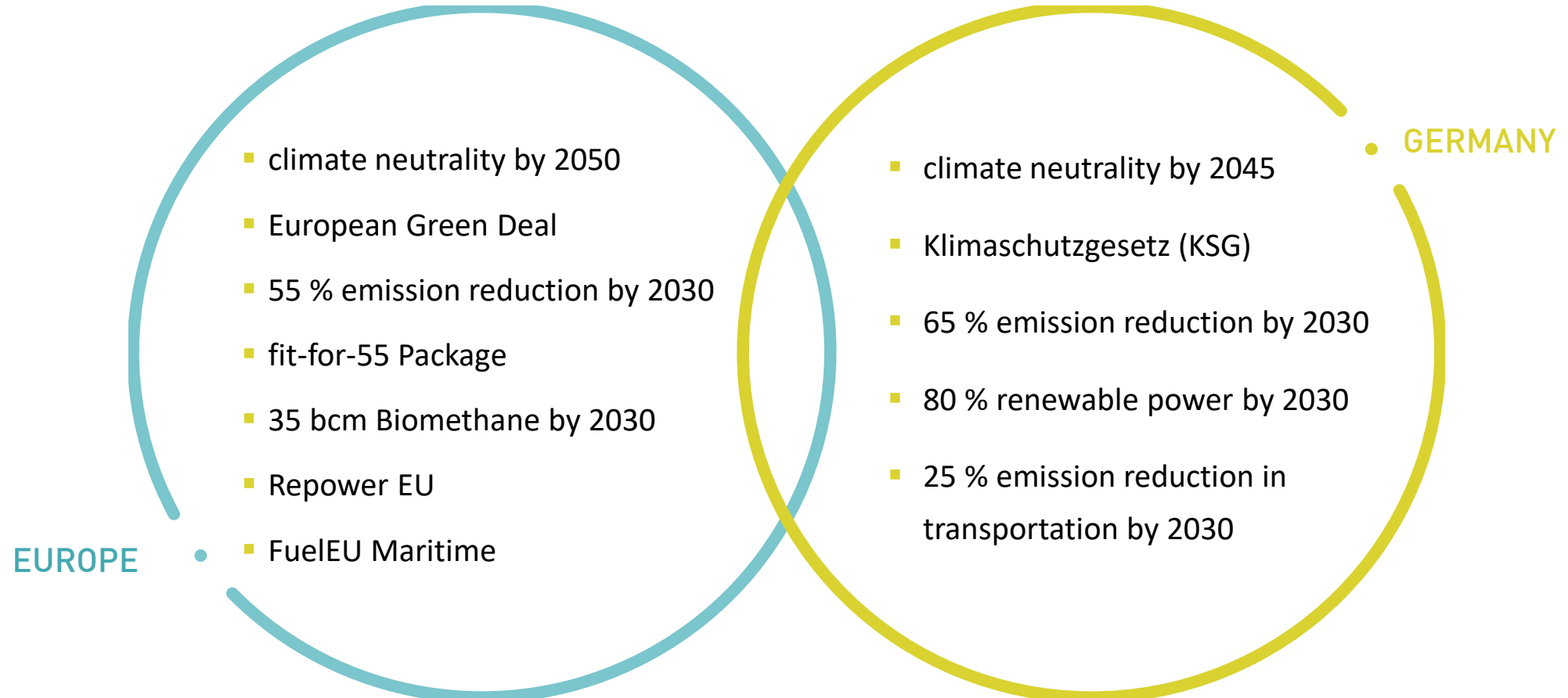


A scenic photograph of a rural landscape. In the foreground, there is a field of tall grasses. A dirt path winds through the field on the right side. In the background, there is a dense forest of trees. The sun is low in the sky, creating a bright glow and lens flare effects across the scene.

POWERING A CLIMATE-POSITIVE FUTURE: UNLOCKING THE POTENTIAL BEHIND BIOMETHANE WITH CARBON CAPTURE

John Cosmo Dwelle | Head of Business Development and Operations | Landwärme GmbH
Carbon Capture Storage and Reuse 2024 | 15th of May 2024

WHAT WE HAVE SIGNED UP FOR - TARGETS, TARGETS, AMBITIOUS TARGETS



WHERE WE ARE ON THIS JOURNEY



TECHNOLOGICALLY

- maturity of some technologies
- challenges of others
- Infrastructure is lagging behind

POLITICALLY

- camps of extremists
- different advancement options are tested individually and therefore the search continues often times blindered
- high bureaucratic burden slows development

A photograph of a dirt path winding through a field of tall, golden-brown grass. A small, faint rainbow is visible on the path. A semi-transparent teal banner is overlaid on the bottom half of the image.

