

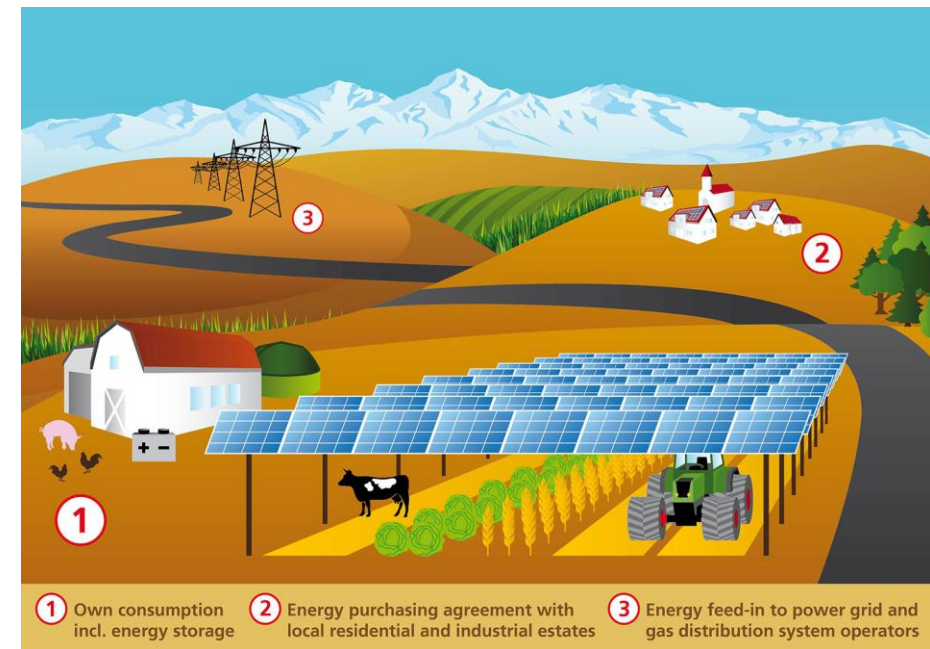
Agrivoltaic systems as part of modern energy sector

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Outline

1. Introduction to agrivoltaic systems
2. Pilot projects in Europe
3. CZ x AT (energy, electricity mix, ...)
4. Legislative background



Types of agrivoltaic systems

- The main division of agrivoltaic installations is in vertical and horizontal forms
- Mainly are used bifacial photovoltaic panels
- Horizontal agrivoltaic system – south oriented panels or east-west “roofs” oriented with panels – protection role
- Vertical agrivoltaic system – east-west oriented “fences” – less than 10 % of land for technology



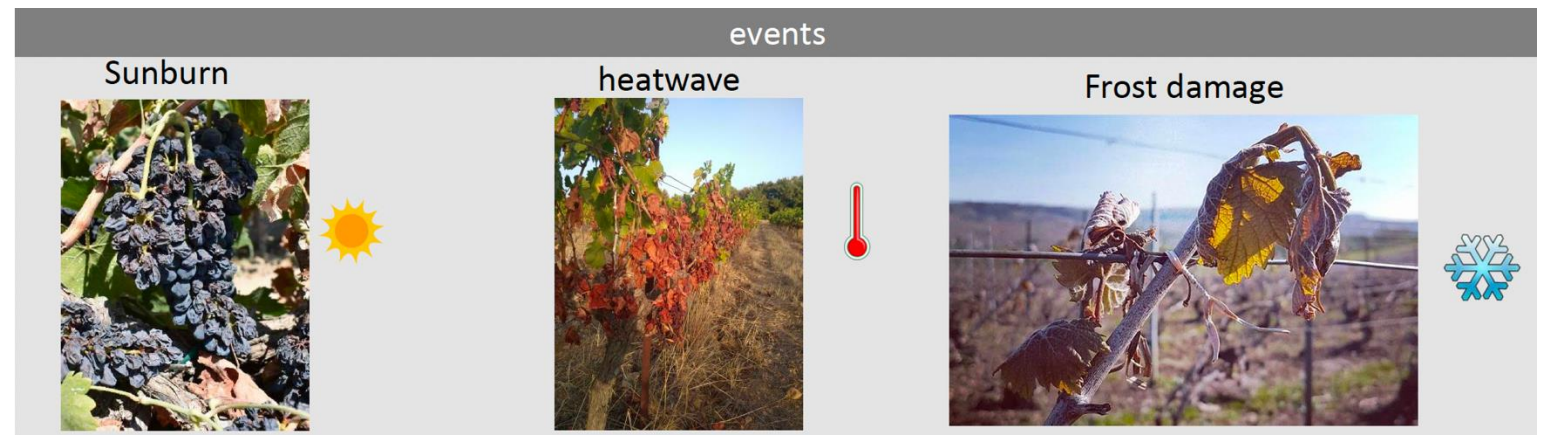
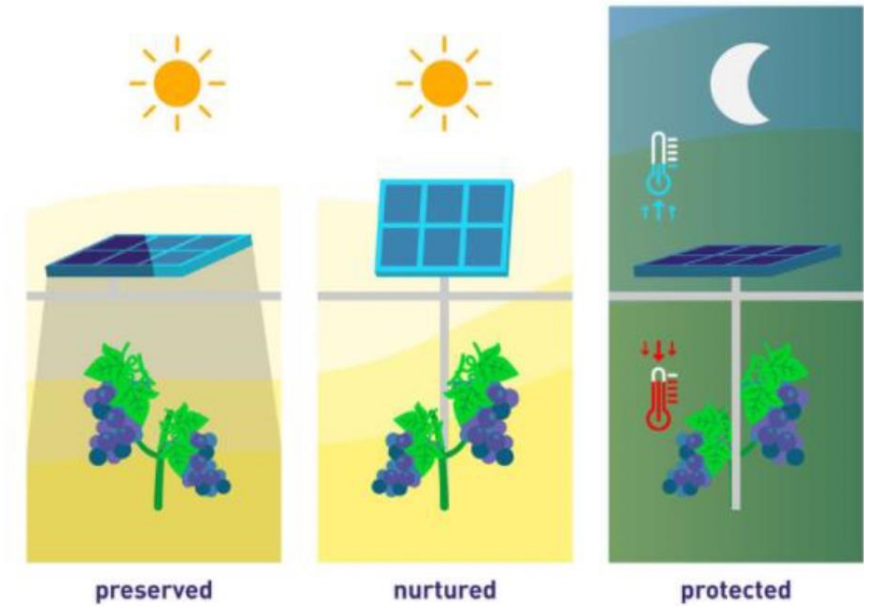
Multiple benefits of agrivoltaic system

