Subsidising renewable electricity in Estonia

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Abstract

The purpose of this paper is to assess the impact of Estonia's feed-in tariffs (FIT) on combined heat and power (CHP) plants. The assessment follows previous practice and provides a novel approach by including a case study based on company data. The results of our assessment show that the Estonian FIT system has effectively supported the establishment of CHP capacity and that the administrative costs have been low. In contrast to experiences in other countries we find that the avoided external costs exceed the per MWh cost of FIT. Another feature is that the consumer costs of the FIT scheme have grown more rapidly than elsewhere. Although avoided external costs cover FIT, resources are not used cost-effectively. The case study of two CHP plants suggests that resources are used for supporting production that would have been profitable without FIT.
Keywords: renewable electricity, feed-in tariffs, CHP, energy policy, Estonia.

1 Introduction

Feed-in tariffs (FIT) is the most widely used support scheme for renewable electricity: implemented in 20 EU countries and 30 countries worldwide in 2009 [1]. Denmark and Germany were the first countries to introduce FIT in the mid-1980s and 1991, respectively [2]. Success stories about countries that have exceeded initial goals for renewable electricity seem to be forceful arguments for additional implementation. Further backing from economists supporting the use of price rather than quantity based regulation could be another reason for the popularity of FIT.

According to the national electricity development plan 2005–2015 [3] the goal is to increase the share of renewable electricity to 5.1% of gross consumption in Estonia by 2010. In the succeeding development plan, which stretches until 2018, the goal has been set to extend the share of electricity from renewable resources to 15% by 2015 [3, 4]. For Estonia, these goals imply

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significant changes. In 2007, the share of renewable fuels in electricity production was 1.75% of gross production while the main supply originated from oil shale electricity, which made up 93.6% [4]. Based on capacity under construction, it is estimated that Estonia outperforms the goal in 2010and reaches 9.7% renewable electricity [5].

Estonia's goal to 2020 is to increase electricity produced from renewables in combined heat and power plants (CHP) to 20% of gross production [4]. Following introduction of FIT in 2007, there has been a substantial increase in energy produced from renewable fuels in CHP plants. In 2009 Tallinn and Tartu CHP started operation and the share of renewable electricity is further increasing. Pärnu CHP is under construction and several small CHPs are being planned in different parts of Estonia. Recently, also oil shale electricity producers have begun to use biomass as an input. It seems thus that Estonia shares the experiences of other countries that report a rapid increase of renewable electricity following introduction of FIT [2, 6].

Besides the positive effects, the change seems to have come at a high cost. The costs of FITs have increased from 6 million to almost 55 million Euros between 2007 and 2011 [5]. This cost is collectively paid by consumers by an addition to the price of electricity. In 2010, this addition makes up about 10 percent of the consumer price and the Estonian Competition Authority, who regulates the price of electricity, has questioned the size of the subsidy [7].

The purpose of this paper is to assess Estonia's FIT scheme on CHP plants. Assessments have been carried out by several other authors, see [6] for references. The goal of this paper is to assess whether the current tariff level paid to CHP plants is motivated from an efficiency perspective, and its implications on consumer costs. Another aim is to find the benefits in terms of avoided external costs. The authors are not aware of previous assessments concerning CHP plants, suggesting that this paper may represent the first assessment of FIT on CHP plants. In addition, the case study of this paper applies a novel approach by using company level data.

The next section provides a literary overview about FIT assessments. In section 3, we give details about the Estonian FIT. Section 4 presents calculations that assess the company level impact of FIT on two CHP plants and compares the outcome to marginal cost and cost price. In section 5 we calculate the external costs of electricity produced from oil shale and compare this with electricity produced by biomass and peat in CHP plants. Section 6 summarizes the assessment and the last section concludes the paper.

