RENEWS PAPER NR. 1

POWERING EUROPE'S HEATING TRANSITION: SOLAR'S LOCAL IMPACT IN GERMANY AND UKRAINE

ENERGY TRANSITION TOWN TWINNINGS

AUTHOR:
Simon Stark, AEE

This paper investigates the vital role of solar energy – both photovoltaics (PV) and solar thermal – in decarbonising local heating systems across Europe. It draws a comparison between two distinct contexts: Germany, which is optimising its well-established infrastructure, and Ukraine, which is undertaking a massive reconstruction effort following war-related destruction. The analysis is enriched by practical insights from the "Energy Transition Town Twinnings 3.0" project, a collaboration involving Düsseldorf, Hoyerswerda, Chernivtsi, and Novovolynsk. We argue that solar energy offers a flexible, resilient, and emissions-free solution that is essential for increasing energy security and achieving climate goals. The paper concludes with concrete proposals for officials and providers on how to implement solar power for a resilient and future-proof heat supply.

photo © ainur-khakimov-unsplash

WITH THE SUPPORT OF:

Auswärtiges Amt

IN COOPERATION WITH:

RENEWABLE ENERGY AGENCY

INTRODUCTION

The provision of heating in urban and rural areas across European states is undergoing a major transformation. Heating accounts for a significant share of total energy consumption throughout Europe. This makes it even more urgent to reduce dependence on fossil fuels, stabilise energy prices, and meet climate targets. While national and European strategies provide the overall framework, the actual implementation and design of a sustainable heat supply largely lie in the hands of local authorities. They are responsible for considering local conditions, involving citizens, and developing practical solutions.

This policy paper highlights the crucial role of solar energy – both photovoltaics (PV) and solar thermal – as a core component of a future-oriented and climate-neutral heat supply at the local level. It analyses both the German and Ukrainian situations, perspectives, and challenges. For Germany, the established regulatory frameworks, funding instruments, and accumulated experience in integrating solar thermal energy and solar electricity for heat pumps into municipal heat planning are central. In contrast, Ukrainian local authorities, following the extensive destruction and uncertainties caused by the Russian invasion, face the monumental task of rebuilding and redesigning their energy infrastructure. Ukraine's status as an EU candidate state opens additional perspectives and potentials for aligning with European standards and facilitating international cooperation. For these communities, solar energy offers not only a path towards climate neutrality but also an opportunity to increase energy independence and resilience.

The insights for this analysis are significantly enhanced by practical experiences drawn from the "Energy Transition Town Twinnings 3.0" project, funded by Germany's Federal Foreign Office. This initiative actively involves four key cities: Chernivtsi and Novovolynsk in Ukraine, alongside Düsseldorf and Hoyerswerda in Germany. These partnerships offer unique perspectives on the challenges and successes of municipal heat planning and solar energy expansion across diverse settings.

Specific challenges and approaches to implement solar thermal energy in local heating networks and the decentralised use of photovoltaics for self-consumption are addressed in this comparative analysis. A central aspect is the acquisition of funding, which plays a crucial role in the financial viability and scalability of projects for both countries, though with different priorities and access points. It will be argued that solar energy offers not only ecological benefits but also significant social and economic potential for communities.

This policy paper presents concrete recommendations for policymakers, urban planners, and energy providers to maximise the potential of solar energy and ensure a resilient, affordable, and climate-friendly heat supply at the local level. Only through coordinated efforts at the municipal level, the energy transition in the heating sector can make a vital contribution to climate protection and sustainable development in both countries.

PERSPECTIVES ON MUNICIPAL HEAT SUPPLY AND THE ROLE OF SOLAR ENERGY

The sustainability of heat supply in European municipalities depends heavily on the specific context. While Ukrainian local authorities are facing the enormous task of re-building their energy systems and making them more resilient, German municipalities are focusing on optimising their existing, often very dense infrastructures, making them more climate friendly. They are utilising structural change as a real opportunity. In all these scenarios, solar energy plays a crucial role.

