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Life Cycle Assessment for
South African Food & Agriculture Reduced Impacts

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Assessment of Cleantech Options to Mitigate Environmental Impacts of South African Dairy & Maize farming

Regula Keller[1], Lea Eymann, Sarah Wettstein[1], Deborah Scharfy[1], Matthias Stucki[1]
[1] Zurich University of Applied Sciences ZHAW, Switzerland, Regula.Keller@zhaw.ch

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CONTEXT OF RESEARCH

Context of research: Challenges

Picture: Eddie Jim/Fairfax Syndicatio

Context of research: Project goals

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South African Food & Agriculture – Reduced Impact ("SAFARI")

1. Identification of **environmental hotspots** in the life cycle (most relevant agri-food products in South Africa).
2. Quantification of **environmental mitigation potentials**.
3. Development and dissemination of sustainable practise **recommendations**.
4. Preparation of **datasets** for the ecoinvent database.

The project "SAFARI" is part of the Swiss South Africa joint research programme ("SSAJRP")

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GOAL & SCOPE

Research Questions

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How can **milk be produced** with **less environmental impact?**

1. **Direct emissions**: Which impact does the feeding of the methane inhibitor 3NOP (3-nitrooxypropanol) to lactating cows have?
2. What is the impact if **cleantech** is introduced in the production of maize (used as cow feed)?
   a) Irrigation powered with solar electricity («**solar**»)
   b) Smaller electricity demand due to the integration of a variable frequency drive in the water pump («**VFD**»). *A VFD regulates the motor to provide the force needed instead of running at maximum capacity, thus saving energy.*

Maize: Why tackle irrigation?

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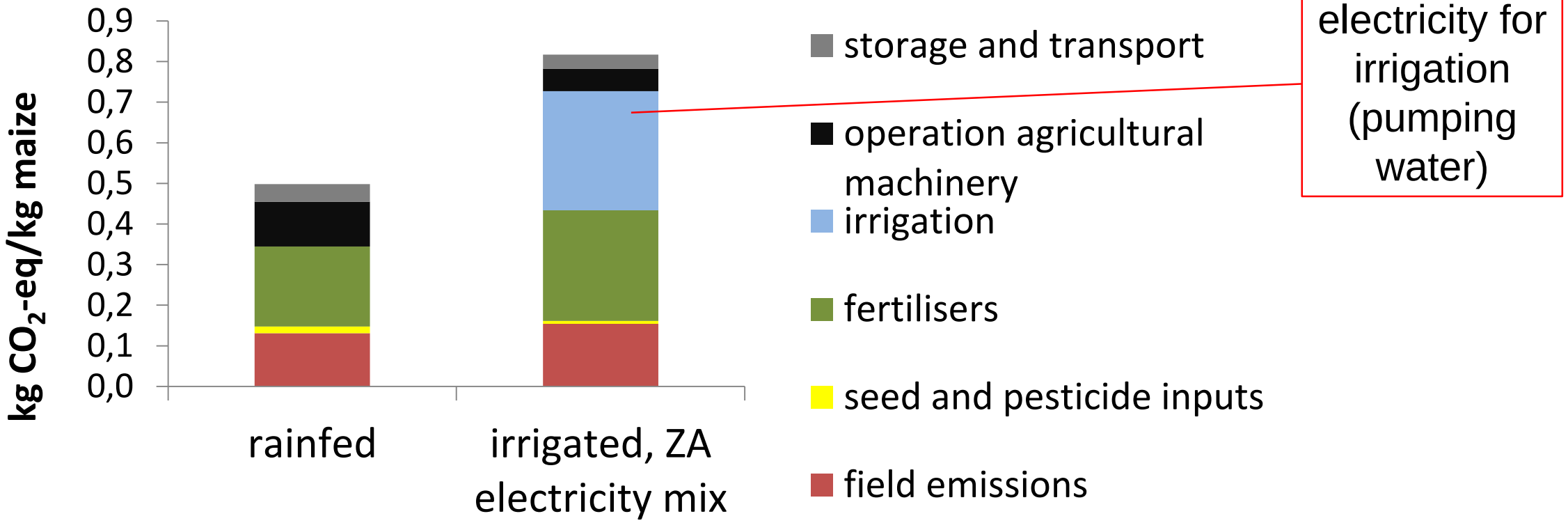
Global Warming Potential (IPCC 2013, 100a) of rainfed and irrigated maize



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Scope: Funcional unit, included processes

