D3.1 B – Innovative investment model for waste heat recovery application in steel industry

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Introduction

Energy efficiency is considered a key tool to ensure sustainable and safe energy supply and to reduce greenhouse gases emissions and to improve the economic growth and competitiveness of industry so that European Union has set a 20% energy efficiency target for 2020 (compared to 1990) and a dedicated directive on energy efficiency to establish a common framework to achieve it.

The European Energy Union, presented at the beginning of 2015, aims to ensure a secure, sustainable, competitive and affordable energy for citizens and businesses. Today there is a clear policy framework for energy and climate, and the creation of an integrated energy market throughout the European Union is the next step. The Energy Union confirms the importance of energy efficiency that should be rethought as a source of energy with its own rights, like oil, renewables, etc. This should allow more incisive energy policies for the promotion of energy efficiency. The Energy Union will be based on the 2030 framework for climate and energy policies that sets the following targets (to be reviewed in 2020, having in mind for energy efficiency a 30% target): to reduce at least by 40% greenhouse gases emission by 2030 compared to 1990, to raise at least by 27% renewable energy, and to increase energy efficiency at least by 27% [14].

Energy efficiency also plays a key role in the IEA scenario for the “battle of two degrees”, a detailed action plan on what can be done to reach the target, based on existing technologies already adopted and tested that would not undermine economic growth in any country. According to this, to limit the increase of the global average temperatures within 2 degrees centigrade, the contribution of energy efficiency will be the 40% of the emission reduction [13].

Energy consumption in industry is about one third of the global consumption in Europe. Energy efficiency in the manufacturing sector is not only a way to reduce greenhouse gas emissions and to participate in the 2020 and 2030 energy efficiency targets, but is a fundamental resource to improve the competitiveness of European enterprises and to move on in the path of resource efficiency. Thus industry is a key sector in terms of energy efficiency potential and importance.

Even if in general investing in energy efficiency is the most cost effective way to reduce the EU’s reliance, and expenditure, on energy imports (costing over €400 billion a year) and energy efficiency projects are usually interesting investment opportunities, their implantation by end-users is hampered by a set of constraints, of which the availability of financial resources is a fundamental one.

In case of financiers, the issue could be seen from two points of view: lenders want to deal with solid projects with short payback time, but the development of these projects is limited by the lack of confidence in granting loans. Therefore it is not an issue of lack of funds, but mainly of availability of investment grade borrowers and information and knowledge.

The main drivers that affect the demand for energy efficiency investments in the large industry are: investment returns, clear business case, awareness at key decision maker level, price and volatility of energy, and limited business interruption risk [1]. Financing energy efficiency in buildings (residential, office) is in some ways easier due to their long life and reusability, whereas in the industrial sector is very unlikely that a shed, or a site, could be sold to someone that does the same activities and therefore doesn’t have to undergo a more or less deep renovation.

The main barrier of energy efficiency and of its financing is that the industry must continue to operate over a certain level during the years to generate the energy and economic savings needed to repay the investment, so the lenders require higher guarantees or a higher rating of the host to lower the risks. For
this reason another point to consider when evaluating an energy efficiency investment in industry is the value of the asset on the total investment and the possibility to easily remove, re-place and re-use the asset itself.

This document describes the main financial instruments for energy efficiency in industry, in particular for heat recovery for electricity generation through Organic Rankine Cycle (ORC). Mature and emerging instruments are presented, taking into account their benefits and barriers, with descriptive schemes to point out the different players involved and the mechanism. In this report different icons are used to identify the financial, technical, and usage risks:

- Financial risk
- Technical risk
- Usage risk

Steel sector

The iron and steel industry is highly intensive in both materials and energy. The CO\textsubscript{2} emissions are relevant and are related to three main factors: a) providing the sufficient temperature in order to carry out the chemical reactions and physical treatment needed, b) providing a reductant (mainly CO) to the system in order to reduce the iron oxide, and c) providing the power and steam necessary to run the steelworks.

The energy consumption has been constantly reduced by introducing energy-saving equipment in steel manufacturing processes and improving the efficiency of energy conversion facilities such as power plants. Among the various processes here are considered the heat recovery opportunities in electric arc furnaces (EAF) and reheating furnaces of rolling mill.

The direct smelting of materials which contain iron, such as scrap is usually performed in EAF which play an increasingly important role in modern steelworks and represents around 40% of the European steel production, with considerably higher shares in some Member States. The major feedstock for the EAF is ferrous scrap, which may be comprised of scrap from inside the steelworks, cut-offs from steel product manufacturers (e.g. vehicle builders) and capital or post-consumer scrap (e.g. end-of-life products). Direct reduced iron is also increasingly being used as a feedstock due to its low gangue content, variable scrap prices and lower content of undesirable metals (e.g. Cu). Ferroalloys may be used as additional feedstock in greater or lesser quantities to adjust the desired concentrations of non-ferrous metals in the finished steel. There are some examples of waste heat recovery in EAF in Europe, while the waste heat recovery to power generation (WHRPG) started in the last few years. One of the main obstacles to the adoption of this solution is the long payback time, even if it is proven and its rate of return is interesting.

In steel plants reheating furnaces are used in hot rolling mills to heat the steel stock (billets, blooms or slabs) to temperatures of around 1200 °C which is suitable for plastic deformation of steel and hence for rolling in the mill. The heating process in a reheating furnace is a continuous process where the steel stock is charged at the furnace entrance, heated in the furnace and discharge at the furnace exit. Many design features of the furnace affects the energy efficiency. These includes type of burners, furnace dimensions, number of furnace zones, type of wall and roof insulation, skid design and preheating of fuel and combustion air in the recuperators by the hot flue gases coming out from the furnace exit. It is possible to recover energy from the exhaust of the rolling mills, but so far there is only one example of WHRPG.
Players in energy efficiency projects

With the aim to better understand the world of energy efficiency in the industrial sector, it is important to know the players that operate in this market. Firstly, we introduce the operative players that provide technologies and energy services. ESCOs and sometimes other operative players can also provide financial services in particular circumstances, but this is discussed in the next section.

Operative players

Within the scenario of energy efficiency different kind of operative players can be distinguished:

- providers of energy efficiency measures (i.e. technology suppliers),
- providers of energy efficiency measures with guarantee of a perfect installation (i.e. contractors);
- providers of one or more integrated energy efficiency measures (i.e. service providers);
- providers of a wide range of measures, able to deliver the most appropriate mix after an energy audit, offering contract paid in relation to performance criterion and a way of financing it (i.e. ESCOs, acronym for energy service companies).

The following diagram (Figure 1), shows how the responsibility and the interest in the project change for different players.

In general it is worth noticing that traditional business models, such as technology providers and contractors, will prove insufficient in addressing all the demand of energy efficiency applications. This is due to the characteristics of many energy efficiency solutions:

- complexity for non-experts, which results both in difficulty in grasping the opportunities and in understanding how the proposed solutions work;
- need for tailored solutions;
- necessity of regulations and management of the energy efficiency project to obtain the best results;
- measurement and verification of the performance requires skilled experts.

For these reasons many end-users (and financial institutions) will benefit for the presence of an EPC contract and the relative O&M activities.

