# De-carbonisation, guaranteed: realising affordable, equitable and long-term financing for industrial SME projects

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## Abstract
Using an investment simulation model, the authors compare the financial viability of three renewable energy technologies with natural gas based industrial process heat generation under different scenarios. The main burden of long-term decarbonisation investments to replace natural gas with renewable technologies has to be shouldered by private companies. For debt financing, the inherent long-term credit risk has a decisive impact on the availability and on the risk premium included in the cost of debt. Therefore, public guarantees designed to address long-term credit risk can be highly impactful when compared with e.g., subsidies for CAPEX or high carbon prices/taxes. The authors find that the use of long-term public guarantees will be necessary to support small and medium sized companies' (SMEs) access to bank loans. Further, such guarantees render renewable technologies with high initial investment requirements financially viable by reducing risk premiums and thus financing cost. In conclusion, the authors suggest linking support for decarbonisation initiatives to the amount of $CO_2$ reduced or substituted (the concept of "climate guarantees").

## Introduction: Determining financial viability of renewable energy investments
Partners in the EU Horizon 2020-financed project TRUSTEE developed a numerical simulation model ("PHESIMA") to assess the financial viability of investments of three renewable technologies used to generate process heat for industrial production: biogas, biomass, and solar thermal systems. This investment assessment model is used to compare the financial viability of these renewable technologies with process heat generation using natural gas under different scenarios. "Financial viability" is defined in this article as positive net present value over the lifetime of the investment.

The model uses a "reference system" approach. A reference system represents a technology category (i.e. biogas, biomass, and solar thermal) with technological properties defined to provide representative energy yield results (which are different for each technology), not using energy or heat storage . The macroeconomic and financial parameters were defined using best available information in 2018–19 and include: energy cost assumptions, inflation scenarios, and representative technology costs. The simulation model also takes into account the following assumptions/parameters:

- Geographical impacts (local weather conditions resulting in ambient temperature and solar irradiation)
- Discount rate defined by small and medium enterprise (SME) financing costs in different European countries
- Linear depreciation along lifetime (biogas: 15 years; biomass: 25 years; solar thermal: 20 years) with no residual value
- Corporate tax defined by country.

While the authors gathered data for all EU countries, the simulation results are presented here only for Austria and Spain.

The authors find that the main burden of long-term investments to replace natural gas with renewable process heating technologies has to be shouldered by private companies. They have to raise the financial means for investments by equity and long-term debt. For debt financing, the inherent long-term credit risk has a decisive impact on the availability and on the risk premium included in the cost of debt. *The use of long-term public guarantees will be necessary to support small and medium sized companies access to bank loans. Further, such guarantees also render renewable technologies with high initial investment requirements financially viable by reducing risk premiums and thus financing cost.*

The paper is organised as follows:

1. The first section summarises the different *cash flow profiles* of the three technologies analysed.
2. Section 2 deals with the *cost of decarbonizing process heat generation* in industry based on a "business as usual" (BAU) scenario, where current market conditions and expectations for the evolution of energy prices (cost for natural gas, and interest rates for SME loans) were used to calculate subsidies on investment cost (CAPEX) for reaching financial viability and the magnitude of investment needed to substitute fossil fuel-based process heat production with no-carbon sources.
3. Section 3 summarises available *policy instruments for decarbonizing process heat in industry*, evaluates them and compares the cost of supporting the financial viability of renewable energy investments versus natural gas using different public interventions: CAPEX investment subsidies; a carbon price (or $CO_2$ tax) on fossil fuels; and public guarantees.
4. Section 4 show how the *access to finance can be enhanced using Climate Guarantees* and why public guarantees for supporting decarbonisation investment should be linked to the saved or substituted amount of $CO_2$ – the concept of "climate guarantees".

## Cash flow profiles of renewable process heat technologies

Biomass, biogas and solar thermal process heat production technologies have very different cash flow profiles regarding initial investment (CAPEX), operating cost (OPEX) and fossil energy cost savings. These different cash flow profiles have to be considered in the context of discussions about the adequate mix of public policy instruments to support decarbonisation of industrial production.

### BIOMASS

The cash flow profile for investing and operating the "reference" biomass appliance for process heat production defined in the model is characterised by comparatively high cost of production due to the feedstock cost (Figure 1).

Over the lifetime of 25 years, **only 6 % of total cash expenditure is spent on CAPEX**. Therefore, subsidies reducing the initial investment cost do not have a high impact on overall cash flows. Policy levers influencing operating cost or energy cost savings are much more relevant for the financial viability of biomass investments.

### BIOGAS

For the defined "reference" biogas appliance, which is not depending on purchased feedstock, the cash flow profile is more balanced (Figure 2).

**CAPEX is 55 % of total cash expenditures** over the lifetime of 15 years. Consequently, subsidies influencing initial investment cost are of equal importance relative to policy measures to increase cash savings from substituted fossil sources.

### SOLAR THERMAL

Solar thermal heat production by the "reference" technology is dominated by high initial CAPEX, because the sun shines at no cost and O&M expenditures are low (and in Figure 3 hardly visible).

Over the lifetime of 20 years, total cash flow requirements are dominated by **the initial cash outlay on the investment cost of 84 %**. Under current market conditions CAPEX cannot be recovered by fossil energy cost savings over the lifetime of the installation in Austria. Decreasing investment and financing cost are therefore the most effective ways to improve the financial viability of solar thermal investments.

