THE QUESTIONS OF RENEWABLE SOLAR ENERGY USAGE WITHIN EUROPE THROUGH TWO IMPORTANT CASE FOR HOUSEHOLDS AND THE POSSIBILITIES OF ALTERNATIVE FUEL USE, AFFECTING THE INFRASTRUCTURE AND TAXATION FROM THE ASPECT OF CLEAN/GREEN ENVIRONMENT

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ABSTRACT

In the last few years, along the wide spread of solar-systems which are getting cheaper, like air-conditioning and the similar spread of hybrid and only/cleanly electric powered (e-)cars, arises the idea that any electric energy surplus produced by the solar system or extending it till the calculated level, could decrease the monthly budget of a household, while the expected return of the investment is significant. Beside auxiliary heating and electric car usage arises the problem of daily overproduction of electricity and the lack of storing it Europe-wide. Another aspect of renewable energy are the alternative fuels (e.g.: bio-ethanol, bio-diesel, bio-methanol) plus (e.g.) bio-gas instead natural gas and the conflict between EU directives in connection with sustainable development and national regulations of taxation where usually the excise-tax loss would affect mainly all nation's balance of budget. In case of heating (natural-gas) the dependence from Russia and the existing centralized infrastructure are the key elements which shall be reconsidered if the clean and green economy/life is the objective.

KEY WORDS

Renewable energy. Fuels. Taxation.

JEL CLASSIFICATION

Q42, Q43, Q48.

INTRODUCTION

This paper approaches the problem from four sides. The first is the alternative energy sources and new devices like e-cars, the second is is the regulation of the EU which declared in 2009 that „Sustainable development is set out in the Treaty as the overarching long-term goal of the EU“ (EU Commission, 2009) and inclusive renewable (clean and green) energy shall be used anywhere, the third is the taxation in member states (specially the excise tax+VAT on fuels) and the fourth is the problem of infrastructure.

In a previous study in 2015 (Bunkóczi & Szalay, 2015) it was calculated also and stated, that home solar systems are a reasonable long term investments everywhere in the EU. Reasonable as about 10% or at least 10% turnover is expectable. So the question taking into account on the earlier, that how many plus solar panels (and inverter capacity) should be mounted on the roof (e.g.) to have free heating/cooling and anything else...

1 THEORETICAL BACKGROUND

This paper shows two cases where the internal rate of return for investments of solar panels and inverters may reach and exceeds 100% so this kind of investment would be reasonable.

The first is auxiliary heating with air-conditioners, while the other is electric car usage till daily 80 km range supplied with own produced solar energy.

The others like alternative fuels, and bio-gas is only on mentioned level, as perhaps we could redeem non-renewable fuels (like petrol and diesel oil) and also natural-gas mainly from Russia with bio-gas, but the latter is more problematic.

1.1 Alternative energy sources

The first is the alternative energy sources (like sunshine and also biofuels like E85, biodiesel, bio-methanol, biogas for heating etc.) and the technical development of devices (like e.g.: solar-panels, inverters, air-conditioning, hybrid and cleanly electric cars etc.) that can be seen around us in Europe and these devices now are in the reasonable and payable range.

The question may be raised when will they totally replace the old ones, which use non renewable fuels and energy.

1.2 Directive and the regulation of the EU

The second side is the regulation of the EU which declared in 2009 that "Sustainable development is set out in the Treaty as the overarching long-term goal of the EU. The Sustainable Development Strategy of the European Union (EU SDS), as revised in 2006, is a framework for a long-term vision of sustainability in which economic growth, social cohesion and environmental protection go hand in hand and are mutually supporting." (EU Commission, 2009)

The most important here is: „As part of the Climate and Energy Package [20], the EU is committed to sourcing 10% of its transport fuel consumption from renewable energy sources by 2020 (incl. biofuels, renewable electricity and hydrogen). This target is accompanied by binding sustainability criteria for biofuels included in the Renewable Energy Directive [21] and the Fuel Quality Directive [22].“ (EU Commission, 2009)

Although this was set as an axiom EU-wide, the E85 (bio-alcohol) in Hungary was taxed also with excise tax in 2001 (Suhajda, 2016), so the E85 almost disappeared and become as expensive, that economically it's not worth to use it. It's a miracle some ways that somewhere it can be bought/sold.

