ENERGIAKLUB
CLIMATE POLICY INSTITUTE
APPLIED COMMUNICATIONS

SHORT STUDY

Who can economically benefit from wind farms?

Over the past 10 years, the rapid expansion of wind power worldwide has been driven by the growing demand for climate-conscious and climate-focused, quasi-zero carbon renewable energy, the development of technology, market expansion and the resulting radical reduction in production costs.

Our key findings and recommendations are:

The creation of a predictable investment environment in the long term will make it attractive for wind power developers to install and operate wind power plants in Hungary.

In Hungary, wind farms could do without any extra support (e.g. the current renewable energy subsidy scheme) on a purely market basis.

In-depth economic analyses and the assessment of the investment environment in the regions concerned are needed in order to guide developers as well as the municipalities and decision-makers in the vicinity of future wind farms.

Revenue structures should be managed through policies to reduce barriers to developers and at the same time to support the economic development of local communities. We recommend a review of the relevant forms of taxation and, where possible, their reduction or abolition.

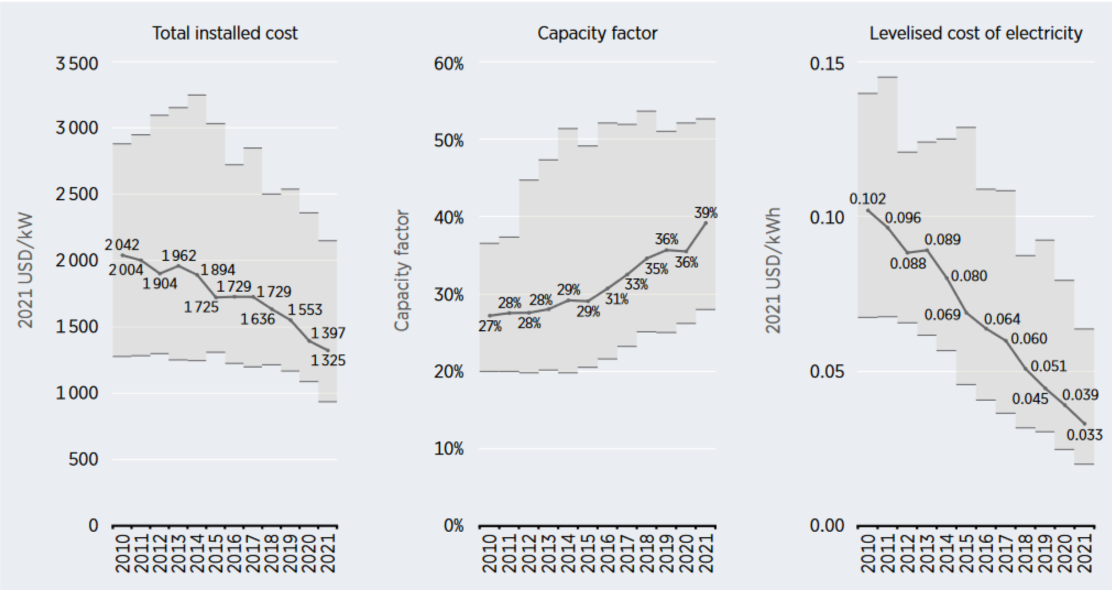
Informing and involving local communities is essential to maximise the economic viability of wind farms.

Both distribution and microgrids need to be upgraded to improve grid resilience and access to electricity.

Improved return on investment

In its declaration of 5 December 2022, the European Council endorsed Hungary's Recovery and Resilience Plan (RRP), one of the reforms of which is "Facilitating Wind Energy Investments". Under this, the Government will significantly ease the rules on setback distance that currently prevent the installation of new wind farms and there will be no restrictions on capacity.

According to IRENA's 2022 report, the average price of globally installed wind power plants decreased by roughly 35% between 2010 and 2021 in terms of unit (per kW) investment costs (see Figure 1, left).



Source: IRENA Renewable Cost Database.

