2025

FIELDS FOR FOOD OR FUEL?

SCENARIOS FOR A NEW BIOMASS REGIME

Contents

The Challenge

Biomass, whether used for production of power, heat and transport fuels or indirectly as renewable material and feedstock, has been hailed as a key option to replace fossil fuels, mitigate GHG emissions and provide a major opportunity for rural development on a global scale. Many nations embraced this option in their energy policies and started large scale investments.

However, in 2008, following an explosive food crisis, a media storm rapidly changed perceptions and blamed particularly biofuels for rising food prices, increasing pressure on land and forests resulting in a poor GHG performance. The investment boom in biofuels ground to a halt.

Late in 2008, as food and crude oil prices started to decline, the controversy has settled a little. Noting the public sensitivity towards food crops, many governments have moved away from food crops to biomass residues, trees and grasses as raw material for biofuels. Globally, sustainability criteria for responsible biomass production and land-use are being developed and implemented.

The need to reduce GHG gases, replace oil and develop rural economies is stronger than ever before, but biomass is not a simple story: the sustainability of its potential depends on how we manage land and food production at large. A careful balance with water use, protecting biodiversity and rural development is needed. New technologies and cropping systems promise better performance, but our experience in these areas is limited. Furthermore, effective safeguards and policy frameworks securing sustainable production and use should be in place. Will this all materialize and if so, how soon?

The Fields for Food or Fuel project provides a unique and multifaceted insight into different possible drivers that will affect biomass, bioenergy and biofuels in the future. By using a rigorous and dynamic multi-stakeholder process, different potential biomass regimes have been explored, providing a concise overview of the complexities and the sensitivities of the bio-based economy. The resulting scenarios provide a wealth of information and are valuable for many years to come for all the stakeholders.

Prof. Dr. André Faaij, Professor Energy Systems Analysis, Copernicus Institute - Utrecht University, Netherlands

Why this project?

FFF was conceived as a collaborative scenario development project. Its basic aim is to bring together a range of parties concerned with the central underlying question – how the balance between global demand and supply of agricultural raw materials for food, feed and energy evolve in the next 20 years? Arguably, the project title – fields for food or fuel? – captures only part of the complexity surrounding global supply and demand balances.

