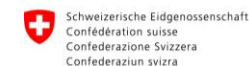


# Insights from modeling the European and Swiss electricity future



**Prof. Evelina Trutnevyte**  
**University of Geneva**

24 January 2025  
12<sup>th</sup> Swiss Symposium on  
Thermal Energy Storage



Swiss Confederation

Federal Department of Economic Affairs,  
Education and Research EAER  
State Secretariat for Education,  
Research and Innovation SERI

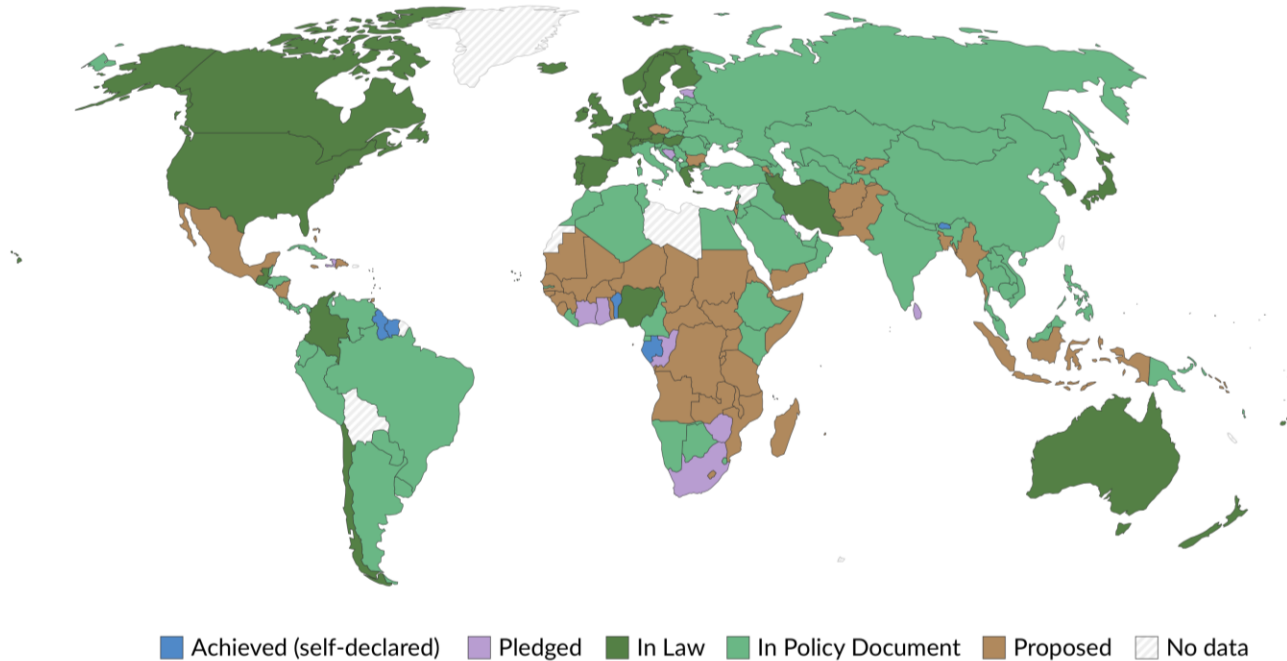


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## For today

- Current targets and the needed transformation of the electricity sector
- Expected progress for now
- Implications for thermal energy storage

# Net-zero carbon emission targets

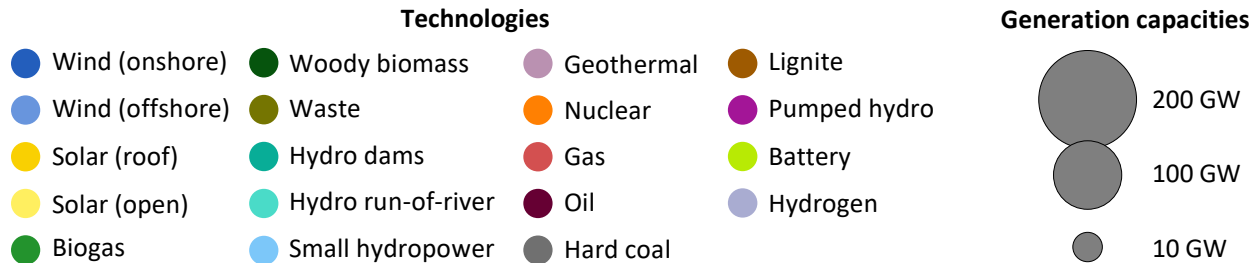
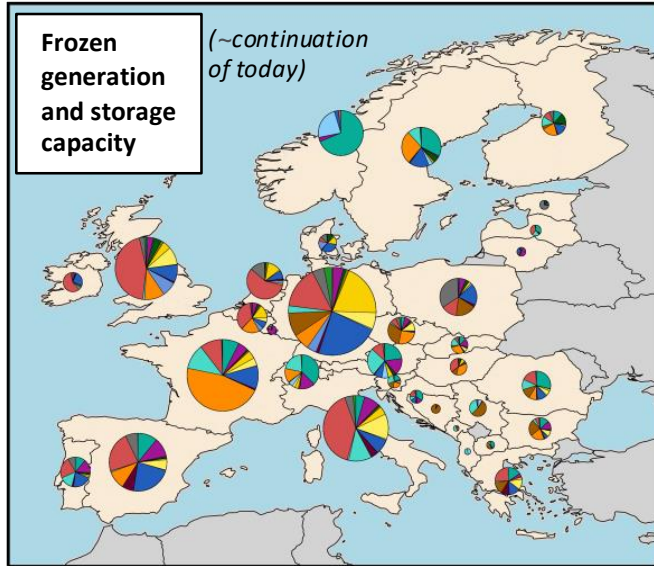


Electricity sector needs to decarbonize first to allow other sectors to decarbonize