Figure 1: Changes in total installed costs, capacity factor and levelized cost of electricity (LCOE) of wind power plants between 2010 and 2021, source: IRENA

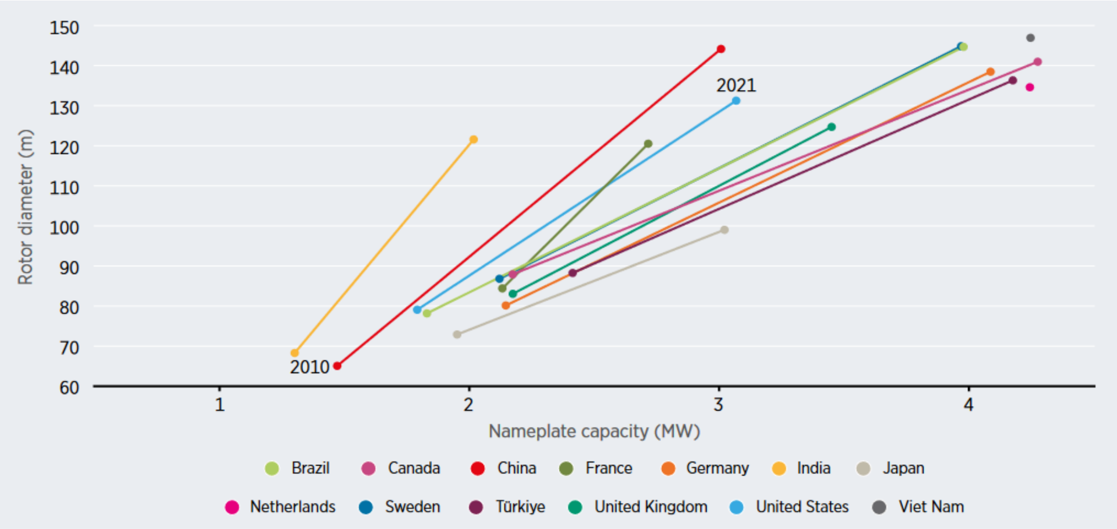
In addition, the annual utilisation (capacity factor; see Figure 1, middle) of wind power plants has improved significantly, as modern wind turbines can start up at lower wind speeds and produce at higher altitudes with better wind conditions. While in 2010 they had an average capacity factor of "only" 27%, by 2021 this had increased to an average of 39%, meaning that a wind turbine with the same capacity will produce 45% more energy with the technology available in 2021 than with the technology available in 2010.

As a result of the above two market/technological effects, the levelized cost of electricity (LCOE) of wind power (i.e. how much it costs to produce 1 kWh of wind energy) has fallen dramatically by one third (!) over the last decade.

These positive changes have not been felt or measured in Hungary, where no new wind farms have been built since 2011.

A forecast by the world's leading wind energy research laboratory estimates that the current unit construction and operating costs of offshore and onshore wind farms could fall by an additional 35% by 2035 and by 37-49% by 2050 (Wiser et al. 2021, Nature Energy, Lawrence Berkeley National Laboratory research.)

In addition to the five main elements of the cost calculation (upfront capital cost, operating costs, capacity factor, project design life and financing cost), Berkeley National Laboratory researchers say it is important to take into account the ever-increasing size of the turbine.



Source: IRENA Renewable Cost Database.

Figure 2: Average change in rotor diameter and nameplate power of wind turbines between 2010 and 2021 by country, source: IRENA

The average size of wind turbines has increased worldwide, from an average turbine capacity of 2 MW in 2010 to an average of 4 MW in 2021 (for onshore turbines only), a trend that is projected to continue until at least 2035 (Figure 3).

