Energy and greenhouse gas emission in food production chains

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Introduction

- Center for Energy and Environmental Studies, University of Groningen
- Dutch Environmental Quality Label
  - LCA use to find ‘hot spots’ in product life cycles
    - Food
    - Non-food
- LEI: Agricultural Economic Research Institute, part of Wageningen University
- Lawrence Berkeley National Laboratory

- Food related research:
  - Energy use and greenhouse gas emissions Dutch household food consumption.
  - Life cycle energy use of fruit and dairy product consumption in the catering sector.
  - Life Cycle Assessment horticulture (conventional and organic).
  - Life cycle energy use plant-based proteins (to use in the catering sector).
  - Life cycle energy use in the pork chain.
  - …
- Greenhouse gas emissions Californian residents (PIER)

Energy use and greenhouse gas emissions of food product life cycles, methodologies

- Assessment of total energy use and greenhouse gas emissions of food

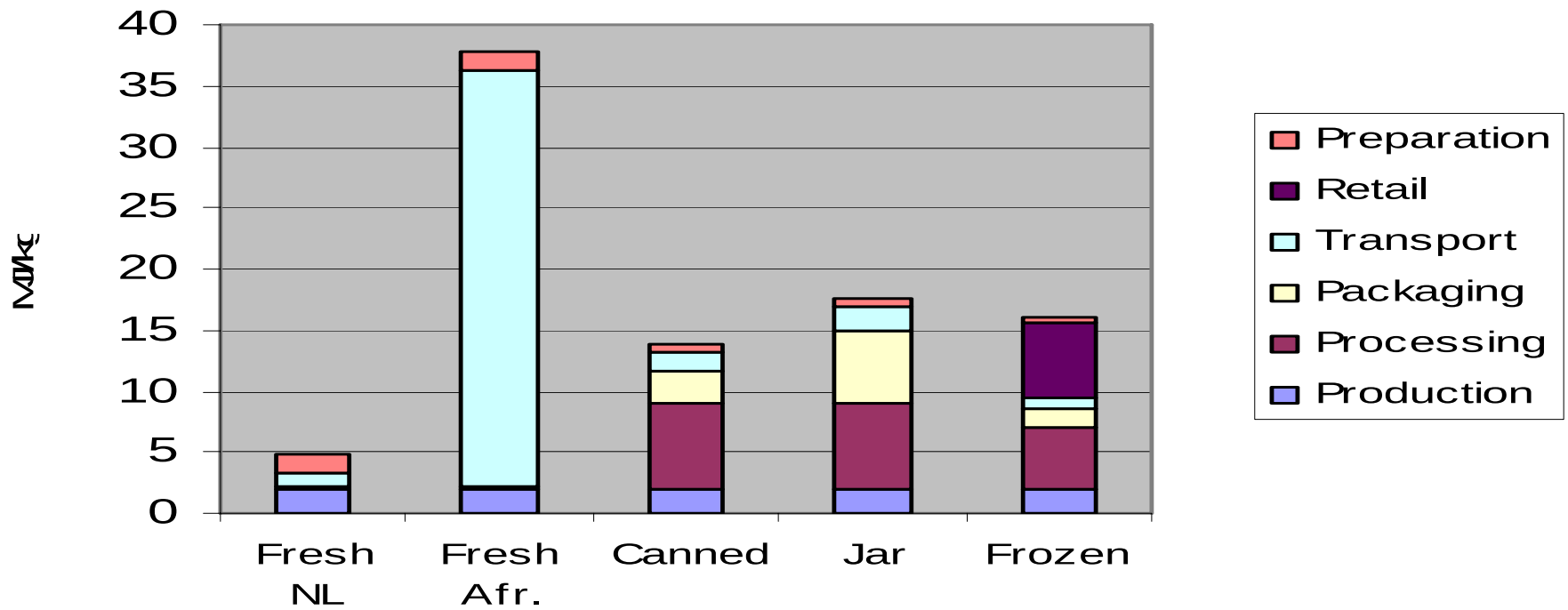
- 2 (3) possible approaches
  - Process analysis,
    - LCA
    - Input and output in physical units; kg/lb/gallon
  - Environmental Input-output analysis, economic ($).
    - Input-output table: financial deliveries to sectors
    - Combine with environmental data
    - Financial inputs and outputs: $

