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ECONOMIC INITIATIVES FOR INTEGRATION OF RENEWABLE ENERGY SOURCES INTO THE HOUSEHOLDS

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Overview

Renewable energy sources (RES) is leading the new installed capacities in EU, US and other industrial countries. After successful introduction of feed-in tariff system, development of the new wind or solar PV parks became an attractive investment option for corporations, risk capital and pension funds. Taking into account the reality of the small and economically less developed country most of the benefits of RES development leave the country without creating positive noteworthy impact on neither local communities nor economy. The major part of equipments and investments come from the foreign countries making a negative impact on the countries import/export balance. Some positive impacts are observed only during the construction phase: part of engineering work is done by local contractors. After power plants are committed little of the benefits reach local communities. Common people are faced by increased electricity prices without any noticeable benefits. This situation creates ever-increasing opposition to the big wind or PV parks or even to the RES in general. Feed-in system is a suitable approach to rapidly increase share of RES in countries, but it creates a negative long-term macroeconomical effect and triggers opposition in local communities. This article analyses the measures of the RES support at the household level identifying support requirements and the benefits to the state and the households.

Method

Levelised cost of energy (LCOE) is one of the most widely used approaches for comparison of different energy generation alternatives. It is based on the principal that considering to the chosen discount rate the present value of total life–cycle cost is calculated and distributed per one unit of production unit. The LCOE approach is especially useful to assess competitiveness of different energy generation alternatives, possible gains for project developer; it helps to make insides into macroeconomic effects (after external data are utilized); as well to compute the effect of different financing instruments on energy cost. The classical representation of the LCOE is provided in Eq. (1):

$$LCOE = \frac{\sum_{t=0}^{T} \frac{I_t + O\&M_t + F_t}{(1+d)^t}}{\sum_{t=0}^{T} \frac{C_I \cdot 8760 \cdot LF}{(1+d)^t}} \tag{1}$$

Here: I_t – investment cost at time step t, EUR; O & M_t – operation and maintenance cost at time step t, EUR; F_t – fuel cost at time step t, EUR; C_I – installed capacity, kW (MW); LF – load factor, %; d – discount rate, %; t – life time, years.

In this analysis an extended version of LCOE was applied, adding other important factors such as subsidies for generation or construction, degradation rate of the output (important for analyzing PV), residual value, etc. An extended version of LCOE is represented in Eq. (2):

$$LCOE = \frac{\sum_{t=0}^{T} \frac{I_t + O\&M_t + F_t - PTC_t - ITC_{tt}}{(1+d)^t} - \frac{RV}{(1+d)^T}}{\sum_{t=0}^{T} \frac{C_I \cdot 8760 \cdot LF \cdot (1-DR)^t}{(1+d)^t}} \quad (2)$$

Here: PTC_t – subsidy for energy production, EUR; ITC_t – investment subsidy, EUR; RV – residual value, EUR; ATL_t – income / cost for emissions/emission allowances, EUR, EF – CO_2 emission coefficient, t; ATL_{ft} – number of free emission allowances, EUR/t; DR – degradation rate of technology, % per year.

In this analysis small-scale installations suitable for single family houses were analyzed, based on currently available equipment in the market. The state support requirements were analyzed based on the cost of alternative energy it replaces. If LCOE of analyzed alternative is less then alternative energy cost it is assumed that selected technology at current market conditions does not need financial support (but it still may need a non-financial support). If LCOE exceeds the alternative energy cost, then different support measures (based on currently available practices) are used to evaluate the selected support mechanism and amount of funding. Assumption is made that household acts based only on pure economic logic.

Countrywide macroeconomic impacts were assessed on technology by technology bases taking into account origin / price of the fuel replaced, availability / market share of locally produced materials and equipment, installation procedures, salary level, existing legislation and tax regimes, etc.

Results

Several different RES technologies suitable for a single family house were analyzed. Calculation of heat, electricity and space heating demand was based on average 180 m^2 houses with brick walls inhabited by 4 persons. Technologies analyzed:

Solar collector for a hot water preparation. For cost comparison purposes, an alternative electrical boiler was used assuming system designed for non-heating season utilization. At current electricity and solar collector price level this technology is still less attractive than existing regular electrical boiler, but introduced a 30% investment subsidy could trigger the change. Taking into account that over 50% of installation cost may be locally produced and it would replace imported electricity it may prove to be beneficial from the country's macroeconomical perspective.

Small scale solar PV. For cost comparison purposes, a current residential electricity price was used. Assumption was made that electricity generated by solar PV is consumed within the household, using electricity grid for accumulation. Currently there is no such legislation in place, but it is prerequisite in for solar PV to be even marginally attractive. With above mentioned limitations small-scale solar PV is an interesting option, having only 15% higher electricity price compare to the price of electricity for households.

Wood pellet boiler. For cost comparison purposes, a high efficiency gas boiler was used. At current natural gas and pellet price levels these two alternatives have very similar cost. Due to high equipment costs, there is no economic benefit for the household to change existing gas boiler to the pellet boiler, but for new installations pellet boiler solution cost around 5% less, but involves extra maintenance: pellets should be supplied and ash removed constantly. From the macroeconomical perspective wood pellet boiler should be a more desirable alternative: it use local fuel, therefore creates local jobs and decreases import dependency.

Increase of the heat insolation of the house. Cost comparison was done for the house using gas heating. Based on a current price of material and labor cost this alternative is not economically attractive. If calculations were done for 20 years period, it would be necessary to have 60% investment subsidy to make house renovation economically attractive. Even taken into account high share of labor cost and locally produced materials this alternative is not economically justified.

Other technologies analyzed**:** shallow geothermal, small scale wind turbine.

Conclusions

Deployment of RES technologies may be the fastest and the most cost-efficient way to fulfill country's RES targets, but this may not be an optimal approach when taking into account cost / benefits distribution, country's macroeconomic indicators or other goals (regional development, 20-20-20 target and etc.). Some of available small-scale technologies that are suitable for a single family house could increase RES penetration with a wider distribution of benefits and at the same time give additional positive effects: lower unemployment, additional tax revenue and less foreign import. Based on the results the best alternatives for households are solar collector and wood pellet boiler. With a change in the local legislation solar PV is also may be an attractive option for the single family house, but, being and imported technology, it procure less worth mentioning additional benefits.