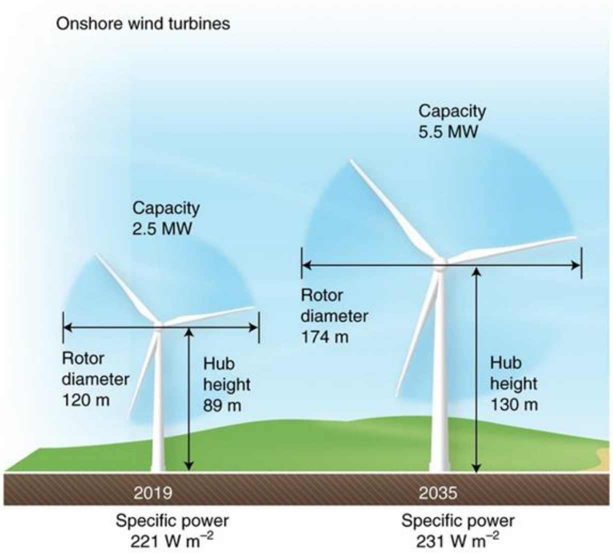


Figure 3: Projected changes in size and capacity of onshore wind farms 2019-2035[1]

[1] https://www.renewableenergyworld.com/wind-power/wind-power-experts-expect-wind-energy-costs-to-decline-up-to-35-by-2035/

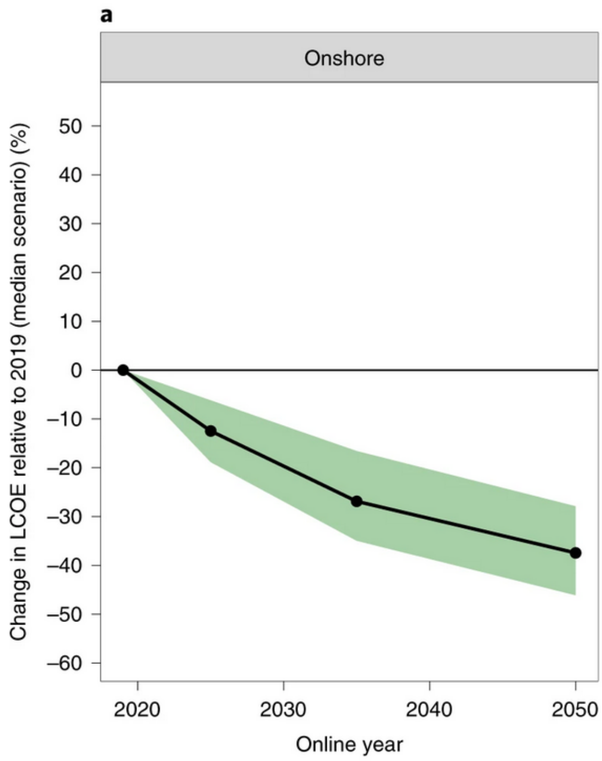


Figure 4: Projected change in levelized cost of electricity for onshore wind power by 2050 compared to 2019, source: Nature [2]

Increases in turbine size could be an important factor for lower levelized cost of electricity (LCOE). Since 2020, experts have been even more optimistic about further increases in turbine power, hub height and rotor diameter. In 2020, turbines were forecast to have an average nameplate power of 5.5 MW by 2035 (see Figure 4).

In recent years, wind power generation costs have fallen faster onshore and offshore, making previous cost projections outdated. However, the domestic energy sector needs up-to-date assessments and therefore more in-depth analysis of the domestic investment environment is needed.

According to Hungarian experts[3], wind power plants in Hungary would be able to operate on a purely market basis without any extra support (e.g. the current renewable energy subsidy scheme). Investments could in any case be paid back over a timespan of 8-10 years. Given the current pricing and market environment at the time of commissioning and during operation, this payback could be much faster.

A 3 MWp wind power plant with a capacity factor of 23% (similar to the current Hungarian wind power plants) could generate roughly 6 million kWh of electricity per year, which at a selling price of 15-30 HUF/kWh would generate an annual income of 100-200 million HUF from the sale of electricity. Based on experience in Western Europe, the total installation cost of a 3 MWp wind turbine (including the necessary balancing capacity) is in the range of 1-1.5

[2] https://www.nature.com/articles/s41560-021-00810-z

[3] Energy Club wind energy workshop (09.09.2022)

billion HUF. In general, larger turbines cost less per kW than smaller ones, and single turbine sites cost more per kW than multi-turbine sites.[4,5]

Income opportunities for communities, government agencies

Municipalities and other governmental bodies can generate revenue from wind energy development through taxation, levies, fees, and other forms of compensation. This is relevant not only from their perspective, but also for legislators, as the currently evolving legislative environment will determine which of the options will be available in practice (and for whom). The following is a general overview of the options, broken down into four groups.

