



THE CIRCULAR DAIRY ECONOMY

Exploring the business case for a farmer
led, 'net-positive' circular dairy sector

Discussion paper
prepared for the
World Dairy
Summit 2016



FrieslandCampina 

SUMMARY

This discussion paper is prepared jointly by FrieslandCampina and Circle Economy for the World Dairy Summit held in Rotterdam, the Netherlands in October 2016. The document presents insights into the potential of circular dairy farming from a Dutch perspective.

The global dairy sector is forecasted to experience steady growth and create a positive impact on farmers livelihoods and human nutrition. However, it also faces major challenges and sustainable growth compatible with the intents of the Dairy Sustainability Framework is imperatively needed. Circular economy principles offer a promising avenue to resolve these challenges.

The dairy sector traditionally features circular practices and examples abound, that demonstrate the potential of circular dairy farming. Yet, significant challenges remain to achieve a truly circular dairy sector that is regenerative and closes nutrient, water, carbon and waste cycles while promoting biodiversity, optimising land use and safeguarding farmer income.

The Dutch dairy sector is a recognised innovation leader and Dutch dairy farmers have an important role to play in leading a transition toward circularity. To start this transition, three archetype pathways were identified:

- **Optimised grazing**, which seeks to maximise the productivity of the land by combining biological and technological approaches to achieve circularity. This system plays to the many of strengths of the Dutch dairy sector, but requires significant improvements from current practices.
- **Extensive grazing**, which builds on biological processes and organic farming methods to close the soil-plant-animal-nutrient cycle locally. The pathway is the closest to achieving full circularity and being restorative, but requires improved governance and revenue models.
- **Intensive high-tech farming**, which leverages technological solutions to close key cycles. This pathway presents advantages in terms of productivity and circular performance, but is at risk from lower resilience and public acceptance issues.

This paper presents both the potential for the success of circular dairy practices and the challenges ahead. Further research is needed to broaden the proposed archetypes to the full, global scope of dairy practices and deepen the analysis of the business models and feasibility at regional and local levels. It is also essential that farmers take a leading role on the ground to probe, test and learn from improvements in each of the transition pathways, and thereby guide the transition in a practical and effective way.

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CALL TO ACTION

The circular economy presents a promising pathway to meet the dairy sector's growth and sustainability challenges, yet achieving a truly circular dairy sector that is regenerative for the environment and the economy is no easy task.

FrieslandCampina and Circle Economy are committed to enabling the transition to circular dairy farming. This report, prepared jointly for the World Dairy Summit held in Rotterdam in October 2016, presents insights into the potential of circular dairy farming from a Dutch perspective.

FrieslandCampina and Circle Economy acknowledge the needs for additional work to be conducted after the World Dairy Summit and for farmers to engage in the discussion to ensure actionable propositions are put forward.

A multi-stakeholder coalition is needed to support this process and delineate practical and scalable pathways toward a circular dairy sector. The report should therefore be read as a **CALL TO ACTION** to make circular dairy farming a reality.

3 STEPS TO SUPPORT A TRANSITION TO A CIRCULAR DAIRY SECTOR



Build a coalition of front running farmers and key stakeholders throughout the dairy value chain to invest in systemic change and support in-depth research.



Develop circular pathways for different farming models around the world, building on a comparison of their performance across a range of environmental, economic and social indicators.



Probe, test & learn by helping farmers implement best practices and effectively lead change on the ground.

THE CASE FOR CIRCULAR DAIRY

The dairy sector provides essential livelihoods and vital nutrition to billions of people

The global dairy sector involves international value chains and is characterised by highly diverse farming practices: from smallholders to industrial farms and extensive grazing to intensive stable-based models. The dairy value chain contributes to rural economies and supports farmer livelihoods.

Dairy is a strongly income-elastic commodity and the sector's growth is now fuelled by demand in developing and emerging economies. To meet this demand, milk production is forecasted to grow by an average of 1.8% per annum to 2025. This growth will meet the nutritional needs of billions of people around the world, with dairy products forming an important part of their diets.

In a strained global agrifood sector, the 'license to operate' is under pressure

Despite positive growth prospects, the dairy sector's 'license to operate' is under threat. Mount-

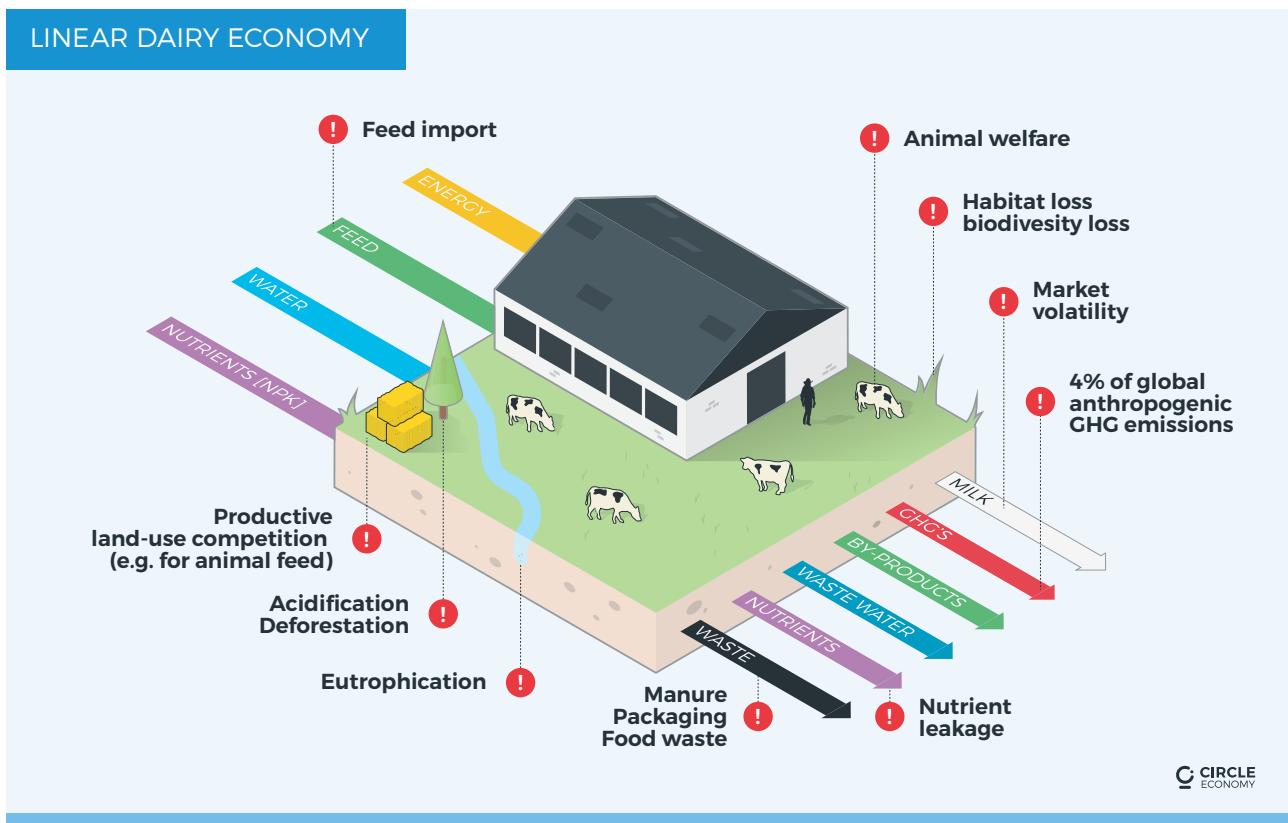
ing pressures are prompting actors across the value chain to revisit the sustainability of their operations.

