The Fundamentals Of Bioeconomy The Biobased Society

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The Fundamentals Of Bioeconomy

The Biobased Society

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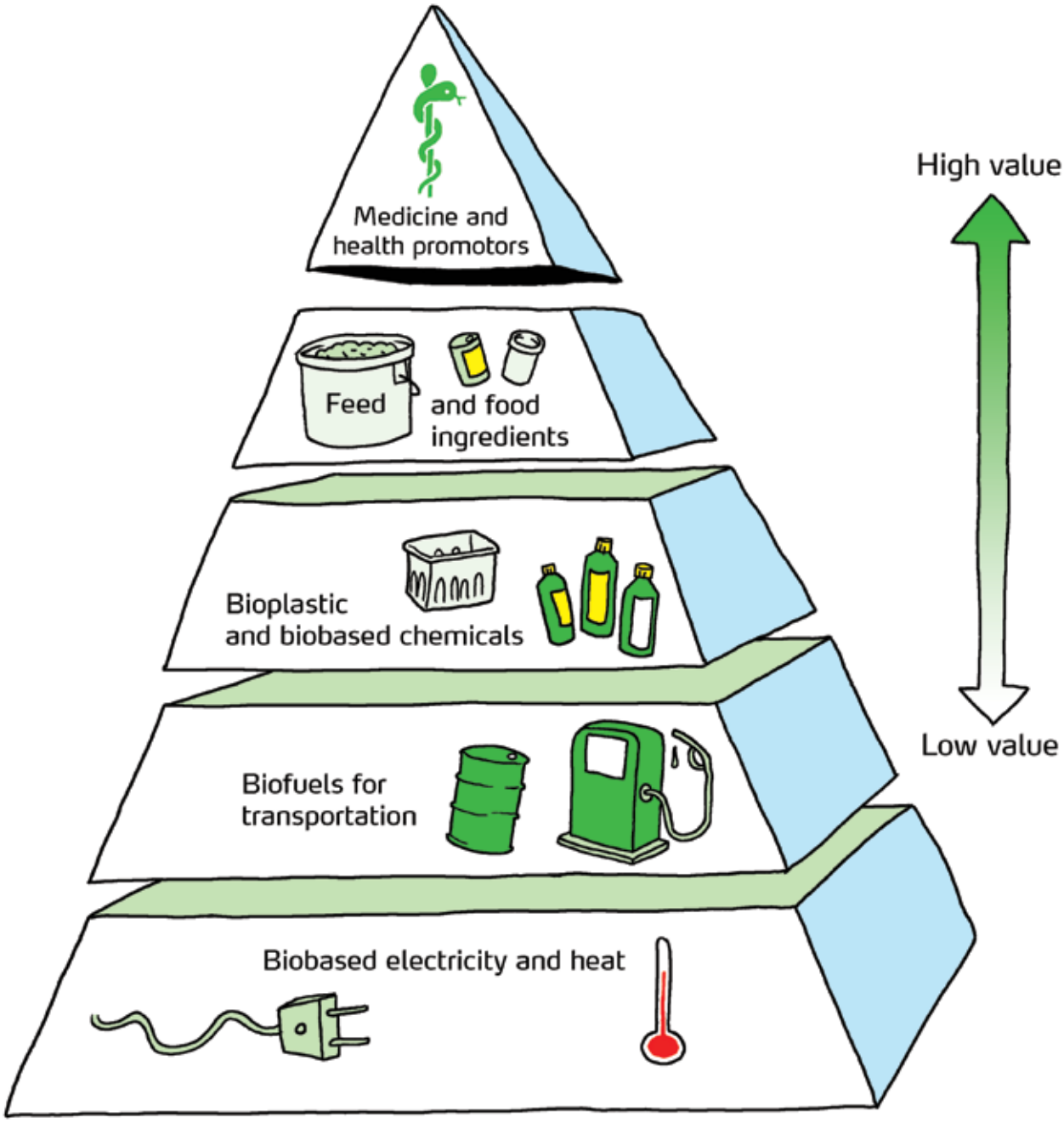

United Federation of Danish Workers

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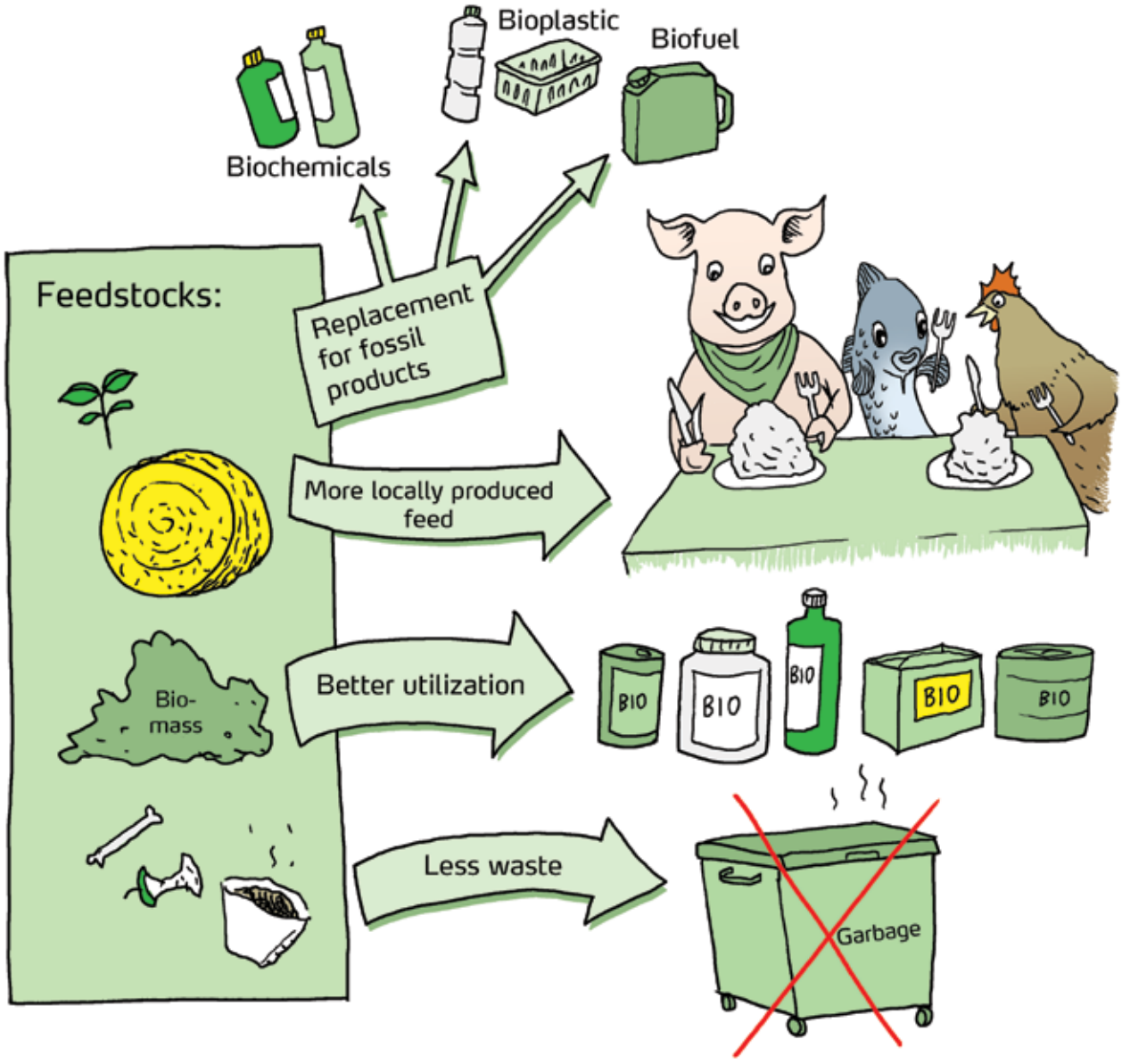
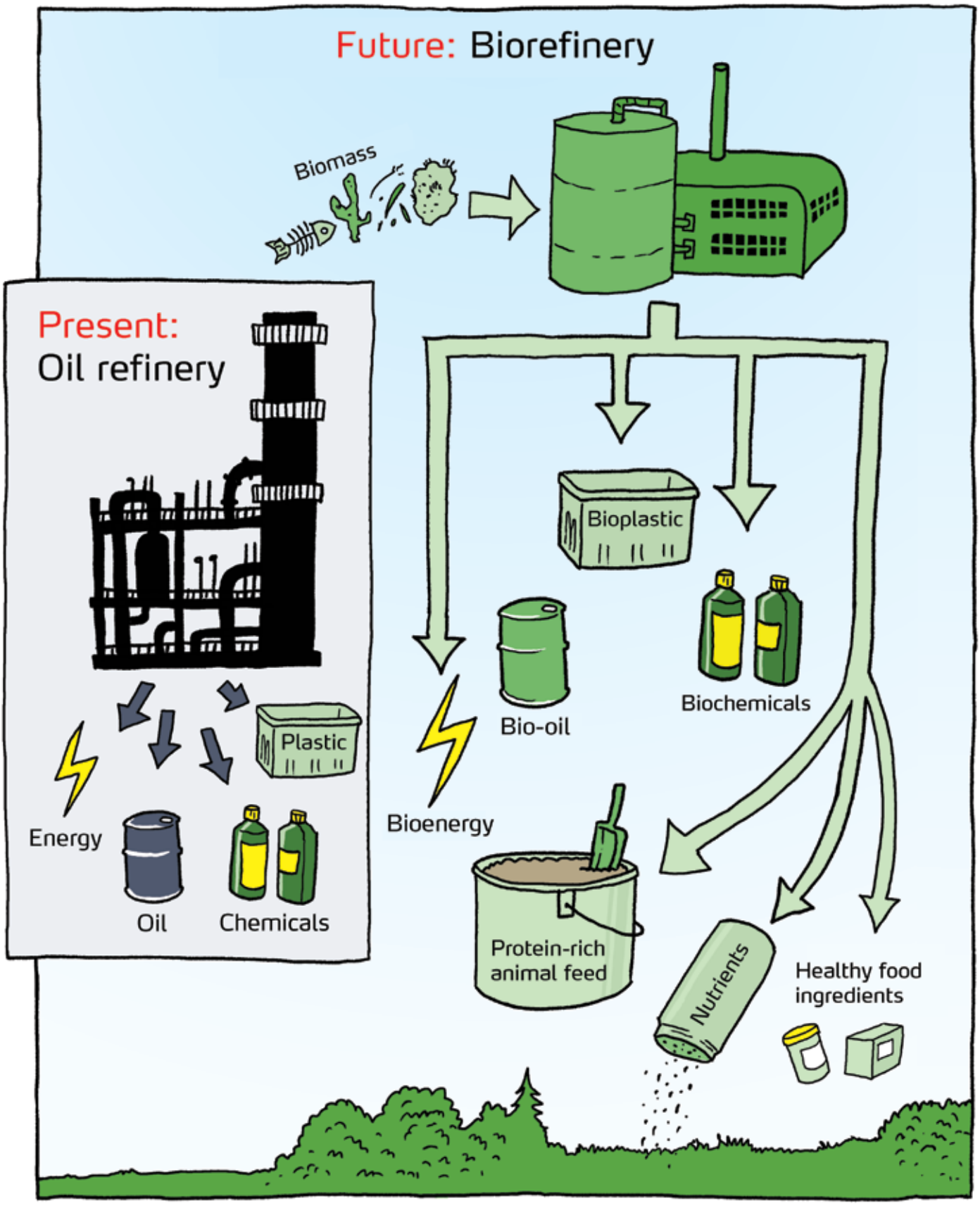
The population on Earth is growing and we need more food. Climate change is both a reality and a threat. The answer is simple: We absolutely must use our biological resources better, so there will be food for more people with less environmental and climate impact per unit produced, and renewable biological material enough to produce the replacement for what we currently get from fossil crude oil (e.g. materials, chemicals and plastics).