1. **Community considerations**: due to different tax assessment procedures and authorities, communities will probably have differing experience in licensing, assessing and collecting wind energy revenues.
   Some communities may have greater leverage in negotiating with wind developers (e.g., priority investments), while other communities must comply with tax, exemption, and other restrictive structures specified by national law. Revenues may be set by the state or region/county or may be agreed upon individually between the parties. Developers and communities play an important role in ensuring economic viability. This is particularly the case in taxation. For owners/developers, tax considerations are a key factor in the selection of a wind energy project location. For communities, the additional revenue generated from taxing wind energy projects can support economic development, which can be part of a higher level economic strategy.
   Taxes, fees and other revenues from the development of wind energy projects can be used in a variety of ways, depending on the needs and priorities of the local community. Some communities have used wind energy revenues to increase funds for school budgets, reduce homeowner tax burdens, meet community needs through local infrastructure, or improve basic local services and support other local investments.
   Revenue structures should be designed in a way that reduces barriers to developers while supporting the economic development of local communities.

2. **Development fees**: development fees typically consist of a one-off payment paid before or during the construction phase of the development project. These fees can be application or permit fees, as well as sales or use taxes. Sales or use taxes are collected during the development phase and are associated with large construction purchases such as wind turbine parts or construction materials.
   a. **Use tax**: applicable to goods and materials purchased outside the community but consumed within the community where the wind energy project is located, such as when a developer supplies wind turbine parts or construction materials to the community. The entity authorized to collect the use tax may choose to impose or exempt the developer from the use tax.
   b. **Licensing or construction fees**: a one-off fee, usually collected at the time of application during the licensing process, which can be used to cover various costs incurred by the licensing authorities. The size and location of the project usually (in other countries) determines whether the state, county or municipal government has the authority to oversee the permitting of the proposed wind energy project and the collection of the associated fees. These types of permits are related to construction, road use and

[4] https://www.researchgate.net/figure/Energy-and-financial-estimation-of-3-MW-Vestas-V90-wind-turbine-versions_tbl7_259169211
[5] https://www.renewablesfirst.co.uk/windpower/windpower-learning-centre/how-much-does-a-wind-turbine-cost/

zoning issues. The fee assessment is typically part of the permit or ordinance.

c. **Recurring long-term revenues**: recurring long-term revenues can provide an ongoing source of revenue for the local (or county) government, providing community benefits over the life of the wind energy project. This recurring revenue is often revenue from property taxes or from agreements negotiated annually by the community (e.g., business taxes).

d. **Ancillary revenues**: communities can generate indirect revenues supported by the wind energy project. These are often sales tax revenues collected from products, goods, materials and services purchased during the construction, operation and maintenance of the project. Local businesses, such as grocery stores, restaurants and hotels, are likely to generate more sales during the construction phase. In addition to providing direct sales revenue to these businesses, the increased sales also generate significant additional revenue through sales taxes paid by construction and operations workers who spend their earnings in the community, increasing the local tax base.

For more on the sources of income from land use and agricultural activity, see the Agriculture and Wind Energy study[6].

The largest incremental cost drivers: network development and balancing

One of the main challenges for grid development is the expected evolution of power plant construction and the changing demand for existing power plant fleet on a market basis.

The increasing penetration of renewable energy generation requires transmission grid upgrades. This is most likely to happen if large wind farms (a few hundred MW) are built in a relatively small region. In this case, the collected renewable energy must be fed into the transmission grid at voltage level and transported to the place of consumption. A good example of this is the Austrian energy system, where the output of a major wind farm east of Vienna is received at 400 kV. Plans are underway to accommodate the wind power capacity envisaged in the Szombathely-Csorna area in a new 400 kV substation.

