

All you need for microalgae photo- bioreactors

Microalgae – the green source

Ideal solutions for commercial photo-bioreactors

Why using tubular photo- bioreactors?

Material

- High surface quality prevents internal contamination

Quality

- Effective illumination for higher yield
- Supports to mix nutrients for improved yield

Optimization

- Ideal for research and development
- Usage with genetically modified strains possible

Costs

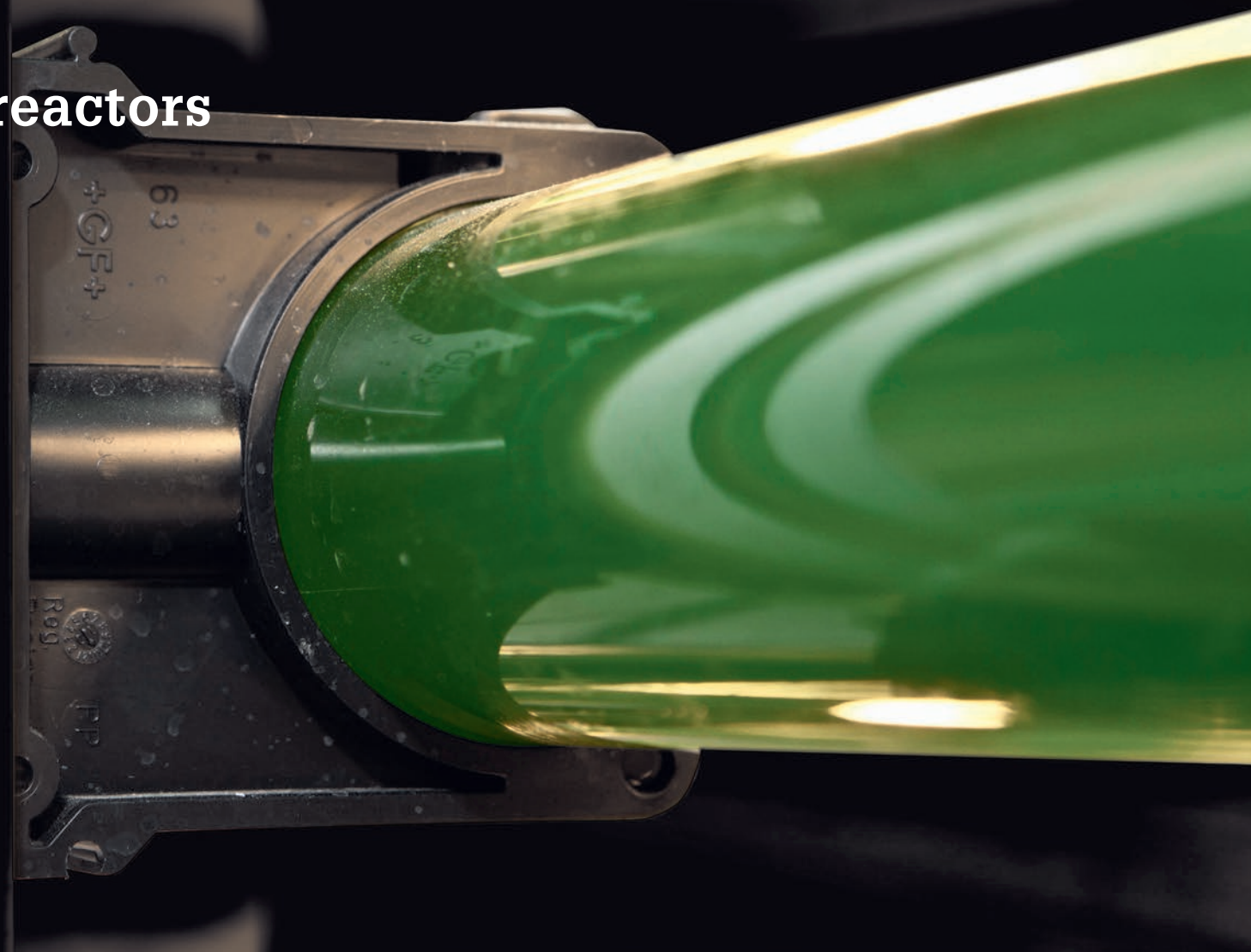
- Lower operating costs and reduced carbon footprint
- Proven commercial value on an economic scale

