Policy brief - Energy Communities to support Photovoltaic Greenhouses

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Introduction

With the global population projected to reach 9 billion by 2050, the Food and Agriculture Organization estimates that food production will need to increase by 70% to meet growing demand [1]. As traditional farming becomes increasingly constrained by climate change, urbanization, and soil degradation, greenhouse agriculture has emerged as a crucial alternative offering a controlled environment to sustain and expand food production. Greenhouses enable higher yields, extended growing seasons, and more efficient water use, factors that are especially critical in regions with harsh or unpredictable climates. However, greenhouses, which have become indispensable for food security, also raise significant sustainability concerns, particularly due to their high energy demands and associated greenhouse gas emissions [2].

Ensuring high yields and energy security

While greenhouses can achieve yields up to ten times greater per unit area compared to open-field farming [3] their heating and cooling demand requires up to 80 times more energy than growing crops in open fields [4]. As a result, greenhouse-grown produce often has a greater environmental impact per unit of product than conventionally grown crops [5,6]. This energy footprint is largely driven by a reliance on fossil fuels, a practice that is not only unsustainable but increasingly costly and volatile. This was particularly highlighted by the energy crisis, fueled by the dependance on imported fossil fuels, heightening the urgency to transition toward sustainable energy sources.

Retrofitting greenhouses

Meeting the dual challenge of food and energy security requires forward-thinking solutions that decouple agricultural productivity from fossil fuel dependence. A promising technological innovation lies in the integration of photovoltaic (PV) systems into greenhouse structures. Recent advancements in semi-transparent PV technologies, which utilize spectral filtering to transmit the needed light for photosynthesis and convert the unused wavelengths into solar energy, have made it possible for greenhouses to simultaneously cultivate crops and generate renewable energy. This dual-function approach ensures that crop yields are not compromised while turning greenhouses into decentralized power producers.

The potential impact of this innovation is substantial. Retrofitted greenhouses can produce a significant portion of their own energy needs, improving their energy independence and reducing exposure to market fluctuations. In optimal cases, PV-equipped greenhouses can generate surplus energy, which can be fed back into the grid, contributing to broader renewable energy targets.

Need for adapted frameworks

Nevertheless, the broader adoption of this technology is hindered by regulatory and infrastructural limitations. In Switzerland, frameworks like Regroupement pour la Consommation Propre (RCP), Virtual RCP (RCPv), and Local Energy Community (LEC) offer mechanisms for local energy sharing and consumption. However, these models are often underutilized or not sufficiently adapted for agricultural contexts. Without supportive policies, greenhouse operators may lack the incentives and clarity needed to invest in energy-generating retrofits.

The remainder of this brief will explore several strategies to realize this potential, of a scalable and sustainable solution to two of the most pressing challenges of our time: ensuring food and energy security, by exploring targeted policy interventions that can utilize key levers such as modernizing grid access rules, adapting energy tariffs, streamlining permitting processes, and offering financial incentives for retrofitting. By aligning agricultural and energy policies, governments can transform greenhouses into climate-smart infrastructure, bolstering food production while advancing clean energy goals.

Regroupement pour la consommation propre (RCP)

To improve the economic viability of solar-integrated greenhouses, Swiss regulatory frameworks in 2025 have introduced mechanisms such as the RCP and its virtual extension, RCPv [7], [8]. These models allow electricity produced on-site, notably from PV systems, to be shared among multiple consumers either through a private grid (RCP) or via virtual metering within the same distribution network (RCPv) [10]. By enabling electricity to be consumed locally at the retail rate, rather than exported to the grid at a significantly lower feed-in tariff, these frameworks enhance the financial return of decentralized solar installations [4]. In the context of agriculture, where greenhouses often have limited on-site consumption and are spatially disconnected from other energy users, RCPv offers a means to allocate surplus electricity to nearby residential or commercial consumers, thereby increasing self-consumption rates and revenue potential.

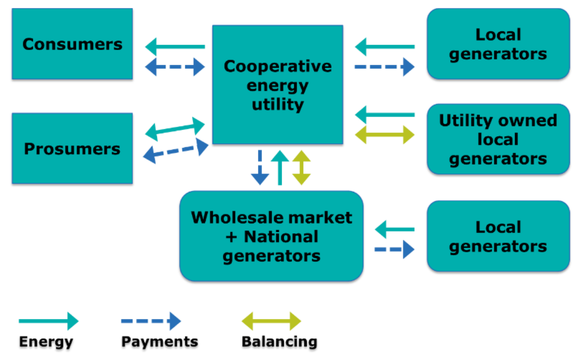

Figure 1 - The cooperative energy utility business model, taken from [12]

Limited adoption

Despite the regulatory provision for RCPv as of 2025, its implementation remains limited due to administrative, technical, and institutional challenges. These include unclear procedures for group formation, variability in distribution system operator (DSO) engagement, and limited standardization of metering and billing practices across cantonal jurisdictions. As a result, the potential for agricultural PV systems to function as efficient, decentralized energy producers is not yet fully realized. Facilitating the broader adoption of RCPv may require coordinated actions such as the development of uniform technical guidelines, simplification of administrative processes, pilot demonstrations in agricultural settings, and targeted dissemination of information to potential participants. Clarifying roles and responsibilities among DSOs, municipal authorities, and energy

Table 1 - Differences between frameworks (adapted from [11])

Aspect	LEC	RCP	RCPv
Legal Scope	Broad concept aligned with EU/Swiss energy policy	Specific legal construct in Swiss law	Specific legal construct in Swiss law
Geography	Can include multiple buildings or even municipalities	Limited to one building or closely connected unit	Not necessarily in the same place, but same canton.
Energy sharing	Diverse sources (PV, wind, hydro), flexible sharing using the DSO grid	Mostly solar PV, shared behind one grid connection	One or very few energy producers, legally bound to consumers

regulators would support more effective implementation. Improved uptake of RCPv could contribute to increased integration of renewable energy in rural and semi-urban areas, while enhancing the economic sustainability of greenhouse agriculture and aligning with national energy and climate objectives.