Advantages and disadvantages of approaches

	Process analysis	IO-analysis
Labor intensity	Intensive, data requirement	‘Easy’
System boundaries	System boundary definition	No system boundaries
Level of detail	Detailed information	Sector information

Process analysis: energy use ‘French beans’

- What are the most important factors for energy use?



Energy use French Beans

- **Important factors:**
- Crop production systems
- Geography
- Industrial processing
- Packaging

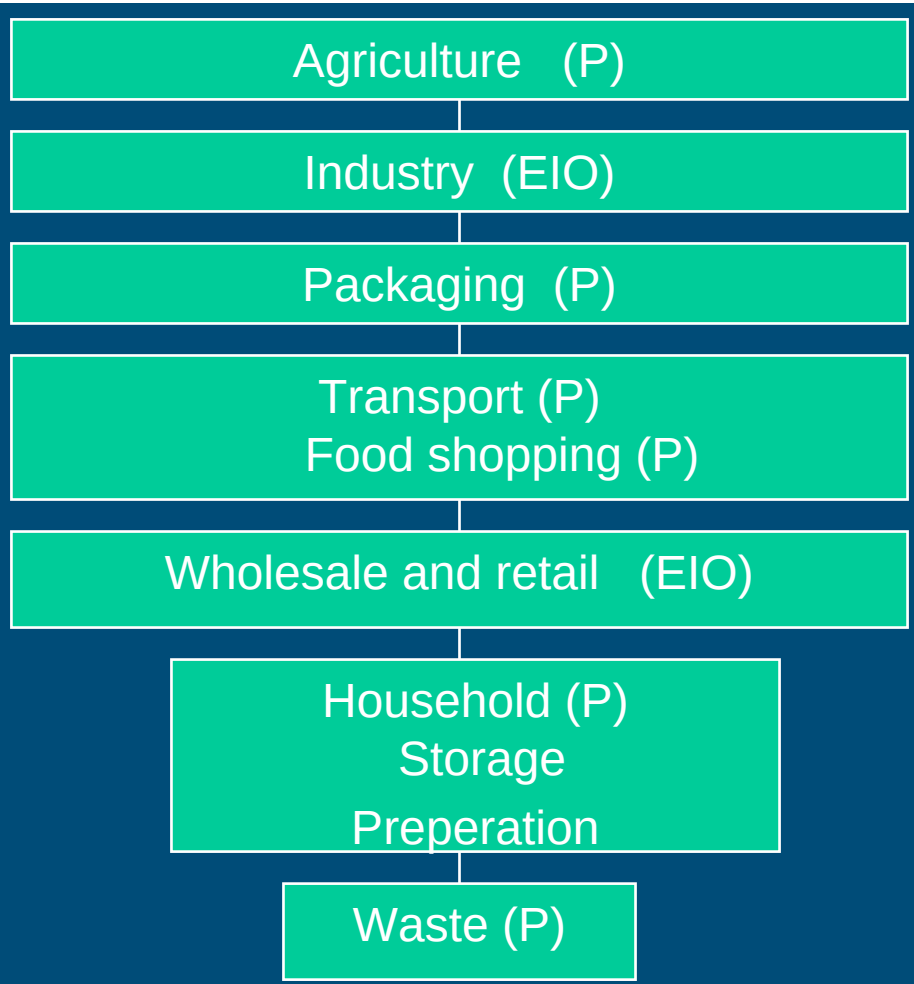
Hybrid Energy and Greenhouse Gas Analysis

- Hybrid approach combines ‘the best of both approaches:
  - process analysis, LCA
  - Input-output analysis
- Balance
  - Mass balance: kg/lb
  - Financial: $, cost breakdown

