Economic and legals aspects of EMS - Support notes

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3.1 Market design

Currently we are at a market design shift, where some countries are already under liberalized market, others in transition.

Most Utilities operated under a Monopoly, namely a horizontal one, where Generation, Transmission, Distribution and Delivery, was done by the same entity.

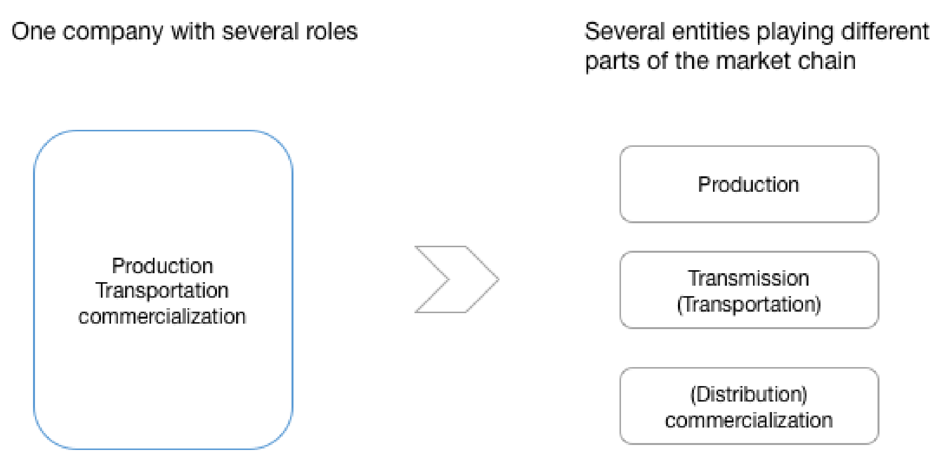


Figure 3.1:

To get to a fully to liberalized market, Europe has chosen an ownership unbundling model, where infrastructure access plays a central role.

Regulation of the infrastructure access´ prices, or guarantee a fair access to infrastructure so as the need to guarantee safety so as sustainability of supply, are central issues when arguing about a fully integrated

Energy Market.

The split of generation, transportation (and grid operations & management) and commercialization, is reshaping the energy sector. The consolidation and integration of the EU Energy Market presents a great opportunity for several stakeholders and a challenge to consolidated utilities companies.

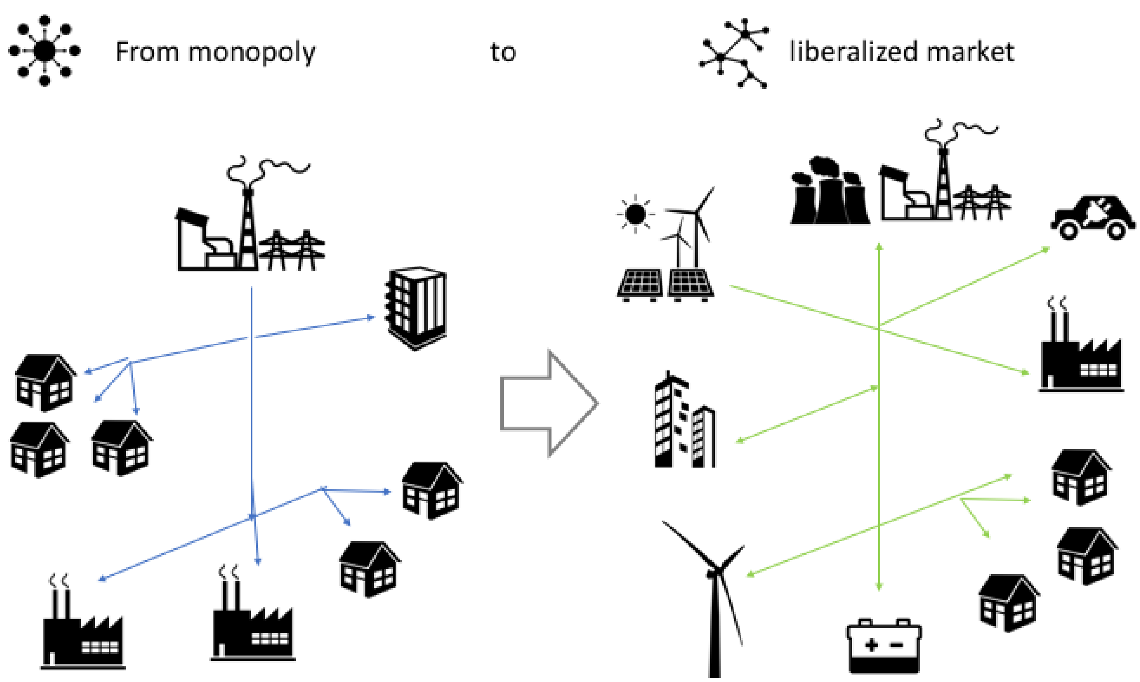
When dealing with industries that have a common infrastructure, as utilities (which includes energy and water), telecoms, access to infrastructure plays a central role. You can just think of activities where building infrastructure by each player would be undoable, so they all share the same. Most, namely in Europe, were build by Governments, where access do energy, water, telecommunications was a competence of Governments.

So when liberalizing markets, Antitrust and competition are central concerns on creating and promoting a fair and competitive market. The ownership unbundling model (regulation of the infrastructure access´ prices) is one models used where:

Infrastructure´s assets belongs to the state (even if concession may be considered for long periods of time, under public interest).

There is the coexistence of Free market and last resort suppliers, so the need to regulate relationships between liberalized market and last resort supplier so as these two with the end consumers.

The Pricing (of using the grid), such as : historical cost, incremental costs, Retail Minus, Free access, Price Caps – will promote different incentives, will define the behavior of the company managing the grip. For example, if you put a price cap and don´t pay any contribution for maintenance and improvement of the overall grid, most likely you will have and overexploitation of the grid. On the other hand, if you have any top limit for investment, these companies have an incentive to over investment and, most likely this investment will have some reflection on the final energy prices.



Currently, we are going through a transition on how energy markets operate, from a centralized monopoly model to a distributed and liberalized market.

This transition has been occurring in many countries over the last decade, with special emphasis in the European Union.

With the growth of distributed generation, namely RES (as Wind farms, Rooftop PV), but also with the current technologies Combined Heat and Power Plant, plus as Storage, Electrical Cars (EV), the grid management tends to go from top down approach to complex network management.

This market transition has occurred in parallel with an energy systems transition, from centralized generation models to distributed generation models.

In centralized generation systems, energy is generated in large powerplants which are typically located away from final users.

Now, with the increasing use of different technologies, namely renewables like wind and solar, it is possible to generate electricity closer to final users in smaller powerplants. Ultimately, users can themselves generate electricity for self-consumption or to inject in the grid.

Both these transitions, which cannot be decoupled as one contributed to the other, introduced many challenges and are reshaping the energy sector, technologically and economically.

Grid management had to change from a model where only one company was responsible for all activities and where all the flows had one direction (from generation to commercialization) to a model where many companies can operate both at the generation and commercialization, but also to a model where the customers themselves can generate energy. So, grid management is becoming more complex due to the existence of multiple players and because energy flows can have two directions. Further, the increasing use of renewables, characterized by their intermittency, as well as new technologies like electric vehicles or storage systems, introduces additional technical challenges.

3.2 Market Players and Supply Chain

3.2.0.1 Market Players

As you recall, we are dealing with a model where all players share the same infrastructure (the energy grid – electricity, gas or other).

In order to this model work, besides supply and demand players, there´s the need of regulators, Distribution and Transmission System Operators, and entities that their role is to make sure supply always meet demand.

The main players in energy markets are:

The Governments, which are responsible for planning, and have the ultimate responsibility to oversee that all players develop their activity within the rules;

National Regulatory Authorities (NRAs): which are responsible for monitoring and supervising the activities of all agents;

The Transmission System Operator (TSOs) and Distribution System Operator (DSOs), which are the companies responsible for managing the physical infrastructures (overhead electricity lines, pipelines, substations, etc.) – the transmission refers to the infrastructure in which the bulk energy between the power plants and cities or between countries is transported; while the distribution refers to the infrastructure in which energy is transported between the transmission infrastructure and the final users.

The suppliers (under regulated, liberalized market or, both), which are responsible for supplying the energy to the energy system (powerplants, refineries, etc)

Retailers, which are responsible for selling the energy to the final clients;

3.2.0.2 Supply Chain

Electricity

In the case of electricity, the power plants are operated by the suppliers. Then, the electricity is transported first through transmission lines at very high voltage (to decrease losses) and then through distribution lines

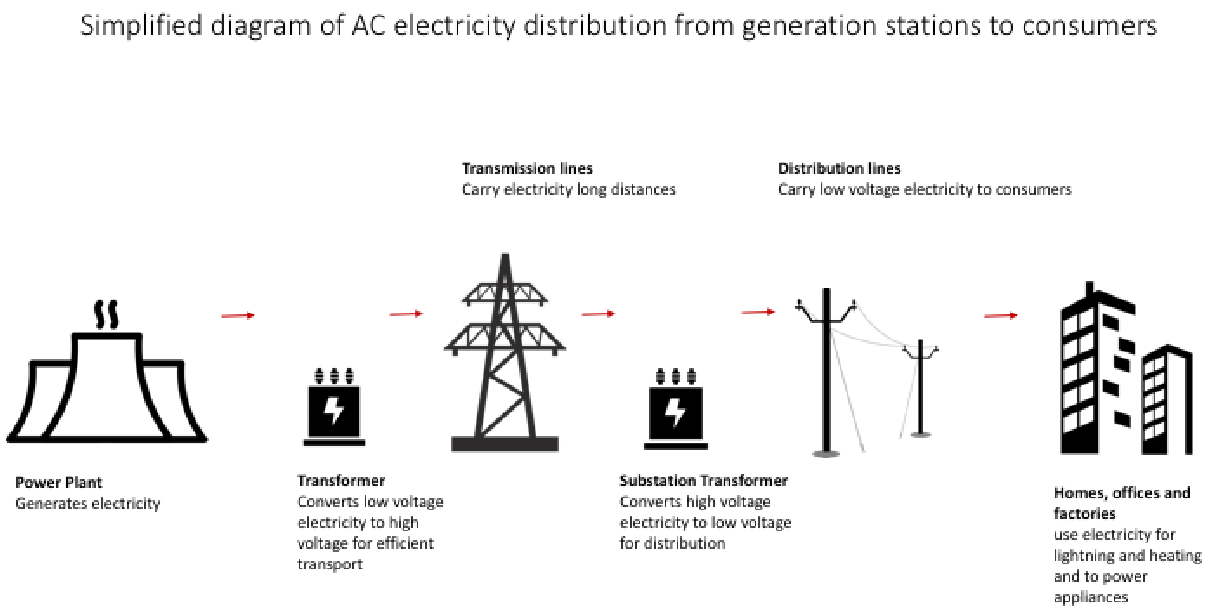
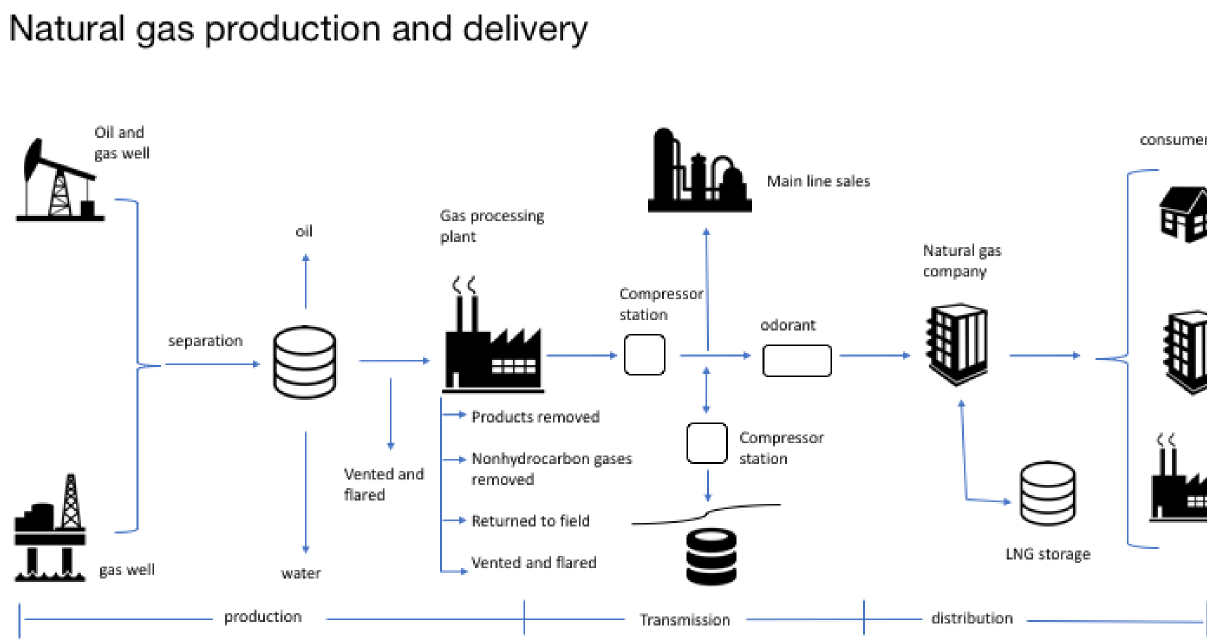


Figure 3.2:

(at high, medium or low voltage) to the final users (homes, offices and factories). Between power plants, transmission, distribution and final users, we have substations that are responsible for converting the voltage and connecting the different layers, acting therefore as infrastructures that provide safety and security to the operation of the grid.

3.2.0.3 Natural Gas



In the case of natural gas production and delivery, the players are very similar.

The natural gas extracted at the well is transported (or stored) through ships and pipelines. Several compression stations are placed along the pipelines (or liquification and gasification stations in the case of transport by ship) to guarantee the transport. Finally, the gas arrives at the final users, which can be power plants for electricity or heat production. One of the main difference between the electricity and natural gas grids is that in gas it is easy to have storage elements and therefore the match between the supply and demand is much easier to manage.

The oil supply chain is slightly different. The core infrastructure is the Refinery, so the transport of the raw material (crude oil) is generally a responsibility of suppliers (extraction) and the transport and distribution of the refined materials (diesel, gasoline, liquified petroleum gas) is a responsibility of retailers.

Looking to combined Gas Natural and Oil, from extraction to delivery, we still can split between production, transmission and distribution. Still in oil & gas you also refer as to upstream, midstream and downstream, where:

Upstream (Exploration & Production, which includes separation),

Midstream (Transportation & Storage), to

Downstream (Refining, Petrochemical, & Marketing)

As you may notice pipelines play a central role in transmission and distribution, still unlike in electricity, you have more storage capacity. Also most electricity is also generate using gas (and coal).

So, if you think what are the costs associated with the different energy fuels, apart from the energy raw material (oil, gas, coal), it is necessary to transform and to transport the energy. In the cases of electricity and natural gas, it is necessary to consider that the management of the transportation and distribution infrastructure represents an additional cost, as well as cost associated with the regulatory activities. Therefore, the cost is not only the cost of how many kWh or m^3 you consume. It is that plus all the costs related to getting that unit of energy where it is needed, which basically covers the costs of maintaining the reliability of the energy grid.

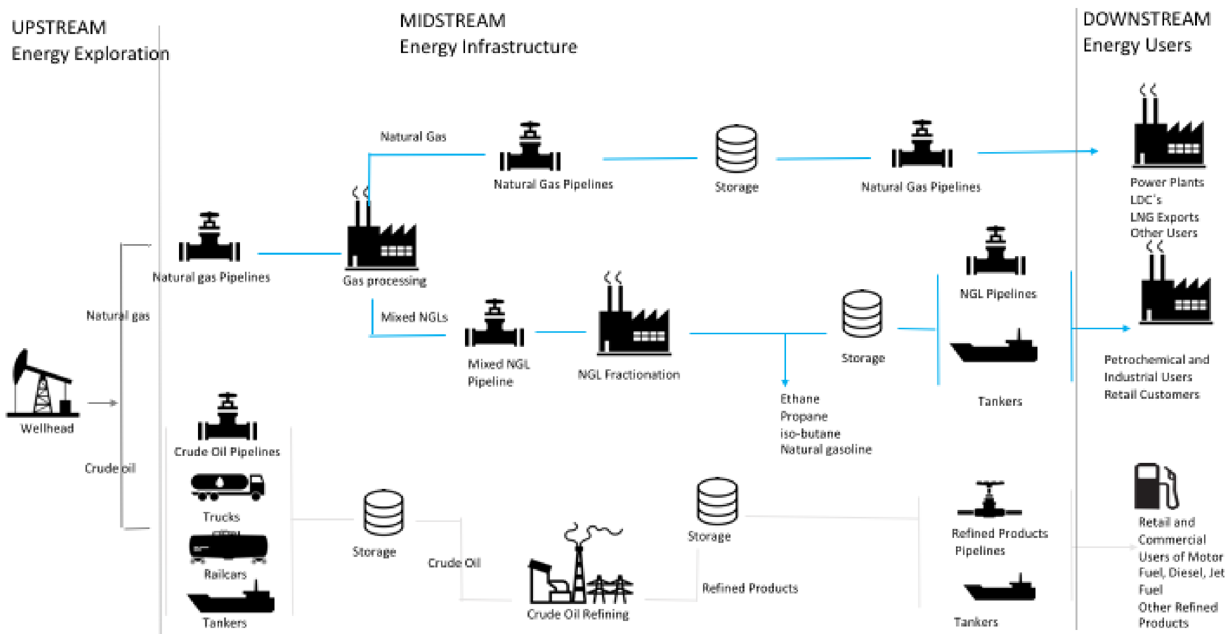


Figure 3.3:

3.3 Price for energy Components

Looking to the final energy price, we can start by decomposing it in 3 components: energy, network and taxes and levies.

The energy component corresponds to the costs of extracting the energy, converting it and commercializing it and are in general charged by kwh of consumed energy;

The network costs correspond to the costs of transporting the energy through the infrastructure (transmission and distribution) and include in general a part that depends on the energy consumption (kWh) but can also depend on the power drawn from the grid (kW). It also includes a fixed cost corresponding to the availability of supply

The Taxes and Levies costs correspond to the taxes associated with the consumption of any good (like VAT) but also to levies, that correspond to special payments to the government related to a very specific end. Examples of levies are levies associated with the system operation, such as those associated with particular energy resources (renewables, nuclear, CHP).

In this chart, we see the average weight of each component in Europe and how is has been changing over time. Considering 2008 as a baseline, and 2015, you can see a significant increase of the RES & CHP levies of electricity prices that mostly supported the feed-in-tariff support mechanism of renewable technologies.