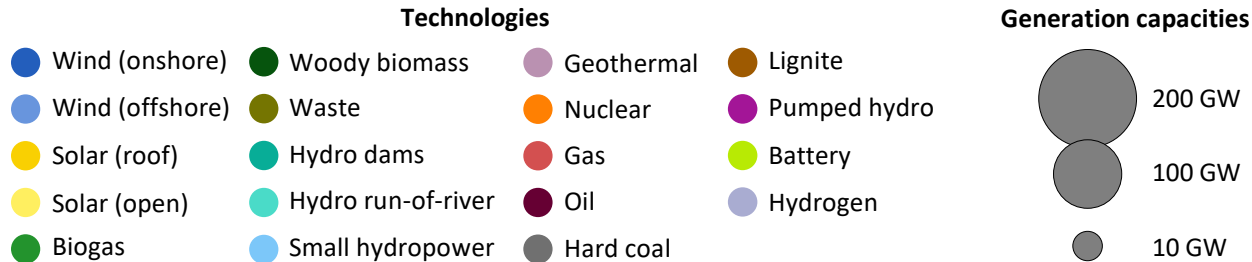
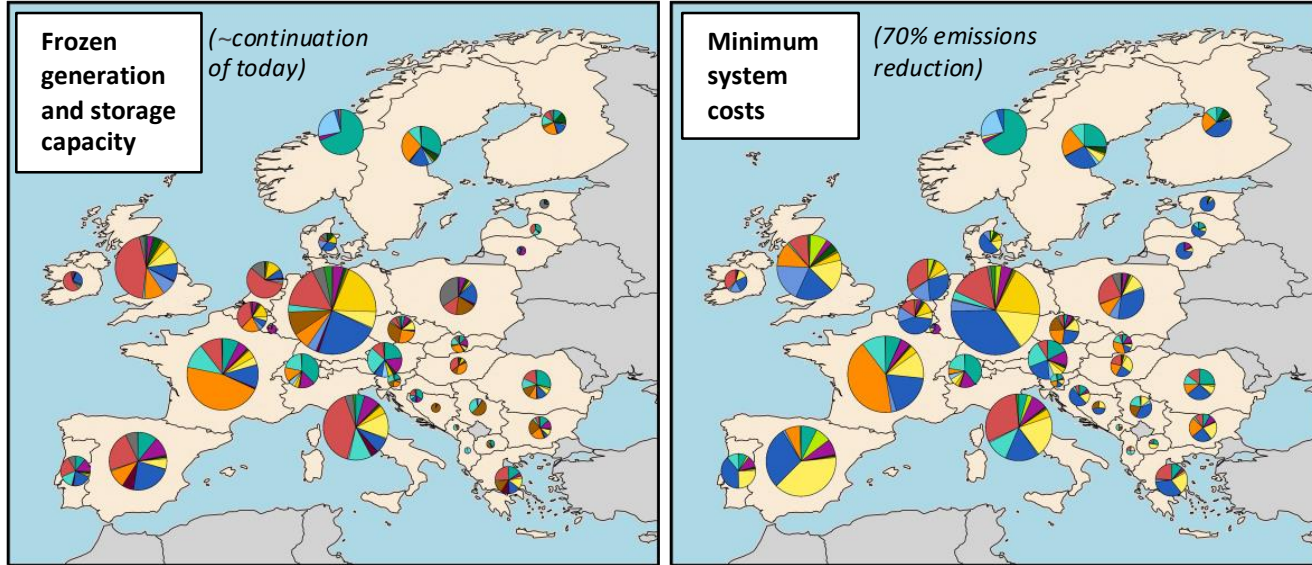
Data source: Energy and Climate Intelligence Unit, Data-Driven EnviroLab, NewClimate Institute, Oxford Net Zero - Net Zero Tracker (2023)

[OurWorldinData.org/co2-and-greenhouse-gas-emissions](https://OurWorldinData.org/co2-and-greenhouse-gas-emissions) | CC BY

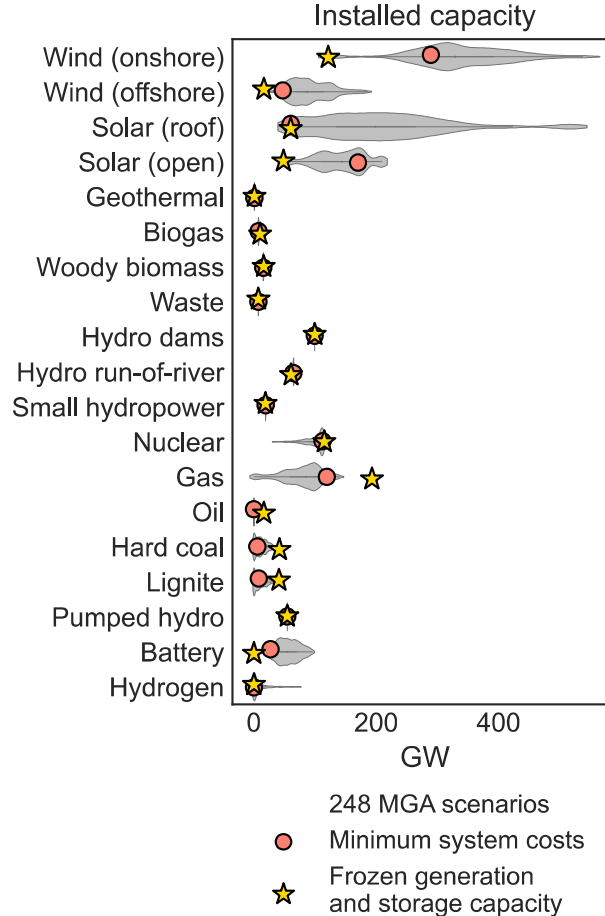
# 70% emissions reduction in the European electricity sector by 2035 (1)



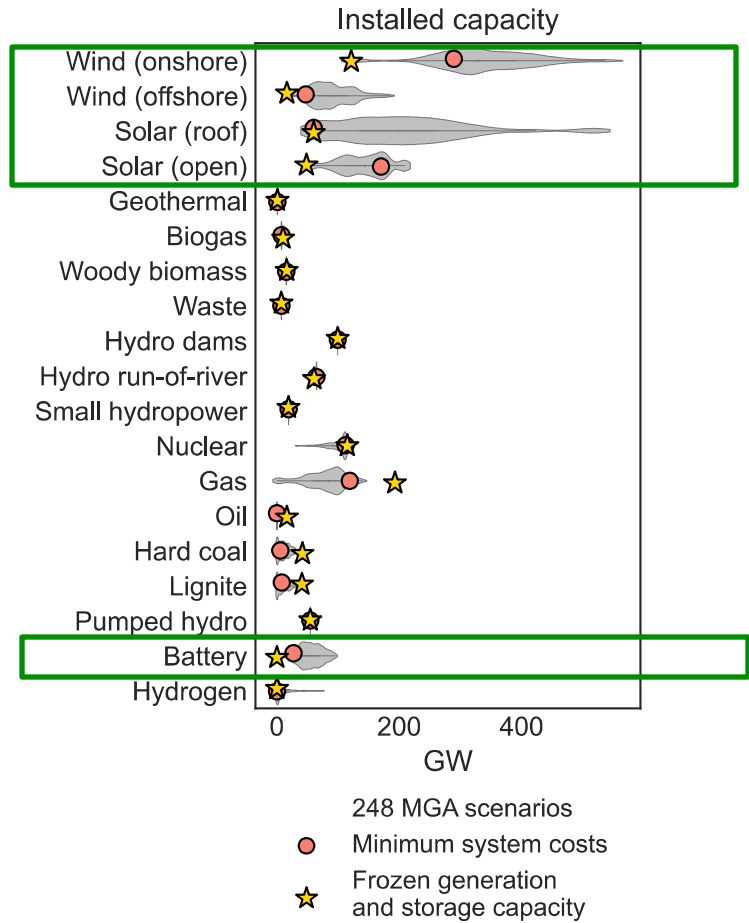
# 70% emissions reduction in the European electricity sector by 2035 (1)