Energy use and greenhouse gas emissions of food products, hybrid approach

- Main stages in life cycle: process analyses
- Other stages: energy/greenhouse gas Input-Output analyses
- Assessment with help of computer-based Energy Analysis Program
  - Energy and greenhouse gases: both MJ/euro as well as MJ/kg
  - Annual household spending to 130 food products in euro (Statistics Netherlands)
  - Intensities * annual spending = total annual energy use and greenhous gas emission related to food

Food Chain

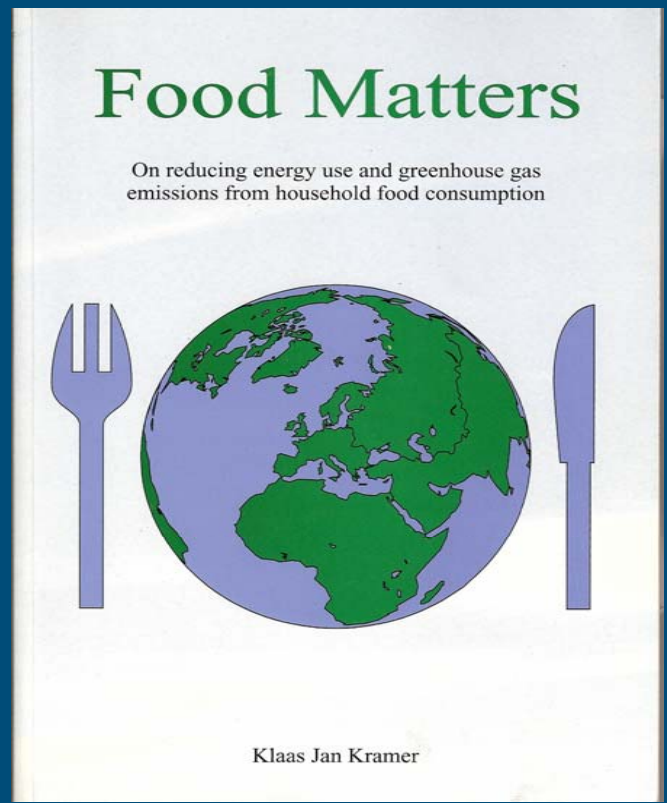

Agriculture (P)
Industry (EIO)
Packaging (P)
Transport (P)
Food shopping (P)
Wholesale and retail (EIO)
Household (P)
Storage
Preperation
Waste (P)

