From Net Metering to Net Billing: Ensuring Fair Tariffs in the Age of Prosumers

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ERRA

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Scope and structure of the paper

GE

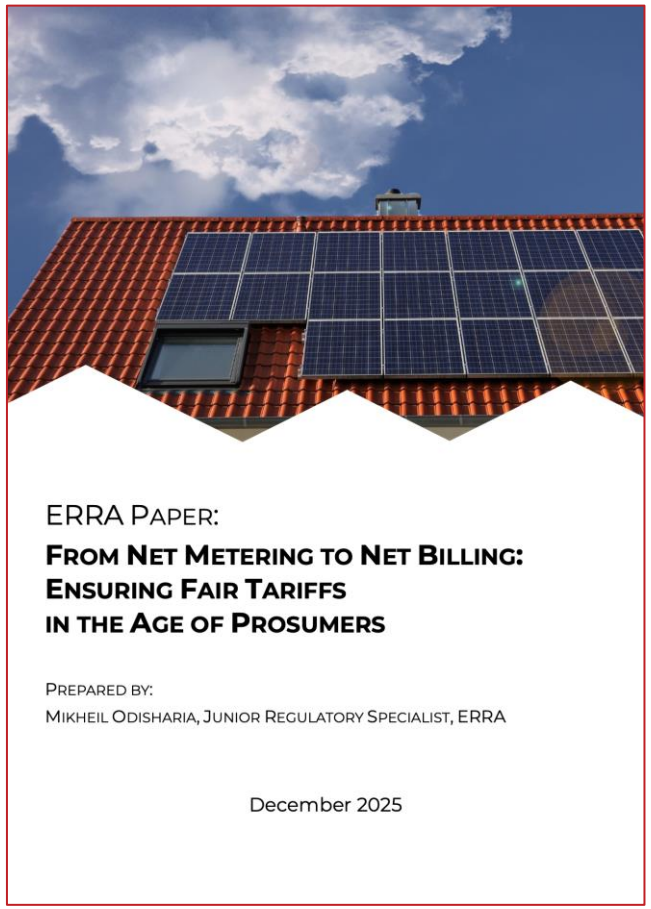
Main case study: recent transition from net metering to net billing (2023)

IT

Long-term regulatory evolution and design rationale (Scambio sul Posto phase-out) (EU example)

XK

Early regulatory adjustment and preventive shift to net billing (2023) (ENC example)



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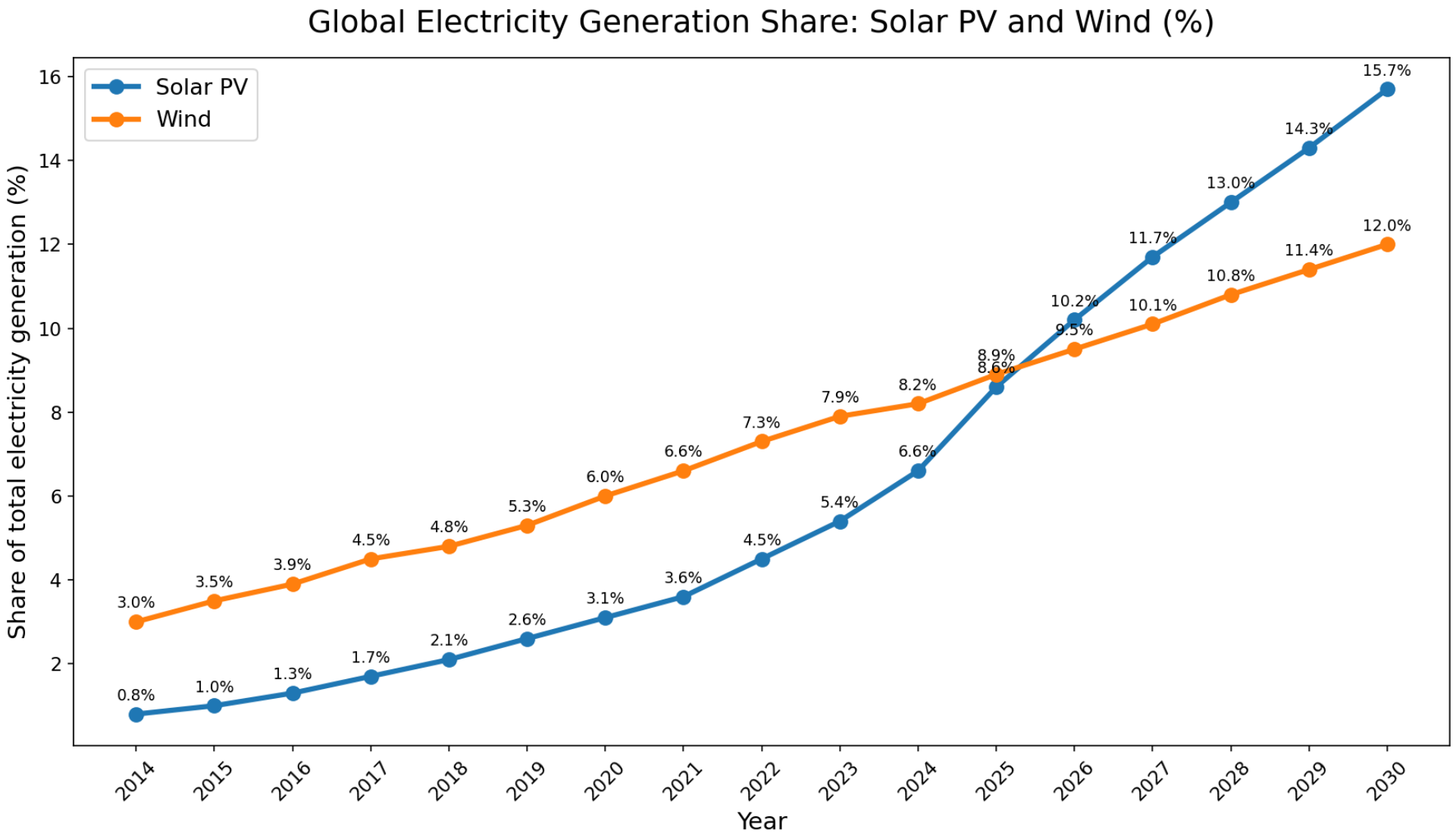
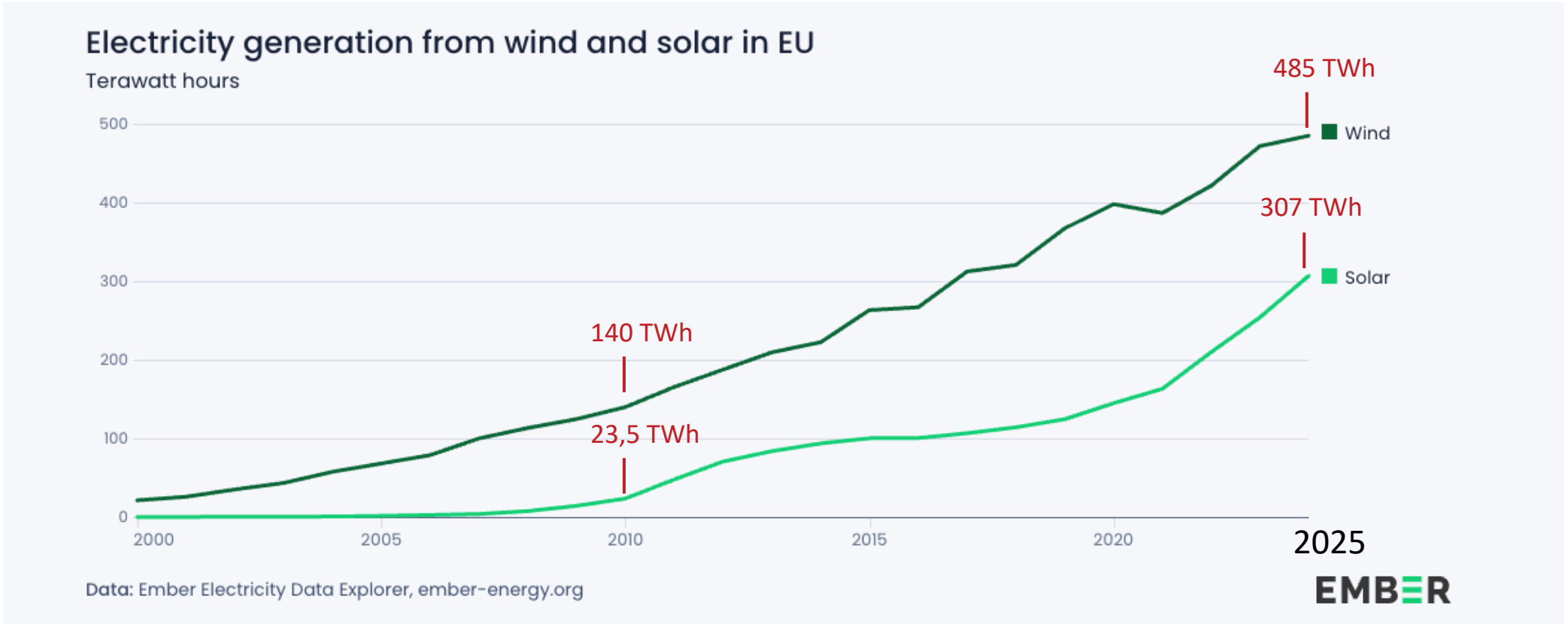
Global Context for Solar and Wind