THE SIGNIFICANCE OF SOLAR ENERGY

Solar energy – including both photovoltaic systems and solar thermal technologies – is an ideal energy source for driving the heat transition in villages, towns and cities for several reasons. Solar energy can be deployed in a decentralised and modular fashion. This means it can be excellently adapted to local conditions. Long transport routes for fuels become unnecessary, which is a major advantage – especially for areas where the construction of large, centralised infrastructure is complicated or uncertain. It also contributes to the democratisation of energy supply. Solar energy is an endless, emissions-free resource. It allows local authorities, businesses and households to reduce their dependence on volatile global energy prices and geopolitical tensions, enhancing the security of energy supply. Having a diversified energy mix improves resilience and spreads risk. But in Ukraine, like in many other countries, the rollout of other renewable sources like wind, biomass, hydropower or geothermal energy is not always straightforward. Many places lack infrastructure, approval processes are complex, and resources are limited. Solar power, on the other hand, is flexible and scalable, making it one of the quickest and most practical ways to locally generate electricity and heat for reconstruction and strengthening energy autonomy. Additionally, the costs of solar modules are consistently decreasing on the global market, as a secondary market for used modules gradually develops.

GERMAN PERSPECTIVES: SOLAR ENERGY AS A CENTRAL COMPONENT OF MUNICIPAL HEAT PLANNING AND STRUCTURAL CHANGE

Local authorities in Germany are facing the challenge of fundamentally decarbonising their heat supply systems while ensuring security of supply. The integration of solar energy plays a key role, both in densely populated urban areas and in regions affected by structural change.

Many German cities pursue ambitious political goals for climate neutrality, based on the principle of avoiding energy consumption before decarbonisation and compensation. In large cities, such as Düsseldorf (655.000 inhabitants), photovoltaic systems attached to buildings are a central building block of the energy transition, as they often represent the most practical way to generate climate-neutral electricity locally. Additionally, as the state capital of North Rhine-Westphalia, pilot projects for PV on less conventional surfaces such as car parks, open spaces, or as floating structures are being examined in Düsseldorf. The city administration is pushing ahead with a solar offensive to equip suitable roof areas of municipal buildings with PV. The energy generated is increasingly being used directly on-site through direct consumption and local energy balancing. PV subsidies are also being intensified in

the private and commercial household sectors, for example, through programmes supporting PV and plug-in PV systems, often in combination with electricity storage or specific subsidies for low-income households.

The decarbonization of the heat supply is of great importance to German municipalities, as heating accounts for over 50 percent of the total final energy consumption in Germany. The development of municipal heat planning is a central instrument for creating a roadmap for decarbonising heat supply. This strategy typically provides for densification and expansion of existing district heating networks, as well as decentralised solutions such as heat pumps and solar thermal energy where heat networks are not economically viable. In the future, heat supply is supposed to come increasingly from renewable sources such as deep and shallow geothermal energy, ambient air, water bodies and wastewater, waste heat from industry and data centres. A general reduction in heat demand is also targeted through energy-efficient renovations. Detailed planning of urban areas into zones helps to determine suitability for various supply systems. The goal is a secure, climate-neutral, and socially acceptable heat supply that holistically considers ecological, economic, and social factors.

Specific potential for solar energy in both the German and European context is offered by post-mining landscapes such as the East German region of Lusatia – home to the city of Hoyerswerda (30.000 inhabitants). In these regions, the necessary structural transformation goes hand in hand with the energy transition. The vast, recultivated areas of former open-cast mines provide unique opportunities for the development of large-scale wind and solar farms. These installations can not only generate significant amounts of climate-neutral electricity for the region but also form the foundation for innovative heat supply concepts. Converting these areas into solar energy sites directly supports the region's economic and ecological transformation and creates new jobs in the renewable energy sector. In addition, such large-scale projects can create synergies with the development of new infrastructure and industrial settlements as part of the broader structural shift. Given the region's proximity to neighbouring countries like Poland or Czech Republic, there is also strong potential for cross-border energy projects that strengthen cooperation and increase energy security across regions. Solar thermal energy can play a key role in new, neighbourhood-based heating networks, with the availability of large volumes of solar electricity enabling the operation of large-scale heat pumps. The use of post-mining landscapes for renewable energy development is a clear example of how structural change can be actively harnessed to support the energy transition – both regionally and beyond national borders.

STATUS QUO IN UKRAINE: RESILIENCE AND GRADUAL MODERNISATION OF HEAT SUPPLY

For Ukrainian local authorities, the energy transition is a central pillar for ecological sustainability and energy security. Interest in alternative energy sources is growing, particularly after the war-related disruptions to central heating systems and in view of rising energy costs. Solar energy is considered a key element for increased energy independence and resilience.

The city of Chernivtsi (265.000 inhabitants), capital of the Chernivtsi Oblast in Western Ukraine, envisages the development of a gradual transformation of its district heating system through the introduction of hybrid solutions. Here, the use of solar energy for enhancing the efficiency of heat pump systems is particularly being considered. Serhiy Bostan, Director of the Department of Socio-Economic Development and Strategic Planning of the Chernivtsi City Council, says, "This will reduce our reliance on fossil fuels, lower our CO_2 emissions and decrease operating costs. We are also considering the possibility of installing solar collectors and photovoltaic panels on the roofs of boiler houses and administrative buildings."