2 Literary review

A feed-in-tariff (FIT) denotes a guaranteed price to producers of electricity generated from renewable sources, combined with a purchase obligation by grid companies [6]. There principally are two different ways to cover the costs of the policy measure, either by consumers via the electricity bill or via the public budget. An important reason to subsidise renewable electricity is that production costs typically are higher than that of non-renewable electricity [6]. In this sense

FITs represent a second-best policy by giving a subsidy to a preferred choice rather than correcting for external costs of electricity from non-renewable sources. Not only the choice of which market to regulate, but also the FIT levels have been questioned. In an overview of support schemes in 2005, it was shown that German support levels typically were twice the level of those of the Nordic countries, mainly using quantity based regulation combined with green certificates [8]. The same study indicated that the costs of FITs on the margin cannot be motivated by the social benefits from renewable electricity [8, 9]. At the same time, there seems to be efficiency arguments to use FIT for wind power [1]. Most probably these efficiency reasons denote dynamic efficiency in order to provide technology change and support market take-off [6].

Based on German and Danish experiences, Sijm [2] has assessed the sustainability of feed-in tariffs. The German FITs were until 2000 based on a percentage of earlier consumer prices of electricity and varied by the source of energy. After implementation prices rose significantly and due to a rapid expansion of wind power, the system led to competitive distortions between grid companies in different parts of the country. When the German market for electricity was liberated, the system needed urgent revision. The new FITs are based on the production costs of various renewable energy resources with digressive payments during 20 years [2, 10]. Denmark revised its FIT in 2000 for reasons of a high burden on the state budget [2]. In his assessment of FITs, Sijm [2] concludes that FITs are effective in promoting electricity generation from renewable sources, but costly, inefficient and distortive.

Spain is another country that has been successful in renewable energy promotion. In their assessment del Rio and Gual [6] find that the Spanish system has been effective in its support of wind energy, but not equally successful concerning other energy sources. They conclude that although consumer costs were relatively low, increasing from 0.14 to 0.26 eurocents /kWh between 1999 and 2003, the costs are relatively high compared to the externalities avoided.

3 Feed-in tariffs in Estonia

According to the Estonian Electricity Market Act production of electricity from wind, small hydropower and biomass receive the same level of FIT [11, 12]. The FIT for CHP plants differs according to fuel. Generating electricity in efficient cogeneration regime by biomass (wood chips), the producer is paid support at the rate of 54 €/MWh for selling electricity to the network. While operating in efficient cogeneration regime and using waste or peat as a fuel, the producer is paid support at the rate of 32 €/MWh. If wood chips, peat, waste or other fuels are combined, the support granted for selling electricity to the network is calculated in proportion to the fuel used. The FIT schemes apply within twelve years as of the commencement of electricity generation.

After introduction of FIT on May 1st in 2007, the expenses for financing FIT are funded by network charges paid by consumers. In 2010 the renewable energy charge is 0.8 € cents/kWh. An additional line setting out the renewable energy charge was added to the electricity bills of end users enabling customers to see how much they pay for financing feed-in tariffs.

The Estonian electricity market is divided into two – an open market and a closed market. 35% of the market was opened on 1 April 2010. Starting from 2013, the market is going to be fully liberated. While selling electricity in the closed market, approval must be obtained under the law [11] according to the weighted average price limit of electricity. In its approval, the Estonian Competition Authority takes into account operating expenses and returns on invested capital. In order to determine the price, the authority considers the undertaking's annual average residual value of fixed assets and adds 5% as profit margin. The justified rate of return is the undertaking's weighted average cost of capital (WACC).

4 The impact of FIT on CHP plants

The case study takes as its starting point, two 25 MW_{el} CHP plants that began operations in 2009. The evaluation of the investment decision and profitability of the CHP plants are based on annual reports [13, 14]. In order to assess profitability without FIT, we apply the rules of the Estonian Competition Authority and we calculate the per MWh revenue without FIT. The results are then compared to marginal cost and the cost price of electricity (the cost price is the price that exactly balances production costs, not adding profit).

4.1 Ratio analysis

The annual reports consist of the balance sheet, income statement and notes on the accounts. The methodological approach used in the evaluation of the financial reporting is based on ratio analysis, carried out as comparison with accounting benchmarks. Ratio analysis is the main instrument in financial analysis that enables to elicit relations between financial indicators and compare different undertakings with one another.

The investments in the plants were of the same order of magnitude, i.e. approximately 77 M€ respectively. Although no trend analysis can be made on the basis of the publicly available financial results for 2009 of the CHP plants, the data still allow evaluating, in general lines, plant profitability in 2009. Results of the evaluation are displayed in Table 1.