https://www.iea.org/data-and-statistics/data-tools/renewable-energy-progress-tracker

EU solar and wind growth



Georgia Solar PV installed capacity

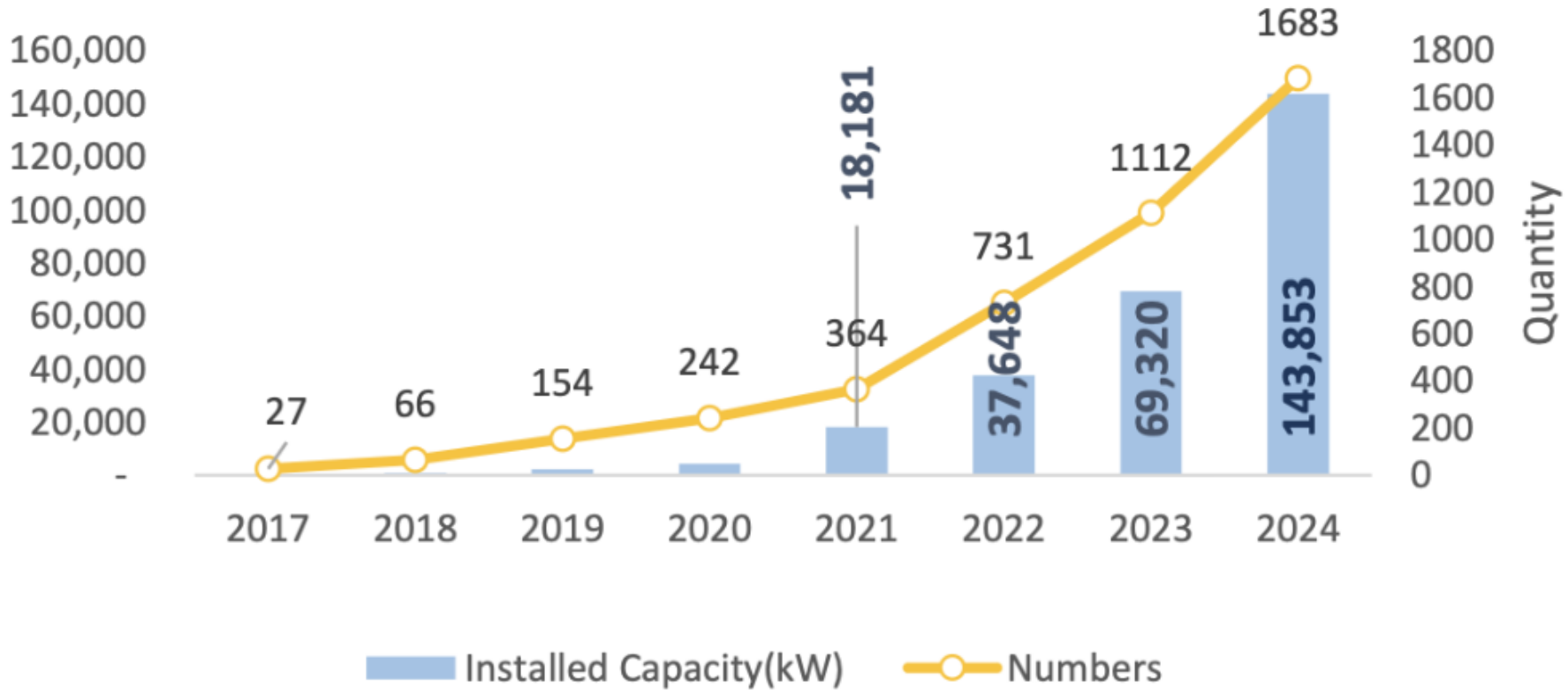
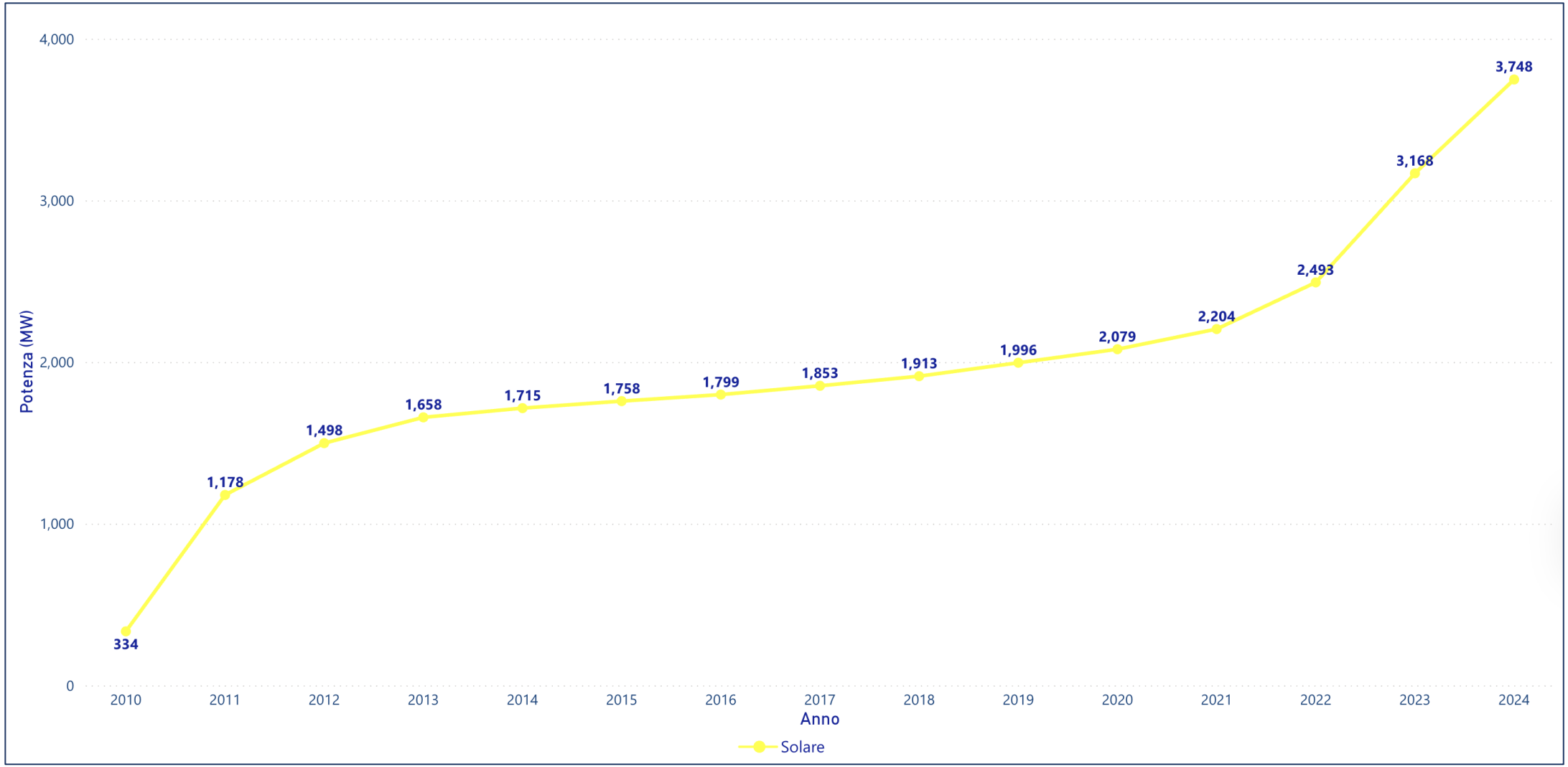


