

Electronic grade silicon wafer production: review and update of life cycle inventory data

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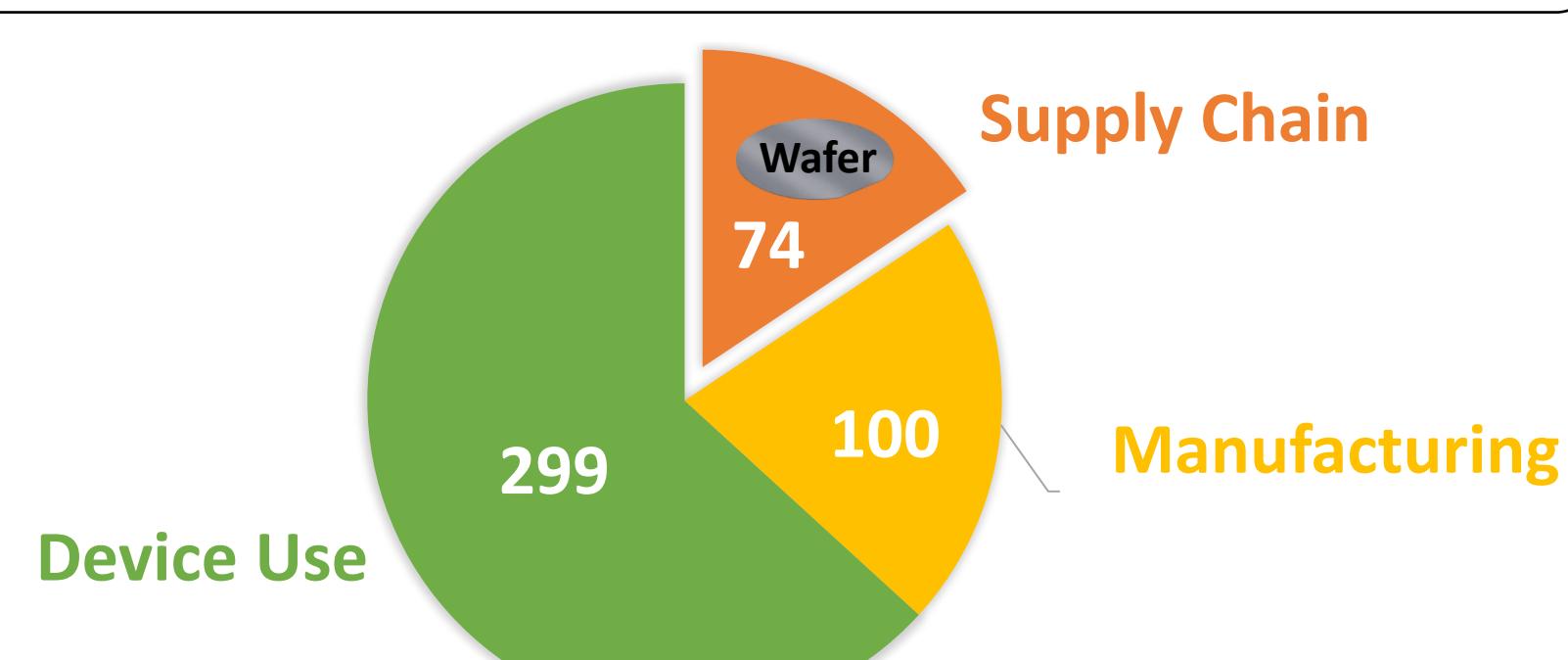
Semiconductor manufacturing starts with Si wafers

In 2024

→ 280 million wafers
were processed globally

→ 100 million m²
of Si wafers used each year

Life cycle emissions of the semiconductor industry
(Megatonnes CO₂eq, 2021)