Considering the aims of this guide only ESCOs are described in detail, also because they open new financial opportunities.
ESCOs

ESCOs can play a very important role, offering not only the whole energy efficiency service, but also a way to finance it, directly or through a financial institution. ESCOs take a part of the financial and/or performance risks instead of the customer (a share of the risk, e.g. the usage risk, etc. remains in any case on the customer) and are repaid and gain a profit thanks to the higher energy efficiency obtained by implementing the considered project.

ESCOs can be sorted in different ways by their size, by the sector they operate in, by their focus on particular energy efficiency measures or services (hard and soft, see Table 1) offered, by their structure, etc. Considering the latter, ESCOs can be divided in integrated and not integrated ones.
The structure of the non-integrated ESCOs is lighter than the integrated ones, since they perform directly only a part of the tasks (typically the initial evaluation/energy audit and the risk management) while outsourcing some of the other (typically installation, maintenance, etc.). In any case they are able to offer to their customers Energy Performance Contracts (EPC) and third party financing (TPF). In general they can operate at 360° in the market, from the industrial to the service and residential sectors and can offer multiple solutions, including innovative ones. In recent years many non-integrated ESCOs has been created to answer the rising demand for energy efficiency solutions.

Integrated ESCOs are usually bigger and much more capitalised and are able to provide, with internal resources, both soft and hard services with EPC and TPF. In some cases they are integrated or in partnership with the producer/supplier of the technology or are able to directly offer all the services (design, installation, maintenance) at least for specific solutions (i.e. cogeneration). The integrated ESCOs have a higher capability in financing projects thanks to their capitalization, can offer real guarantees within a financial agreement with a bank or fund, and sometimes can finance the EE projects with their equity.

Vendor ESCOs (for further information see the Vendor financing – Vendor ESCO chapter) can be considered as a subset of integrated ESCOs with activities oriented to specific product(s). Vendor ESCOs typically offer the installation and management of more efficient, but also more expensive, solutions, usually with limited market diffusion. The guaranteed performance and the absence of upfront costs can be a powerful marketing tool, thus vendor ESCOs are often participated by the producer/provider itself.

Financial players

This section is dedicated to the companies involved in financing energy efficiency projects. Banks and investment funds are the main private actors in this field, but there is also an important presence of public funds and other private players that offer financial services in bundle with technical ones.

Development banks

Development banks are supranational institutions that collect funds on international markets and benefit from contribution regularly paid by donor countries. Their importance has been heightened by the financial crisis, which limited the ability of credit of private banks, whereas these development banks have increased their funding.

The main development bank in EU is the European Investment Bank (EIB), which represents the interests of the European Union Member States¹ providing advice and finance for sustainable energy efficiency projects.

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Its main activities are therefore **lending, blending** (offering warranties to unlock other sources to form the final package of financing), and **advising**.

EIB, in support of its actions for investments and in partnership with European Commission, has set up two funds dedicated to the financing of technical assistance in the energy field: ELENA and JESSICA. Both are designed to provide public authorities the means to fulfil those activities that are preparatory to develop large private investment programs.

ELENA covers up to 90% of the technical support cost needed to prepare, implement and finance the investment programme. This could include feasibility and market studies, programme structuring, energy audits and tendering procedure preparation. ELENA thus addresses some of the main barriers to the development of an effective energy efficiency programme among local authorities. In addition, a beneficial side-effect of the programme is the possibility to access financial resources provided by private banks and/or EIB in order to finance the EE projects defined in the investment programme. ELENA can be applied to action such as: retrofitting of public and private buildings, sustainable building, energy-efficient district heating and cooling networks, environmentally-friendly transport, etc.

JESSICA provides a range of financial tools – including equity investments, loans and guarantees – to promote integrated and sustainable urban-renewal projects. The main aim of the programme is to make EU structural funds more efficient and effective by overcoming the traditional use of these resources as grants. Thus it is possible to mobilise more financial resources, both private and public, through public-private partnership initiatives.

EIB has also contributed to the creation of the fund EEEF (European Energy Efficiency Fund) consisting in public-private partnership initiatives directed to contrast climate change by implementing measures of EE and renewable energy in the EU member states. EEEF aims to provide market based financing, and does not provide subsidies or grants. It can provide financing in the form of debt or equity as well as leasing structures and forfeiting loans for specific industry partners. In general, EEEF invests a maximum of 25 million euro per project, variable in function of the project’s structure and needs and of the risk associated with the investment [18].

EIB is also involved in the European Fund for Strategic investment (EFSI), proposed by the European Commission as part of the “Juncker plan”, which aims at boosting the economic growth and making investments without creating new debt. In January 2015, the European Commission submitted its proposal for a regulation: EFSI will have an initial capital of 21 billion euro (in mid-2015 only 13 billion euro were allocated) of which 5 billion euro will be provided by the EIB, the other 16 billion will come from the EU budget. The plan provides for a final capital of 315 billion euro in the period 2015-2017, of which 240 directed to long term investment, and 75 to SMEs and mid-cap firms. The projects to be funded will principally concern infrastructure development (in the areas of transport, energy interconnection and digital infrastructure), investment in education and training, health, research and development, information and communications technology and innovation, expansion of renewable energy and energy and resource efficiency [17].
European and national funds

European and national funds play a key role in the financing of energy efficiency measures. European Commission manages the funding program Horizon, a tool to fund initiatives with a strong innovative content. For “Horizon 2020”, the EU has allocated 80 billion euro, adopting simpler and more consistent rules that will reduce the different barriers for the access to financing. One of the pillars of the program is related to the industrial leadership: over 17 billion to support European industry, with a strong focus on investment in key technologies (ICT, biotechnology, advanced manufacturing) and the improvement in access to credit, in order to make Europe a more attractive place to invest in research and innovation (with a particular focus on green economy and environmental sustainability). Within the Horizon program, European Commission has also set up a series of facilities funding Project Development Assistance (PDA), whose aim to make sustainable real investment by supporting all the activities necessary to prepare and implement investments in energy efficiency projects: these activities can include feasibility studies, stakeholder and community mobilization, financial engineering, business plans, technical specifications and procurement procedures [1].

Article 20 of 2012/27/EU requires the Member States to provide financing facilities for energy efficiency improvement measures and suggests setting up an Energy Efficiency National Fund, with the aim of supporting national initiatives in energy efficiency. The presence and the applicability of the Energy Efficiency National fund or similar facilities should be checked in the Member State of interest. This fund provides a useful contribution to the achievement of energy savings by each Member State under Article 7 of Directive: to ensure this, obligated parties (energy distributors or sales companies retail energy) can contribute annually to the Fund by the same amount to the investments required to fulfil these obligations [6].

The European Structural and Investment Funds (ESIF) – consisting of the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund (CF), the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF) – can be used to support
Development in a comprehensive way across EU, with additional resources available for developing regions. Financing lines include businesses enhancements, research and development, infrastructure, employment and training, agriculture, forestry and fisheries development, with the overall objective to improve the quality of life of EU citizens. Energy efficiency, renewable energy, and emission reduction are one of the main topics of the partnership agreement that every country stipulates with the managing EU body.

Member States and regions can use financial instruments as an efficient and sustainable way of providing support targeted at the priorities of a programme co-funded by ESIF. Financial instruments are suitable for financially viable projects, i.e. those which are expected to generate enough income or savings to pay back the support received. Among the initiatives linked with EU funds, it is worth noticing the Fi-Compass platform\(^2\) – provided by the European Commission in partnership with the European Investment Bank – that provides information and support to the stakeholder to understand what kind of financial tools they can use under ESIF – i.e. loans, guarantee funds, equity and mezzanine financing (quasi-equity) – and microfinance under the Programme for Employment and Social Innovation (EaSI).