Energy/GHG emissions use in agriculture, crop production

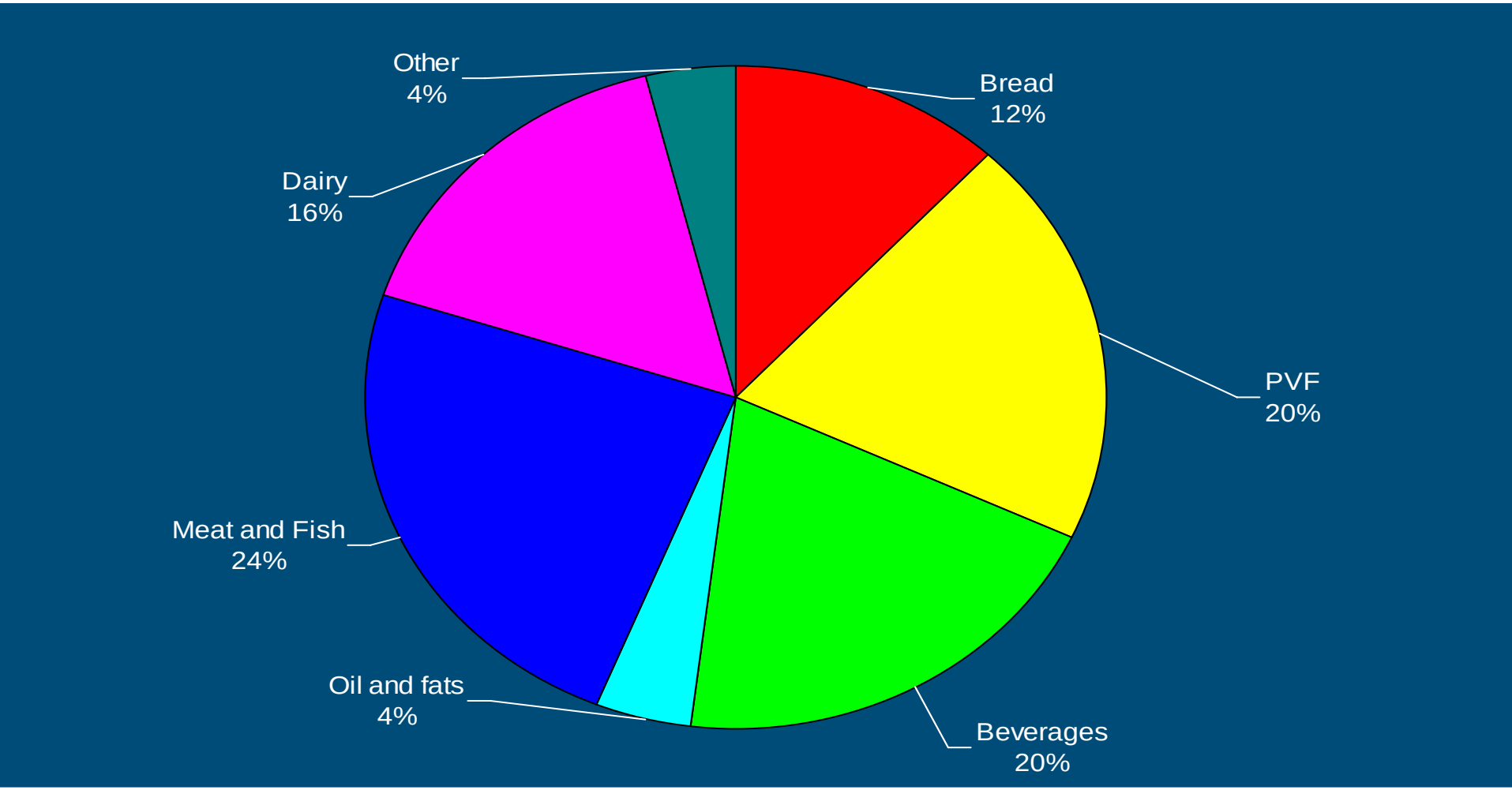
- Process analysis
  - Indirect
    - Seed
    - Fertilizers; N/P/K
    - Pesticides
  - Direct
    - Land operations:
      - Hour/ha
      - Diesel use per hour agricultural machinery
- Kg CO_2-eq/kg crop (conventional crops)