In a feed-in-tariff scheme, the renewable energy generation agents did not have to participate in the liberalized market because they got a fixed tariff for renewable generation, usually above market prices. This reduced the financial risk of the investors in this project, but is has been supported by the final users in the form of levies.

Another example are Levies in Energy Efficiency, which were also residual in 2008, but have been gaining importance in the overall taxes and levies of electricity prices.

IMAGE MISSING

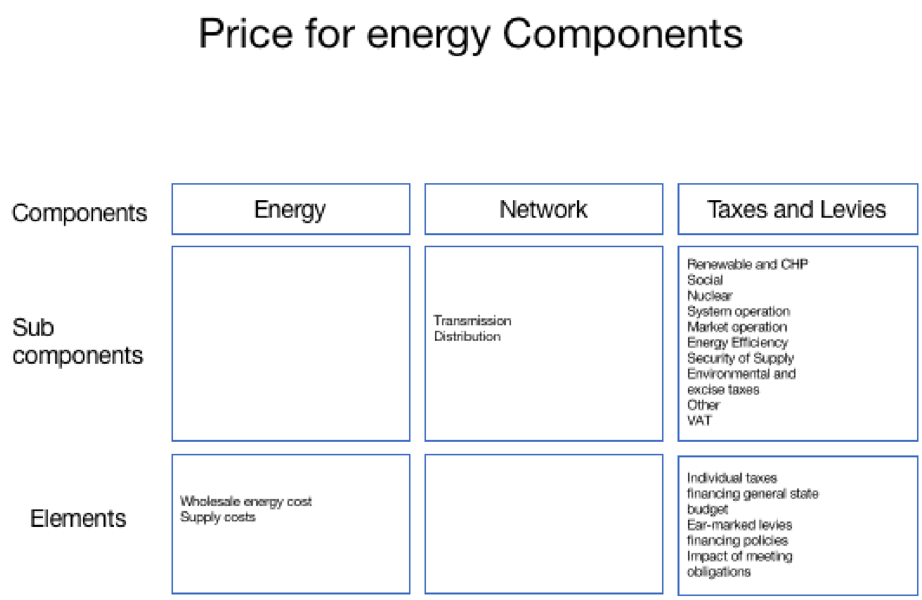


Figure 3.4:

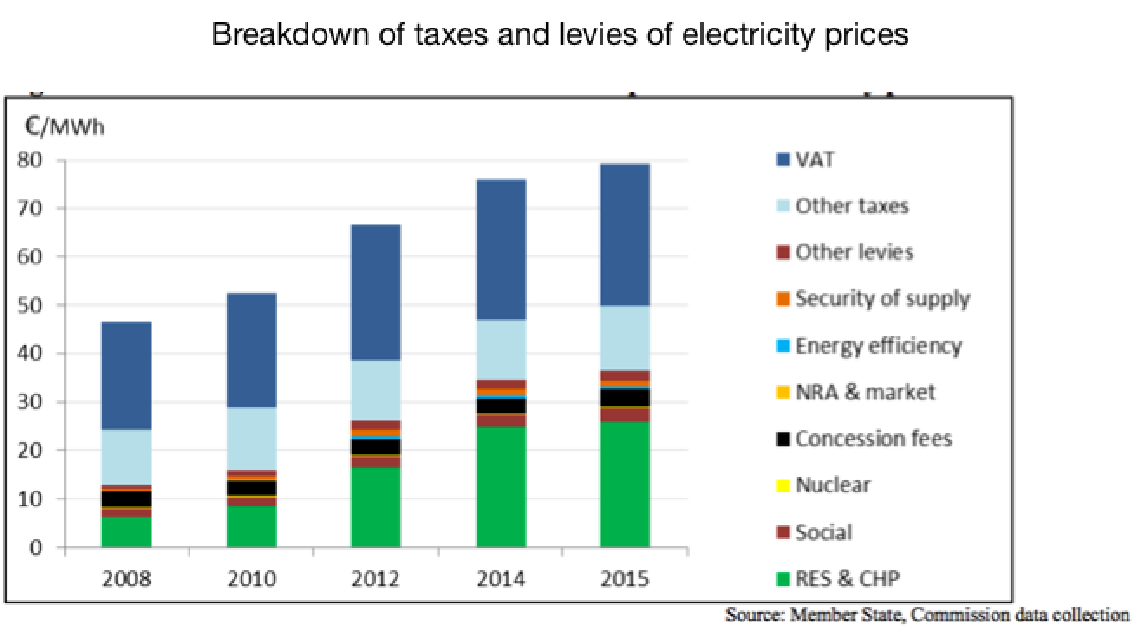


Figure 3.5:

This figure shows the electricity cost for household consumers in European Countries in 2015. Here you can see that not only the base energy price is different but that the taxes and levies relative weight varies significantly, as well as the VAT.

These taxes and levies are a reflection of a country's own resources, policies and its targets. In general, in countries that want to push RES, they may impose either taxes on fossil fuels or subsidize RES, or a combination of both. A country may also charge fossil fuels to penalize their negative externalities (like CO2 emissions).

So, when analyzing the components among the different countries , you will see the impact of such policies and choices on the energy prices.

3.4 Drivers of Energy Prices

main drivers of Energy Prices, focusing on three factors: the primary energy resource costs, the energy mix and the context (weather, geopolitical conditions, economy).

As seen in the on energy price components, the main component in cost is in general the energy extraction, conversion and commercialization.

The cost of the primary energy resources influences directly the cost of energy. In general, the specific cost of fuel per unit of energy is lower for coal than for natural gas. This is explained by the fact that coal is a resource that is more available in nature, requires simpler technology to extract and to transport. At this level, renewable resources are in general the energy resources with the lowest price (except for biomass, whose collection may present a significant cost).

The cost of primary energy resources is also affect by the existence of this particular resource in the country or not, in which case that country will have to import the fuel.

Regarding the conversion, the cost depends on the investment required to install a powerplant or a refinery, the operation and maintenance costs. Nonetheless, the final price is still largely dependent on the cost of the fuel. In the case of electricity, natural gas power plants are more efficient that coal power plants, require lower investments but still, the cost of electricity produced by natural gas power plants is at the end still more expensive than coal.

Finally, the commercialization costs may be affected by different taxes and levies also depending on the origin.

A second factor that influences the final prices of energy is the energy mix. The energy mix is the group of different primary energy sources from which a final energy vector is produced. In the case of electricity, the energy mix represents then the relative contribution of each primary energy resource (coal, gas, renewables, nuclear and others). If the contribution to the energy mix is mostly done by primary resources whose cost is expensive, it will impact negatively on the energy price. For example, countries where the electricity generation is based on coal have generally lower energy prices than countries that use more natural gas. Countries that have a significant share of renewables have in principle a higher cost, not directly because of the primary resource cost or the operation and maintenance costs, but mostly due to the taxes and levies collected to support the operation of the system.

Finally, other factors that may influence significantly the energy prices are the costs associated with the context, which include weather, geopolitical conditions and the economy.

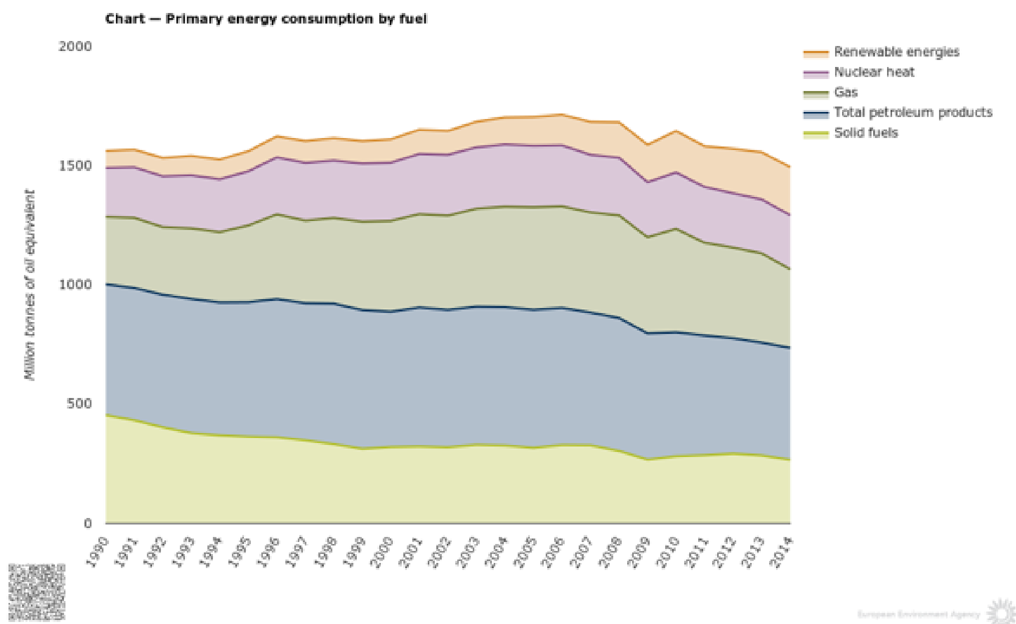
Weather is maybe the context factor that mostly affects the prices, in many different ways. In general, cold winters will require the use of much more heating fuels, like coal or gas and as the demand will increase, it will make the prices higher. Reversely, if the winter are mild, the consumption of fuels for heating will drop and the prices will tend to decrease. However, weather also affects significantly renewable resources. For example in countries that depend on hydro power plants, dry years will require the use of other technologies, like gas, so the prices will increase, while in wet years, the hydro power plants production will be significant, so the use of other technologies will be smaller and therefore the prices will go down.

Geopolitical conditions also affect the prices of resources: for examples wars usually impact negatively on the prices of primary energy resources as in general the extraction is affected.

Finally, economic conditions also affect the prices. In general, when the economy is growing, the competition for energy resources is higher, so the costs will increase. When we have economic crisis and the industrial activities decrease, there is less demand and the prices tend to go down.

So, the costs of energy depend on many different factors and that is why, in general, an energy system – a country or a building – is more robust to energy price variations if the energy mix is more diverse and flexible.

3.4.1 The EU Energy Bill



This chart gives you an idea of the relative importance of each fuel used in different activities.

In 2014, primary energy consumption in the EU-28 countries amounted to 1 507 million tonnes of oil equivalent (Mtoe), 1.6 % above the 2020 target.

Between 2005 and 2014, primary energy consumption in the EU-28 countries decreased by 12 % due to energy efficiency improvements, the increase of the share of energy from hydro, wind and solar photovoltaics, the economic recession and climate warming.

Fossil fuels (including non-renewable waste) continued to dominate primary energy consumption in the EU-28, but as a proportion of total primary energy consumption, they fell from 77.8 % in 2005 to 71.6 % in 2014.

The proportion of renewable energy sources almost doubled over the same period, from 7.1 % in 2005 to 13.4 % in 2014, increasing at an average annual rate of 5.8 % per year between 2005 and 2014. The proportion of nuclear energy in primary energy consumption was 15.0 % in 2014.

Looking to the annual growth rates for different fuels, there is a decrease of gas and an increases of RES.

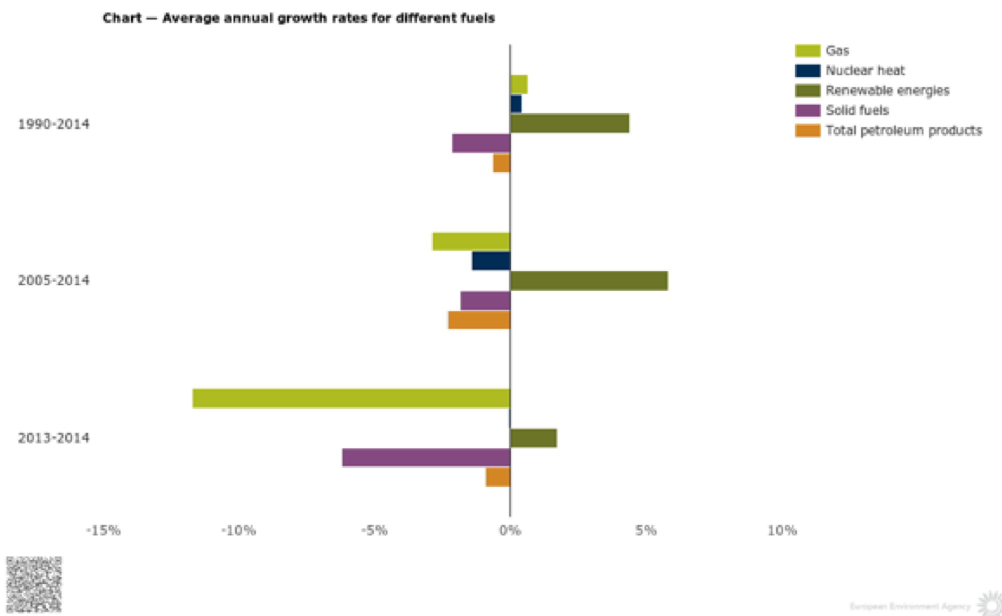


Figure 3.6:

Considering the average annual growth rates for different fuels, there is a decrease of gas and an increases of RES. Still even having the most average annual growth, percentage wise, looking to its absolute numbers it is not still a main component of the energy mix.

So when looking to percentages you should take in consideration its relative percentage too.

As you may be aware there are 3 main sectors: as transportation, industry, households.

Considering the Final energy consumption of petroleum products by sector, most part is used in transportation,

In Final energy consumption of natural gas by sector, households and industry are the two main sectors and

Electricity is mostly used by households, industry and services.

Buildings most are allocated to households and services sectors.

High import dependency means that the EU faces an important energy import bill.

In 2013, the EU's estimated import bill reached EUR 400 billion. Since then, falling energy prices allowed the import bill to fall significantly, although the weakening of the euro has partly offset this effect.

In 2015, the estimated import bill amounted to EUR 261 billion, 35% less than in 2013. In 2 years, the import bill decreased by EUR 142 billion, about 1% of EU GDP, thereby giving a significant boost to the economy.

Crude oil is by far the main component of the import bill, making up 68% of the total in 2015.

The share of gas and hard coal was 28% and 4%, respectively.

Russia is the main supplier of all three fossil fuels: crude oil, natural gas and hard coal. In 2015, 34% of the import bill went to Russia. Russia was followed by Norway (19%) and Nigeria (7%).

The import bill basically depends on the volume and the average price of imports. Like most commodities, energy sources are typically traded in US dollars and therefore the development of the USD/EUR exchange

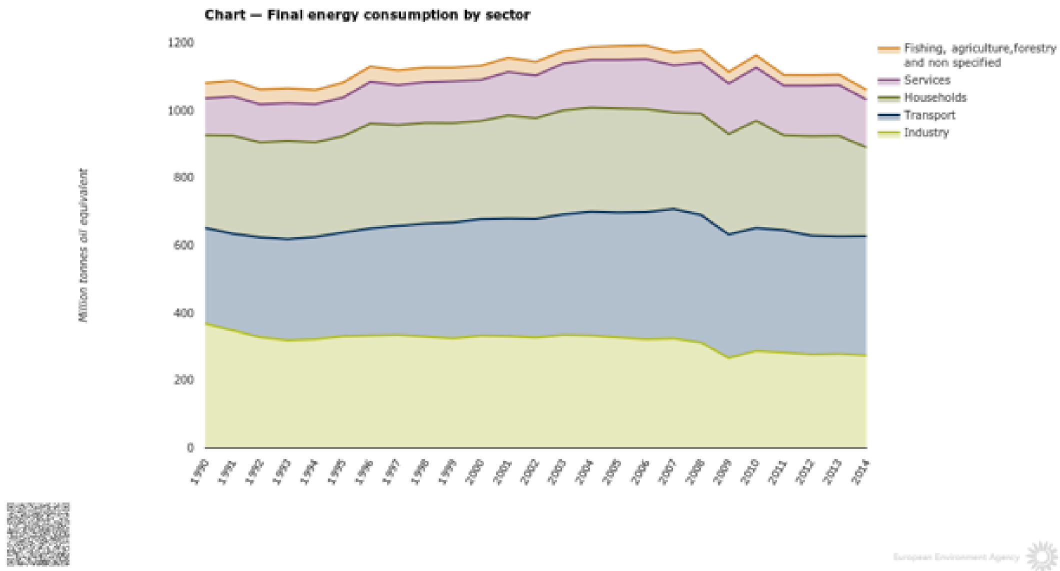


Figure 3.7:

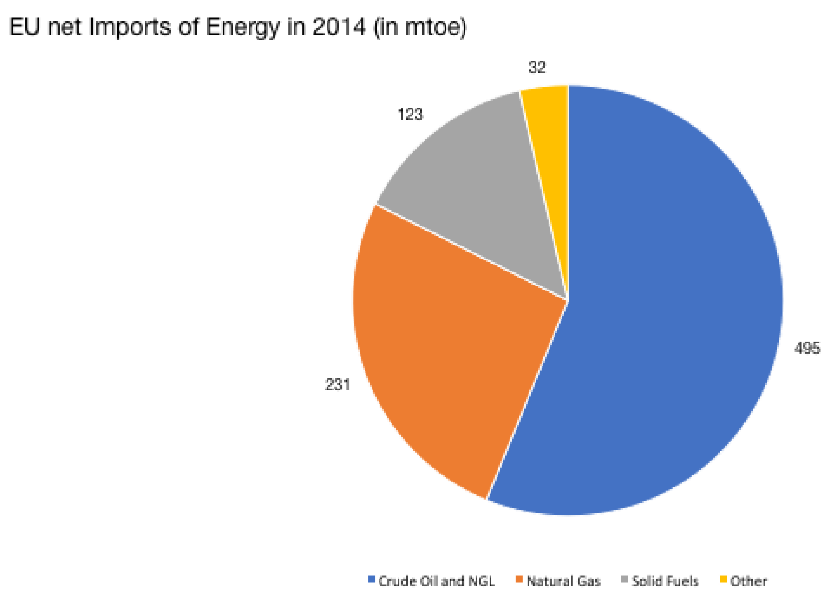


Figure 3.8:

rate will also influence the import bill (if expressed in euros). ”

3.4.2 Demand Side Management

Until now we only refereed annual demand and supply. Still there is no perfect match with supply or demand or can easily shift supply forward, to when will be a higher consumption.