Local Energy Communities

Local Energy Communities (LECs) present a promising solution to enhance citizen engagement in energy production and consumption. It was propelled by the Law on Electricity Supply in 2023 and will enter into force in 2026 in Switzerland. Table 1 lists differences between the frameworks. LECs are more general and complex than RCP and RCPv, as they can include multiple prosumers.

International Examples

The European Commission keeps up to date with its Energy Communities policy database [15]. Two especially advanced countries on this topic, that were driven by high rates of renewable penetration, early government support and simpler rules for creation:

- Austria: Over 30,000 local energy communities are already operational. These communities allow energy sharing within families, participation in multiple communities simultaneously, and the coexistence of multiple grid managers.
- Spain: Members of LECs are exempt from certain distribution fees and taxes when consuming energy within a restricted area, typically within 2 km of the production site.

Business models and tariff structures

The success of LECs hinges on the business models they adopt. For LECs open to new members, it is crucial to find a balance that is attractive to both producers, enabling them to recoup their investments, and consumers, offering them cost savings. Tariff structures within LECs are flexible and decided internally, which may lead to varying levels of tariff stability, and hence discourage people from adopting this solution. This stability can be influenced by:

- Tariff Policies
- Storage Solutions: Extending local consumption periods.

- Consumption Flexibility: Tools to manage and optimize energy use, including smart meters, forecasting methods and digital twins.

Decision-support tools to help consumers choose the right LEC model would be highly beneficial. To this end, an extension of the public office such as EnergieSchweiz, which already proposes to guide cities and regions through the energy transition, would be beneficial for LECs.

Potential Impact in Switzerland

A key finding from Geneva University is that LECs in rural Swiss municipalities could generate up to 8 TWh/year of renewable electricity by 2035, contributing 23% to Switzerland's renewable electricity target of 35 TWh/year [11]. Another study tends to show the need to increase decentralized production [13].

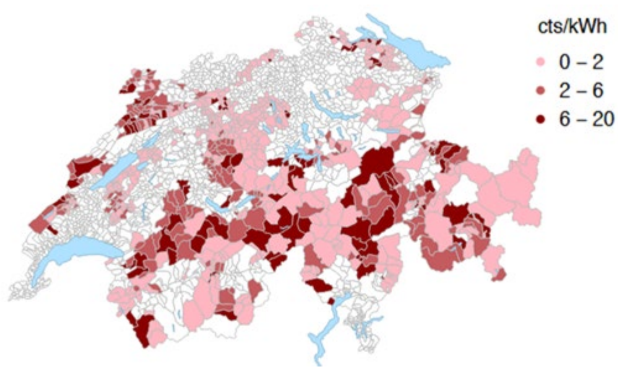

Figure 2 – Simulated competitiveness of LECs, measured as a difference between the costs of LECs as compared to grid tariffs for rural areas [11].

Risk for the investment in grids

However, as the electricity market is a zero-sum game, the money saved by prosumers is a shortfall for distribution and transmission companies. This measure, as stated by BKW, should not remove the importance of maintaining a high-quality grid [14].

"Our findings demonstrate a clear advantage in promoting decentralized electricity production and consumption. With an investment of 1260 CHF/year per capita in local energy communities, districts can produce about half of Switzerland's total energy needs by utilizing around 60% of the available roof surface.", François Maréchal, Professor at EPFL [13]

Policy recommendations

This brief advocates for the **rapid and informed implementation of energy communities**—particularly RCPv and LEC frameworks—as a necessary step to unlock the potential of PV-retrofitted greenhouses in Switzerland. Legislative tools are now in place, but realization on the ground depends on administrative clarity, capacity-building, and strategic engagement of key actors. To this end, the following targeted actions are recommended:

1. Build administrative and technical capacity to operationalize energy communities

→ Stakeholders: Cantonal energy authorities, Swiss Federal Office of Energy (SFOE), Distribution System Operators (DSOs)

- Deliver tailored training sessions for cantonal and municipal energy offices to ensure consistent interpretation and implementation of RCPv/LEC rules.

- Provide DSOs with practical guidelines on metering, billing, and coordination of local groups, especially in agricultural contexts.
- Clarify division of responsibilities between actors at local and federal levels to reduce delays and inconsistencies.

2. Raise awareness and facilitate participation among agricultural stakeholders
→ Stakeholders: SFOE, cantons, energy consultants, growers' associations

- Launch information campaigns and demonstration projects targeting greenhouse operators
- Promote simple, replicable business models and legal templates for forming or joining energy communities.
- Incentivize intermediaries (consultants, installers, platform providers) to support agricultural actors in navigating the administrative setup process.

3. Coordinate and monitor implementation to ensure accessibility and impact
→ Stakeholders: SFOE, cantonal governments, Swissgrid

- Create a national coordination mechanism to track implementation progress, share pilot results, and identify barriers across cantons.
- Ensure that RCPv and LEC models remain accessible to smaller producers, including those in rural or single-site agricultural operations.
- Encourage flexibility in local applications (e.g. inter-municipal/inter-cantonal groupings) where grid topology allows it.

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