Table 1: Ratio analysis of two CHP plants, 2009.

Ratio	Bench-mark	CHP 1		CHP 2	
		Ratio	Evaluation	Ratio	Evaluation
Net profit margin	5.0%	37.6%	High	10.3%	High
Operating profit margin	17.0%	48.1%	High	23.9%	High
Rate of return on equity capital	15.0%	100.0%	High	34.5%	High
Rate of return on assets	9.0%	11.8%	Normal	2.4%	Weak
Debt coefficient	40.0%	88.2%	High (risk)	93.0%	High (risk)

The table shows that the power plants' rate of return on equity capital is high indicating efficient management in using the capital invested by shareholders. Profit margin that characterises profit on every euro of turnover is also high. The debt coefficient, pointing at how big a proportion of total funds are financed from borrowed funds, is extremely high in both plants. The profitability of assets shows the rate of return on the funds invested in the company irrespective of their source. Profitability is weak in CHP 2 being approximately 5 times lower that of CHP 1.

It can be concluded from the above that due to the implementation of FIT, the new power plants have managed to start profitable economic activity. Despite a large debt burden and strong dependence on borrowed capital, the rate of return on equity capital and the net profit margin hint at management efficiency and ability to gain initial results in activity.

However, case study data covers only one year. Additional sources of uncertainty include the development of prices of renewable fuels and the impact of market liberalisation. Notwithstanding these uncertainties, there are reasons to believe that the plants will continue operations successfully. It is possible to argue that these plants are well prepared to meet changes in input prices. In case of a rapid price increase, there is flexibility to shift fuels. Both plants are licenced to use wood chip and peat as fuel. Boiler technology allows additional fuels and the plants have fuel producing companies as subsidiaries. While market liberalisation will take place on electricity sales, the profitability of heat production can be predicted to be stable due to the continuation of a closed heat market. Since electricity prices in the Estonian market currently are below Nordic spot market prices [15], market liberalisation is expected to lead to price increases.

In theoretical terms, each power plant could generate a maximum of 25 MW * 7200 h=180 GWh of electricity per year. The generated volume of electricity depends on the number of operational hours. A smaller number of stop pages and standstill periods imply more operational hours and more generated electricity.

Pursuant to the actual annual report of 2009, CHP 1 generated circa 128 GWh and CHP 2 generated circa 110 GWh of power. Electricity generation in the plants were in the range of 68%-80% of the theoretical maximum. In CHP 1 the size of support comprised 54 €/MWh * 128 * 10^3 MWh ≈ 6.9 M€. Since CHP 2 used peat, the support size was32 €/MWh * 110 * 10^3 MWh ≈ 3.5 M€. Regarding different plants, FIT revenue accounts for approximately 50–60% of the operating profit, and excluding FIT comprise approximately 40–50%. Dependence of operating profit on the size of FIT can be expressed by eqn. (1).

$$\pi_{el} = \pi_{el}^{excl\,FIT} + (Q_{el} \times FIT_i) \tag{1}$$

where π_{el} denotes operating profit on electricity sales, $\pi_{el}^{excl\,FIT}$ operating profit on electricity sales excluding FIT, Q_{el} generated electricity and FIT_i feed-in tariff for *i*=1,2 (1=wood chip and 2=peat). According to the annual report, operating profit on the electricity sales of CHP 1 amounted to circa 12 M€; excluding FIT, operating profit would be 5.1 M€. The respective sums for CHP 2 are circa 7.5 M€ and 4 M€. These results suggest that the operating profits of both plants would have been positive also without FIT.

4.2 WACC

Assuming that the plants had operated without FIT and that their electricity prices were set by the Estonian Competition Authority, we apply the method of the regulator [16] according to eqn. (2), which shows the Weighted Average Cost of Capital (WACC).

$$WACC = k_e \times \frac{OK}{(VK+OK)} + k_d \times \frac{VK}{(VK+OK)} \tag{2}$$

where:
k_e– is cost of equity capital (%);
k_d– is cost of borrowed capital or external liabilities (%);
OK – is proportion of equity capital determined by the regulator (%);
VK – is proportion of borrowed capital determined by the regulator (%).