New wind farms are required to provide balancing control capacity in an appropriate proportion of the maximum installed electrical capacity to compensate for deviations from the schedule.[7]

A diversified spatial distribution of planned wind farms in all regions of the country is needed to achieve a more balanced load on the grid. With the current technology, the average wind speed in the Great Plain is sufficient for economical wind energy exploitation. A wide spatial distribution, in addition to the more even national production resulting from the partial equalisation of weather fluctuations, will also help to distribute and reduce the fluctuating voltage on the electricity system.

Microgrids have to be upgraded in order to improve grid resilience and access to electricity.

A good example is the Danish "HyBalance" project[8], which uses excess wind energy to produce hydrogen through electrolysis to balance the grid. The hydrogen produced is then used in the transport and industrial sectors in the Danish city of Hobro. This project is expected to improve the feasibility and economic viability of hydrogen investments through the potential

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[6] https://energiaklub.hu/files/study/Sz%C3%A9lenergia%20%C3%A9s%20mez%C5%91gazdas%C3%A1g_kett%C5%91s%20haszon.pdf

[7] detailed rules can be found in section 5.1.9 (H) (b) (bf) of the MAVIR Operating Rules (page 68)

[8] https://hybalance.eu/

revenue streams from hydrogen. Therefore, it is recommended to plan wind energy investments in parallel with and linked to hydrogen developments.

Innovative distributed energy and financing - the PPA scheme

Green Power Purchase Agreements (PPAs) are now also available in Hungary. Their importance is that, especially in the current difficult economic situation, they allow companies and even the public sector to make progress in meeting their environmental obligations without spending capital, while improving their own reputation and making their energy costs more predictable.

A PPA is a contract for the purchase of electricity generated by a power plant. These agreements are a critical part of the design of a successful wind project, as they provide a long-term source of revenue for the project through the sale of the electricity generated by the project. Securing good PPAs is often one of the most challenging aspects of wind power development.

A PPA is a long-term agreement between the seller of wind energy and the buyer. The conclusion of a PPA is also a condition for the equity and debt financing of the project. The energy can be sold through the PPA to an investor-owned, municipal or rural electricity cooperative in the local market, or in some cases to more distant utilities or wholesale or retail customers in unregulated markets. Under a PPA, the buyer does not need to make a capital investment, has no ownership responsibility for the wind farm and has no ongoing operation or maintenance costs. The buyer simply pays a fixed price per kilowatt-hour for the electricity generated by the wind farm. This gives long-term control of energy costs, typically below the price of grid electricity (the extent depend on the size of the project and the duration of the contract). Buyers in these situations are known as off-takers.

In Hungary, one of the main barriers to the wider deployment of PPAs is currently that electricity generators are also taking a significant financing risk by installing PPAs, so there is a relatively limited pool of credible players in the domestic market. According to experts, the abolition of the "Robin Hood tax", which removes 31% of “extra” profit before tax (increased to 41% in December 2022 by the government[9]), would also greatly facilitate the domestic uptake of PPAs.

Although price terms are often considered the most important element of a PPA, PPAs typically contain a number of key provisions that address issues such as the duration of the agreement, the commissioning process, the purchase and sale of energy, limitation agreements, transmission issues, milestones and default, credit, insurance and environmental features.

The main benefits of PPA for the consumer are:

- Clean energy supply that can be traced from a single device.
- They generate additionality: signing a PPA allows investment in renewable assets, thereby reducing the amount of energy from polluting sources.
- Opportunity to brand the renewable asset.
- Competitively priced energy (significant discounts on current and future energy prices).
- Stable and predictable electricity prices.
- Each product is tailored to the customer's needs.

Benefits for PPA developers/providers:

- They allow them to invest in new assets by providing long-term income security.

[9] https://magyarkozlony.hu/dokumentumok/ddc43c6b4ec1a604be33a8f39004da233a5e3bab/megtekintes

- They allow investment decisions to be made on the basis of profitability versus risk criteria.
- They make the project bankable.
- They build long-term relationships with end users.
- Alternative means of investing in renewable assets, in addition to participating in auctions or commercial investment.