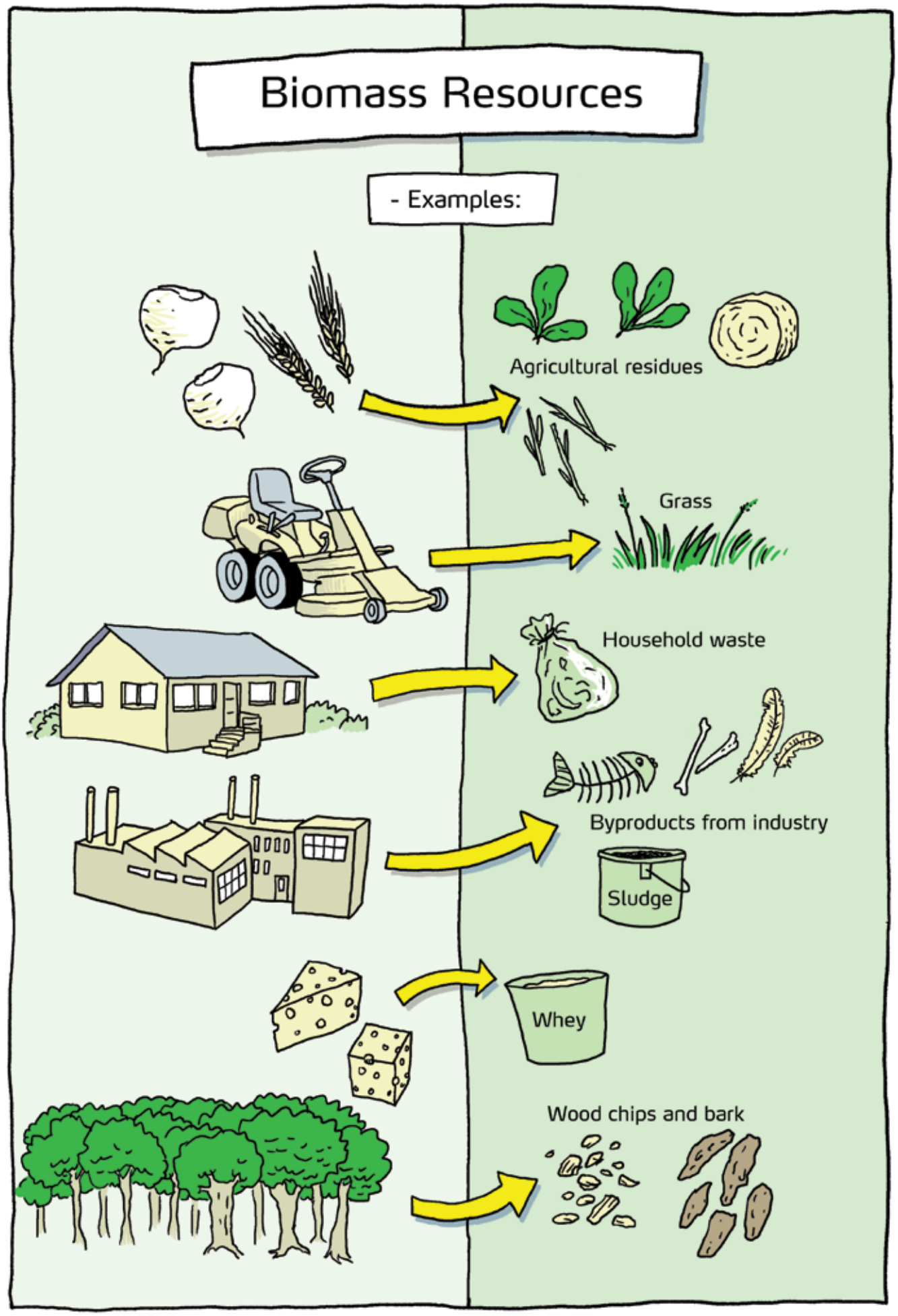
The good news is that by doing this we can create a lot of new good jobs; and a large part of the technologies are already developed. It is possible. The optimism lies in the fact that in Denmark we are already very good at green technologies, biological production and food production. The next step is to come up in scale, optimize processes and show that it works.



We are already moving towards **“the biobased society”**: less waste generated by optimally utilizing what we grow, harvest, produce and eat; development of bio-based alternatives to fossil-based products: bioenergy, bioplastics and biochemicals. Plus locally produced protein-rich animal feed and new types of healthy food ingredients; and last but not least the circulation of nutrients back to the soil. Already now we can get more types of products from biomass than from oil.



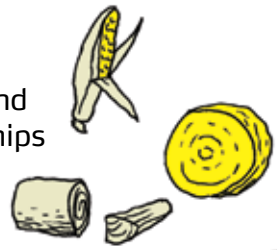
Available biomass resources in Denmark constitute much more than straw! It includes residues from agriculture, forestry, fisheries, food processing, parks, gardens, and households.



It is easier to get an **overview** of biomass possibilities if we use names and colors that show the biomass origin.

The yellow biomass

Yellow straw and wood chips



The green biomass

Green leaves of e.g. grass, clover and beets

The blue biomass

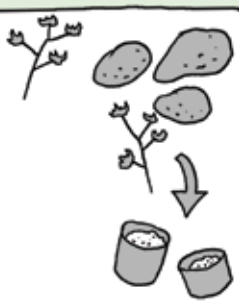
what we can get from the sea (fish, seaweed, clams, etc.)