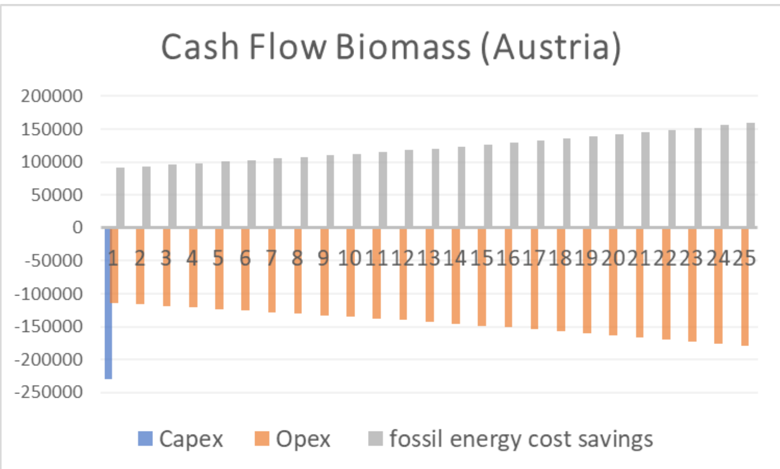


*Figure 1. Cash flow profile of biomass heat production in Austria.*

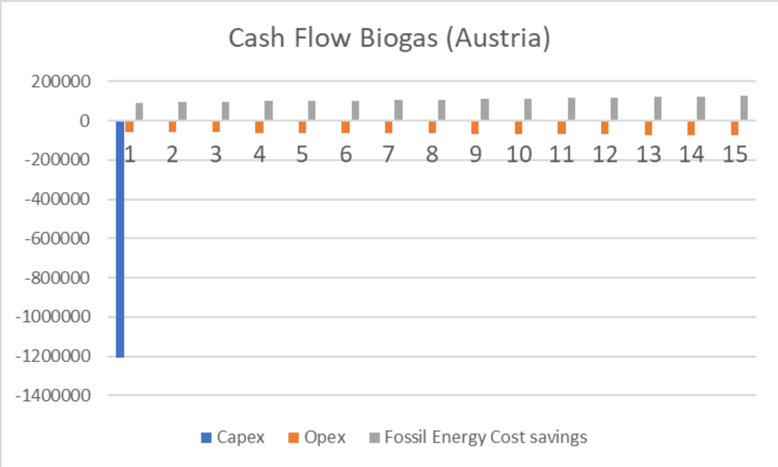


*Figure 2. Cash flow profile of biogas-based heat production in Austria.*

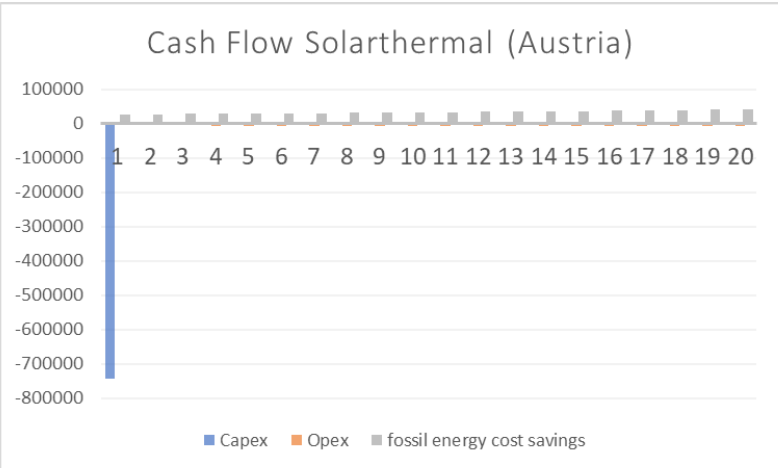


*Figure 3. Cash flow profile of solar thermal heat production in Austria.*

## The cost of decarbonising process heating in industry

The PHESIMA model has been applied on savings and substitution of natural gas for heat production for industrial processes by using the country-specific prices and the $CO_2$ emission factor of natural gas.

We have looked primarily at the substitution of natural gas for process heat by solar thermal, biomass and biogas appliances in the temperature range of up to 200 °C. In the European Union natural gas is the most important fossil fuel energy carrier for this temperature range (Figure 4). However, on the individual country level the picture is more diversified.

### INVESTMENT COST ESTIMATE FOR SUBSTITUTING NATURAL GAS WITH RENEWABLE SOURCES

The PHESIMA model compares the CAPEX and OPEX requirements needed for a renewable technology to generate a certain amount of energy with the achieved cost savings on fossil fuel based process heating sources (natural gas) based on the economic parameters of the "Business As Usual" ("BAU") scenario. By assuming that the deployed renewable heat generation technology should generate as much energy as industry currently consumes using natural gas[1], CAPEX for substituting natural gas based heat production by either solar thermal or biogas heat production can be estimated. We have selected the energy consumption data for natural gas in the temperature range of up to 200 °C, where renewable heat production is more appropriate than in high temperature ranges.

Using those sets of data and assumptions on heat production and heat consumption we have calculated for selected countries (Austria, Germany, Portugal, Spain and Sweden) the investment cost to cover industrial heat energy consumption by solar thermal. For Austria and Germany we also analysed biogas process heat generation.

We did not include biomass as this technology is already a partially financially viable alternative (e.g. Sweden). The main limitation for substituting natural gas with biomass is the sustainable availability of feedstock. Existing biomass resources are already widely used. Biogas resources are not immediately disposable at a scale where they can provide a 100 % substitution, but there is certainly more room for exploitation and innovation. Blending "green methane" with natural gas in exist-

1. Fraunhofer ISE 2016a.

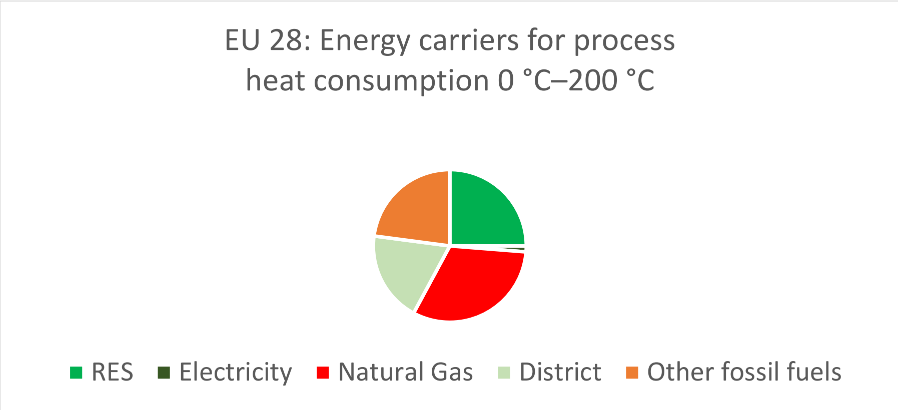


*Figure 4. Shares of energy carriers for process heat in the EU 28 (source: Fraunhofer ISE 2016b).*