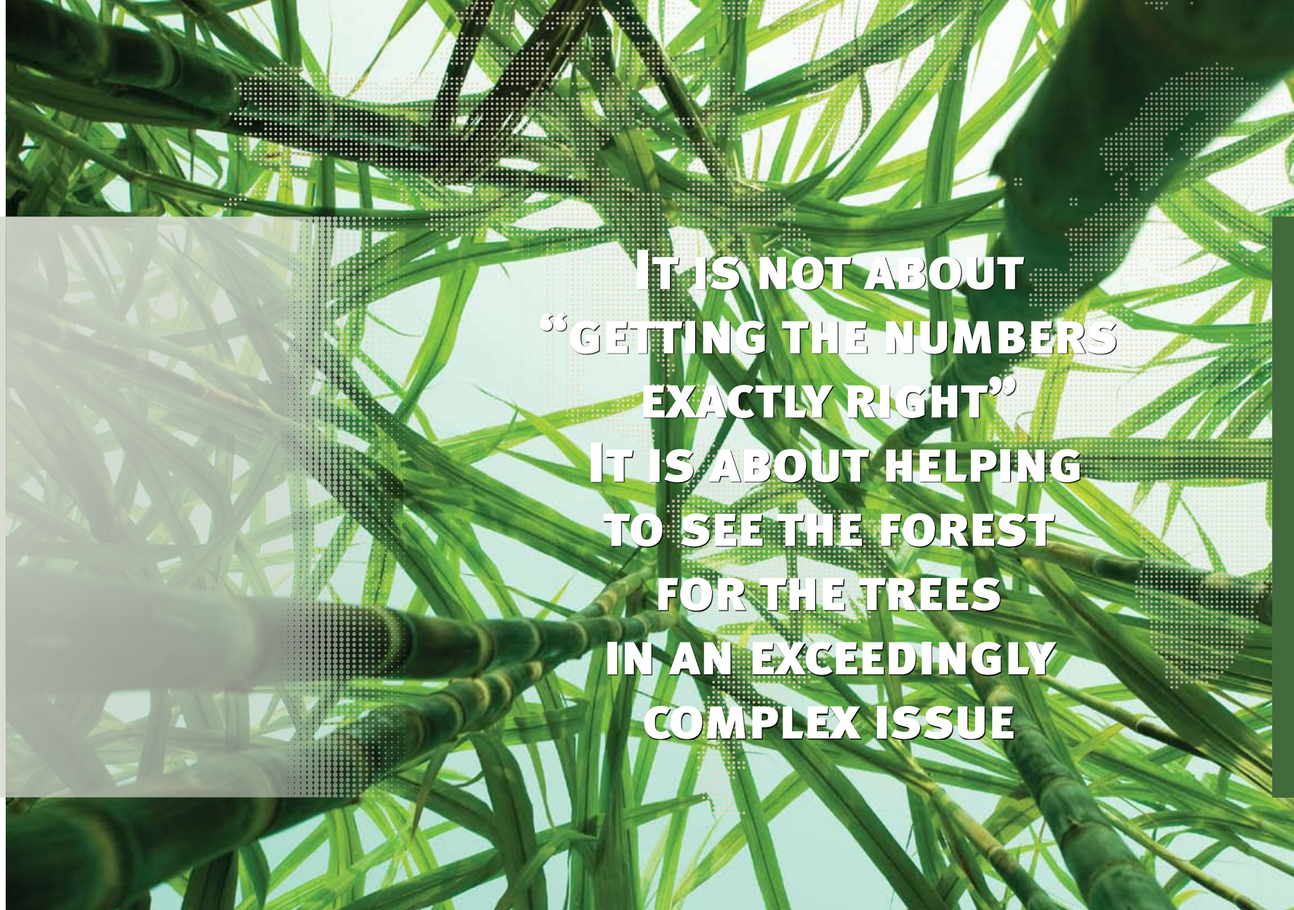
This question is particularly relevant against the background of two key developments in recent times: on the one hand there has been a rapid and significant increase of agricultural commodity prices over the last 18 months and although prices have declined more recently, price volatility remains important. The other very significant development is the emergence of bio-energy policies to bolster energy security and reduce greenhouse gas (GHG) emissions.

As a result, the dynamics of the emerging biomass regime are highly unpredictable. The supply and demand equilibria towards which the system will gravitate, will have important implications for hundreds of millions of people who spend a large part of their disposable income on food, or who earn their livelihood from food production. In addition, the viability of many different business sectors – not only agrifood, but also traditional energy, chemical, paper and transport companies – will be affected. Finally, there is the possibility of serious environmental damage if the transition to a new biomass regime is not well managed.

The rationale behind this project, therefore, is to provide an opportunity to collaboratively make sense of long term developments in a very sensitive area. It is not about "getting the numbers exactly right". It is about helping to see the forest for the trees in an exceedingly complex issue, extending collaborative networks beyond familiar boundaries and depolarizing a vital societal debate.

This work has been propelled forward by the investment of time and resources of a mixed group of experts from industry, civil society and academia. Financial grants from the UN Foundation and an industry consortium consisting of Jungbunzlauer, Nutreco and Cosun have made this collaborative and visionary effort possible. The process has been designed, facilitated and documented by the combined efforts of Giract and ShiftN. Dr. André Faaij from Copernicus Institute (Utrecht University) acted as a scientific advisor to the project team.

This summary brochure reports the key findings resulting from this work.



How did we build these future scenarios?

These scenarios are the result of a disciplined thinking process between October 2007 and March 2008. Three interactive workshops brought together 24 representatives from different stakeholder groups: industry, civil society actors and academic experts.

First, stakeholders were interviewed and their perspectives were brought together in a systemic analysis of the factors affecting the biomass regime. This was the basis for the first scenario development workshop.

Focus of the first workshop was the inventory of a database of external driving forces. More than 130 drivers were identified. Through an iterative process these were prioritized. A limited set of drivers was thought to have a very large impact on the future dynamics of the biomass regime, while their outcome was seen to be highly uncertain: the critical uncertainties. They expressed what participants believed would really make a difference in the next fifteen years. Among the uncertainties identified in this process were:

- Biomass competitiveness: the degree to which biomass presents a competitive alternative to fossil and especially to alternative non biomass based energy technologies (autonomously or supported by government interventions).
- Biomass production efficiency is the degree to which biomass production can be made available efficiently and economically. This hinges on land availability and technology.
- Global governance is the degree to which standards for and the control of sustainable production of biomass, bio-energy and biofuel are agreed and enforced on a global scale.

