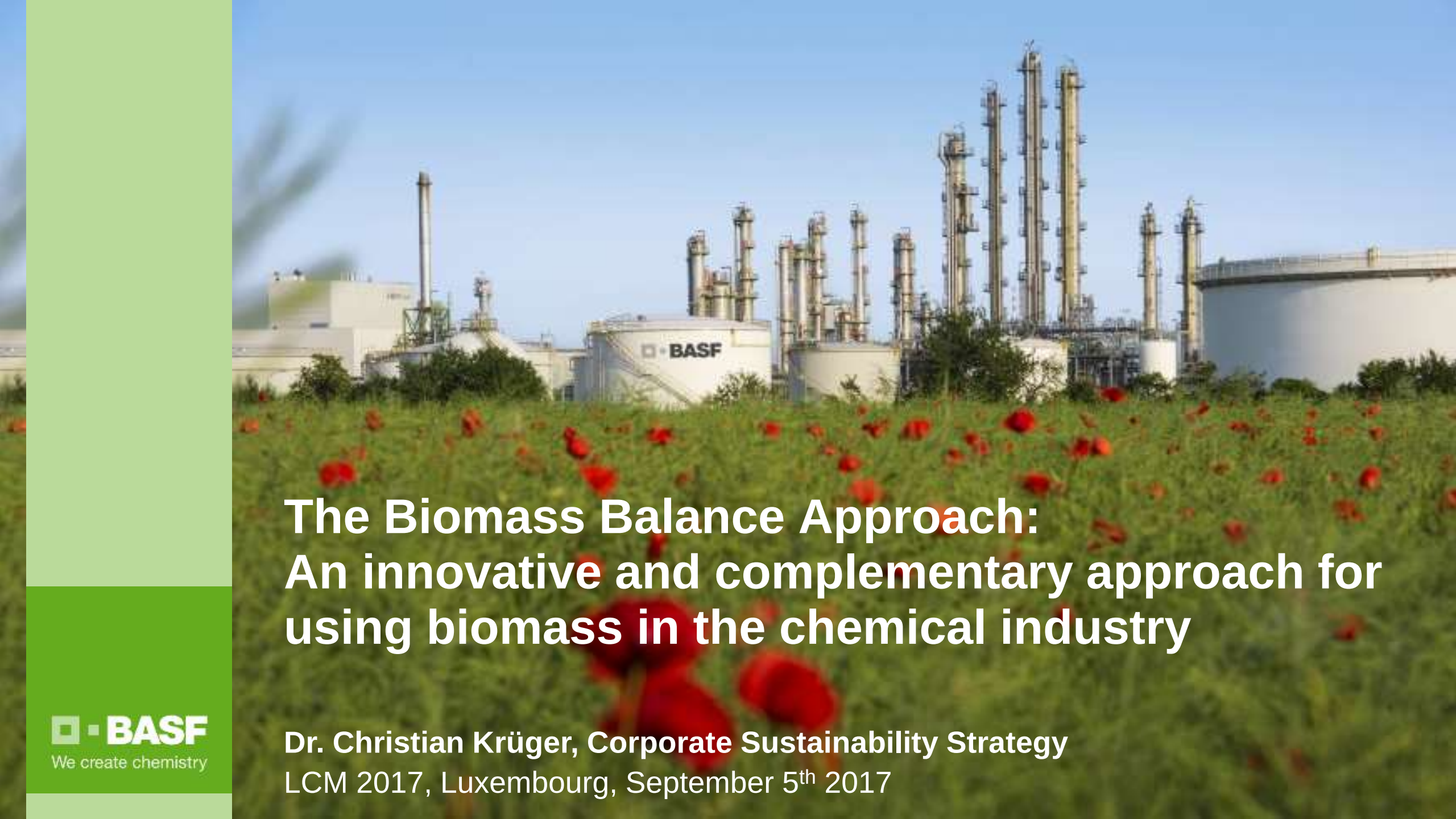


# The Biomass Balance Approach: An innovative and complementary approach for using biomass in the chemical industry

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LCM 2017, Luxembourg, September 5th 2017

BASF
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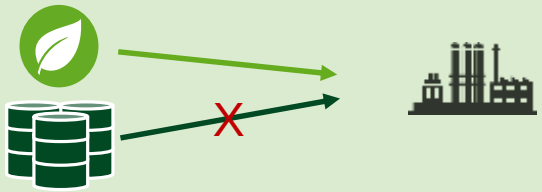
# Four main drivers are influencing BASF's renewable-based portfolio

1 **Competitiveness:** Product with a certain performance not accessible or at higher cost or market demand