Food products

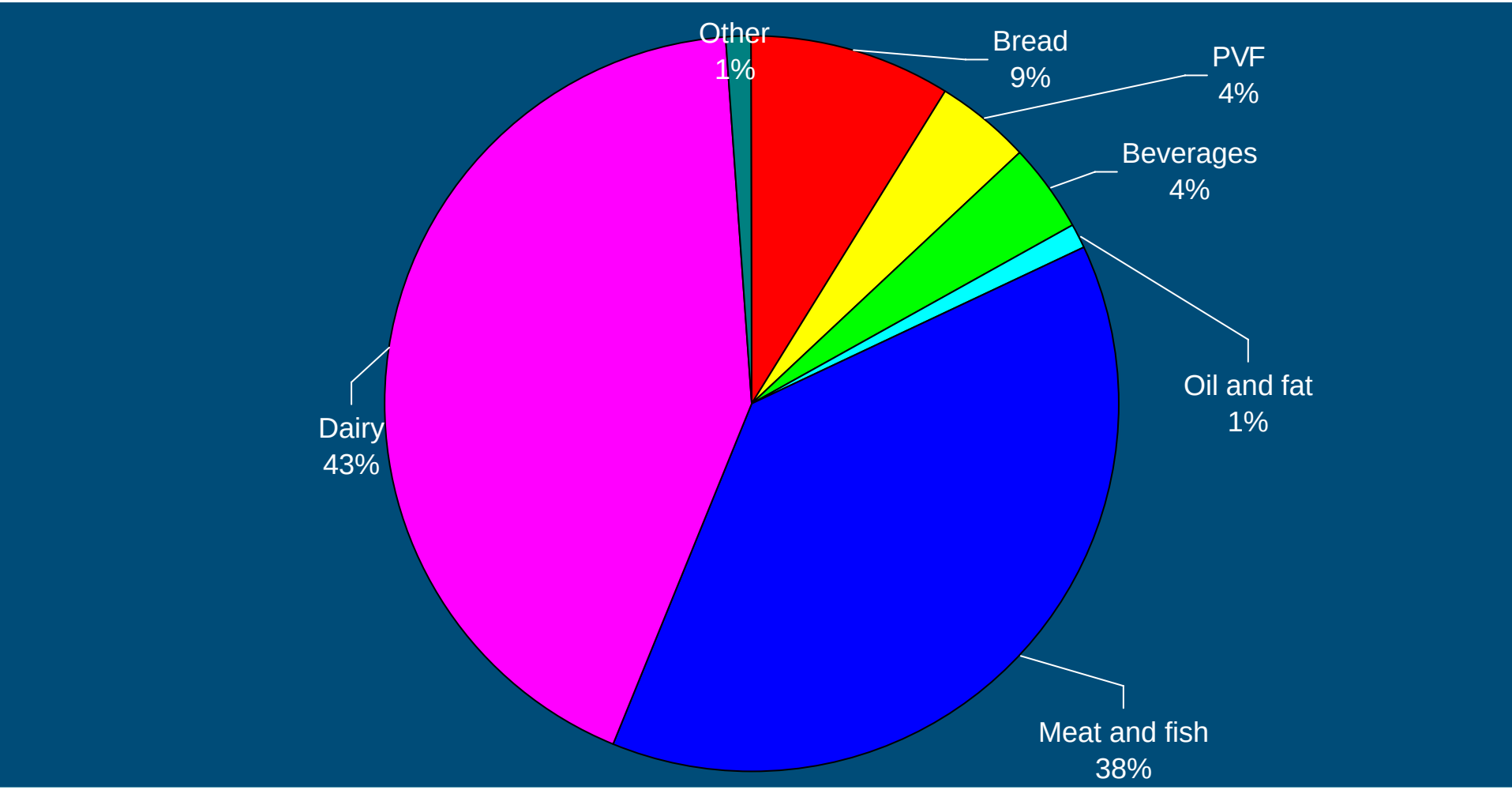
- Categories
  - bread, pastry and flour products
  - potatoes, vegetables and fruits
  - beverages and sugar containing products
  - oils and fats
  - meat, meat products and fish
  - dairy products
  - other food products