1.3 Taxation in member states for fuels – excise tax + VAT

The third is the taxation by member states, where usually e.g. the excise tax content plus VAT and other less important tax content in the price in fuels, averagely is about 64% (Szász, 2016). This tax content may reach about 10% in national budgets or more. Depends on the level of motorisation. Anyone may think about what would happen, if this tax content would decrease to zero in any member state, may cause about 10 or more % extra deficit.

1.4 The infrastructure problems of electricity and natural gas

The question/problem has another side like infrastructure, which is said to be centralized (for electricity and mainly for natural gas) but examining the problem at first for/from electricity, it can be handled easily till that point when the local (in one area, under one transformer) energy production in real-time is less than the use of it, but if daily (at light) the production would exceed the use of it, the transformers transforms electricity bidirectional, so only another place is needed where it could be used. The real problem arises when the energy production from renewable energy exceeds the use of it within one country or EU wide, and it should be moved to another place (more than 1.000 km for e.g.) as electric energy can't be stored easily.

This situation happened sometimes in the last 10 years when electric wires of Poland, Czech Republic and Slovakia were overloaded from northern German electricity which was to use in South Germany.

The infrastructure problem of natural-gas/bio-gas arise from two points:

1. The local networks pressure under streets is about 8 Bar, while within flats it's less than 1 bar. This could be handled, as compressors can be bought, but the direction of gas flow can't

be turned/reversed as reducers everywhere in the network won't change their direction/position so if we could produce bio-gas (during warm seasons), how it could get to gas storages?

2. Bio-gas that could be produced at home is not only clean natural-gas (CH_4). If the first problem could be fixed, this second is still a big challenge as the energy content is less, and there is a lot of other components of the gas which is not in the prescribed standard about the original natural-gas.

2 OBJECTIVE AND METHODOLOGY

In case of solar energy the placing and facing is important. In the following cases the solar panels are supposed to be placed on the roof, usually with 45° sloap. But not all the roofs, face to South so the following table is for deviations from South from -90° till +90°.

Table 1 Annual solar power generation of 1.56 and 1.5kW solar cell panels deviating from South from -90° till +90 °

deviation from South (°)	yearly electric production	1 table's (260W) yearly prod. (kWh/year)	cheap table's (250W) yearly prod. (kWh/year)
-90	1260	210	202
-75	1350	225	216
-60	1440	240	231
-45	1500	250	240
-30	1550	258	248
-15	1580	263	253
0	1590	265	255
15	1580	263	253
30	1550	258	248
45	1490	248	239
60	1420	237	228
75	1340	223	215
90	1250	208	200

Source: Own calculation based on http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php.

2.1 Supplementary heating with air conditioner powered with solar energy redeeming natural-gas

Basis of calculation: energy content of 1 m^3 of natural gas: 34.1 MJ, for heating only e.g. 89% of this value is used (105% efficiency condensing gas boilers are not working exclusively above 100% efficiency), which is calculated with electricity and with a given SCOP (e.g. 5):

34.1 * 0.89 * 0.28 * 5 = 42.4886 kWh of electricity. The 0.28 changeover is a constant between MJ/kWh (1kWh = 3.6MJ, thus 1MJ = 1/3.6 kWh= 0.27777), and SCOP 5 indicates that the air conditioner pumps 5 kWh heat energy using 1 kWh electrical energy only. SCOP is the seasonal average value for heating given by the manufacturer.

The EER value is used to provide cooling efficiency, which is hardly relevant here. The difference between the SCOP and EER values is that the SCOP is always higher, because the energy loss / heating of the electric motor and other heat exchangers contribute to the heating process, improving the result.

About the SCOP it's knowable, that the given 4.6 or 5 value is already seasonally adjusted (COP can be up to 7 at about 9°C outdoors temperature), thus in the calculation the values ranging between 2-5 mean, that we are underestimating this value rather than more/above.

As the demands are differing, so the calculation is made for the combination of gas deeming from 100 to 500m3 (step is 20) and between 2-5 SCOP-s AC devices and there is another parameter that changes the result: orientation of the solar cells compared to the south direction -90° to + 90°.

Based on these 3 parameters, the energy savings in MJ and HUF and 2 types of solar panels are calculated (annual saving / investment requirement) with a new 260W (60 000 HUF/table) and a used 250W (35 000 Ft/panel (Szabó, 2018), depending on the expected annual energy demand, may vary from 1 to 3.