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- **Functional unit**
  - **Milk:** 1 kg raw milk
- **Cradle-to-gate:**
  - Milk: Feed production, dairy farming
  - Maize: Seed bed preparation, cultivation steps incl. irrigation, land use, application of fertilizers and pesticides, field emissions, harvesting, storage, diesel consumption, machines, transports

Scope: Impact indicators

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Impact indicators (*abbreviation in bold*)

- ***GHG emissions:*** Climate Change (IPCC 2013)
- **CED non-renew.:** Non-renewable Cumulative Energy Demand (Hischier et al. 2010)
- ***Eutr.*:** Eutrophication (Goedkoop et al. 2009), Freshwater and Marine
- ***Freshw. Ecotox.:*** Freshwater Ecotoxicity (Rosenbaum et al. 2008)
- ***Land use*** (Frischknecht et al. 2013)

Scope: Data sources

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- **Milk**: Data collection in 2014: 5 farms in the province of KwaZulu-Natal
- **Maize**: Grain SA (2014) planning models from three different regions* of maize production in South Africa from 2006-13 (Share of irrigated and rainfed maize according to model)
- Background data from **ecoinvent** v3.2 (2015) (system model: Allocation, recycled content)
- Methane inhibitor 3NOP: Values from **Hristov** et al. (2015) (30% reduction)

** Eastern Highveld, North West and Central and Northern Free State*

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Scope: Allocation

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- **Allocation at farm-level (milk / meat):**

  Based on the physiological feed requirements to produce milk and meat as recommended by the International Dairy Federation (2015).

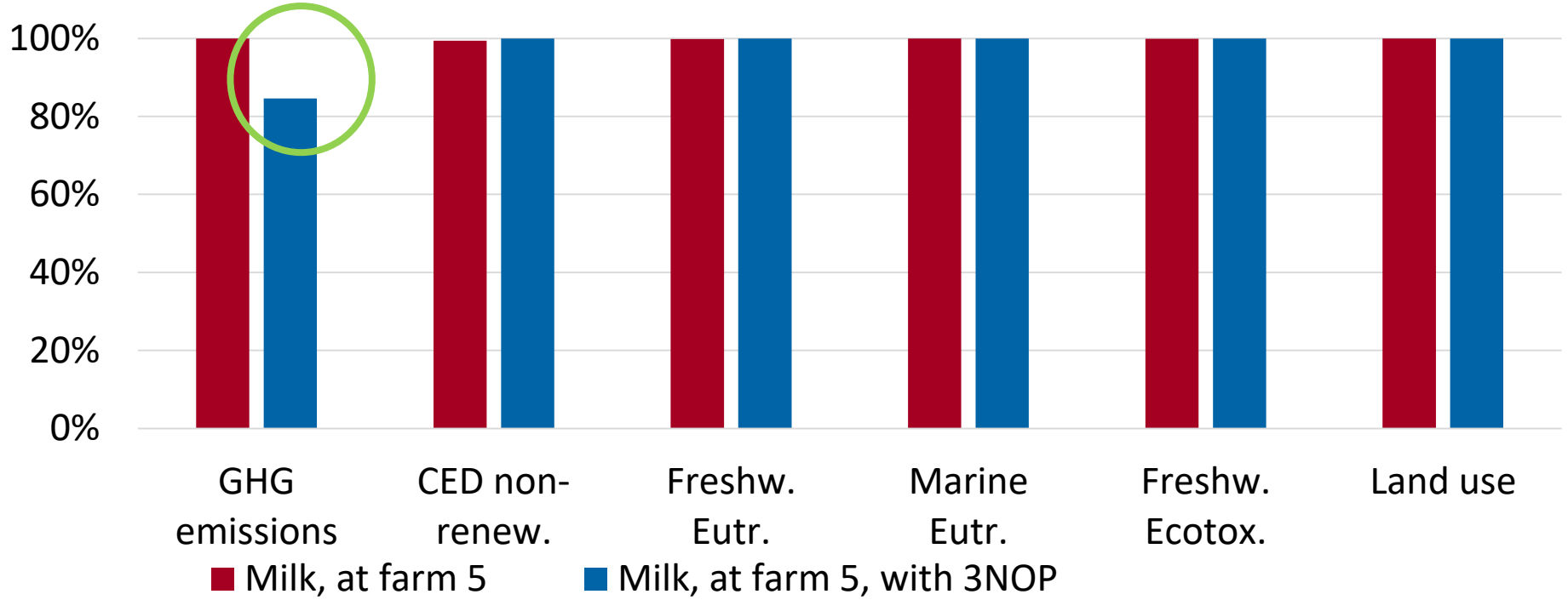
- **Allocation of meat:**

  To distribute the beef's environmental impact between calves and cull dairy cows, economic allocation was performed.