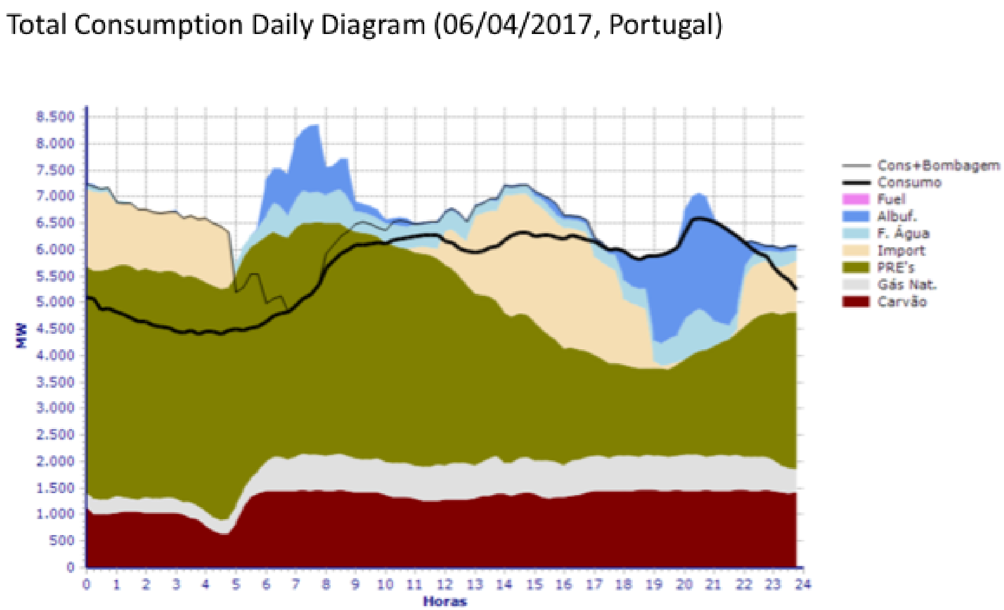


Figure 3.9:

Taking for example the total daily Consumption diagram gives you important information as:

Total Consumption; Total supply; Excess or deficient of supply at a given time and; Imports or exports due to the last.

You may notice two peaks, one in the morning and other around late evenings. If you think about you daily routines, including factories and services, it´s much a reflection of people´s activities, where during late nights you consumption decreases.

If you breakdown demand you will also notice that supply varies quite differently depending on each source, where solar has a peak around midday, wind late nights, hydro depends on weather and availed capacity, combustion plants most of the times needs a lot of hours to be in full steam and are also used as a backup system, when RES are not available.

RES has the problem of intermittency, so until can secure that supply always meet demand, grid operators have the task:

Securing supply to match demand; Trying to match and manage all available energy sources, according to timely and future needs; real-time dispatch of generation and managing security

The role of the System Operator in a wholesale market is to manage the security of the power system in real time and co-ordinate the supply of and demand for electricity, in a manner that avoids fluctuations in frequency or interruptions of supply.

Balancing demand and supply:

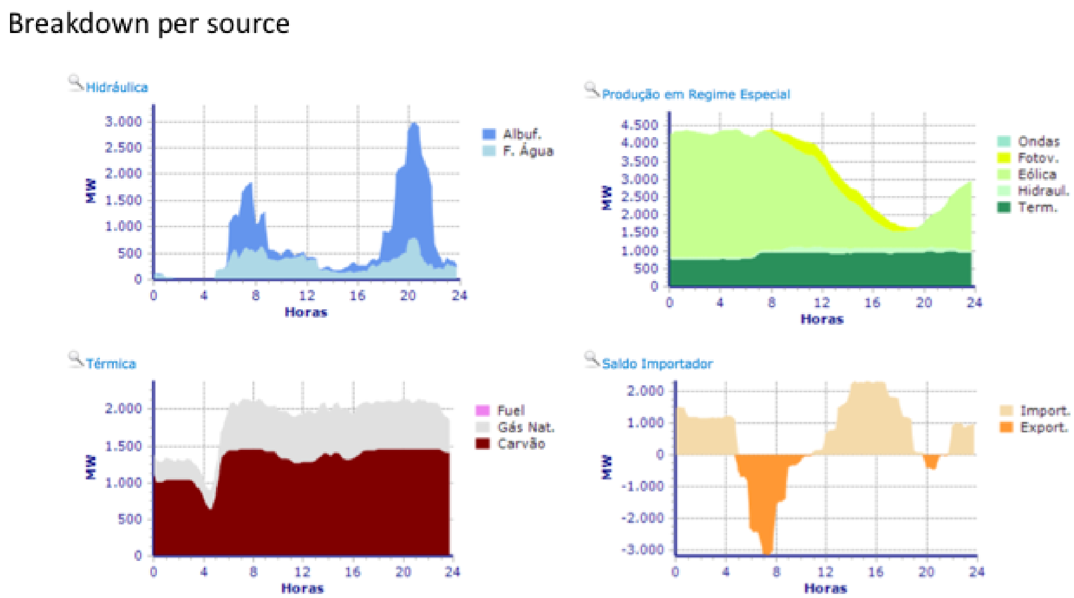


Figure 3.10:

Securing supply to match demand;

Trying to match and manage all available energy sources, according to timely and future needs;

Real-time dispatch of generation and managing security

This can be achieved by:

- Determining the optimal combination of generating stations and reserve providers for each market trading period,
- instructing generators when and how much electricity to generate, and -Managing any contingent events that cause the balance between supply and demand to be disrupted.

You have to also take into account factor behind changes in energy consumption, witch changes across countries, such as: Change in Total Consumption. Consumption habit change; Increase in household stock and appliances Energy Savings

As you may notice there is an overall increase in Increase in household stock and appliances

And Energy Savings. A change in consumers habits tend to be hard to implements or promote incentive to that change.

As one way to incentive EE, there each country defined its indicative national energy efficiency targets for 2020

Currently some country already fulfilled those targets, namely Germany and France. Other don´t.

Real time monitoring (smart meters) to:

Provide information to Shift consumption patterns to match supply

For example, one of the important pieces to promote EE measures is real time monitoring, or providing users with smart meters.

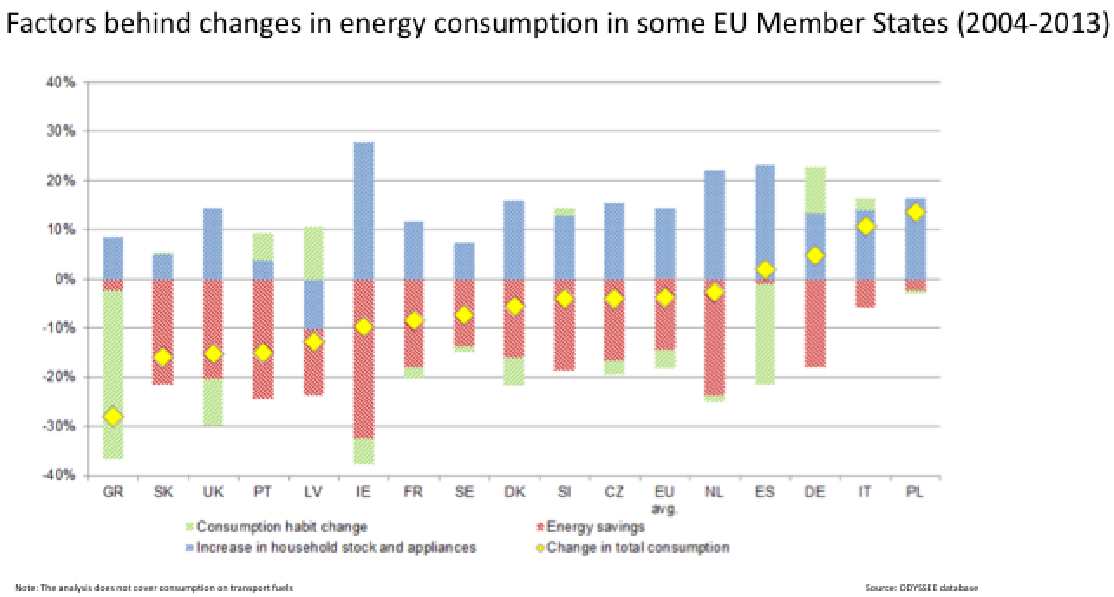


Figure 3.11:

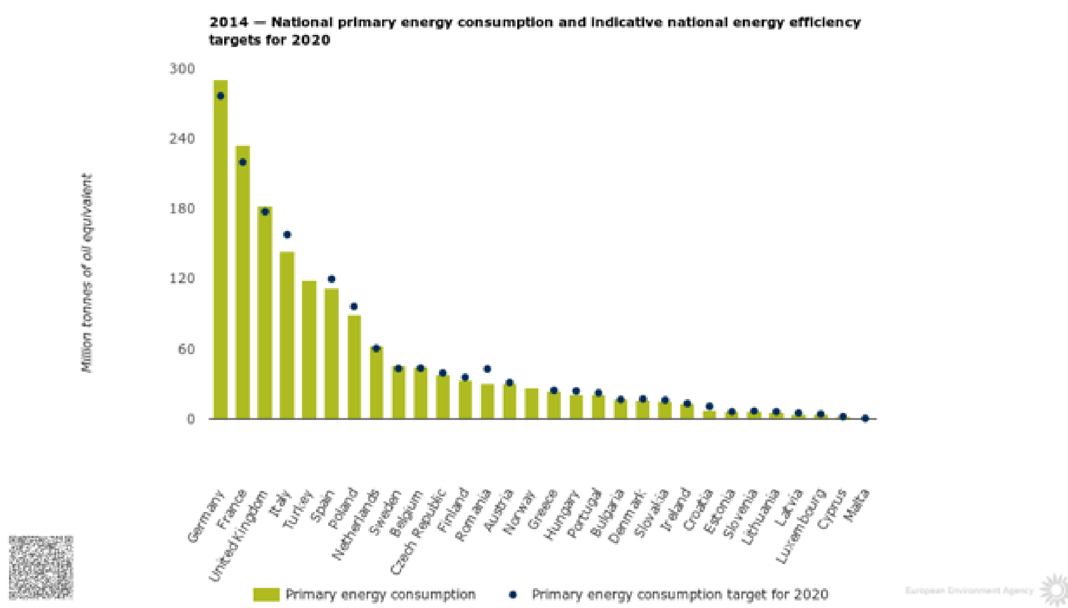


Figure 3.12:

This would enable real time monitoring to either provide information to either human or machines to adapt consumption to market (supply).

Demand Side Management, needs that information available in forms that can be used to make decisions on when and how much energy purchase. So when referring demand side management, means doing the best allocation of resources (price) to needs (quantity), considering that prices varies depending on supply and some consumption - the demand - can be deferred to moments where there is abundance of supply.

3.4.3 Dynamic Pricing and Intervention in Prices setting Mechanisms

Several methods of dynamic pricing exist, depending on two main factors:

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(i) the granularity of the period during which consumption is metered separately, and

(ii) the dynamics/statics of Time-of-Use (ToU) prices.
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The impact on consumers (who can be rewarded for adapting their energy consumption to price signals, but can also be penalised if they continue to consume at peak times) depends on the combination of these two factors, i.e. “dynamic pricing application”, for instance:

```
a) "static ToU" is a dynamic pricing application in which fixed time bands are set and the price for ea

b) "critical peak pricing" is a dynamic pricing application in which a higher price is charged in limit

c) "real-time pricing" is a dynamic pricing application in which the price is posted in real time and c
```

There are several Dynamic pricing mechanism, with several levels of granularity.

Most commonly applied methods of dynamic pricing for electricity and gas and network charges

<table>
<tr><th>Granularity of Dynamic Pricing</th><th>Supply</th><th>Network</th></tr>
<tr><td rowspan="5"></td><td colspan="2">A Time-of-Use tariff (ToU) is a price determined in advance which varies by time of the day, day of week and/or season of year. It is:
- Seasonal if it charges different price depending on the time of the day;
- day(nigh price if it charges different prices regularly expected to have a higher/lower than usual demand (e.g. weekday early morning, evenings/weekday midday)</td></tr>
<tr><td colspan="2">A critical peak price/tariff is a price which is higher during short period which represent the critical peak in consumption</td></tr>
<tr><td rowspan="2">Other method of dynamic pricing supply price/tariff, which includes spot-based pricing for consumers on the basis of monthly spot-exchange prices</td><td>A dynamic network pricing method combines and defines capacity and energy component according to different pricing arrangements</td></tr>
<tr><td>Interruptible network tariff options provide for the option to control a predefined amount of load in return for a lower network tariff</td></tr>
<tr><td colspan="2">A real-time price/tariff is a price that is posted in real time (typically at least hourly) and communicated automatically to the customer as it charges.
Hourly-time electricity/gas supply pricing can be based on hourly metering, whereby consumers pay the wholesale price at the time of consumption</td></tr>
</table>

Source: ACER(2016)

Figure 3.13:

Where time of use pricing, in blue, is quite prevalent if you consider the Share of standard household consumers supplied under dynamic pricing for supply and network charges of electricity in EU MSs – 2015 (%), percentage wise.

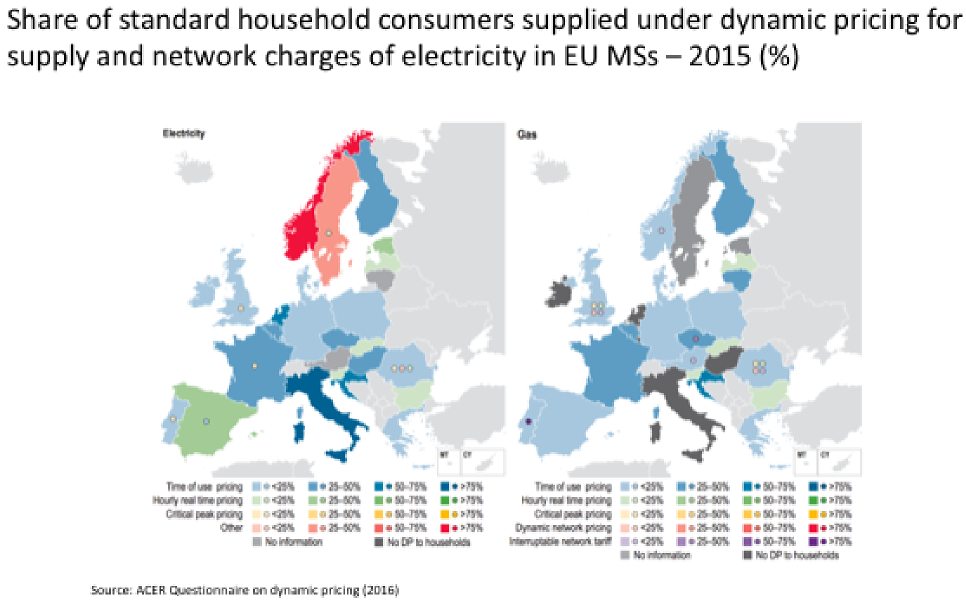
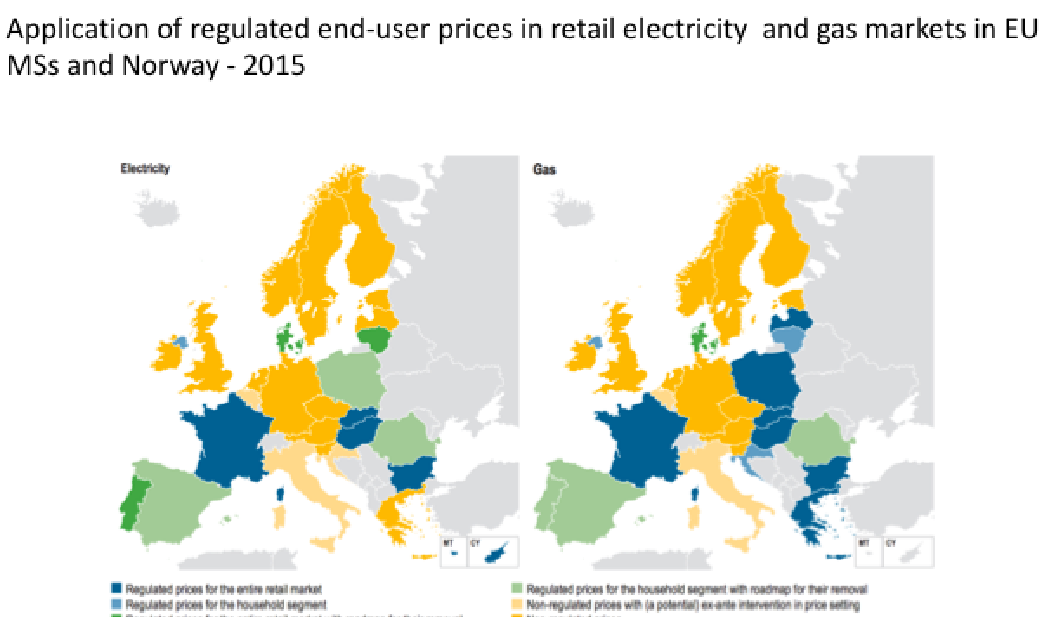


Figure 3.14:



If you look to the application of regulated end-user prices in retail electricity and gas markets in the EU and Normay, in 2015, there is still a combination of:

Regulated prices for the entire retail market Regulated prices for the household segment Regulated prices for the entire retail market with roadmap to their removal Regulated prices for the household segment with roadmap to their removal

And

Non regulated prices with (a potential) ex-ante intervention in price setting Non-regulated prices

Where, in electricity and gas markets, Non-regulated prices, Regulated prices for the household segment with roadmap to their removal and Regulated prices for the entire retail market are the most common.

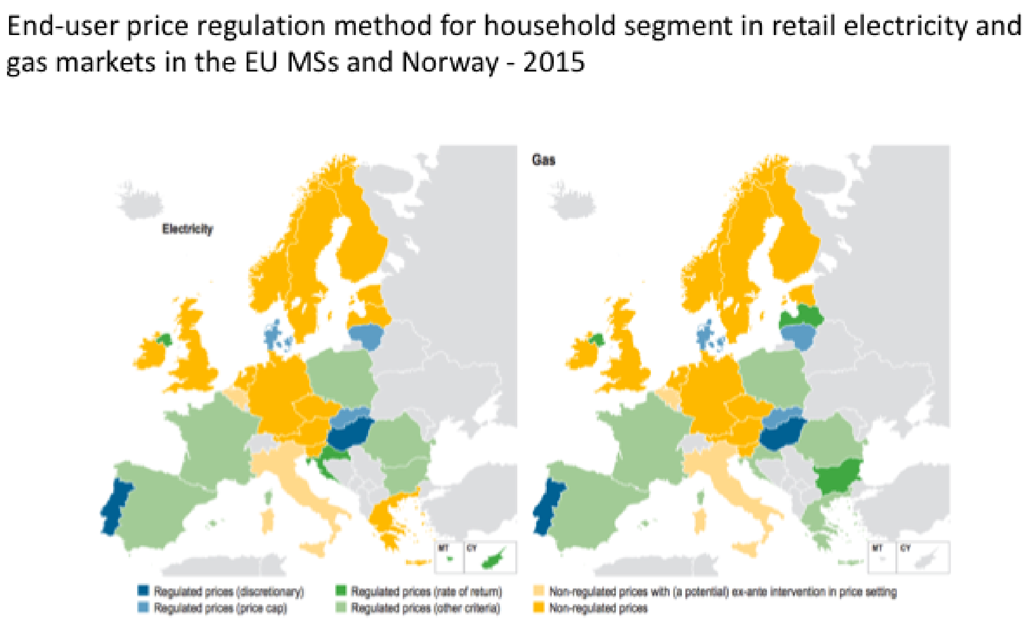


Figure 3.15:

If you remember, as refereed in a previously, infrastructure access' prices plays a central role in energy markets.