**Commercial banks**

Commercial banks are the most classic of funding institutions: they lend money to another economic subject under the constraint of the return of capital of equal value or more. This form of funding has however been affected by the economic crisis and banks want to reduce their risk exposure. In energy efficiency projects the risk is linked with the project risk, the risk of beneficiary and of ESCOs if involved. Banks usually evaluate the creditworthiness of the customer/ESCO rather than of the project, unless the value of the investment reaches the thresholds to consider project financing as an option.

The following table shows, a resume of the financial players, divided by typology, and the typical instruments offered:

<table>
<thead>
<tr>
<th>Financiers</th>
<th>Financial programs</th>
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<tbody>
<tr>
<td><strong>Development banks</strong></td>
<td>ELENA and JESSICA funds (BEI)(^3)</td>
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<td></td>
<td>European Energy Efficiency Fund (EEEF)</td>
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<td></td>
<td>European Fund for Strategic investment (EFSI)</td>
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<tr>
<td><strong>UE and governments</strong></td>
<td>Horizon 2020</td>
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<td></td>
<td>Risk sharing facilities</td>
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<td></td>
<td>European Structural Investment Fund (ESIF)</td>
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<td></td>
<td>Energy Efficiency National Funds</td>
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</tbody>
</table>

Table 1. Financial programs

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<thead>
<tr>
<th>Financiers</th>
<th>Financial instrument</th>
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</thead>
<tbody>
<tr>
<td><strong>Commercial banks</strong></td>
<td>Corporate lending</td>
</tr>
<tr>
<td></td>
<td>Bonds</td>
</tr>
<tr>
<td></td>
<td>Leasing</td>
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</tbody>
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\(^2\) www.fi-compass.eu.

\(^3\) ELENA and JESSICA refer only to public sector.
Green Investment Bank

The Green Investment Bank (GIB) is a bank created and totally owned by the UK Government, aiming at financing green projects on commercial terms. The double bottom line of GIB is to show that it is possible to invest in green project and at the same time make a profit. GIB funds the creation of new energy and waste infrastructure across the whole UK. GIB’s purpose is to accelerate the UK’s transition to a greener economy (the UK’s targets by 2020 require an investment of 474 billion €) by following robust principles and policies designed to ensure that each their investment impact is assed, monitored and reported to highest standard. GIB has about 5.5 billion € to invest in green projects, in particular energy efficiency, offshore wind, waste & bioenergy and community scale renewable. At the moment the Green Investment Bank has committed about 3 billion euros to 51 projects and they have backed large and small projects with CapEx ranging from 3 million to 1,5 billions euros.

GIB’s business model can be summarized as follows:

- They primarily invest in energy efficiency, waste and bioenergy and off-shore wind in UK based projects.
- Each investment must make a positive contribution both on the green side and the economic side.
- They do not offer low-cost finance or grants.
- They work to mobilise other private sector capital.

Other players

There are many other players that can play a role in financing EE in industry, especially in particular regions or for specific solutions. Their actions can be deployed in synergy with the above mentioned players.

Investment funds

Pension funds usually have large financial resources and they are always looking for long-term funding opportunity due to their typical inertia. Industrial EE projects with a low risk profile can be of interest for such funds, together with the funding of building renovation. Their action is hampered by the requirements on the credit worthiness of end users and ESCOs, limited by the low risk profile of such funds.

Technology providers

Manufacturers and dealers of EE technologies can offer their product as an energy service with EPC and TPF, acting as a vendor ESCO. In the case of heat recovery solutions, for example, heat exchangers and ORC cycles this solution can represent an alternative to direct financing from the end-user. An agreement with some banks or investment funds can support the development of this type of approach, which could rely on solid business plans and accurate risk analysis to reduce the request of guarantees from the end-users. Some investment funds are already active, especially on RES and CHP solutions. EE financing is more recent and the financing strategies are still under development.

District heating networks managers

Managers of the district heating network, who are already used to make investments with long return periods in networks, may be interested in funding interventions that leverage new sources of cheap heat,
especially if demand forecasts are expected to exceed supply. District heating networks managers can find useful synergies and sign win-win agreements with industrial facilities, in order to use their waste heat to feed their networks at low cost. This is an approach already implemented with success in many projects, usually including CHP, ORC and large boilers plants whose excess heat is sold to the local district heating network.

**Electricity and gas suppliers**

Electricity and gas suppliers started in recent years to offer EE products and services in bundle with their commodities, in order to counteract the decreasing margins due to increased competition on their respective markets and the trend to energy consumption reduction. Suppliers have a wide clients chain and can usually rely on a solid capitalization, a long tradition and link with the territory they operate in, and a good brand penetration. They also have strong technical know-how, even if usually not on EE. Among the pros suppliers can easily reach both public, SMEs and residential clients and use their commercial chain to deliver EE and RES solutions with TPF. Among the cons, the main one is usually the difficulty to train their commercial agents to understand and sell effectively EE solutions, apart from the simplest and more standardized solutions. For this reason it is more simple to start with solutions such as electric motors, VSD, lighting, small CHP appliances, etc.

**Business angels and venture capitalists**

Both can play an important role in the development of new EE and RES products for the industrial sector, but equity financing for traditional EE projects in industry is presumably a limited option.
Mature Financial Instruments for energy efficiency projects

Many tools are available to finance energy efficiency projects. The traditional ones are loans, leasing, guarantees, bonds, equity and quasi-equity financing, and project financing. A brief description of each instrument is given hereinafter.

Internal and corporate financing

Internal financing uses the equity of the company to finance projects and is the easiest way for a company to collect the resources needed to implement the EE action. This kind of funding is usually related to small investments, for example energy efficiency projects about led-illumination or electric motors. But in general companies can use internal financing for projects considered strategic for their activities (i.e. projects delivering relevant economic streams or reducing the energy cost of the production, etc.).

If internal equity is not available, it is necessary to raise capital through other means. A possibility is to borrow money, another is to increase the available equity in the company. A company can emit new shares (equity financing, such as business angels, venture capitalists, etc.) or bonds (mainly for corporations) in order to obtain large quantities of cash. Both the processes are complex, requires a solid due diligence and time and are used for the expansion of the core business activities. For this reason it is difficult to use these financing options for EE projects.

Figure 4. Corporate financing scheme
Corporate lending

Corporate lending is the most used way that companies adopt to finance energy efficiency projects, in general commercial banks fund energy efficiency measures through loans evaluating the creditworthiness of the company and not the project. To protect themselves, banks may ask also for additional warranties as insurances or sureties.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Weaknesses</th>
</tr>
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<tbody>
<tr>
<td>• Capital is immediately available.</td>
<td>• Loss of cash liquidity.</td>
</tr>
<tr>
<td>• No influence of intermediaries and transaction costs.</td>
<td>• 100% of economic risk on the company (unless risks sharing facilities are present).</td>
</tr>
<tr>
<td>• No interest payments.</td>
<td>• Expensive because internal financing is not tax-deductible.</td>
</tr>
<tr>
<td>• No control procedures on creditworthiness.</td>
<td>• There is no financial leverage for the shareholders equity.</td>
</tr>
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Table 3. Advantages and weaknesses of corporate financing

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• It is an instrument widely used and known.</td>
<td>• The bank only evaluates the creditworthiness of the customer and not the reliability of the project.</td>
</tr>
<tr>
<td></td>
<td>• It increases the financial exposure of the companies and the possibility of gathering new debts.</td>
</tr>
</tbody>
</table>

Table 4. Advantages and weaknesses of corporate lending
Leasing

Leasing is a financing form where the customer has to pay a periodic fee (e.g. monthly) in order to have a useful good (i.e. an equipment) for his own activities. The main interest in using leasing is that it merges capital and operational expenses and can be cheaper than senior loans, depending on the characteristics of the EE project.