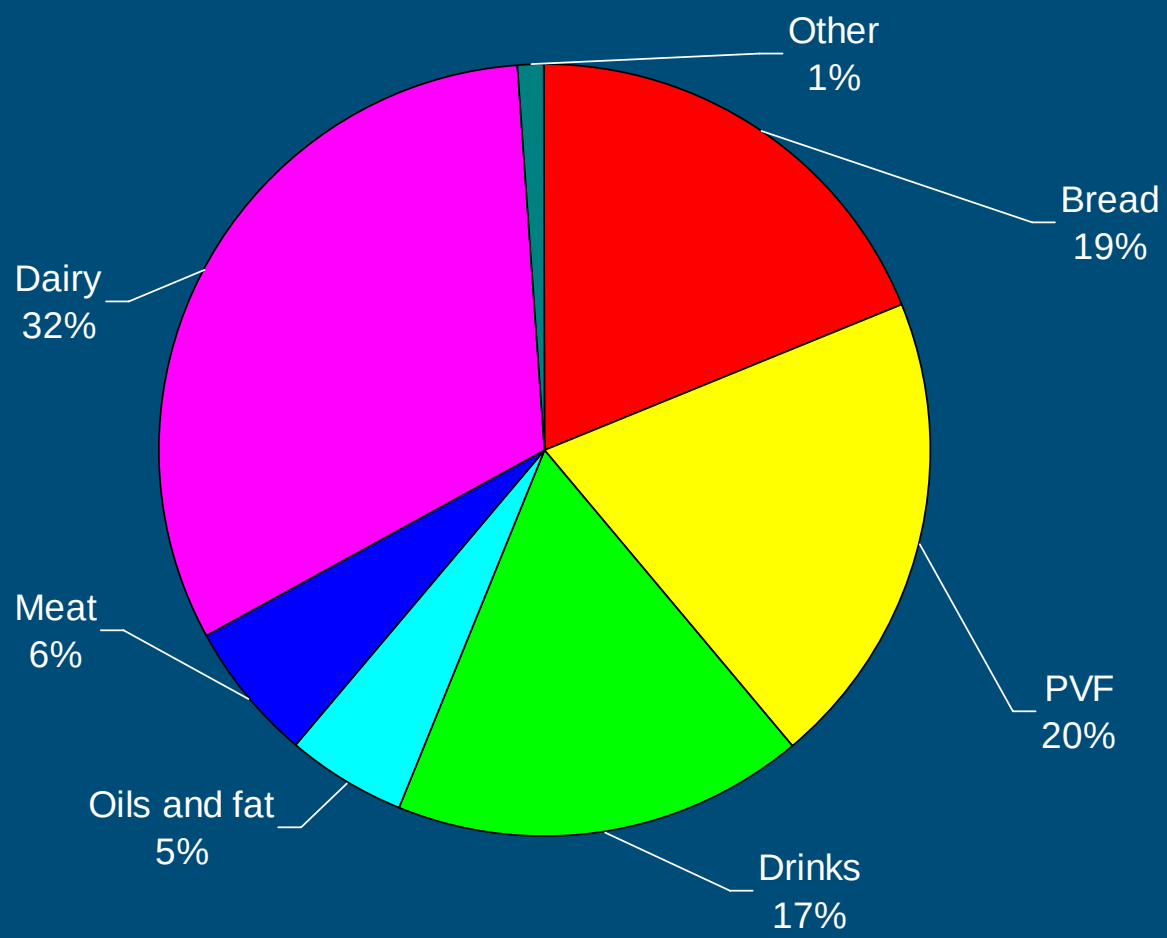
Food and energy/CO2



Food and CH_4


Other
1%
Bread
9%
PVF
4%
Beverages
4%
Oil and fat
1%
Meat and fish
38%
Dairy
43%

Food and N_2O



Emissions in the life cycle

	In %
Agriculture	39,0
Industry	17,0
Packaging	5,0
Transport	6,0
Trade	10,0
Consumption	23,5
Waste	-0,5
Totaal	100,0

With results, options to reduce energy and GHG emissions

- ‘Project related options’
  - Efficiency measures
  - Fertilizer efficiency
  - ....
- ‘Consumer related options’
  - Food choices, low(er) carbon diet, attention to food intake
    - Meat
      - Less meat
      - Other proteins
      - ..
    - Vegetables
      - Glasshouse crops
      - Import
      - ..
    - Carbohydrates
  - Appliances
  - Shopping

Critical questions….

- Critical issues
  - Differences in production systems.
  - Pre- and post-retail
    - Pre-retail: logistics
      - Large share of miles related to food
    - Post-retail: Important to include
      - Large share of energy use and ghg emissions
      - Wasted food
        - » 15% food purchases are not consumed

- Organic: pesticides and mineral uses

LCA methodology, LCA database

  - Geographical
    - How treat imported crops (as domestic?)
    - Production in different states
    - Electricity mix

Critical questions….

- Databases
  - US LCI database
  - Existing databases,
    - EAP database, extensive database
    - EIO-LCA data for manufacturing industry and retail
      - Averages
      - At least 5 years old
      - Extended by BIE

Thank you for your attention

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