Addressing key challenges, the Dairy Sustainability Framework (DSF) was established in 2013 as a common approach to drive continuous improvement of sustainability in the Dairy sector. The DSF now covers over a quarter of global dairy production, up 10% in a year.

Circular economy principles can help to reconcile competitiveness and sustainability

The circular economy seeks to decouple economic growth from the consumption of natural resources, to achieve net-positive impact that is regenerative. It is founded on resource-efficiency, the cycling of resources, value optimisation and the elimination of waste from industrial systems and can help reconcile economic competitiveness and sustainability.

This report explores circular dairy practices, from their current reality to their future potential. It further lays down the building blocks of a dairy sector that successfully activates key competitiveness levers to guide different farming practices toward the circular economy and thereby address many of the DSF's ambitions.

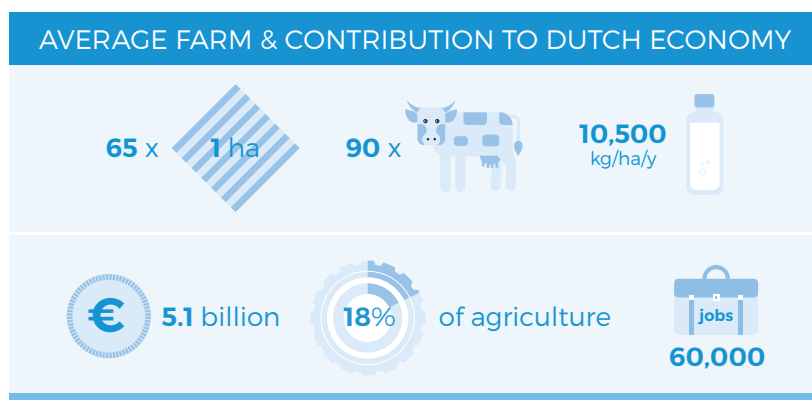




The Dutch dairy sector is suited to lead the circular dairy transition

The Netherlands has strong, historic ties to dairy farming. It benefits from a favourable environment, with a temperate climate suited for grazing and a plentiful supply of water, skilled workforce and supportive policies. These features have contributed to making the Netherlands an innovation leader.

Up until the 1960s, dairy farms were run by a large number of small, family farms practicing traditional, low-input farming and typically owning less than 10 heads of cattle. The sector has since gone through a spectacular transformation encouraged by favourable agricultural policies, market developments and other factors. Today, the Dutch dairy sector showcases an annual production of over 12.5 billion kilograms of milk by close to 18,000 farms owning 1.6 million cows, representing a gross value of over 5.1 billion euros. [↗](#)



Such numbers attest to the general trend toward intensification of dairy farming, yet the Dutch dairy sector remains diverse. The Dutch dairy tradition remains strong and smaller, more traditional farms now cohabit with intensive operations that leverage a full range of modern technologies.

Taking a step back: where does the (circular) dairy business model stand?

A transition to circularity will require circular dairy practices to be both profitable and resilient to changing markets and regulations, all while meeting sustainability obligations.

With high milk prices, intensive farming models have demonstrated their ability to generate high incomes for farmers. Their capital intensity, combined with current low prices, has however made it difficult for farmers to make ends meet. It is therefore necessary to identify which intensive farming practices are compatible with circular principles and how circular strategies can alleviate the vulnerabilities of intensive farming.

Conventional grazing models, on the other hand, have different requirements and can be more resilient to price fluctuations. Nonetheless, they also face significant challenges to meet sustainability imperatives, and understanding the levers that can close the gap in achieving a sustainable business case with more circular practices, is essential to enabling a transition.

CIRCULAR PRACTICES & VISION

Dairy farming is traditionally circular in concept

Dairy farming has traditionally featured circular practices for thousands of years, which provide robust foundations to build on. For example, if we consider the simple dairy cycle: soil nutrients enable grass to grow; cows graze on this grass in order to produce milk; the cow excretes urine and dung containing valuable nutrients; these nutrients are broken down by soil fauna and become available again for growing grass, closing the nutrient cycle. Dairy farming in the Netherlands often takes place on marginal (peat) lands, traditionally make use of food waste and valorizes many by-products such as whey.

Current dairy farming practices often utilise inputs to maximise productivity, and these inputs often come from far away and include mined

phosphorus and potassium. This has added complexity to the dairy cycle, resulting in adverse effects to the environment such as nutrient displacement and leakages, greenhouse gas emissions, intensive water use and wastes. However, shifting the dairy sector back to its circular roots is possible over time.