- Technical – e.g. distributed electricity production
- Economic - decrease electricity costs and bring additional economic profit/savings for farmers
- Social - sector development and local employment increase
- Environmental - agrivoltaics systems produce “green” electricity, improve soil conditions, improve conditions for planting crops



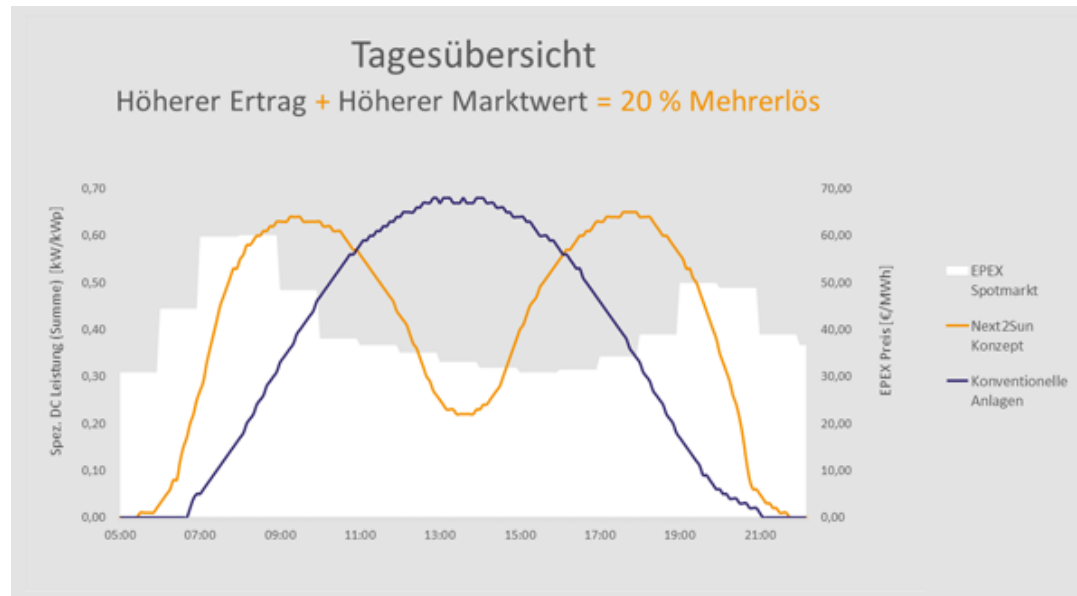
Production protection

- Physical protection of fruit from heavy rain/hail
- Reducing the pressure of fungal diseases
- Protection against damage from strong direct sunlight
- Protection against spring frosts and high temperatures
- Differences between fixed structures and structures with a tracker



Agrivoltaics – technical aspects

- It depends on the orientation of the panels
- Land slope -> selection of appropriate technology
- A compromise between electricity production and ideal conditions for cultivated crops



