Investment Aid and Contract Bound Energy Savings: Experiences from Norway

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ABSTRACT

The investment aid to energy efficiency projects in the Industry is linked to contract bound energy savings. If the specified energy result is not met the investment aid is reduced proportionally. This is also the case if the actual investment costs are less than those estimated when the contract is signed. The level of investment aid is determined by the profitability of the project.

The requirements in the contract introduce asymmetric risk elements to the project owner, one enhancing the possible downside of not achieving the expected energy result, the other reducing the possible upside of reductions in the investment costs. Could an alternative design of the investment aid avoid introducing an asymmetric risk to the project, but keep the incentives to achieving energy results cost effectively?

After four years of practice assessing the economics of energy efficiency projects we find few cases where the projects act on the inherent incentives of the investment aid programme.

The return on capital required by project owners indicates that characteristics of the project owner like split budgets between investments and operations and lack of knowledge, interest or focus on energy in the management and the fact that energy is not the core business of the major part of industry the introduce an extra risk premium on the energy efficiency projects, hence increasing the required return on capital. Is investment aid an efficient measure to compensate for the factors above or would other policy measures be more efficient?

Introduction

Before 2002 the regional transmission system operators (TSO) had an obligation to provide energy efficiency measures within their regions. There was no coordination between the regions and the TSOs could to a large extent decide the extent of the measures. There was no obligation to measure the energy savings effect of the measures.

The energy efficiency agency Enova was established in 2001 (operational from January 2002) by the Norwegian Ministry of Petroleum and Energy (MPE) to become more comprehensive and consistent in the effort to promote renewable energy generation and energy efficiency.

Enova operates on a contract with the MPE. The contract obligates Enova to through their measures to reach an energy target 12 TWh by 2010 either by energy savings or by increased production on renewable energy. To finance the measures Enova manage the means in the Energy Fund. The Energy Fund is then financed through a levy on the distribution tariff.

Enova has several different programmes both regarding production of renewable energy and energy saving. The main measure for the majority of the programmes is investment aid and energy efficiency in industry is a priority area.

This paper will give a short description of the characteristics of the Norwegian manufacturing industry before describing in details the design of the investment aid programme.

The paper will further focus on the inherent incentives in the programme to signal high costs and energy savings potential. The paper will also look into some alternative designs of the programme.

In the later part of the paper we will discuss whether the investment programme is suited to overcome the underlying barriers to energy efficiency projects.

Background

Norwegian Industry can be divided into four different groups, based on the level of their energy consumption. Energy intensive industry is industry with an annual energy consumption exceeding 50 GWh and where the energy costs often amounts to 10-15% of the annual production costs. In Norway around 100 companies can be identified in this group.

Industry with annual energy consumption lower that 50 GWh can be divided in to three groups: Those in the range 5-50 GWh, those in the range 0.5-5 GWh and those below 0.5 GWh. In these groups the energy costs will typically amount to 0.5-3% of the annual production costs. The group below 0.5 GWh will constitute more that 10 000 companies while the groups in between runs up to a total of around 5-600 companies.

The focus on energy and the understanding of energy investments will vary between the groups and therefore call for different initiatives. The companies with the lowest energy consumption will not respond to investment aid. They lack knowledge and focus and the limited size of the individual investments that can be done and the savings that can be achieved in this group, calls for other initiatives – like information campaigns, web-based learning systems or limited stereotyped aid for defined investments. The creation of sector based energy networks for companies in sectors with equal challenges can also be a possible mean in order to increase focus and knowledge.

For the energy intensive industry on the other hand the knowledge is often substantial, both when it comes to technology and economy. But the necessary energy investments often run up to millions of dollars and the size of the projects calls for external attention. Often a combination of investment aid and the possibility of positive public attention that can be achieved by cooperating with an institution like Enova is what is needed in order to release a positive investment decision.

The companies in the groups between the energy intensive industry and the 10 000 companies in the other end of the scale will benefit from a mix of instruments. Knowledge building, public attention, stereotyped aid and investment aid to individual projects.

The Programme

The objective programme is to increase energy efficiency in industry, and the main measure is investment aid which might cover up to 40 percent of investment costs.