The Dairy Sustainability Framework already encourages circular dairy practices

Addressing key challenges, the Dairy Sustainability Framework (DSF) was established in 2013 as a common approach to drive continuous improvement of sustainability in the Dairy sector. The DSF identifies 11 different criterias within which specific goals and ambitions were established for the dairy sector. Six of these criterias focus on environmental aspects and are highly relevant to defining a circular dairy sector. Furthermore, a fully circular dairy sector will also create an environment for the remaining five socio-economic criteria to be realised. [↗](#)

DAIRY SUSTAINABLE FRAMEWORK & CIRCULARITY



Environmental criteria

Closed cycles and regenerative processes are at the heart of the circular economy. This involves:

- **Reducing** the use of synthetic fertilisers, imported feed and antibiotics
- **Recycling** nutrients from manure, water, wastes and other by-products such as whey
- **Extending** cow lifespans for high 'lifetime milk production' or expanding local feed production

Socio-economic criteria

The circular economy relies on continuous systemic improvements and cross value chain collaboration. This involves:

- **Innovating** with new technologies, business models and alternative revenue sources
- **Leading** by implementing best practices, sharing know-how, setting targets or raising awareness
- **Collaborating** with other farmers, researchers, consumers and other stakeholders



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'GROUND-BASED' DAIRY FARMING: A PERSPECTIVE ON BIOLOGY AND CIRCULARITY

In your opinion, what does circular dairy entail?

Dairy farms (and farming in general) are based on biodiversity, which enables our agricultural production systems. There is a tendency to think that we need to add chemistry before we optimise biology. That is wrong! First we have to optimise biology and then technology, chemistry and medicine can be used to resolve specific issues. If you do this right, you will create positive links with the land, water and climate and - importantly - improve animal health and milk quality.

How do you view current trends toward intensification in dairy farming?

I believe that dairy farming should be 'ground-bound'. This is easier in some places than others but there are many grasslands where this should be the approach. A second, intensive and stable-based system exists but, in such system, we should ask ourselves: why even use cows when we can produce industrial milk? The question is then to know how 'ground-bound' milk compares with industrial alternatives, but my belief is that ground-bound milk is the way forward, mainly because of the expected difference in milk quality.

Can extensive farming models meet global demand using available land?

This is of course something we must consider. First, I would say we need to have a better distribution of production to match demand. There is also a lot to be done re-

garding waste, as a major share of production is now lost in the system and we need to be critical of diets and make sure that we are addressing real needs, not just growth. Lastly, there remains a margin for improving yields without intensifying in many parts of the world.

What are your thoughts on manure valorization?

If we are talking about truly circular systems, then the 'soil-plant-animal-manure' cycle is key. Manure should be used on the land on which cows graze to feed the soil and its biodiversity, to sequester carbon and to optimize grass production. For intensive systems, it is true that valorizing manure nutrients is a step forward, but we have to recognise that this means valorizing imported feed. There are also efforts for methane capture and energy valorization, but that is a very inefficient system and should not be done. If we are trying to capture carbon, sequestration in soil is considerably more effective.

How do you see the way forward for circular dairy?

It is important to demonstrate the feasibility and viability of ground-bound models and there are great examples in the Netherlands. We must continue to do our best and export our knowledge to help others do things right. It is also important to recognise that there is a lot of inertia behind models that focus on optimising yields. We need to find a model that works for other actors such as banks, equipment manufacturers and cooperatives. Many powerful actors stand to lose in a transition, which is a huge barrier for change. ■



Examples already exist on-the-ground

Various circular initiatives and practices that can contribute to a circular dairy sector exist in the Netherlands. A selection of examples aligned with the environmental criteria of the DSF are presented below.



Greenhouse gas emissions

Greenhouse gas emissions across the full value chain are quantified and reduced through all, economically viable mechanisms. For example, Klimaatmeetlat is an interactive online tool that shows dairy farms their current level of greenhouse gas emissions, and proposes reduction measures. The Dutch dairy industry is increasingly using green electricity and gas, with targets to achieve 10% renewable gas and 100% renewable electricity by 2020.



Soil nutrients

Application of animal feed and fertilisers are managed to minimize impacts on water and air, while maintaining and enhancing soil quality. Examples in the Netherlands include KringloopWijzer, an online tool for farmers to monitor the nutrient cycle of animal feed, soil and fertilizer and better manage the use of minerals. 92% of the feed in the Netherlands already consists of grass and corn from farmers' own land or from nearby farms, minimising the need for imported animal feed and thereby the risk for land use change and impact on the soil abroad.



Waste generation

Wastes from dairy farming are minimised and, where unavoidable, waste is reused and recycled. Dairy farms in the Netherlands are working with bioenergy companies to install waste digesters that process manure into biogas for the national grid. In addition, 20% of the waste and by-products from the food industry are used as feed for dairy cows in the Netherlands, minimising waste generation beyond just the dairy sector.



Water

Water availability, as well as water quality, is managed responsibly throughout the dairy value chain. For example, Doc Kaas, a dairy cooperative that processes milk into cheese, ensures that water extracted during the cheesemaking process is recycled and used as cooling water and for sanitary purposes. As a result, DOC Kaas is entirely self-reliant in terms of water.



Soil

Soil quality and retention is proactively managed and enhanced to ensure optimal productivity. In the Netherlands, grazing traditionally takes place on marginal lands - peatland and poor sandy soils - where hardly any other agricultural activities are possible. This ensures that land use is optimised and more productive lands maintain their soil quality.



Biodiversity

Direct and indirect biodiversity risks and opportunities are understood, and strategies to maintain or enhance biodiversity are established. FrieslandCampina, WWF and Rabobank are collaborating to develop a monitor for dairy farm biodiversity. The initiative's aim is to make sure all dairy farmers complying with these metrics are eligible for green financing and government benefits.