Agrivoltaics in France



- Vineyards, orchards



Agrivoltaics in France



Agrivoltaics in Italy

- Corn, flax, alfalfa, vegetable
- <https://www.youtube.com/watch?v=CTxudB8sYqg>



Typ 1.0 – year 2011

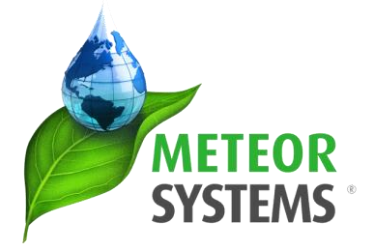


Typ 2.0 – year 2023



- Shading 11 % → 50 %

Agrivoltaics in Holland



- Blueberries, raspberries, strawberries, cherry, red currant

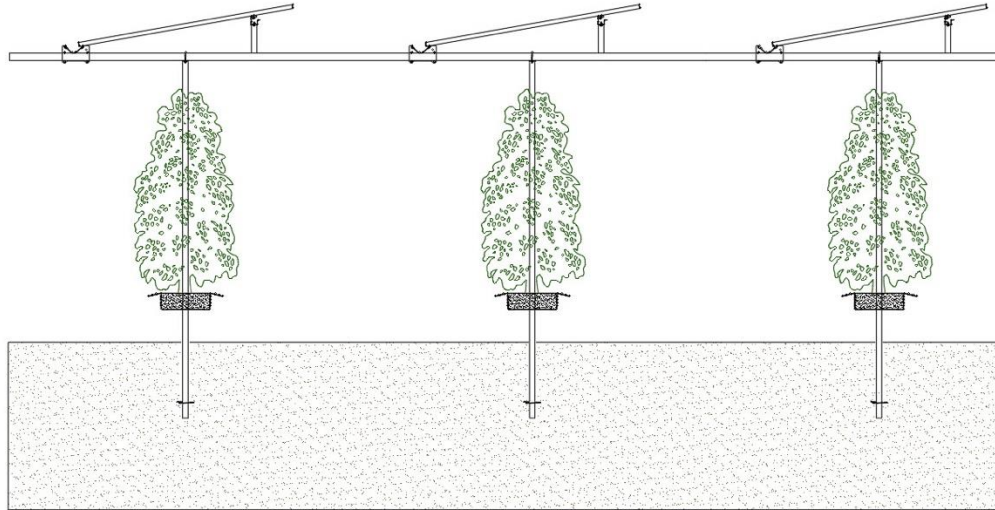


Agrivoltaics in Holland

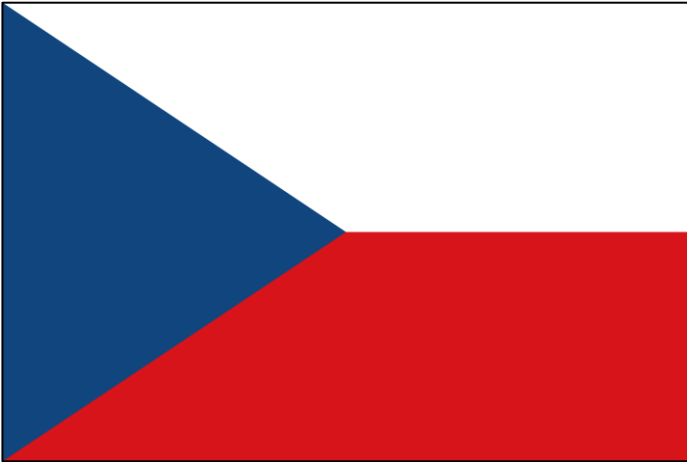


Holland – GreenMeteor technical solution

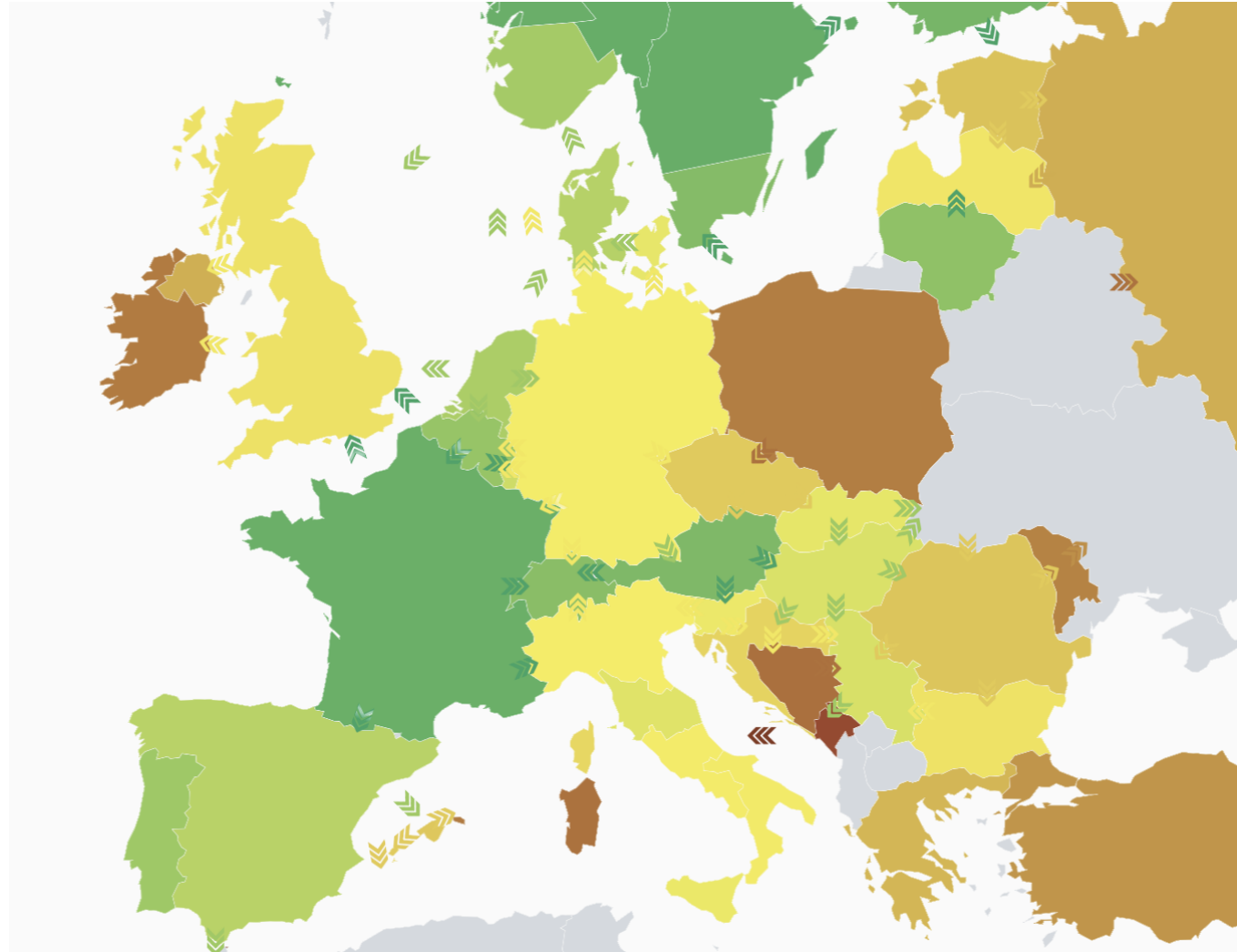
- Irrigation and rainwater retention - a solution from the Green Meteor company - manufactures structures for fruit growing, also solves irrigation systems
 - Water use – retention capacity or direct drainage to plants at current rainfall