Flexibility

- Relatively easy to scale up to large production farms

Reduced water loss

- No evaporation of water within piping



**PVC – an ideal material
for photo-bioreactors.
Advantageous material
properties support all
microalgae cultivation
phases generating
energy balance and
productivity.**

Dekadur G

- Ideal thermoforming
- Smooth inner surfaces reducing surface build up
- Dedicated optical properties for algae growth
- Chemical resistance (pH shifts, CIP process)
- Compatibility with optical functionalizers
- Variable jointing possibilities (welding, solvent cement, push-fit)
- Flexible concepts for durable UV protection
- European food approval available upon request
- Pipes can be dimensioned according to well-established DIN 8061/62 standards for PVC-U pressure pipes up to T = 40°C

EnviroKing UV - ThinWall

EnviroKing ThinWall is a low-pressure containment pipe, manufactured in IPS sizes and specifically optimized for use in photo-bioreactor applications.

- Improved transmission characteristics

EnviroKing UV - Schedule 40

In addition to ThinWall, EnviroKing UV is also manufactured in IPS sizes to Schedule 40 dimensions, which provide sufficient wall thickness for algae systems.

- Corrosion-resistant
- Non-conductive
- Lightweight, easy to handle and install
- Lower overall costs of installation than glass, acrylic or other transparent alternatives
- Manufactured in IPS dimensions
- Fully compatible with standard PVC pipes, fittings and valves

+ The green energy

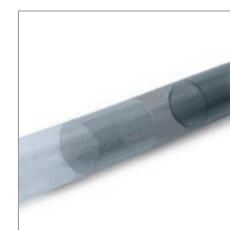
GF Piping Systems recognized the need for innovation early, as the microalgae industry began to rise. Clearly, the critical component of any photo-bioreactor system is the reactor tubing itself - whether in the horizontal or vertical configuration and whether for indoor or outdoor installation. Ideal solutions include a tubing which is transparent and at the same time shielding. A tubing which is transparent enough to pass useful light such as the renewable energy of the sun, but without any premature damage by UV and without allowing precious algae to be easily scorched by other harmful wavelengths.

Ideal solutions for tubing feature:

- Lightweight enough to avoid unnecessary bulk and cost
- Robust and safe enough for high pressure loads
- Simple jointing
- Non-fragile piping
- Easy integration of other system components