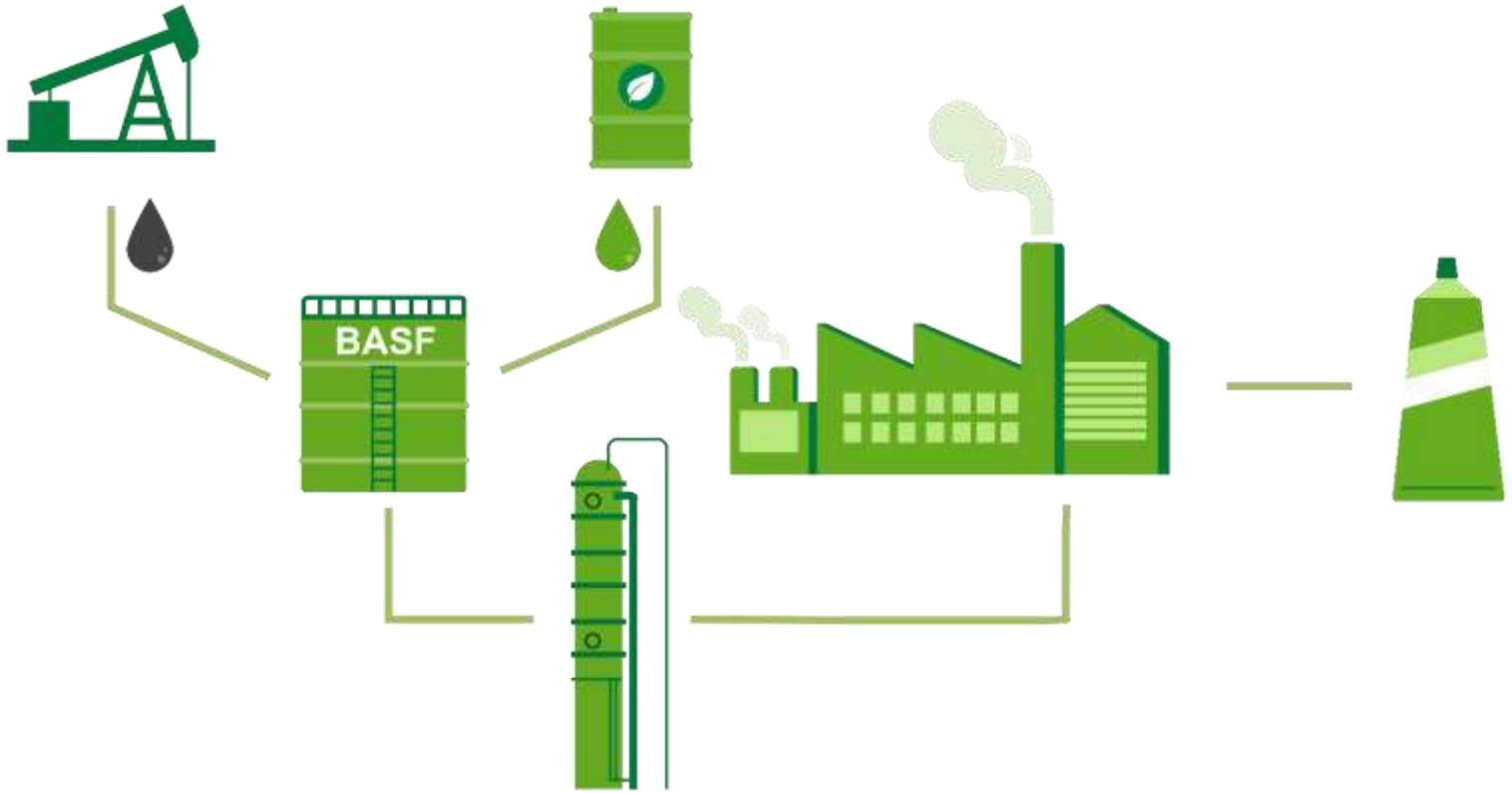
2 **Sustainability:** Save fossil resources and protect climate

**Vision 2050: a world in which nine billion people can live well, and within the planet's resources**

3 **Opportunities:** Customer / consumer demand and regulations

4 **Diversification** of raw material base

# The Biomass Balance Approach




Biomass is added at the very beginning of our production chain

# Biomass Balance is the viable option for an immediate switch to renewable raw materials in the chemical industry

## Traditional production

- Fossil feedstock
- Known performance
- > 20.000 products available in production scale
- Verbund production

## Biomass Balance approach

- Biomass-derived with 3rd party certification
- Same performance
- > 20.000 products available in production scale
- Drop-in BASF Verbund production
- Often additional cost for renewable feedstock