A PATH FORWARD – CARBON MANAGEMENT

REQUIREMENTS FOR CARBON CAPTURE



**HARD-TO-ABATE
EMISSIONS**



**TECHNICAL
NEGATIVE EMISSIONS**



**NATURAL
CARBON REMOVALS**

REQUIREMENTS FOR CO₂ TRANSPORTATION

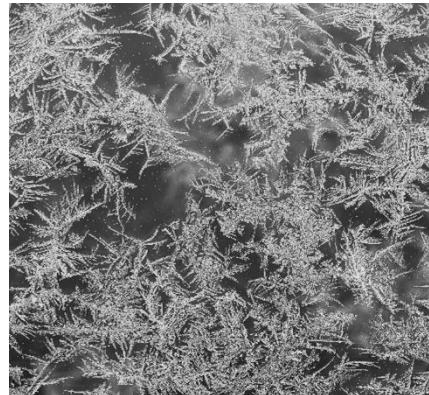


CO₂ transport needs to be multimodal: Integrating grid, road, rail, ship and storage hubs

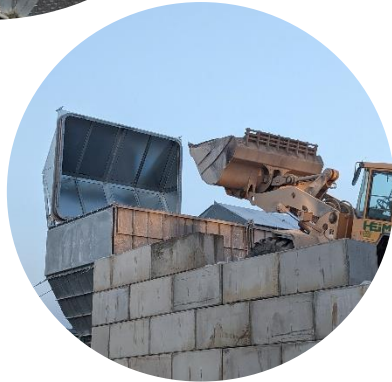
REQUIREMENTS FOR CO₂ USAGE



CO₂-Usage



REQUIREMENTS FOR CO₂ STORAGE



Storages permanently hold captured and recycled CO₂ and prevent its release into the atmosphere