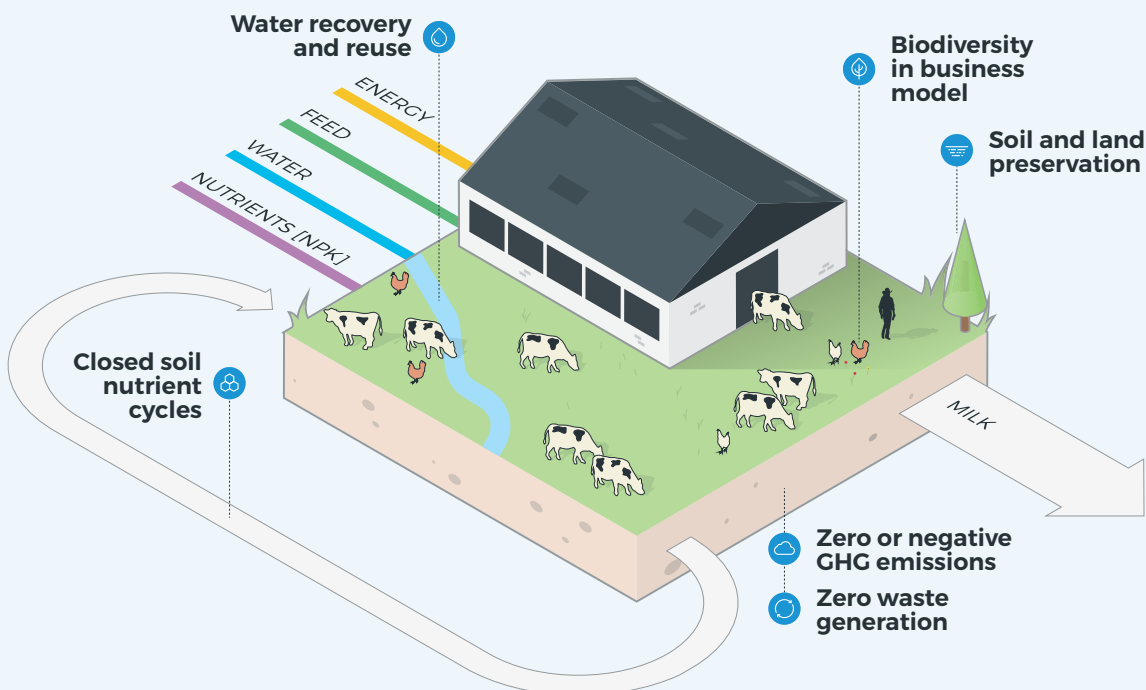
A truly circular dairy sector achieves net-positive impact

A circular dairy sector is focused on closing resource loops within dairy operations and enhancing natural capital. This means going beyond mitigation to achieve a net-positive impact that supports regeneration of landscapes and ecosystems. The characteristics of a truly circular dairy sector exceed the circular economy related aspects of the Dairy Sustainability Framework.

In the Netherlands, greenhouse gas emissions, nutrient cycles and biodiversity are key to understanding the performance of different farm types. Soil and land preservation, water and waste at the individual farm level are indeed less of an issue given the country's environmental characteristics and regulatory landscape.

CIRCULAR DAIRY VISION

- Zero or negative GHG emissions** Net greenhouse gas emissions, including carbon sequestration, across a full dairy value chain are zero, or even negative.
- Closed soil nutrient cycles** Nutrients extracted from the soil are returned to the same soils, without leakage to the environment, and nutrient levels are carefully optimised to reduce the use of artificial fertilisers.
- Zero waste generation** There is no waste from dairy operations and all waste streams are treated and reused or recycled to maximise value recovery.
- Water recovery and reuse** Dairy cows do not prohibit renewable freshwater availability for human food production.
- Soil and land preservation** Dairy farming does not constrain available arable land for human food production, does not drive land use change and deforestation and has positive impact on the resilience of agriculture landscapes.
- Biodiversity in business model** Soil, landscape and natural biodiversity are prioritised and incorporated in the farm's business model.





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LEVERAGING TECHNOLOGY FOR COWS AND FARMS

What work do you conduct at Courage?

Courage works on multiple projects regarding the dairy farm and dairy-chain. In one of our projects e.g. we are trying to develop a governance model for biodiversity in dairy farming, focusing on landscapes and nature. The real challenge is making this “non-functional” biodiversity important to farmers since it doesn’t impact farmer income but is important to preserve and manage their farms.

What is your perspective on circular dairy?

For agriculture worldwide circularity is a survival strategy. In the Netherlands we should aspire to be the World Dairy Lab for circular, high quality dairy farming. However, full circularity might be a step too far and depends on your scope and framing and is possibly not necessary. In circular dairy, farmers have two natural assets, the cow and the land. The farming system should be modelled with the focus on using these assets for their natural strength. Circular dairy farming is impossible without a focus on the land to improve soil quality and fertility, as well as maintain soil biodiversity through efficient and optimal soil management and nutrient cycling. This will optimise crop production per hectare and reduce import of feed and fertilisers. On the other hand circular dairy farming should focus on the cow, with respect to the animal’s integrity and utilising its natural resilience.

How do you see the role of technology in dairy farming?

With the Floating Farm in which we incorporated our concept of the Cow Garden, we try to turn the traditional dairy farm system on its head. First: instead of fitting the cow into a system, we designed the system and technologies around the cow. So for the cow we create an environment that comes close to its natural habitat, biological needs and behaviour as possible. Second: we try to maximise the efficiency of all the nutrient flows around the cow with the help of the latest high-tech regarding manure refin-

ery and indoor LED-based feed-production. In this way we aim to create a new type of ultra-circular dairy farm system, that has major positive effects on land-use, water-use, biodiversity and climate change. These are all topics the sector is struggling with worldwide. We hope the innovations coming from this concept can be integrated into existing dairy farming practices.

With all this innovation, do you need a cow to produce milk?