RESULTS

Results I: Methane inhibitor 3NOP

- Reduction of impact in greenhouse gas emissions of 18%
- No observable trade-off in other categories



Impact of feeding 3NOP to cows, calculated using Farm 5 as an example (South African farm with Holstein cows)

Cleantech grain maize: Variable Frequency Drive

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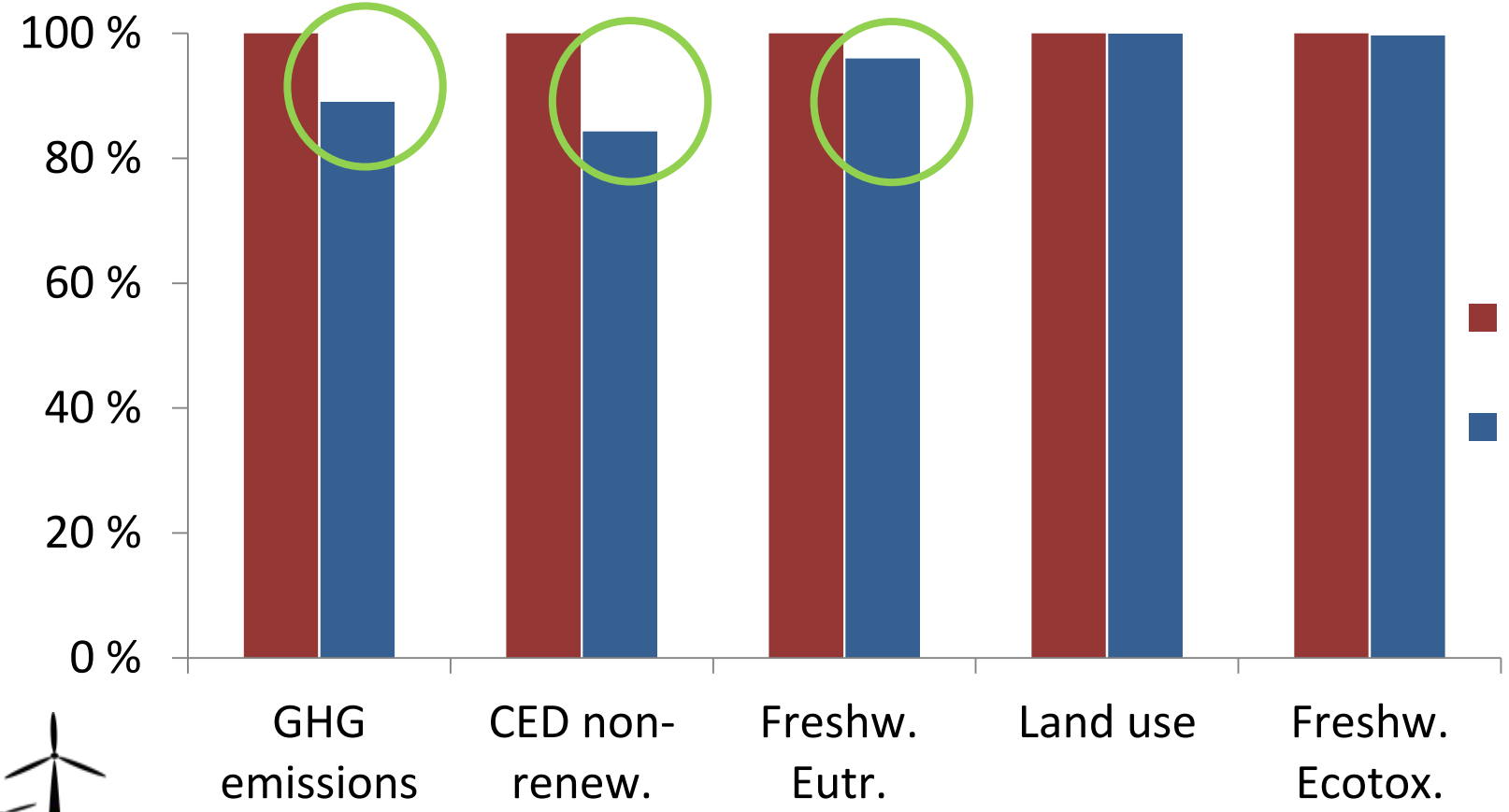
Mitigation potential: Using a variable speed drive for the pivot irrigation systems



Electricity demand for pumping the water:
Reduction of **34%** with the integration of a variable speed drive is assumed.