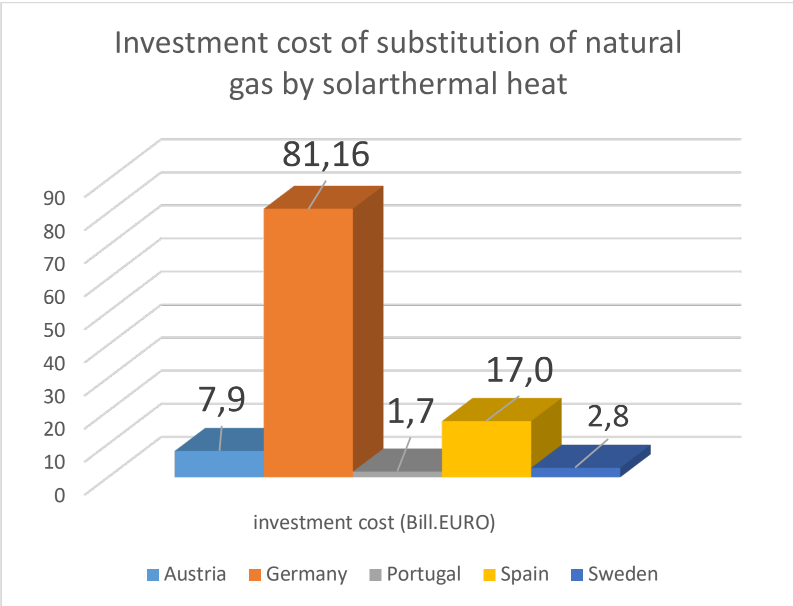


*Figure 5. Costs of substituting natural gas with solar thermal heating.*

ing gas grids is an additional option with growing importance. Therefore, biogas is included in the calculation for the countries where a significant part could be covered by this resource even if a 100 % substitute is not feasible.

We performed the calculations separately for solar thermal and biogas, assuming that *each technology has to completely substitute natural gas consumption* by itself. The PHESIMA tool uses only one specific technological layout for the calculations concerning size, yield, production efficiency, used feedstock, etc as the reference layout. This "one size fits all" assumption for decarbonisation of process heat production in industry is certainly not realistic. Nevertheless, we use it to calculate a first rough approximation of the scale of investment capital and policy action required for real-world decarbonisation.

The CAPEX assumptions for the heat production technologies used by PHESIMA covers only the energy generation installation. Additional components, such as heat storage facilities, pipes, control systems, etc. which are needed for providing heat for a continuous production process are not considered. Therefore, the total investment cost for decarbonising industrial process heat production would be substantially higher than just the CAPEX for the heat production unit. All calculations have been made in reference to natural gas. Results would be different for other fossil fuels (primarily coal and fuel oil).

Figure 5 shows the result of the calculations in absolute amounts of EURO. These might seem counterintuitive, as the cost for decarbonising process heat production with solar thermal installations in sunny Spain are much higher than in Sweden, where irradiation is far lower. The reasons are very country specific: Sweden has high natural gas prices and a very low share of natural gas in total process heat production, which means, that only few natural gas-powered installations would have to be replaced. In Spain, natural gas prices are low (lowering energy cost savings) and the production share of gas is very high (meaning that much more natural gas-powered installations would have to be replaced).

As already pointed out above, the absolute amount of investment needs should not be taken at face value. What we want to show in the next section is the percentage of subsidies needed relative to the investment cost (whatever they might finally be) depending on the climate policy instrument which is applied.

## Policy instruments for decarbonizing process heat consumption in industry

The PHESIMA tool has been designed to calculate investment returns of biomass, biogas and solar thermal process heat installations under defined assumptions on macroeconomic and market conditions. Under the "BAU" scenario, solar thermal and biogas heat production shows a negative present value of cash flows consisting of CAPEX, OPEX and energy savings; with some exceptions this is also true for biomass heat production. Using a non-negative present value as a benchmark for financial viability, the PHESIMA tool can be used for calculating the critical values (CAPEX, OPEX, or fossil fuel energy prices) allowing for a non-negative cash flow.

### INVESTMENT SUBSIDIES (GRANTS)

In our calculation, the difference between the (lower) value for a "financially viable" CAPEX and the (higher) CAPEX figure assumed for the deployed renewable heat production technology is the subsidy (grant) needed to reduce CAPEX for end-users of the renewable process heat installation to a financially viable level.

However, the impact of a grant on the financial viability of the project (covering part of CAPEX) depends on its cash flow profile over the life cycle. For solar thermal heat production, CAPEX is the main component of the negative part of the present value equation. So, financial viability can be achieved with an investment grant. For biomass, OPEX is the main negative component. In some cases financial viability cannot even be reached even with a 100 % grant (meaning that the end-user would get the biomass installation for free).

But investment subsidies are not the only way to improve the financial viability of renewable energy projects. Financial viability can be indirectly improved by increased energy prices of fossil fuels.

### PRICE OF FOSSIL FUEL: CARBON PRICING/$CO_2$ TAX

Concerning fossil fuel prices, scenarios for the financial viability of renewable energy investment in industry are normally calculated using different energy price development assumptions (e.g. using different International Energy Agency energy price scenarios).