The grant is linked to an obligation to save energy by increasing energy efficiency. If the obligation (the energy savings) is not met the grant might be reduced or in extreme cases withdrawn. The grant is also linked to the investment costs. The grant is given as a percentage of the investment cost with a maximum limit. If the investments costs are less than anticipated the grant is reduced proportionally.

The design of the grant scheme results in asymmetric consequences of increased and decreased investment costs. If the actual investment costs increase beyond the estimate the grant

does not increase. On the other hand if the actual investment costs are less than estimated the grant is reduced proportionally. The grant is calculated based on estimated investment costs of the energy efficiency measure and the baseline measure at the time of application.

$$\hat{G} = \alpha * \left(\hat{I} - \bar{I}\right)$$
where
$\hat{G}$ = grant based on application
α = aid intencity
$\hat{I}$ = investment cost ee - measure in application
$\bar{I}$ = investment cost baseline (1)

In typical industry energy efficiency project the baseline is business as usual. This means that the investment cost baseline equals zero and the grant is equal to the aid intensity times the investment costs of the EE-measure.

$$\hat{G} = \alpha * \hat{I} \quad (2)$$

The actual grant is determined by the actual investment costs.

$$G = \alpha * I$$
where
G = Actual grant
α = aid intencity
I = actual investment cost ee - measure (3)

The Incentive

The expected grant at the time of application is determined by the probability of the actual investment costs being less than the investment cost in the application. The design of the grant scheme gives the industry an incentive to exaggerate the investment costs in the application. In the cases where the actual investment costs turn out to be less than the expected at the time of application the final grant will still equals the actual investment cost times the aid intensity, but in all cases where the investment costs exceeds the expected investment costs at the time of application the industry would benefit from exaggerating the investment costs in the application.

The expected grant level is:

$$E(G) = \int_0^{\hat{I}} f(I) * \alpha I + \int_{\hat{I}}^{\infty} f(I) * \hat{G}$$
where
$E(G)$ = expected grant
$f(I)$ = the probabilityfunction of actual investement costs (4)

If the industry signals an investment costs in the application beyond the true expected investment costs the expected actual grant will increase.

$$E(G)_{\dot{I}} - E(G)_{\hat{I}} = \int_{\hat{I}}^{\dot{I}} f(I) * \alpha(I - \hat{I}) + \int_{\dot{I}}^{\infty} f(I) * \alpha(\dot{I} - \hat{I})$$
$$\text{If } \dot{I} > \hat{I} \text{ then } E(G)_2 - E(G)_1 > 0 \qquad (5)$$
$$\text{where}$$
$$\dot{I} = \text{signalled investment costs}$$

From equation (5) we can also observe that the increase in expected grant level due to signalling, depends on the aid intensity and the probability function.

Although the industry has an incentive to signal high investment costs, the design of the grant scheme does not remove the industry's incentive to minimize actual investment costs. But the incentive decreases as the aid intensity increases, since the cut in aid subsequently account for an increasing part of the cost reductions.

The Alternatives

Two obvious alternative designs of the investment aid scheme would be either to grant fixed aid intensity or fixed aid level.

Fixed Aid Intensity

The obvious difference from the existing aid scheme is that the aid intensity would be constant independently of the actual investment costs are lower or higher than the signalled investment costs in the application.

From the projects point of view this alternative would be preferable to the existing alternative. For all cases where the actual investment costs are equal or less than the signalled investment costs this alternative would result in the same actual investment aid as in the existing scheme. But for all cases where the actual investment costs exceed the signalled cost this alternative would give a higher level of investment aid.

$$E_{FI}(G) = \alpha I$$
$$E(G) - E_{FI}(G) = \int_{\hat{I}}^{\infty} f(I) * (\hat{G} - \alpha I) \qquad (6)$$
$$\text{where}$$
$$E_{FI}(G) = \text{expected grant fixed aid intensity}$$

From Enova perspective the fixed aid intensity alternative impose a budget uncertainty. Given fixed budgets, Enova would have to keep a reserve to cover possible increases in the actual aid.