2.2 Solar energy for electric cars

Comparing to the earlier, it's easier, as only the deviation and the daily usage shall be combined but one constant is important: for 100 km a smaller e-car uses about 8,761 kWh electricity (Rácz, 2015). The price of the petrol is set for 349 HUF/l which is about 1,118 EUR/liter.

With the higher daily km usage the more electricity is needed, so beside the number of solar panels a bigger inverter is calculated (3kW instead 2kW size) in price, so till daily 80km e-car usage the size/capacity will be enough.

Thus we have a 91 (rows) combination (13*7, 13 deviations from South and 7 daily km usage), and the results as investment demand (HUF) and yearly cost saving of petrol in HUF and after dividing the cost saving with investment the internal rate of return (IRR) also.

3 RESULTS AND DISCUSSION

3.1 Results for solar powered (auxiliary) heating

Since depending on the combination of 3 parameters the resulting 2+2 (Investment Demand 2* in HUF, and Simple Returns 2*: IRR and IRR_1) result, the disclosure of the full 4.368 series results table is omitted, only a portion of the table is given with the highest return values.

Table 2 Part of the 4,368 series (rows) results table dependent on 3 parameters with the best return values

replaced gas (m3)	SCOP	deviation from South (°)	yearly savings (HUF)	solarpanel investment value (HUF)	IRR (%)	cheap solarpanel investment value (HUF	IRR_1 (%)
160	5	-45	16 000	49 042	32,63%	35 000	45,71%
160	4,8	-30	16 000	49 042	32,63%	35 000	45,71%
160	5	-30	16 000	49 042	32,63%	35 000	45,71%
160	4,8	-15	16 000	49 042	32,63%	35 000	45,71%
160	5	-15	16 000	49 042	32,63%	35 000	45,71%
320	5	-15	32 000	98 084	32,63%	70 000	45,71%
160	4,8	0	16 000	49 042	32,63%	35 000	45,71%
160	5	0	16 000	49 042	32,63%	35 000	45,71%
320	5	0	32 000	98 084	32,63%	70 000	45,71%
160	4,8	15	16 000	49 042	32,63%	35 000	45,71%
160	5	15	16 000	49 042	32,63%	35 000	45,71%
320	5	15	32 000	98 084	32,63%	70 000	45,71%
160	4,8	30	16 000	49 042	32,63%	35 000	45,71%
160	5	30	16 000	49 042	32,63%	35 000	45,71%
160	5	45	16 000	49 042	32,63%	35 000	45,71%

Source: Based on own calculation.

And there's also a diagram with returns for 3.8 SCOP valued AC-s.