We have used a different and policy-oriented approach, introducing a carbon pricing/$CO_2$ tax assumption to increase fossil fuel prices/energy savings. In the context of a net present value calculation this can be regarded as an alternative to subsidising EE or RE projects through CAPEX grants by increasing energy cost savings as the "positive" cash flow component in the cash flow equation. As a target value we calculate the "switching price" for process heat technologies, which is the mark-up on current energy prices by a carbon price/$CO_2$ tax required to increase energy savings to a level where the present value of the project gets positive.

We would like to emphasise a point. Increasing fossil fuel energy prices via a carbon price/$CO_2$ tax is only a "neutral" alternative to subsidising investment cost when considering the cash flow calculation of the project investment. For the company making such an investment it is not neutral. Production costs are increased accordingly, which reduces its profit margin. Even if the renewable investment is financially viable because of the resulting higher cost of fossil fuel, the high cost of renewable heat energy production still burdens the profit margin. When this level becomes prohibitively high, introducing such high carbon prices or $CO_2$ taxes cannot be seen as an economically viable instrument for a smooth and equitable transition to a carbon free economy.

Instead of presenting "switching prices" we therefore prefer to model a "moderate" carbon pricing scenario. This includes an initially small, but steadily increasing carbon price to send a price signal intended to re-orient long-term perspectives towards avoiding $CO_2$ emissions. With this scenario, we want to contribute to the increasingly relevant discussion about carbon pricing. Regarding our assumptions for a moderate carbon pricing scenario ("$CO_2$ tax scenario"), we refer to the conclusion of report by Stern-Stiglitz for the High-Level Commission on Carbon Prices (Stern Stiglitz 2017):

> Countries may choose different instruments to implement their climate policies, depending on national and local circumstances and on the support they receive. Based on industry and policy experience, and the literature reviewed, duly considering the respective strengths and limitations of these information sources, this Commission concludes that the explicit carbon-price level consistent with achieving the Paris temperature target is at least US\$40–80/t$CO_2$ by 2020 and US\$50–100/t$CO_2$ by 2030, provided a supportive policy environment is in place.

We calculate this "$CO_2$ tax scenario" for each country in the EU based on:

1. A carbon price starting from 32.9 EURO/tonne $CO_2$ in 2019 and increasing year by year until it reaches 90 EURO/tonne $CO_2$ in 2030 and increases with the same compounded growth factor in the years afterwards,
2. which is added to the non-household price for natural gas *without taxes and levies* (because the carbon price should substitute such already existing taxes in a transparent way) shown by EUROSTAT for the different countries of the EU, and
3. which is also increasing with the energy price inflation/the general inflation we are using in our macroeconomic scenario.

Based on these energy price assumptions, the investment grants needed for a positive present value can be reduced.

### FINANCING COST/PUBLIC GUARANTEES

This "$CO_2$ tax scenario" substantially improves the competitive position of energy efficiency and renewable energy technologies to substitute heat production by fossil sources. However, in the discussed "moderate" range it is not sufficient for deep decarbonisation of industry. For some technologies and in many countries the "switching price" would be much higher than the proposed level for the $CO_2$ tax. Filling the gap with investment subsidies would be very expensive. Such subsidies build on the investment cost for installations at the time of calculation. As these investment costs tend to decrease in the future with the typical industrial learning curve, investment grants have a tendency to overshoot and/or to distort price competition. Therefore, they should be kept as low as possible.

The present value equation also includes financing cost for SMEs – loans as the factor for discounting future positive cash flows. Reducing financing cost increases future cash values, which improves the financial viability of EE and RE projects. Therefore, the cost of financing is an important parameter to model financial viability of EE and RE investments.

In this scenario, we assume that financing such investments by industrial users (including SMEs) is credit –risk free. The credit risk premium component is removed from the financing cost on a country-by-country basis, and we look at the cost impact on financial viability in the following chapter. The enhancement effect for mobilising financing is discussed in the last section.

In practice this could be achieved through public guarantees ("climate guarantees") on a national level. Instead of using the discount factor of the "BAU scenario" (equal to the country-specific SME financing costs), we use the level of the financing cost for government bonds in the respective EU member countries + a guarantee fee margin of 25 basis points. Such a guarantee would eliminate the well-documented financing cost disadvantage for SMEs.

## The fiscal cost of support measures for decarbonizing process heat generation in industry

Starting from the investment cost estimates for solar thermal and biogas installations, we calculated the cost for governments subsidising these investments in order to make them financially viable. For subsidies in the form of investment premiums (grants), the financial burden for the government budget is calculated directly by PHESIMA by the percentage of CAPEX that has to be subsidised. We are comparing the "BAU scenario" with the "$CO_2$ tax scenario", where energy prices are increased by a moderate carbon price/tax and financial costs (the risk premium component) are reduced by public guarantees.

For the BAU scenario, the fiscal burden to the government is simply the amount of investment premiums granted. For the "$CO_2$ tax scenario" the fiscal burden consists of two elements: the investment premiums granted (which are lower, because financial viability is improved by higher energy cost savings due to higher fossil energy cost) *and* the fiscal burden to cover payments on guarantees triggered by defaults on guaranteed loans.

The financial burden of lowering financing cost by public guarantees depends on the default rates of the beneficiaries of guaranteed loans. Concerning default rates, we have chosen the following simple assumptions:

- 100 % of the investment volume is covered by guaranteed loans which are paid back in equal instalments over the lifetime of the investment (i.e., 20 years for solar thermal appliances, 15 years for biogas). This means that no equity portion is used.
- Considering this diversified credit risk portfolio the net default rate (guarantee payout not covered by guarantee fees) is assumed to be 1 % per year. Therefore, the total cost of climate guarantees amounts to 10 % for solar thermal investments, and 7.5 % for biogas investments (disregarding discount factors, which would reduce the present value of the fiscal burden).

These assumptions allow us to calculate default payments for public guarantees. In Figures 6–10, we compare the level of subsidies needed as a percentage of the total investment cost for Austria (solar thermal, biogas), and for Spain (solar thermal only as the amount of natural gas-based heat production is far too big for available biogas resources) to substitute natural gas using the BAU and the "$CO_2$ tax scenario".