## Dedicated production

- Biobased analyzed by $^{14}C$ method
- Often different product performance
- Not available for all products
- Investment in R&D and new plants
- Often additional cost for renewable feedstock

# How does the Biomass Balance Approach work?

## Feedstock

Fossil

Renewable

Use of renewable feed-stock in very first steps of chemical production (e.g. steam cracker)

## BASF Production Verbund

Utilization of existing Production Verbund for all production steps

## Products

Conventional

Allocated

Allocation of renewable feedstock to selected products

# Challenge: Renewable materials cannot be directed to one specific product

## Feedstock

Fossil

Renewable

## BASF Production Verbund

Therefore,
**a credible external certification** system is needed

## Products

Conventional

Allocated

# Our solution: Certification and standardization

## Feedstock

Fossil

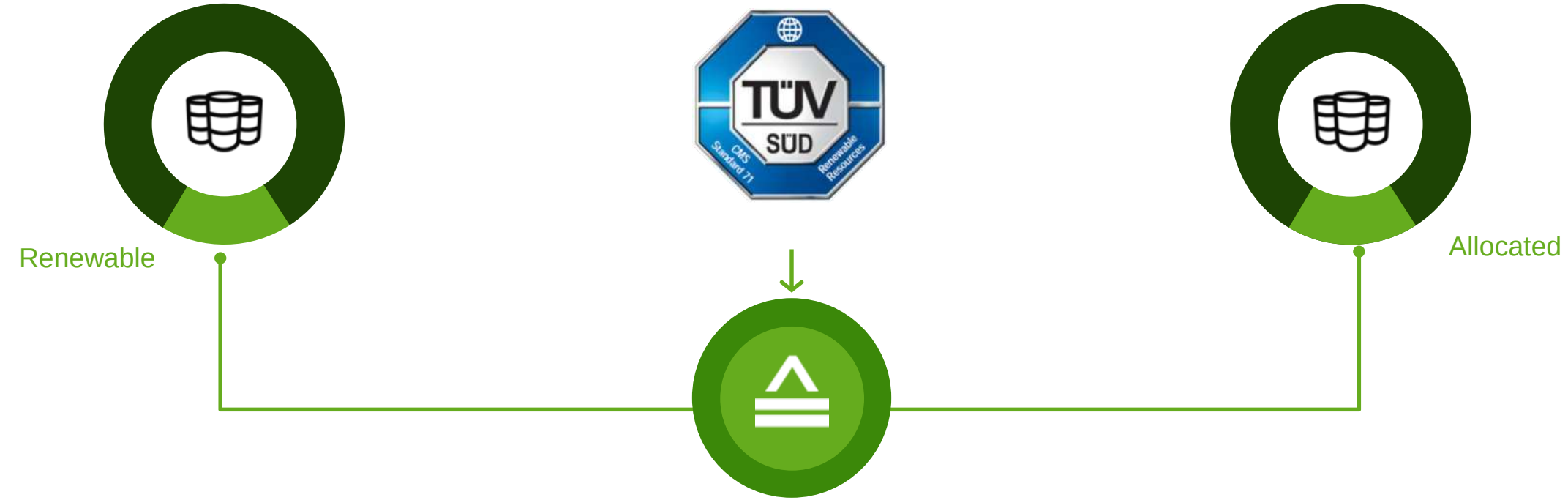
Renewable

## BASF Production Verbund

## Products

Conventional

Allocated



# Renewable raw materials need to be sourced sustainably

## Use certified renewable raw materials

- Bionaphtha from vegetable and organic waste oils
- Biogas from organic waste (e.g. kitchen waste)
- Certification example: ISCC EU

## Apply standardized sustainability criteria

- Greenhouse gas emissions savings
- Responsible biomass production
- Protection of areas with high biodiversity and large carbon stocks


We are exploring and qualifying feedstocks according to international sustainability standards and in dialog with NGOs (e.g. RED*)

*RED = Renewable Energy Directive of EU Commission

# Biomass Balance approaches are addressed in existing standards

## Sustainability standards for biomass

- RED* supports existing mass balance standards
- RED* describes strict requirements for such biomass feedstocks
- TÜV SÜD CMS 71 is the 1st standard applicable for chemical industry

## Political and market standards

- Enhanced importance of green public procurement and product labelling
- Market labels are already using biomass balance

