these retailers are relevant as well.

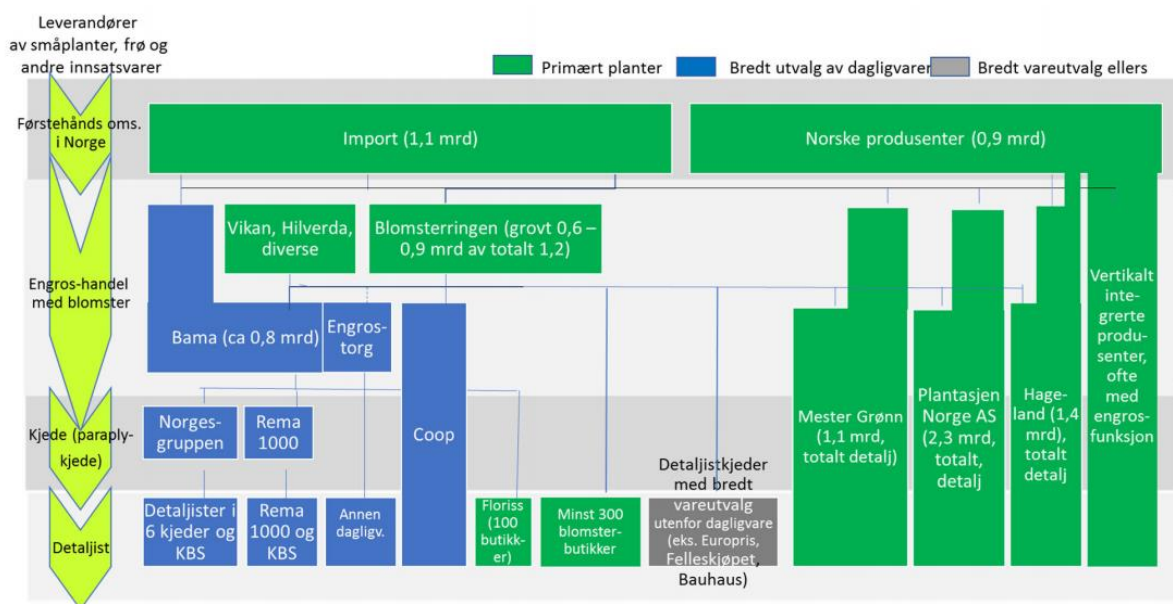


FIGURE 3 OVERVIEW THE VALUE CHAIN THAT POWERPLANT WILL DELIVER THE SYSTEM TO.

Our position in the value chain will be sales to a supplier that sells complete system to the end user in order to obtain a scalable business model.

PowerPlant ambition is to use the Student Forny as stepping stone get a market entry in a segment that we estimate will generate a yearly revenue of 5-10 MNOK within a 2-3 years. Further market estimations will be done accordingly in the preliminary stages of the project.

Business model - PowerPlant focuses on the B2B segment. PowerPlant business model will be based on the main segments of the value chain which is the retailer.

Investment required in the PowerPlant system will be 1500 NOK (ex MVA) pr unit in addition to a 50 NOK pr month service fee which enables us create subscription.

An alternative business model – or in combinations with the B2B segment - is to focus on the end-consumer directly. Sales channels could be a web shop with marketing trough social and analogue media targeting plant enthusiasts and the mass market. Like facebook-groups, garden magazines and plant fairs.

The team are currently and will continue to collect more data and do validation concerning target costumers, business model and the value chain.

Conditions and rights

SWOT analysis for the project - In order to obtain an overview of the assumptions that facilitate PowerPlant, we have conducted a SWOT analysis to provide an overview of the assumptions that must form the basis for successful commercialization and identify possible pitfalls in advance of the project.

Strengths– strong market insights and interdisciplinary project group.

- Project group has developed their own PlantLab at “Eik Ideverksted” which reduces the time for getting the demonstration system up-and-running.
- The core team consists of expertise in Plant Science, Electronics, Economics, Innovation, Entrepreneurship, Programming and industrial design.
- Project group has extensive knowledge about electronics and LED lights in plant applications.
- Short way from demonstration to pilot.
- Previous experience and projects has established good dialogue with potential partners eg. Bama and Gartnerhallen.
- Based on new but mature technology.

Weakness – Detailed market overview

- Business model needs to be further developed.
- No detailed national and international market estimate, this is something PowerPlant will aim to work with as a prep work before and early in the project.

Opportunities -

- Increased competition throughout in the value chain.
- The value chain is looking a way to digitalize their operations.
- More focus on product quality

Threats – small business

- PowerPlant is a small company that does not have an established brand name. Migrated through collaboration with established key players.
- Weak IP on the hardware itself, but the training data and model will be protected through an encrypted EmML algorithm that is PowerPlant trade secret.