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Cleantech grain maize: Solar irrigation

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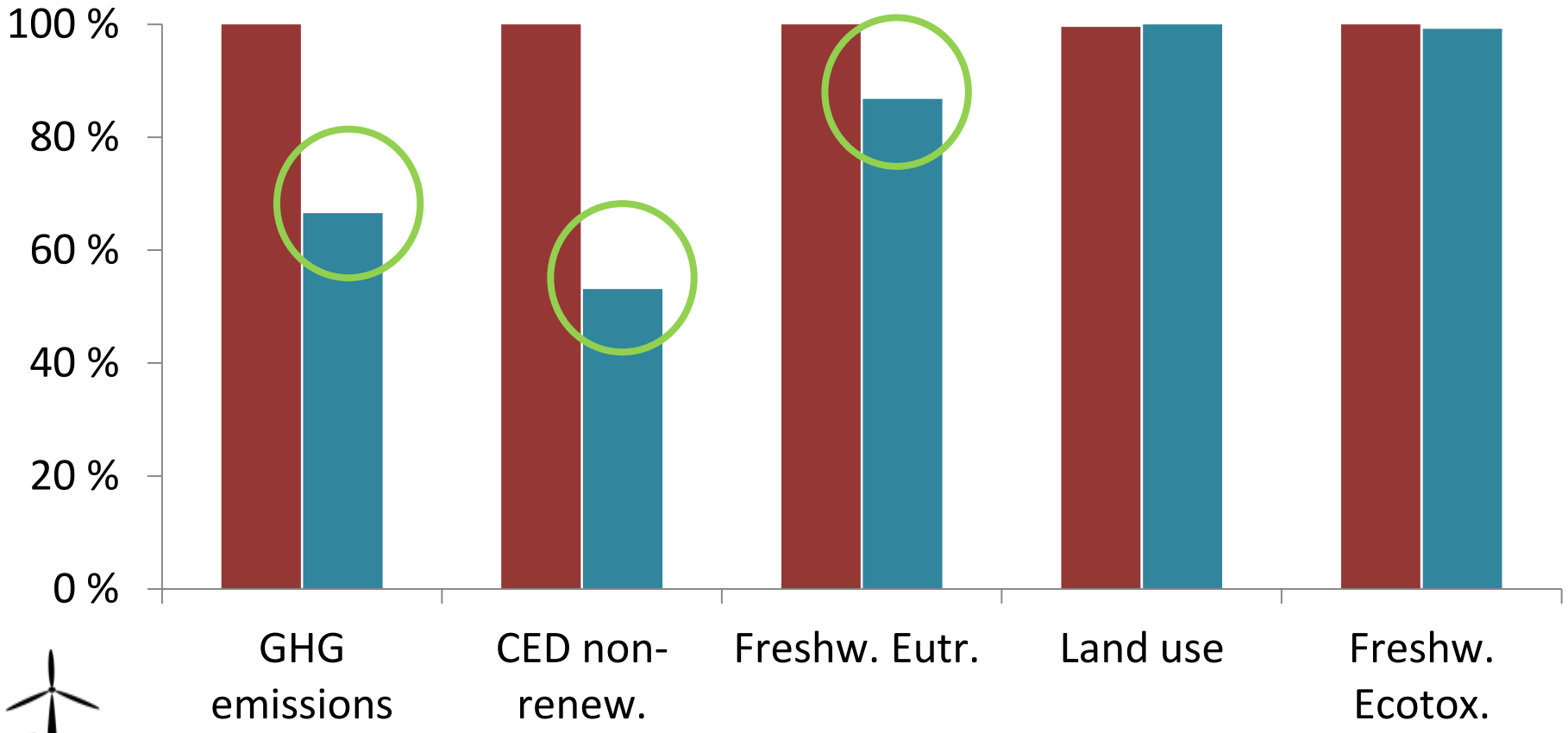
Mitigation potential: PV powered centre pivot irrigation systems