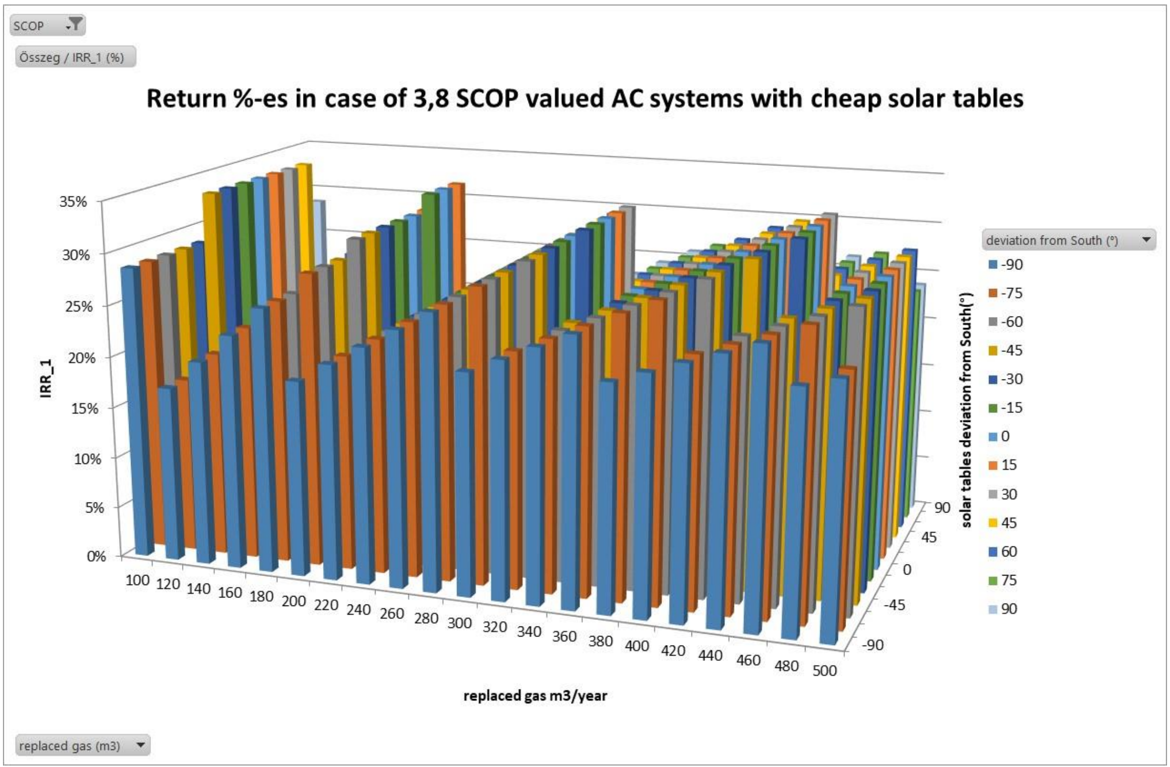


Diagram 1 Return %-es in case of 3.8 SCOP valued AC systems with cheap 250W solar panels

Source: Based on own calculations.

In this run 4.368 combinations were calculated, resulting in "low" returns (13.03% for IRR_1) also and we get quite high values (45.71% for IRR_1) respectively, of which 13.03% is around 6 times value of safely available risk-free (as it is known) bank debit investment, while 46% is 23 times respectively.

In these circumstances, these appear to be a reasonable investment, ignoring the time factor at any case, since it is worth investing in such a thing if someone is going to be able to use it for the next 10-20-30 years, as heating will be needed in Central-Europe probably forever.

The 30-45% value of the annual return on investment in the real economy (annual gas savings of 100 to 200 m3) (IRR_1 - cheap solar panels) indicates that from an investment-economical point of view it is not unreasonable to think that using surplus electricity If you already have AC-s with 4-5 SCOP values.

3.2 Results for the return of solar powered electric car usage

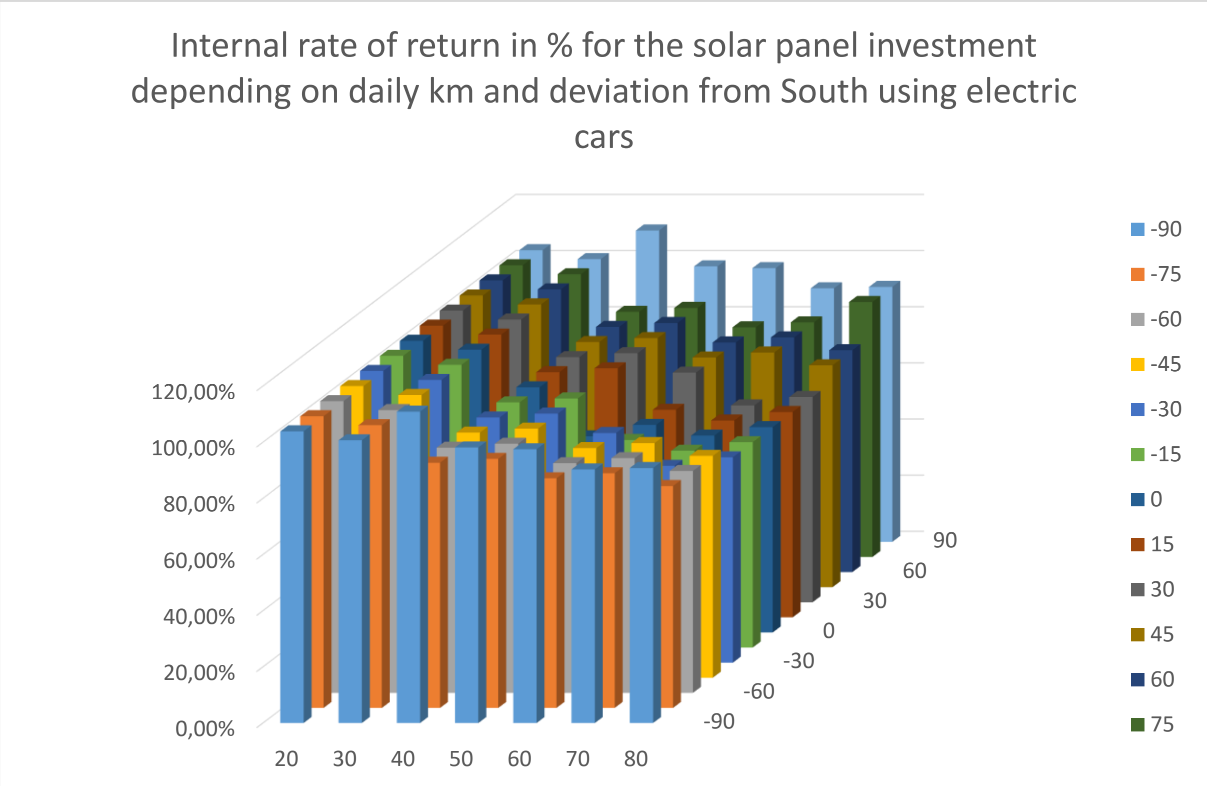
As the best results for electric car usage the following table part is listed:

Table 3 Part of the 4,368 series (rows) results table dependent on 3 parameters with the best return values

daily k	deviation from South	new solar panels	used solar panels	price new (HUF)	price used panels (HU	saved petrol (6l/100) for a year	IRR for new panels	IRR for used panels
70	-30	6	6	405 000	237 000	382 574	94,46%	161,42%
80	-30	7	7	465 000	269 000	437 227	94,03%	162,54%
60	-15	5	5	345 000	205 000	327 920	95,05%	159,96%
70	-15	6	6	405 000	237 000	382 574	94,46%	161,42%
80	-15	7	7	465 000	269 000	437 227	94,03%	162,54%
50	0	4	4	285 000	173 000	273 267	95,88%	157,96%
60	0	5	5	345 000	205 000	327 920	95,05%	159,96%
70	0	6	6	405 000	237 000	382 574	94,46%	161,42%
80	0	7	7	465 000	269 000	437 227	94,03%	162,54%
60	15	5	5	345 000	205 000	327 920	95,05%	159,96%
70	15	6	6	405 000	237 000	382 574	94,46%	161,42%
80	15	7	7	465 000	269 000	437 227	94,03%	162,54%
70	30	6	6	405 000	237 000	382 574	94,46%	161,42%
80	30	7	7	465 000	269 000	437 227	94,03%	162,54%

Also on this diagram can be seen all of the return rates:

Diagram 2 Internal rate of return %-es for the solar panel investment depending on daily km and deviation from South using electric cars charged with own panels



Source: Based on own calculations.

As it's clearly seenable, above 100% internal rate of returns may appear, which means, after one year the next 30 year could be free.

CONCLUSION

Taking into account the obtained internal rate of return values for both electrical (auxiliary) heating with Air Conditioners and for charging electric cars, these values clearly shows that renewable energy (these one are only from solar energy/sunshine) is close, is here next to us. This two example is only for showing, that other renewable energy sources (bio-gas, bio-alcohol, bio-diesel) may substitute the conventional non renewables like petroleum, natural gas which can be seen today as the basis of "normal civilised" life in the EU.

The next problem will arise if the tax (excise-tax + VAT) content of these new energy resources will be reduced to zero after the non-renewable ones (if the EU directive is important), and the whole taxation shall be transformed to hold the budget balances. Till this point some other problems like storing electricity and storing bio-gas may arise, but the latter is not applicable in the world which was planned for natural-gas storing and distribution, so something other should be used instead.

The other problem is the source of the natural-gas, which nowadays is merely Russia, so anyone may think about in the EU about the idea of dependency (in late February, early March, when it was about -20 °C) or independency but choosing the latter may cause problems in more levels.

With this paper the only goal was to raise the attention about the ambivalent and not definitely obvious relation of the EU and EU member states to the "new" renewable energy sources, which may make clear/green (??) our life or the air, or we may raise the question also whether it's green enough or not really e.g.: batteries in electric cars, which can't be seen green at all in all aspects.

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