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Modern Physics in Classrooms



3.2 Turning the School's Electricity Green with Student Power

Rainer Mertens, Kantonsschule Küsnacht, ZH

Solécole is a cooperative founded and supported by students and teachers at the Kantonsschule Küsnacht, ZH, which has, over almost twenty years, built a small, self-sustaining power network step by step from an empty school roof, a physics elective course, and a lot of perseverance. Today it operates four photovoltaic (PV) systems with almost half a megawatt peak power, covers far more than the school's own electricity consumption, generates over CHF 100000 annual revenue at the upper secondary school level. It further provides a basis for student research projects, combining physical modelling with real-world measurements.

Origin in the Elective Course: From Lesson to Cooperative

In 2007 the Kantonsschule Küsnacht received a new classroom wing with an unshaded flat roof (see figure 3.2-1) – ideal for a photovoltaic system. Unfortunately, it was cut from the budget shortly before construction began. The physics teachers of the time responded pedagogically rather than politically: they offered a one-semester elective course "a solar installation for our school" to 11th graders.



Figure 3.2-1: The empty roof of the new building

After a few lessons, the basic physics concepts – efficiency, power curves, wiring – were understood by the nine participants. The setting allowed students to move beyond conceptual understanding and engage with authentic questions of real-world implementation. The remaining questions were in the areas of project management and governance: How is a PV system financed? What legal form is possible when the building belongs to the canton? Who may approve what, and which authorities must agree? Because the school administration could not dispose of the roof, the course leaders and learners decided to found a non-profit cooperative with a clear purpose: promoting environmentally friendly renewable energy through the construction and operation of solar installations at the grammar school in Küsnacht. In an intensive week in 2007, Solécole was officially founded. The students then created a logo, promotional videos, informational material, sought sponsors and members, and learned public relations in the literal sense “hands-on”. A public financial barometer in the school building makes transparent how the capital build-up develops and that the energy transition is a collective task. In this way, students not only applied physical concepts, but also experienced how scientific knowledge interacts with technical, economic, and societal contexts.

First Installation: Obstacles, Financing and Commissioning

The road to the first installation was riddled with spatial-planning and financial potholes. The architect, heritage preservation, and the cantonal building master were initially sceptical of a visible alteration of the new roof; the originally slanted modules were considered aesthetically disruptive. Only when a flat ring along the roof edge was proposed and the school administration and the mayor mediated in a clarifying discussion did a solution emerge. Meanwhile, the arduous process of financing the project proceeded: cooperative shares were sold to students, parents and teachers, donations were collected, and low-interest loans were raised from private individuals. A request for KEV feed-in remuneration was rejected in 2008 for capacity reasons; finally, Solécole obtained, through a tender for the solar power exchange of the city of Zurich (EWZ), a 20-year feed-in contract that secured the economic viability. Thus in 2009 the first installation with 162 polycrystalline modules and 36 kWp on 259 m² could be realized. It was financed by roughly CHF 64000 cooperative capital and donations, CHF 51000 cantonal subsidies, and private loans at 2% interest – a teaching example of how citizen energy can be channelled, even in a school context.

Expansion and Vision 2020: From the School Installation to a Neighborhood Power Plant

The first success triggered a new dynamic. In 2010 Solécole formulated the “Vision 2020”: By 2020 the school should produce more electrical energy than it consumes – through consistent saving and the expansion of PV capacity. In February 2012 the second installation on the same roof was accompanied by the students themselves (see figure 3.2-3) and expanded the PV area to a total of 899 m² with 134 kWp. The electricity yield tripled, enabling the school to cover about half of its electricity demand with its own PV production – roughly equivalent to almost 40 households (see figure 3.2-2). The project received media attention, environmental awards and subsidies. The vision, however, remained ambitious: the school's self-consumption still far exceeded the production capacity. Solécole therefore turned to the municipality and specifically asked for additional suitable roofs. From several options the cooperative selected the roof of the “Alters- und Gesundheitszentrum



Figure 3.2-2: The two photovoltaic installations on the roof stem from the initiative of learners and teachers of the school and belong to its non-profit cooperative.



Figure 3.2-3 During the construction of the second system, the learners could get hands on themselves.

Tägerhalde", on which 736 modules were installed. 90% of them are sensibly consumed directly in the senior center itself. Since 2020, with this third system Solécole has supplied so much electricity that the production targets formulated a decade earlier are exceeded by about 50%: The cooperative produces, on the balance sheet, significantly more electrical energy than it consumes. At the same time, the PV portfolio proves to be not only ecological but also an economic success, so Solécole is installing a fourth power plant at the school's winter camp residence in Sedrun, Graubünden. Today the cooperative operates four PV systems with a total capacity of almost 0.5 MWp, generates over CHF 100000 annual revenue, and the remaining loans from a total investment of roughly 1.4 million Swiss francs are expected to be repaid by 2027. Long-term feed-in contracts with EWZ and Swissgrid as well as purchase guarantees from the municipality of Küsnacht and the warehouse operator secure stable income well into the 2030's, and the equity ratio could be significantly increased after years of debt reduction.