There are start-ups in Silicon Valley working on the development of milk produced without the cow. To me, this represents the extreme end of completely industrialised food production. I expect that these developments will grow and for a big market to develop for this kind of cow-free milk, but there will still be milk produced from cows. People like ‘the real thing’, authentic quality and people like to be surrounded by animals. These will be big selling points for traditional farmers in the face of cow-free milk. There is also a quality aspect of milk from cows, which traditional dairy farmers will have to highlight over cow-free milk.

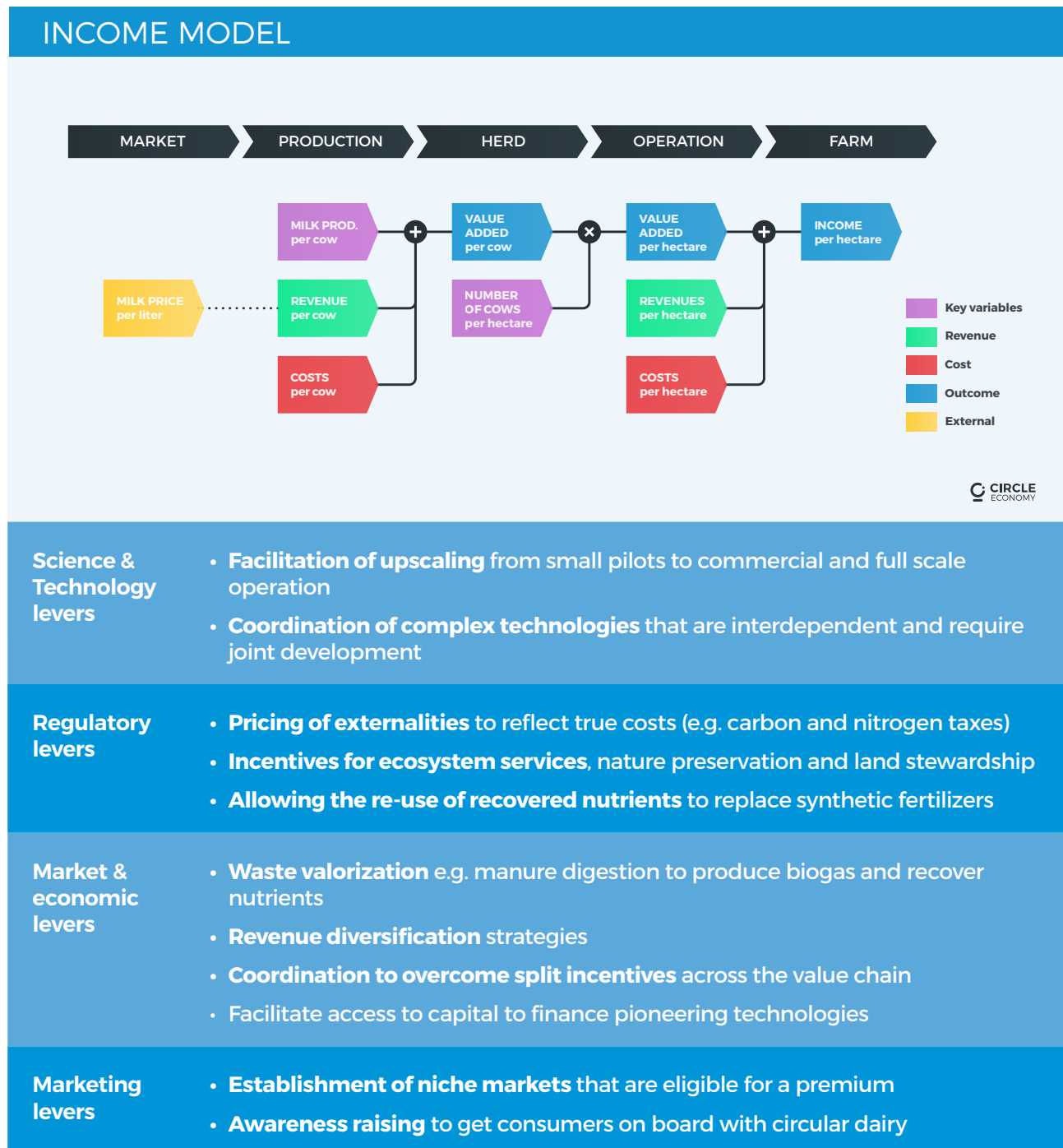
How do you view current trends toward intensification in dairy farming?

Global trends are shifting agriculture to become increasingly industrialised and commoditised. This is not a good pathway when we as a society handle and trade feed and grains and animals like we trade and handle industrial products and resources. Farmers used to have special policies in trade, tax, legislation etc. since agriculture was considered to be different from production system. Treating agriculture like a random industrial business leaves us with a purely industrial food system. And the negative effects of such a system can be seen on every continent. These pressures are making farmers conflicted - on the one hand you have a need for biodiversity, proper land use, nature conservation, and animal welfare, while on the other you have increasing industrialisation and liberalisation of markets. In my opinion, agriculture is considered closer to nature than industry. Food is not a car or an iPhone. Dairy is and should be conducive to life and promote health and wellbeing, and as such there is an urgent need to rethink agriculture and the whole food system. ■

TRANSITION PATHWAYS

Circular dairy farming strategies require strategic levers to be activated to become competitive