# 70% emissions reduction in the European electricity sector by 2035 (2)



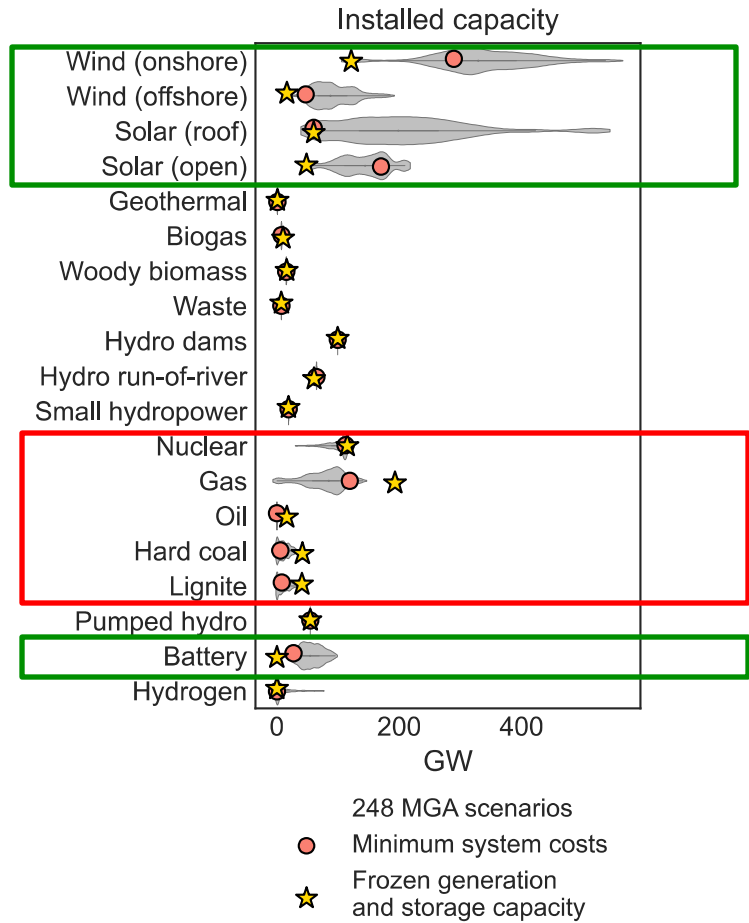
# 70% emissions reduction in the European electricity sector by 2035 (2)



## Certain technologies

Cost competitiveness, growing markets, decreasing risk, modular and hence easier projects etc.

# 70% emissions reduction in the European electricity sector by 2035 (2)



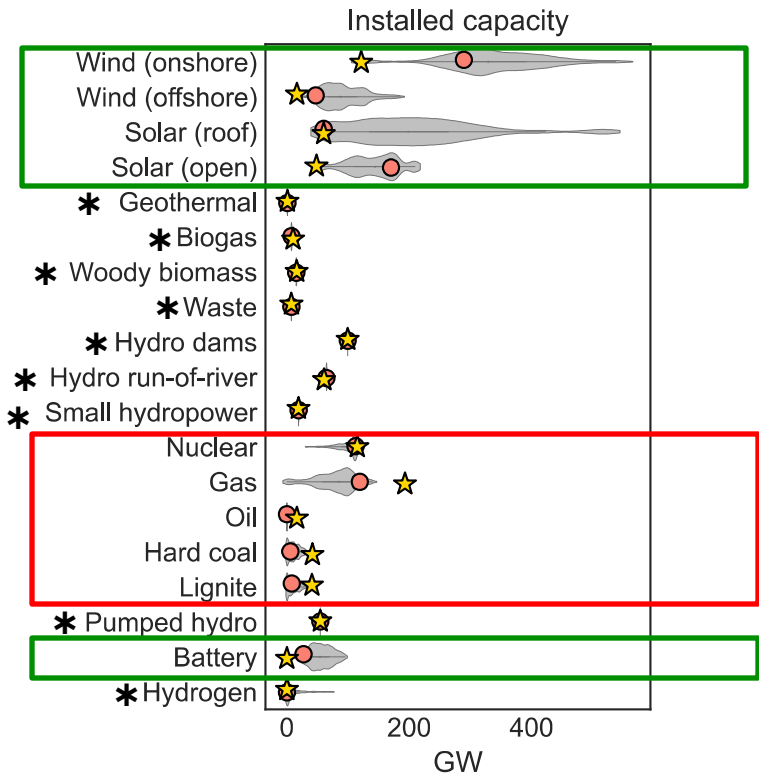
## Certain technologies

Cost competitiveness, growing markets, decreasing risk, modular and hence easier projects etc.

## Declining technologies

Declining markets and supply chains, ever increasing transition risk, high complexity of nuclear projects etc.

# 70% emissions reduction in the European electricity sector by 2035 (2)



## Certain technologies

Cost competitiveness, growing markets, decreasing risk, modular and hence easier projects etc.