### AUSTRIA

See Figures 6–8.

### SPAIN

See Figures 9–10.

### $CO_2$ ABATEMENT COST

From a climate policy perspective the cost efficiency of investments and policy measures can be measured by the abatement cost of $CO_2$ in EURO per metric ton. This metric allows for the direct comparison of alternative investments and policy measures, including carbon pricing/$CO_2$ tax rates or to penalties a state would have to pay for breaching $CO_2$ avoidance targets.

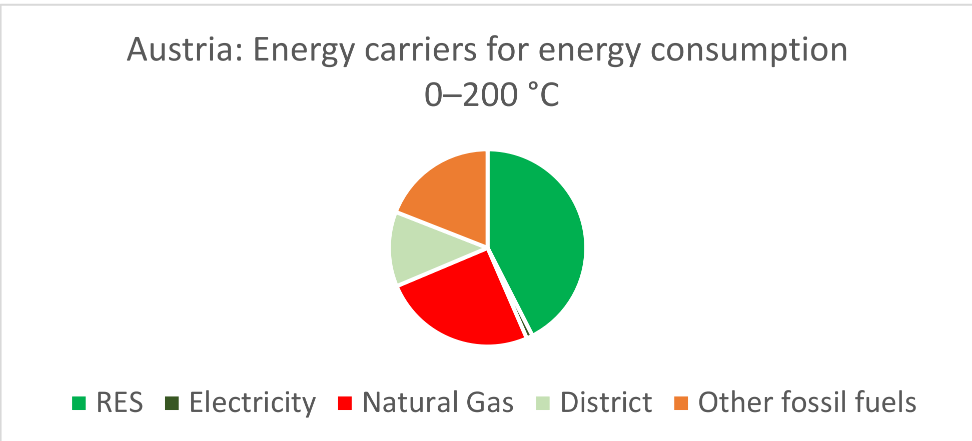


*Figure 6. In Austria natural gas is the most important fossil fuel for industry in the low to medium temperature range (source: Fraunhofer ISE 2016b).*

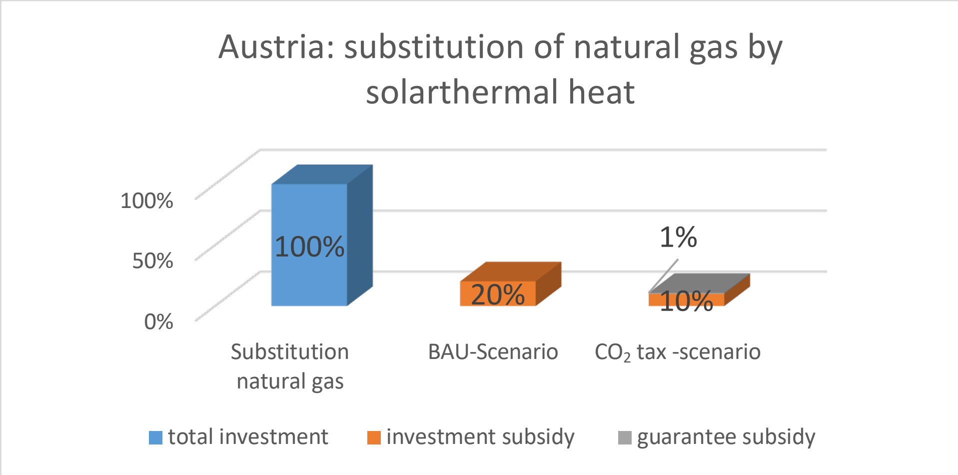


*Figure 7. A combination of a moderate $CO_2$ tax plus low financing cost would reduce the subsidization needs for a 7.9 billion investment by 1.9 billion Euro.*

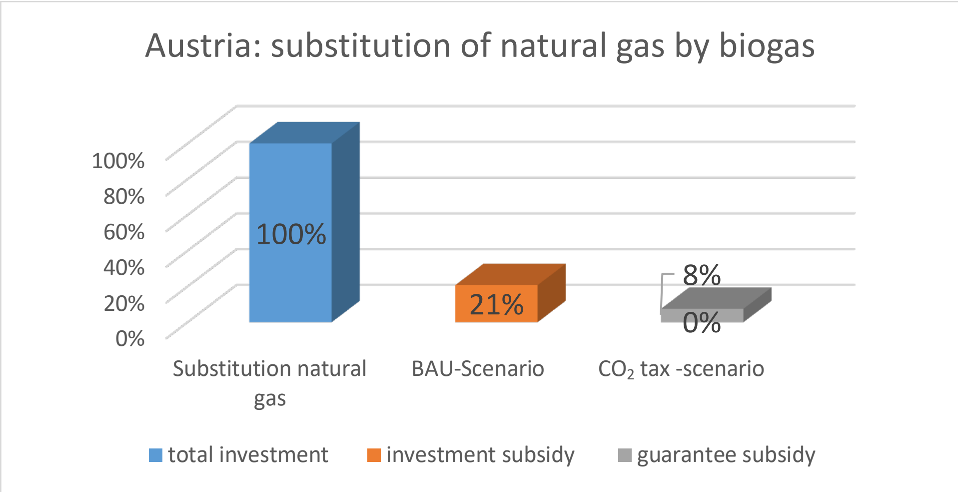


*Figure 8. Substitution by biogas would be feasible under the low $CO_2$ tax scenario without direct subsidies, relying solely on climate guarantees.*