This kind of financing policy is usually used for industrial equipment and it has two main characteristics:

- The frequency of payments depends on the contract;
- The customer is able to see the benefits of the project while he is making lease payments because usually the payments are arranged in a way that the stream of income of the cost savings covers them.

Leasing can allow to include the payments in the income statement as a lease expense, not on balance sheet as a purchase. Thus the customer doesn’t have to dip into his line of credit, or other capital reserves, to fund the EE project, leaving those resources available to realize other projects.

Leasing is a very suitable solution for companies with a constant consumption patterns, characterized by high load factors, since this allows the energy savings to generate the cash flow to repay the leasing. In the industrial sector leasing is typically used for short payback time and/or easily removable/reusable energy efficiency measures such as high efficiency motors, inverter and combined heat and power plants. Moreover, the leasing can be used for special complex projects (e.g. tri-generation, district heating).

Many efficiency products are reliable and at least partially removable and reusable. Thus specific leasing agreements for these products can be developed by providing the roles and responsibilities of the involved parties (supplier/installer, ESCO, end user, bank).

There are two kind of leasing: capital lease and operating lease.

Capital lease

In a capital lease, the lessor (i.e. a financial institute) purchases an asset from a supplier and grants it in use to a lessee (i.e. a company) for a set period of time, where the lessee has to pay a periodic fee. At the end of the contract, the lessee may purchase definitely the asset and it becomes of his own property. So, the periodic fee is not just considered a “simple monthly payment” but as a way to pay back the financing (equal to the cost of the asset increased by the remuneration for the lessor). The goal of the capital lease is to modernize an asset of the customer, raising his competitiveness, without using corporate money. It can be applied to many EE solutions, provided they are removable and recoverable.

![Capital leasing scheme](image.png)
Operating lease

In operating lease, the owner of the asset (lessor – i.e. the ESCO, the supplier) owns the equipment and essentially rents it to the lessee for a set monthly fee. A requested characteristic of such leases is that the lease term covers a limited part of the asset’s estimated useful life. The main advantage of the operating lease is to be considered as an off-balance sheet financing source. This kind of leasing is also interesting because it shifts the risk from the lessee to the lessor. Unlike in capital lease, the lessee can’t claim any tax benefits associated with the depreciation of the equipment. Operating lease has a non-appropriation clause, thus the financing is not seen as debt.

Figure 7. Operating leasing scheme

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Weaknesses</th>
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<tbody>
<tr>
<td><strong>Operating and Capital Leasing</strong></td>
<td><strong>Operating Leasing</strong></td>
</tr>
<tr>
<td>- It can cover the total investment.</td>
<td>- It can obtain off-balance sheet accounting treatment.</td>
</tr>
<tr>
<td>- It integrates life cycle costs, reducing the impact on the financial statements.</td>
<td>- At the end of contract the asset come back to the owner.</td>
</tr>
<tr>
<td>- Working capital is not depleted and down payments are avoided.</td>
<td>- No depreciation.</td>
</tr>
<tr>
<td>- It is generally restricted to removable assets (e.g. in the energy efficiency field: energy management systems, boilers, cogeneration, printers, IT, etc.).</td>
<td></td>
</tr>
<tr>
<td>- Host may pay a higher price over the long term.</td>
<td></td>
</tr>
<tr>
<td>- The customer is “forced” to maintain the asset for a certain period of time, causing a degree of “lock in”.</td>
<td></td>
</tr>
<tr>
<td>- It can be resource consuming to develop a (capital) leasing agreement for a new type of asset.</td>
<td></td>
</tr>
<tr>
<td><strong>Capital Leasing</strong></td>
<td></td>
</tr>
<tr>
<td>- Access to most forms of tax advantages at local, national or European level.</td>
<td>- It is on-balance sheet.</td>
</tr>
<tr>
<td>- It can be realized in short time and with simple mode if the leasing agreement has already been developed.</td>
<td>- At the end of contract the asset remains to the lessee.</td>
</tr>
</tbody>
</table>

Table 5. Advantages and weaknesses of leasing
Project financing

Project financing consists in the creation of a project company (SPV – Special Purpose Vehicle) that collects the capital of different investors and whose mission is to implement a particular project. The SPV is a subsidiary company that has to isolate risk from the parent company by maintaining its asset and liabilities on a separate balance sheet. Within the company there are the developers, which are involved in planning activities (technical part), and the financiers. This project company usually has a limited life as it is intended only to develop and manage a single specific project. In case of energy efficiency projects the enterprise where the efficiency measures are implemented usually participates in the vehicle company, stating its involvement and sharing risks and benefits.
Project finance is more efficient than traditional financial tools, since it is dedicated on a single project, is covered by a solid risk analysis and mitigation strategy, all the parties participates in the project giving their own contribution. The basic feature is the possibility to repay the debt through investment’s cash flow only, leaving out every other investor’s asset and not touching the financial creditworthiness of the investor. Due to this, project financing is often defined as a form of off-balance finance, where project’s asset and debt does not appear in the balance sheet of the investors.

Due to its complexity there are limits to the minimum size of the projects, which typically must be greater than 5M€. Under this threshold it is possible to use the corporate financing or to bundle a number of smaller projects.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• A clear sharing of risks and responsibilities.</td>
<td>• Minimum size of the project.</td>
</tr>
<tr>
<td>• The commitment of all the involved parties to the success of the project.</td>
<td>• Initial costs for the creation of the company (legal, insurance, structure).</td>
</tr>
<tr>
<td></td>
<td>• Complexity of administrative procedures, identification and allocation of risks.</td>
</tr>
</tbody>
</table>

Table 6. Advantages and weaknesses of Project Financing

Thanks to its benefits, project finance is certainly a practical alternative to traditional corporate financing strategies for energy efficiency investments, but it requires a high degree of specialization bringing together elements that are traditionally separately managed, such as design, construction, management, etc.
There is no standard model of project financing, because there are deep differences depending on the countries and sectors in which it is practiced.

**Example 1**

An example of Project financing is represented by a big Italian glass industry [22] that, in 2007, decided to have a proactive approach to the process efficiency in order to become a sustainability landmark in its field. The aim of the industry was to recovery the wasted energy to raise its efficiency. The investment approach matches with the project financing model, indeed it has been created a Special Purpose Vehicle where a service provider and the same industry have participated fifty-fifty. The SPV financed and manages the heat recovery and electricity generation system. The sale of the generated electricity to the industry is the financial stream repaying investment, operative expenditure and generating the earnings.

This is also the first time an ORC system for electricity production in the glass field has been implemented.