The municipality of Novovolynsk (50.000 inhabitants), located in northwestern Ukraine, prioritises the installation of solar systems on municipal buildings such as schools, council buildings, and medical facilities. "Our community recognises the critical need to modernise the centralised heating system, which is currently outdated and inefficient. We envision the future of heating in Novovolynsk as one based on modern, energy-efficient, and sustainable solutions. In particular, our vision includes a gradual replacement of old boiler houses with modern modular units, which will ensure greater flexibility and efficiency in the system", states Borys Karpus, Mayor of Novovolynsk. Furthermore, the installation of combined heat and power (CHP) plants in densely populated areas is planned to simultaneously generate heat and electricity and maximise energy efficiency. Additional heat storage points in each district are intended to minimise heat losses and ensure supply stability during peak loads or emergencies. These measures aim to create a reliable, resilient, and environmentally friendly heating system.

CHALLENGES IN THE HEAT TRANSITION AND SOLAR ENERGY EXPANSION

Shifting heat supply systems towards climate neutrality presents a major challenge for local authorities across Europe. Despite the differing contexts, all European countries encounter similar obstacles. Solar energy plays a vital role in Germany and Ukraine, but unlocking its full potential requires overcoming a series of structural, financial, and social barriers.

UPGRADING COMPLEX SYSTEMS IN GERMANY

Germany has set ambitious climate goals, and cities like Düsseldorf and Hoyerswerda are working hard to reach them. One of the biggest challenges is financing the transformation. The shift to climate-friendly heating needs huge investments – not just for developing new heat sources like large-scale solar thermal systems or expanding district heating networks, but also for upgrading old buildings and installing heat pumps. These costs often strain local budgets, especially in smaller towns.

In Düsseldorf, a relatively big and wealthy city with well-established structures, high upfront costs stop many households from replacing heating systems or properly insulating their homes. This is why steady, long-term public funding for households, businesses, and associations is so vital – not just from European, national, and federal programmes, but ideally backed up by local schemes. Initiatives offering full

subsidies for lower-income households are great examples of how to make investments affordable and get public backing.

Another major hurdle is staffing and expertise. Local councils often don't have enough skilled personnel like energy engineers or project managers to plan and manage heating projects. To close this gap, some cities have created new roles, like climate protection managers or even (solar) energy coordinators, though the private sector also struggles with a shortage of skilled workers, especially in the skilled trades, and is responsible for implementing the energy transition locally. The private sector still recruits much of the available talent.

Moreover, the sheer technical complexity of decarbonising heating networks remains significant. Expanding infrastructure, particularly grid systems, demands careful planning and coordination. Sector coupling – also called integrated energy – is crucial but often challenging to implement. Understanding how electricity, heating, transport, and industry systems can work together makes energy systems more efficient. Yet, cities like Hoyerswerda, a former coal-mining town in Lusatia, show how big structural changes can go together with climate action. Here, old mining areas are being transformed into huge solar parks, delivering both clean energy and economic revitalisation through creating new jobs. Furthermore, existing energy infrastructure from the coal era is being repurposed for a climate-friendly heat distribution network.

UKRAINE: REBUILDING WITH A VIEW TO THE FUTURE

Ukraine faces a different set of challenges – but also unique opportunities. The Russian invasion has caused severe damage to the country's energy infrastructure. Yet, in places like Chernivtsi and Novovolynsk, the reconstruction process offers the chance to build a modern, efficient, and sustainable system from the ground up.

In the past, solar energy in Ukraine was supported through feed-in tariffs and tax benefits. Now, new instruments are needed – both to drive further expansion and to meet the legal requirements of mechanisms like the EU's Carbon Border Adjustment Mechanism (CBAM). However, local governments often face limitations: a lack of funding, too few specialists, and little capacity to implement or manage complex projects. The digitalisation of processes is also a challenge that requires investment and training.

Just like in Germany, public engagement is crucial. Awareness of the benefits of renewable energy remains limited in many parts of Ukraine. During the exchange as part of the project "Energy Transition Town Twinnings 3.0", Chernivtsi and Novovolynsk have both pointed to this as a barrier. For the energy transition to succeed, people need to be well-informed and involved. Municipal planning can help guide this process – but it must be supported by strong communication and accessible financial support for households and small businesses.