Fixed Aid Level

To get around the Enova budget constraint problem the investment aid could be granted as a fixed level, removing the link between the aid and the actual project costs. The projects would not risk any reduction in the aid level due to cost reductions, nor would the aid increase with increased costs.

$$
\begin{aligned}
E_{FL}(G) &= \alpha\hat{I} \\
E(G) - E_{FL}(G) &= \int_0^{\hat{I}} f(I) * \alpha\left(I - \hat{I}\right) \\
&\text{where} \\
E_{FL}(G) &= \text{expected grant fixed aid level}
\end{aligned}
\tag{7}
$$

As for the fixed intensity alternative the expected aid level in this alternative would exceed the expected aid level in the actual scheme. The incentive to signal high investment costs is also stronger since the project would not risk a reduction in the aid level even if the actual investment costs are less than signalled.

Comparison

As the level of signalling increases the $E_{FL}(G)$ increases accordingly. The E(G) does also increase since a larger fraction of the actual investment costs will be less than the signalled investment costs. As the level of signalling increases the difference between E(G) and $E_{FI}(G)$ will decrease, as the probability of actual investment costs exceeding the signalled decreases.

The attractiveness of the different alternatives depends on the perspective. From the projects perspective the fixed level alternative has the highest expected grant, and does not introduce or alter the normal business decision criterions. From the Enova perspective the perspective is different. Both the actual scheme and the fixed level alternative satisfy the budget planning constraint, since the maximum grant is set. But since the actual scheme has a lower expected grant level it is preferable to Enova.

The Challenge

The objective of Enova is to maximize the energy savings subject to the budget constraint, hence minimize the aid intensity in each project. The major criterion for making priorities is aid per energy saving (NOK/kWh[1]). And in the case of an excess of projects applications projects are given priority according to their NOK/kWh.

The priority criterion can, from the project's perspective, be regarded as the probability to get the grant applied for. If the NOK/kWh in the projects is above the threshold[2] the project will not get the grant.

$$
\begin{aligned}
P(G) &= \int_{\omega}^{\infty} g(\overline{\omega}) \\
\omega &= \frac{\alpha \dot{I}}{\Omega} \\
&\text{where} \\
P(G) &= \text{The probality of being granted aid} \\
\omega &= \text{the project's NOK/kWh ratio} \\
\overline{\omega} &= \text{the marginal NOK/kWh ratio for projects being granted aid} \\
\Omega &= \text{the estimated energy saving}
\end{aligned}
\tag{8}
$$

[1] NOK = Norwegian kroner

[2] The aid to energy savings ratio of the marginal project being granted aid.

As the project's aid to energy savings ratio increases the probability of being granted aid decreases. The ratio is dependent on both the signalled investment costs and the expected energy savings in the project. If we expand equation (4) with the aid probability from equation (8) we find the new expected grant.

$$E_{V1}(G) = P(G) * E(G)$$
$$E_{V1}(G) = \int_{\omega}^{\infty} g(\overline{\omega}) * \left[\int_{0}^{\dot{I}} f(I) * \alpha I + \int_{\dot{I}}^{\infty} f(I) * \alpha \dot{I} \right] \quad (9)$$

where

$E_{V1}(G)$ = the expected grant version 1

From equation (5) we found that the project has an incentive to signal higher investment costs to increase the expected grant. When we take into account the probability of actually being rewarded the grant in the first place the picture is less obvious, since signalling high investment costs reduces the probability of being rewarded a grant. The net effect of signalling high investment costs will depend on the shape of the probability functions and the reference NOK/kWh cutoff-ratio.

On the other hand, equation (9) introduces an incentive to signal high energy saving results. Signalling high energy savings reduces the aid to energy savings ratio, and increases the probability of being granted aid. The effect on the expected grant level of signalling high energy results will always be positive, since it only affects the probability of being granted aid.

The Risk

The contract gives Enova the possibility to withdraw the grant if the actual energy result is less than stated in the contract. Since the estimated energy savings as all estimated has uncertainties/risks Enova accept that the actual energy savings result might be less than stated in the contract. But at some point a reduction in actual energy result would be regarded as a breach of contract.