**Example 2**

An hypothetic example of Project Financing could be represented by a Special Purpose Vehicle formed by the IFC (International Finance Corporation) and another co-investors. The IFC is an international financial institution, member of the World Bank and established in the 1956, that offers investment and encourages the development of the private sector. The participation of the company, interest to the project, is not mandatory (e.g. a cement plant). The company could take part in the creation of the SPV, with its own money, in order to underline its commitment in the project. The company can follow two different kind of agreements with the SPV as it is shown in Figure 9:

![Figure 9. Project financing - off balance sheet model [19]](image)

1. **Heat supply agreement**: Cement Plant supplies residual heat to Project Company that would otherwise be lost. The contract guarantees to Project Company a minimum amount of heat to be received to be able to produce electricity

2. **Off-take agreement**: Cement Plant commits to purchase power from Project Co at a predefined price. Project Company commits to deliver electricity to the Cement Plant in a reliable manner [19].
Risk-sharing facilities and guarantee funds

Risk-sharing facilities are a funding tool that give mainly to SMEs the necessary creditworthiness to borrow money through a warranty. Thus the interested company doesn’t have to present the real warranties that are generally requested by the banks. Start-up or innovative companies typically can use this instrument. These warranties share the risks between the institutes that disburse the loan and the guarantors (e.g. the State) and generally cover the 40-80% of the total amount of the loan. Risk-sharing facilities could be a good tool to promote EPC and TPF projects in industry.

Risk-sharing facility would enable the banks to protect themselves against risks that could endanger the solvency of the energy efficiency projects, thus facilitating the financing of industrial EE projects proposed by ESCOs.

Guarantee funds are a typical form of risk-sharing facilities. They present a multiplier effect, due to the capability to move more capitals then the amount of the guarantee (usually the ratio between the total amount in loans and the guarantee fund can be between 3 and 5). Guarantee funds are characterized by the guarantee rate (the maximum portion of each loan covered by the fund in case of default), the cap rate if present (the maximum portion of the total amount of loans covered by the fund), and the revolving effect (i.e. repayments of the loans are usually put back in the fund and thus are available for reinvestment in other projects). A first loss portfolio guarantee ensures that the fund covers the loans up to the cap rate, instead of considering the guarantee rate on each loan.

An alternative solution to portfolio guarantees is the subordinated loan, a form of quasi-equity financing that ranks after other loans in case of bankruptcy or liquidation of the company. The subordinated loan is another transition instrument used to decrease market failure (risk of transactions, uncertainties around asset’s energy efficiency performances), allowing a greater participation by the private sector. The subordinated loan is granted mainly by public entities, which can afford more risk than private. It is particularly useful to raise funds in a cheaper and less intrusive (since there is no acquisition of shares) way than equity financing.

It is worth noticing that also some types of incentive schemes can work as collaterals, facilitating the use of traditional financing. A well know example applied to renewable energy sources is the feed-in tariff that in many countries offered to banks a guarantee capable of covering most of the risks, thus allowing to offer even 100% of CAPEX with senior loans and reduced traditional guarantees. Another example applied to energy efficiency is the Italian white certificate scheme that is used by banks to reduce the requirements of traditional guarantees, although it is not capable to produce the same amount of collateral as with the photovoltaic feed-in tariffs.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reduces the risks for banks and enables them to lend greater amounts.</td>
<td>• Time to structure and negotiate.</td>
</tr>
<tr>
<td>• Provides extra leverage for private sector funds.</td>
<td>• Moral hazard if substantially all risk is removed from bank lending.</td>
</tr>
<tr>
<td>• Potential to boost energy efficiency services market in EU.</td>
<td>• Know-how needed to implement at regional and local government levels.</td>
</tr>
</tbody>
</table>

\(^4\) Without portfolio cap rates the funds covers the guarantee rates (e.g. 70%) on each guaranteed loan. With portfolio cap rate (e.g. 20%), the guarantee rates are reduced if the portfolio cap rate is reached by adding together the loans in default.
Intermediate financing

An interesting possibility, which put together traditional loans with European funds and supporting actions, is intermediate financing, where a development bank, such as the European Bank for Research and Development (EBRD) and the EIB, offers funds to local banks to finance SMEs through senior loans. The main advantages are that SMEs deal directly with the local banks they already know and get support in terms of information, whereas the banks receive funds to work on medium size loans and are supported in building the know-how required to evaluate energy efficiency projects.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Allow EU funds to finance SMEs through local banks, avoiding the complexity of direct financing and allowing to lend money for smaller projects.</td>
<td>• Long term commitment and resources are needed.</td>
</tr>
<tr>
<td>• Provides support to banks and SMEs, facilitating the diffusion of awareness and know-how.</td>
<td>• Building capacity programmes require time.</td>
</tr>
<tr>
<td>• Boosts the financial markets in the countries in which is applied.</td>
<td>• Both policy makers, banks and SMEs representative should be engaged in the programme.</td>
</tr>
</tbody>
</table>

Table 7. Advantages of weaknesses of Risk Sharing Facilities[1]

**Example 1**
The European Energy Efficiency Fund (EEEF) and the PF4EE (Private Finance for Energy Efficiency) guarantee scheme are examples of risk sharing facilities. EEEF is described in the European and national funds chapter. PF4EE is a financial Instrument, set up jointly by the EIB and the European Commission, that aims to address the limited access to adequate and affordable commercial financing for energy efficiency investments. It will help intermediary banks in Member States to develop and offer specific loan programmes for energy efficiency projects.

Table 8. Advantages and weaknesses of intermediate financing
Energy performance contracts with third party financing

An energy performance contract (EPC) with third party financing (TPF) is a trilateral agreement among a customer who need to implement an energy efficiency project, an external company (ESCO) capable to provide it as a service with guaranteed performance, and a financer (usually a bank). In this case the financial agreement can be assimilated to traditional lending or leasing, but the presence of an EPC can favour the
lending process or allow for more favourable conditions (e.g. lower interest rates, higher coverage, lower DSCR, etc.).

The financer can be the same ESCO. In that case a bilateral agreement takes place. This special contract transfers the technical and financial risks from the customer to the ESCO. The agreement between the two players is based on some performance criteria (i.e. energy efficiency improvement or financial savings) that the ESCO must satisfy. The ESCO uses the cost savings deriving from the higher efficiency to repay the investment and the cost of the entire project and earn money. Many different types of EPC contracts are known to having be used in different sectors. If the project underperforms the expectations, according to the contract, the ESCO gets lower revenues up to severe penalties. In case of overperformance the additional earnings are usually divided between the customer and the ESCO.

Due to the capability to put together a performance contract, an energy service, and the financing, an EPC is a suitable way to finance an energy efficiency project if the company does not have engineering skills, manpower or management time, capital funding or technology knowledge. The EPC with TPF model benefits from the possibility to access risk-sharing facilities and/or insurance risk mitigation. In this way the ESCO will only cover the performance risks and a smaller part of the economic one. For this reason guarantee funds can be a very effective financial tool in regions in which an advanced ESCOs’ market exists.