Figure 4. Installed capacity growth under Net metering (GNERC's annual report 2024)

Italy



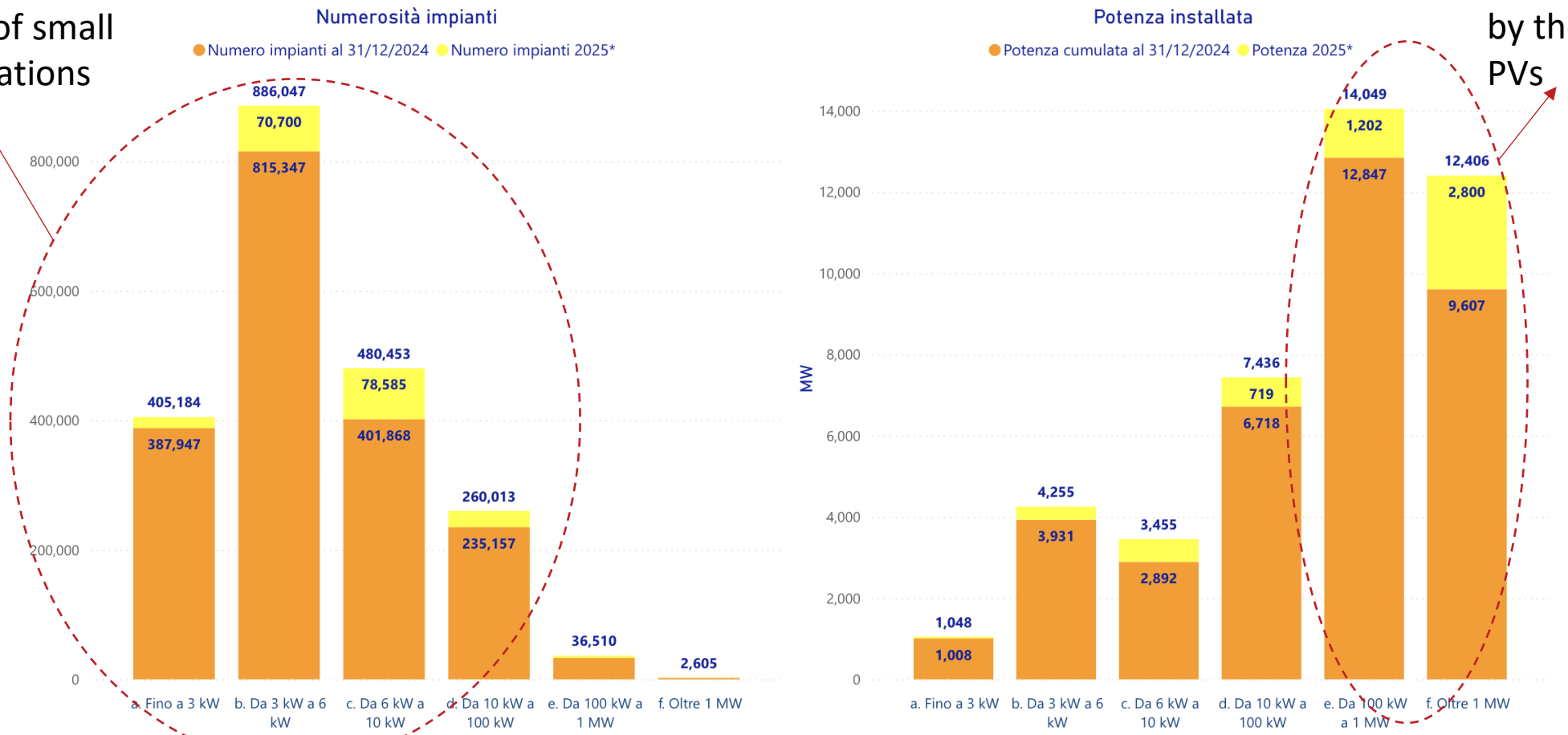
https://www.pniecmonitoraggio.it/Risorse/Dati%20e%20statistiche/Fontienergeticherinnovabili/settore%20elettrico/Pagine/settore%20elettrico.aspx