LEGAL AND REGULATORY FRAMEWORKS

The transformation of energy systems is a global challenge, shaped significantly by national and supranational legal and regulatory measures. This chapter examines current approaches in Germany and Ukraine. The European Union plays a key role for both countries by setting the framework for energy and climate policy among its member states and serving as a reference point for non-member countries like Ukraine.

GERMANY: AMBITIOUS TARGETS WITHIN A COMPLEX LEGAL SYSTEM

Germany has established an extensive and continually evolving framework of laws, regulations, and funding instruments to advance its energy transition. This system aligns closely with the climate policy of the European Union, which, under the European Climate Law, aims for climate neutrality by 2050 as a core component of the European Green Deal. However, Germany has set an even more ambitious timeline: its Federal Climate Action Act (Bundes-Klimaschutzgesetz – KSG) commits the country to reaching climate neutrality by 2045. These long-term climate goals are backed by ambitious interim targets for 2030 (a 55 percent cut in greenhouse gas emissions by 2030 compared to 1990 levels) and 2040 (current proposal: a 90 percent reduction in emissions relative to 1990), designed to ensure steady progress in reducing emissions. Some municipalities are declaring even more ambitious goals. For example, Düsseldorf aims at reaching climate neutrality by 2035.

At the heart of Germany's regulatory structure is the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz – EEG), which has played a key role in scaling up renewables. It ensures priority access to the grid and establishes mechanisms for remuneration – traditionally through feed-in tariffs, though auctions are becoming increasingly important. Direct marketing has also become a standard tool. The Buildings Energy Act (Gebäudeenergiegesetz – GEG) is essential for progress in the heating sector. It sets minimum energy performance standards for both new and existing buildings and promotes the use of renewables – such as the requirement that new heating systems must draw at least 65 percent of their energy from renewable sources. The obligation for municipal heat planning is closely linked, which requires cities to draft strategic plans for transitioning to climate-neutral heating. Larger cities like Düsseldorf must do so by mid-2026, smaller ones like Hoyerswerda by mid-2028. The legal basis for this lies in the Heat Planning Act (Wärmeplanungsgesetz – WPG), which reflects elements of relevant EU building directives. The Energy Industry Act (Energiewirtschaftsgesetz – EnWG) forms the broader framework for electricity and gas supply. It regulates grid operations, access, and market structure, and is vital for integrating renewables and enabling the necessary expansion of grid infrastructure. Much of its content reflects EU internal market rules.

In addition to regulation, Germany offers a wide range of funding and incentive schemes—administered, for example, by the KfW Bank (Kreditanstalt für Wiederaufbau) or through the Federal Funding for Efficient Buildings (Bundesförderung für effiziente Gebäude – BEG). These programmes support investment in renewables, efficiency improvements, and innovative technologies. As with other instruments, they must align with EU state aid guidelines. To create stronger price signals, Germa-

ny introduced a national carbon price, which complements the EU Emissions Trading System (EU ETS). The EU ETS remains the EU's core tool for carbon pricing in industry and the energy sector. Accelerating planning and permitting procedures for renewable energy and grid projects has become a political priority – also in response to EU-level initiatives such as the REPowerEU plan. Germany's regulatory landscape is shaped by decades of energy transition policy and the need to coordinate many actors and technologies, all while staying within the EU's legal framework.

UKRAINE: MOVING TOWARDS CLIMATE NEUTRALITY UNDER EXTRAORDINARY CIRCUMSTANCES

Ukraine is amidst profound transformation. Despite the ongoing war, the country is taking determined steps to modernise its energy sector. Its legal and regulatory approach to solar energy and the broader energy transition is based on a mix of environmental, energy, land, and economic laws – with a clear focus on aligning with the European Union. Integration into the EU requires gradual harmonisation with the Acquis Communautaire.

A major milestone in this direction is Ukraine's national Climate Law of January 2024. It aims for climate neutrality by 2050 and aligns Ukraine's goals more closely with the European Union. This is a strong signal of the country's intent to join the European energy market in the long term.

So far, key incentives for expanding renewable energy – especially solar – have included feed-in tariffs and various tax benefits. These measures have significantly contributed to the growth of the country's solar capacity. In the future, Ukraine's climate policy instruments will play an even greater role. The new Climate Law paves the way for a more consistent approach to emissions reduction and is designed to ensure compatibility with the European Carbon Border Adjustment Mechanism (CBAM).