Taking into account the value of the debt coefficient for the financial year 2009 of the power plants CHP 1 and CHP 2 and applying eqn. (2), we find that:

$$WACC_{CHP1} = (6.31 \times 88 + 9.61 \times 12)/100 = 6.74\% \tag{3}$$

$$WACC_{CHP2} = (6.31 \times 93 + 9.61 \times 7)/100 = 6.54\% \tag{4}$$

Assuming that all economic indicators, except investments, are evenly distributed over a 25-year period (according to accounting principle), and taking into consideration the expenditure and revenue (9.7M€ and 24.9M€, respectively) as well as investments of CHP 1, we find that the internal rate of return (IRR) of the plant is 19% on invested funds. Setting IRR equal to WACC, we find that, revenues corresponding to 16.3 M€ would be sufficient to receive WACC from the investment of the undertaking.

Considering the fact that revenue from the sale of heat is a fixed value 12.9 M€ (the amount of generated heat corresponds to the need/weather conditions, and the limit price for heat is confirmed by the Estonian Competition Authority), we gain the needed income from the sales of electricity for achieving the WACC rate that comprises 16.3–12.9=3.4 M€. As the volume of electricity sold in 2009 was 128 GWh, the regulated price per MWh of electricity would equal 3.4 M€/128 GWh=27 €/MWh. By applying the same method as above for CHP 2, we find a price of52 €/MWh. These prices can be compared to the regulated price of oil shale electricity which was 29 €/MWh in 2009 [17]. In principle, this level is the guaranteed or lowest electricity selling price for all plants. Thus, even without supports, provided that electricity is sold at 29 €/MWh, CHP 1 would earn more than necessary for achieving WACC, while CHP 2 would earn less.

There could be several reasons why we receive significantly different results for the two plants. One could be that the plants use different fuels. However, it cannot be excluded that the method of regulation gives incentives to plants to adjust their financial accounts. According to the ratio analysis the rate of return on assets and the debt coefficient are surprisingly weak in CHP 2.

4.3 Price comparison

Since the results of the WACC calculations are somewhat inconsistent, we derive the price excluding FIT from observed sales data. Assuming that the price of electricity was equal to the regulated price implies that the per MWh revenue was 83 € for CHP 1 and 61 €CHP 2, respectively. Using these revenues, we find that electricity sales were 145 GWh and 123 GWh. Since reported sales were smaller, it can be concluded that CHP 1 and CHP 2 earned higher revenues than in the closed market setting. This can be regarded as a result of beneficial contracts entered into with balance providers (Nord Pool Spot's operations). Calculations show that, the average revenues were 40 €/MWh of CHP 1and 36 €/MWh of CHP 2. Based on our analysis, including the above calculations and the previous section suggest that CHP 1 would have operated successfully even without FIT. The evidence of CHP 2 is inconclusive though.

In order to take the analysis one step further we compare the prices to general information about production costs. From a theoretical point of view, we ideally would like to compare prices to marginal costs [18]. Since marginal costs are not available, we approximate marginal costs by average variable costs. In a forthcoming article by Latõšov et al. [19], the authors present cost data of different sized CHP plants in an Estonian context. Using data for the 25 MW_{el} plant, it is possible to calculate the variable cost. Depending on the method of allocating costs between electricity and heat, we arrive at an interval of 4.7–6.7 €/MWh. This is in the same order of magnitude as the average variable cost in the Nordic market, which is 8-9 €/MWh, according to estimates based on [20]. The result shows that both plants receive prices substantially above marginal costs. Comparing revenues to the cost price will provide another benchmark to our case study observations.

The above case study concerns relatively large CHP plants and since unit costs depend on the size of the plant [21] it might not be possible to generalise our results to all plant sizes. In [19], the authors estimate the cost price of electricity of different sized CHP plants. They use data collected in Estonia and the Nordic countries and make calculations of plants with capacity of 1, 10 and 25 MWh_{el} respectively. Assuming a fixed heat price, they derive the per MWh_{el} cost price. Using these observations for fitting a curve, it is possible to approximate the cost prices of a wide range of different plant sizes.