We stated in the section above that the project has an incentive to signal high energy saving to increase the probability of being granted aid. But by doing so the project would also increase the probability of not making the breach of contract threshold.

$$P(C) = \int_{\dot{\Omega}}^{\infty} h(\Omega)$$

where

$P(C)$ = The probality of not being in breach of contract (10)

$\dot{\Omega}$ = the estimated energy saving

$h(\Omega)$ = The probabilitydistribution of the actual energy saving

If we expand equation (9) with the probability of not being in breach of contact P(C)

$$E_{V2}(G;\dot{I},\dot{\Omega}) = P(C) * P(G) * E_{V1}(G)$$
$$E_{V2}(G;\dot{I},\dot{\Omega}) = \int_{\dot{\Omega}}^{\infty} h(\Omega) * \int_{\omega}^{\infty} g(\varpi) * \left[\int_{0}^{\dot{I}} f(I) * \alpha I + \int_{\dot{I}}^{\infty} f(I) * \alpha \dot{I} \right] \quad (11)$$

where

$E_{V2}(G;\dot{I},\dot{\Omega})$ = the expected grant version 2, given $\dot{I}$ and $\dot{\Omega}$

The model in equation (5) has an incentive to signal high investment costs. This incentive was reduced by taking the probability of being granted aid into account in equation (9). A new incentive to signal a high energy result was introduced. Again by taking into account the probability of being in breach of contract the incentive is reduced.

There is a distinct difference between the probability of breach of contract and the probability of not being granted aid. If aid is not granted the projects is not realised and the project owner might lose a profit opportunity. But if the breach of contract threshold is not met and the aid is withdrawn the investments are already made.

How the project owner reacts to the inherent incentives would depend on his/hers perception of the grant- and breach of contract threshold together with the assessment of the consequences of the different outcomes.

Experience

The experience show that in general projects do not act on the inherent incentives in the scheme. On the contrary it seems like projects owners are more likely to be conservative in their commitments on energy results, which would reduce the probability of actually being granted aid. This might indicate that the project owner regards not being granted aid, hence not realizing the project, as more favorable than not meeting the energy savings in the contract and having the aid withdrawn.

But there are exceptions. Project owner who has submitted several project applications over time has learned how the scheme works and tries to exploit the incentives in the scheme. The other case is when the project owner is very professional and can see the incentives in the scheme. But again, the large majority either is not aware of the incentives or they do not act on them.

When Enova assesses the projects the profitability of the project is taken into account, using a standard net present value approach. The core of the negotiation is the internal rate of return (iir) needed in the project to ensure realisation. Enova has an incentive to minimize the grant, hence the irr of the project. And the project owner naturally wants to maximize the irr.

Within the maximum limit of an aid intensity of 40%, imposed by state aid guidelines, Enova has the discretionary powers to set the aid intensity. The latter part of the paper will discuss how this discretionary power is utilized to overcome underlying barriers.

How Does Investment Aid Address Marked Failures?

According to a study prepared for IEA **(Prindle B. et al. 2007)**, the barriers for carrying out energy efficiency measures can broadly be arranged into four categories. The key question is; how does investment aid address these barriers?

Principal-Agent (P/A) Barriers

This barrier appears when the decision maker (the agent) is not the same actor as the bearer of the consequences (the principal). From an outsider's point of view, this is obviously not the case in an industrial setting. But as Bjoerndalen (Prindle B. et al. 2007) points out in the same paper, there could be internal P/A barriers within organizations.

In larger organizations, investments budgets are set centrally and presented to the decision maker who may not have any responsibility for the operating costs. There are several examples of applications to Enova initiated by maintenance personnel or others coping within the limits of a constrained investment budget. When the return on investment is calculated, it is found to be too high to be granted support. After the rejection, the applicant still argues for the necessity of support stating that the limits of the investment budget are to be kept even though the project is highly profitable. In some cases, the exercise of producing an investment analysis, and the rejection of Enova grounded on too high profitability, has aided the applicant to promote the project internally to the level where internal financing has been found. But investment support does not address internal P/A barriers adequately in it self.

Information Cost Barriers

Lack of information combined with high costs for obtaining information may constitute a substantial barrier for the realization of energy projects. Provided that these costs can be budgeted and included in the investment costs, investment support could help to overcome this barrier. The issue is that this barrier will normally stop the projects from even being considered at all, no matter how high the potential investment support is.

Externality Cost Barriers

When the full cost to society is not reflected in the nominal market price, there is a marked failure due to externality cost barriers. This is actually the background for establishing the investment support in the first place and the barrier should therefore be lowered with available investment support.

Other Barriers

Among the barriers lumped into this category are barriers connected to bounded rationality and organizational barriers, both which are relevant for energy use in the industrial sector.