The results of the first workshop were validated with a group of external experts.

The second workshop was dedicated to exploring a scenario framework that tied together the various strands in the thinking and provided a solid foundation for an interesting, diverse and challenging portfolio of future scenarios. A number of scenario seeds – based on particular interactions between the critical uncertainties – were explored.

In the third and final workshop in this process, the focus was on developing these seeds into fully fledged, well argued narratives.

Scenario 1 - Fragile Utopia

A sustainable biomass regime slowly emerges as a result of a delicate interplay of drivers at macro and micro-level.

A food crisis apparently took the world by surprise in 2007. But for those with an eye on poor agrarian economies, it had been a long time coming. And it got worse. Average worldwide harvests in key agricultural commodities such as wheat and rice kept prices rising through 2010. Combined with skyrocketing prices for crude, further eroding poor people's already precarious livelihoods, an explosive cocktail was in the making. Social unrest spread like wildfire through the developing world and emerging economies. Mobs engulfed capitals from Abidjan to Ulaanbaatar. By the end of 2010 food and oil-related confrontations had claimed thousands of lives and cornered economic and political elites around the world. The crisis spiraled into a global security problem.

In just the space of a decade, a confluence of three major challenges hit worldwide public consciousness: climate change, the end of fossil fuels and the food crisis. The traumatic violence that enveloped the globe in 2010 brought people to the realization that we, as a species, were at a crossroads. Either we rose to the challenge or we adopted an ostrich strategy and perished.

The governance challenge was enormous, however. The tools to tackle interdependent global problems multilaterally simply weren't there. Decision-makers had great difficulty to letting go of the old top-down, one-size-fits all paradigm and engage in some kind of action learning. Kyoto was, perhaps, a hesitant and laboring beginning in building up this capability. In 2009, the Parties to the UNFCCC did in fact agree to adopt a "son of Kyoto" climate pact after 2012.

Biofuel production was another big issue in the climate-energy-food nexus that was drawn into the orbit of multilateral policy making. The traumatic events of 2010 made it amply clear that people in developing countries wanted to produce bio-energy crops ontheir own terms, on their own lands and for their own purposes.

In the early years of the second decade a consensus grew around the outlines of a bioenergy regime that stood a better chance of being a force for agricultural modernization in developing countries. A Global Bioenergy Compact was established.The partners to the Compact came to the conclusion that traditional staple foods, such as cassava and sweet sorghum, offered better opportunities compared to jatropha and sugarcane.

Their unmined potential reflected the systemic difficulties that had plagued developing country agriculture for decades. If the intrinsic nutritional and energetic qualities, the pest and drought resistance, and the post-harvesting properties of these kinds of staple food crops could be improved, then small-holders would have a vastly more resilient source of food, of livestock fodder and energy. This could be the start of a virtuous circle that would enable rural communities to build a springboard of modest food security and energy independence out of the poverty trap of subsistence agriculture and fossil fuel dependence.

The challenge for the Compact was to mobilize foreign and domestic investments for socially and ecologically sound bioenergy production schemes and to build local capacity to use these resources wisely and effectively. A mix of top-down meta-standards and local interpretations of sustainability criteria emerged as the only workable solution.

Slowly but surely the regime stumbled forward into a new reality. There was no other choice, really, as the world kept teetering at the edge. A critical mass of key players came to support the Global Bioenergy Compact. There was a window of opportunity to establish a largely level playing field in moving towards a global bioenergy regime. That was the key lever that the Compact was able to pull. Industry adapted to the new circumstances and started to seek value creation opportunities within the emerging sustainability framework for bioenergy production. Research funds started to flow into crop improvement, infrastructure development and capacity building.

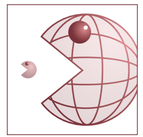
New technologies – ranging from genetic engineering to sophisticated remote sensing techniques and $50 laptops - helped to put critical pieces of the puzzle together.