Figure 1 below, indicates that the cost prices of CHP plants with capacity less than 10 MWh_{el} have significantly higher cost prices than larger plants and that there is a rapid increase in cost prices when plant sizes become smaller. Subtracting the FIT from the cost price (see lower curve in Figure 1) shows an even more interesting picture: the FIT covers the cost price of electricity production from a CHP plant with capacity of 25 MW_{el} and when FIT is excluded its cost price is similar to a plant of 4 MW_{el} that receives FIT. These findings confirm the results of the case study and indicate that large plants are overcompensated by the current FIT, while small plants might not receive sufficient support.

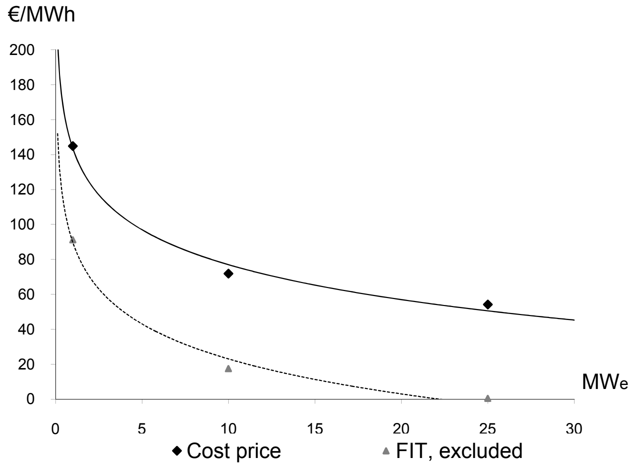

Figure 1: Cost price of CHP plants, euro per $MWh_{el.}$

5 Avoided external costs

A gradual shift from oil shale electricity to renewable sources will have a positive impact on the environment. In order to assess the benefits of FIT in terms of avoided costs, the external costs of air emissions of electricity production from oil shale, wood chip and peat have been calculated. The emission factors are shown in Table 2.

Table 2: Emission factors in g/ $MWh_{el.}$

	Oil shale	Wood chip	Peat
Carbon dioxide, CO_2 (kg)	1156	306	386
Sulphur dioxide, SO_2	7147	400	1676
Nitrogen oxides, NO_X	1075	353	2236
Particulate matter, PM_{10}	494	75	280

Sources: [17, 22–24].

The emission factors of oil shale are based on emission measurements at the Eesti power plant in Narva [22], where about 20% of electricity is generated in fluidized bed combustion and about 80% in pulverised combustion. The external costs were collected from ExternEestimates [25]. Although, Estonia is not represented in ExternE, we follow the application in [26] and base the external costs on Czech brown coal. This transfer of external costs could result in an upward bias, since the estimates also include health effects of pollutants. The risk of bias is due to the fact that population density is higher in the Czech Republic than in Estonia, and the values in use might therefore exaggerate health costs. In the Czech values, health costs make up about 40% of the external cost of brown coal combustion.

Table 3: External costs €/MWh_{el}.

	Oil shale	Wood chip	Peat
Carbon dioxide, CO_2	22.0	5.8	7.3
Sulphur dioxide, SO_2	40.6	2.3	9.5
Nitrogen oxides, NO_X	3.3	1.1	6.8
Total suspended particulates, TSP	3.3	0.6	2.1
Sum	69.2	9.7	25.8

The external costs show relatively large differences. Every MWh of oil shale electricity that can be substituted by electricity produced from wood chip in CHP plants reduces external costs by almost €60 and if replaced by peat, the avoided cost would be about €43.Comparing these values to the Estonian FIT of €54/ MWh and €32/MWh respectively, show that the estimated environmental benefit are higher than the FITs. However, since power plants pay environmental charges, internalisation already takes place. The pollution charges are relatively low though: only about €2 per MWh of oil shale electricity is currently being internalised [17]. Assuming that the influence of a possible upward bias is at an equally low level, the cost of the Estonian FITs are supported by arguments of avoided external costs. An important additional requirement is that the renewable electricity replaces oil shale electricity. So far this replacement has not taken place, but in 2016 when more stringent EU regulation will come into force, pulverized combustion must be equipped with flue gas purification otherwise these boilers have to be shut down [4].