Italy

Andamento del settore fotovoltaico per classe di potenza – dati mensili

Number of small PV installations

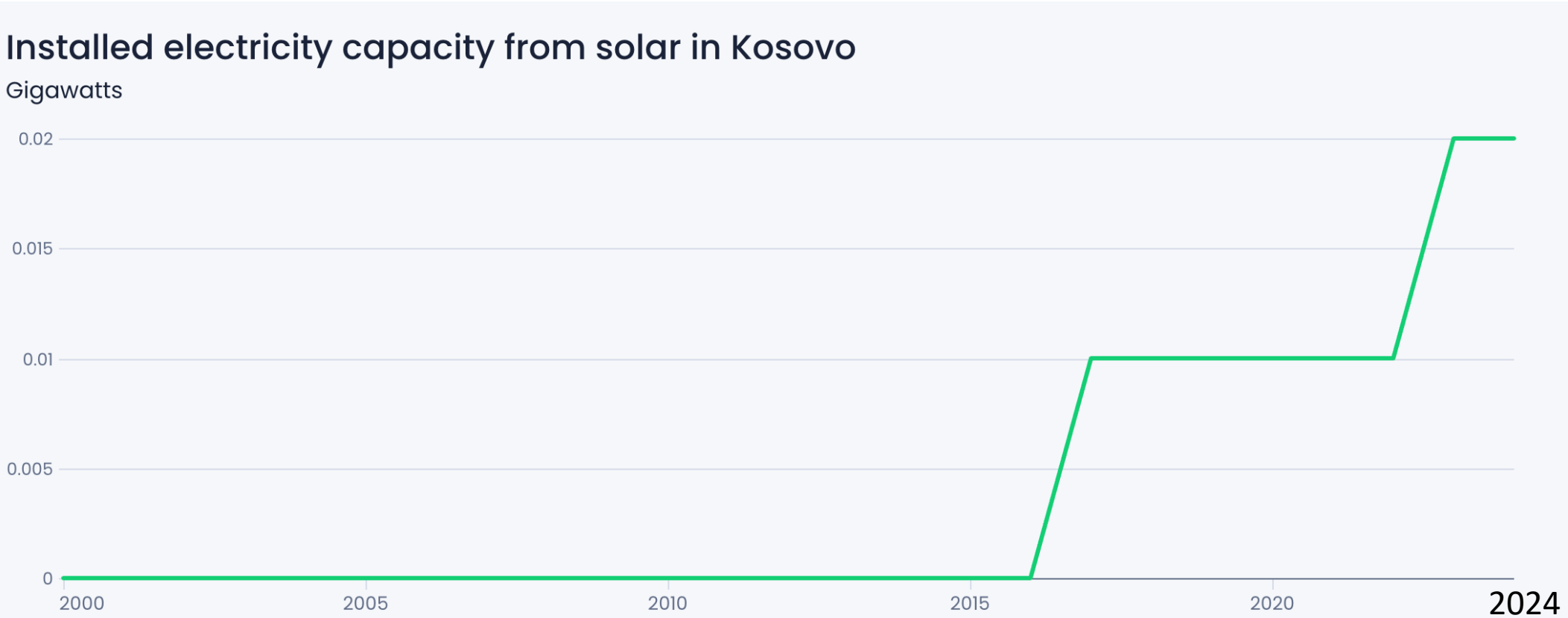
Energy produced by the industrial PVs



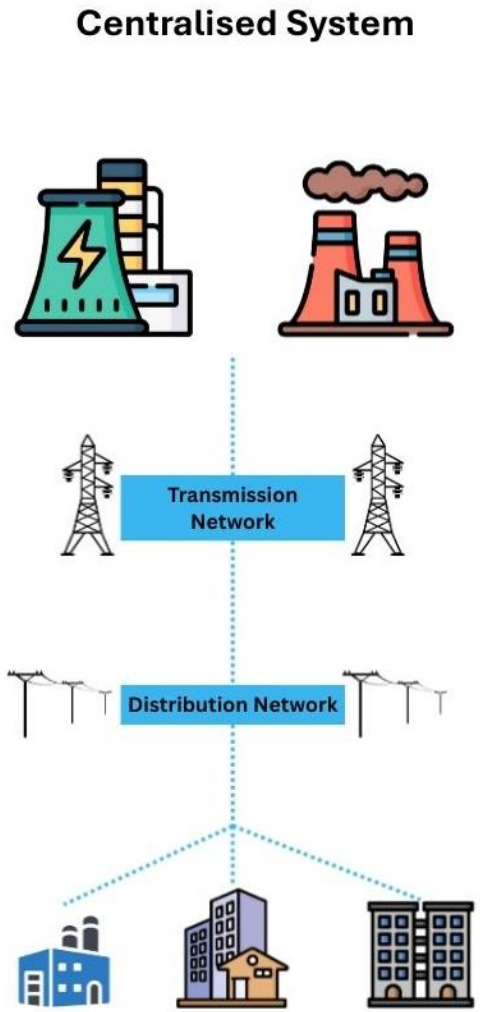
*Dato cumulato tra il 1° gennaio 2025 e il 30 novembre 2025 (stima preliminare). La differenza assoluta tra le grandezze all'inizio e alla fine di un periodo non corrisponde necessariamente alla potenza effettivamente entrata in esercizio nel corso del periodo stesso.

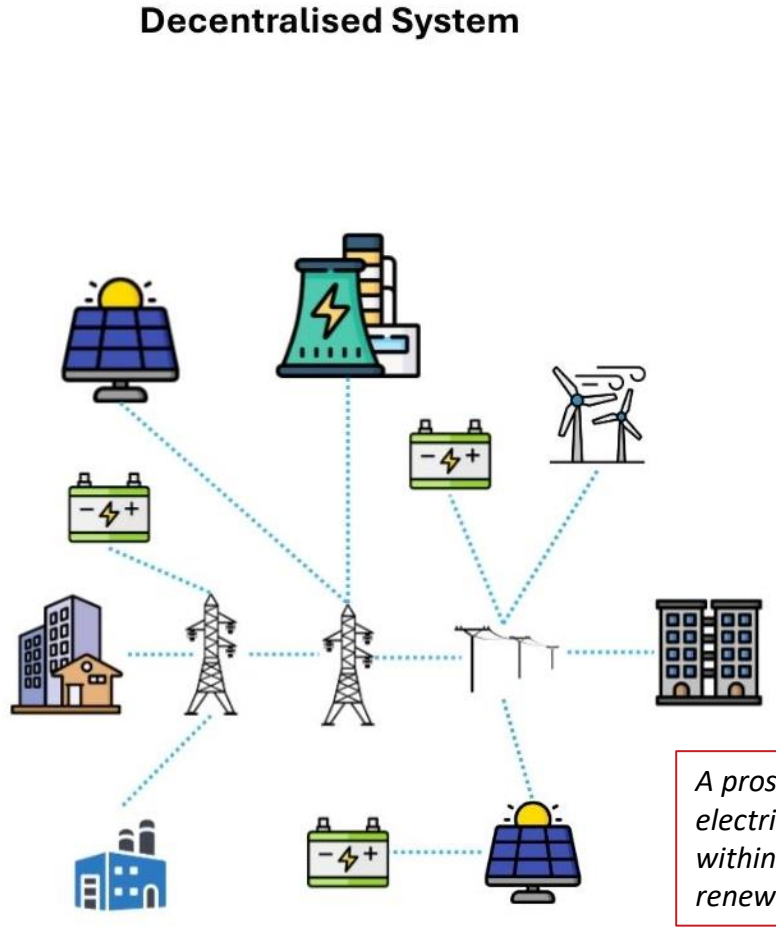
https://www.pniecmonitoraggio.it/Dimensioni/Rinnovabili/FER%20Elettriche/Pagine/Monitoraggio.aspx#FOTOV