So when setting the method for End-user you can see the connection with the , infrastructure access' prices and regulation method for the household segment.

Where you see: Regulated prices (discretionary); Regulated prices (price cap, for example by setting maximum % increase, usually indexed to some economic indicator, as Consumer Index Price, Inflation) Regulated prices (rate of return, this one can also be design as the minimum rate return for the utility has to have, scheme quite common in Portugal, not only in utilities, but also for other PPP) Regulated prices (other criteria)

And

Non-regulated prices with (a potential) ex-ante intervention in price setting; Non regulated prices;

Specially in household segment there there´s special provisions to access to basic good and services, as energy is.

On Network tariffs, the Energy Efficiency Directive states Network or retail tariffs may support dynamic pricing for demand response measures by final customers, such as:

(a) time-of-use tariffs;
(b) critical peak pricing;
(c) real time pricing; and
(d) peak time rebates.

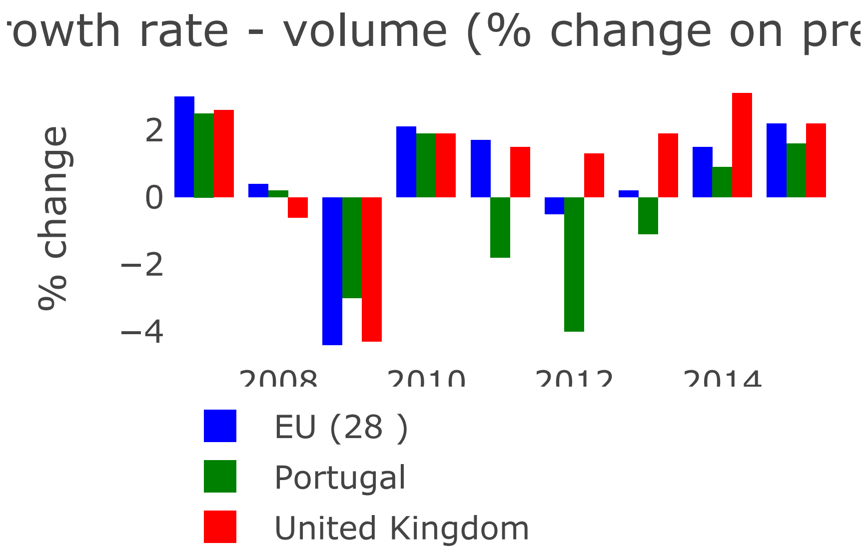


Figure 3.16: GDP

(#fig:r gdp-fig)

It also states that network tariffs shall be cost effective of cost savings in networks.

Also, network tariffs shall not prevent:

(a) the shifting of the load from peak to off-peak times by final customers;
(b) energy savings from demand response of distributed consumers by energy aggregators;
(c) demand reduction from energy efficiency measures undertaken by energy service providers, including energy service companies;
(d) the connection and dispatch of generation sources at lower voltage levels;
(e) the connection of generation sources from closer location to the consumption; and
(f) the storage of energy.

Chart 1 - Real GDP growth rate

Chapter 4

Project Management

4.1 Basic Concepts

4.1.1 Economic and financial dimensions

Projects evaluation can be described as a methodology for assessing the economic and financial (and social and environmental) impact of a proposed investment.

Project evaluation should focus on two dimensions:

- An **Economic analysis**, which is a systematic approach to determine the optimum use of resources (capital, human resources) and it involves the comparison of two or more alternatives to achieve a specific objective under certain assumptions and constraints. In particular, it attempts to measure in monetary terms the costs and benefits of the project to the organization or the community or economy.
- A **Financial analysis**, which aims to determine the financial resources to develop the project, like choosing the funding sources (equity or debt).

When we refer to the economic analysis of a project, we are most of the times referring to the idea of the Opportunity Cost of a given decision.

4.1.2 Opportunity cost

The opportunity cost is the benefit or value that you give up by choosing one option over another. In other words, the opportunity cost of a decision is the difference between the value you receive from pursuing a certain option and the value that you would have received from the alternative that you chose not to pursue.

We can express opportunity cost in terms of a return (or profit) on investment by using the following mathematical formula:

$$OpportunityCost = ReturnonMostProfitableInvestmentChoice - ReturnonInvestmentChosentoPursue$$

Unless the investment returns are fixed and guaranteed to be paid (like a Treasury bond you intend to hold to maturity), you'll have to base your calculation on the expected returns.

Example: imagine you want to buy an efficient equipment.

You have two potential options:

- Change lighting system to LED (20% return on investment)or
- installing a PV system (10% return on investment).

The opportunity cost is the difference between the benefits you would get from the one option (e.g. Change lighting system to LED) over another (installing a PV system).

What is the opportunity cost?

If you decide to leave install a new PV system, the opportunity cost is:

20% (changing the lighting system) - 10% (installing the pv system, option that is being pursuit) = 10%

This is your trade off for choosing one option instead of another.

4.1.3 Time value of money

When dealing with financial investments one of the basic underlying issues emerges from answering the question:

> Do you prefer to have 100€ today or invest 100€ for a future income?

The idea of time is quite fundamental in finance, because in general, the money available at the present time is worth more than the same amount in the future, due to its potential earning capacity.

Time value of money can reflect that a certain amount of money today has a different buying power (value) than the same currency amount of money in the future, but is not an equivalent.

If you consider as geometric series, the first term would be the present value, the common ratio would be (1+i) and n, number of periods.

So we start by this basic formula:

$$Future\ Value = PresentValue \cdot (1+i)^n$$

Or the present Value of a certain amount of money C (at n year) is given by:

$$Present\ Value = \frac{C}{(1+i)^n}$$

Cash Flow C - Net amount of money that goes in or out of a project

If we want to estimate how much is the Present value of a certain future cash flows C that will be collected in the future "n" year,
where n is the number of compounding periods between the present date and the date where the sum is worth C i is the interest rate for one compounding period (the end of a compounding period is when interest is applied, for example, annually, semiannually, quarterly, monthly, daily).

(The interest rate i is given as a percentage, but expressed as a decimal in this formula. If using periods with less than one year, for example 6 month would be power of ½ or 6/12)

Compounding is the process where the value of an investment increases because the earnings on an investment, both capital gains and interest, earn interest as time passes. This exponential growth occurs because the total growth of an investment along with its principal earn money in the next period. This differs from linear growth, where only the principal earns interest each period.

If you consider as geometric series, the first term would be the present value, the common ratio would be (1+i) and n, number of periods

Figure 1 - Geometric growth

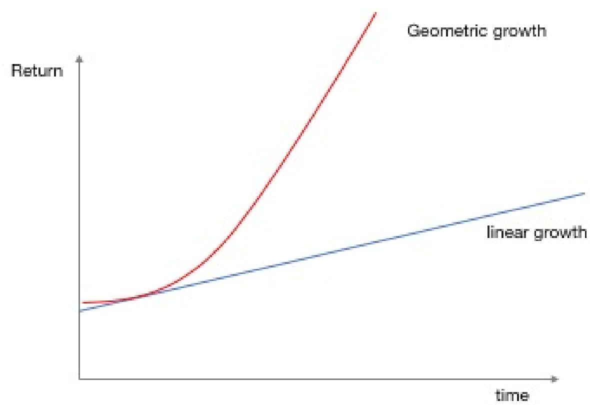


Figure 4.1:

If you notice, more than the interest rate, times plays a central role, or what so called the power compound interest, so you are dealing with geometric growth, not linear and the reasoning can be linked to the idea of trade-offs. You will defer consumption today, to have a certain return in n years, but because you just will have that return in n years it is like if you were reinvesting every year.

Example:

year 0, you have 100€, year 1, you would have 100+1.10 (10% rate), year 2, you start with 110 (and not 100 €) so you will have 121 (110*1.1) and so on.

Another way to put is:

What is would you choose? 1) 100€ today or; 2) 103€ in 1 year

If you consider a 4% interest rate

We would level both options with the previous formula

So option 1 would be equivalent to: $100 \times (1.04)^1$ or 104€

or doing for present value $C_0 = 103/104 = 99$

So 100€ are equal to 104€ in 1 year and 103€ in 1 year time is equivalent to 99€ today.

The time value of money is the assumption that money can generate value if it is invested (for example interests in a bank), so it is better to receive the money now than later.

At the end, the same amount of money today has a different and higher buying power (value) than the same amount of money in the future, it is not an equivalent.

The rate at which the money is appreciate or depreciate is called the discount rate. This discount rate may represent different factors but is often considered to be the interest rate given by the treasury bounds of central banks at 10 years, usually are used as benchmark (risk free) to computed riskier investments. It is often represented by the letter “i” of interest.

Example 2

1010=1000x(1+0.01), with n=1

Imagine that you have 1000€ and you put in the bank with a 1% interest rate. In one year, the 1000 euros you have today will be worth 1010€.

In 2 years it will be worth 1020.1€.

Cash Flow C - Net amount of money that goes in or out of a project If we want to estimate how much is the Present value of a certain future cash flows C that will be collected in the future "n" year, we can invert the future value formula and obtain the present value formula:

Time of value example

990.01=1000/(1+0.01), with n=1 Imagine that you have the opportunity to collect 1000€ in one year.

That is equivalent to receiving today only 990.01 € (because if you put in the bank today 990.01 €), you will have 1000 euros next year.

4.1.4 Money

Money can also be defined as:

- It's a store of value, meaning that money allows you to defer consumption until a later date.
- It's a unit of account, meaning that it allows you to assign a value to different goods without having to compare them. So instead of saying that a car is worth ten cows, you can just say it (or the cows) cost 10 000 €.
- And it's a medium of exchange—an easy and efficient way for you and me and others to trade goods and services with one another.

The idea that a euro today is worth more than a euro tomorrow, relates more to the second and last roles, storage and medium of exchange, because the value of money at a future point of time would take account of interest earned and the inflation accrued over a given period of time.

Inflation is the rate at which the general level of prices for goods and services is rising and, consequently, the purchasing power of currency is falling. Central banks attempt to limit inflation, and avoid deflation, in order to keep the economy running smoothly, namely by setting interest rates.

4.2 Indicators

Basic indicators that should be computed to evaluate a project and aid in the decision of developing it or not: net present value, internal rate of return and payback period.

4.2.1 Net Present Value (NPV)

The first indicator to evaluate a project, is the Net Present Value (NPV), which basically estimates the value that will be gained at present costs by developing the project. This estimate consists in adding all future net earnings (the cashflows) minus the initial investment that is required to execute the project.

$$NPV_{i,N} \sum_{n=0}^{N} \frac{C_n}{(1+i)^n} - Investment$$

Net present value (NPV) of a project is the potential change in an investor's wealth caused by that project while time value of money is being accounted for. It equals the present value of net cash inflows generated by a project less the initial investment on the project. It is one of the most reliable measures used in capital budgeting because it accounts for time value of money by using discounted cash flows in the calculation.

Net present value calculations take the following two inputs: Projected net cash flows in successive periods from the project. A target rate of return i.e. the discount rate.

Where,

Net cash flow equals total cash inflow during a period, including salvage value if any, less cash outflows from the project during the period.

Hurdle rate is the rate used to discount the net cash inflows. Weighted average cost of capital (WACC)is the most commonly used discount rate.

NPV > 0	the investment would add value	the project may be accepted
NPV < 0	the investment would subtract value	the project should be rejected
NPV = 0	the investment would neither gain	We should be indifferent in the decision whether to accept or reject the project. This project adds no monetary value. Decision should be based on other criteria, e.g., strategic positioning or other factors not explicitly included in the calculation.

Figure 4.2:

NPV (even and uneven)

Calculation Methods and Formulas

The first step involved in the calculation of NPV is the estimation of net cash flows from the project over its life. The second step is to discount those cash flows at the hurdle rate.

NPV (even and uneven)

The net cash flows may be even (i.e. equal cash flows in different periods) or uneven (i.e. different cash flows in different periods).

When they are even, present value can be easily calculated by using the formula for present value of annuity. However, if they are uneven, we need to calculate the present value of each individual net cash inflow separately. Once we have the total present value of all project cash flows, we subtract the initial investment on the project from the total present value of inflows to arrive at net present value.

Thus we have the following two formulas for the calculation of NPV:

When cash inflows are even: NPV = R × 1 − (1 + i)-n − Initial Investment

In the above formula, R is the net cash inflow expected to be received in each period; i is the required rate of return per period; n are the number of periods during which the project is expected to operate and generate cash inflows.

When cash inflows are uneven: NPV =

R1 + R2 + R3 + …

− Initial Investment

(1 + i)1

(1 + i)2

(1 + i)3

Where, i is the target rate of return per period; R1 is the net cash inflow during the first period; R2 is the net cash inflow during the second period; R3 is the net cash inflow during the third period, and so on …

Decision Rule In case of standalone projects, accept a project only if its NPV is positive, reject it if its NPV is negative and stay indifferent between accepting or rejecting if NPV is zero. In case of mutually exclusive projects (i.e. competing projects), accept the project with higher NPV.

Examples Example 1: Even Cash Inflows: Calculate the net present value of a project which requires an initial investment of \$243,000 and it is expected to generate a cash inflow of \$50,000 each month for 12 months. Assume that the salvage value of the project is zero. The target rate of return is 12% per annum. Solution We have, Initial Investment = \$243,000 Net Cash Inflow per Period = \$50,000 Number of Periods = 12 Discount Rate per Period = 12% ÷ 12 = 1% Net Present Value = \$50,000 × (1 − (1 + 1%)^-12) ÷ 1% − \$243,000 = \$50,000 × (1 − 1.01^-12) ÷ 0.01 − \$243,000 \$50,000 × (1 − 0.887449) ÷ 0.01 − \$243,000 \$50,000 × 0.112551 ÷ 0.01 − \$243,000 \$50,000 × 11.2551 − \$243,000 \$562,754 − \$243,000 \$319,754

Example 2: Uneven Cash Inflows: An initial investment of \$8,320 thousand on plant and machinery is expected to generate cash inflows of \$3,411 thousand, \$4,070 thousand, \$5,824 thousand and \$2,065 thousand at the end of first, second, third and fourth year respectively. At the end of the fourth year, the machinery will be sold for \$900 thousand. Calculate the net present value of the investment if the discount rate is 18%. Round your answer to nearest thousand dollars. Solution PV Factors: Year 1 = 1 ÷ (1 + 18%)^1 0.8475 Year 2 = 1 ÷ (1 + 18%)^2 0.7182 Year 3 = 1 ÷ (1 + 18%)^3 0.6086 Year 4 = 1 ÷ (1 + 18%)^4 0.5158 The rest of the calculation is summarized below: Year 1 2 3 4 Net Cash Inflow \$3,411 \$4,070 \$5,824 \$2,065 Salvage Value

900 Total Cash Inflow \$3,411 \$4,070 \$5,824 \$2,965 × Present Value Factor 0.8475 0.7182 0.6086 0.5158 Present Value of Cash Flows \$2,890.68 \$2,923.01 \$3,544.67 \$1,529.31 Total PV of Cash Inflows \$10,888

− Initial Investment − 8,320

Net Present Value \$2,568 thousand

Strengths and Weaknesses of NPV

Strengths Net present value accounts for time value of money which makes it a sounder approach than other investment appraisal techniques which do not discount future cash flows such payback period and accounting rate of return. Net present value is even better than some other discounted cash flows techniques such as IRR. In situations where IRR and NPV give conflicting decisions, NPV decision should be preferred.

Weaknesses NPV is after all an estimation. It is sensitive to changes in estimates for future cash flows, salvage value and the cost of capital. Net present value does not take into account the size of the project. For example, say Project A requires initial investment of \$4 million to generate NPV of \$1 million while a competing Project B requires \$2 million investment to generate an NPV of \$0.8 million. If we base our decision on NPV alone, we will prefer Project A because it has higher NPV, but Project B has generated more shareholders' wealth per dollar of initial investment (\$0.8 million/\$2 million vs \$1 million/\$4 million).

4.2.2 Internal Rate of Return (IRR)

The Internal Rate of Return (IRR), corresponds to finding out what is the rate of return of the project that makes the NPV equal to 0.

$$IRR = \sum_{n=0}^{N} \frac{C_n}{(1+i)^n} = 0$$

Imagine you want to develop this project, but one of two things may happen:

1) you need to go to a bank, ask for a loan and will have to pay an interest rate of 5%;
2) you need to take the money from the bank and will loose a 5% interest rate.

If the IRR is higher than this (5%), it means you should develop the project, as the value that you will get from the project is higher that what you need to invest.

4.2.3 Payback Period

Lastly, sometimes you want to know how much is the period of time required for the return on an investment to "repay" the sum of the original investment.

So the simple formula to answer that question is given as:

$$Payback\,Period = \frac{Amount\,Invested}{Estimated\,Net\,Cash\,Flow}$$

The payback can be calculated in a simplified way – where the time value of money is not taken into account - or in a discounted way, where the net cash flows are calculated using the present cost (discounted payback period).

Project evaluation should never be only based on the analysis of one single indicator. Only the combined analysis of all indicators, will provide enough information to take a well informed decision.

4.3 Cash Flows

4.3.1 Nature

As we mention, the cashflow is the net balance between positive and negative money flows in the project. When we are dealing with project evaluation we can split the money flows between costs and revenues, by nature in the following categories:

Investment, Operating Financing

The investment costs are related to how much is it necessary to spend to generate future revenues. In the energy field, this is the investment necessary to increase energy savings (e.g. changing the lighting system or install a new monitoring system) or eventually to get some revenue (e.g. Installing a PV system that can back sell to the grid the excess)

The cash flow is the net balance of all the revenues and costs, regardless of their nature (financing, operating or investment)

In a project evaluation it should be always positive, as it means that the revenues are larger than the expenses.

4.3.2 Fix costs and variable costs

You also can spilt by:

Fix costs and variable costs.

A variable cost and fixed cost are the two main costs a company has when producing goods and services. A company's total cost is composed of its total fixed costs and its total variable costs. Variable costs vary with the amount produced. Fixed costs remain the same, no matter how much output a company produces.