STEP-BY-STEP



technology-neutral progression
of all options



on a level playing field

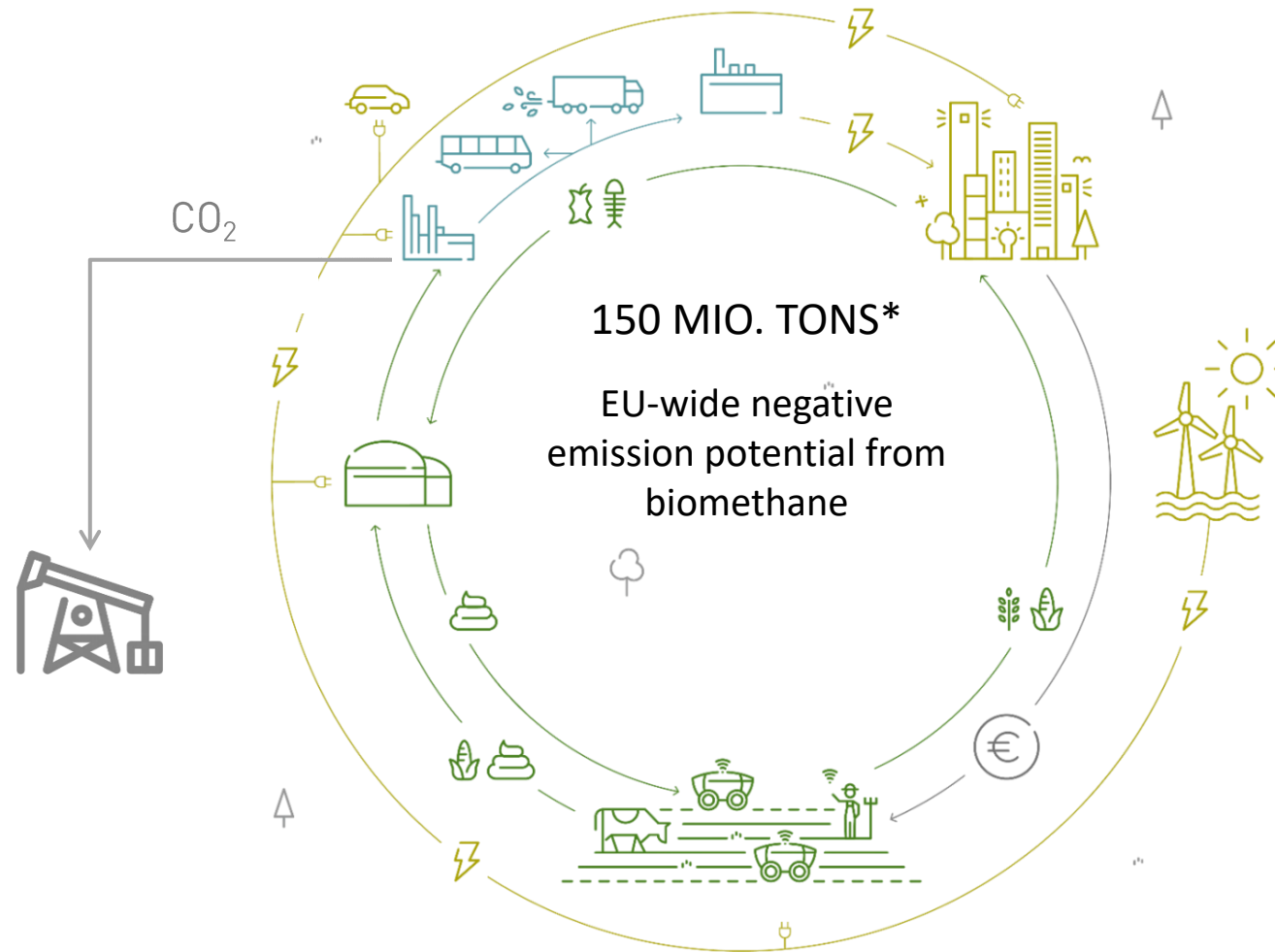


according to availability and cost

A wide-angle photograph of a rolling landscape under a sunset sky. The sun is low on the horizon, casting a warm, golden glow over the hills. The foreground and middle ground are filled with green fields, some of which appear to be rapeseed. The hills recede into the distance, creating a sense of depth. A semi-transparent teal banner is overlaid across the middle of the image, containing the text "WITH A LITTLE HELP FROM BIOMETHANE".

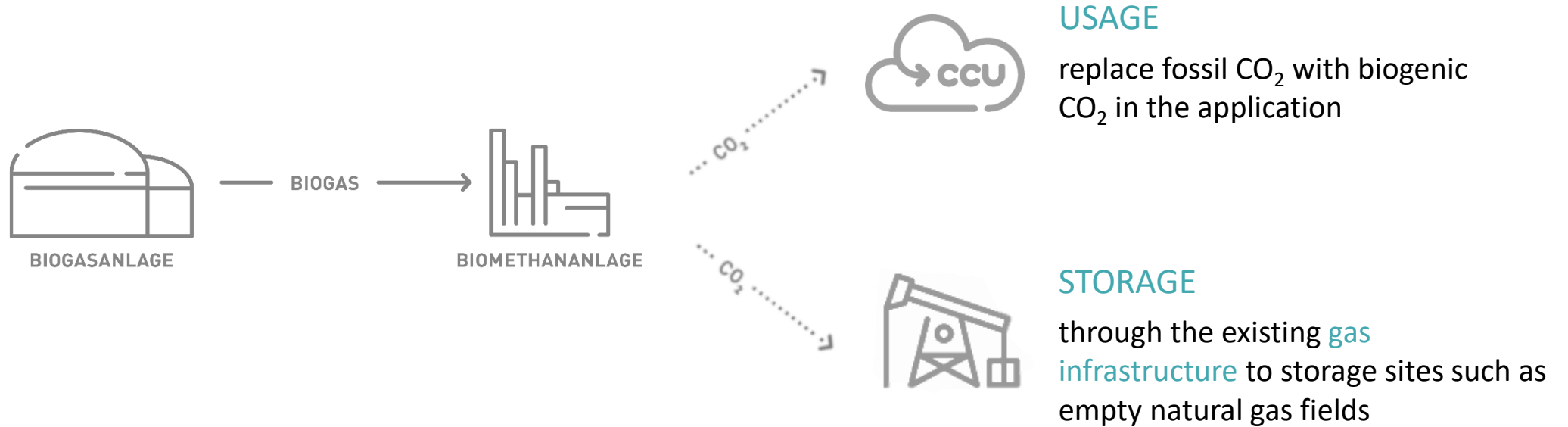
WITH A LITTLE HELP FROM BIOMETHANE

BIOMETHANE WITH CCS ALLOWS US TO GO BEYOND NET ZERO



*yearly, slightly more than the Netherlands' emissions in 2021

CCS AT BIOMETHANE PLANTS IS AN EFFECTIVE WAY TO DECARBONIZE THE ATMOSPHERE



CARBON CAPTURE is already part of biomethane production

Biomethane + CCS has enormous potential to combine carbon removal & energy supply

EUROPEAN STORAGE INFRASTRUCTURE DEVELOPMENT

- oil and natural gas fields as optimal CO₂ storage sites
- storage in rock through mineralization
- storage in products with permanent binding as solids
- detailed monitoring concepts ensure permanence
- incentives for Carbon Removal in Development


Storage: permanent final repository for captured and recycled CO₂



CCU – MAKING USE OF BIOGENIC CO₂ IN NEW APPLICATIONS

Carbon Usage can be achievable at high levels of purity in plants with stable production.