The red biomass

All we can get out of residues from animal meat production

The gray biomass

Residues from industrial processing of feed and food



The brown biomass

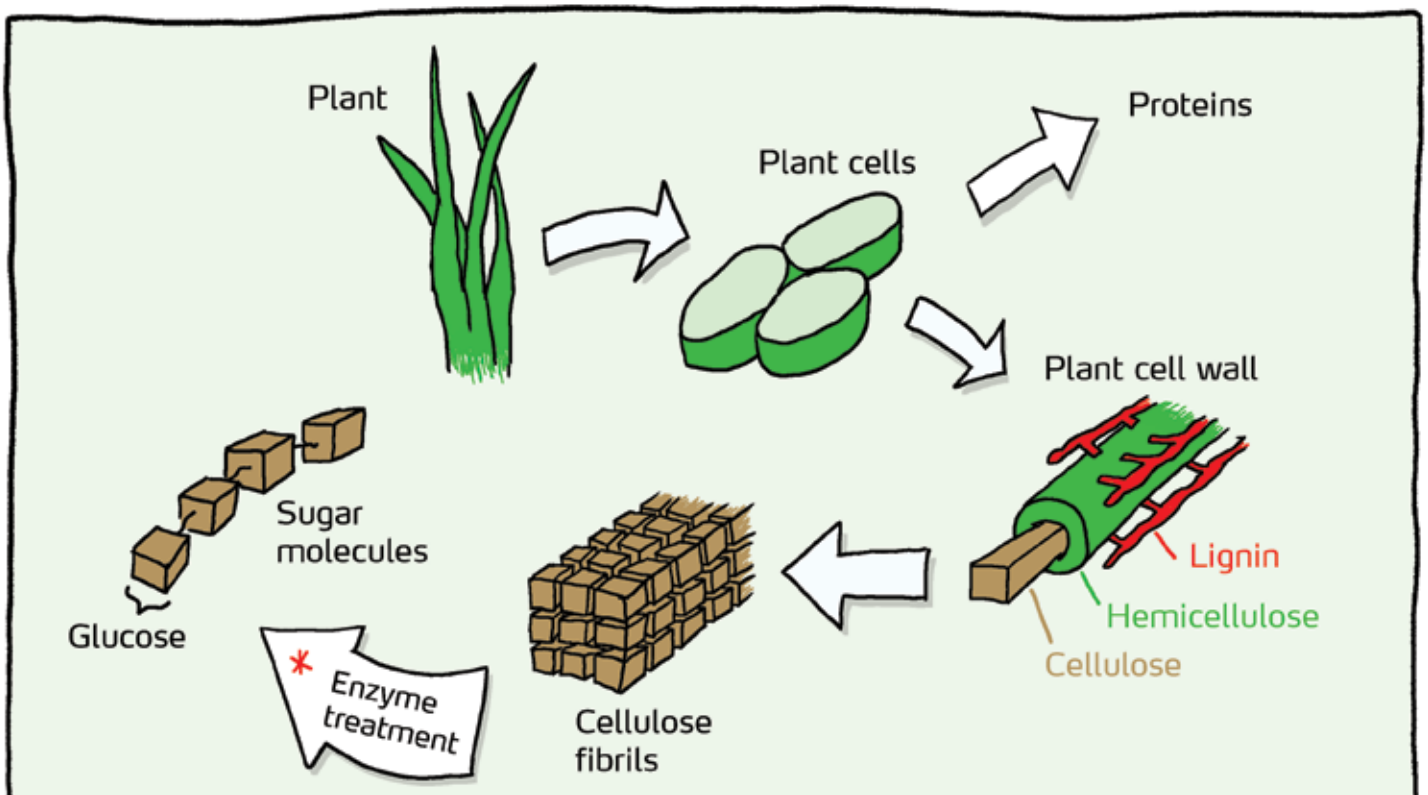
The organic content of sewage sludge

Household waste

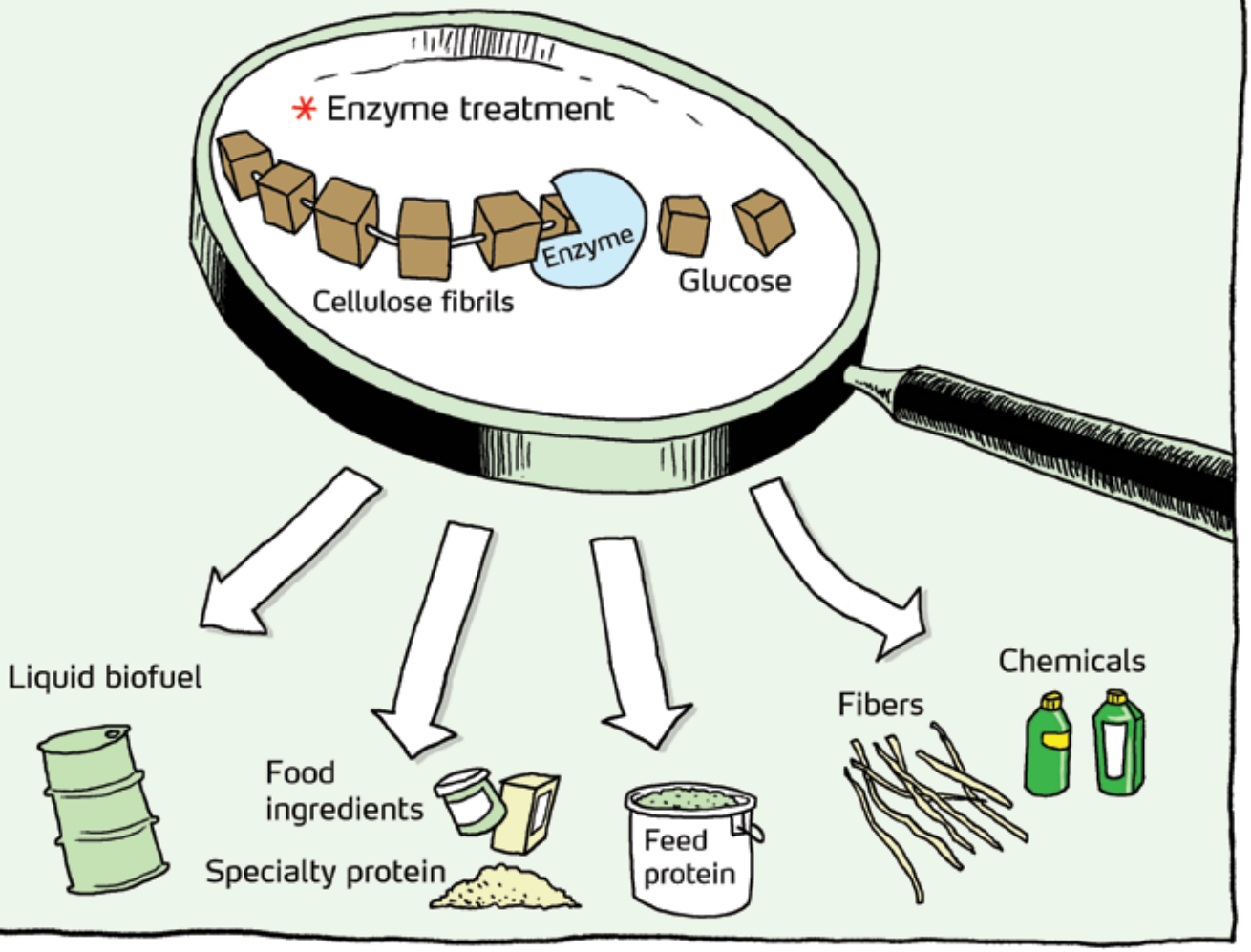
The new biomass

The organic biomasse

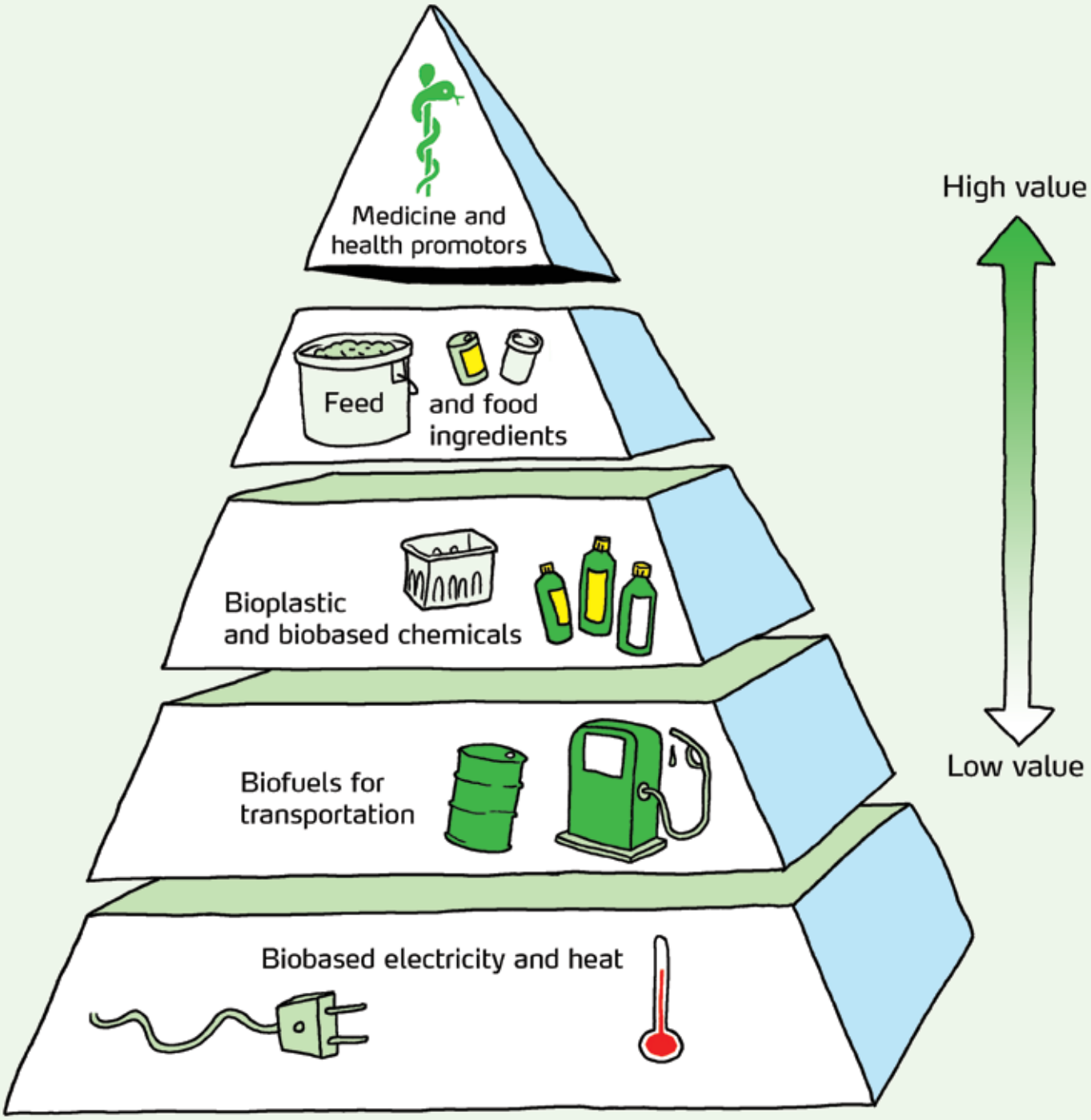
For all color types, great potential exist in collecting residues from the organic production; and there are exciting new opportunities by growing fungi or insects on biological debris. This creates new protein-containing biomasses!



Utilization of biomass resources is also called “Biorefining”. Biorefining is based on enzymes from microorganisms opening the biomass structure to make each component available to be used for food and feed; as well as substrate to grow bacteria and fungi on, which in turn can produce bio-based materials, chemicals and energy.