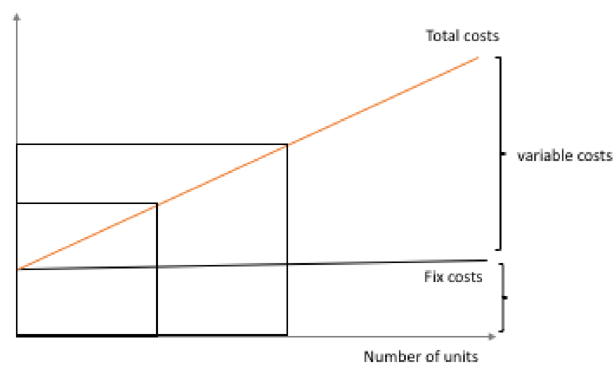


Figure 4.3:

A variable cost is a company's cost that is associated with the amount of goods or services it produces. A company's variable cost increases and decreases with the production volume. For example, suppose company ABC produces ceramic mugs for a cost of $2 a mug. If the company produces 500 units, its variable cost will be $1,000. However, if the company does not produce any units, it will not have any variable cost for producing the mugs.

On the other hand, a fixed cost does not vary with the volume of production.

A fixed cost does not change with the amount of goods or services a company produces. It remains the same even if no goods or services are produced. Using the same example above, suppose company ABC has a fixed cost of 10,000 per month for the machine it uses to produce mugs. If the company does not produce any mugs for the month, it would still have to pay 10,000 for the cost of renting the machine. On the other hand, if it produces 1 million mugs, its fixed cost remains the same. The variable costs change from zero to $2 million in this example.

value of money that has been used up to produce something, and hence is not available for use anymore Investment costs – value used to buy an asset required to the project Operation costs – value used to operate the asset required to the project Fixed costs – value of money spent because there is a project going on

4.3.3 Break even analysis

We can relate Total Costs and its Fix and Variable Costs to answer a simple question:

How many units do I have to sale to pay for the Fix Costs? Or to Break even?

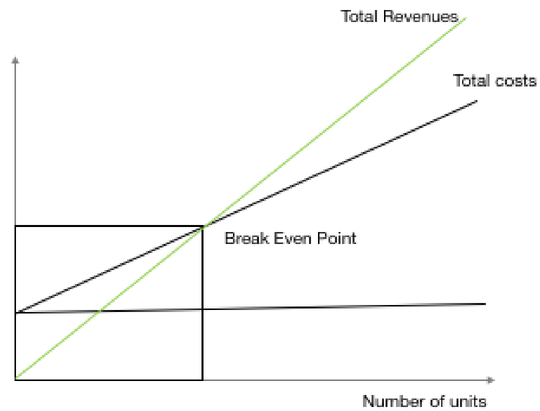


Figure 4.4:

$$Fixed\ Costs \sphericalangle (Price - VariableCosts) = Breakeven\ Point\ in\ Units$$

Where you divide the Fix Costs by the difference between Price and Variable Costs, that can also the the Cost of goods Sold,

The result is the Breakeven Point in Units, meaning how many units you have to sell to pay for the fix Costs.

If you look to the graph, you can see the BEP, or the equilibrium point of the Total revenues curve and Total Cost Curve, where any value on the left, mean that you be in loss region, and on the right profitable region.

4.3.4 Cash Flows in EE

In energy efficiency, the cash flows have a special nature as they in general they do not represent a real money inflow to the company, but rather a smaller expense or outflow. When we implement an energy efficiency measure, we do not receive money for it (except in few cases, like selling electricity to the grid), but we spend less money in energy.

Most will assume that savings, namely in EE projects are equal to future earnings (or a future stream of cash flows), but you should be aware that is not, namely:

Savings means fewer costs, not more revenues;

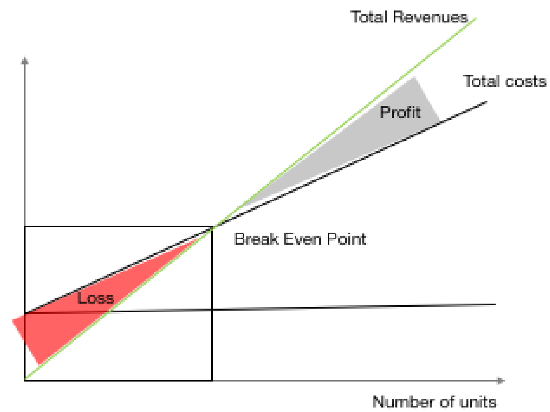


Figure 4.5:

Means that unless you take those savings and invest in a similar project with a similar stream of cash flows, you can´t compound negative value (or for simplicity, assume that you can only compound values greater than 0).

You will have to make payments in the future, namely if under a EPC Contract, so when looking to an EE investment you better consider as an investment, where you may have to pay something upfront the rest delayed in future payment and in the future (after payment the investment) you will have to use fewer funds for energy.

So you can consider as net flows of inflows and outflows of money, where EE measure will impact the outflows, still, if the outflows are 0 (you don't spend any in energy, means that you will have 0 savings because there's no efficiency to apply to outflows.

4.3.5 Financial Statements

The Relationship Between the Financial Statements

The income statement, balance sheet and cash flow statement are all interrelated.

The income statement describes how the assets and liabilities were used in the stated accounting period.

The cash flow statement explains cash inflows and outflows, and it will ultimately reveal the amount of cash the company has on hand, which is also reported in the balance sheet. By themselves, each financial statement only provides a portion of the story of a company's financial condition; together, they provide a more complete picture.

In the context of corporate financial reporting, the income statement summarizes a company's revenues (sales) and expenses, quarterly and annually for its fiscal year. The final net figure, as well as various other numbers in the statement, are of major interest to the investment community.

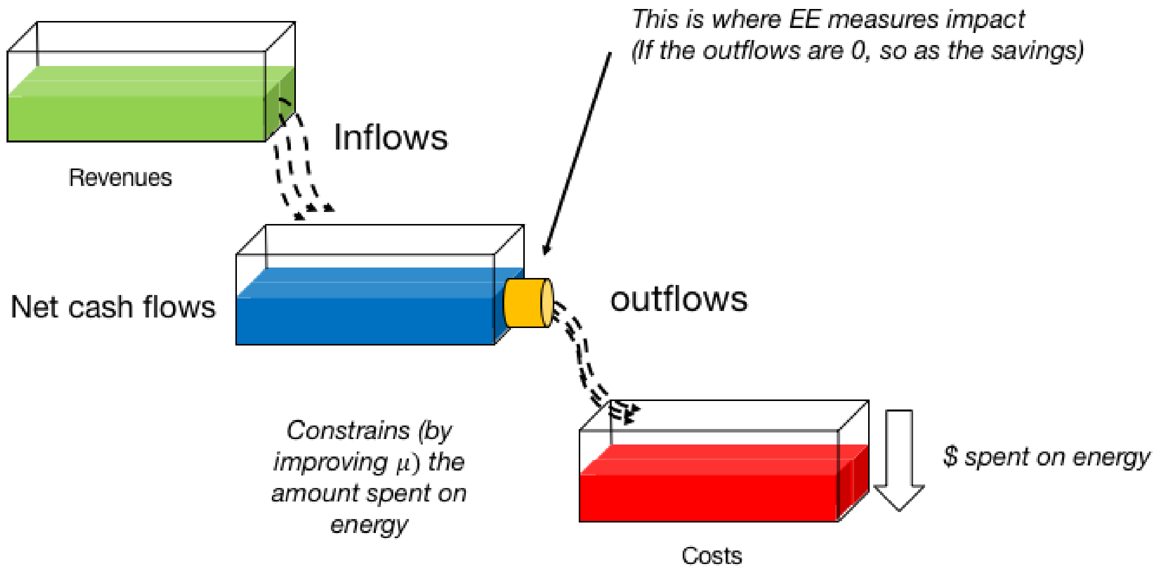


Figure 4.6:

Multi-Step Format Single-Step Format Net Sales Net Sales Cost of Sales Materials and Production Gross Income* Marketing and Administrative Selling, General and Administrative Expenses (SG&A) Research and Development Expenses (R&D) Operating Income* Other Income & Expenses Other Income & Expenses Pretax Income Pretax Income* Taxes Taxes Net Income Net Income (after tax)* –

4.3.6 Investments

A capital expenditure, or CAPEX, is considered an investment into the business. The money spent is not immediately reported on the income statement; rather, it is treated as an asset on the balance sheet. A CAPEX is deducted over the course of several years as a depreciation expense, beginning with the year following the purchase. The depreciation expense is reported on the income statement in the tax years it is deducted, resulting in reduced profit.

For example, say you own a flower shop and in 2012, you purchase a delivery van for $30,000. The van is recorded as an asset on 2012's balance sheet, leaving the income statement for 2012 unaffected by the purchase. You expect to use the van for six years, so it is depreciated by $5,000 each year. So, on 2013's income statement, a $5,000 expense is then reported. While a CAPEX does not directly affect income statements in the year of purchase, for each subsequent year for the expected useful life of the asset the depreciation expense affects the income statement. A CAPEX may indirectly have an immediate effect on income statements depending on the type of asset that is acquired. Using the previous example, the van purchased for the flower shop is not recorded on the income statement for 2012, but gas and insurance expenses for the van are considered business expenses that affect the income statement. However, the expenses incurred by the van may be offset by the increase in revenue produced by the delivery van.

The term cash and cash equivalents includes: currency, coins, checks received but not yet deposited, checking accounts, petty cash, savings accounts, money market accounts, and short-term, highly liquid investments with a maturity of three months or less at the time of purchase such as U.S. treasury bills and ...

A cash position represents the amount of cash that a company, investment fund or bank has on its books at a specific point in time. The cash position is a sign of financial strength and liquidity. In addition to cash itself, this position often takes into consideration highly liquid assets, such as certificates of deposit, short-term government debt and other cash equivalents.

4.3.7 Loan

Principal + interest

4.3.8 Capital Structure

The way you decide to finance the project (Capital Structure) plays a central role in Financial Analysis.

EV

BOX

You can use an opportunity cost analysis to help you decide how to best capitalize a project. A project' capital structure is simply how a company finances its operations. Capital structure may involve a mix of debt (long-term or short-term) and equity, and Equity, which is the infusion of capital into a business using the company's resources, such as savings or through the sale of shares.

If you finance your investment through DEBT, you have to pay it back even if you aren't making any money. Moreover, money allocated to servicing debt can't be spent on investing in the business or pursuing other investment opportunities. However, debt is considered to be a cost to a company, so can be deducted.

Using equity means that the financing costs may be lower, but it may compromise liquidity in this or other projects.

Additionally, remember that depending on the Energy Efficiency projects and the regulation of the country, some investments may have a positive fiscal Impact (e.g. tax abatement) or may give access to special credit. So at the end, the project evaluation should consider the advantages of different capital structures.

4.3.9 Capital Structure Decisions

You can use an opportunity cost analysis to help you decide how to best capitalize a project. A project' capital structure is simply how a company finances its operations. Capital structure may involve a mix of long-term debt, short-term debt, and equity. Equity is the infusion of capital into a business through the sale of shares of common stock or preferred stock to investors.You can also use own company's resources, as savings. What does opportunity cost have to do with a business's capital structure? If you finance your capital through debt, you have to pay it back even if you aren't making any money. Moreover, money allocated to servicing debt can't be spent on investing in the business or pursuing other investment opportunities,

4.3.10 Fiscal Impact

Depending on how structure is an EE investment can have: -Fiscal Impact by using: - Debt(debt is considered a cost of a company, so can be deducted); - Investment(also is possible to deduct, still depends one fiscal regulation

Also you increase Risk of bankruptcy if you have a higher debt level.

The cost of capital is not equal, meaning that you can use an weight the use of equity and debt.

For example the same 1000€ investment, if you funded 50% with debt, with 10%interest rate, meaning 50€, you can deduct these costs, so you would pay less corporate tax, if your EBITDA (earning before interest, tax, depreciation and amortization) due to this characteristic.

Table

Observe this example to understand that the cost of capital is not equal, meaning that you can use a balance of equity and debt. For example the same 1000€ investment, the company may choose option A or option B. Option A considers that 50% of the investment is funded with debt, with 10%interest rate, while option B considers that the project is financed 100% by Equity (or own resources). In option A, it will be possible to deduct 50€ per year, but in option B this will not be possible, because only interest is considered as cost of Company. As a result, in option A the company will pay less tax (in this case 25% of EBITDA -earning before interest, tax, depreciation and amortization). So, with option A, the company will have a higher Net Income (in this case of 12,5€ euros, compared to option B) due to the fiscal impact of debt

4.4 Project

Now look at this example of a project of installing a PV power plant in our facility.

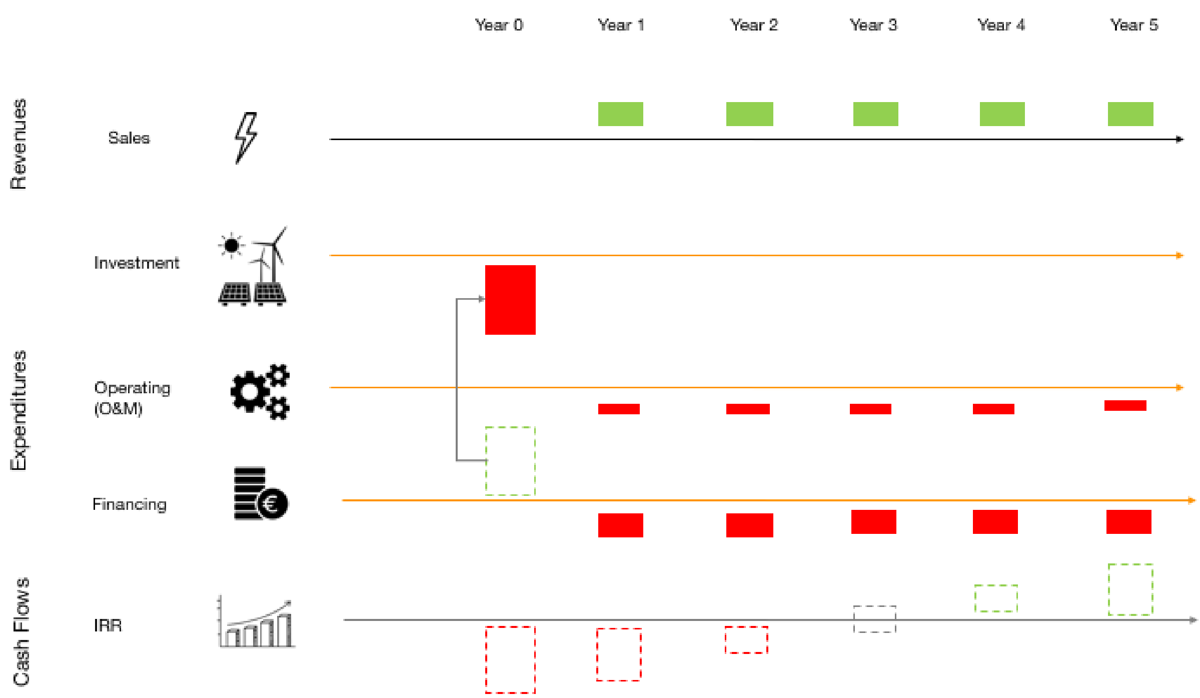


Figure 4.7:

The investment in the power plant has an initial investment that will be done in year 0 (the present). We will be able to sell some electricity back to the grid and for that we will have some positive cash flow from sales, but there will be some operation and maintenance costs. We also need to ask for a loan to develop the project, so we will have some financing expenses throughout the years.

At the end, the balance between the investment, and the sales from power plant minus the expenses in operating and financing will generate sufficient cash flows not only to payback the investment in 3 years, but also to generate additional earnings. Now, of course this depends on the considered interest rate.

One important aspect in project evaluation is to look to the evolution of cash flows and not only to the final end result (NPV, IRR or Payback Period).

4.4.1 Liquidity trap

The pitfall of just looking to NPV and not to cash flows or to answer the simple question: will I have enough funds to pay all committed obligations and?

Do I have working capital to secure is any future earning is delayed lead companies to stressful situations. Using again the same representation of Cash Flows and now imagine this planned cash flows. All seem ok, there is enough money to pay O&M, financing activities and in year 5 IRR will be positive, meaning that you already repaid all financial investment

Imagine you have a malfunction that had two consequences: a)Needed to spend more money in O&M and b) you were sole able to generate electricity, so you will have no sales in this year. c)How are going to pay for the financing activities?

This is the liquidity trap, when you may have a great balance sheet will future revenues streams, but if you have few liquid resources for the short run you may end in what is so called "Financial Slack" As a side effect, even if you are able to borrow money, you IRR will also be worse than forecasted and you will need to more time to have the expected return on investment (that at this point you understand that also carries a cost)

One of the most common traps is the liquidity trap than be framed as follows:

What is worse? Owing 100€ tomorrow or 1 € today?

Imagine company A that has 0€ today but will receive 100€ tomorrow. The problem is if has to make payments today so, technically could A)ask for a loan(which carries costs)

B)may be not able to secure such loan and technically would be bankrupt.

The pitfall of just looking to npv and not to cash flows or to answer the simple question:will I have enough funds to pay all committed obligations and? Do I have working capital to secure is any future earning is delayed lead companies to stressful situations.This is the liquidity trap, when you may have a great balance sheet will future revenues streams,but if you have few liquid resources for the short run you may end in what is so called "Financial Slack"

This is called the liquidity trap, when your balance sheet with future revenues streams looks good, but if you have few liquid resources for the short run you may end by failing your duties. In this case, for example, if you need to borrow additional money, you NPV will also be worse than forecasted and you will need to more time to have the expected return on investment. If you ha

You already understand cash flows still there are some details you should consider: A Cash Flow is a stream of income (money) into or out of a business, project, or financial product measured during a specified, limited period of time. It corresponds to a stream of income, where can change if you increase sales, or price or increase or decrease costs, as savings.

So when looking do a cash flow statement,

We can see:

Revenues of Sales, or how much money in coming in,

Investment, meaning money spent on investments activities)

Operations, usually referred as Operations & Maintenance (O&M) and Financing.

In green are all inflows of money, in red the outflows, so, breaking down per year, a typical investment, demands high capital investment in year 0 and if you don´t have, you may ask for a loan. So in year 0 you have a loan that goes to investment activities. In year 1 you will have inflows of money from sales, but you also have to pay for O&M and financing activities.

Lastly, if you notice, your IRR will go from a negative one to a positive one. As you may notice, if don´t have enough inflows of cash to pay for O&M or Financing, you would end in a “negative” net cash flow position, meaning that you are not generating enough income to pay for your activities.

Coming back to the example of the PV System project, imagine that in Year 3, there is a stop in the production. This has two consequences: the money for Operation and Maintenance will increase, there will be no sales, so we how are we going to pay for the financing activities?