Systems



Customized Filter



Static Mixer



Push-Fit Jointing



Designed U-Bends

Photo-bioreactor systems for future markets

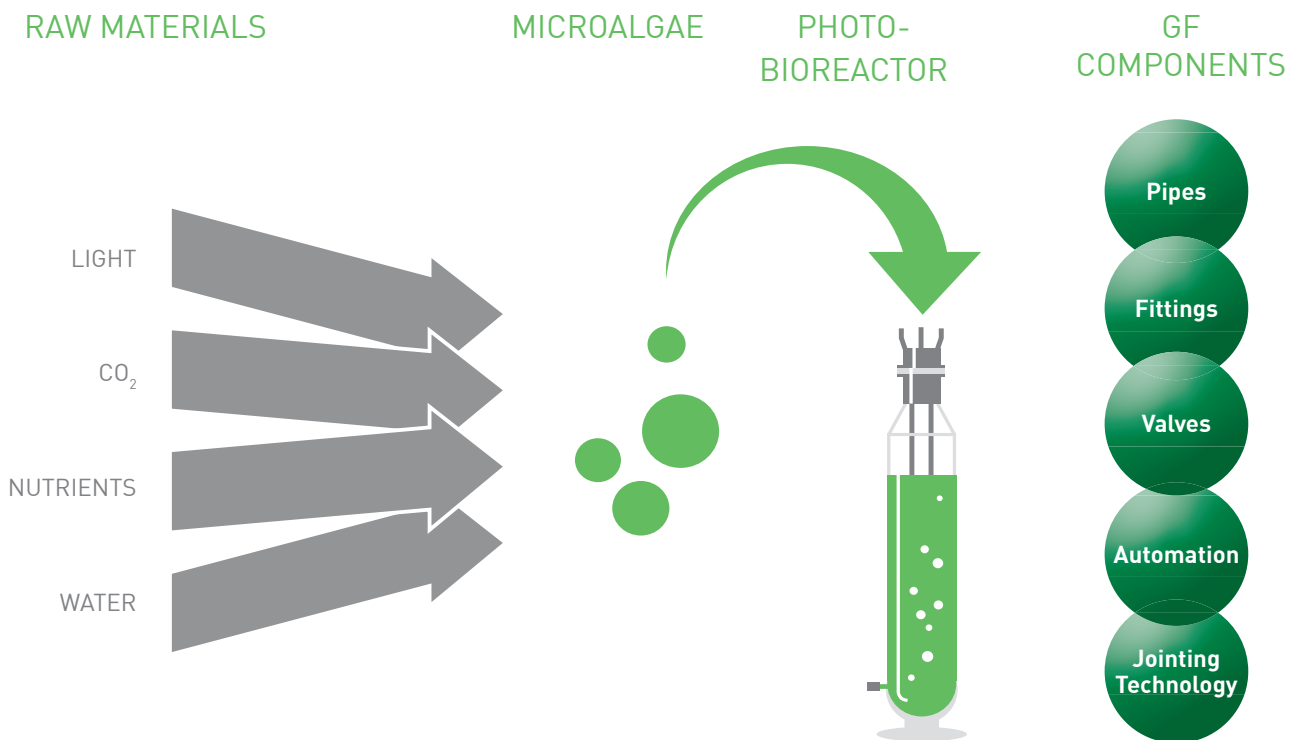
Individual components for building your own PBR systems.

Microalgae are receiving increased global attention and show rapid market growth. They offer important benefits such as:

- Use of sunlight as main energy source to convert the greenhouse gas CO₂ into biomass
- High concentrations of valuable contents such as proteins, lipids, pigments or acids
- Potential use of salt or fresh water, which can even be replaced by waste water

Choose our individual solutions for your PBR tubing, fittings, manual and actuated valves, sensors and instrumentation.

UPSTREAM – COMPONENTS



+ All you need from one source

We offer our customers not only reliable and innovative products, we supply tailor-made solutions from one source. The diversity of pipes, fittings, valves, jointing as well as automation technologies in the portfolio is as diverse as our customers and their individual challenges.



Pipes



Fittings



Valves

From fabricated subassemblies to turnkey systems, our complete offering helps to ease your project.

As a global player, GF Piping Systems offers a wide range of comprehensive solutions for diverse applications – all from one source. We also offer professional services, from consulting and design to manufacturing and assembly as well as a fast and reliable delivery.

Our custom-made components perfectly meet your needs and complete your system. Our global network offers you the right partner to work with wherever you are located.

Fields of application: Their benefits make microalgae a potentially rich source for a vast array of sustainable products with applications in various industries:

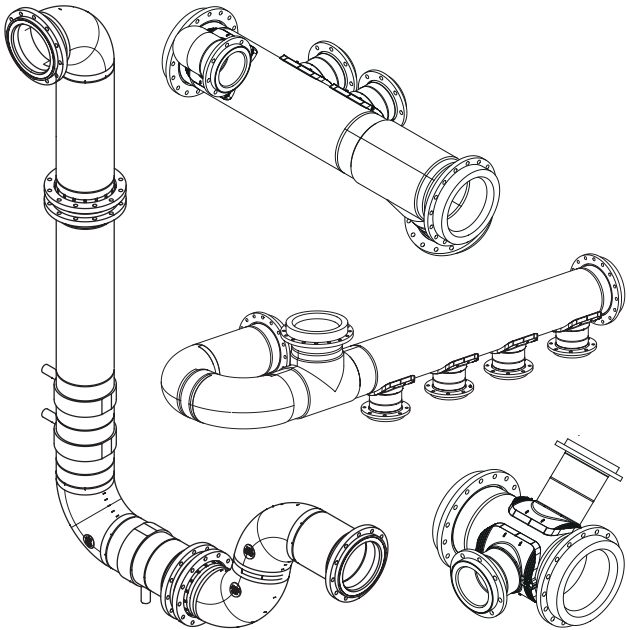
- Nutrition
- Pharmaceuticals
- Fish food and feed
- Food and feed
- Cosmetics
- Fuel
- Fertilizer

Right to the end, processing of algae requires a wide variety of refining before use.

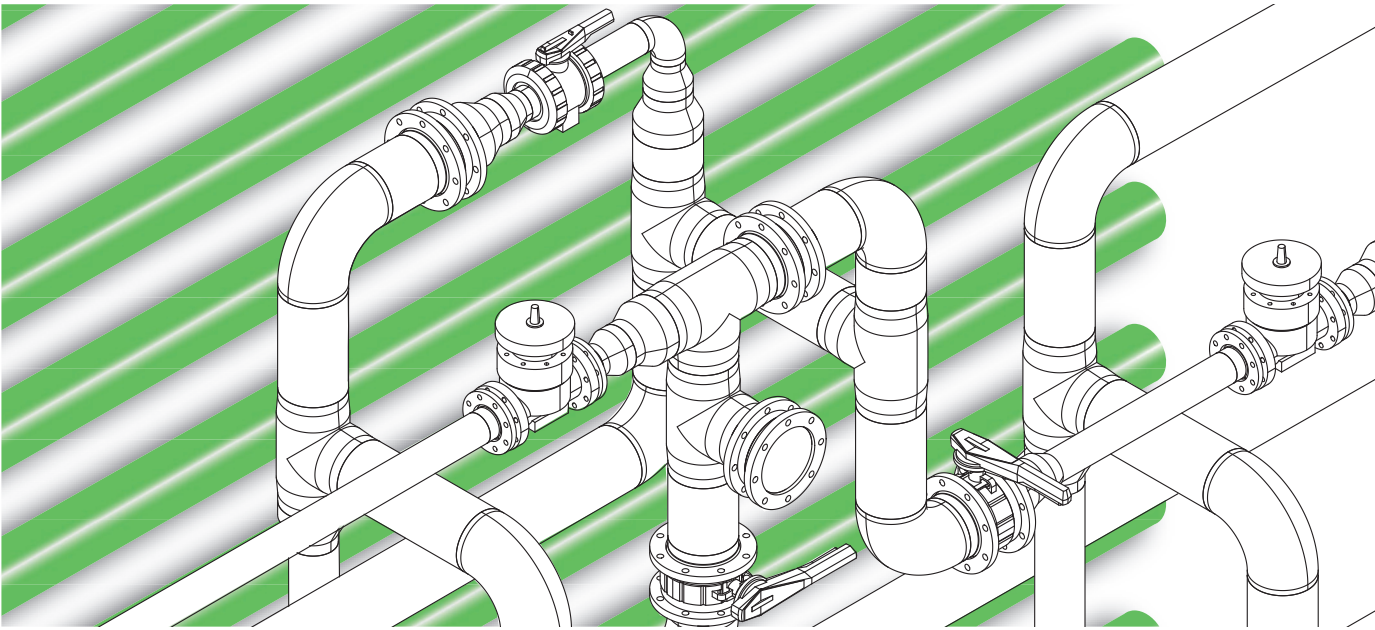
We supply piping systems for every step of the way to deliver your final product. More than 20 different complete plastic solutions are all designed to meet your demanding needs.