Czechia vs. Austria

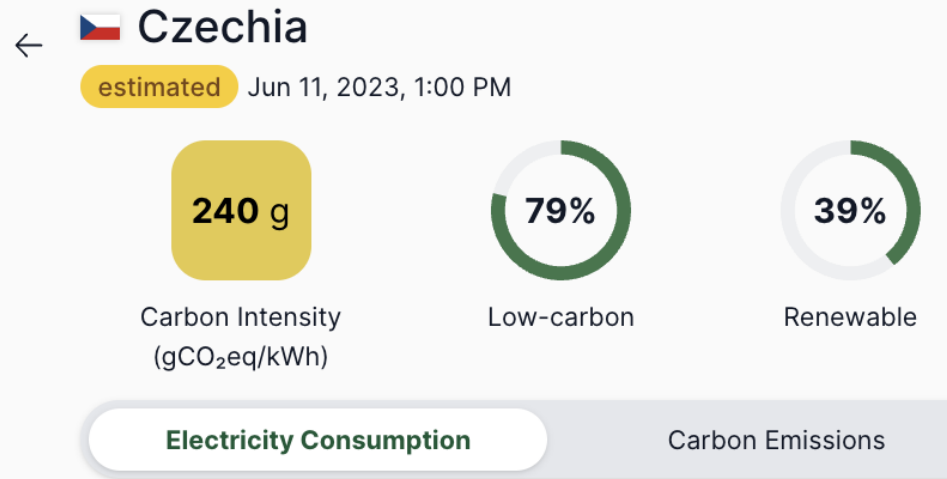


Electricity production – 11. 6. 2023 13:00

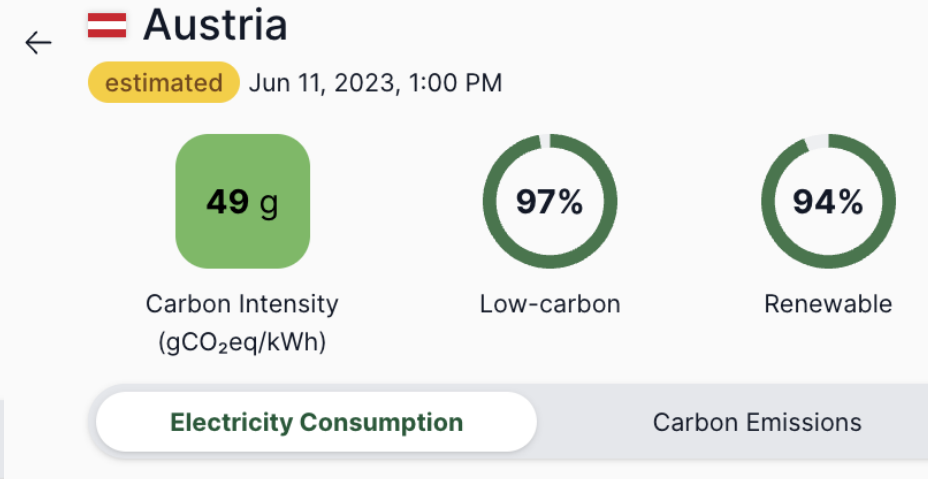
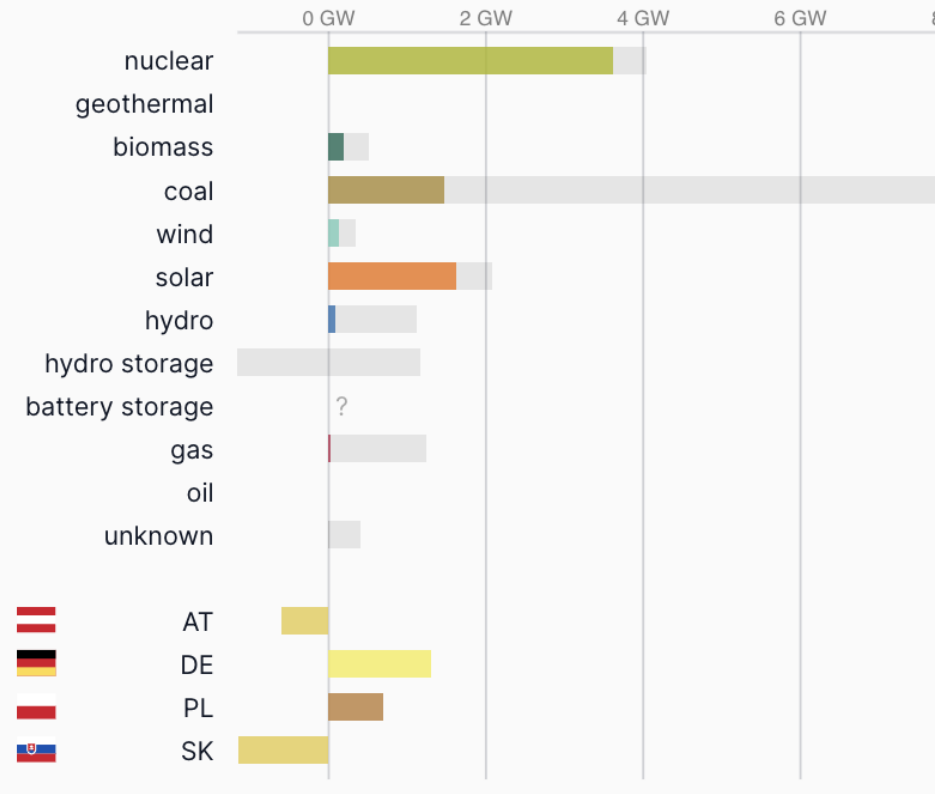


Electricity mix CZ x AT

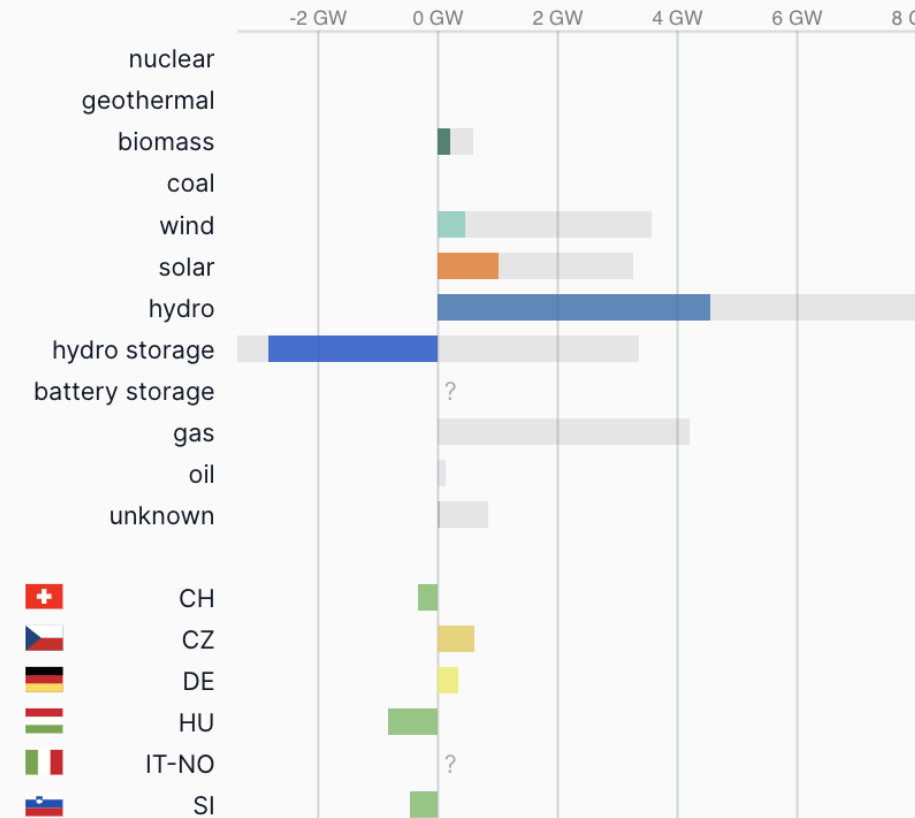
- Installed capacity
- Actual production
- Import x Export
- 11. 6. 2023 13:00



Electricity production by source



Electricity production by source



Agrivoltaics in Austria



Agrivoltaics in Austria

- Grassland, conventional crops



Agrivoltaics in Austria

- Grassland, conventional crops



Agrivoltaics in Austria

- BOKU – university research project
- Wien Energie



Agrivoltaics in Austria – Styria 1 MW



Agrivoltaics in CZ – research project - VÚKOZ

- Agroforestry & conventional crops



Agrivoltaics in CZ – 06/2023

- The first commercial pilot project
- South Moravian region
- Wineryard
- 99 kWp installed power