 **SYNTHETIC FUELS:** Often produced directly on-site in adjacent reactor

Most prevalent use cases (food and beverage industry) require certification and monitoring, as well as stable, crop-based substrate input. Emerging utilization options broaden the scope of applications for renewable CO₂.

CHALLENGES AROUND CCS AND CCU AT THE BIOMETHANE PRODUCTION

DECENTRAL PRODUCTION AND LOGISTICS

- nearly 1,000 existing biomethane sites
- wide range: 1,000 – 50,000 t of CO₂ p.a.
- 5,000 – 10,000 new sites for 35 bcm
- average size will be ~10,000 of CO₂ p.a.



STANDARDS AND TRANSPORT MODES

- liquid carbon standard and analytics for usage
- truck based transportation is status quo
- grid based transport for Mt scale storage more efficient and ecological
- unclear linkage between decentral production and backbone carbon grid



A wide-angle landscape photograph of rolling green hills under a bright, hazy sky. The sun is low on the horizon, creating a warm, golden glow. The hills are covered in lush green grass and some yellow wildflowers. A few small trees are scattered across the landscape.

LANDWÄRME: LIGHTHOUSE PROJECTS

AS A LEADING BIOMETHANE TRADER IN EUROPE, LANDWÄRME CONNECTS PRODUCER & CONSUMER



BIOMETHANE PRODUCTION

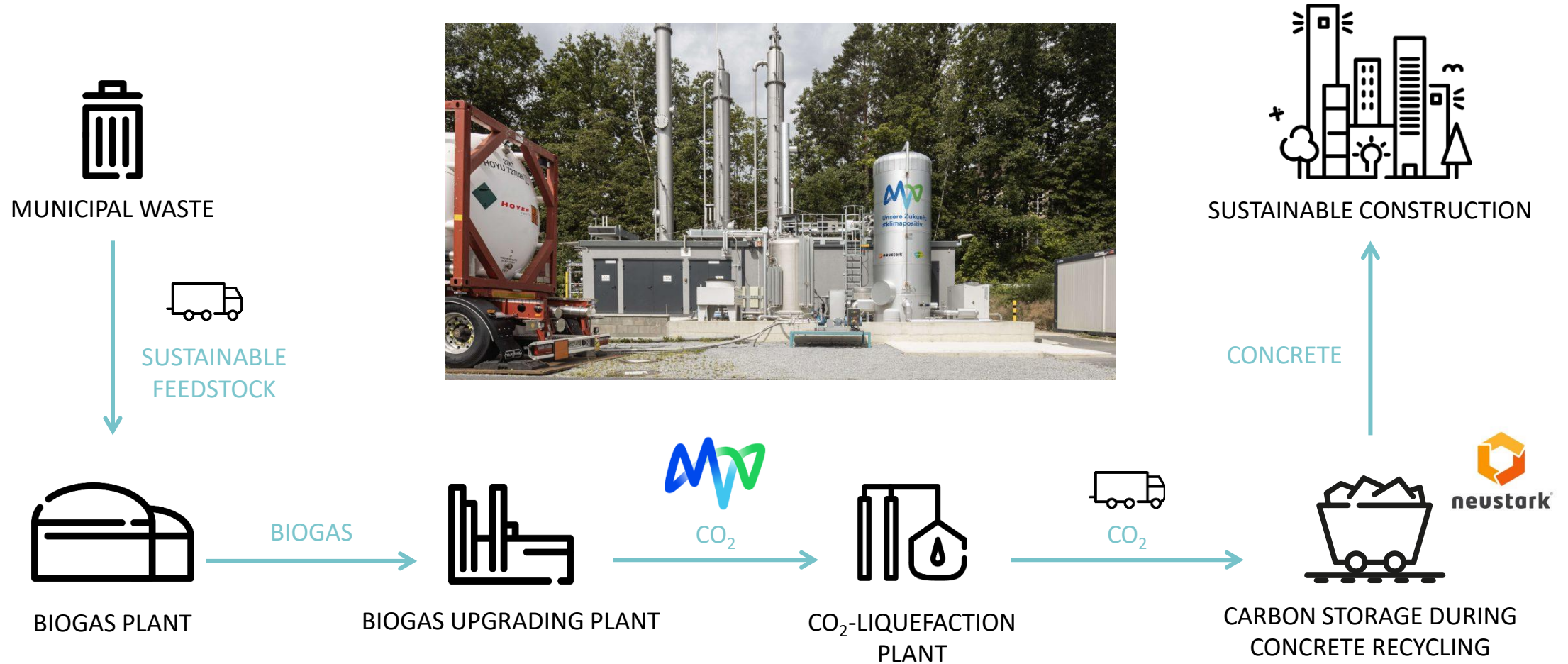
TRADING

SERVICES

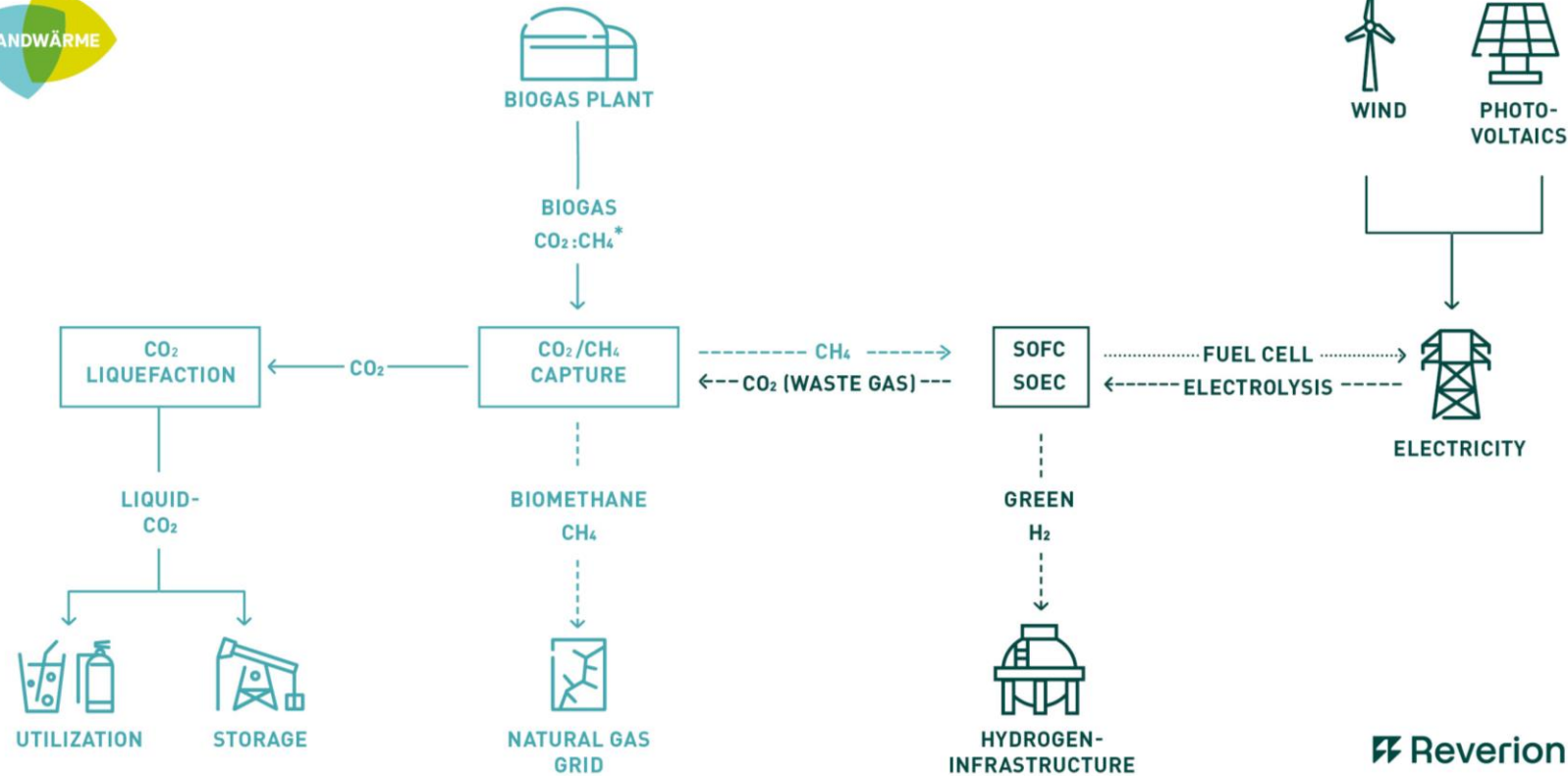


From our offices in Berlin, Budapest, Dortmund and Munich, a team of 100 + manages a portfolio of over 3,5 TWh and supplies more than 300 utilities & consumers with biomethane.