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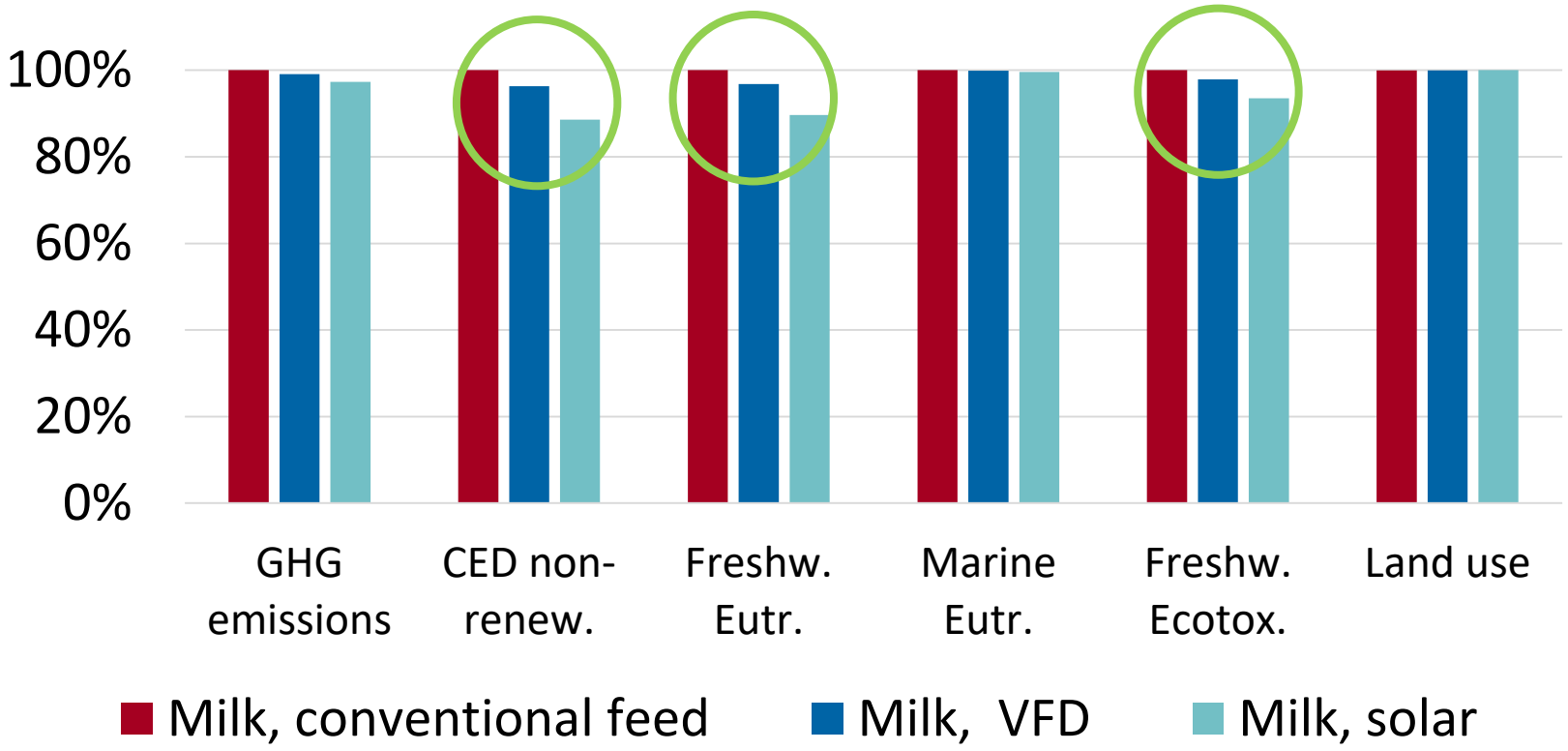
Results milk: Cleantech feed

Influence of cleantech in the irrigation of feed on the environmental impact of milk



- Reduction in three impact categories
- No trade-off in others
- Highest reduction for cumulative energy demand (11% solar, 4% VFD)
- Solar: higher reduction
- Reduction depends on farms considered

CONCLUSIONS

Conclusions I: Direct emissions

- Option 1: Methane emissions: Reducing enteric methane emissions with 3NOP
  - Only advantage for climate change → but direct emissions are the major share
  - To consider: Long-term safety of 3NOP and consumer acceptance

Conclusions II: Cleantech feed

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- Option 2 & 3: Irrigation: solar electricity or variable frequency drive
  - Feed production dominates all impact categories apart from climate change.
  - Decreased impact in 3 of the 6 considered impact categories, no trade-off in the others.
  - Solar electricity reduced the impact to a higher degree than the integration of a VFD.

√

Conclusions III: All options

- **All three options** can generally be recommended.
- **Early implementation** of cleantech could potentially have a strong effect on the state of the environment both in South Africa as well as worldwide.
- Different measures should be **combined** to decrease the environmental impact of milk.

Thank you for your attention!

Questions?

Contact

Regula Keller
ZHAW Zurich University of Applied Sciences
Institute of Natural Resource Sciences
Grüental, P.O. Box, CH-8820 Wädenswil

Phone: +41 58 934 57 19
E-Mail: Regula.Keller@zhaw.ch
Internet: www.zhaw.ch/iunr/lca/en

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