The expansion not only increased the technical capacity of the project, but also broadened its educational potential, providing students with access to more complex systems and long-term data for analysis. For example, a direct comparison of the solar radiation data from the various power stations showed that the cleaning process resulted in a 30% energy surplus. Further data analysis is planned for this summer, which aims to highlight the energy and financial implications of installing a 15-kWh battery.

Energy School in the Sense of BNE: Learning Laboratory in Real Operation

In the reform of upper secondary education in Switzerland (WEGM - Weiterentwicklung der gymnasialen Matur) the cross-disciplinary educational area "Education for Sustainable Development" is defined as a new educational objective – Solécole has been providing a successful, multifaceted example at the grammar school of Küsnacht for almost two decades. Pedagogically, the cooperative works in several directions:

- In physics lessons, basic concepts such as energy, power, kilowatt-hour or efficiency can be illustrated not abstractly but with the school's own rooftop power plant.
- In the topic area of climate change, there is an immediate solution approach on campus with exemplary character – a proof that decarbonisation does not only happen "somewhere else".
- Tours of the installations allow observational teaching on module technology, wiring, inverters, monitoring and yield statistics. Numerous Matura theses have originated directly from Solécole: feasibility studies on cleaning robots for PV areas, experimental evidence for efficiency gains through active module cooling, detailed analyses of all electricity flows on the school grounds with derived saving measures, solar-powered drones, or the conversion strategy of a parent house to Minergie standard. These works combine physical modelling with measurement data from the real-world installation and lead to concrete measures on the school site: retrofitting lighting to LED, optimisation of supply- and room temperatures, improvement of building control, replacement of inefficient boilers and reduction of standby losses, especially in computer rooms.

Beyond electricity production, Solécole initiates further projects, such as converting the school's heating system to wastewater heat recovery in cooperation with the municipality and a contractor: a heat-pump solution largely replaces the former gas heating and reduces CO_2 emissions by roughly 70%. Thus, the school site also becomes a real laboratory for cross-sectoral decarbonisation on the heat side.

Cooperative Structure: Physics, Politics and Economics in the Same System

The legal form of the cooperative proves advantageous for the sustainability of the project and the sense of community. Learners, teachers, parents, alumni and other interested parties can become members; all receive share certificates and thus have a say at the general assembly. From a physical perspective this structure enables the intertwining of energy and climate issues with economic and legal frameworks: students can, if interested, experience how feed-in tariffs, funding programmes, VAT regimes and long-term investments interact. Financially, Solécole does not pursue profit maximisation but cost coverage and risk minimisation. Investments are secured exclusively through equity and loans from membership, debt reduction proceeds according to plan, and a climate fund from prize money (including the Zurich Cantonal Bank environmental prize 2012 and the Zurich Insurance climate prize 2013) enables additional funding projects. This climate fund supplies the Vision Prize, with which the best energy initiatives at the school are honoured – ranging from efficiency projects to behaviour-change programmes (e.g. vegetarian day and local procurement at the lunch table) to technical innovations around the installations.

School Culture, Membership and Long-Term Impact

Social sustainability is evident at Solécole in the composition of its membership and its embedding in school culture. The number of cooperative members grew sharply after an initially hesitant start with the construction of the first installation, and today includes nearly 700 members, of whom just over two thirds are current or former students. The annual general meeting serves not only for formal decision-making but also as a gathering point for former school affiliates; it strengthens the connection to the school and the shared pride in what has been achieved. In the school building, a showcase with project information, an artistically designed sun displaying the names of all members, and a real-time yield display at the entrance make the cooperative visible. Organizationally, the operation of the installation itself requires some effort by the volunteer board; another labor-intensive task is the continuous information and outreach to new students who will carry forward and further develop the project. The volunteer board receives support from the school board as well as the facilities staff, who handle maintenance tasks as part of their daily routine – an example of institutional cooperation beyond formal duties. From the perspective of physics education research, the project is noteworthy for how it combines scientific inquiry, real-world application, and sustained student involvement across generations. This creates a unique continuity in which both knowledge and responsibility are passed from one cohort to the next. Solécole thus goes far beyond what many schools label as a 'project week' or 'model trial,' establishing its own environmentally friendly energy production as a financially sound, technically demanding, and pedagogically fruitful answer to the pressing climate question within the school system.

Solécole as a Model Case for Physics Education and the Energy Transition

The Solécole cooperative represents a well-established and inspiring example of how schools can take an active role in the energy transition. It offers a model that may inform similar initiatives in other contexts, particularly in new school constructions or renovations where photovoltaic systems are often underutilised. It serves the climate debates taking place in schools as a sustainable and long-term investment and catalyst, encouraging learners to take on the challenge. With regard to the BNE (Education for Sustainable Development) embedded in the new curriculum framework, the cooperative is a concrete, replicable example of how schools can become active actors in the energy transition – and how physics education plays a central role in this. It is a system that has grown over years, in which teaching, small-scale research (Matura projects), infrastructure, governance, and a focus on the common good interlock.

For more information, visit www.solecole.ch.



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