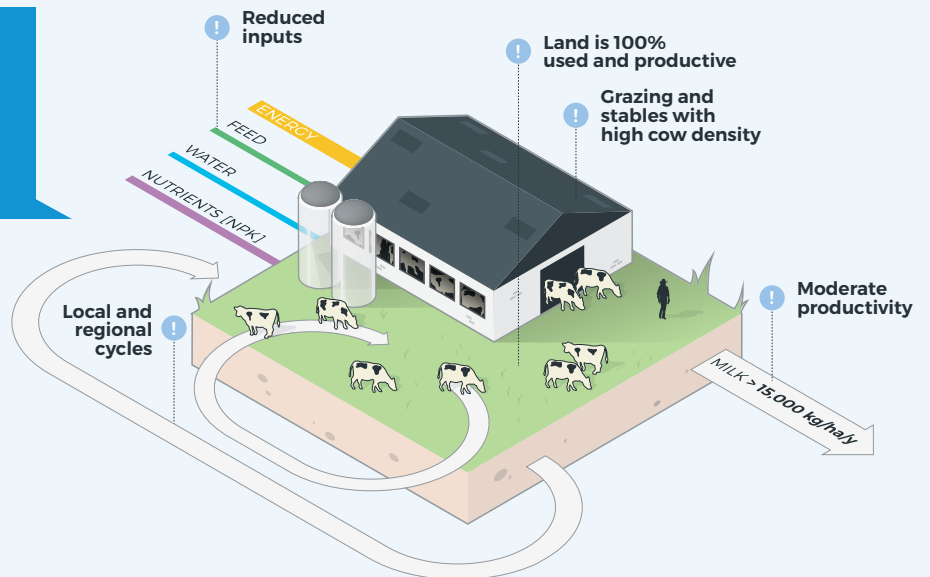
As showcased earlier, many circular dairy practices are already being implemented. Scaling these up is however difficult and strategic levers must be activated to consolidate the business case by shifting the cost and revenue balance of milk production and farm operations. In some cases, these practices may also influence milk prices by enabling differentiation strategies and consumer marketing. They further rely on or affect key variables in dairy farming systems such as herd density (i.e. cows per hectare) and productivity (i.e. milk produced per hectare per year).



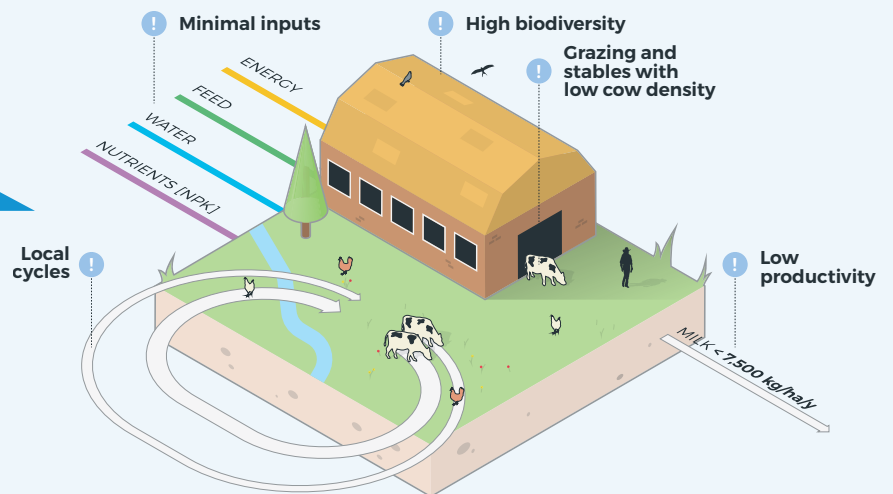
Different farming models require different transition strategies

Dairy farming in the Netherlands is far from monolithic and a transition to the circular economy must embrace this diversity. This report proposes three archetype pathways, illustrated below and described on the following pages.

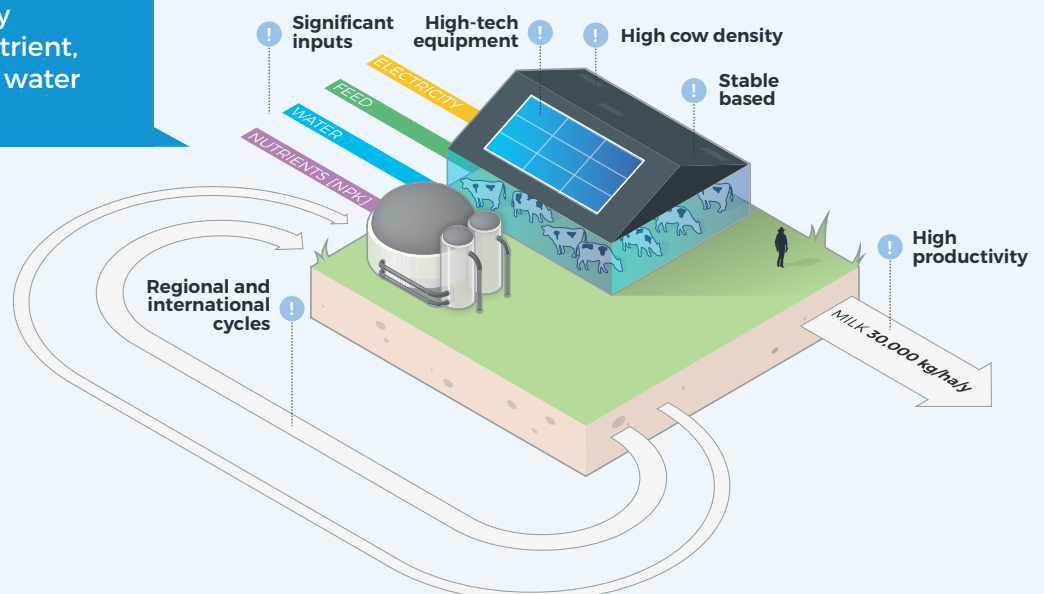
OPTIMISED GRAZING maximises land productivity while leveraging biological and technological processes to achieve circularity.



EXTENSIVE GRAZING is inspired by biological processes and organic farming to close the soil-plant-animal-manure cycle locally.








INTENSIVE HIGH-TECH leverages technology solutions to close nutrient, greenhouse gas and water cycles.



Pathway 1 OPTIMISED GRAZING

The first pathway seeks to make optimal use of the land to achieve high productivity. Such an approach can achieve a good level of circularity by combining biological processes with technical approaches to ensure high nutrient efficiency and close key cycles. It is however based on optimised land productivity, which leaves little room for the integration of biodiversity into farming models.

Key strengths of this pathway include alignment with the Dutch dairy sector's conventional practices, and ability to generate high yields and a good business case without significant changes to current markets and policies. The success of such a pathway requires technology levers to be activated such that greenhouse gas emissions and nutrients can be recovered from manure and productivity can be optimised. It also requires economic fine-tuning of the cost-revenue balance. A remaining challenge is that significant improvements from current practices are needed, which rely on a high level of farmer expertise. Achieving full circularity will also require the addition of landscape elements (e.g. trees), which implies productivity trade-offs or a revenue model for these landscape elements.