Large scale sustainable biomass production eventually came on stream as well, but only after careful zoning exercises, matching specific types of land with carefully optimized plant characteristics. A prerequisite for these large projects was also that the interests of the local population were genuinely taken into account.

At the end of the 1990s scientists started to convince the world that the globe was warming. They used a "hockey stick" curve – showing global temperature patterns over a long period of time - as a potent visualization of man's growing impact on Earth's climate. Now, in 2025, another "hockey stick" curve has emerged, showing how rural communities are finally boot-strapping themselves out of dire poverty. The head of the stick is still short. It may be too early to tell if this is another, benign bifurcation point…

Biomass Competitiveness	HIGH	LOW
Biomass Production Efficiency	HIGH	LOW
Global Governance	TIGHT	LOOSE

Scenario 2 - Biomass Bullies



Open markets, concentration and economies of scale even the playing field for a breakthrough of next generation biofuels, however without delivering a long term sustainable answer to social unrest and environmental concerns.

The food crisis that hit the world in 2007 had a paradoxical legacy. A first paradox was that the crisis proved to be a boon to the very biofuels that had been considered by many to be one of the prime causes underlying the steep climb of food commodity prices. Indeed, what the food crisis did was to sound the death knell for traditional, first generation bio-energy crops. But the pressures of a high oil price and a warming planet remained. Hence, significant public and (particularly) private investment was mobilized to unlock the potential of next-generation crops based on cellulose feedstocks and capitalizing on better conversion routes. Compared to the biofuel bonanza, the dot com boom of the late 1990s looked like a small party.

The first commercial-scale applications were introduced on the market very early in the second decade. In the next couple of years the feedstock palette progressively widened – eventually to include genetically modified tall grasses, domesticated and oil-rich jatropha, cellulose-busting fungi that decomposed agricultural waste and "blue" (aquatic) biomass such as algae. Clearly, biofuels were here to stay.

Another implication of the food crisis was a breakthrough in the WTO talks. The reasoning was that many countries were, in response to the crisis, bringing down tariffs anyway to secure access to raw material and food. And with high food prices domestic support schemes were less necessary. And wouldn't free trade offer smallholders better access to critical production factors (land, water, seeds and capital) and a better connection to global markets? So there was a rationale to bringing the Doha round to a close. Whether this resulted in significant trading opportunities for nations that depended on agriculture is still a matter of debate. What the new rules certainly did was to create a more predictable commercial and investment environment for dominant players in the agrifood and energy sectors.

This further amplified the international investment boom in biofuels. Large multinationals were best placed to take advantage of these opportunities and to mobilize the very significant funds necessary to drive the R&D, and to build the conversion and logistic capacity to supply a world enormously thirsty for alternatives to expensive petrol. Trade in bio-energy feedstocks and biofuels ballooned from 2015 onwards.

A key milestone was the creation of a new Global Biofuel Exchange and in 2017 the BIOPEC was created, the counterpart of OPEC, for Biomass and biofuel Producing and Exporting Countries. Powerful alliances were formed. China played a dominant role in Africa, while the US and Europe built a key position in Latin America. Russia as well as the Ukraine developed into key players in the biofuels arena. Even before 2020 the first price controls for biofuels were established. It was hardly surprising that the bio-energy sector's industrial base underwent a process of significant consolidation.

Agrifood, biotech and energy companies merged into biofuel behemoths in order to be more effective in building, protecting and exploiting their key intellectual and biological assets. Incumbents were joined by startups that capitalized brilliantly on their technological capabilities. As a result biofuels made big inroads in the transport sector. By 2022, transport GHG emissions started to dip for the first time. This was seen as a major achievement in building a planetary strategy to combat climate change.

However, these successes came at a cost. One result was that pressure on forest areas was increasing, because the conversion of forested land to highly productive plantations was so very profitable. However, the monoculture character and strong rationalization of land-use gave way to visible biodiversity losses in these agricultural and grassland areas.

Governments were largely unable to oppose such developments and enforce sustainability criteria, since these were seen as protectionist measures and undesirable in the free trade environment that had developed.