Objectives

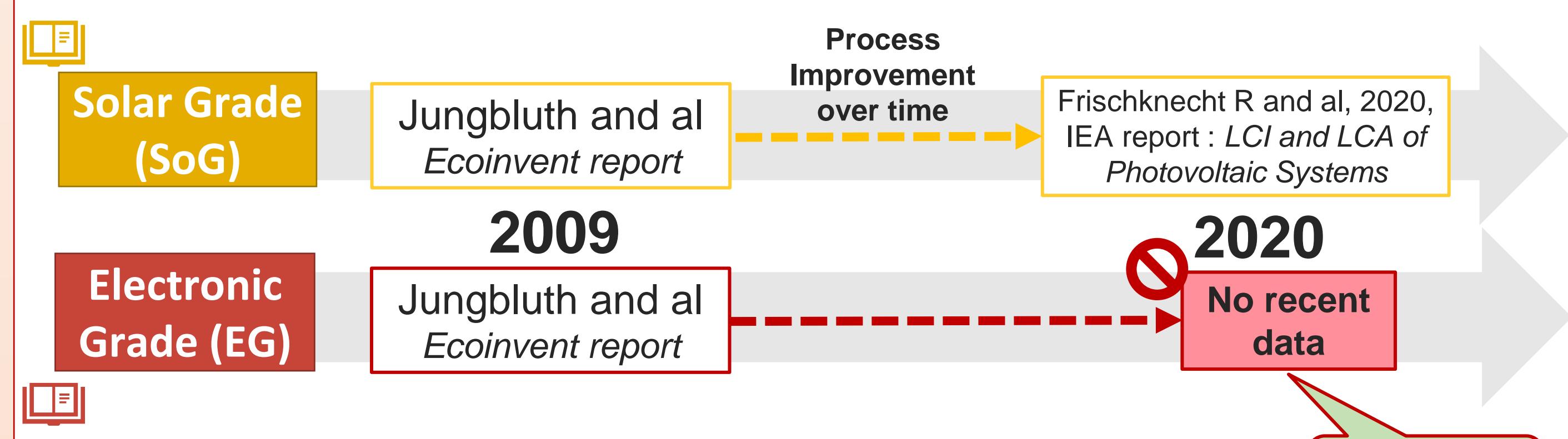


Product Environmental Footprint (PEF) method :
Harmonized method with 16
environmental indicators

SimaPro
ecoinvent

Life cycle inventory (LCI) update of
the production of an EG Si wafer
+
Life cycle analysis (LCA)

What we know on environmental impacts of Si wafers manufacturing ?



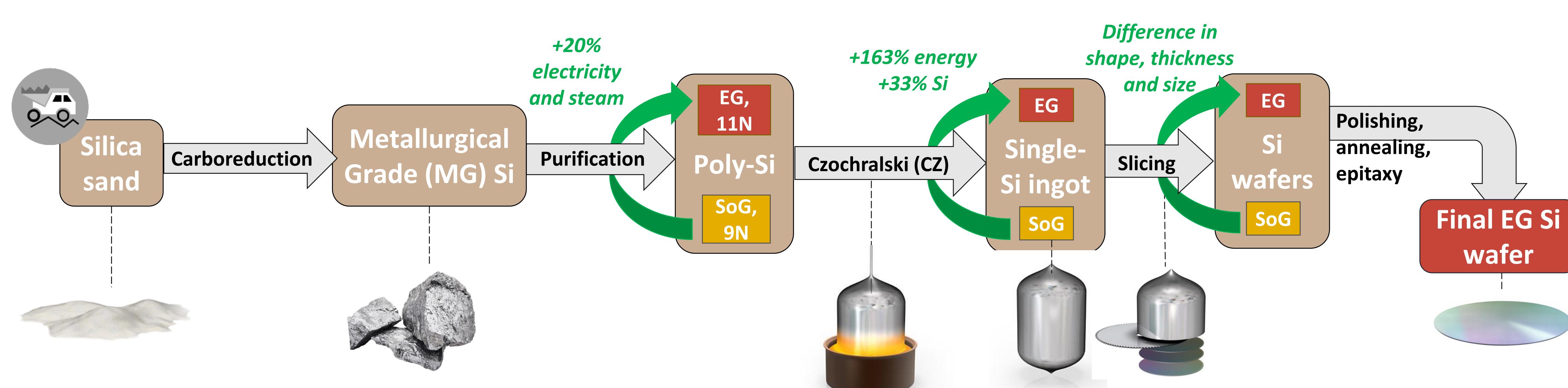
Differences between an Electronic Grade (EG) and a Solar Grade (SoG) Wafer