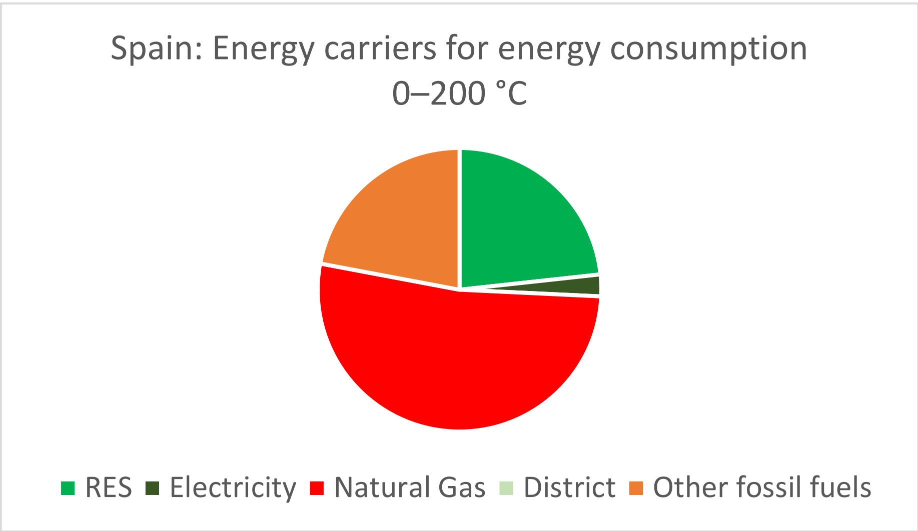


*Figure 9. Spain is very dependent on natural gas. Calculated substitution cost by solar thermal would be 17 billion (source: Fraunhofer ISE 2016b).*

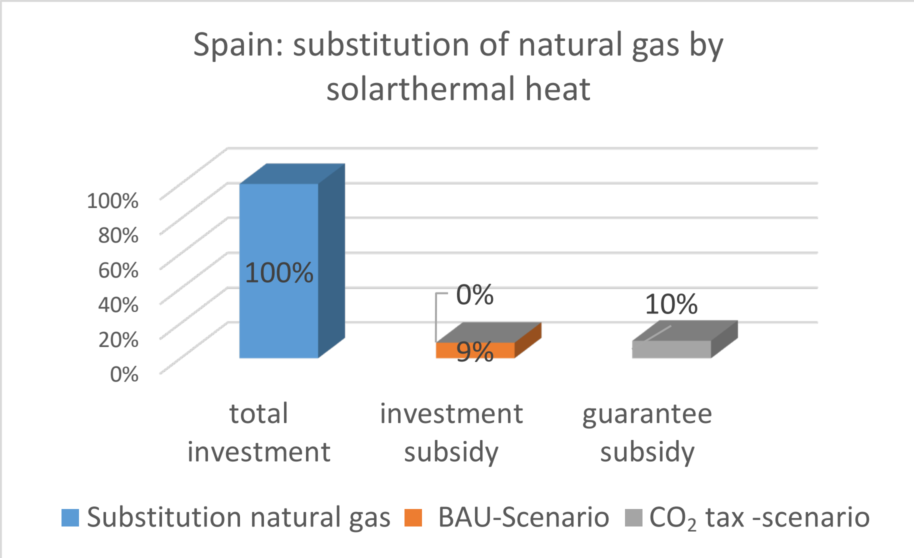


*Figure 10. Due to favourable irradiation conditions, subsidy needs are relatively low; with moderate $CO_2$ taxes even without investment premiums.*

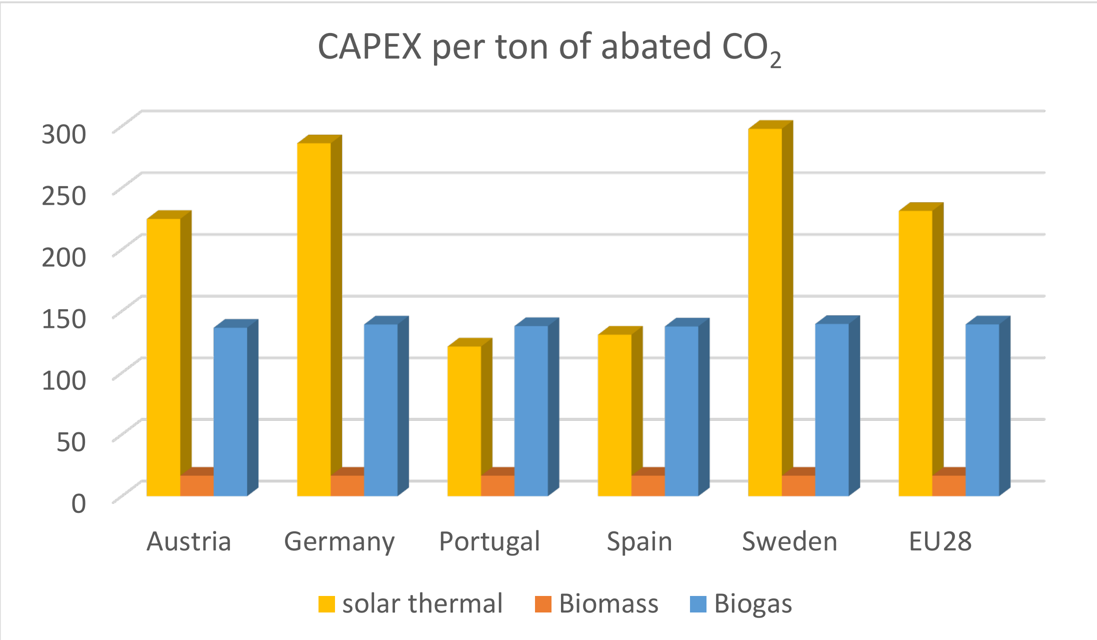


*Figure 11. Abatement cost of $CO_2$ for investments in renewable energy heating technologies in Euro.*

With the PHESIMA model we have calculated how many tonnes of $CO_2$ can be avoided over the lifetime of the renewable process heat installation compared to burning natural gas for the same amount of process heat. Dividing the CAPEX of the installation by the avoided $CO_2$ over the lifetime of the installation shows in Figure 9 the abatement cost per tonne of $CO_2$ in five countries of the EU and the EU average.