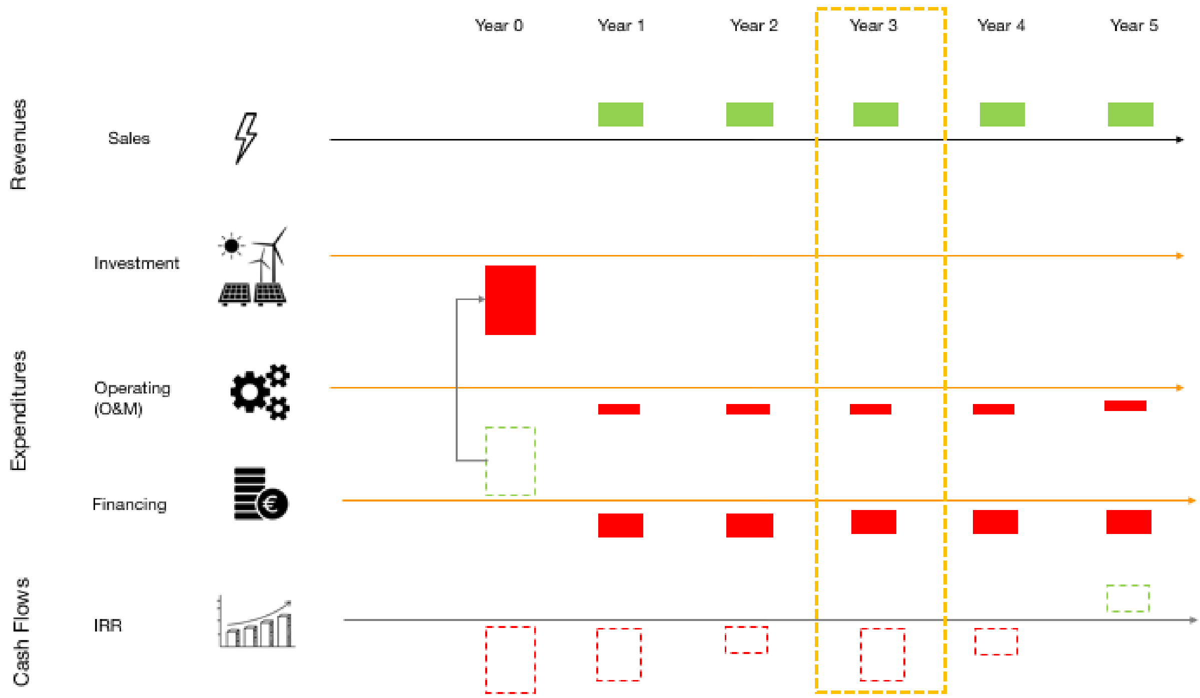


Figure 4.8:

4.4.2 EE metrics

4.4.3 Levelized Cost of Energy (LCOE)

The LCOE Measures lifetime costs divided by energy production or:

- Calculates present value of the total cost of building and operating a power plant over an assumed lifetime.
- Allows the comparison of different technologies (e.g., wind, solar, natural gas) of unequal life spans, project size, different capital cost, risk, return, and capacities

It is quite similar to the NPV formula, where:

$$LCOE = \sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}$$

It = Investment expenditures in year t (including financing) Mt = Operations and maintenance expenditures in year t Ft = Fuel expenditures in year t Et = Electricity generation in year t r = Discount rate n = Life of the system Note on degrading factor

If the fuel also releases CO2 you also have to consider (if industrial) the EU ETS Allowances (or other,depending on the countries regulation).

Focusing on the variable cost, the CO2 main price driver is the "Fuel Switching cost" and coal forwards (coal releases more CO2) and gas forwards, having a direct impact on power prices.

The price dynamic in the emissions market is driven by the power sector.

At the end, it gives a metric of the cost of energy by implementing the projects, so the project with the lowest LCOE should in principle be more advantageous.

For energy generation projects like PV Power plants, or energy savings project (like changing the lighting system), the LCOE is quite similar to the NPV formula and represents the ration between the stream of cash Flows to generate the electricity (or saving electricity) during n years divided by the energy produced (or consumed) during that period.

For example for the PV System project, where its have a 1 y term (for simplicity), the LCOE would be:

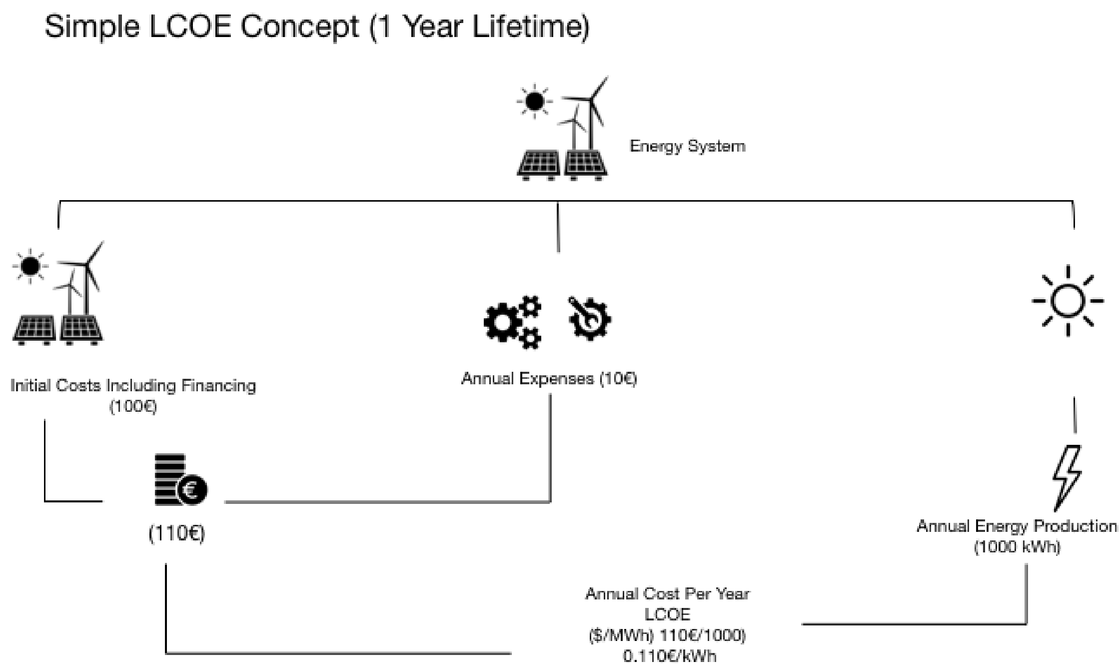


Figure 4.9:

The Initial Costs Including Financing (100€), plus Annual Expenses (10€) (if you have more years, would be the projects O&M), or 110€ of costs.

Imagine that generates 1000kWh per year, so the costs of each would be 0.11€/kWh.

There are some things you should be aware when using this model:

- Increasing and decreasing the lifespan of equipment may change a lot results;
- Efficiency of equipment tends to decrease over time and use (meaning that in year 10, you may not be able to generate the same amount of year 1)
- If it relies on natural resources, you should be aware of intermittency of generation;
- O&M may increase due to overuse of equipment

4.4.4 Cost-Optimaly Methodology

The Cost-Optimaly Methodology gives all relevant definitions needed to make the cost-optimum calculations and analyses of the implementation of energy efficiency measures in buildings.

It is defined as technologically neutral and does not favour one technological solution over another. It ensures a competition of measures/ packages/ variants over the estimated lifetime of a building or building element".

The global cost must be calculated according to EN15459 as indicated in the formula:

$$C_g(\tau) = C_I \sum{}_j[\sum_{i=1}^{\tau}(C_{a,i(j)} \cdot R_d(i)) - C_{f\tau}(j)]$$

Where:

Cg(t) are the Global costs referring to the starting year =0 Cl are the Initial investment costs Ca,i(j) are the annual costs year i for energy-related component j (energy costs, operational costs, periodic or replacement costs, maintenance costs) Rd(i) is the discount rate for year i (depending on interest rate) (minus) Vf, (j) is the final value of component j at the end of the calculation period (referred to the starting year =0).

The cost-optimum calculations are based on a net present value calculation.

According to Boermans, Bettgenhäuser et al., 2011 (Cost-optimal building performance requirements - Calculation methodology to report on national energy performance requirements on the basis of cost-optimality within the framework of the EPBD, eceee).

when we discuss the cost-optimal levels and the effort to achieve energy savings, only the lower boundary of the cloud is interesting to identify the cost-optimal level. In case of a flat cost-curve, it was suggested to set the requirements in the lower (left) part of the calculated cost-optimal points. This will ensure that the most energy-efficient solution sets are selected. On the other hand, one should also try to avoid going too far on the left side of the curve, as cost-curves often show a tendency of a steep increase in costs when moving to the far left.

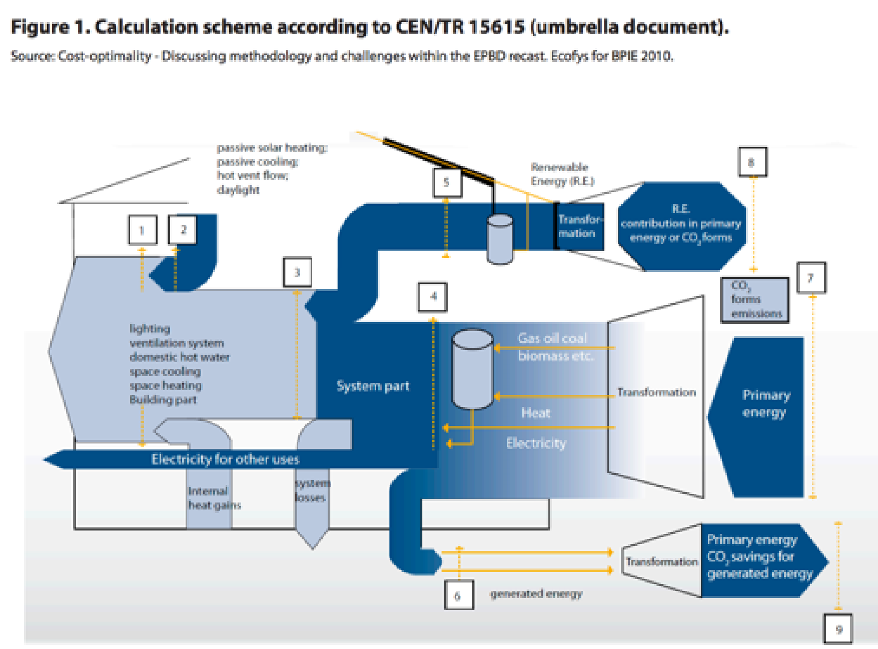


Figure 4.10:

Source http://bpie.eu/wp-content/uploads/2015/10/Implementing_Cost_Optimality.pdf pages 74 and 75

4.5 Scenario and Risk Analysis

4.5.1 Risk and uncertainty

When referring to risk, most relates to the idea if certainty (or the lack of it) and or high or low volatility.

You understand that a deposit is safer than investing in the stock market. For the last you will demand a higher return, or risk premium (usually is equal to risk free rate plus a certain risk on top of that). The later carries higher risk, that could mean you could lose all you invested money (and more if you add some complex financial products).

4.5.2 financial risk and operational risk

It also refer to safety and reliability. In engineering usually it is referred to risk as something you have to mitigate to guarantee a certain level or safety, efficiency or other parameter or, to have safe gauge in the case that something fails. As a control system that may stop some task, send an alarm an so on.

So you have financial risk and operational risk, referring to the implementation and operations of a certain investment.

Understanding risk, means understanding exposure, or what type of events could change you basic underlying assumptions

- Technical and operational risk;
- Regulatory risk;
- Market Risk;
- Financial Risk;

As an example if you run your projections assuming a certain amount of sales and a small change will set to unprofitability, so running several scenarios will help you understand how exposed you are to a change of the demanded volume.

A change in regulation will set more companies working on the same space so setting cannibalism behaviors (as dumping);

First you start by acknowledging the event, then mitigate or (trying to) by different strategies. You may also choose to pursue option in less probability to being exposed to a certain risk

One of the most common ones relies on technical and operational risk, or how often projects access that the initial parameters still hold.

Basic example is can be described as follows:

Certain manufacturer states stat a certain equipment works for a determined use and need repairs and maintenance every x year of other parameter. Project managers wants to “maximize profit and its being working fine until now, nothing seems wrong” so will save a few Euros and delaying replacement of some fundamental pieces or maintenance and looks great on the financial documents. Until a certain day where either have a huge accident or the systems breaks.

It’s the typical fat tail risk where from previous observations, everything will look “average”... in historical data. If you discard that some things will not decrease efficiency, just go from one state to other, because reached a breaking point (or change of state).

Considering corporate finance, risk is priced ,usually by the Beta Coefficient of the CAPM model, that coupons the minimum return adjusted to risk

4.5.3 Due diligence

Due diligence is verifying that all statements are true, this means verifying all assumptions prior and then you should have proper compliance mechanism to avoid having misrepresentation of the facts.

Projects are run by humans and humans (and machines) make errors, so you always should have systems to track errors, not dependent in a single person.

This is why you order audits to third parties which has 2 effects: People will perform differently in they know someone else will verifying;

If more than on person or entity will check the project, you will have lower probability of missing some critical element or information.

Narrowed Due diligence so as corporate governance structure can mitigate opportunist behaviors, misrepresentation of facts or important element important to make any investment decision.

4.5.4 Externalities

Finally, you can also consider other metrics, as environment impact (as carbon footprint) and social impact in these projects.

So you also can incorporate on the initial goals so as quantifying such metrics so as risks.

4.5.5 Project evaluation steps

Figure 4.11:

Identify service need and define objectives and scope Identify options to accomplish the objectives Narrow down the options Do the economic and financial analysis of the different options Identify benefits (avoided costs and saving costs) Identify investment and operation costs Evaluate net benefits Due risk analysis and sensitivity analysis Rank and choose the best option

Chapter 5

Energy Contracts

5.1 Basic Concepts

When dealing with Energy Services, some of the main challenges are:

Challenges in energy efficiency - Most organizations (building owners) don´t have the initial capital upfront to invest in Energy Efficiency measures;

No capital for investment - Banks are not specialized in this type of investment or, able to make an offer alone;

Difficulty to get bank loans - It´s a regulated market with technical certification needed, so out of scope of the usual business of usual lenders;

Technical complexity - Technical and complex deal structure, with several entities; and

No standard contracts - The insistence of a real standard Contract across countries or even within the same jurisdiction.

Most contracts are designed to answer a specific need or problem.

When we refer to a contract, on a very simples terms we mean:

An agreement with specific terms between two or more persons or entities in which there is a promise to do something in return for a valuable benefit (or consideration, in common law)

The existence of a contract requires finding the following factual elements:

an offer;

an acceptance of that offer which results in a meeting of the minds (also referred as “the mirror image rule”);

a promise to perform;

a valuable consideration (which can be a promise or payment in some form);

a time or event when performance must be made (or also refereed as meet commitments);

The terms and conditions for performance, including fulfilling promises;

performance, and

an intention to effect legal obligations (so we are excluding what doctrine refers as “not a serious proposal” too)

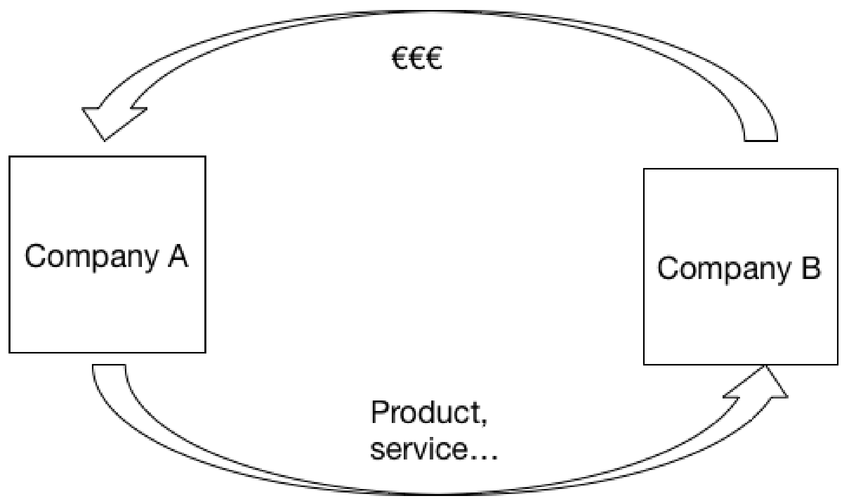


Figure 5.1:

Depending on how the deal is structured, performance and its payment can be designed differently. Usually are dragged along the whole term of the contract (not a single performance and payment), namely if there are several installments instead of a single payment or, it´s a recurrent service.

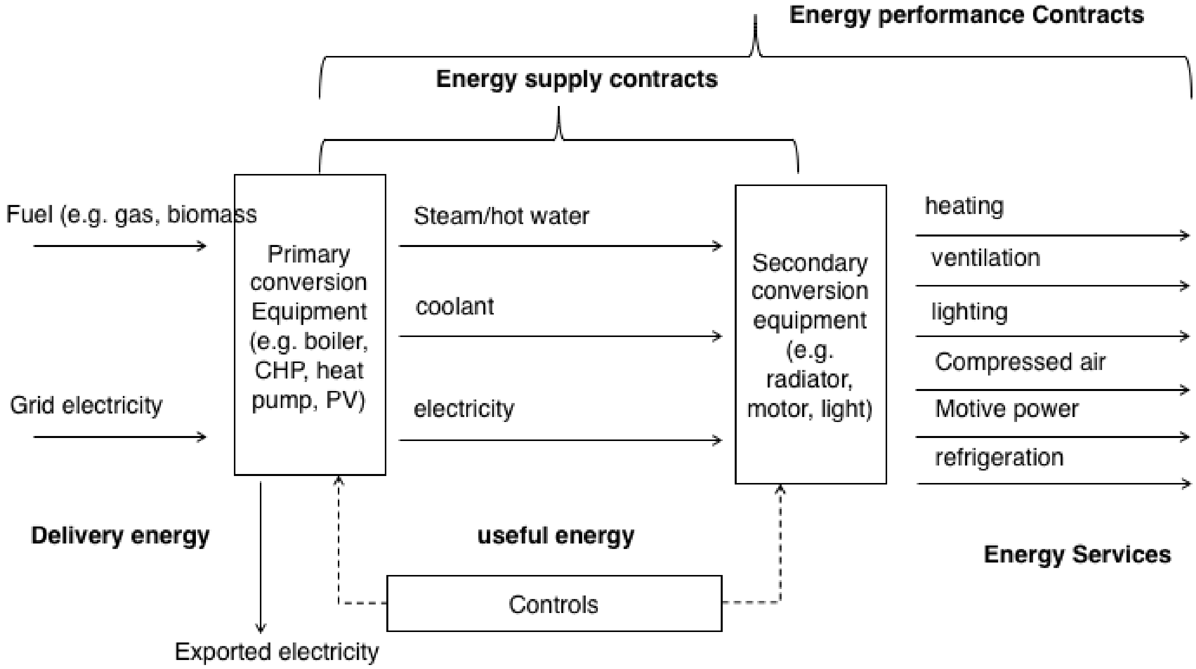
Contract elements

Performance and Payment

Exhange (product /service) for a

Price

Terms and conditions



The total energy used (not useful) can be expressed as how we use energy services, or secondary conversation that concerts to heating, ventilation, lighting and so on.