Another consequence, especially in Africa and Latin America, was that smallholders were unable to position themselves favorably in these biomass flows. That was another paradoxical implication of the 2007-2010 food crisis. What had initially started as a well-intentioned effort to provide developing countries and their smallholders access to global markets, eventually turned against them.

Small producers could not develop the economies of scale to benefit from the new regime. In many cases they simply stood in the way of large players in search of land. Habitat destruction led to displacement of rural populations to either marginal or urban areas. Those that could stay were forced into unprofitable biofuels cropping schemes. Intensive mechanization of biofuel production offered only meager opportunities for seasonal labor. The biofuels boom in many cases did not benefit rural populations in developing countries but it increased their plight and led to social unrest in many of the poorest countries.

Scenario 3 - Mandated Mania

Exogenous factors cause a variety of biomass regimes to emerge in which biomass competitiveness and production efficiency are decoupled in order to support survival of economies at domestic or regional level

Somewhere along the way humanity stumbled. The world was confronted with a toxic cocktail of a changing climate and reducing natural resources (energy and food) at a time when its capacity for foresight and concerted action was at an all time low.

The collapse of the UNFCCC was followed by a period of confusion. A fragmented landscape of bilateral and limited multilateral agreements emerged – relying on a variety of tools and approaches to price carbon and mitigate effects of climate change. The absence of clear policies muddled investment priorities for the business world and money was only funneled into those business ideas that promised a quick return.

So investments continued to pour into traditional biofuel crops enticed by high oil prices, favorable subsidy schemes and captive markets. Farmers were eager to recapture some of the losses they had been suffering as a result of decades of low commodity prices. As a result it was more difficult to mobilize capital flows into R&D for riskier second generation crops.

By 2012 the first generation biofuels juggernaut already had impressive momentum, claiming millions of hectares in the US, Brazil, Indonesia, Western Africa and increasingly Ukraine.

Energy security drove key players to particularly support domestic production: sugar beet and rapeseed in Europe, corn in the US, sugarcane in Brazil and Africa. Trade barriers were maintained to discourage importation of competing feedstocks. This was a constant source of irritation between the dominant powers and it helped to further poison the climate of indifference and occasional acrimony that stifled potential multilateral solutions to global problems.

Despite opposition from vocal civil society groups, US and EU Governments responded with more rather than less mandates for biofuels. The pressure of climate change-related disruptions and high fossil fuel prices progressively reduced policy makers' budgetary room for maneuver. With prices of energy crops under pressure biofuels remained an attractive option in climate mitigation strategies. The option was all the more necessary as the general public, mesmerized by isolated breakthroughs such as a very successful hypercar, remained unwilling to adopt a more energy-thrifty lifestyle.

Finally, sensing that support for biofuels might fatally crumble, the agricultural sector engaged in forceful lobbying. They cleverly capitalized on the global climate of suspicion and uncertainty in persuading governments to keep the mandates in place, indeed to increase them so as to cushion domestic economies against the vicissitudes of Realpolitik strategies of the major trading blocks.

In the US a novel 50 billion gallons target for 2035 was proposed in the 2014 Energy Bill. Most of it was mandated from domestic sources. A year later, the EU unveiled a new climate action plan that included a mandatory 15% share of biofuels in transportation by 2030. Exactly where these volumes were going to come from remained at that point unclear, but there was talk of admitting Turkey to the Union by 2020, thus giving access to almost 50 million hectares of arable land where significant yield improvements were possible. Further down the road Ukraine might come on board – an accession dossier was opened in 2018 – and this would provide the EU with access to a vast potential of underutilized land.

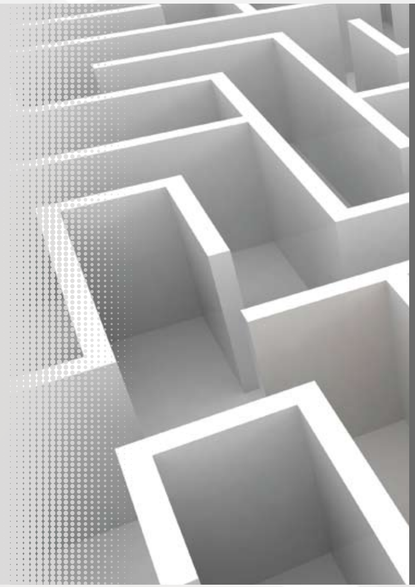
The biofuels sector matured, quickly. "Economies of scale" was the name of the game. Margins and budgets were tight. Investments in R&D were rerouted or postponed. The second generation mirage evaporated. Globally, isolationist policies and zero-sum games were stifling the potential for growth, leading to further anxieties. A vicious circle was set in motion that dragged advanced economies into an unavoidable recession.