	Circularity indicators	Optimised grazing
Circularity potential	Nutrient cycle	
	GHG cycle	
	Biodiversity	
Productivity & business	Best practice productivity	 > 15,000 kg/ha/y
	Capital intensity	 Low
	Key levers	Farm economics Technology
Farmers & value chain	Farmer profiles	'Virtue' farmers
	Value chain	Preserved role Regional

CASE STUDY ENHANCED FERTILISATION PILOT WITH 250 FARMERS

Vruchtbare Kringloop Achterhoek (VKA) is a collaborative initiative of farmers' federation LTO Noord, Rabobank, FrieslandCampina, the province of Gelderland, drinking water supplier Vitens, water board Waterschap Rijn en IJssel and the multinational ForFarmers. The two year project involved 250 farmers and ran from 2013 to 2015. The aim was improve soil fertility and the quality of ground and surface water by reducing the leakage of phosphorus and nitrogen. This was done through more timely feeding and tailor made diets, and by inducing higher yields of feed crops to reduce the surplus of minerals in the soil.






As a result of this initiative, the phosphorus surplus on the farms has been eliminated and the nitrogen surplus of the soil was reduced by 9%. The 25% best performing companies used 100% of the phosphates and 48% of the nitrogen. As a consequence, milk production and the number of cows increased on average by 10%. Milk production increased on average by 6% to 19.000 kg of milk per hectare, while the cost of disposing of excess manure decreased due to the increased on-farm use.

The success of VKA can in part be attributed to the technical expertise offered by the project partners and external experts. The KringloopWijzer, a farm management tool that allows for monitoring the two mineral cycles, also played a vital role.

Pathway 2 EXTENSIVE GRAZING

The extensive grazing pathway prioritises biological processes to close the soil-plant-animal-manure cycle on the farm, and promotes holistic integration of biodiversity within farm operations. Input use is limited to curative measures, and this pathway is best positioned to achieve full circularity. It performs particularly well with nutrient cycles and biodiversity but relies on carbon sequestration in soils, which cannot fully close the greenhouse gas cycle.

While this model results in a significant reduction of the capital intensity and input costs, this does not fully compensate for smaller herds and lower yields that the land can support. As such, this pathway requires regulatory and economic levers that price externalities or reward ecosystem services and land stewardship. Consumer marketing levers are also a promising avenue to consolidate the business case, as extensive grazing models are well suited to product differentiation and niche markets.

Circularity indicators		Extensive grazing
Circularity potential	Nutrient cycle	
	GHG cycle	
	Biodiversity	
Productivity & business	Best practice productivity	 < 7,500 kg/ha/y
	Capital intensity	 Moderate
	Key levers	Regulation Consumer marketing
Farmers & value chain	Farmer profiles	'Rights' farmers
	Value chain	Smaller role Local

CASE STUDY ORGANICALLY PRODUCED MILK SOLD AT A PREMIUM AND LOCAL FEED PRODUCTION

On the island of Schiermonnikoog a group of seven farmers have formed a cooperative based on extensive cow farming. Their aim is to shift to only locally sourced fodder, turn fully organic and set up a resilient, independent dairy company. Minimal dependence on external inputs like compound feed combined with higher biodiversity is expected to ensure a greater stability in feed production. This will also contribute to lowering the levels of nitrogen deposition – a major challenge on the island.






Currently the farms have an average size of 54 ha (including located on the mainland) with 91 cows and 765,000 kg milk. Extensive grazing will be required to shift to a new, more circular system. For this reason, the farmers have agreed to reduce their combined herd from 640 to 330 cows. Milk production per cow will decrease from 8.365 to 7.270 kg. In this scenario, the total production will drop from 5.4 million to 2.4 million million liters of milk.

For the business case to work, close cooperation between farmers and stakeholders in the value chain is needed. Milk needs to be sold at a long-term price premium of at least 10 cents above the price of normal milk by virtue of an organic or local food label. Ideally, the milk is processed in a local factory which would require an additional investment of 1 million euro. The necessary initial investments may come from a public fund, the Waddenfonds, and possibly through a green investment scheme from Rabobank.

Pathway 3 INTENSIVE HIGH-TECH

The intensive high-tech pathway relies on technology to achieve circularity. Best practices have shown strong performance on key circularity indicators, with biodigesters and methane capture for example, limiting greenhouse gas emissions and allowing for efficient nutrient recovery. This pathway however, typically requires significant inputs, which means circularity is only achievable at regional or international scales, and biodiversity considerations are largely inapplicable.

Technology levers are pivotal to this pathway, both to enable the closure of key cycles, and to allow scaling and cost reductions. Regulatory shifts are also needed, for instance to permit the re-use of nutrients recovered from manure in lieu of synthetic fertilizers. Being more capital intensive, this pathway is less resilient to price shocks. Its acceptance by consumers is also in question in light of animal welfare concerns. Lastly, questions should be explored regarding the long term competitiveness compared to emerging technologies to produce 'animal-less' milk on industrial scales.

Circularity indicators		Intensive high-tech
Circularity potential	Nutrient cycle	
	GHG cycle	
	Biodiversity	
Productivity & business	Best practice productivity	 30,000 kg/ha/y
	Capital intensity	 High
	Key levers	Technology Regulation
Farmers & value chain	Farmer profiles	'Utility' farmers
	Value chain	Greater role International

CASE STUDY **LANDLESS FARMS CAN CLOSE CYCLES WITH TECHNOLOGY**

A high-tech, stable-based production farm, the Floating Farm, aims to be an innovation lab to research and develop the optimal process of food production, energy and water handling and waste-treatment. The concept also aims to close the distance between consumers and farmers and educate consumers on the innovative processes of milk handling, animal welfare, and high-tech robotics.