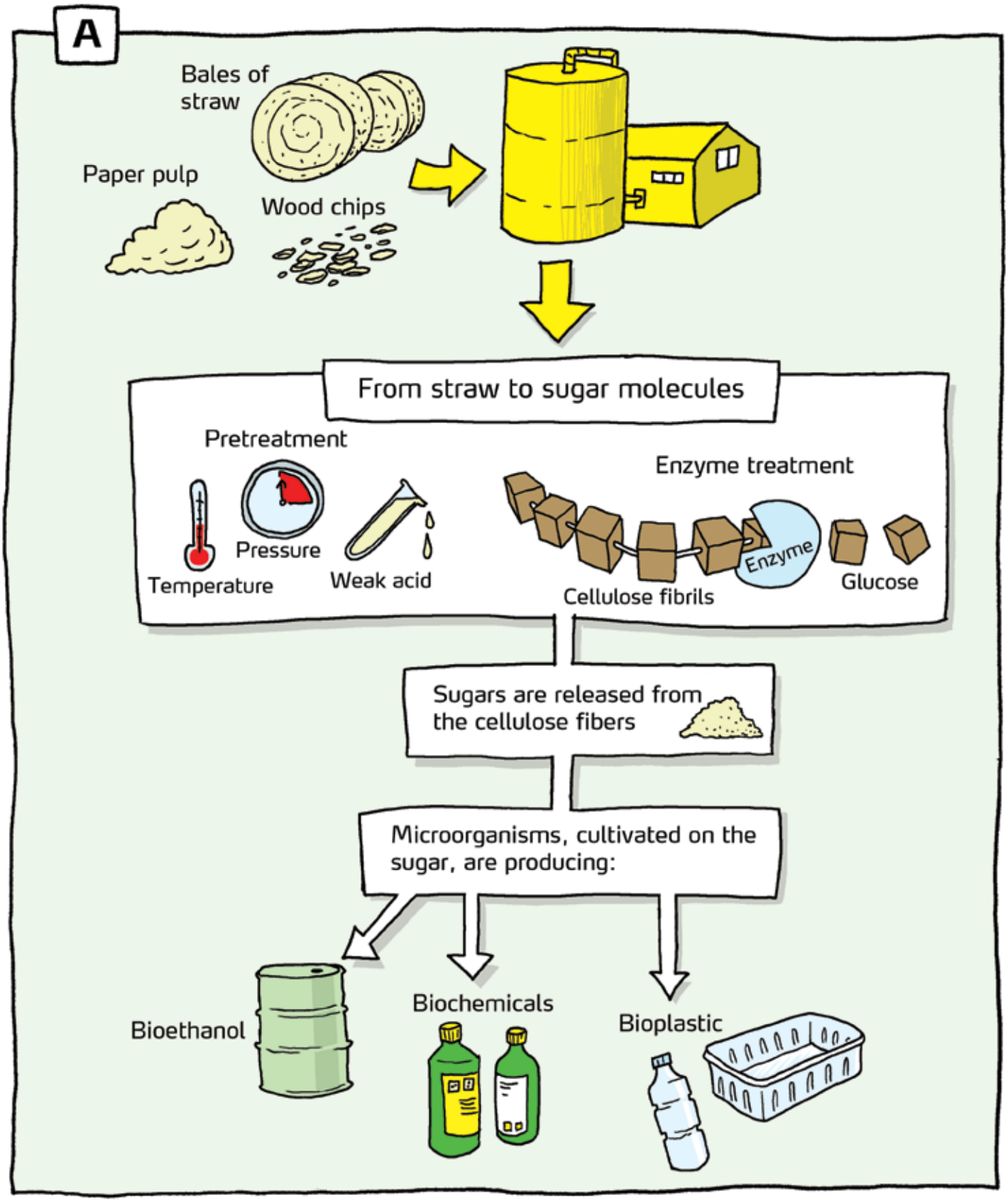
The Pyramid of Value illustrates the many opportunities we have to create value from the biomass. We gain the lowest value if we burn biomass to produce electricity and heat. The value is low because we do not exploit the structures of the biomass - only the energy content.



The optimized way of using biomass is to utilize each of the biomass components to their full potentials, using energy content, structural building blocks and nutritional value. Meaning we should try to use as much biomass as possible for the products in the high end of the value pyramid: health promoting products, food ingredients, animal feed ingredients and to replace fossil products with bio-based chemicals and new functional materials, such as e.g. biobased and biodegradable plastics.

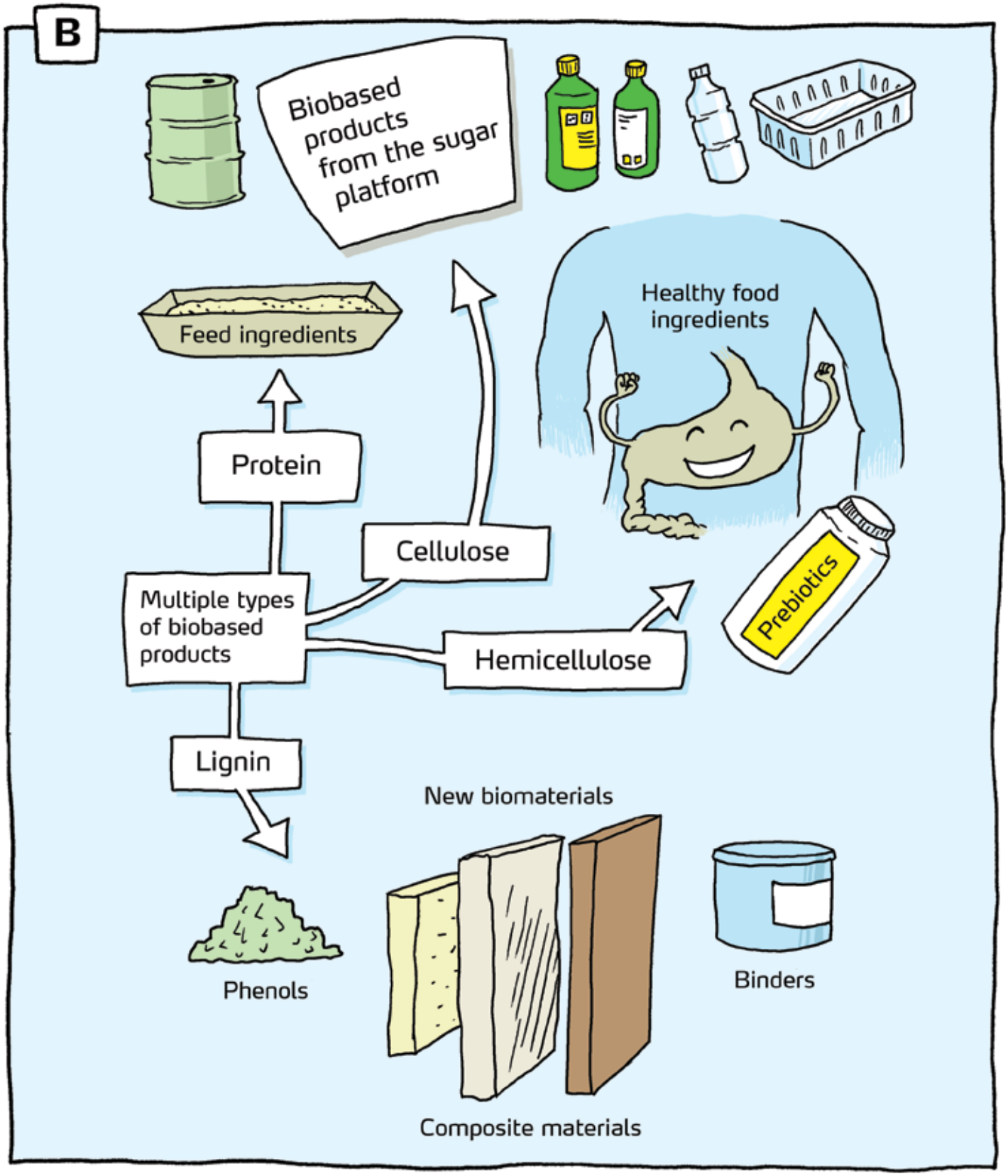
There are basically two ways to use the various components of the biomass: A. To use enzymes to break down biomass into simple molecules that can be used to cultivate fungi and bacteria. The selected strains of bacteria and fungi can then produce new building blocks for biochemicals and biomaterials.

And if you grow fungal yeast on these substrates bioethanol can be produced to replace part of the fossil fuel in the transport sector; all in order to reduce CO_2 emissions and create sustainable solutions.

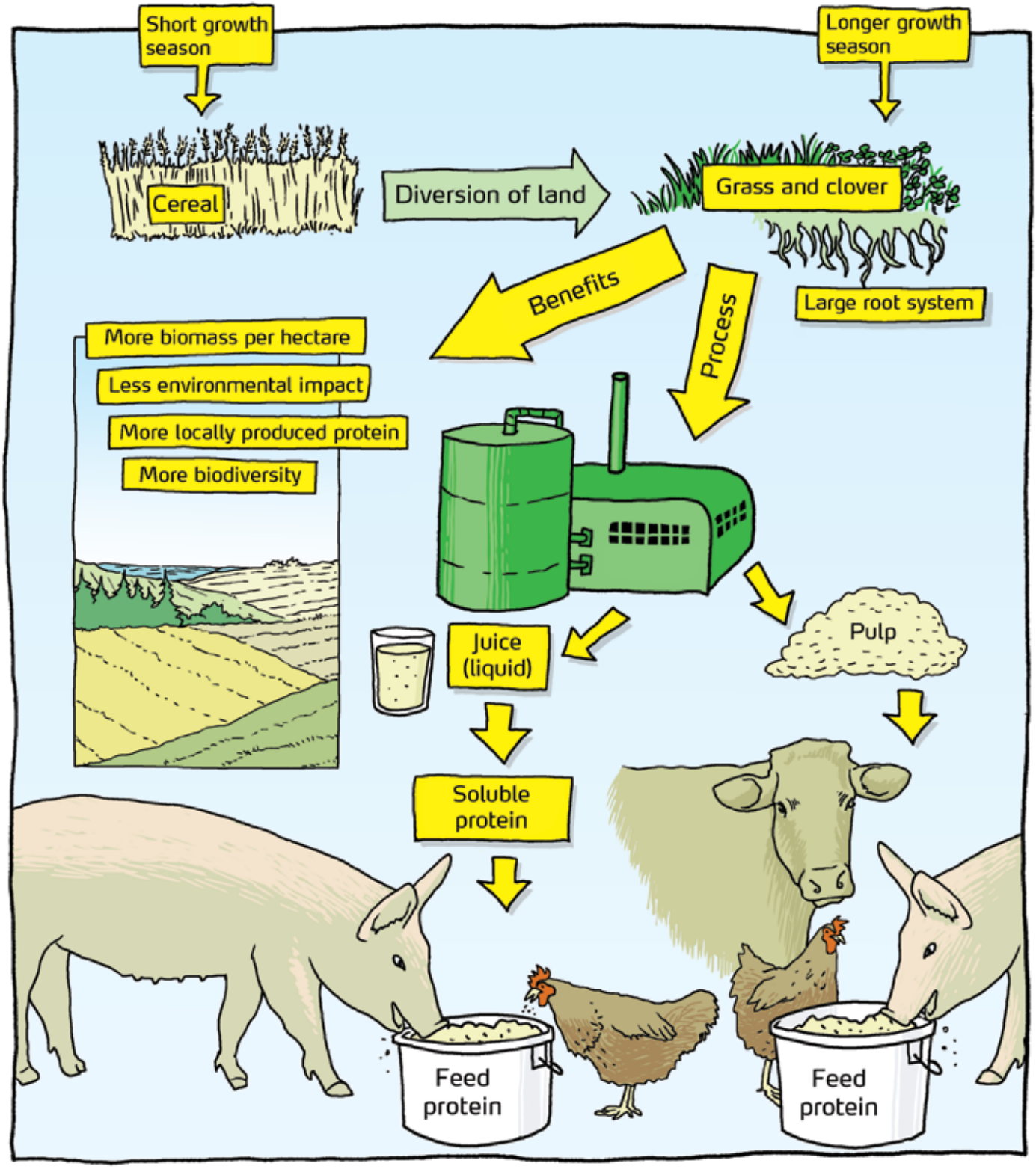


The other way to go is to split for instance the plant biomass into protein, cellulose fibers, hemicellulose and lignin. And then use each of these compounds to produce valuable new products.