Bear in mind, that energy supply and energy performance are not equivalents. Contracting a certain amount of energy and an end use are not equals. Besides losses with secondary conversion, the first is related to a commodity (or raw material you buy to generated a certain output), the last to the end result.

The same amount of energy may give the same thermal comfort, or not, for example.

Energy contracts:

Energy Supply Contracts

Power Purchase Agreements (PPAs)

Energy Services Agreement (ESAs)

Energy Management Contracts (EMCs)

Energy Performance Contracts (EPCs)

Finally, to have a Contract you need, at least two persons or entities.

The Energy Efficiency Directive (EED) defines an ‘energy service provider’ as a “natural or legal person who delivers energy services or other energy efficiency improvement measures in a final customer’s facility or premises”.

They can be (alone or jointly):

-Utilities;

-Equipment manufacture/supplier;

-Supplier Manufacturer of building automation and control systems

-Facility management and operation company

-Consulting/engineering firm

-Independent specialist (focused on Energy efficiency services);

-Energy Data Companies;

-Governmental entities (namely under subsidized schemes)

-Banks and other Financial institutions (as intermediaries for EE related type of investments) and

-Others.

In a raw sense, you should understand that entity will not define the contract, meaning that a EPC will be a EPC, regardless if is specially used by one type of Entity (typical example of EE contracts with the Public Sector). Also, you can have a variety of entities so understanding the responsibility, strengths and weaknesses and governance among them is an import matter.

Finally, To have a Contract you need, at least two persons or entities.

The Energy Efficiency Directive (EED) defines an 'energy service provider' as a "natural or legal person who delivers energy services or other energy efficiency improvement measures in a final customer's facility or premises".

5.2 PPA´s

A power purchase agreement (PPA), or electricity power agreement, is a contract between two parties, one which generates electricity (the seller) and one which is looking to purchase electricity (the buyer). The PPA defines all of the commercial terms for the sale of electricity - it can be fixed, indexed or "shaped"- between the two parties, including when the project will begin commercial operation, schedule for delivery of electricity, penalties for under delivery, payment terms, and termination. A PPA is the principal agreement that defines the revenue and credit quality of a generating project and is thus a key instrument of project finance.

This differs from the traditional approach of simply buying electricity from licensed electricity suppliers, often known as utility (or wholesale) PPAs. PPA also are a way of choosing a certain type of energy, the most common example, if a company wants to achieved a certain percentage of renewables (or decrease its carbon footprint) to either improve overall rating of its assets (from real estate to overall company), doing a PPA with solar or wind farm is a way to achieve that goal.

There are several Business Models Involving PPAs We can have:

On-site sale

– Direct sale to customer on site (shopping centres, commercial centres, manufacturing industry, airports, ports etc.)

– Saves costs related to the use of the transmission grid (transmission, distribution, dispatching, general costs of system)

Or Sale through the grid

– Utility scale ground-mounted plants;

– Sale to energy utilities (peak load purchases, renewable energy source obligations);

– Sale to end users (large industrial clients);

– Sale to wholesalers or "aggregators";

There are several Power Purchase Agreement structures, namely:

Onsite direct wire PPA

Sleeved off-site PPA

Synthetic PPA

Mini-utility

Wholesale PPA

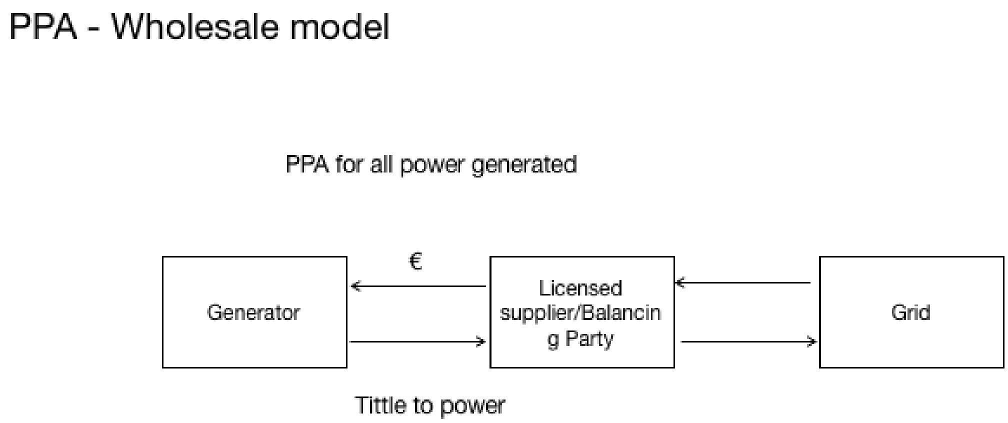
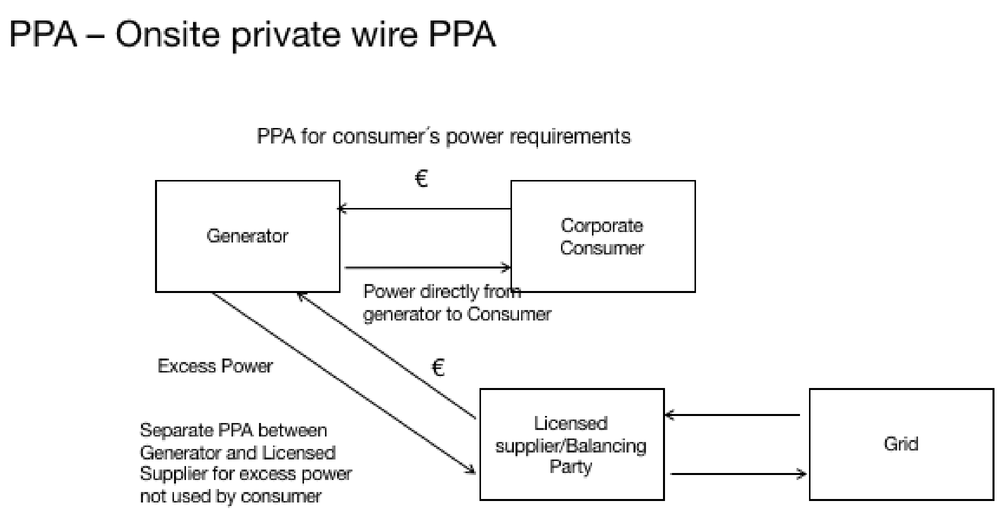


Figure 5.2:

The most simple PPA is the "Wholesale model", where the generator sells all power supplier back to the grid. Most of the RES where implemented using this structure, where licenses where auctioned to generate a certain amount of energy in an exchange for a certain predefined tariff per MWh.



Not all PPA are wholesale PPA´s and increasingly we see more often onsite private wire PPA´s. Instead of selling all back to the grid, namely activities that are energy intensive, as running servers of a company, or, they want to improve the % of RES in their overall energy mix, they can have power directly from generator to them and, a separate PPA, for either the excess power produced or as a last resort supplier.

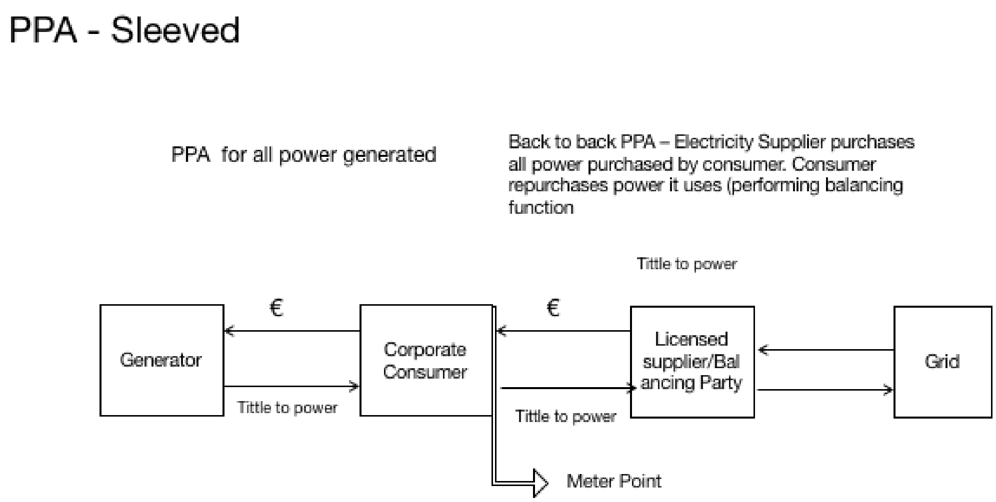
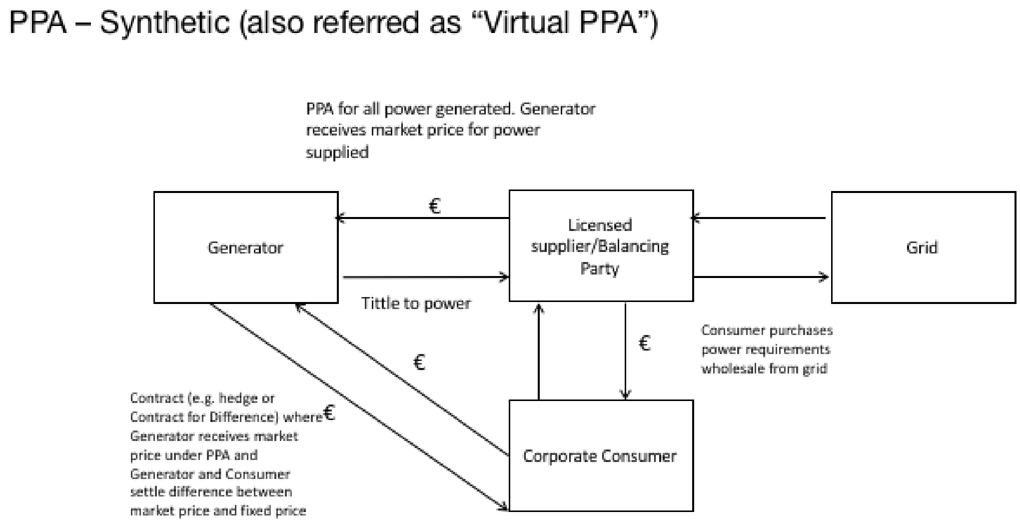


Figure 5.3:

In a Sleeved PPA, all power generated is sold by the corporate consumer to the licensed supplier – or balancing party – still is a Back to back PPA – Electricity Supplier purchases all power purchased by consumer. Consumer repurchases power it uses (performing balancing function).



A Synthetic PPA or, also referred as a “Virtual PPA” is a Contract (e.g. hedge or Contract for Difference) where Generator receives market price under PPA and Generator and Consumer settle difference between market price and fixed price. Its virtual, because there is no physical purchased of electricity, like most Contract for Difference. If you already looked to commodities trading (as brent, for example), you you see that most have “financial liquidation and not physical liquidation.

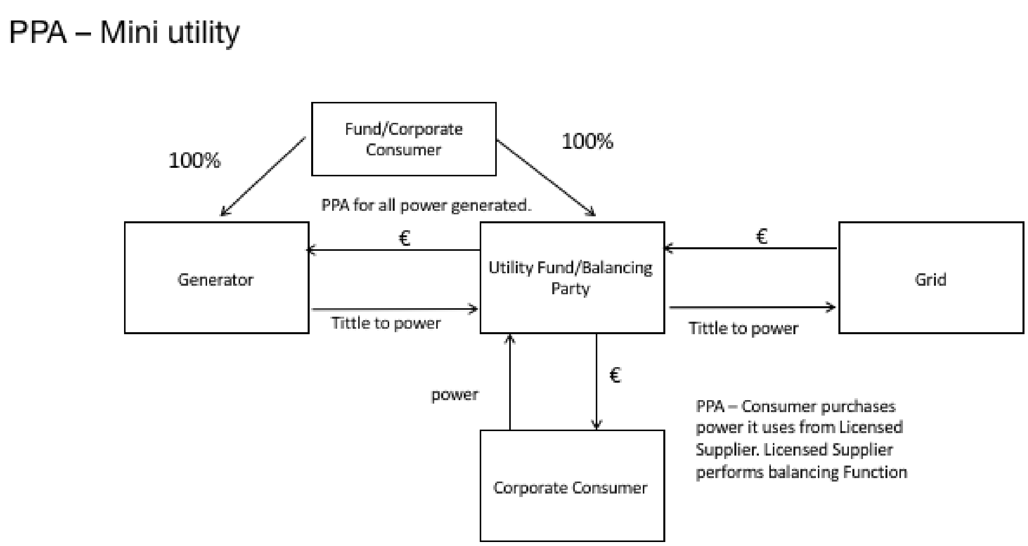


Figure 5.4:

Lastly, a mini utility PPA – Consumer purchases power it uses from Licensed Supplier. Licensed Supplier performs balancing Function too.

5.2.1 Curtailments

There are what so called Default provisions related to Curtailments

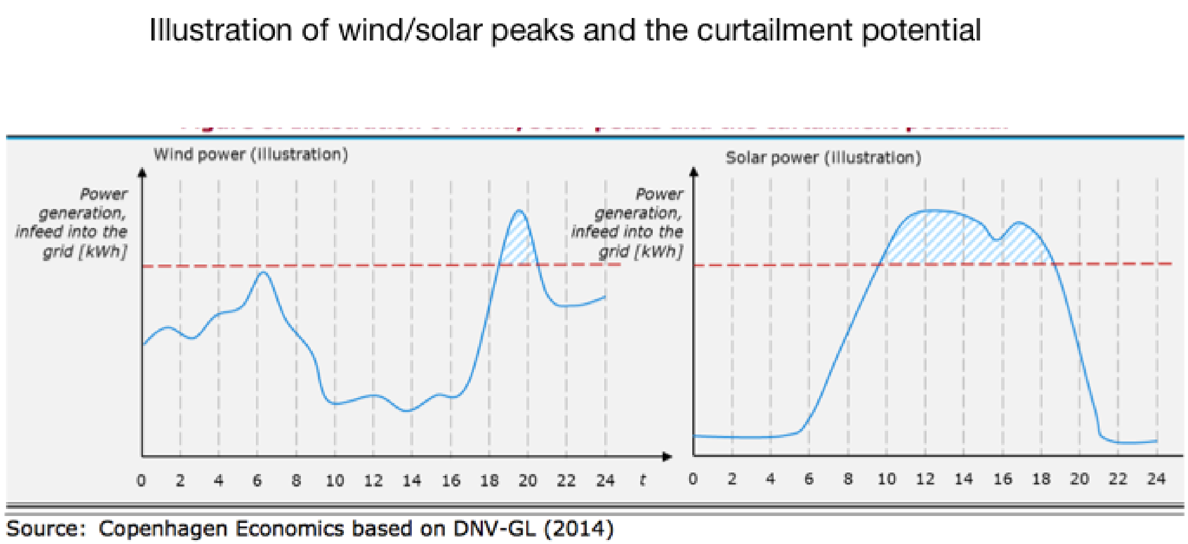


Figure 5.5:

On the Buyer-Directed Curtailment: – Buyer may have the right to direct Seller to decrease or stop deliveries – Generally for economic reasons – Seller should be compensated – Make sure the Project is capable of complying

Third-Party Curtailment: – Interconnecting Utility or Transmission Provider – Broad curtailment rights in Interconnection Agreement – e.g. emergency, reliability, system maintenance – Frequency may depend on level of transmission service – Seller may or may not be compensated

Curtailments can be Compensated or not, where:

On the Compensated Curtailments: – Contract Price for each MWh Seller could have delivered – Plus, if applicable, value of lost benefits, grossed up for taxes

Or Non-Compensated Curtailments: – Big negotiation point and financing issue – Seller wants to maximize ability to get compensated – argument is that anything affecting transmission beyond the the Point of Delivery (POD) is Buyer's risk – Generally no compensation for an "Emergency" – Buyer treats this like a force majeure; definition is important – Generally no compensation if curtailment results from Seller's failure to maintain required permits or interconnection facilities at or prior to the Point of Delivery (POD) – Mechanics depend on market rules and Project specifics – Be careful if Buyer is also the Transmission Provider or Interconnecting Utility

5.3 Incentives and other schemes to support EE implementation

The Article 18 of the EED (Energy Efficiency Directive) stablishes regarding “Energy services”, that all Member States shall promote Energy Services and access by disseminating clear and easily accessible information, among other; on: (i) available energy service contracts and clauses that should be included in such contracts to guarantee energy savings and final customers’ rights; (ii) financial instruments, incentives, grants and loans to support energy efficiency service projects; (i) providing model contracts for energy performance contracting which include at least the items listed in Annex XIII;

Direct support as:

-Grants/Subsidies that can be as: Subsidy on a certain percentage of EE investment (CAPEX); or Financial Mechanism (Loans, Credit line…)., with better finantial terms as offereced by usual lenders, as banks. Most of the times, banks offered this termsunder certain governmental initiative, so they act as intermediaties of such Financial mechanims too.

Or as a Fiscal incentives, such as Rebates Deductions over taxable income (…) Or other schemes

They can be:

Special Purpose Vehicle (SPV), or a legal person, a company to perform a certain task/goal, Direct loan to acquire equipment + services contract; Rental with buy option (leasing); Other;

The main implications and differences may are: ownership and risk (namely in some events such as: bankruptcy, breach of contract, etc)

Lastly there are EE targets for specific sectors, namely for

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non SME´s,
Specific industries (large combustion plants),
Energy intense activities;
Public sector, etc)
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There are targets these type of entities must comply under the general EED or other national legislation. Unlike the other cases, were such improvements are not mandatory, this entities have a strong incentive: legal one, not a market one.

5.3.1 Interconnections with Public Law

Most of the EE contracts may fall into a Public Contract (namely if you managing a public building, as a public hospital, school):

A Public Contract (also referred as Public Procurement) can be defined by Subjective or objective imputation, as:

- By type or entity (Public Entities and related);
- By type of Contract (more than 50% financed by public funds);

By sectorial areas (specific utilities markets in certain countries may be exempt from public procurement rules): If you will be considering using national or EU financial schemes you may have to fulfill public procurement rules, even not being a public entity, but because more than than 50% is financed by public funds)

For a utilities market to be exempt: the legal/regulatory environment permits access and competition in the sector concerned; the utility operators in the market concerned are subject to competitive pressure.