## \*Optional technologies

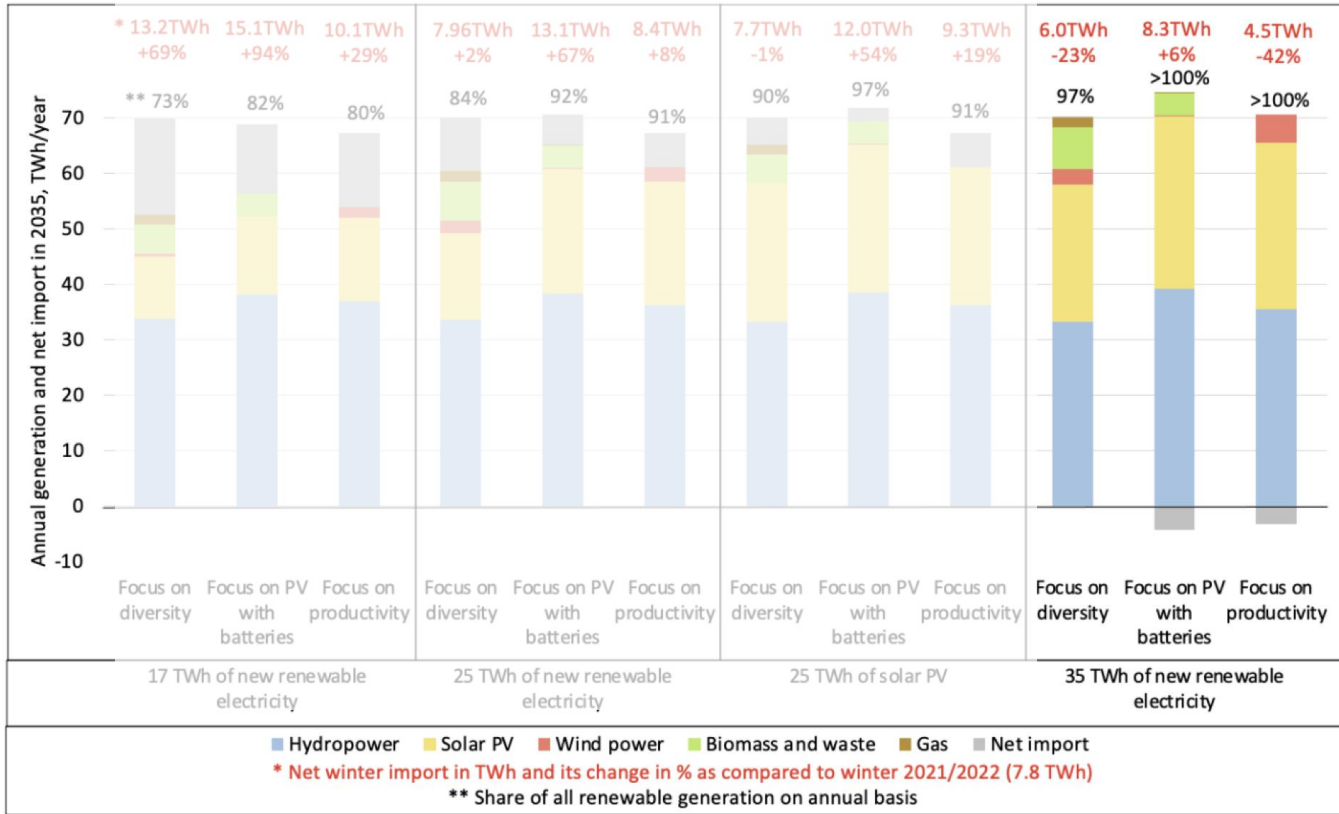
Good low-carbon technologies with limited market potential (e.g. geothermal) or some risk/uncertainty (hydrogen)

## Declining technologies

Declining markets and supply chains, ever increasing transition risk, high complexity of nuclear projects etc.

248 MGA scenarios  
 ● Minimum system costs  
 ★ Frozen generation and storage capacity

# 35 TWh new renewable electricity in Switzerland by 2035 (1)

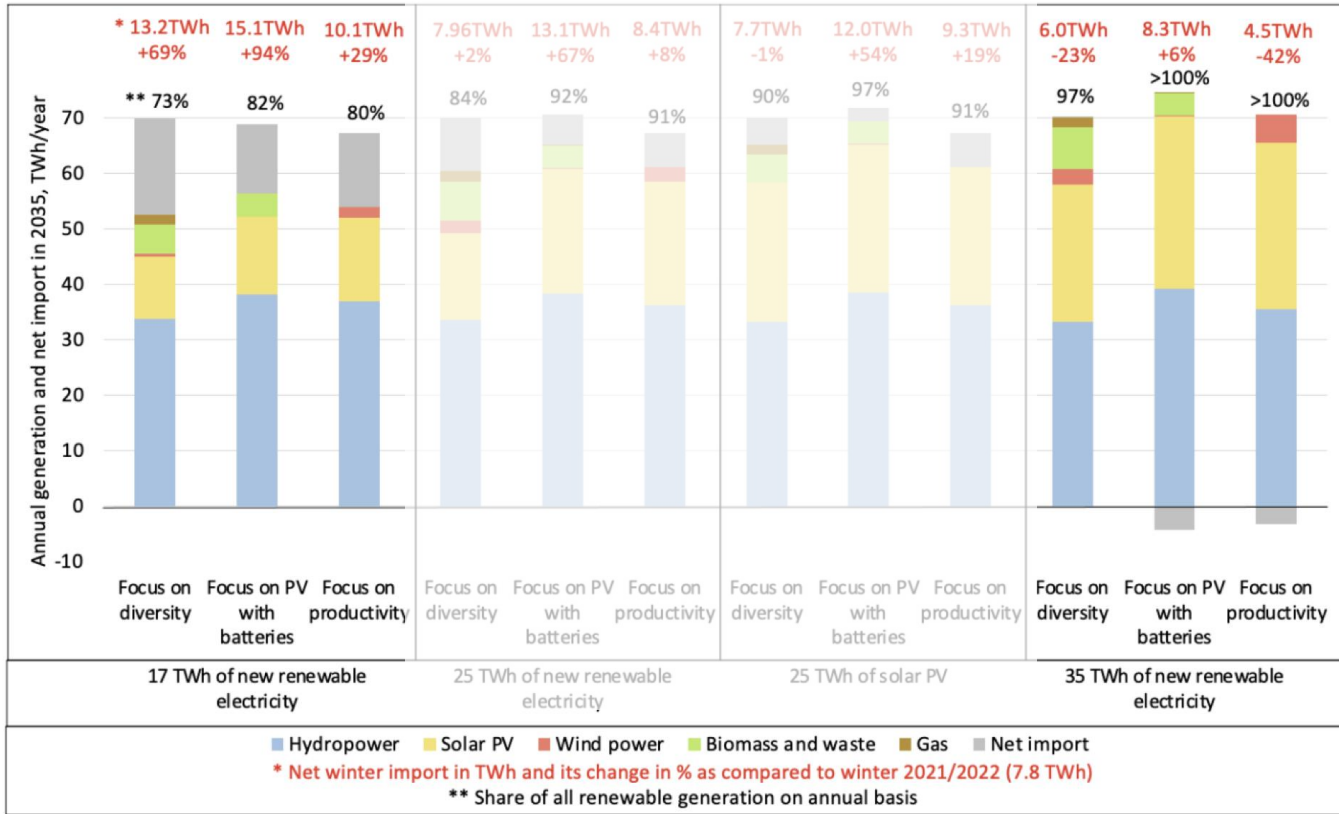


**Assumed demand:**  
 8.5 TWh heat pumps +  
 5.0 TWh EVs + 47.7 TWh  
 other = 61.2 TWh

**Note:** Electricity  
 interconnection with  
 neighbouring countries  
 remains key!

Source: Renewable Energy Outlook 2024,  
 Heinisch et al. (2023) *Applied Energy*