The technologies and methods employed in the Floating Farm include urine capture and manure collection robots via separate streams for more efficient biogas production; milking robots; indoor farming of high-nutrient grass with LED technology; wastewater capture, recycling and reuse; and solar panels and renewable energy generation. Animal welfare is prioritised and calves and young stock are raised on a nearby nature reserve to promote biodiversity through grazing.

The farm is expected to be operational in 2017 in Rotterdam, with plans to expand this model to other cities. The innovations and technology coming from the Floating Farm will be carefully studied and developed into integrated technology units that can be utilised on normal farms worldwide.

FARMER AND VALUE CHAIN PERSPECTIVE

Farmer values and management practices should also be considered

A transition to circularity will not be possible at scale in the absence of a business case. It is however also important to consider non-economic factors such as farmer profiles, management styles and craftsmanship. Researchers at Wageningen Economic Research (LEI) identified three value-based farming systems that can be applied to the proposed pathways. [↗](#)

- **'Virtue'** farmers take a practical approach to farming, building on traditional values and focusing on effort and learning, which matches the conventional grazing pathway.
- **'Rights'** farmers focus on obligations to fairly consider farmer labour and income, consumers, animal welfare, biodiversity, etc. This value system is related to the extensive grazing pathway.
- **'Utility'** farmers, focus on the costs and benefits and use hard performance indicators, which typically results in the adoption of high-tech practices in line with the intensive pathway.

Farm economics will also need to be complemented by other elements. The **RESET** framework illustrates drivers for change, including: the required **R**ules; **E**ducation to support capacity building, **S**ocial norms that influence farmer decisions; **E**conomics, for example behind the business case; and **T**ools to practically facilitate change.

Enabling cooperation among farmer communities is also essential so that the best practitioners can lead the transition. Approaches, such as Awareness-Based-Collective action (ABC), can trigger normative changes that promote creativity, risk-taking and rapid 'fail-learn-improve' cycles, which could help scale-up best practices and develop 'next-practices'.

A transition to circular dairy will also impact the broader value chain and face systemic inertia

Many of the impacts of the dairy sector take place at the farm level. The dairy sector's value chain however includes other actors that must be involved in the transition to circular practices. Upstream, stakeholders include feed and fertilizer producers, technology and equipment suppliers and financing partners. Downstream, cooperatives, dairy product manufacturers, distribution partners and consumer brands also play important roles.

The transition to circular dairy farming will affect the value chain and it is important to consider who stands to win or lose, and to find solutions that tackle systemic inertia. For example, a focus on extensive models that have a lower reliance on inputs and technology could have negative impacts on feed and equipment suppliers. On the other hand, a shift to high-tech and more capital intensive systems would likely increase the role of technology suppliers and financing actors in the system.

Additionally, the proposed pathways have geographic implications. In optimised grazing systems, collaboration at regional levels is needed to maximise land productivity while closing cycles at scales that are as small as possible. Extensive grazing systems, on the other hand promote local circularity and would imply better balance of production and demand. Lastly, intensive and high-tech systems require significant inputs and would therefore play to a global market.



WAY FORWARD

Multiple pathways to circular dairy are possible and face different challenges

Three archetype pathways towards circularity were identified that can achieve a net-positive impact on the planet and communities over time. In line with their current state and the issues described above, it is clear that each of these pathways faces its own challenges:

- **Optimised grazing** is an improvement from current practices, but does not yet fully close nutrient and greenhouse gas cycles. It performs well from a functional (soil) biodiversity perspective, but does not promote landscape restoration. Improved governance and revenue models, promoting ecosystem services, are needed for farmers to progress and achieve circularity.

- **Extensive grazing** is the closest pathway to being fully circular and 'net positive'. Productivity is substantially lower than the Dutch average, but still higher than the global average, meaning it could drive 'ecological intensification'. The business case is a hurdle, requiring higher milk prices and incentives for ecosystem services and/or taxing of externalities of conventional farming models.

- **Intensive high-tech** can potentially achieve full circularity, but is still in the early development stage and technology scale-up is needed to analyse how competitive it would be compared to other pathways. Issues include animal welfare, consumer perception and long-term competitiveness with new, 'animal-less', industrial systems.

Circularity indicators		Optimised grazing	Extensive grazing	Intensive high-tech
Circularity potential	Nutrient cycle			
	GHG cycle			
	Biodiversity			
Productivity & business	Best practice productivity	 > 15,000 kg/ha/y	 < 7,500 kg/ha/y	 30,000 kg/ha/y
	Capital intensity	 Low	 Moderate	 High
	Key levers	Farm economics Technology	Regulation Consumer marketing	Technology Regulation
Farmers & value chain	Farmer profiles	'Virtue' farmers	'Rights' farmers	'Utility' farmers
	Value chain	Preserved role Regional	Smaller role Local	Greater role International

MORE RESEARCH IS NEEDED TO PUT FARMERS IN THE DRIVING SEAT OF THE TRANSITION TO CIRCULAR DAIRY

In order to attain a truly circular global dairy sector, further work is needed to improve the exploration presented in this report. Pathways should be broadened to cover, for example, developing and emerging economy contexts, extensive grazing with large herds on large land areas, highly intensive systems with up to thousands of cows per farm and water stressed areas. Research is also needed to deepen the analysis of different pathways, comparing their economic, social and environmental performance, identifying strategic levers that can be activated to make circular dairy farming competitive, and ensuring their feasibility and relevance at regional and local scales around the world.

It is also evident that practical steps must be taken to ensure farmers are in the driving seat, as any successful transition will rely on actionable, collaborative approaches taken on the ground. While this report provides exploratory insights into the pathways that could enable the transition to circular dairy, subsequent steps will require the contribution of best practitioners and collaboration with the broader value chain.





About this report

The report has been commissioned by FrieslandCampina.

About Circle Economy

A social enterprise, we accelerate the transition to circularity through the development of practical and scalable solutions. Our tools and programs are designed to facilitate decision making and action plans for businesses and governments in a wide range of sectors.

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Publication date

October 2016



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