Definition and legislative framework

- The core of the concept is similar in all countries: it is a **combination of food production and renewable electricity production**
- Formal definition doesn't exist till today – few tries in Germany France and now Czech Republic
- Each country has different legislative background → Problem to make one definition for all countries
- France try to make certification office and Germany make Din Spec norm

Technical-economic aspects

- Main differences against conventional photovoltaic are mighty construction and less installed power of each panel
- In all research articles about agrivoltaics just “electrical part” is in LCOE calculation

Country	Year	Installed power (KWP)	LCOE (EUR/kWh)
Germany	2020	1038	0.0829
Italy	2021	1000	0.0754
India	2022	520	0.0400
Netherlands	2022	130	0.0713

Czech and Austria power futures

EEX-PXE Czech Power Futures

2023-06-09  Day Weekend Week Month Quarter Year






Baseload

Name	Last Price	Last Volume	Settlement Price	Volume Exchange	Volume Trade Registration	Open Interest
Cal-24	-	-	135,340	-	-	677
Cal-25	-	-	125,250	-	-	214
Cal-26	-	-	106,300	-	-	10
Cal-27	-	-	-	-	-	-
Cal-28	-	-	-	-	-	-

EEX Austrian Power Future

2023-06-09  Day Weekend Week Month Quarter Year

Baseload

Name	Last Price	Last Volume	Settlement Price	Last Price	Last Volume	Settlement Price	Volume Exchange	Volume Trade Registration	Open Interest
Cal-24	-	8 784	145,300	8 784	-	17 568	219		-
Cal-25	-	-	132,880	-	-	-	46		-
Cal-26	-	-	114,250	-	-	-	2		-
Cal-27	-	-	102,500	-	-	-	-		-
Cal-28	-	-	102,020	-	-	-	-		-

Spain

EEX Spanish Power Futures

2023-06-09



[Day](#) [Weekend](#) [Week](#) [Month](#) [Quarter](#) [Year](#)