| | EG | SoG |
|-----------|----------------|---------------|
| Purity | 11N to 13N | 9N |
| Shape | round | square |
| Thickness | 725-775µm | 170µm |
| Size | 200mm to 300mm | 156 to 162 mm |

No recent available data for the impact of the production an EG Si wafer.

But for SoG wafer : Publicly available and recent data exist.

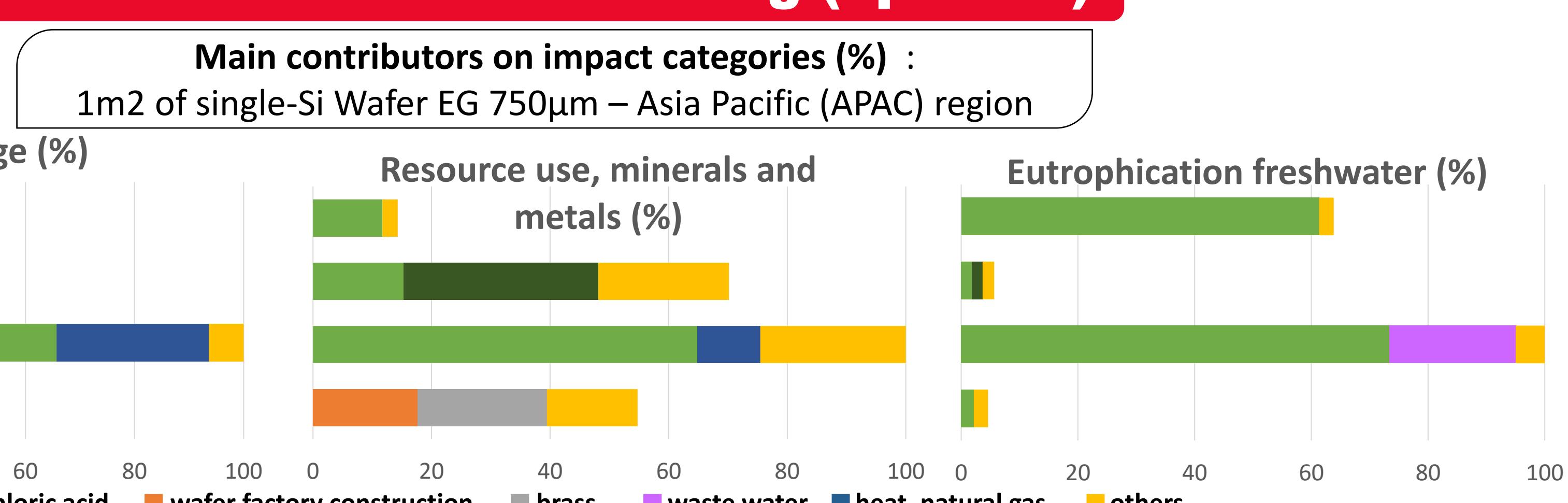
EG wafer production adapted from SoG