By 2025 the price for the politics of collective inaction that plagued the global community early in the 21st century has become a little bit clearer. The planet was simply in dire straits.

Despite fragmented progress in renewables, nuclear and energy saving technologies, fossil fuels (oil and coal) were still, by far, the key energy carrier and demand for them continued to grow. Meanwhile, global carbon emission levels stood at 420ppm. The impact of a changing climate was visible everywhere.

Indeed, the age of abundance was over, at least for the time being. Citizens all over the world had to make do with less. The cake had gotten smaller for everyone. The question that haunted some of the more enlightened minds was: who will stand up and breathe some life into the rusty network of multilateral institutions? It's time to think again about win-win …

Biomass Competitiveness	HIGH	LOW
Biomass Production Efficiency	HIGH	LOW
Global Governance	TIGHT	LOOSE



Scenario 4 - “Biomass Bottleneck”

Multiple drivers interact to create a context in which biomass is not able to deliver its promise.

Today, halfway to the 2020s, hardly anyone talks about biofuels. Sure, Brazil continues to be a wayward outsider on the energy scene with a vibrant economy that runs largely on sugar cane-based ethanol. And a few West African countries that imported the Brazilian model trail in its wake. But that’s about it. The biofuels boom that grabbed headlines at the end of the first decade simply fizzled before it really got well under way.

With hindsight it is not easy to point out a single cause for this demise. The food crisis that hit the world in 2007 and culminated in an unprecedented price spike halfway through 2009 was a first, significant bump in the road. This, in fact, sealed the fate of so-called first generation biofuels derived from arable crops also grown for food. Environmentalists vocally opposed energetic policies enacted by leading OECD countries to mandate significant volumes of these biofuels for use in transport. Advocates of the original policies had a hard time making their subtle arguments heard. So when commodity prices continued to rise, governments were under pressure to reconsider their biofuels strategy.

Mid-2009, the EU Commission suspended its proposed target of 10% of renewable sourcing for transport fuel until further evidence was available that second-generation energy crops would, in the short term, be able to contribute significantly to biofuel stocks. Indeed, the hardening resistance to first-generation feedstocks significantly increased the pressure to deliver solutions, quickly. Financial support for growing traditional energy crops was massively reallocated to research and investors turned away from first to second and even third generation technologies. But here the bio-energy dreams hit another bump in the road.

A number of unfortunate incidents started to convince the environmental community that a genie had been left out of the bottle. For starters, it appeared that many of these woody, non-food plants – such as reeds and wild grasses – that were being piloted or cultivated for bio-energy production proved to be very difficult to control. Many of their characteristics – their fast growing cycles, weedy nature and their ability to outcompete other plants – were also found among invasive species. Infestations of wilderness areas with migrating bio-energy “weeds” started to create serious problems.

There were other, possibly even graver concerns with a bearing on the technologies that were being mobilized for a new generation of bio-energy crops. An utterly benign experiment to harvest anticancer compounds from synthetically designed marine sponges went awry. The sponges produced a pathogen. The result was an explosive, massive destruction of marine life in the Mediterranean. The sponge disaster was a turning point in the public perception of advanced biological technologies to exploit the economic potential of biological resources. Swiftly an international Biological Technology Framework Convention was put into place that imposed significant restrictions on biological research in signatories’ countries. Inevitably, the momentum behind the next-generation bio-energy wave was severely dented. Once more, financiers became jittery and reallocated their funds to less risky business ideas. Biofuels started to get an altogether bad name in investment circles.

It would take another decade before a narrow portfolio of commercial-scale developments of next-generation bio-energy crops would become reality. But by then the tide had really turned. The window of opportunity for biofuels had closed. With global energy demand, emissions and temperatures rising, there was no way the global community could wait until the third decade of the 21st century to get its act together. There was increasing evidence that the economic, social and political cost of frequent extreme weather events and chronic water shortages would significantly surpass the massive investment necessary to put a sustainable, decarbonized energy system for the planet in place.