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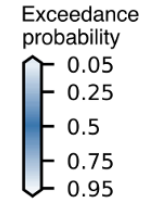
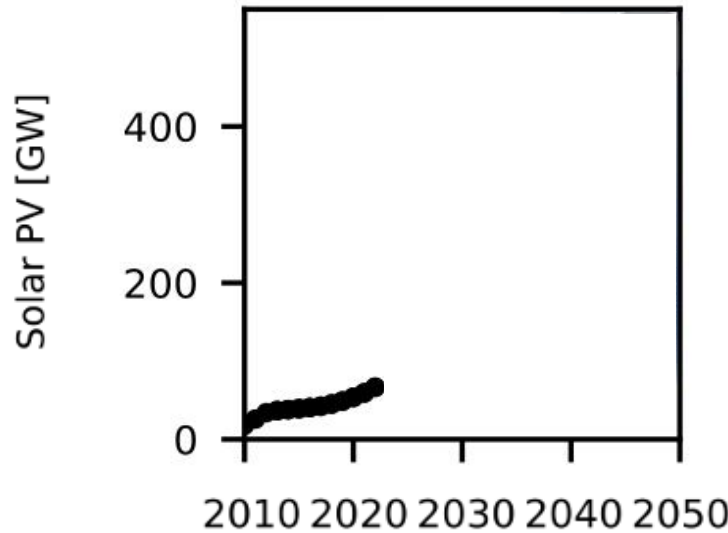
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# Expected progress in Europe (1)

## Solar PV in Germany



Required quantities:

- European Green Deal - Fit for 55
- ◆ TYNDP 2022 - National Trends

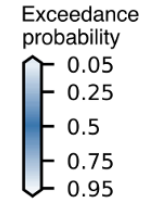
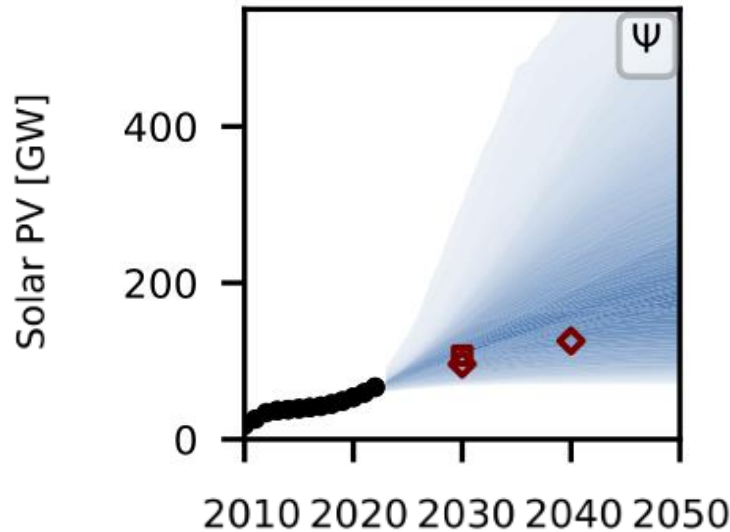
Data suitability indicator:

- ⊖ Short historical diffusion
- △ Rates in historical diffusion decrease
- ψ Multi-S-curve in historical diffusion

Source: Zielonka and Trutnevyte (2025)  
iScience, Zielonka et al. (2023) PNAS Nexus

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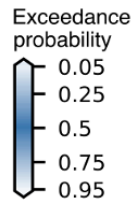
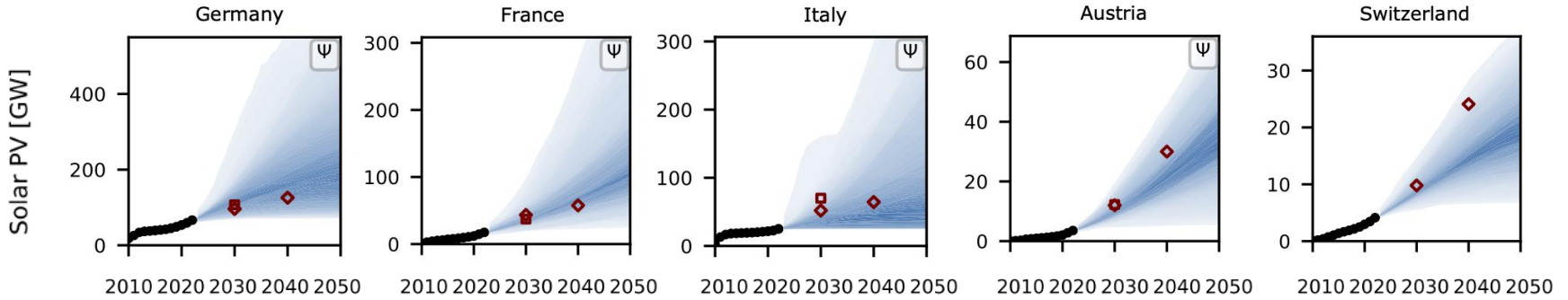
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# Expected progress in Europe (2)

## Solar PV



Required quantities:

- European Green Deal - Fit for 55
- ◆ TYNDP 2022 - National Trends

Data suitability indicator:

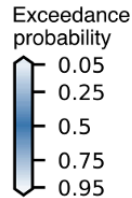
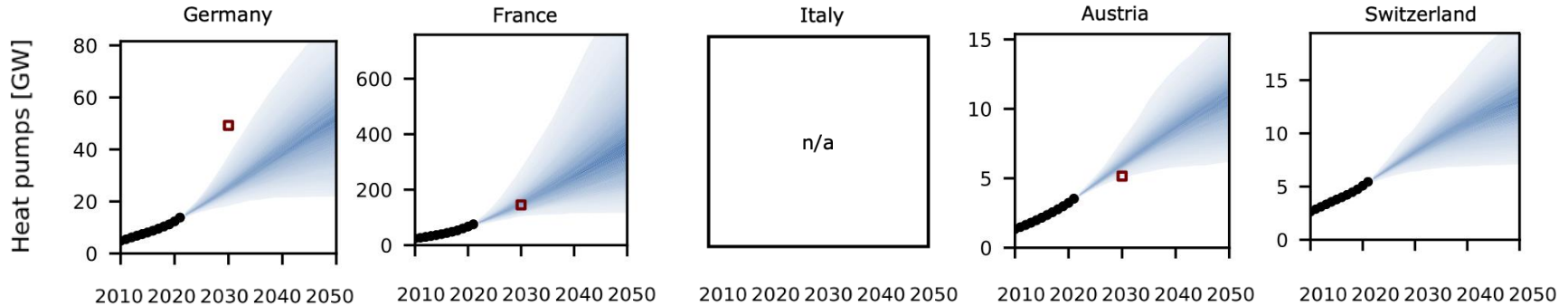
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Source: Zielonka and Trutnevyte (2025) *iScience*, Zielonka et al. (2023) *PNAS Nexus*