Kosovo


Installed electricity capacity from solar in Kosovo
Gigawatts
0.02
0.015
0.01
0.005
0
2000
2005
2010
2015
2020
2024
Data: Ember Electricity Data Explorer, ember-energy.org
EMBER

Transformation of the Power Grid

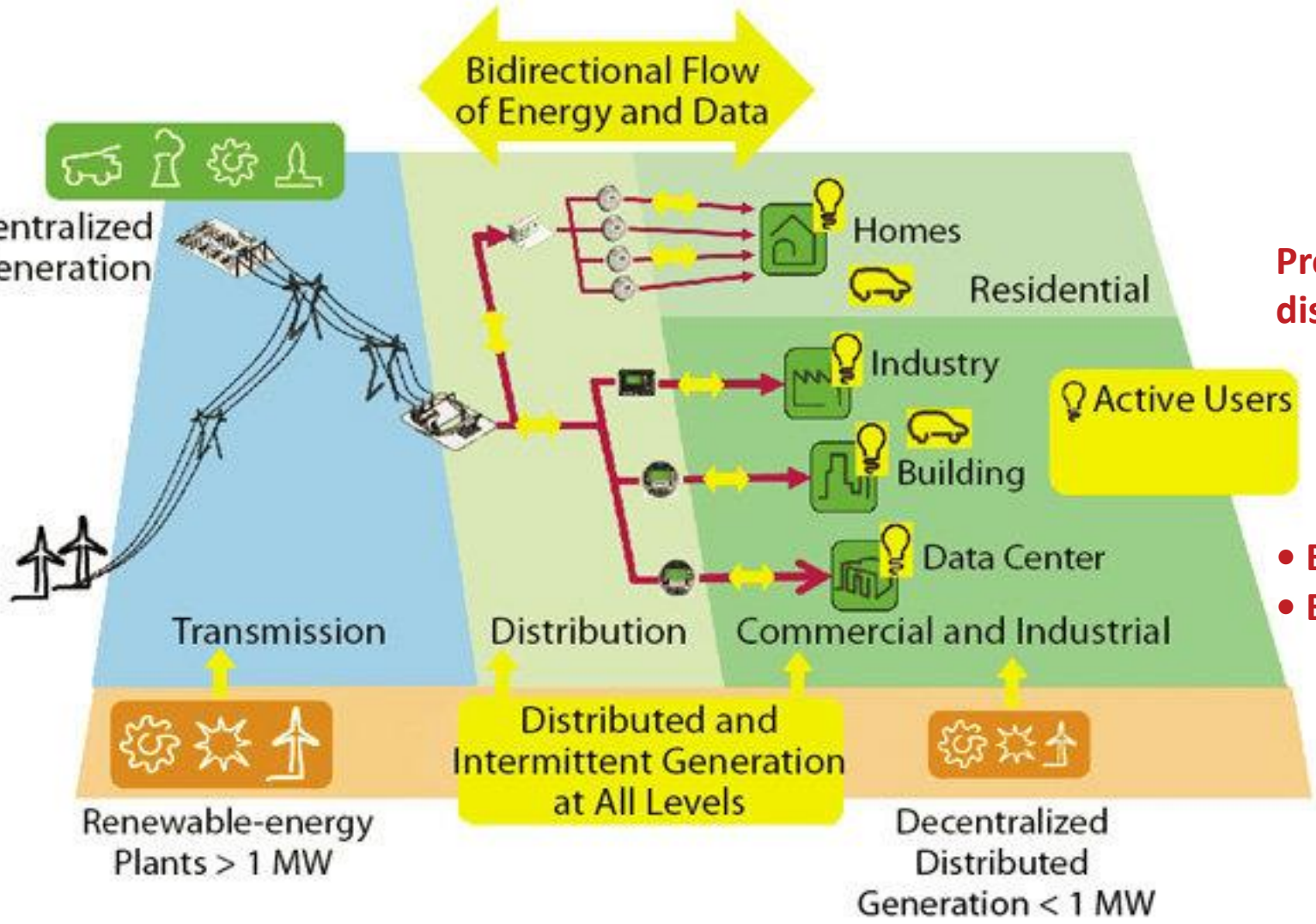




Electricity systems are undergoing a structural transition from centralised supply to decentralised, bidirectional operation. **Prosumers** are no longer marginal actors: their growing scale increasingly affects network loading, voltage quality, and investment needs.

A prosumer is defined as an end-user who produces renewable electricity for its own consumption at a private site located within defined boundaries and can store or sell self-produced renewable electricity.

Two flows, One economics



Source: A Generic Ontology for Prosumer-Oriented Smart Grid

Prosumers interact with the grid through two distinct flows:

- **Electricity withdrawn from the grid**
- **Electricity injected into the grid**

What is Net Metering?

Under net metering, the grid is fully used, but billed as if it were not used at all.

Bill results after one month:

Nothing to pay BUT:

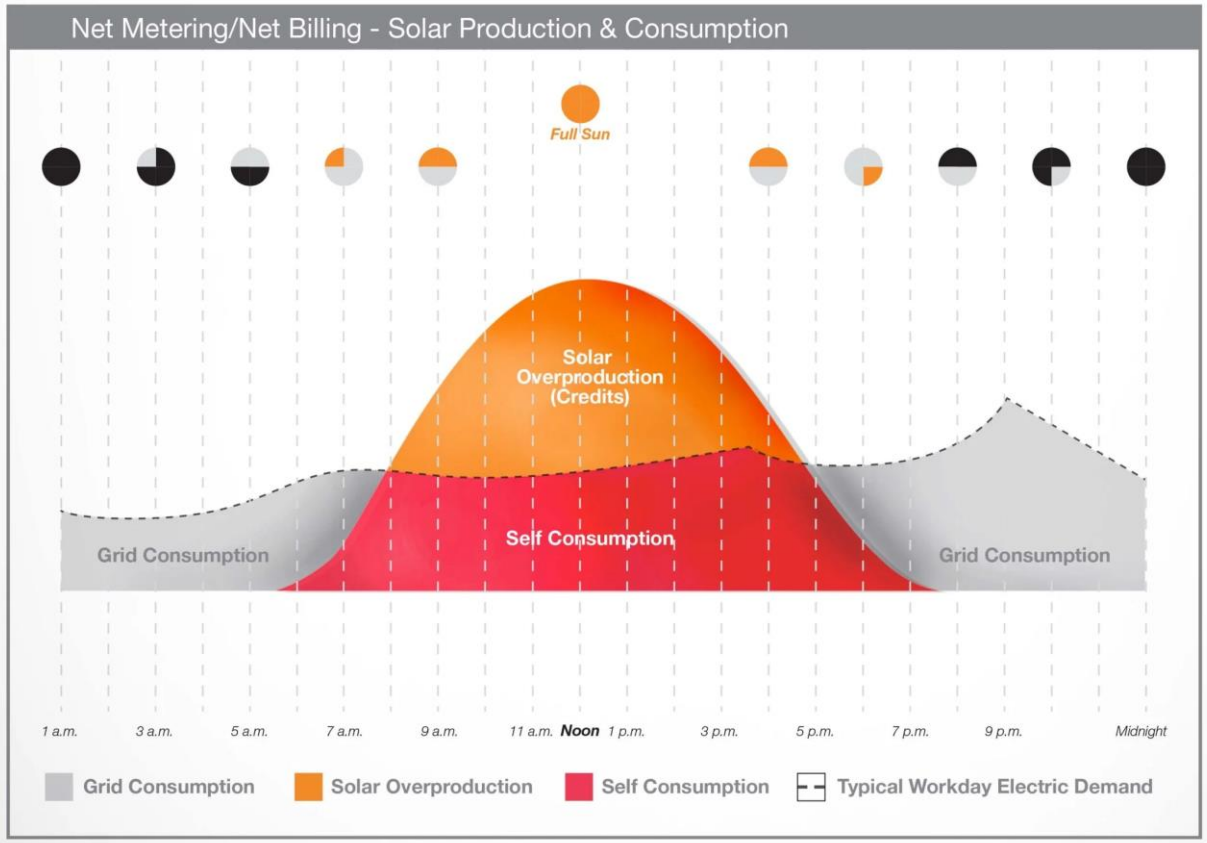
- **The grid is used as a free storage**
- **The DSO does not recover network costs**
- **Other consumers pay instead**
- **Time and system value do not matter**

Source: GNERC Regulatory Mecchanism for Micro Generators

Paradox of net metering

- Monthly netting may spiral out of control
- A bridge example – Using the bridge twice but paying net 0

Net Metering do not follows the time



Grid used as a virtual battery where you can save electricity as a credit and use it after weeks, but grid doesn't work that way every second and every minute load and generation is adjusted to keep system stable, that why we need framework adjusted to realtime operation that can react on market signals. In that case Net Billing is good alternative

Curtailment Rates

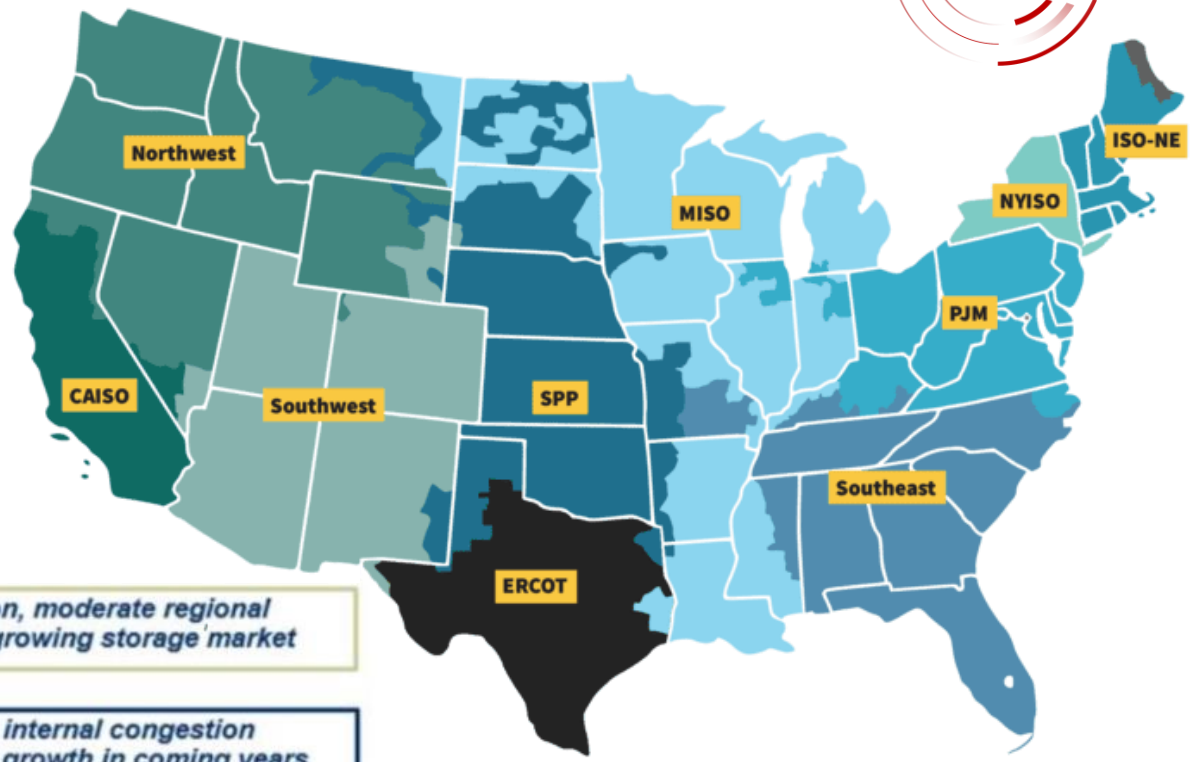
ISO/RTO	2022 Solar Generation [TWh]	2022 Annual Solar Penetration [%]	2022 Solar Curtailment [%]
CAISO	60.9	25.6%	3.4%
ERCOT	24.7	6.4%	9.0%
ISO-NE	8.3	6.8%	0%
MISO	9.2	1.4%	0%
NYISO	5.0	3.2%	0%
PJM	19.1	2.37%	0%
SPP	1.6	0.6%	0%

CAISO – High solar penetration, moderate regional connections, larger grid, big/growing storage market