The illustration shows a number of interesting possibilities. The combination of A and B could be to separate the biomass into components using the protein, the hemicellulose and the lignin for higher value products; and then break down only the cellulose fibers to single molecules on which fungi and bacteria can be cultivated to produce biochemicals, biomaterials and bioenergy.

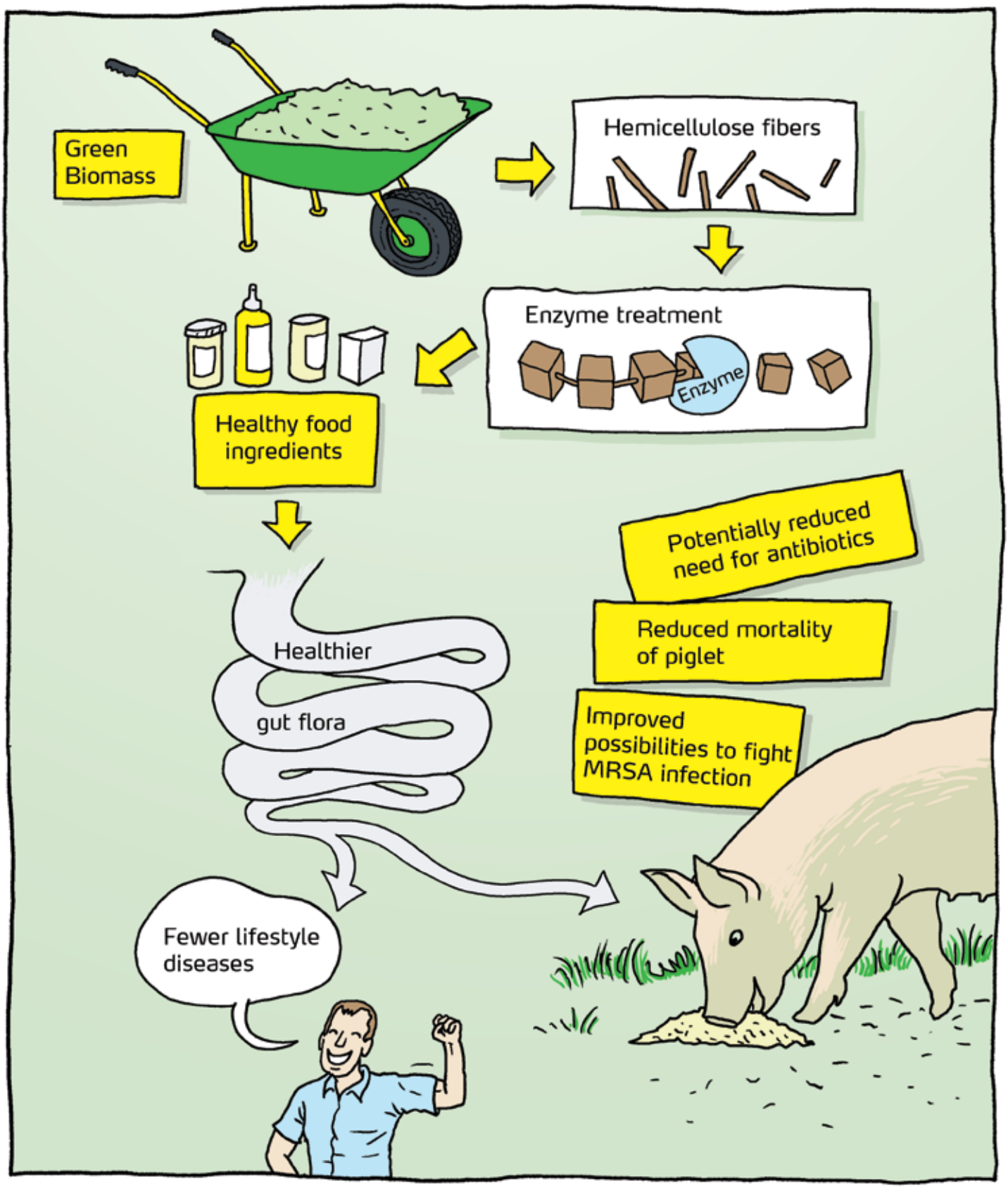


We have **large opportunities for bioeconomy** in Denmark. One of the most obvious opportunities is to convert some of the hectares, now used for growing e.g. barley for animal feed into grassland, particularly on marginal soils. It is possible to harvest up to double the amount of biomass from grass per hectare compared with cereal. The reason for this is that grass is green and thus grows by utilizing solar energy several months a year as compared to cereal, finishing to grow already end of July. Grass is also more environmentally friendly as the root system utilizes nutrients throughout the long growing season and thus leads to less run off of surplus of nutrients to groundwater, lakes and streams. Also, in addition to the environmentally friendly production the green biomass from grass and clover has potentials in the future to create more food and feed value per hectare; and to create jobs and technology leadership.



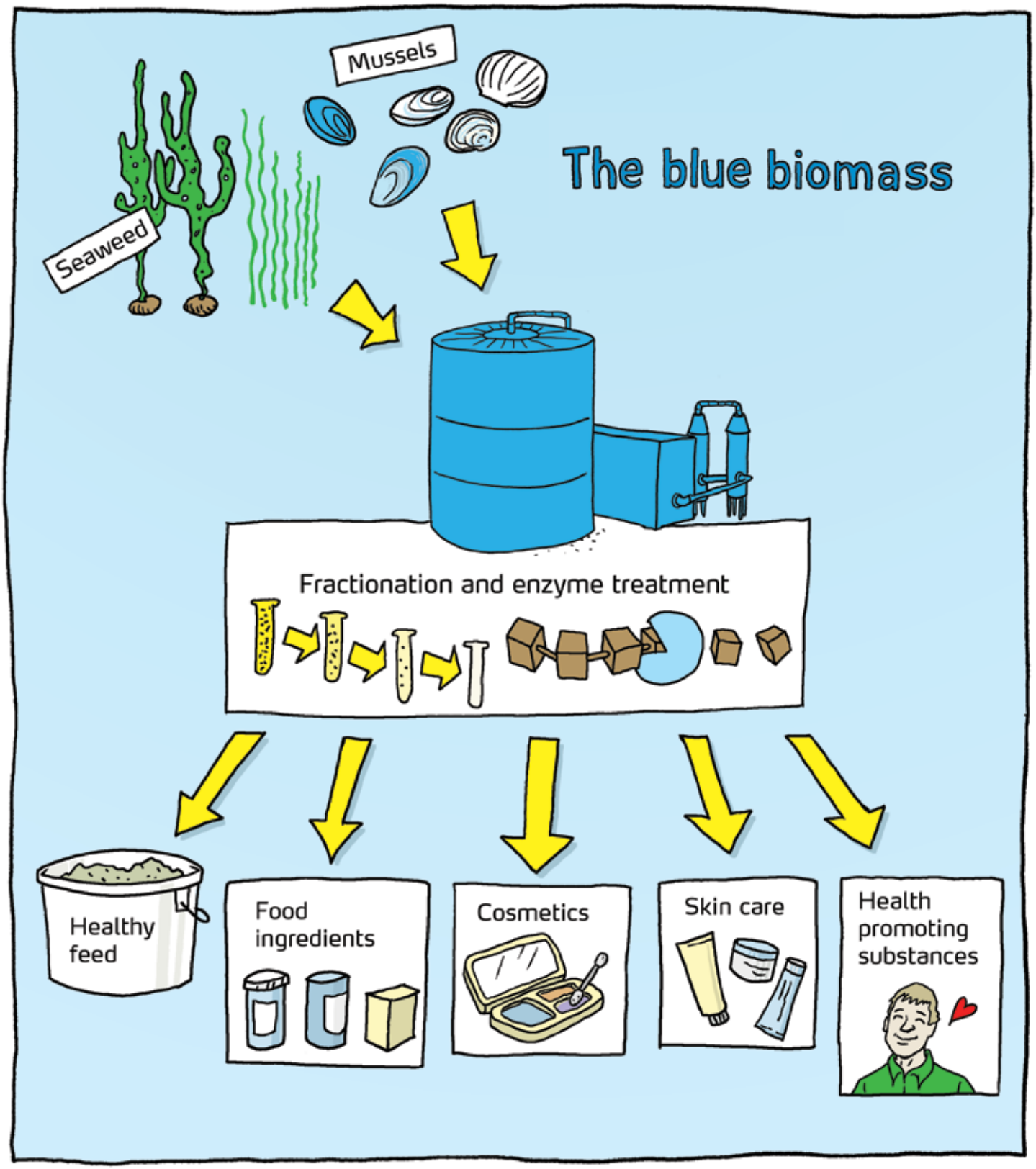
Grass and also for example **clover** can produce more protein-rich feed than if we used the entire field for e.g. barley for animal feed. It can thus give more locally produced protein-rich feed; and at the same time we can also get healthy food ingredients from bio-refining of the green biomass.