The main barrier of the EPC model with the ESCO as financer is the limited capacity of the ESCO to finance projects without depleting its cash availability and the possibility to borrow money. TPF with banks or other financial institutions as funding partners has the advantage of overcoming this issue, since it is the customer the borrow the money. In this case the lack of standardization of the model and the need to have a credit worthy customer are the main barrier to the growth of the EPC market. An interesting development, possible with the diffusion of the model, would be the capability to consider the repaying capabilities of EE projects as guarantee in order to reduce the other guarantees requested to finance the project, as it happens with project financing. Some steps in this direction have already been made in the residential sector or for particular solutions.

![Figure 10. EPC&TPF](image)
Vendor financing – Vendor ESCO

A vendor financing program is a programmatic relationship between an equipment marketer (the “vendor”) and a financial services company to provide financing at the point of sale. Marketing effort is supported by the vendor, which becomes a stakeholder of the project. Vendor financing rarely offers a comprehensive approach to energy efficiency, but is closely linked to the provision of equipment. One of the advantages is that the repayment can be lower than the savings, thus the customer has no upfront costs to install the more efficient equipment.

The supplier will receive the money from the customer or simply be a guarantor in its favour, so that its financial creditworthiness is not affected [10].

Vendor ESCOs are part of vendor financing. They can be linked to one or more technology producers and offer EPC and TPF, providing both service and product with no upfront costs for the customers.
<table>
<thead>
<tr>
<th>Advantages</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>For the Customer:</strong></td>
<td>• A thorough analysis of the financial feasibility and of the weight that the loan strategy would have on the vendor’s financial statement has to be conducted.</td>
</tr>
<tr>
<td>• Vendors are the most motivated stakeholders and are thus in the best position to secure financing.</td>
<td>• Vendor finance is only suitable for standardized and removable/reusable technologies.</td>
</tr>
<tr>
<td>• A vendor have the best knowledge about the benefits and technical risks of his product(s), thus may be more willing, compared to financial markets, to lend money to install the product(s).</td>
<td></td>
</tr>
<tr>
<td>• Some of the energy efficiency equipment vendors are large multinational corporations with access to attractive rates and innovative financial products.</td>
<td></td>
</tr>
<tr>
<td><strong>For the Supplier</strong></td>
<td></td>
</tr>
<tr>
<td>• Vendor finance can be used by the supplier as a way to increase its sales and open up new markets.</td>
<td></td>
</tr>
<tr>
<td>• Vendor can secure long-term contracts with the customers.</td>
<td></td>
</tr>
</tbody>
</table>

Table 9. Advantages and weaknesses of vendor financing
Emerging Financial Instruments for energy efficiency projects

Mini Bond

Mini bonds are a tool that allows companies to obtain liquidity from the stock market even though they do not reach the requirements (organization type, minimum turnover, rating assessment…) needed to use such financial tools. In this way, they can enjoy financial facilities as for more structured companies.

Mini bonds can finance investments in energy efficiency in two ways: either directly through bonds issued by corporations, or indirectly through bonds issued by banks, which in turn can on-lend to all types of energy efficiency project hosts. They are particularly suitable for fragmented and unstructured energy efficiency projects, but they are penalized by the lack of benchmarks and high-perceived risk.

A particular category related to energy/resource efficiency and renewables is represented by green bonds. These were born as tax-exempt bonds issued by federal organizations for the development of brownfields sites, and their use can be extended to many green projects, such as energy efficiency and RES.

Green bonds can be flexible and allow for the collection of huge amount of money, but are complex to design, implement, and manage. They require a certain level of standardization of the eligible projects and procedures to select, evaluate and monitor them.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Large and deep pools of investor finance.</td>
<td>• Long times for trading and positioning on the market.</td>
</tr>
<tr>
<td>• Could be applied to most energy efficiency investments.</td>
<td>• Need to meet investors’ expectations in terms of size of issue and liquidity.</td>
</tr>
<tr>
<td>• Financial facilities for the issuers, which can deduct interests paid on bonds.</td>
<td>• Management issues, requiring the presence of a third part.</td>
</tr>
<tr>
<td>• High leverage effect.</td>
<td>• Investors are not able to exit if use of proceeds is not in line with their expectations or if the investments are not implemented.</td>
</tr>
<tr>
<td>• No need for public funding.</td>
<td></td>
</tr>
<tr>
<td>• No need for accessory guarantees.</td>
<td></td>
</tr>
</tbody>
</table>

Table 10. Advantages and weaknesses of mini bond
Citizens Financing

Citizen financing is a very emerging financing solution, in a few years it could be suitable in certain situations. For example this instrument could be used in areas close to industries whose activity, or strategic choices, influence in a positive way the surrounding population.

It can be broadly split in two categories: community energy finance (usually a local community using a cooperative structure) and crowdfunding (usually using the web to aggregate small investors, often to fund international development projects).

The crowdfunding models are different, in particular the most important are:

- Donation based: no reward is expected for the donations.
- Rewarded based: a reward is expected.
- Crowdlending: the participants lend their money to the project in change of a profit.
- Equity crowdfunding: it is possible to buy a portion of the company through the purchase of some financials shares.

Example 1

A best practice of this financial instrument is represented by the Delaware model, where the energy efficiency projects are performed by ESCOs that are funded by a bond emission. The Delaware model, adopted by state of Delaware in USA, is based on the creation of a public-private utility whose job is release the bond that will be re-paid by the energy efficiency savings. Presently this model considers only building renovation, but, since it is an emerging instrument, no one rules out the possibility that it could be extended to industry in the next future.

![Figure 12. Delaware model scheme](image)

---

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![Figure 12. Delaware model scheme](image)
Table 11. Advantages and weaknesses of corporate financing

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low-cost way for financing projects.</td>
<td>• Legal framework is still unclear and immature.</td>
</tr>
<tr>
<td>• Involvement of citizens in the projects and their raise-awareness in</td>
<td>• Fear of “web fraud”.</td>
</tr>
<tr>
<td>environment and energy themes.</td>
<td>• Competence in project of the citizens.</td>
</tr>
<tr>
<td>• Positive social feedbacks.</td>
<td></td>
</tr>
</tbody>
</table>

Table 12. Advantages and weaknesses of insurance

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• It enhances the customers’ confidence in the success of the operation</td>
<td>• Constant payment of the insurance (additional cost).</td>
</tr>
<tr>
<td>and performance of the technology.</td>
<td>• Available for standardised projects only.</td>
</tr>
<tr>
<td>• The insured companies can access financing thanks to the lower risks due</td>
<td></td>
</tr>
<tr>
<td>to the insurance.</td>
<td></td>
</tr>
<tr>
<td>• Protect the future cash flow of the investment.</td>
<td></td>
</tr>
<tr>
<td>• Bankability of the project, favoured by a better technical solidity of</td>
<td></td>
</tr>
<tr>
<td>the intervention.</td>
<td></td>
</tr>
</tbody>
</table>

Table 12. Advantages and weaknesses of insurance

Factoring fund

Factoring is a financial transaction in which an entity sells its receivable accounts to a third part at a discount. In the energy efficiency sector, a factoring fund can buy an asset directly from the customer or (more frequently) from an ESCO, enabling them to freeing up resources.

A new instrument to finance energy efficiency has been recently tried, based on energy performance contract. The operation mechanism is as follows: a fund finances the upfront costs of an already existing and working project, subscribing an energy performance contract with the asset’s owner. Afterwards the fund receives the majority of the energy savings over a period (e.g. 10 years) after which the full project
rights and full energy savings revert to the owner. Practically, the fund buys the entire asset of the project and resells it to the host during the years. The benefits are a stable return profile, very low correlations to public markets, risk minimization, and measurable sustainable impact.