LCI of SoG wafer from :
• Frischknecht R and al, 2020

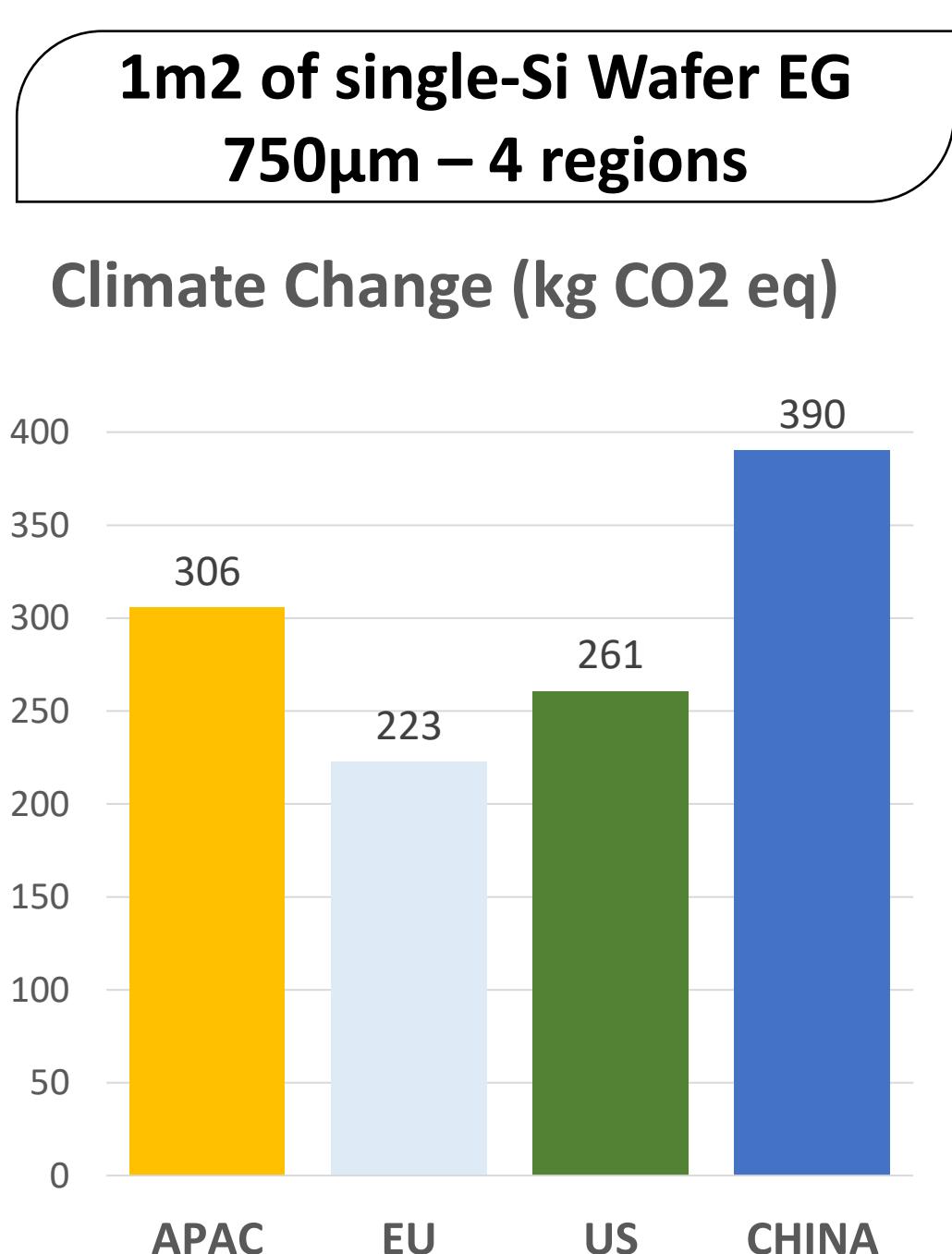
Adapted to EG with:
• differences from Jungbluth and al, 2009, PV and electronics
• and additional information from Woodhouse and al, 2019.

Environmental impacts of EG Si wafers manufacturing (updated)



- CZ process → most impactful stage in every impact categories
- Electricity consumption → main contributor