When we refine a crop like grass, we also create more local jobs in relation with the several types of products being produced.



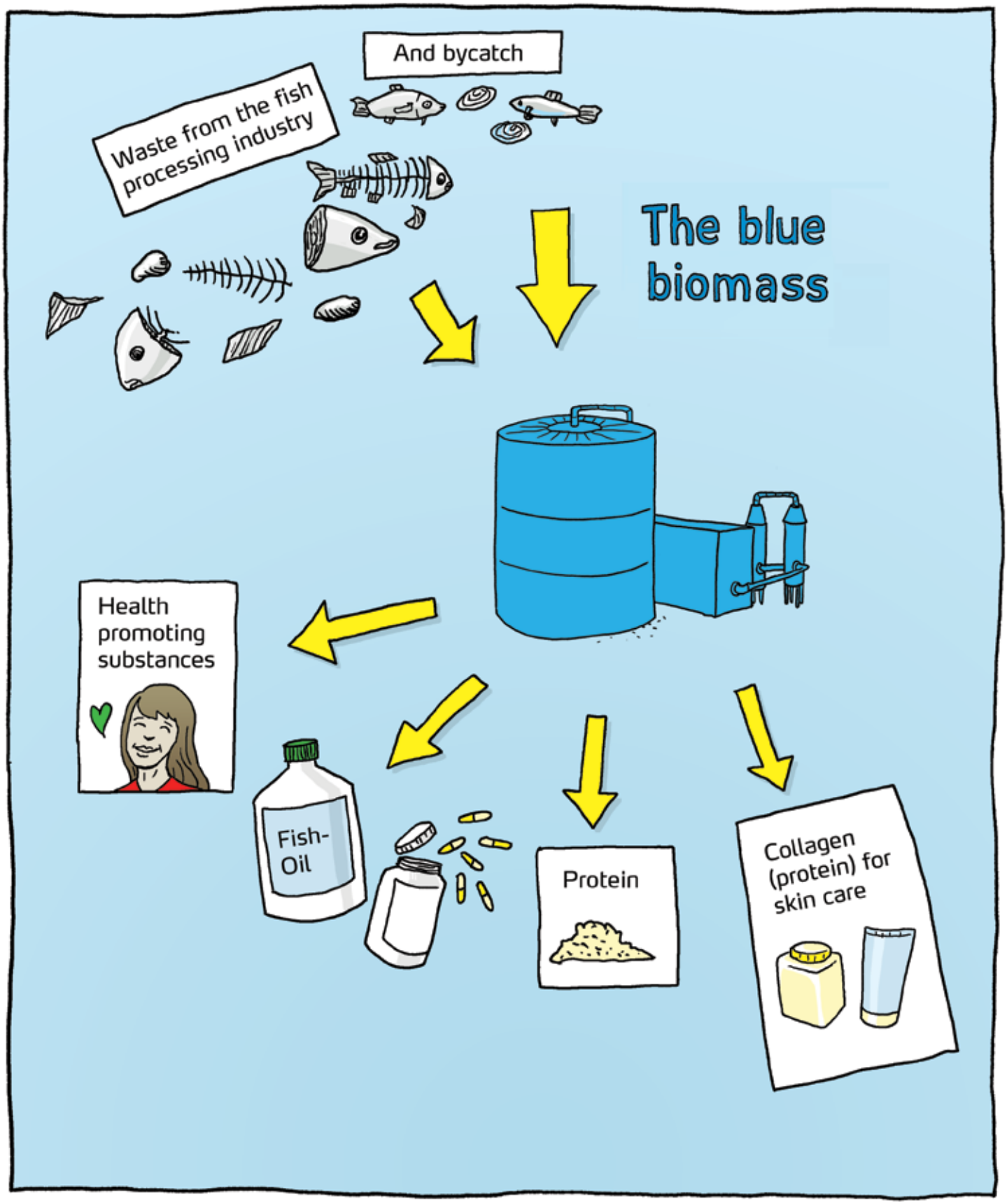
In the future, **marine biological resources** will be used for much more than fishing. Here, focus is to make the use of marine biomass both environmentally friendly and smart. The ideology is the same as for agricultural crops: we shall not only use 50% of the fish for consumption - we must use all parts of the fish.

And fish should not be the only resource we use from the sea, we should also use seaweed, mussels and exciting new biomass such as sea cucumbers and jellyfish.

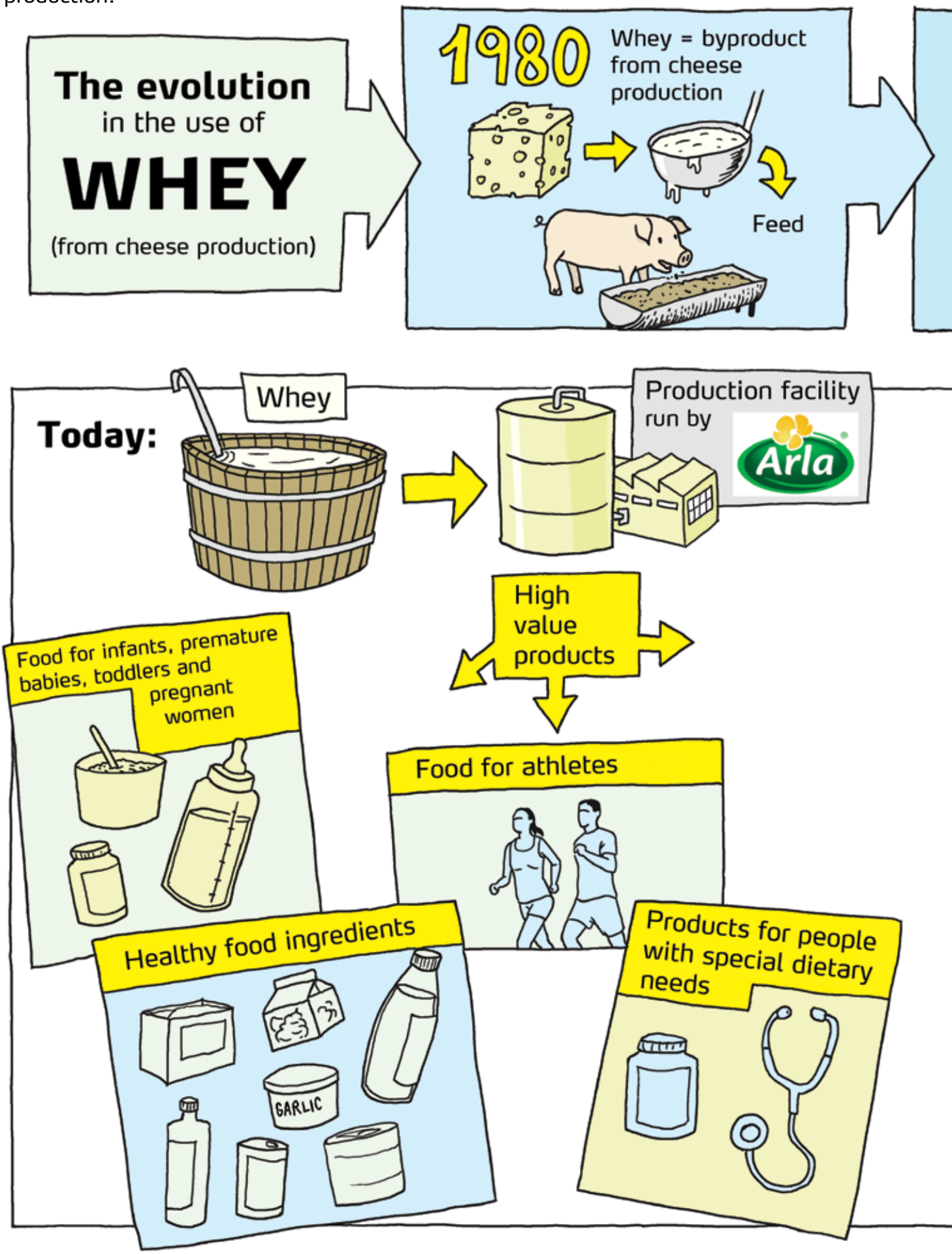


The illustration on the **left-hand** side shows the wealth of biological resources existing in the sea, and their potential to be transformed into healthy and valuable products.