This mechanism is suitable for projects with a maximum life of 12 years [11] and a minimum investment size of one million euros (to reach this threshold a portfolio of interventions can be created too). The financier looks for deals with credit-worthy customers and with proven technologies, so that the project has a firmer foundation. For more flexibility, the cash flow is adjusted in relation to the creditworthiness: if there is a worthy customer, financier can afford to recover less at the beginning and more in the end, whereas if the customer is less deserving, financier tries to maximize cash flow in the first period.

![Figure 13. Factoring fund](image)

**Energy efficiency risk management**

When energy efficiency and its benefits are considered, it is important to underline that the different measures designed by the operative players (i.e. ESCO) will generate positive cash flows until the customer regularly uses the asset. This differentiate EE projects from electrical renewable energy projects, which are the typical energy assets on which banks and funds have been investing in the last decade. Electrical RES projects implemented by an end-user, indeed, are capable of generating cash flows even if the user reduces or stops its activities.

The principle of *usage risk* is the following: energy efficiency intervention may result in an avoided energy expenditure if there is a high use of the technology, but if the activity decreases the intervention will generate fewer savings, so the financier, which in many cases is paid by the cash flow, wants to avoid or mitigate this possibility. A guarantee is therefore required by the player who stands the economic risk (banks, lessors, ESCOs, etc.) against the customer.
Usage risk is linked to the payback period of the intervention: the longer, the riskier the project will be. Typically to ensure its economic return, the financer/ESCO considers only short and medium pay-back periods and usually requires a commitment of the end-user for a certain minimum use of the product/service. Alternatively, the only possibility for financing the project is for the end-user to present various forms of guarantees. However, in competitive and advanced markets financers/ESCOs can accept a weaker commitment from the end-user, especially if risk sharing facilities of insurance tools are available, accepting greater risks and usually rising the cost of lending money.

The following table summarizes the distribution of risks between the different players involved in the financing instruments described before:

<table>
<thead>
<tr>
<th>EE financial instrument</th>
<th>Technical risk</th>
<th>Economic risk</th>
<th>Usage risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate financing</td>
<td>ESCO / Contractor</td>
<td>End-user</td>
<td>End-user</td>
</tr>
<tr>
<td>Corporate lending</td>
<td>ESCO / Supplier</td>
<td>End-user</td>
<td>End-user</td>
</tr>
<tr>
<td>Vendor financing</td>
<td>Vendor</td>
<td>End-user</td>
<td>End-user</td>
</tr>
<tr>
<td>Leasing</td>
<td>Supplier</td>
<td>Financial institute</td>
<td>End-user</td>
</tr>
<tr>
<td>Operative Leasing and ESCO</td>
<td>Supplier / ESCO</td>
<td>Financial institute / Provider / ESCO / End-user</td>
<td>End-user</td>
</tr>
<tr>
<td>EPC&amp;TPF</td>
<td>ESCO</td>
<td>ESCO</td>
<td>End-user</td>
</tr>
<tr>
<td>Resell asset</td>
<td>Investment advisor</td>
<td>Investment advisor</td>
<td>End-user</td>
</tr>
<tr>
<td>Project financing</td>
<td>Project company</td>
<td>Financial institute</td>
<td>End-user</td>
</tr>
</tbody>
</table>

Table 13. Risks distribution
Solutions for standard and customized asset

As for any complex project, also for structured energy efficiency measures in industry each case presents its own features and deserves to be analysed under the financing point of view. This document tries to distinguish two main cases with different characteristics and analyse which kind of solution is most viable (of course the case of self financing is not considered here).

It’s worth noticing that the way to finance the project may not deal with one solution, but can be a combination of some of them. For instance, an EPC, through the involvement of an ESCO, could guarantee the performance of the result and a shared-risk fund could cover a portion of the economic risk, giving to the ESCO the creditworthiness needed to raise capital at suitable conditions to implement and replicate the project. Moreover, an ESCO could subscribe an insurance to cover a bigger part of the risk.

ESCOs have a very important role into the implementation of energy efficiency projects, for this reason it could be advisable the standardization, both regulatory and fiscal, of EPCs. The relevance of this kind of funding is becoming higher and ESCOs are increasing their market.

In any case, a monetary involvement by the beneficiary is advisable when possible, since it ensures the commitment of the beneficiary and thus reduces the cost of lending money.

Corporate lending is currently the most widely used tool for EE financing. Its limitation consists in the higher attention to the creditworthiness of the sponsor rather than to the project. This is mainly due to limited size of many EE projects and the huge variety of available solutions that make banks and other financers unwilling to accept the risk involved in financing the project on the basis of its capability to repay the loan through the generated savings.

In order to analyse the best financial tools to be used, it is useful to consider two different type of projects: the ones that involve standardized and removable asset and the ones with customized solutions, difficult if not impossible to remove and reuse.

**Instruments for standardized assets**

Talking about standardized assets, leasing can be one of the best ways to finance an energy efficiency project. It is relatively easy to manage and sufficiently flexible, since it allows to remove the asset and replace it somewhere else at the end of the contract, thus allowing the beneficiary to change things more easily. Generally, leasing is a financing tool used by company who need a standard asset that could be easily re-covered and re-sold, but, on the other hand, if the customer is a solid company, or a part of a larger group with solid warranties, the leasing could be a suitable solution also for companies who need a customized asset.

Another suitable solution in the case of standard assets is the use of vendor finance, particularly for technologies easy to install and manage. Since vendor financing is based on a specific set of solutions for each vendor it should be possible to develop particularly favourable financing conditions.

**Instruments for a customized assets**

In case of customized assets, which imply a tailored and ad-hoc solution, usually integrated with the building/plant, the situation is more varied. The main issue is the risk associated with the failure of the
company: in this case it is no worth recovering the asset because of its lack of standardization and the high costs associated with its reutilisation.

In this case, a good solution might be an **EPC** or a **project financing**: the first is a well-established tool in energy efficiency, because it permits to transfer the technical risk from the customer to the ESCO, which has more expertise in the field. Project financing allows creating a dedicated company to fund a single project and this feature makes it suitable for interventions that are more complex and costly.

As mentioned, customized asset, in addition to being more complex, presents greater risks for the financiers. In order to limit this issue, there is the possibility of adopting hedging instruments such as a **risk-sharing facility**, which let ESCOs share the economic risk with other bodies, or an **insurance**, which protect against risks connected to asset’s performance. These tools could also be used for simpler or standardised interventions, but in that case simpler financial tools can be preferred both for economic and usability reasons.

In addition to these, other solutions on the market are applicable to all types of interventions but they are still emerging and need a further development (i.e. **resell asset**) or a raise-awareness (i.e. **citizen financing** and **mini bonds**).

### Waste heat recovery in the steel sector

The two options of waste heat recovery analysed regard the EAF and the reheating furnace of the rolling mills. According to the specificity of plant it can be possible to exploit the recovered heat inside the plant (e.g. generate steam if need, preheating raw material, etc.). If there are no internal uses of the recoverable heat or if there is still an interesting amount of unused heat, it is possible to evaluate a waste heat to power generation system and/or the provision to an external user. The amount of heat available depends on the size and on the characteristics of the plant. In the case of EAF, the electricity generated is usually higher than electric consumption of the gas treatment unit.