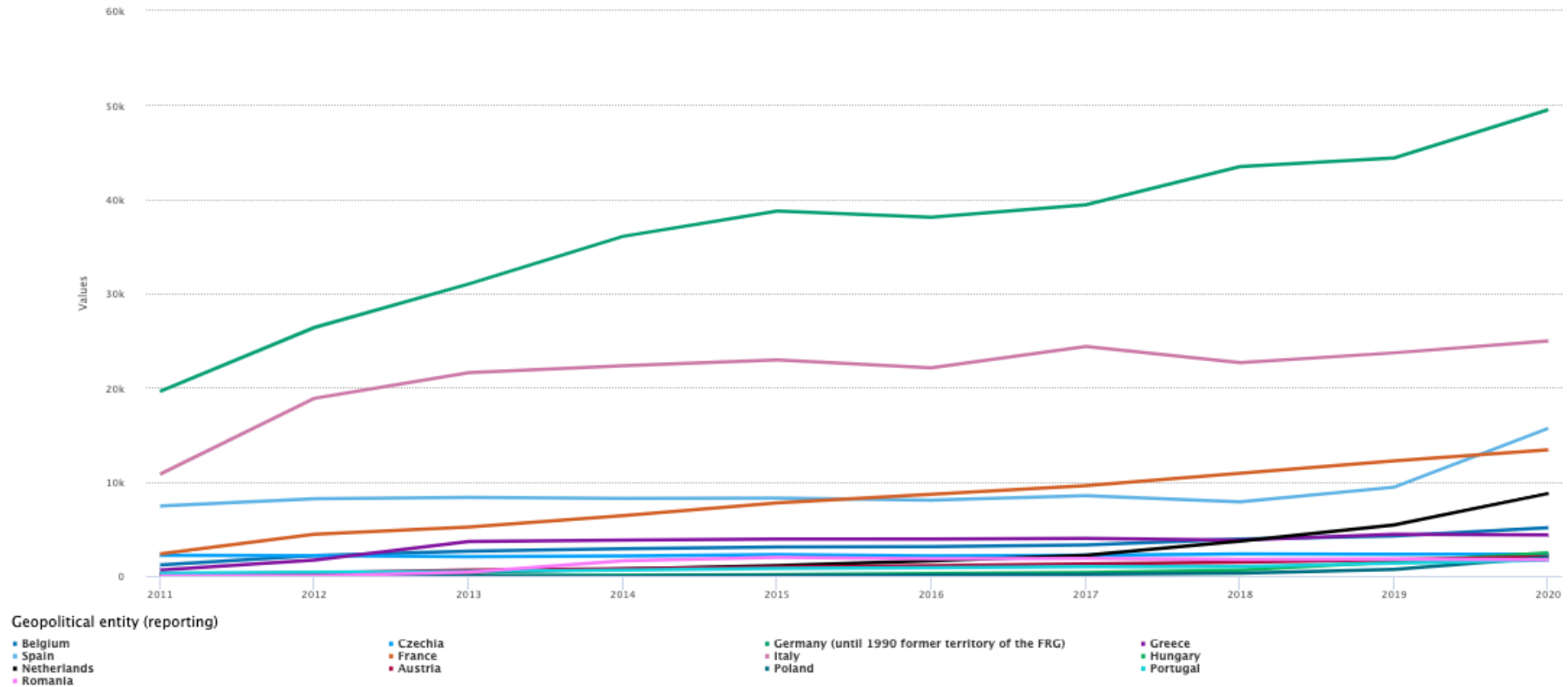
Baseload

Name	Last Price	Last Volume	Settlement Price	Volume Exchange	Volume Trade Registration	Open Interest
Cal-24	-	-	85,920	-	70 272	1 693
Cal-25	-	-	72,850	-	8 760	591
Cal-26	-	-	65,380	-	-	205
Cal-27	-	-	56,630	-	-	175
Cal-28	-	-	50,530	-	-	97
Cal-29	-	-	44,980	-	-	77

- Can we still build agrivoltaics systems? With or without subsidy?

Use of renewables for electricity – details

Time / Geopolitical entity (reporting) Time frequency:Annual Standard international energy product classification (SIEC):Solar photovoltaic Energy balance:Gross electricity production – Renewable Energy Directive Unit of measure:Gigawatt-hour



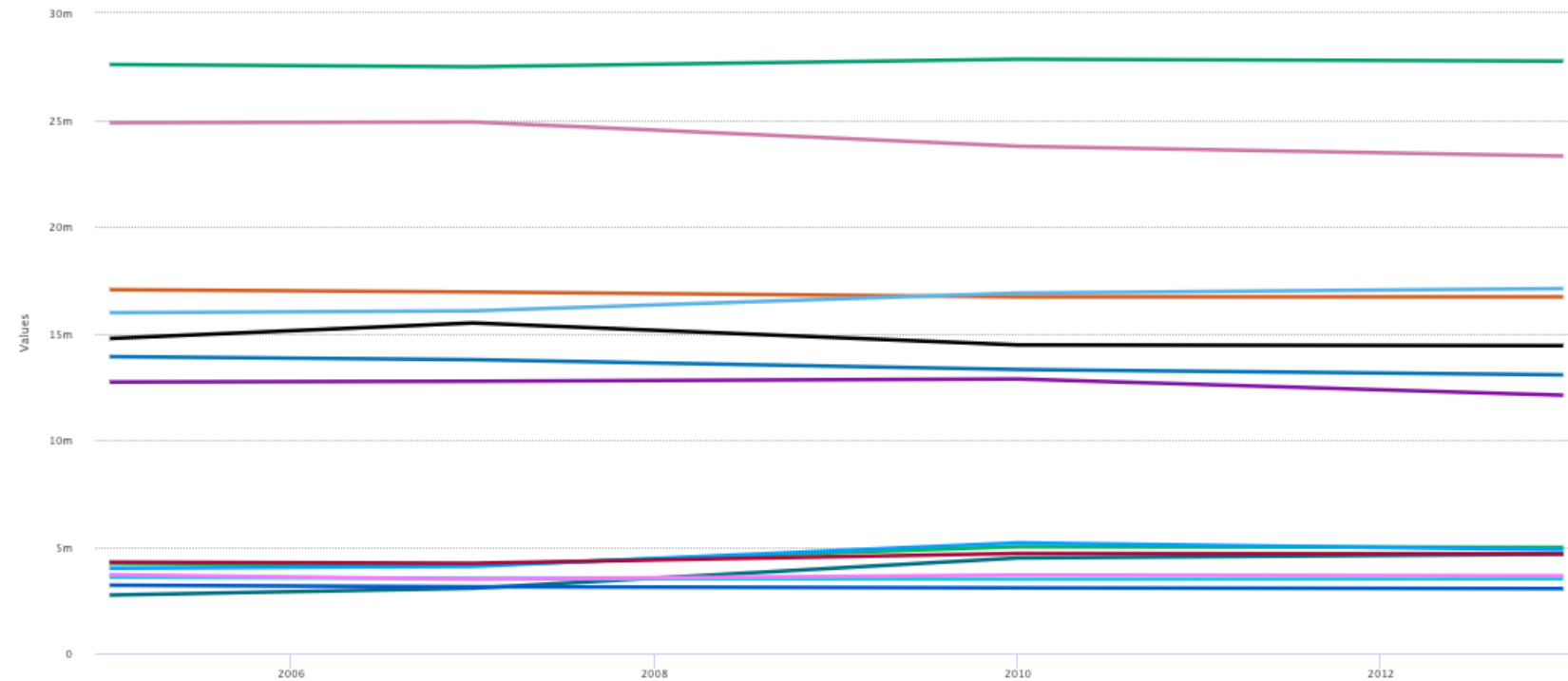
Use of renewables for electricity – details

Source of data: Eurostat (online data code: NRG_IND_URED)
Last update 27/01/2023 23:00

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Other land: number of farms and areas by agricultural size of farm (UAA)

Time / Geopolitical entity (reporting) Time frequency:Annual Agricultural area:Total Eurofarm indicators:ha: Utilised agricultural area