## Life Cycle Assessment

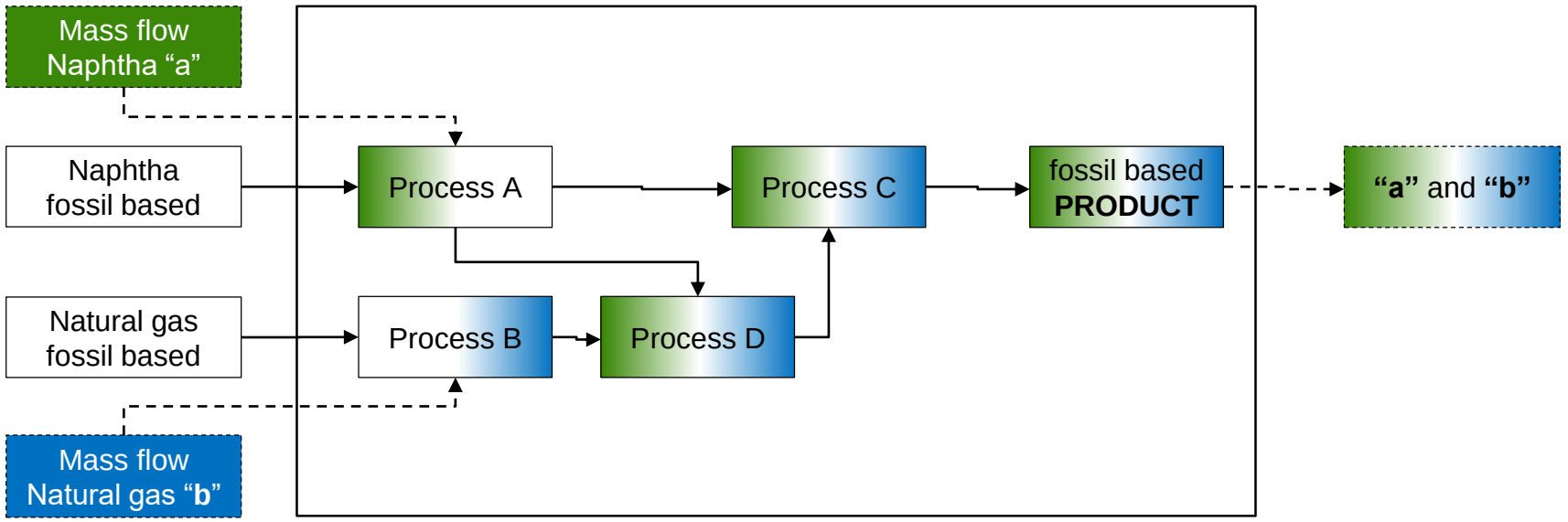
- Existing standards and allocation rules already accommodate MB
- Critical reviews proved conformity

We are implementing the Biomass Balance approach to existing and upcoming standards

*RED = Renewable Energy Directive of EU Commission

# In LCA calculations the raw material use of fossil comparatives needs to be quantified

*Model of production processes in BASF's LCA software according to ISO 14040/14044*




*Quantification of material use of fossil comparatives by mass flows*

# A LCA calculation shall consider the chemical value of the renewables to allow a fair substitution of fossil comparatives

- Biomass has often less chemical value than its fossil comparatives
- Chemical value can be defined as lower heating value (LHV)
- Biomass balanced LCI can be calculated based on the LCI of the fossil comparative:

$$\text{BMB-LCI} = \text{LCI}_{\text{fossil}} + \underbrace{a \bullet (cv_{BN} \bullet LCI_{BN} - cv_{N} \bullet LCI_{N})}_{\text{“a” (amount of naphtha)}} + \underbrace{b \bullet (cv_{BG} \bullet LCI_{BG} - cv_{NG} \bullet LCI_{NG})}_{\text{“b” (amount of natural gas)}}$$

**BMB:** Biomass balance
**LCI:** Life Cycle Inventory
**Cv:** chemical value factor
**Indices:** N = naphtha, NG = natural gas, BN = bionaphtha, BG = biogas

# Summary

## Biomass balance

- is the viable option for an **immediate switch to renewable raw materials** in the chemical industry and is complementary to biobased chemistry
- allows introduction of **certified renewable feedstocks** for a broad range of chemical pathways
- products are **drop-in solutions** without any compromise in performance
- **can be easily implemented to LCA** and shall consider the chemical value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# BASF purchases a broad range of renewable raw materials

## Oils & Fats

- Lauric oils & deriv.
- Natural oils
- Fatty acids & deriv.
- Glycerin

## Grains

- (Modified) starches
- Dextrose
- Glucose syrups

## Sugar

- Sucrose
- Ethanol
- Organic acids

## Wood

- Ligninsulfonate
- Cellulose-derivatives
- Furfural
- Tall oil derivatives

5.4% of BASF's total raw material purchase are renewables