# Expected progress in Europe (4)

## Heat pumps



Required quantities:

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- ◆ TYNDP 2022 - National Trends

Data suitability indicator:

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Source: Zielonka and Trutnevyte (2025) *iScience*, Zielonka et al. (2023) *PNAS Nexus*

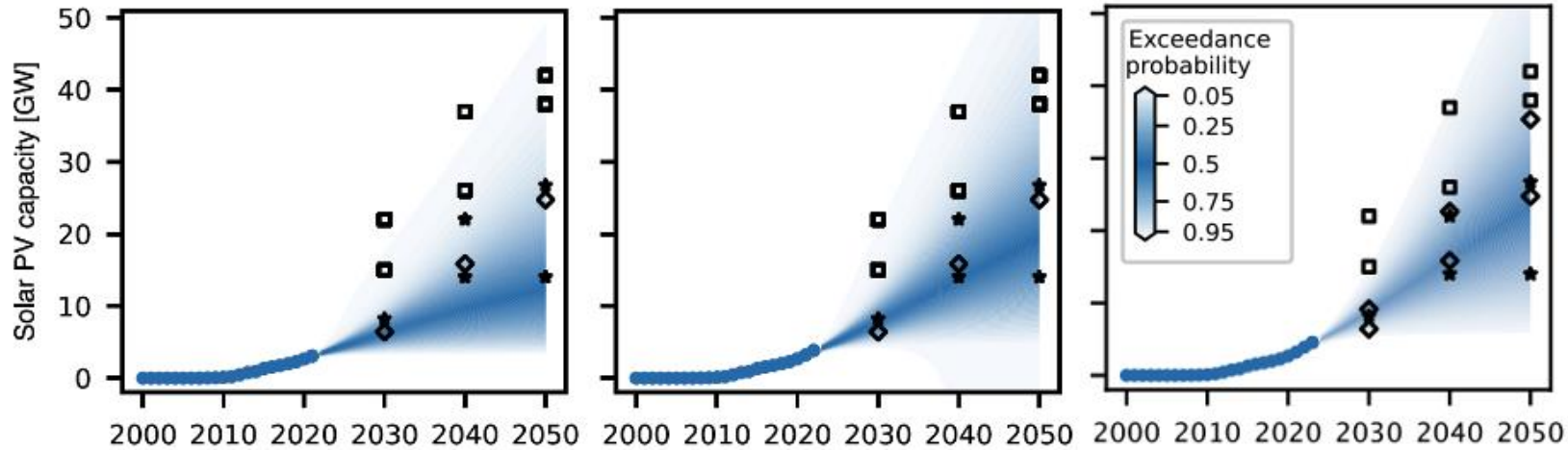
# Expected progress in Switzerland in more detail (1)

Solar PV projections with data until...

2021

2022

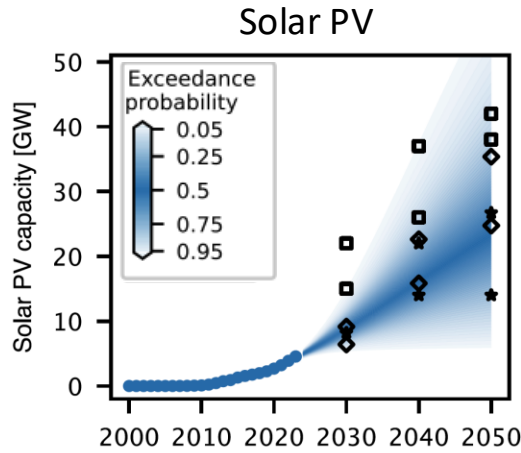
2023



(◇) Prognos et al. 2020  
 (●) Consentec et al. 2022  
 (\*) Verband Schweizerischer Elektrizitätsunternehmen (VSE) 2022

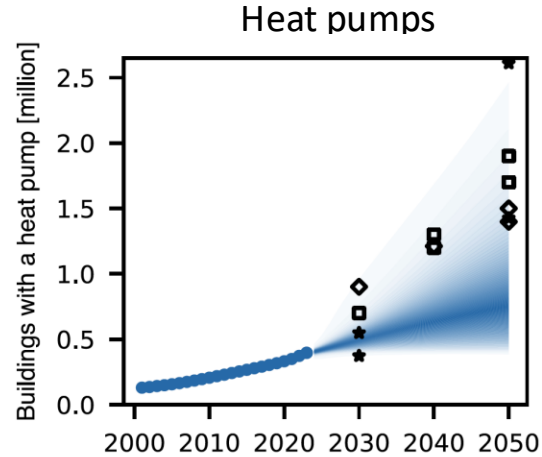
Source: Zielonka et al. (2023) *PNAS Nexus*

# Expected progress in Switzerland in more detail (2)



12 GW // ~ 12 TWh in 2035

REO: >25 TWh



570'000 buildings // ~ 5 TWh in 2035

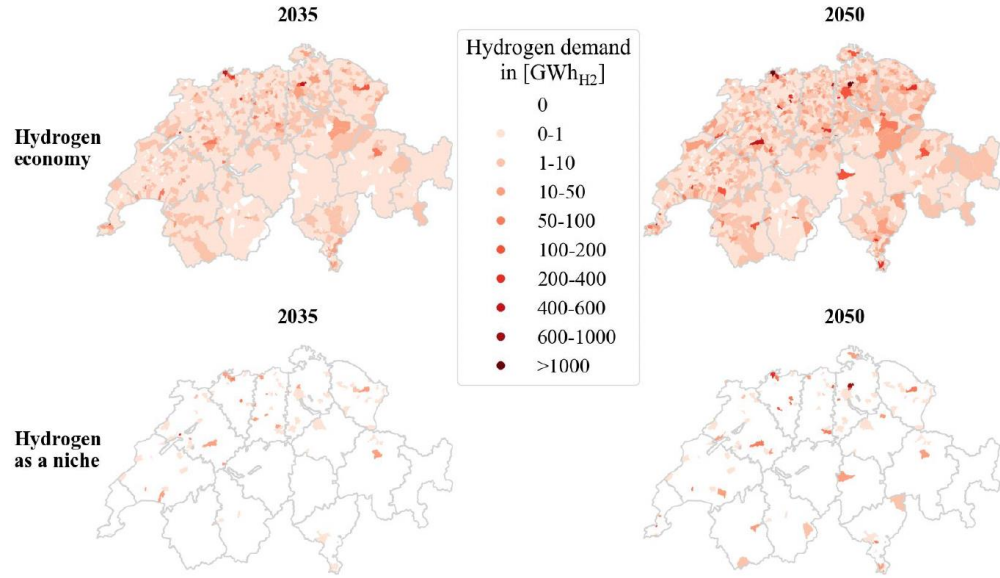
REO: 8.5 TWh

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Source: Zielonka et al. (2023) PNAS Nexus