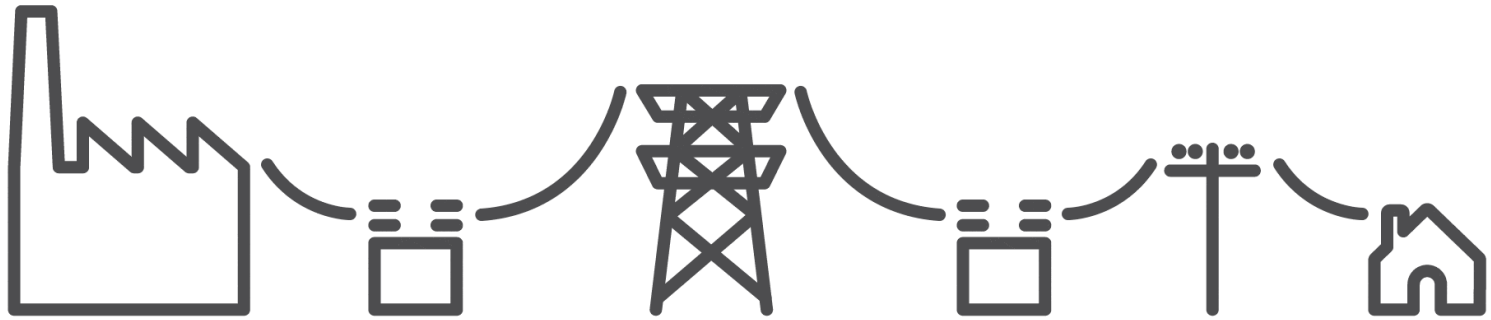
ERCOT – Highly isolated with internal congestion issues, expecting major solar growth in coming years

Other ISOs/RTOs – Low solar penetration → zero curtailment

Outside ISOs/RTOs – Effectively zero curtailment in major vertically-integrated utility service territories

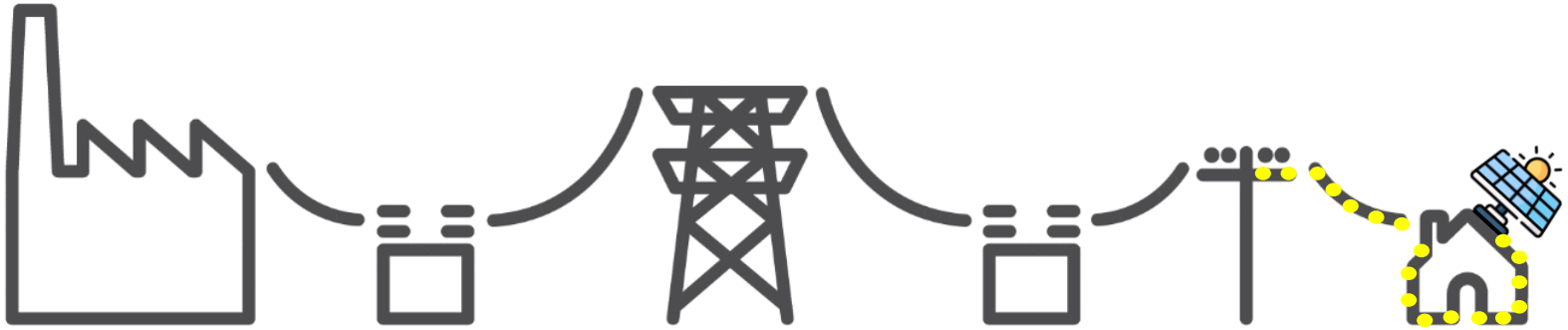


How Prosumers Use the Grid



Generator → Step-Up Transformer → HV Switchyard Busbar → Circuit Breaker → Transmission Line → Transmission Substation Busbar → Step-Down Transformer → MV Switchgear → Distribution Feeder → Distribution Transformer → LV Feeder → Service Drop → Energy Meter → Main Breaker → Internal Wiring → Wall Socket

This is the path which electron goes to be consumed



In the case of a prosumer, electricity from Solar PV is consumed locally, but if there is no consumption, electricity flows back to the DSO grid, which we call reverse flow. When reverse flow occurs with dozens of solar PVs, technical problems appear for the grid owner.

Why Net Metering Creates a Vicious Circle

Consumer

Neighbor A
- Monthly Consumption 600 kWh/month
- Average tariff 5 c/kWh
- Bill amount = 30 EUR

Prosumer

Neighbor B - Net Metering
- Monthly Consumption 600 kWh/month
- PV production 600 kWh/month
- Average Bill = 0 EUR

Power system fixed costs recovered from Neighbour A

Neighbour A average tariff increases as a result

Encouraging more Net Metering → Vicious cycle

In case of “volumetric” tariff Expenditure for network tariff is fully related to kWh withdrawn from the grid

This mechanism leads to cross-subsidisation, tariff instability, and undermines sustainable network cost recovery.

EU and Energy Community acquis

Article 15(2)(e) of Directive (EU) 2019/944

(e) subject to cost-reflective, transparent and non-discriminatory network charges that account separately for the electricity fed into the grid and the electricity consumed from the grid, in accordance with Article 59(9) of this Directive and Article 18 of Regulation (EU) 2019/943, ensuring that they contribute in an adequate and balanced way to the overall cost sharing of the system;

Article 18 of Regulation (EU) 2019/943

7. Distribution tariffs shall be cost-reflective taking into account the use of the distribution network by system users including active customers. Distribution tariffs may contain network connection capacity elements and may be differentiated based on system users' consumption or generation profiles. Where Member States have implemented the deployment of smart metering systems, regulatory authorities shall consider time-differentiated network tariffs when fixing or approving transmission tariffs and distribution tariffs or their methodologies in accordance with Article 59 of (EU) 2019/944 and, where appropriate, time-differentiated network tariffs may be introduced to reflect the use of the network, in a transparent, cost efficient and foreseeable way for the final customer.

EUROPEAN COMMISSION

Brussels, 15.7.2015
SWD(2015) 141 final

COMMISSION STAFF WORKING DOCUMENT

Best practices on Renewable Energy Self-consumption

Accompanying the document

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions

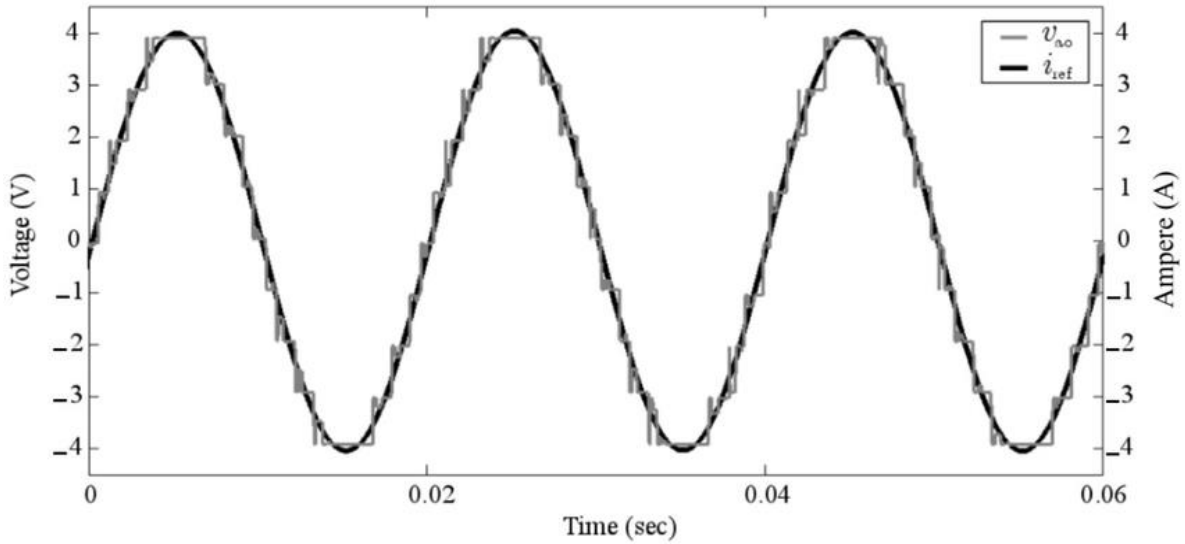
Delivering a New Deal for Energy Consumers