**Application of Waste Heat Recovery to power generation**

The example presented is the waste heat recovery feeding an ORC and an external user is the Feralpi plant situated in Germany, where the steelmaker agreed with the local utility to supply about one-third of the heat recovered from the EAF off gas, (i.e. 10 tons per hour of saturated steam at 27 bar) to be used by an industrial plant located nearby. The project is based on recovering heat from the EAF off gas, generating saturated steam and conveying this steam partly to the thermal user and partly to the ORC power plant to produce electricity that is self-consumed by the steel plant. The off gas duct of EAF before energy recovery system was equipped by water jacket cooled duct, sealing chamber, water jacked cooled duct and quenching tower.

In the new configuration the off gas duct is equipped with an energy recovery system able to generate a steam flow rate by the energy extracted through the cooling system of the off gas using the ECS technology (Evaporating Cooling System). In the internal sections of the off gas cooling system saturated steam is generated in the two sections High Temperature section (HT), where there is a radiation heat exchanger, and the Low Temperature section (LT), where there is a convective heat exchanger. Thus the steam is sent to the steam drum to obtain the separation between steam and water.
The stability of the steam supply to the users is guaranteed by the steam accumulator. Indeed it is able to accumulate the excess of steam generated respect the users necessities or to introduce in the line a steam flow rate in periods of low steam generation.

Figure 14. Scheme of the energy recovery system installed at Feralpi ESF and user disposition

Thermal energy stored in the steam serves both thermal user and ORC system: considering mean values, almost 10 tons per hour of the steam is exported to an industrial process through the district heating grid. The remaining 20 tons per hour feeds the ORC system, giving their thermal energy to the ORC working fluid, which generate up to 2.7 MW of electricity. With an average ORC power of about 28 kW per ton of EAF capacity.

Another application of WHRPG is on the exhaust of reheating furnace of rolling mills, often present downstream of EAF. In the reheating furnaces the gases are cleaner and the heat exchanger is simpler.

In Europe there are around 200 EAF and over 260 rolling mills with a theoretical potential of respectively 300 and 400 MWe of ORC.

Regarding the standardisation of the heat recovery for power generation plant and its re-usability, in the case of a WHRPG on an EAF it can be considered that the ORC system (20 % of the total investment) is re-usable in other applications with similar temperature levels and recovered power – also considering that the ORC is on a skid – whereas the heat recovery system (e.g. heat exchanger – 60 ÷ 70 % of the total investment) is more complex and also requires a intermediate steam circuit and a steam drum. In the case of the reheating furnace of a rolling mill, not only the heat exchanger is simpler, without the intermediate
steam circuit, etc., but it is also possible to use a direct exchange configuration, so the thermal oil circuit can be avoided, with a significant reduction of the investment cost related to the heat recovery system, thus a higher share of investment becomes re-usable.

Positive synergies between electricity generation and the district heating

The Energy Efficiency Directive 2012/27/EU stimulates the exploitation of recovered heat by external users directly or through district heating and cooling networks. The connection to a district heating and/or cooling could guarantee a demand for a more or less long heating and/or cooling season plus eventually the demand for hot water, thus an economic stream, plus the possible involvement of the district heating/cooling network in the investments for the heat exchanger.

The external use of the recovered heat must not be considered only as an alternative to the production of electricity, but can also be synergic. According to the temperature level of the recovered heat, its amount, the profile of the demand, etc. the external heat can be in parallel to use or in cascade the electricity generation cycle. External heat exploitation combined with electricity generation requires a higher investment, but can allow a shorter payback time, due to the higher exploitation of the heat exchanger, the most capital intensive element of the system. [9]
The Whaves survey

In order to validate the contents of this guide and improve its contents, a series of interviews has been implemented in the last months of 2015. Both operative and financial parties has been interviewed in order to collect suggestions and their views on the most used financial tools, the most expected ones and the main issues.

Banks and financial institutions, ESCOs, and industries were presented with a list of 5 questions, adapting them to each group in order to get the right and most informative answers from the participants to the survey. As the Guidelines will refer mainly to the European situation, some extra European contributions have been added to give also an idea of what other countries are doing to manage investment in the industrial sector.

The suggestions received from the survey have been integrated in this report. The survey provided interesting information on the topic related to energy efficiency financing, both on available and future tools and on the existing barriers. The Whaves Guidelines received a positive feedback.

The main results of the survey are the following ones:

• Many end user companies prefer to use equity if available.
• The ESCO model is seen with interest, but mainly for the EPC part, not for the financial one.
• There is a need of building capacity both for banks and financial institution, for facilitators (ESCOs, intermediaries, professionals expert in financial and technical issues, etc.), and for end-users. The diffusion of a technical/financial know how is widely recognized as essential and it can be helped by the standardization of EE projects (possible for the basic solutions, not for the most integrated with the core business).
• The typical size of the EE projects is an issue for the majority of the available financing instruments, thus it is fundamental to find ways to aggregate projects together to reach thresholds in the order of some millions euros.
• Senior loans are the main financial tool, but also leasing is considered an interesting and growing opportunity, whereas project financing is limited due to the typical size of EE projects.
• Guarantee funds and other risk sharing facilities are considered an important booster for the financial market.
• Intermediate financing and incentive schemes used as collateral are effective tools to complement traditional financing (loans, leasing, project financing, etc.).
• Insurances can play an important role di reducing the need for traditional guarantees.
• Crowdfunding and mini bonds are considered interesting, but not seen as something to rely upon in the short term.

This is the list of the respondents, whom we would like to thank for their useful contribution:

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• Stefano Fissolo, SUSI Partners
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• Josuè Tanaka, EBRD
• Miha Valentincic, Petrol energy solutions
• Diego Vergani, Siemens*
• Donato Zambelli, AIB Brescia
• EFIEES

*People interviewed, whose contributions were not granted for publication.

For further information on the survey please refer to the section “Appendices” of Whaves’ Final Report.
Useful initiatives

EEFIG e Compass

EEFIG is a specialist expert working group created in 2013 by European Commission and United Nations Environment Programme Finance Initiative (“UNEP FI”) with the aim of determine possible solutions to solve problems related to obtaining long-term loans for Energy Efficiency. Stakeholders of the sector and financial institutions are so directly involved in order to make possible a dialogue between them and create a working platform with the European Commission.

Fi-compass is a platform provided by European Commission in partnership with EIB: it provides consulting services on financial instruments for the use of EU funds (ESIF, European Structural Investment Fund), enhancing technical assistance and making sure that investments co-financed by the EU will produce positive effects on the real economy.

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5 [https://www.fi-compass.eu/](https://www.fi-compass.eu/)
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[20] International Finance Corporate website
[22] Financing energy efficiency: Sangalli group experience
[23] University of Delaware (2011)
## Glossary

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<th><strong>Term</strong></th>
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<tr>
<td>BREF</td>
<td>Best available techniques reference document</td>
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<tr>
<td>EAF</td>
<td>Electric Arc Furnace</td>
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<tr>
<td>ECS</td>
<td>Evaporating Cooling System</td>
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<td>EE</td>
<td>Energy Efficiency</td>
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<td>European Bank for Research and Development</td>
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<td>Organic Rankine Cycle</td>
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<td>Third Party Financing</td>
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