The law's adoption and the broader political commitment to EU integration are a clear sign of the ambition to align with international standards and build an investment-friendly environment for renewables.

CONCLUSION AND RECOMMENDATIONS

Europe's journey towards climate-neutral heating and electricity is complex, facing both common challenges and unique national situations. This analysis shows that while Germany is busy decarbonising its well-established infrastructure, Ukraine faces the enormous task of rebuilding its energy systems and legal frameworks during wartime. Yet, in both countries, solar energy clearly stands out as a vital solution. It offers a path towards environmental sustainability, stronger energy security, and economic renewal. Insights from the "Energy Transition Town Twinnings 3.0" project further confirm that even though challenges like funding, qualified staff, and public buy-in are universal, solving them effectively requires tailored strategies and teamwork at every level.

The focus on solar energy in Ukraine highlights this technology's significant potential, especially for reconstruction and rapid deployment. Germany, meanwhile, pursues a broader mix of renewable energies and cross-sector strategies, heavily influenced by sector coupling and the hydrogen economy. Ultimately, transforming energy systems is not just a technical challenge but a huge societal effort that needs smart planning, significant investment, and strong community involvement. "Climate neutrality and a transformed energy sector are not just ambitious goals — they are vital steps toward a thriving future. Together, public administration, local businesses, and every citizen have the power to shape a greener, healthier, and more livable Düsseldorf for generations to come", states Dr. Stephan Keller, Mayor of Düsseldorf.

To truly unleash the potential of solar energy for locally resilient, affordable, and climate-friendly heating, we are offering the following practical recommendations for policymakers, urban planners, and energy providers.

First, we need to rethink and diversify how we fund these changes. This means setting up secure, long-term public funding that gives local councils, businesses, and homes the certainty they need to invest. A major obstacle, however, is that municipalities often face significant fiscal challenges, making it difficult for them to support these efforts. Ideally, these national funds should be supported by income from carbon pricing. Ukraine should investigate financial tools like tailored blended finance solutions, green bonds, and targeted international investment partnerships. These are essential for rebuilding its energy infrastructure, with a special focus on solar-thermal and decentralised PV. On top of this, it is crucial to expand support for households and small and medium-sized enterprises (SMEs). This involves continuing and increasing subsidies for energy-efficient home renovations and new heating systems like heat pumps or solar thermal energy. Crucially, these programmes must be easy for everyone to access, including lower-income households, ensuring fairness and widespread adoption.

Second, it is crucial that we enable more systematic knowledge exchange. We can achieve this by promoting ongoing exchange platforms between experienced local authorities and their counterparts, which will help spread the best practices in local heat planning and solar implementation. We also need to intensify private sector collaboration by creating clear guidelines for public-private partnerships. This would provide an opportunity to utilise private sector know-how and capital for significant solar developments and grid expansion, particularly when public funds are limited. For Ukraine, the exchange of best practices and support in building robust regulatory structures will be crucial to achieve its climate goals and shape a sustainable energy future closely linked to the European energy system.

Third, we need to speed up approval processes. This means putting faster procedures in place for renewable energy installations and related grid expansion projects across all levels of government, improving administrative efficiency. It is also essential to integrate heat and spatial planning. We need to require and support robust local heat planning processes that are well-funded and part of wider urban development and land-use strategies. For Ukraine, harmonising standards with the EU remains a top priority. This demands continuous legal alignment with EU energy and

climate rules to ensure future compatibility with mechanisms like the Carbon Border Adjustment Mechanism (CBAM) and to enable smooth integration into the European energy market.

Fourth, we should drive innovation and digitisation. This includes investing in smart grid technologies to help develop and deploy digital tools that are vital for intelligently controlling, monitoring in real-time, and optimising heating networks. This will enable efficient sector coupling and better load management. This means promoting focused research and pilot projects. We should dedicate funding to innovative solar thermal applications, advanced heat storage solutions, and the integration of large-scale PV with heat pumps, particularly in diverse urban and post-mining areas.

Finally, we must cultivate public engagement and acceptance. This calls for implementing strong communication strategies through targeted campaigns. These campaigns should aim to raise public awareness about the benefits of renewable heating, clear up misunderstandings, and explain available support schemes. It is equally vital to facilitate active citizen participation by creating easy-to-access channels for residents, businesses, and community groups to contribute to local heat planning and energy projects. This helps build a critical sense of ownership and shared responsibility. Additionally, supporting decentralised generation by actively promoting initiatives like plug-in PV systems empowers individual households to become direct participants in the energy transition, which in turn builds broader societal acceptance of solar solutions.