{COM(2015) 339 final}

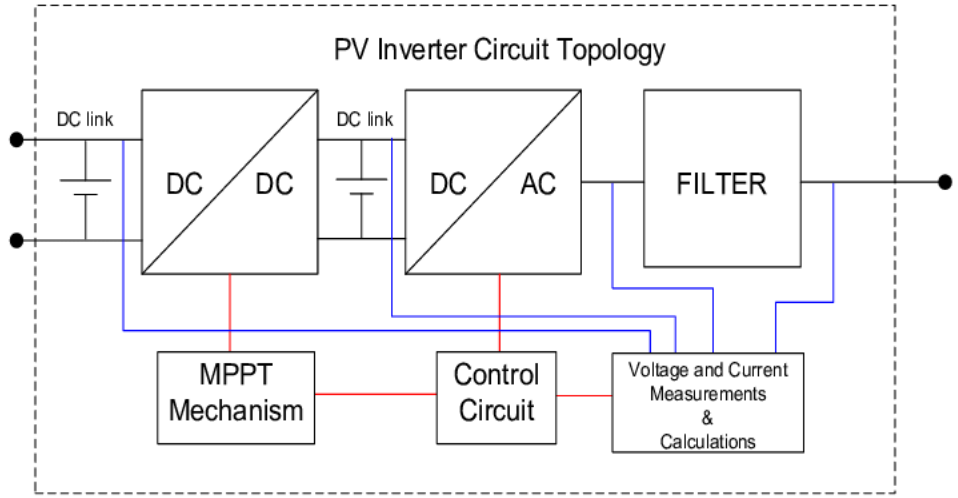
Renewable Energy Directive (EU) 2018/2001

(f) ensure that renewables self-consumers contribute in an adequate and balanced way to the overall cost sharing of the system when electricity is fed into the grid.

Solar PV characteristics



Source: A Novel Control Approach to Hybrid Multilevel Inverter for High-Power Applications



Source: Voltage regulation via photovoltaic (PV) inverters in distribution grids with high PV penetration leve

1) Overvoltage on distribution feeders
Local PV injections push voltage above allowed limits, especially in rural and end-of-line feeders.
2) Reverse power flows
Power flows back toward substations, breaking protection logic and voltage control schemes.
3) Transformer and line overloading
Midday PV peaks can exceed thermal limits of MV/LV transformers and cables.
4) Protection system malfunction
Fault detection and selectivity no longer work properly in bidirectional flow conditions.
5) Power quality deterioration
Harmonics, flicker, and phase imbalance increase with massive inverter deployment.

Phase-out of net metering: country cases

Georgia

- Virtual and group net meteringm separated sites, size limit raised 100 to 500 kW
- Entry of commercial and industrial investors
- Net metering is increasingly used as a financial optimisation tool
- Result: exponential growth in installations and capacity

- Net metering replaced by net billing
- Withdrawal is settled separately. Injection and Injection paid at USS price, network costs no longer bypassed
- Objective: restore cost-reflectivity and protect system integrity

2016 - 2019 — Market Creation

- Net Metering to kick-start rooftop PV and prosumers
- Simple volumetric offset at retail tariff
- Limited uptake, mainly household

2019 - 2022 — Rapid Expension

2021 - 2024 — Network Stress

- High penetration causes: voltage rise, reverse flows, transformer and feeder overload risks
- Gnerc introduced DSO-level hosting capacity caps (% of DSO peak load)
- Caps increased: 2% → 4% → 8% → 14%
- In 2024: largest DSO exceeded 126 MW capacity, 180 MW of requested capacity blocked

2021 - 2024 — Structural Reform

Phase-out of net metering: country cases

Italy

- Rapid diffusion of rooftop PV driven by falling costs and stable support schemes
- SSP is increasingly used not only for self-consumption, but also for economic optimisation
- Rising volumes of energy virtually offset through the grid

- SSP contract expire after 15 years – no renewable beyond scheduled term
- No new SSP connections from 2025
- Transition toward:
  - Ritiro Dedicato (Dedicated Withdrawal)
  - Renewable energy communities
  - Market-based remuneration models

2005 - 2010 — Market Creation

- Scambio sul posto (SPP) introduced to promote small-scale PV and self-consumption
- Volumetric netting mechanism with settlement via GSE
- Strong uptake by households and small businesses

2011 - 2020 — Mass Adoption

2020 - 2024 — Structural Tensions

- Growing penetration revealed misalignment with cost-reflectivity and network usage
- SSP no longer consistent with EU market design and 4th Energy package principles
- Introduction of Time of use constraint and regulatory debate on scheme's sustainabilityn

2024 - 2025 — Orderly phase-out

Phase-out of net metering: country cases

Kosovo

- Sharp increase in rooftop PV installations, driven by:
  - ➢ Energy crisis
  - ➢ Falling PV equipment costs
  - ➢ Attractive economics under net metering
- Uptake expands beyond households to commercial and business consumers
- Increasing volumes of electricity are virtually offset through the grid rather than phisically self-cosnumed

- Regulator starts reviewing the scheme
- Recognition that net metering does not scale
- Direction toward net billing / market-based remuneration in line with the EU & Energy Community

2018 - 2021 — Market Kisck-Start

- Introduction of net-metering to promote rooftop PV and reduce import dependency
- Simple, fast connection procedures and volumetric netting of injections and withdrawals
- Policy focuses primarily on households and small commercial consumers
- Grid implicitly used as a virtual storage, making PV investments low-risk and attractive

2021 - 2023 — Mass Adoption

2023 - 2024 — Structural Tensions

- Distribution networks begin toexperience:
  - ➢ Voltage deviations in LV and MV grids
  - ➢ Reverse power flows during sunny, low-demand hours
  - ➢ Local hosting capacity constraints
- Regulatory concerns intensify around:
  - ➢ Cross-subsidisation between prosumers and non-prosumers
  - ➢ Under-recovery of network costs
  - ➢ Misalignment with Energy Community and EU cost-reflectivity principles

2024 - 2025 — Orderly phase-out

THANK YOU FOR YOUR ATTENTION!

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