Social benefit and sustainability - PowerPlant works to follow the guidelines as defined by the UN in the Global Compact and in the Guiding Principles and by the OECD in the Guidelines for Responsible Business. Furthermore, a fully developed system will contribute to the UN's sustainability goals through innovation. In addition, we are working for solving hunger and local food security. The product itself is recyclable and with a long product lifetime – decreasing production carbon footprint.

3 Implementation

Project plan

PowerPlant currently has an MVP and has received letter of intent from key players in the value chain. The project launch process in August will continue in order to reveal technical problems and completion of test rigs for long-term testing in order to reduce overall risks in the project.

Milestones and activities		2020 - 2021											
		A	S	O	N	D	J	F	M	A	M	J	J
M1	Market-, user-, IPR and partner analysis												
A1.1	Mapping of the market potential (national and international)												
A1.2	In depth stakeholder analysis – identify synergy effects between partners.												
M2	Technology demonstration												
A2.1	Development of hardware module – Dynamic Precision AS or NXTech AS												
A2.2	Test production of IO module - Dynamic Precision AS or NXTech												
A2.3	Set-up of the demonstration system												
A2.4	Software development of MVP – database and Rest-API												
A2.5	Data collection												
A2.6	Data analysis and preliminary model validation												
M3	Business development												
A3.1	Business model												
A3.2	Product and price strategy												
A3.3	Preliminary sales												
M4	Network and financing												
A4.1	Dialogue with investors												
A4.2	Participation on Investment seminars												
A4.3	Incubator membership												
A4.4	Secure seed funding												
M5	Technology demonstration for customer (retail segment)												
A5.1	Production of hardware modules for pilot												
A5.2	Data analysis and presentation for partners												
A5.3	Letter of intent for purchase by retailer												

Financing before and after the STUD-ENT project period:

Before the project period, available, facilities, equipment and personnel from Eik Idea Workshop and through master's theses are used. In addition, the core team partially funds the project using their own time. During the project period, a key milestone in creating investor relations.

As the goal of the student project is to trigger a pilot collaboration that can lead to innovation contracts and direct sales with several players in the value chain to cover parts of the upscaling after the project period

Management, team and expertise

Project team

Name	Role	Percentage
	CEO and project manager	100%
	CTO	100%

Student team

	Product Development	20%
	Data Science	20%

The students will be engaged for hours through the student consulting company Ledo, but will have the opportunity to receive shares in PowerPlant based efforts throughout the project period. The Norwegian research council must approve any redistribution of shares during the project period.

Mentor

Name	Role	Description
Kristian Omberg	Advisor – sensor development	NMBU
Odd-Ivar Lekang	Academic mentor –process technology	NMBU/Førsteamanuensis
Simen Hesleskaug	Business development	Grindøy Rådgivning AS/ CEO

Contribution from university

Contribution	Description of contribution to the project	Tick for yes
Office space	We allocate a office area in our student incubator	x
Access to lab and test facilities	PowerPlant will be given access to low threshold labs and can use our prototype services.	x
Access to specific scientific expertise	We will arrange meeting with relevant faculty personnel if needed.	x
Other advisory services	We will arrange for cooperation with the innovation lab “eik Ideverksted”.	x
Assistance in carrying out tasks	Certain mechanical task can be done through out mechanical workshop or rapid prototype lab.	x
Other		

Budget- Before the project period, available, facilities, equipment and personnel from Eik Idea Workshop and through master's theses are used. In addition, the core team partially funds the project through the use of their own time. During the project period, a key milestone was creating investor relations.

As the goal of the student project is to trigger a pilot collaboration that can lead to innovation contracts with several players in the value chain to cover part of the upscaling after the project period.

To complete the project, PowerPlant applies for NOK 1 000 000 where approximately 40% of the budget is dedicated to salaries to the project team (inc the students). The basis for this distribution is that the interdisciplinary expertise of the project team means that we are confident of being able to carry out this project. The student contributions are compensated through the student consulting company "Ledo", which is an active part of the innovation environment at NMBU.

Budget the project period August 2020 - August 2021.

Activities	Cost (NOK)
Wage project team	400
Mentors	10
Development of production ready prototype system	400
Production of v1.0	100
Market research	40
IP process with the «patentstyret»	20
Administrative costs	30
Total	1030

Amount is shown 1000

Financing plan August 2020 - August 2021.

	2020	2021
Privat funds	30	
NRC STUD-ENT	500	500
Sales		
Total	530	500

Amount is shown in 1000NOK

The financing plan only shows financing during the project period.