MIDSTREAM – FABRICATION

GF FABRICATED SUBASSEMBLIES OR GF CONTRACT MANUFACTURING

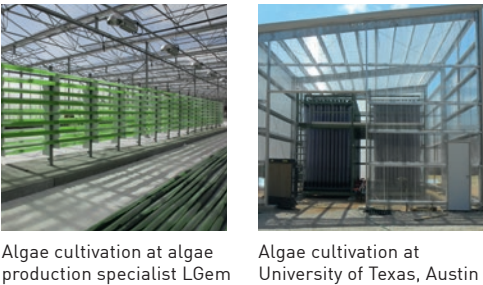
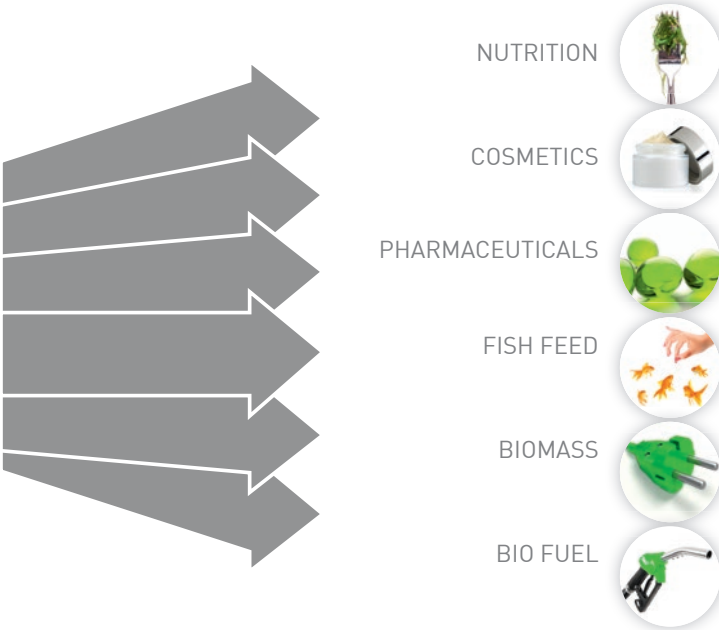


TURNKEY SYSTEM



DOWNSTREAM – REFINING

REFINING PROCESS MARKET END PRODUCTS



+ The perfect system for you

Plastic piping systems are ideal for use in commercial photo-bioreactors. Plastics do not form galvanic elements and are non-conductive. GF Piping Systems with its comprehensive product range offers its customers high product reliability in combination with jointing technologies proven over time in practice.



Globally successful projects

Our successful projects prove our ability to adapt PBR technology to your individual requirements, even in large scale operations.

+ Advantages of GemTube PBRs

- Prevention of fouling by using our revolutionary bubble brush technology
- No growth inhibition as a result of excessive amounts of dissolved oxygen
- Very large tube lengths are possible, efficient and unlimited upscaling
- Extremely low energy consumption ($< 200 \text{ W/m}^3$); option to operate even without a circulation pump for fragile species (dual operation mode)
- Very thin-walled tubes and simple jointing contribute to easy installation and outstanding cost-performance ratio
- Simple and robust process control (optional remote control); just pH control in the basic version



+ Customized best-in-class solution at research facility

This site contains one of the largest scaled algae demonstration facilities of its kind in the United States. It is a collaborative effort between GF Piping Systems, AlgEternal Technologies and the University of Texas College of Natural Sciences, UTEX Culture Collection of Algae and Center for Electromechanics. The algae site is an applied research facility for exploration of science and technology to optimize biomass production through a closed-loop vertical system and to provide an algae source for demonstration of downstream processing techniques. In a very small area footprint, the site demonstrates the enormous potential of algae as a feedstock for domestic biofuels and other algae products.



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