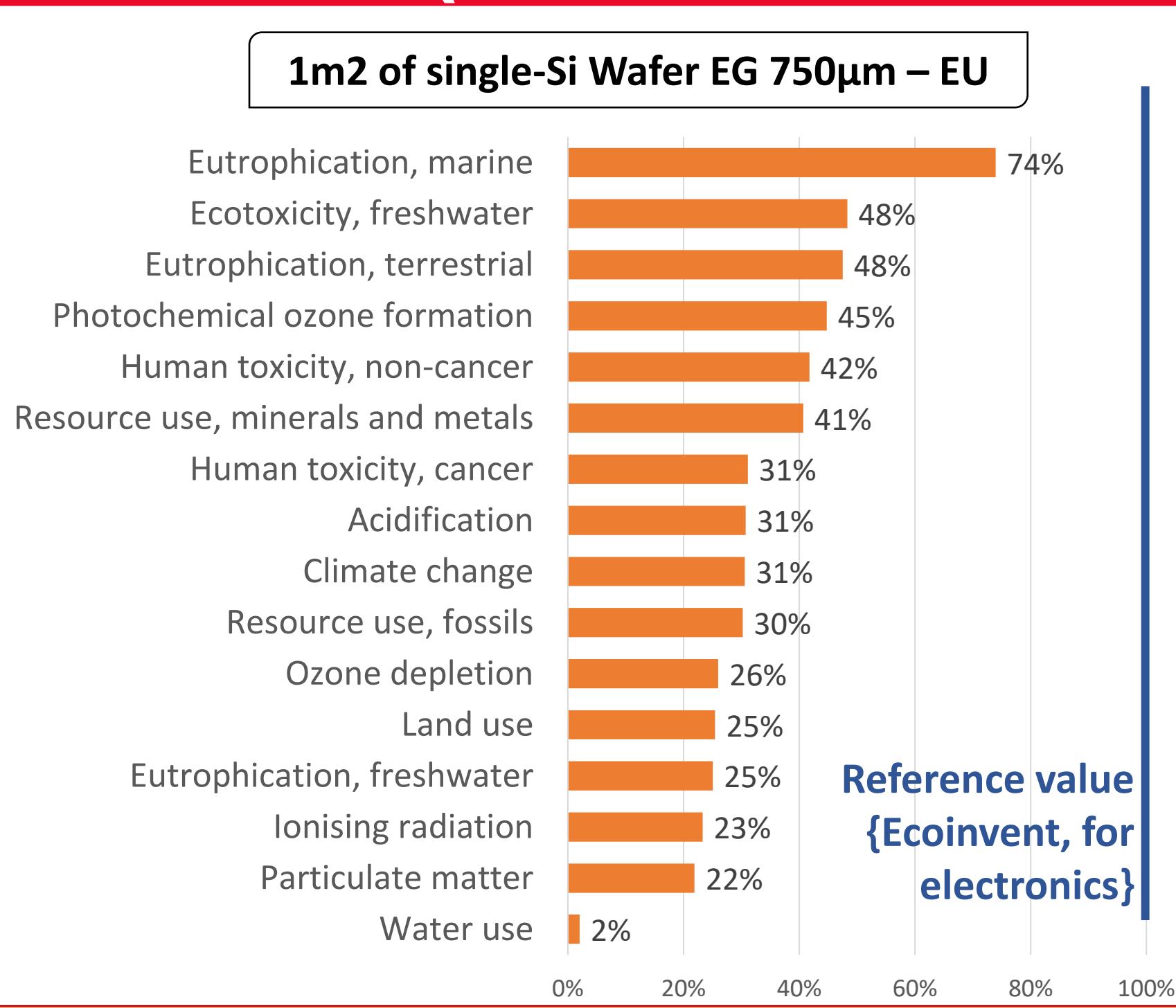
Influence of region of manufacturing



EU region shows lower impacts on 10 impact categories.

→ Mainly due to differences on the electricity mix EU mix relies less on fossil fuels

Comparison of this study (updated) vs. Reference data (ecoinvent database)



Ecoinvent reference value is higher in every impact categories.

Main sources of differences :

- electricity consumption divided by ~6
- Single-Si ingot consumption at slicing step reduced by 38%.

Conclusion

- LCA databases can be outdated → updates are needed as processes improve over time.
- Production region matters - results vary by location.
- Thanks to this update, to reduce the impact of the production of component it is even more important to study manufacturing steps rather than wafers production.

Acknowledgement

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