6 Overall assessment

In our evaluation of the Estonian FIT for CHP plants we follow the assessment criteria used previously in literature [2, 6]. One problem though is that the period of assessment is relatively short, stretching from mid-2007 until 2010. Based on evidence so far, Estonia will outperform the target set for 2010, suggesting that the FIT has been effective [5]. The case study showed that large CHP plants have received substantial investment security during the 12 year support period and that the increase of renewable electricity since 2007 has mainly concerned electricity generated by CHP plants. Nevertheless, significant wind power capacity is under construction. According to forecasts, wind energy FIT will double in 2011 compared to 2010 [5].

Since electricity from renewable energy sources receive the same FIT, the Estonian FITs can be judged as technology neutral. However, there are other reasons to question the Estonian FITs from an efficiency perspective. Although the cost price is not covered by the market price of electricity, the case study suggests that 25 MW_{el} CHP plants would have been profitable also without FIT. In addition, market prices significantly exceed the marginal costs of producing electricity from biomass in a 25 MW_{el} CHP plant. On the other hand, pricing at marginal cost would not cover costs since production of electricity in a large CHP plant is characterised by increasing returns to scale.

Construction of small CHP plants has not been encouraged to the same extent by Estonia's FITs. One reason is that small plants have significantly higher generation cost per unit. It is interesting to note that German FITs, which are based on production costs, are differentiated by plant size and do not cover CHP plants fired by biomass that exceed 20 MW_{el} [10].

Another argument for paying a higher FIT than the cost-effective level relates to dynamic efficiency. One motivation is to support a technology to reach market take-off more rapidly than otherwise. Another is general innovation support. However, generation of electricity from biomass in a CHP plant is a mature technology. Therefore, FIT is questionable also from the perspective of dynamic efficiency. From an efficiency point of view, only arguments of avoided external costs can support the current level of FIT. In contrast to experiences in other countries, we find that the avoided external costs exceed the per MWh costs of FIT. The main reason is the high external cost of oil shale electricity.

Between 2007 and 2010, the per kilowatt hour consumer cost has increased from 0.1 to 0.8 eurocents /kWh. In comparison to the Spanish experiences almost a decade earlier, the starting point is equal, but the speed of increase is significantly more rapid in Estonia. The beneficiaries of Estonian FITs have increased their revenues from 6 to almost 54 million Euros during the same time period [7].

The Estonian FIT has low administrative demands as the same FIT has been applied to different energy sources. Setting prices on the closed market according to WACC is rather demanding, though. Our analyses indicate that the current practice might produce distortive incentives and to increase the share of borrowed capital.

7 Conclusion

The purpose of this paper was to assess the impact of the Estonian feed-in tariffs on renewable electricity generation. We have found that the Estonian FIT system has effectively supported establishment of CHP capacity, the administrative costs have been low and the avoided external costs have exceeded the cost of the support. However, the costs of the Estonian FITs have increased at a rapid rate and these costs have been paid collectively by consumers while beneficiaries include large CHP plants.

Besides distributional concerns, there are other reasons to revise the current FIT scheme. The case study of two CHP plants and the comparison of our findings to average cost and cost prices have shown that the current FIT scheme is not efficient. The targets set for 2010 will be exceeded and from an efficiency perspective, this cannot be assessed cost-effective. In addition, the results indicated that resources are used for supporting production that is profitable also without FIT. Even though the current FITs are administratively attractive, the large differences in unit costs depending on plant size, suggest that there is a need to differentiate the FITs to plant size.

The major drawback of pricing measures, such as subsidies and taxes, is that there is uncertainty about the range of impact. In Estonia, as in most other EU countries, FITs are used to reach quantity targets. It is not an easy task beforehand, to choose the level of an FIT that matches the target. Therefore, regulation by FIT requires revisions. Inevitably revisions pose challenges to the investment climate. Therefore regulation by FIT involves a trade-off between the challenges of revisions and the continuation of costly support schemes. Our findings and the forthcoming market liberation, suggest that it is important for Estonia to reform its FIT scheme.

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