The idea of bounded rationality stems from the idea that individuals optimize their behavior given the constraints present in organizations. Since energy is not the main issue for most industrial companies, being involved in energy efficiency projects is not the most efficient path to a great carrier. One may therefore argue that individuals are rational when they avoid these projects even when they are profitable for the organization as a whole.

Organizational barriers are studied by Sæle et. al **(Sæle H. et al. 2005)**. The study demonstrates that companies do not conduct profitable projects even when the benefits are spelled out for them. This reluctance is attributed to factors like lack of responsible person, decision making structures and missing consciousness.

Nevertheless, the conclusion is that investment support does not help to lower these barriers.

Expanding the Project to Overcome the Barriers

Since investment support to concrete investment projects is not addressing the barriers directly, Enova has lately tried to come around the barriers by extending the scope and size of the project which is to receive financial support.

The first and most important step in the process of setting up such an expanded project is to get top management attention. Enova is fortunate by having access to a substantial fund, approximately $ 200 million in 2007, which is used as bait to get the necessary attention. The shear size of the potential support has been enough to raise interest in CFOs and CEOs.

If the attention of the top management is obtained, and a dialogue is started, they are normally ready to commit to energy efficiency goals. Top management sees the advantages of the cost reductions and the strategic aspects of the social responsibility with the proposed energy efficient project. The interest is also generally high among personnel with hands-on responsibilities for the production processes. The challenge is the middle management which sees the hurdles of carrying out the project and does not want to commit to reach new goals in addition to the ones already set by the top management. The middle management layer is therefore best avoided initially and the strategy is that they will be trapped between the operators and the top management. It must be emphasized that the process is highly individual and demands time to meetings and negotiations. In some cases the process has taken up to two years.

Enovas interests are to set an ambitious, but realistic goal for the energy efficiency program and the accompanying investment budget. The financial support will be proportional with the commitment of the company and it is, as discussed above, in the company's interest to raise commitment in order to maximize the amount of support. On the other hand, being not able to reach an unrealistic energy efficiency goal could lead to withdrawal of the support.

The process leads up to contract between Enova and the company. Enova will provide financial support provided that the company reaches the energy goal and invests according to plan.

In order to reach the ambitious goal, the project will have to involve energy audits, education, the implementing of energy management standards in addition to investments in equipment. These conditions and the energy efficiency goal is specified in a written contract between Enova and the company

The financial support is provided as a fraction of the total costs and is paid out from Enova as the project incurs costs, normally twice each year. In order to get the final 20 % of the support, a financial report controlled by a certified accountant and a technical report which states that the energy efficiency goal and the other conditions of the project is reached have to be provided. If the conditions of the contract are not reached, Enova has the possibility to withdraw the full amount of the support.

These "Portfolio Projects", as they have been denoted, have been quite successful to address the internal P/A barriers, the information barriers and the organizational barriers. The key reason is the top management involvement and the setting of an ambitious energy saving target. The size of the project involves the whole organization, from the board to the operators. The status of energy saving is increased both within the organization but also outside. The

companies do not hesitate to use their commitment and results from the energy efficiency project in the promotion of the Corporate Social Responsibility of the company.

These projects are in reality change management projects as described by Kotter **(Kotter 1996)** as a vision is set, the organization is mobilized and goals are reached. It will be interesting to analyze the results from this approach. The first results should be expected around 2010 and will be the topic of subsequent papers.

Conclusion

Although the design of the investment aid program has some inherent incentives to signal high investment costs and a high energy saving potential. But the discretionary power of Enova when granting aid and the possibility of an ex post reduction or withdrawal of the granted aid reduces the inherent incentives.

The experience indicates that the project owners in general do not act on the inherent incentives in the program. The reason might be that they are not aware of the incentives in the program design and/or put a lot of emphasis in the possibility of an ex post aid withdrawal. The few cases where we find tendencies to signaling are when the project owner (or the consultant) has had several previous projects supported by Enova.

Although the investment aid does not in theory overcome the different typical barriers discussed in the paper it seems to be an effective measure both to ensure the realization of the individual projects but also as an instrument to put focus on the non-economical barriers. The challenge to Enova is to use the opportunity created by the investment support to overcome the underlying barriers.

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