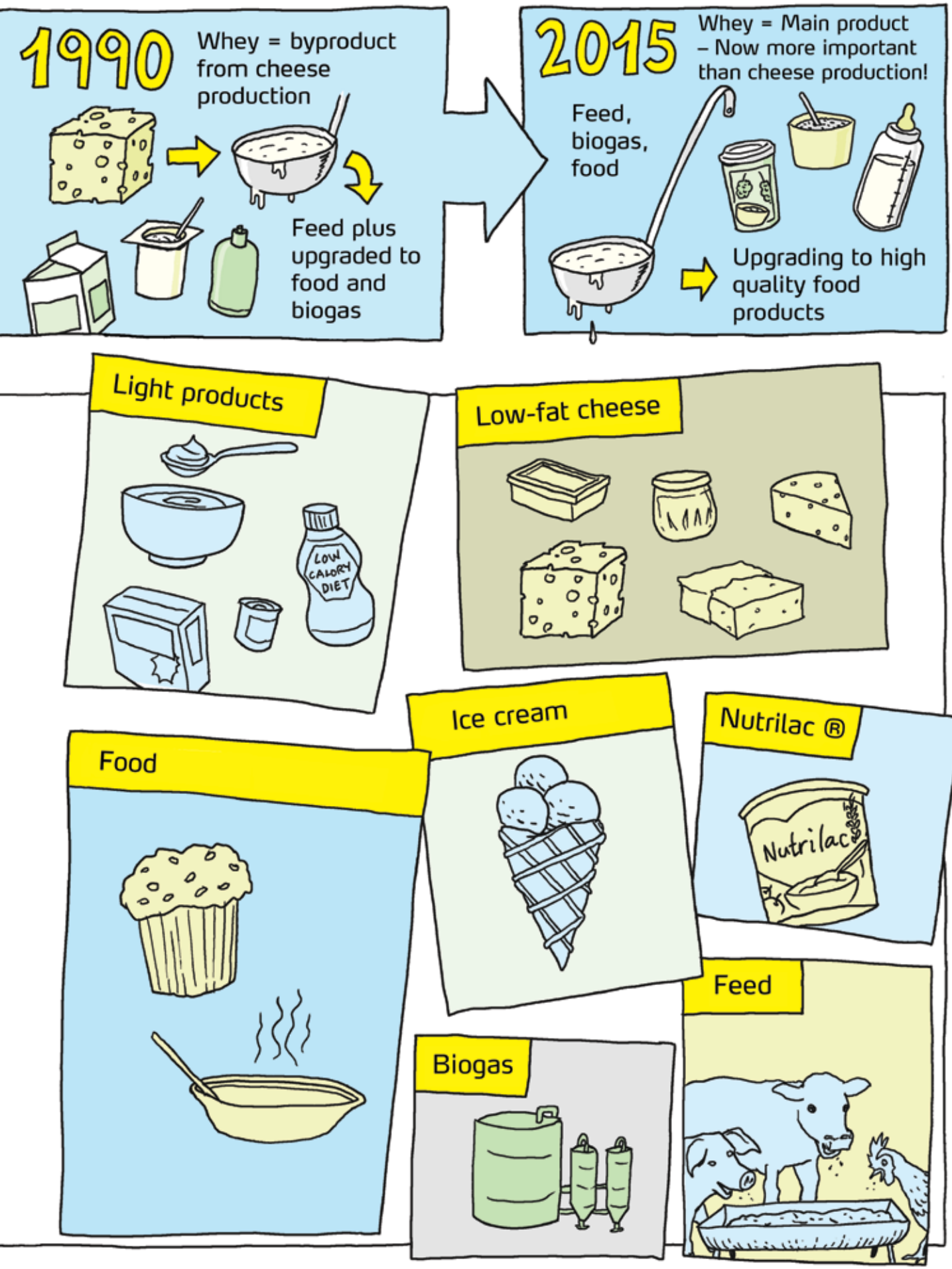
The illustration on the **right-hand** side shows the potential of using everything that we would otherwise denominate as waste from the fish processing industry - from the fish comes out of the sea to the fillet is on the plate.



The Danish food-producing cooperatives, Arla (milk), Danish Crown (animal production) and KMC (potatoes) are now ranking among Denmark's most outstanding examples of biorefineries, effectively exploiting the full potential of their raw material. The illustration shows the development in the use of the valuable substances in whey from cheese production.



Without the use of these side streams Arla would not have the position they hold today in terms of market shares, value creation and especially jobs. There are equally large, not yet fully exploited potentials in many other sections of the Danish food processing industry, for example in flour milling, breweries, biotech companies, etc.

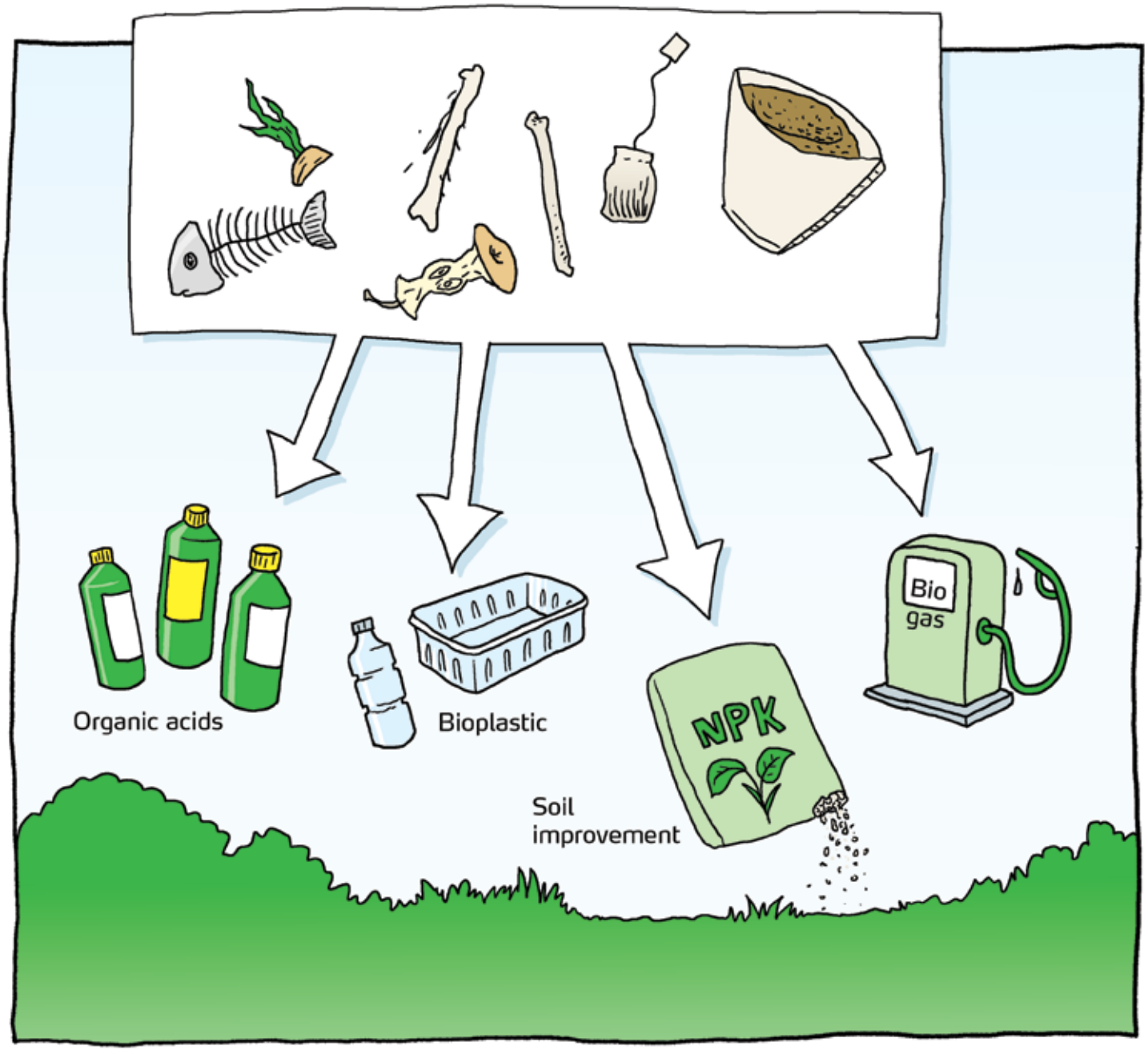


Household waste is a resource with huge untapped potentials for upgrade to higher value. Earlier it was deposited in landfills and/or burned. This resulted in very high greenhouse gas emissions.

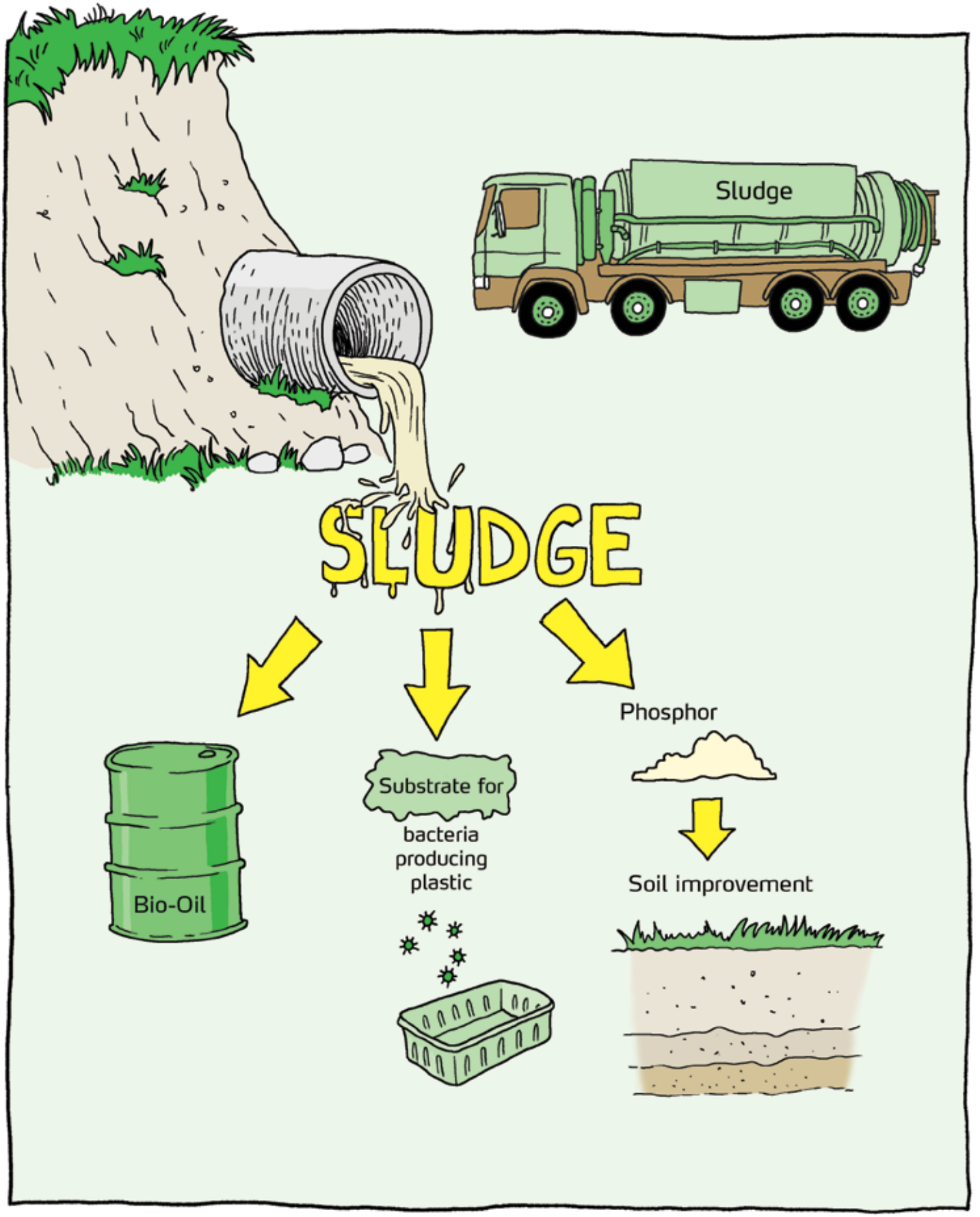
Globally, Denmark has spearheaded the development of highly efficient combustion technology, whereby household waste is converted into electricity and (district) heating.