These total abatement cost per tonne $CO_2$ can be related to the cost of subsidies per ton $CO_2$ to make those investments economically viable as shown here for Austria and Spain.

In the BAU scenario, Austria would have to pay investment subsidies of 77 Euro per tonne $CO_2$ for solar thermal installations or 44 Euro per tonne $CO_2$ for biogas installations, whereas in the case of the moderate "$CO_2$ tax scenario" the fiscal abatement cost per tonne $CO_2$ would be reduced to 48 Euro on the investment subsidy and 22 Euro on default payments for guarantees. In Spain, the respective figures would be 16 Euro on solar thermal and 61 Euro on biogas subsidies in the BAU scenario; whereas in the $CO_2$ tax scenario no investment subsidy would be needed for solar thermal installations, and the guarantee cost for the state would be 13 Euro per tonne of avoided $CO_2$.

## Enhancing access to finance using Climate Guarantees

Discussing the cost of $CO_2$ avoidance in industry raises another financing issue. Such investments do not generate additional revenues from selling products or services. Cash is invested

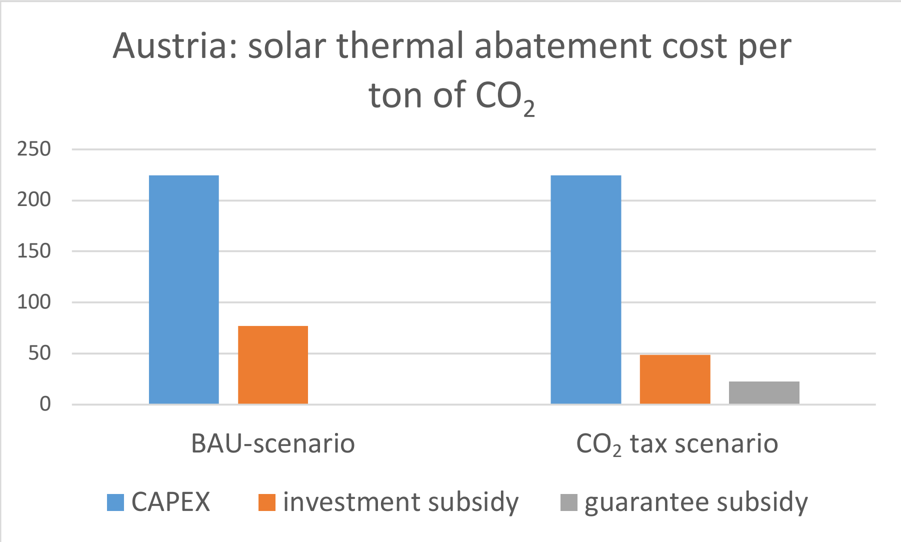


*Figure 12. Cost of subsidising $CO_2$ abatement by solar thermal heat production in Austria.*

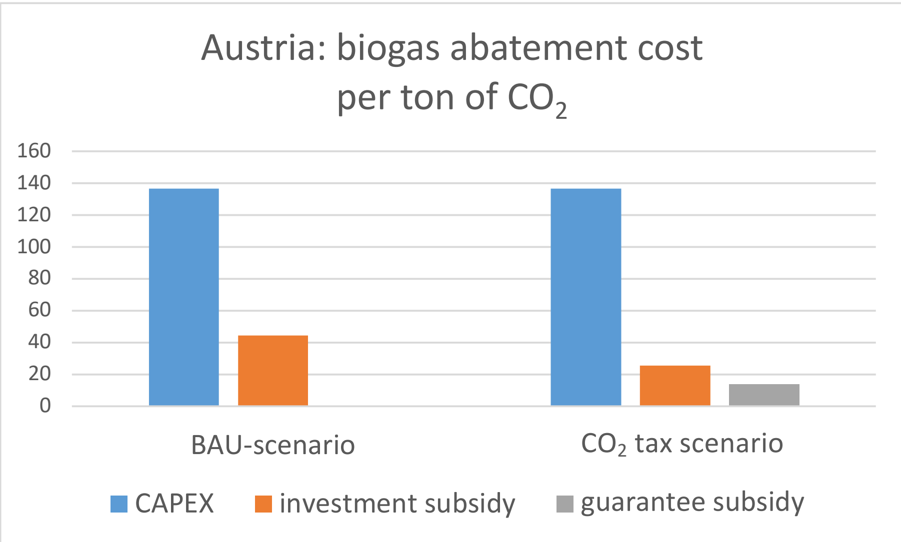


*Figure 13. Cost of subsidising $CO_2$ abatement by biogas-based heat production in Austria.*

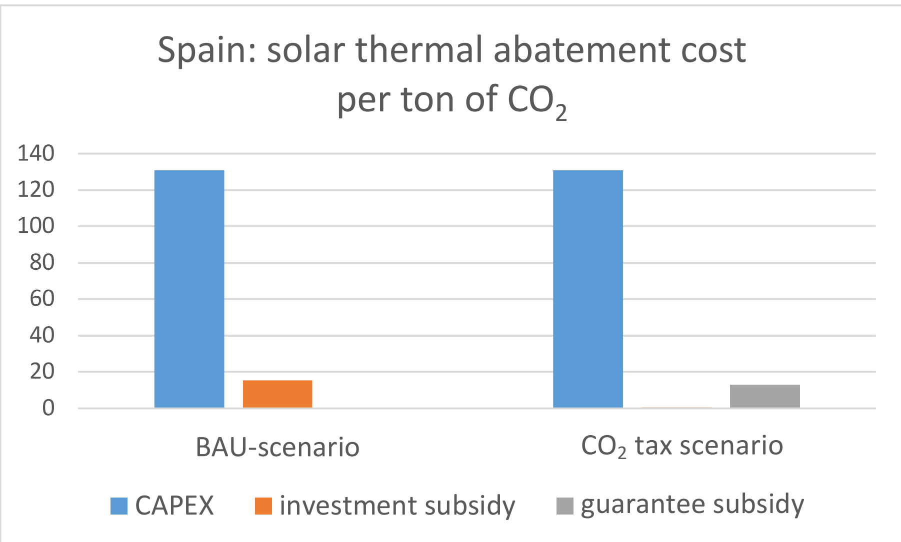


*Figure 14. Cost of subsidising $CO_2$ abatement by solar thermal heat production in Spain.*