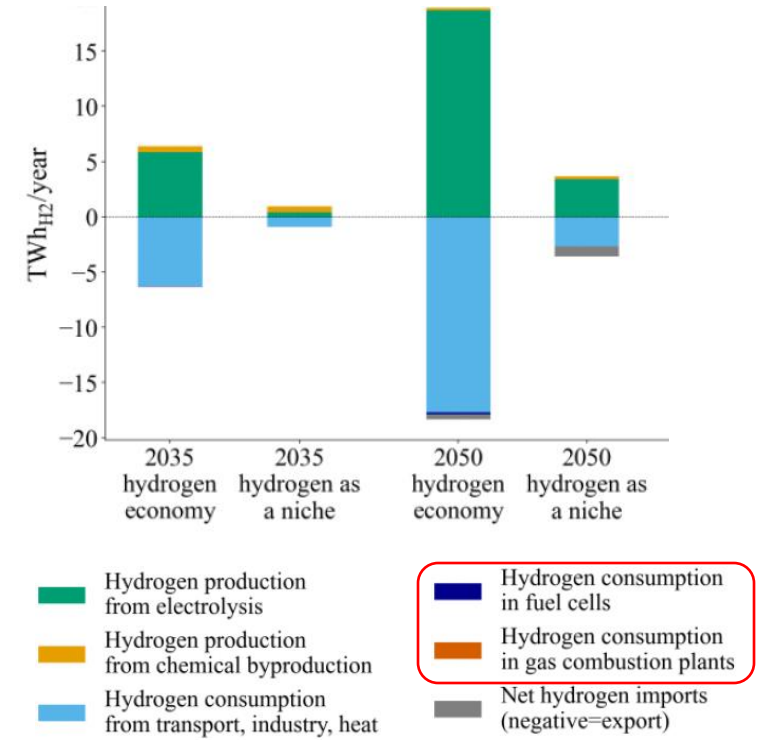
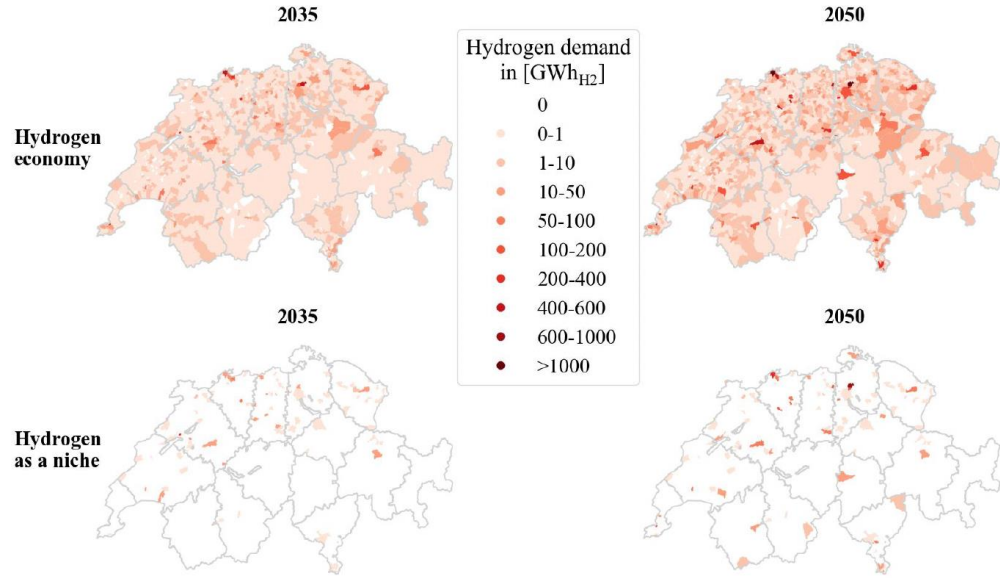
# The potential role of hydrogen

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Source: Wallinger et al. (submitted) *International Journal of Hydrogen Energy*

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## Implications for thermal energy storage

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  - The potential role of hydrogen for seasonal electricity storage for now appears limited in Switzerland



Get in touch with  
questions and  
comments!

Evelina Trutnevyte

University of Geneva

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[@unigeenergy.bsky.social](https://bsky.app/profile/unigeenergy.bsky.social)

[@sweet-edge.bsky.social](https://bsky.app/profile/sweet-edge.bsky.social)



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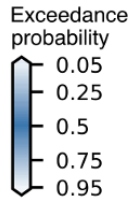
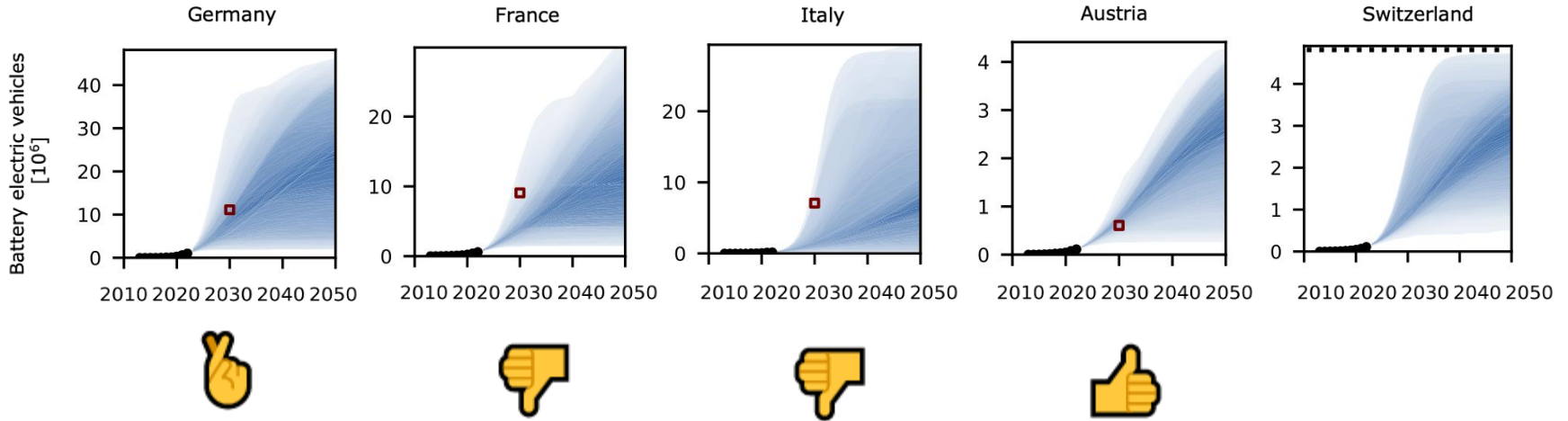
Federal Department of Economic Affairs,  
Education and Research EAER  
State Secretariat for Education,  
Research and Innovation SERI