Geopolitical entity (reporting)

- Bulgaria
- Greece
- Hungary
- Sweden

- Czechia
- Spain
- Poland
- United Kingdom

- Germany (until 1990 former territory of the FRG)
- France
- Portugal

- Ireland
- Italy
- Romania

Other land: number of farms and areas by agricultural size of farm (UAA)

Source of data: Eurostat (online data code: EF_POWOOD)
Last update 08/02/2021 23:00

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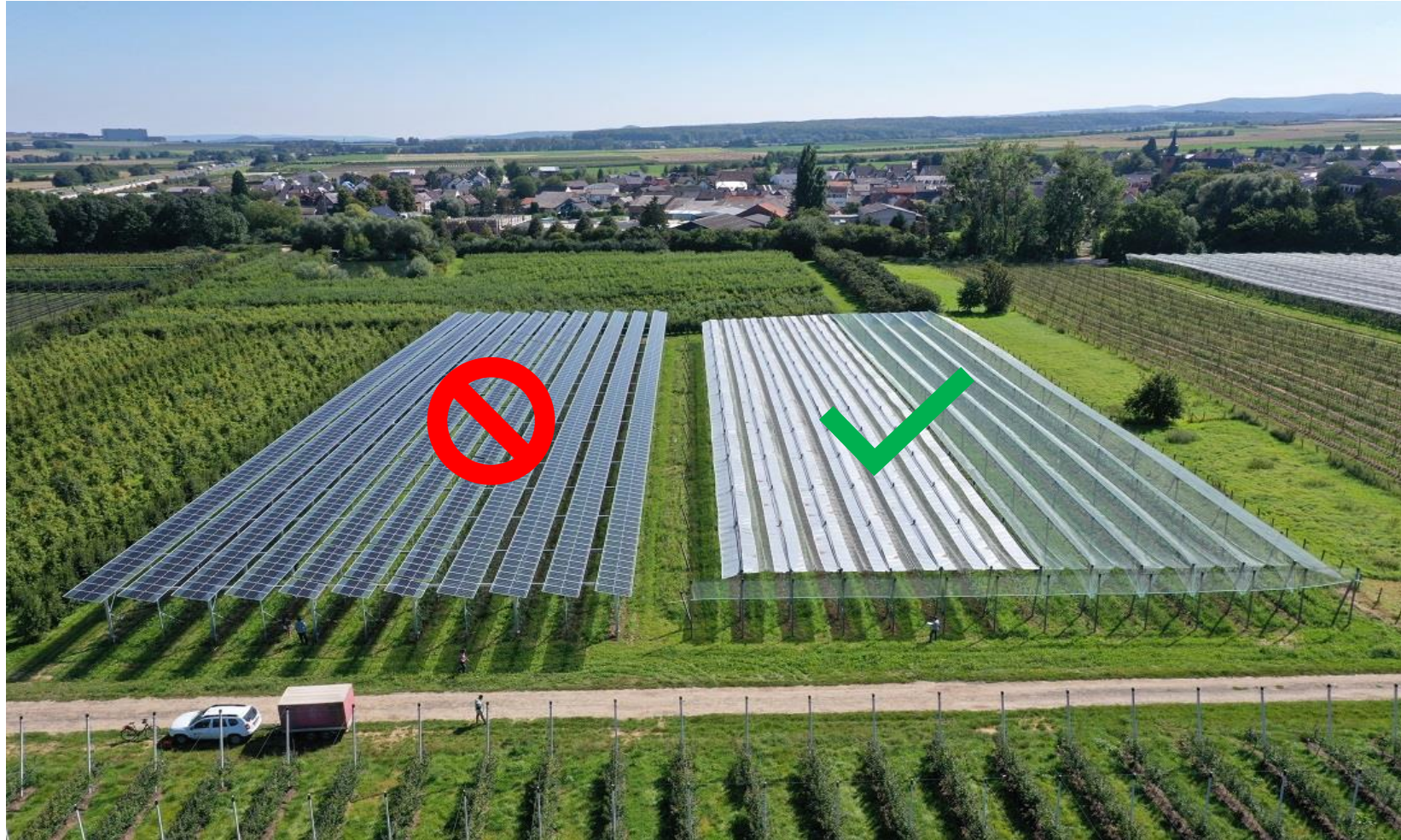
Barriers for development in CZ (Europe)

- The relationship of agrivoltaics to spatial planning - not yet resolved
- Act No. 334/1992 Coll., on the protection of agricultural land fund
 - It defines agrivoltaics, does not require an exemption from the ZPF, specifies a narrow definition of crops - permanent crops

Agrivoltaic legislation in the Czech Republic

- According to the Ministry of Environment, these decrees should contain (among other things):
- Limited types of agricultural culture - **Non-conceptual solution**
- Technical parameters (**e.g. performance limitations, spacing of supporting structures**)
- Cultivability of land, availability of water
- Determination of reference soil yield
- Subsequent reclamation, Anti-erosion protection
- Protection of underground amelioration and irrigation

Agrivoltaic legislation in the Czech Republic



Thank you for your attention

Contact

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