Waste management technologies are now developed even further: The biomass is for example exploited better than when burnt, by producing biogas from household waste, where valuable substances can be circulated back to earth and biogas can be used as transport fuel.

Next step forward is upgrading the organic part of the household waste to higher value products, where the use of the bio resources is optimized even more. An exciting step toward in the more resource-efficient direction is DONG's REnescience technology which is based on enzymatic treatment liquefying the organic fraction of household waste.



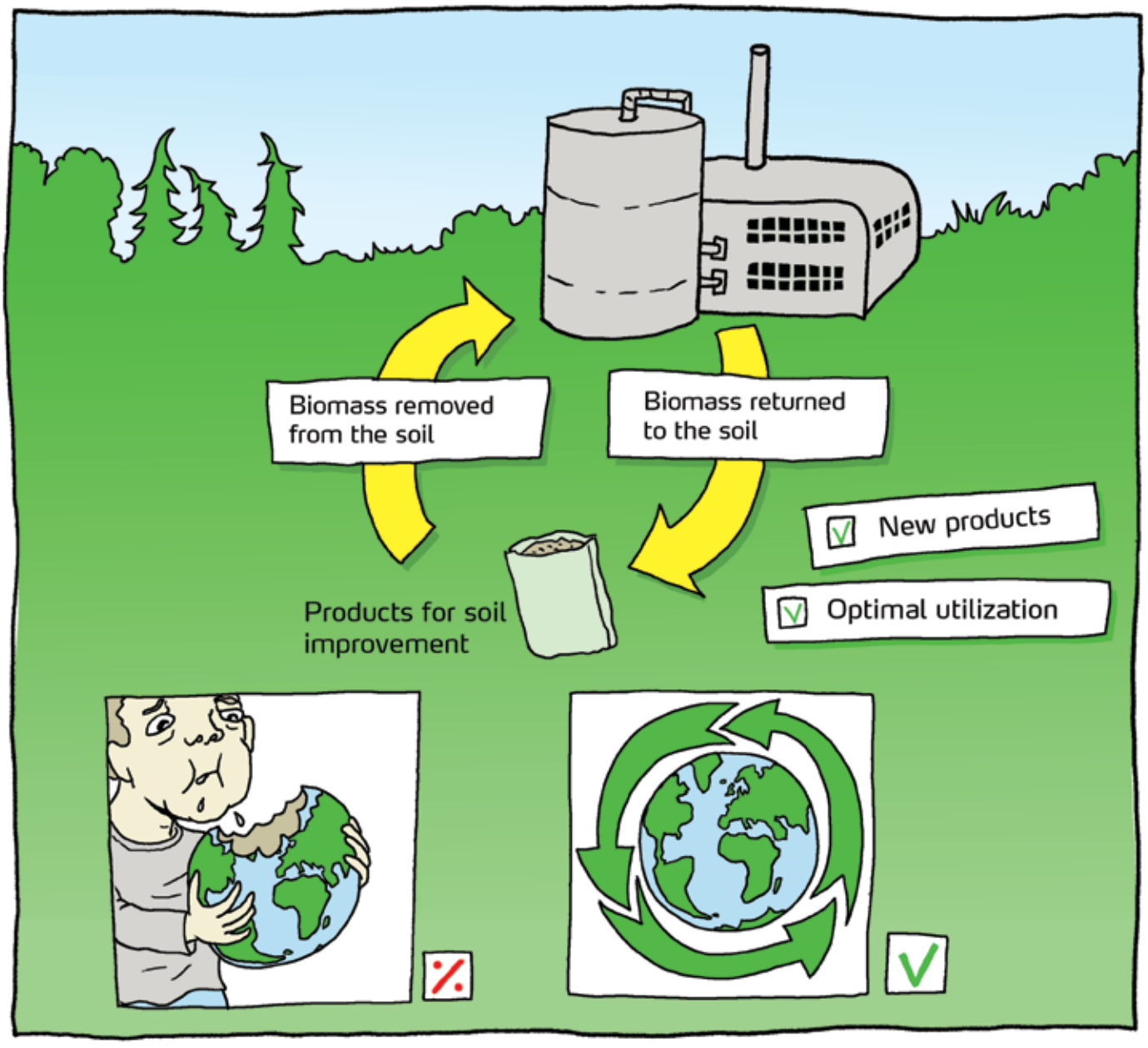
Sludge from e.g. sewage treatment plants is surprisingly rich in organic material. It may be utilized by being converted (via e.g. HTL, hydrothermal liquefaction) to a bio-oil which can be used for marine fuel for example. However, it can also be used to grow bacteria on; bacteria that can produce building blocks, for example for bioplastic!
The content of phosphor can be recovered and reused as fertilizer, bringing the nutrients back to the soil.



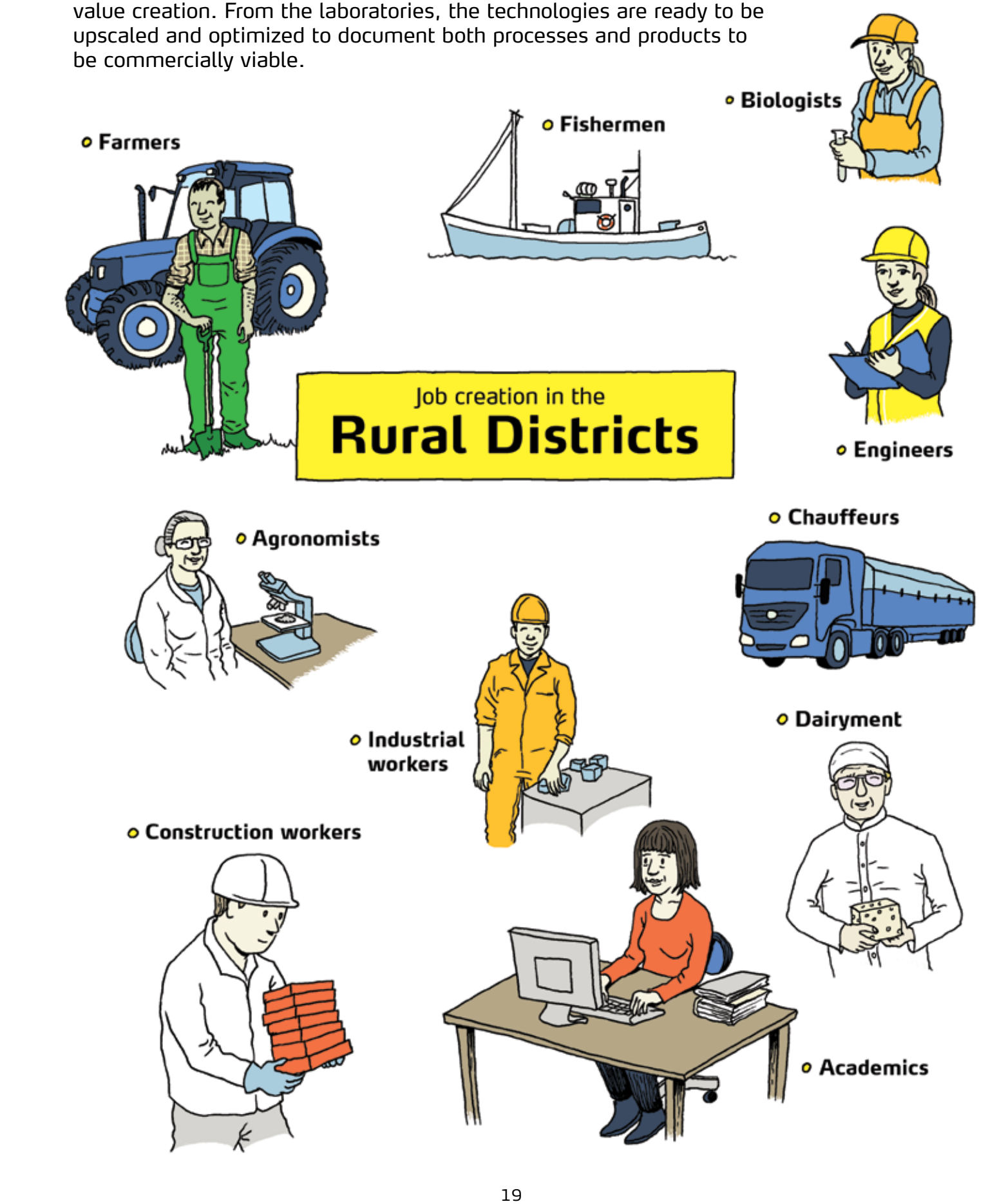
Better utilization of our biological resources is one of the greatest opportunities we have in Denmark to create new jobs, while also strengthening our technology leadership within biological production. At the same time we utilized our local production base, the earth and the sunlight, even better.

By **developing the bioeconomy** we will contribute to the UN Sustainable development Goals and be among the leading countries that develop technologies for a more sustainable global society. Better use of biological resources is an important feature in order to reduce CO_2 pollution; and thus an area with great potential to reduce the threat posed by climate change.

The third pillar as to what the bio-economy can contribute in terms of increased global and local sustainability, is that biomass contains components that can provide the basis for new types of healthy food-ingredients for both people and animals. Improved gut health can help reduce the use of antibiotics in animal husbandry and thereby reduce the risk of development of additional antibiotic resistance - one of the major future threats to human health.



The potential for job creation through the bio-economy is one of the strongest capacities we have for increasing local employment - also outside the big cities. It provides social sustainability, particularly because the bio-economy jobs are of such diverse types; with room for many kinds of talent and effort. And if we design our cropping systems smartly, we can increase their productivity while at the same time also reduce the environmental impact! But new crops and cropping systems require new methods of exploitation and value creation. From the laboratories, the technologies are ready to be upscaled and optimized to document both processes and products to be commercially viable.



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