CARBON MANAGEMENT IN PRACTICE: CO₂ TO CONCRETE IN DRESDEN AND BERLIN



THE ENERGY TRIAD IN ACTION: GREEN ENERGY HUB IN REIMLINGEN

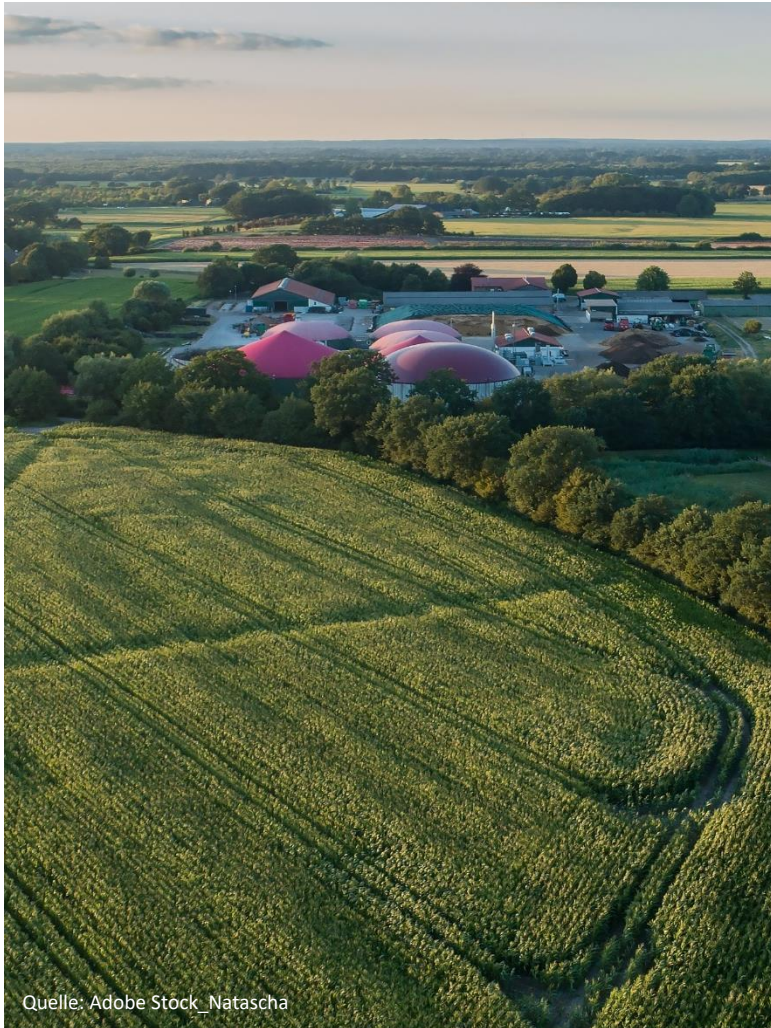


*50:50

..... Balancing fluctuating renewables with CO₂-negative bioenergy

--- Long-term energy storage with green Hydrogen generation

A FRAMEWORK FOR SUCCESSFUL IMPLEMENTATION OF BECCUS



Quelle: Adobe Stock_Natascha

BINDING TARGETS & FRAMEWORK

- binding targets for carbon cycles and -removal
- timely implementation of a reliable framework in all member states
- alignment of CCUS framework across European legislation

FINANCE

- financial commitment dedicated to net zero projects
- transparent market for carbon certificates

PERMITTING AND CERTIFICATION

- fair and timely permitting processes for renewable projects and CCS
- uniform, transparent methodology for certification

INFRASTRUCTURE & INDUSTRY

- robust European backbone infrastructure
- consideration for industry clusters as well as smaller sources
- transparent requirements for different CO₂ utilization options



BIOMETHANE WITH CCUS MIGHT ONLY BE ONE OF
MANY VIABLE OPTIONS TO REACH OUR COMMON GOALS.

IT MOST DEFINITELY IS ONE OF THE FASTEST.

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