Biomass was seen to play only a minor role in this new energy equation. The experiences of the past decades convinced decision-makers that interventions in the biomass realm were fraught with risks for citizens and investors alike. Furthermore, tightening water constraints and a shrinking availability of arable land made it abundantly clear that biomass production had to be maximized to cater to the world’s food needs in the first place.

Alternative energy technologies had to step in where biomass floundered. A large number of conventional power plants were fitted with carbon capture and storage facilities. Support for renewables had gained massive momentum in the late 2010s as high oil and carbon prices continued to give developers of solar, off-shore wind (floating turbines) and tidal energy sources a lift. Nuclear suddenly looked promising too. Finally, energy efficiency technologies helped businesses and households to curtail energy consumption.

Biomass Competitiveness	HIGH	LOW
Biomass Production Efficiency	HIGH	LOW
Global Governance	TIGHT	LOOSE

Overview of the scenarios

Scenario Dimensions – 2025 end state

Framework

Biomass Competitiveness
Biomass Production Efficiency
Global Governance

Energy Mix

fossils | nuclear | alternative | biomass

Prices

2025 prices relative to the scenario starting point - constant currency

0% 10% 20% 30% 40% 50% 60% 70% 80%

Biofuel Production & Consumption

Production / Consumption: Europe | N.America | China | S.E.Asia | S.America | Africa | ROW

Agriculture

Feed Stocks: Cereals | Sugarcane | Oilseeds | Roots | Novel crops
Land Use: Arable | Permanent Crops | Grassland | Marginal | Forest | Urban
Segmentation: Food | Feed | Biofuel | Materials

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1. Fragile Utopia

Framework: High / Low
Energy Mix: Global energy mix; EU energy mix (x 500%); CO2 emissions
Prices: Biofuels; Food; Oil
Biofuel Production & Consumption: Production; Consumption
Agriculture: Feed Stocks: Cereals | Sugarcane | Oilseeds
Land Use: Arable | Grassland | Marginal | Forest
Segmentation: Food | Feed | Materials

2. Biomass Bullies

Framework: High / Low
Energy Mix: Global energy mix; EU energy mix (x 500%); CO2 emissions
Prices: Biofuels; Food; Oil
Biofuel Production & Consumption: Production; Consumption
Agriculture: Feed Stocks: Cereals | Sugarcane | Oilseeds | Novel Crops
Land Use: Arable | Grassland | Marginal | Forest
Segmentation: Food | Feed | Materials

3. Mandated Mania

Framework: High / Low
Energy Mix: Global energy mix; EU energy mix (x 500%); CO2 emissions
Prices: Biofuels; Food; Oil
Biofuel Production & Consumption: Production; Consumption
Agriculture: Feed Stocks: Cereals | Sugarcane | Oilseeds
Land Use: Arable | Grassland | Marginal | Forest
Segmentation: Food | Feed | Materials

4. Biomass Bottleneck

Framework: High / Low
Energy Mix: Global energy mix; EU energy mix (x 500%); CO2 emissions
Prices: Biofuels; Food; Oil
Biofuel Production & Consumption: Production; Consumption
Agriculture: Feed Stocks: Sugarcane | Oilseeds
Land Use: Arable | Grassland | Marginal | Forest
Segmentation: Food | Feed | Materials

Overview of the scenarios

The dashboard on the previous page shows how the four scenarios differ from one another in defining aspects such as energy mix, scale of biomass production and trade, feedstocks, price levels, end uses and negative externalities.

They represent aggregate values or 2025 at a global scale. These are qualitative assessments that merely serve to clarify the general thrust of these future worlds. No quantitative modeling has been done to substantiate these indicators.

And now ...

We hope that these stories demonstrate that multiple bio-energy futures are possible and that we are at a crucial intersection of issues surrounding our planetary life support systems: energy, food and water.

None of these scenarios is intended to be read as an endorsement or a conviction of bio-energy. They represent a spectrum of possibilities in which opportunities and threats for various stakeholder groups are unevenly distributed.

It is up to us to make balanced choices.

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