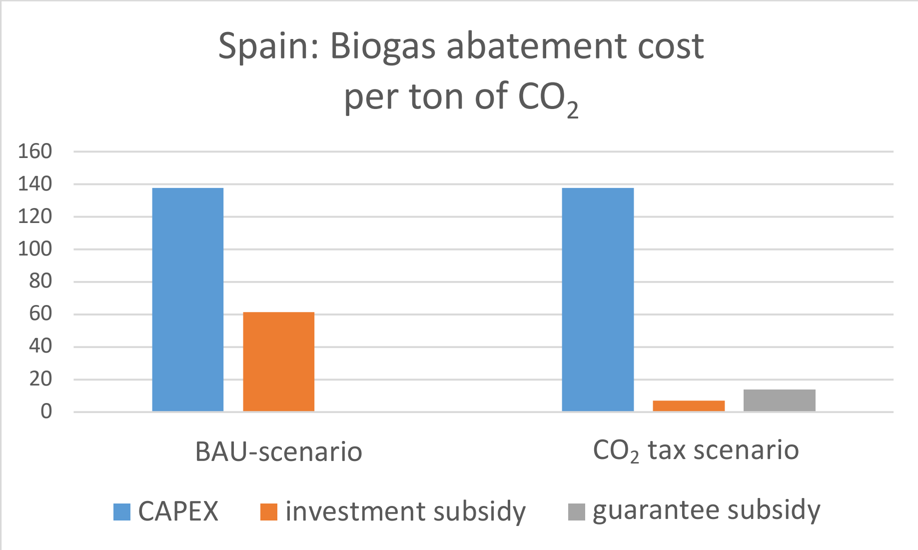


*Figure 15. Cost of subsidising $CO_2$ abatement by biogas-based heat production in Spain.*

upfront in installations to generate process heat by renewable sources for saving ongoing cash expenses for fossil fuels. Even if such investments are economically viable (meaning that over the lifetime of the installation the initial investment is amortized by saving expenses on fossil fuel) the investee does not earn any additional profit.

If such investments are financed by bank loans, the investee builds up additional debt without earning additional income (though reduces cash expenses). As a first assessment of a loan application, banks are comparing the coverage of the financial debt in the balance sheet by the annual cash flow (e.g., EBITDA or the cash flow from operations). As a rule of thumb, banks like to see that this debt coverage ratio is not more than three times EBITDA, meaning that the additional debt should be amortised by fossil fuel savings within three years. Longer amortisation times mean that this simple indicator of creditworthiness (the credit rating) of the investee deteriorates when the owner invests in decarbonisation measures. If the companies' debt coverage ratio is close to this limit, this deterioration becomes critical.

In practice, banks will classify these investments as replacement investments using payback times of 4 to 7 years, sometimes 10 years. We have defined "financial viability" with a positive net present value over the lifetime of installations, which means that the investment sum is amortised only over 15 years (biogas), 20 years (biomass), or 25 years (solar thermal). These long amortisation times can become difficult to finance.

Looking at the magnitude of required investments it becomes clear that it will be difficult for banks to provide substantial additional debt financing. For SMEs with moderate credit ratings, raising debt finance from banks for decarbonisation investments will become all but impossible. *Therefore, without credit enhancement instruments many companies will not be able to invest and decarbonisation investments will not take place with the required speed and in the necessary volume.*

*Public guarantees are therefore a key component in the policy mix for supporting decarbonisation investments in industry*. As has been described, they have a dual function: 1) supporting financial viability by lowering financing cost and, 2) facilitating SME access to long-term debt financing. But how should these guarantees be structured?

#### CLIMATE GUARANTEES INSTEAD OF INVESTMENT GUARANTEES: LOW $CO_2$ – HIGH RESILIENCE

Public guarantees for long-term investment loans are a well-established economic policy instrument in many European countries. Typically, they are designed to enhance the creditworthiness of SMEs, which are currently not fulfilling the "traditional" creditworthiness benchmarks as described above but are in need of financing. The guarantor checks whether the investment project, which typically aims at a new product or service offer, can generate future cash flows to cover the repayment of the guaranteed bank loan. The public guarantee is therefore provided not on the basis of balance sheet ratios, but on future cash flow expectations. The reason for issuing a public guarantee is to increase future cash flows of an investment/project.

This approach is not fully appropriate for public guarantees for decarbonisation projects. A new type of public guarantee called "climate guarantees" would be needed. Rather than generating additional cash flows, the purpose of these instruments is to meet climate objectives i.e., support decarbonisation investments to substitute fossil fuels, save fossil fuel related expenses, and avoid $CO_2$ emissions. Therefore, these investments are not growth investments but replacement investments to avoid $CO_2$ emissions.

The assessment of a guarantee application will have to confirm the $CO_2$ abatement properties of the investment project. A higher credit risk of repayment would be accepted (than a bank would otherwise accept) based on lower $CO_2$ emissions in the future. This does not mean accepting every risk. The higher risk would be justified due to the $CO_2$ abatement properties of the guaranteed investment, with the expectation that decarbonising production will strengthen companies' long-term resilience to the necessary adjustments of the economy.

Climate guarantees should not only be provided as credit enhancement for long-term bank loans for companies who would like to finance their decarbonisation investments. Investments in energy efficiency and renewable energy installations will increasingly be implemented not only by asset owners to replace traditional company assets, but also by third parties like ESCOs offering energy performance contracting or (heat-) energy supply contracts to industrial end-users. Climate guarantees should also be issued to cover counterparty credit risks of the underlying energy performance contracts or (heat-) power purchase agreements.

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