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# Expected progress in Europe (5)

## Battery electric vehicles

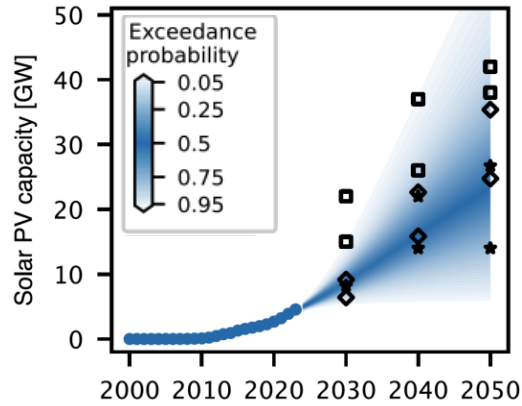


- Required quantities:
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Source: Zielonka and Trutnevyte (2025) *iScience*, Zielonka et al. (2023) *PNAS Nexus*

# Expected progress in Switzerland in more detail (2)

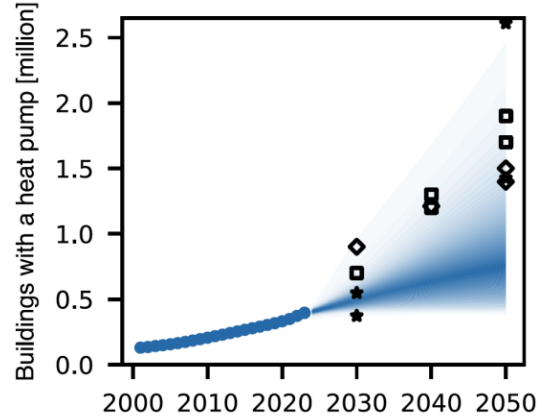
### Solar PV



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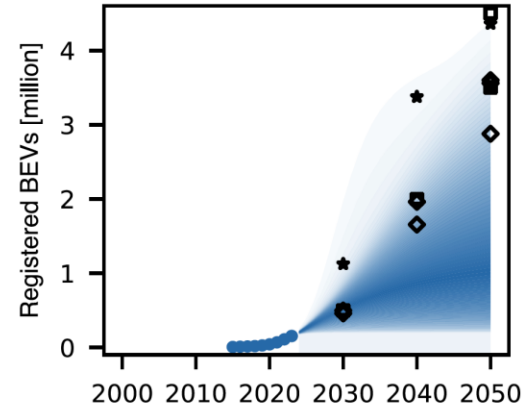
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### Battery electric vehicles



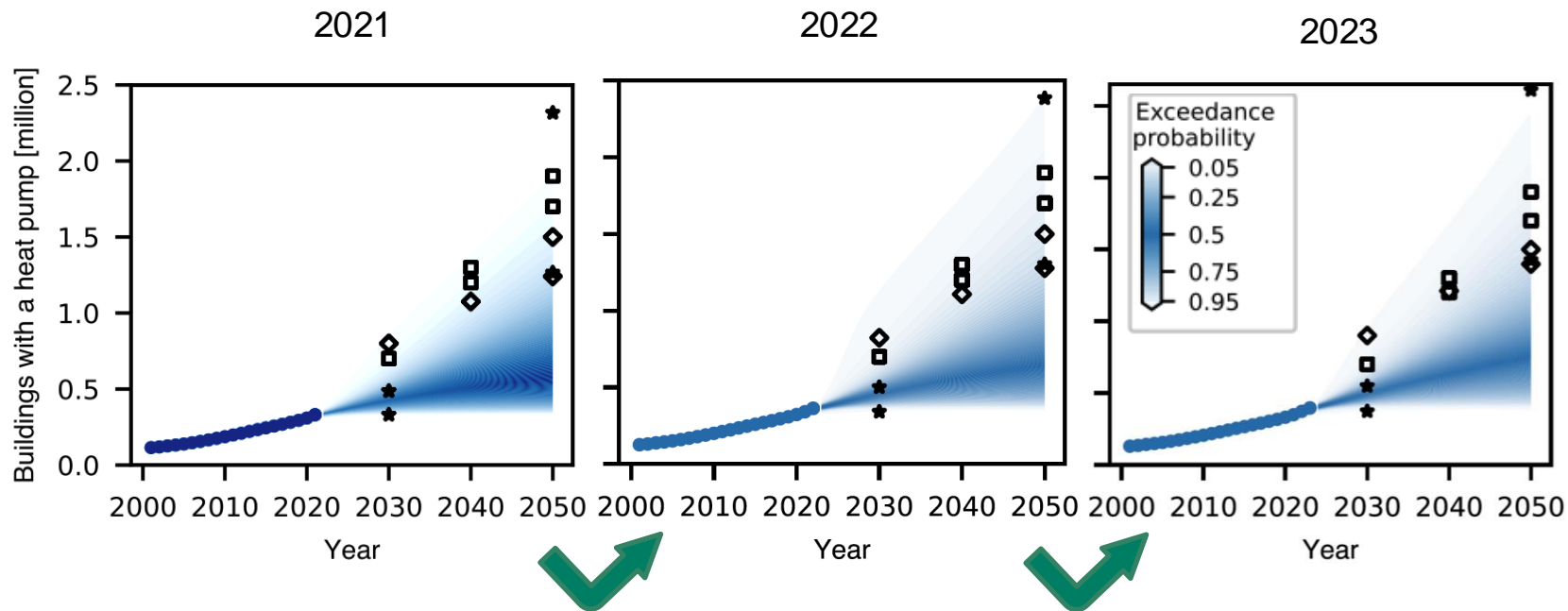
725'000 BEVs // ~ 3 TWh in 2035

REO: 5.0 TWh

(◊) Prognos et al. 2020  
 (•) Consentec et al. 2022  
 (\*) Verband Schweizerischer Elektrizitätsunternehmen (VSE) 2022

Source: Zielonka et al. (2023) PNAS Nexus

# Heat pump projections trained until...



Source: Prognos AG et al. (2020), Consentec GmbH et al. (2022), VSE (2022), Zielonka et al. (2023)