The are Thresholds

EU law sets minimum harmonised rules for tenders whose monetary value exceeds a certain amount and which are presumed to be of cross-border interest. The European rules ensure that the award of contracts of higher value for the provision of public goods and services must be fair, equitable, transparent and non-discriminatory. For tenders of lower value however, national rules apply, which nevertheless must respect general principles of EU law.

Chapter 6

Conclusion

6.1 Main insights

VC investment in Portugal relies, mostly on public funds with an absence of evidence of return of investment adjusted to risk.

Comparing, there are few "high growth companies" and they seem to be in economic areas different that the invested ones. Unlike the idea that all VC deals are different, data show that same degree and forms of investments are used, not in equity instruments, rather in debt instruments. The use of typical instruments of public liability company, as securities are not used, besides issuance of shares.

There is also no evidence that the change on share capital requirement created a significant change in the number of companies.

In spite of a lot of promotion of "startups", results are yet to be demonstrated.

The last of buy side also seems to be a contact, where exists are mostly trough outside countries. The concentration of the market share in few players (most being public funded) also contracts with an idea of market based, but rather policy based. Incentives are drawn by regulation (and funding of State), not market.

The rolling of this assets seems also to be an issue, where no cash (as a fungible and more liquid asset) seems to be realized, rather selling stats to other funds, for reimbursement of the first.

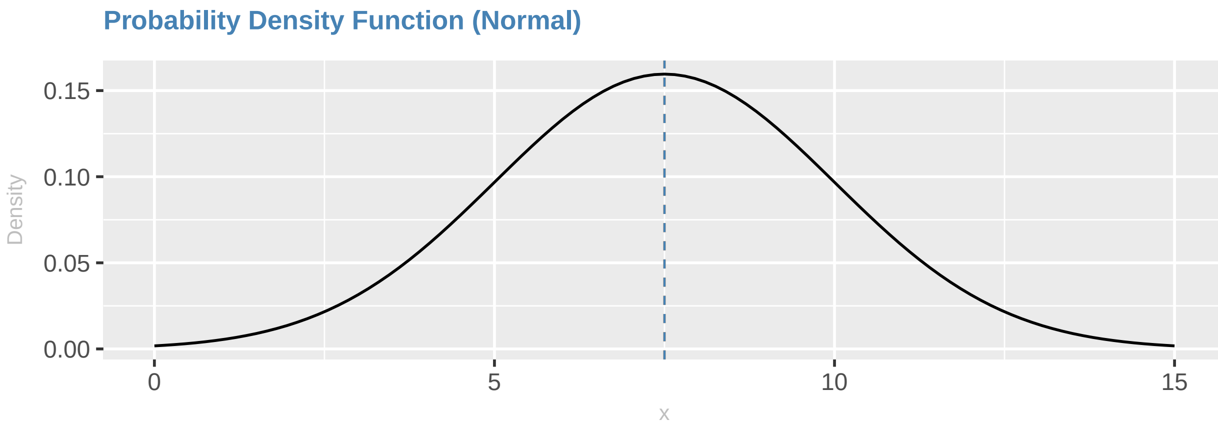
Most observations are not even distributed, meaning that a small percentage have a higher weight than the most frequent ones. It´s a typical case of extreme value distributions, with highly skewed distributions.

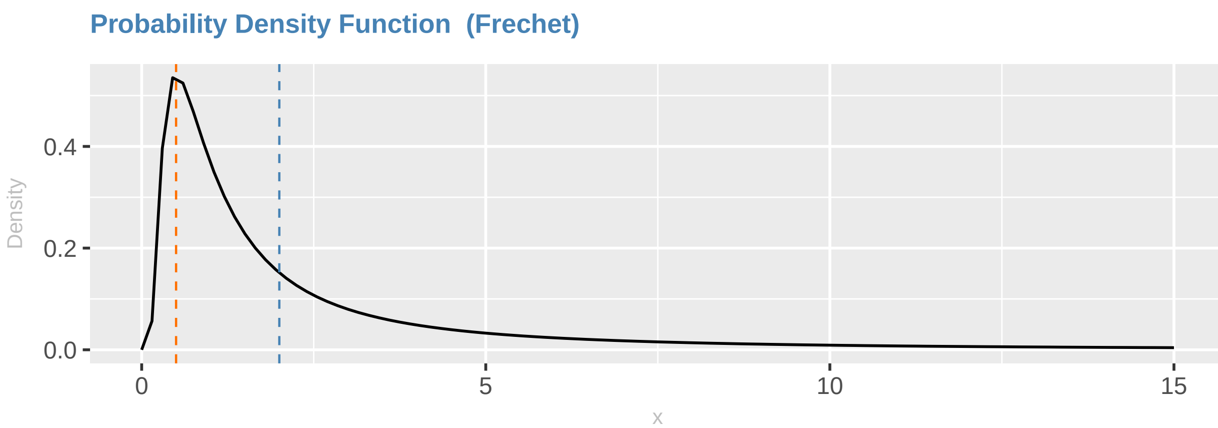
6.2 According to available data, account should be taken:

a) No IPO's (between the period 2007 to 2015 there are 0 occurrences of this form of disinvestment), even considering the total capital (venture capital and private equity), being able to conclude that there is a weak depth of Capital markets;

b) The Government (directly and indirectly) as one of the major players, where in the investment policy is visible the limitations on the instruments used, as well as on the location and investment area. It can be stated that the investment, is in line with structural support funds (Compe case, QREN and currently P2020).

6.2.1 Future work





Chapter 7

Annexes

Notes

Portugal Ventures

There were several inconsistencies between the Funds reports from 2012 to 2015 (latest available), particularly in assets under management.

Taking into consideration the merger, extinction and spin-off of several funds, it is important to take into account that, according to data from Portugal Ventures, it manages "Funds under management: (approximately) € 400 million." (Turismo de Portugal, FAI and some of the AICEP), but this is a management entity and has a double criterion in reports that, on the one hand, it reports (in particular to assess the capital gains of FAI Energia), but it is completely omitted and does not, in fact, include all the assets under management.

TABLE

Type	Incorporation	Change	Holding, stage
1	FCR PORTUGAL VENTURES VALOR	20-07-1994	15-12-2014
2	FCR PORTUGAL VENTURES	19-01-1993	15-12-2014
3	FCR PORTUGAL VENTURES GLOBAL	01-06-1999	01-12-2013
4	FCR PORTUGAL VENTURES INTER-REGIONAL	21-12-1999	31-12-2014
5	FCR PORTUGAL VENTURES VALOR 2	11-08-1994	
6	FCR PORTUGAL VENTURES 2	28-01-1993	01-12-2013

Type	Incorporation	Change	Holding, stage
7	FCR PORTUGAL VENTURES TIEC	06-03-1998	01-12-2013
8	FCR PORTUGAL VENTURES GLOBAL 2	15-07-1999	
9	FCR PORTUGAL VENTURES TURISMO	25-08-1995	TC (not reported)
10	FCR PORTUGAL VENTURES GRANDES PROJECTOS DE INVESTIMENTO	09-08-2004	AICEP
11	FCR PORTUGAL VENTURES - FIEP	29-12-2004	AICEP (not reported)
12	FCR PORTUGAL VENTURES FINICIA	04-05-2007	
13	FCR FAI PORTUGAL VENTURES ENERGIAS	06-05-2009	FAI (not reported)
14	FCR PORTUGAL VENTURES ACELERADOR DE COMERCIALIZAÇÃO DE TECNOLOGIAS	24-08-2009	31-12-2014
15	FCR PORTUGAL VENTURES FIAEA - FUNDO DE INVESTIMENTO DE APOIO AO EMPREENDEDORISMO DOS AÇORES	14-01-2011	
16	FCR PORTUGAL VENTURES BIOCANT	28-12-2011	

Type	Incorporation	Change	Holding, stage
17	FCR PORTUGAL INTERNACIONALIZAÇÃO	18-04-2011	AICEP (reported)
18	FCR PORTUGAL VENTURES INDUSTRIAS CRIATIVAS 01-09-2011		
19	FCR PORTUGAL VENTURES EARLY STAGE	30-09-2011	
20	FCR PORTUGAL VENTURES UNIVERSITAS	28-12-2011	
21	FCR PORTUGAL VENTURES ACELERADOR DE COMER-CIALIZAÇÃO DE TECNOLOGIA II	18-11-2011	
22	FCR PORTUGAL GLOBAL VENTURES I	17-06-2015	
23	FCR DINAMIZAÇÃO TURISMO	TC (not reported)	
24	FCR TURISMO - INOVAÇÃO	TC	(not reported, there are operations through this funds)
25	FCR GLOBAL III	AICEP (not reported)	
26	FCR PORTUGAL VENTURES II	AICEP	(not reported) dissolution
9	Incorporation	(+1)	Total in activity

On the other hand, it does not report its position or affiliated entities to the Directorate-General for the Treasury and Finance [^59] (there are only the management reports of the date of their incorporation), where the changes are known, in particular as part of the restructuring operation in 2012, in which 2014 had more changes and from 2014 to 2015 there is an asset rotation that is not explained.

[^59] : Report of the State Business Sector Entities, should be present and available at: http://www.dgtf.pt/centro-de-documentacao-e-legislacao?tabid=993

The reconstruction (possible, taking into account the constantly changing amounts in portfolios and occurred changes due to mergers):

2011	2012	2013	2014	2015
1.Total Subscribed Net Investment (Share capital entities - Shareholdings)	310.8	203.6	198.5	201.1
1.Direct interests (holdings)	344	334	295.5	257.49
1.1 In companies	17.6	14.4	4.6	30.3*
1.2 In Funds	31.9	22.2	22.6	23.7
2. Indirect interests	308.8	308.1	275.71	227.49
2.2 Share Capital of entities (companies´holdings)	247.4	131.19	74.15	30.3*
2.2 Share Capital of entities under management (Funds)	183.6	128.9	144.09	153.33
2.3 Holdings in investment units under external management	1.3	1.3	2.8	0

- It is not explained, potentially the n/a or registered potential loss

There are variations in reporting, namely the same value has different values from one report to the other, even when they make the comparison with the previous year.

It should also be noted that the investment units of these funds are in many cases reflected in the accounts of other entities (where they correctly put the nominal value and the valuations or impairments, such as the percentage held of the VC Fund). In the latter case, there are no changes in the value of the asset (in which many only put the acquisition price) as significant as reported by Portugal Ventures (some may differ by almost 50M €, i.e. more than 25% from one year to another).

The Portugal Ventures, with visible and is reported in the financial reports, is an investment change process, which is divesting of Private Equity Units and to invest (foresees maintaining the trend) to focus on Venture Capital. In fact, as of 12/31/2015, of a portfolio of € 240, they consider their portfolio, broadly divided as follows:

Number of companies

Number of companies	Portfolio	
2014	2015	
VC	68	89
PE T&LT	19	11
PE E&M	22	17

Investment (acquisition cost)	Asset valuation	
Seed	58.8	58.3
Startup	77.1	58.3
Growth Capital	42.7	41.6
Outros	36.6	22.5
N/A	0.8	

Portugal Ventures Annual Report 2015, page 48, Fig. 25

European Venture Capital Association (EVCA)

Reports the data between 2007 and 2015, according to CMVM, but the method is different. It uses data provided by representative risk capital entities in each country. In the case of Portugal, the data are supplied by the Portuguese Association of Venture Capital and Development (APCRI).

The APCRI sample is also very weak (compared to the CMVM); In which due to having such a small number of observations, any change in one of the variable has a great impact.

In fact, comparing the data of the CMVM with those of the EVCA, the discrepancies are notorious, namely in two key parameters: number of venture capital firms and amount reported.

Notices under SAFPRI:

Aviso	Prazo	Convite específico	Valor
Nº 01/SAFPRI/2008	De 02.12.2008 a 02.12.2008	IAPMEI E TP para constituição do capital do FINOVA – Fundo de Apoio ao Financiamento à Inovação	limite o valor de 107,940 M€, sendo 4,179 M€ afectos ao Turismo (TP) e 103,761 aos restantes sectores de actividade (IAPMEI).
Nº 03/SAFPRI/2008	De 23.12.2008 a 23.12.2008	IAPMEI destinado ao reforço do capital do FINOVA – Fundo de Apoio ao Financiamento à Inovação, com o objectivo de apoiar a criação de um fundo de fundos para dinamização da actividade de capital de risco em Portugal.	limite o valor de 8,75 M€

Aviso	Prazo	Convite específico	Valor
Nº 02/SAFPRI/2008	De 23.12.2008 a 23.12.2008	IAPMEI destinada ao reforço do capital do FINOVA – Fundo de Apoio ao Financiamento à Inovação, e com o objectivo de apoiar a criação de um fundo de capital de risco destinado ao apoio às PMEs do sector cinematográfico e audiovisual.	limite o valor de 23,1 M€
N.º 05/SAFPRI/2009 - “Business Angels”	De 31.08.2009 a 30.10.2009	INVESTIDORES INFORMAIS EM CAPITAL DE RISCO (BUSINESS ANGELS)	10 M€
N.º 04/SAFPRI/2009 - Projectos Fase “Pré-Seed”	De 31.08.2009 a 25.09.2009	(FCR) cuja criação ou reforço terão co-financiamento do programa COMPETE	COMPETE - 10,5 M€; Programa Operacional Regional de Lisboa – 2,4 M€.
N.º 03/SAFPRI/2009 - Projectos Fase “Early Stage”	De 31.08.2009 a 25.09.2009	(FCR) cuja criação ou reforço terão co-financiamento do programa COMPETE	COMPETE - 21 M€;
N.º 02/SAFPRI/2009 - Corporate Ventura Capital	De 31.08.2009 a 25.09.2009	(FCR) cuja criação ou reforço terão co-financiamento do programa COMPETE	10 M€
N.º 01/SAFPRI/2009 - Inovação e Internacionalização de PME	De 31.08.2009 a 25.09.2009	(FCR) cuja criação ou reforço terão co-financiamento do programa COMPETE	90 M€, dos quais 10 milhões de euros serão destinados a FCR orientados para as indústrias criativas

Aviso	Prazo	Convite específico	Valor
Nº 01/SAFPR/2013 - LINHA DE FINANCIAMENTO A OPERAÇÕES DESENVOLVIDAS POR BUSINESS ANGELS	De 13.09.2013 a 27.09.2013	PME INVESTIMENTOS – SOCIEDADE DE INVESTIMENTO, SA	linha de financiamento a operações desenvolvidas por Business Angels, 10 M€

Chapter 8

Formulae

8.0.1

- Jump to Formulas
- Jump to Links
- Jump to RCode
- Jump to Plots

8.0.1.1 Formulas [^1]

8.0.1.2 Energy

8.0.1.3 Energy Efficiency μ (as %):

$$\mu = \frac{energy\, output}{energy\, input} \times 100$$

8.0.1.4 Conservation of Energy Formula

(Closed System)

$$\Delta U = Q - W$$

Where:

ΔU : as a change in internal energy

Q : the net quantity of heat supplied to the system by its surroundings

W : denotes the net work done by the system.

(Open System)

$$\dot{Q} - \dot{W} = \sum \dot{m_{in}} - \dot{h_{out}}$$

Where:

$\dot{m}$: is the change in mass with respect to time ("flow")

8.0.2 Heat transferred by:

8.0.2.1 1. Conduction

$$\dot{Q} = KA\frac{T_1 - T_2}{1}$$

Where:

K : is the thermal conductivity constant (obtained by experimentation in W/m.K.)

A : is the area of the surface

T : is for the temperature of the system

8.0.2.2 2. Convection

$$\dot{Q} = hA(T_1 - T_2)$$

Where:

h : convective heat transfer coefficient

A : is the area implied in the heat transfer process

T: is for the temperature of the system

8.0.2.3 3. Radiation

$$\dot{Q} = \varepsilon\sigma A(T^4 - T_0^4)$$

Where:

ε : is the emissivity of the system

σ : is the constant of Stephan-Boltzmann $5.670367(13) \times 10^{-8} W \cdot m^{-2} \cdot K^{-8})$

A: is the area involved in the heat transfer by radiation

$(T^4 - T_0^4)$: is the difference of temperature between two systems

The PMV index is expressed by P.O. Fanger as

$$PMV = (0.303e^{0.036M} + 0.028)L$$

where:

PMV : Predicted Mean Vote Index

L : thermal load - defined as the difference between the internal heat production and the heat loss to the actual environment - for a person at comfort skin temperature and evaporative heat loss by sweating at the actual activity level.

8.0.2.4 HDD (Heating Degree Days)

$$HDD(T_{ref}) = \frac{1}{24}\sum_{8760}^{i=1} max(T_{ref} - T_{ext,i}, 0)$$

Where:

T_{ref} : reference temperature

T_{ext} : exterior temperature

i : inlet temperatures of hot/cold fluid

8.0.2.5 CDD (Cooling Degree Days)

$$CDD(T_{ref}) = \frac{1}{24}\sum_{8760}^{i=1} max(T_{ref,i} - T_{ext}, 0)$$

####Thermal Balance

$$Q = Q_{in} - Q_{out} = Q_{walls} + Q_{windows} + Q_{roof} + Q_{ceiling}$$

8.0.2.6 Ventilation and Air Leakages

$$\dot{Q} = \dot{m}cp\Delta T$$

Where:

cp : surface pressure coefficient

ΔT : temperature difference

####Overall Heat Transfer Coefficient (U)

$$Q = U\Delta T$$

$$U = \frac{1}{1/h1 + La/Ka + 1/h2}$$

Where:

q : heat transfer (W, J/s, Btu/h)

A : heat transfer area (m^2, ft^2)

k : thermal conductivity of material (W/m K or W/m oC, Btu/(hr or ft2/ft))

dT : temperature gradient - difference - in the material (K or oC, oF)

s : material thickness (m, ft)

8.0.2.7 Heat Balance

$$Q = Q_{heating/cooling} + Q_{envelope} + Q_{internal} + Q_{air}$$

Heat through envelope

$$Q_{envelope} = HDD \times Q_x$$

$$Q_x = A_{ceiling} \times U_{ceiling} \times A_{floor} \times U_{floor} A_{window} \times U_{window} + (A_{wall} - A_{window}) \times U_{wall}$$

8.0.2.8 Heat through air exchange

$$Q = \dot{m}_{leakage} \times Cp \times V \times HDD$$

Where:

V : Volume of the room

Internal Gains

$$Q_{internal} = Q_{occupants} + Q_{appliances}$$

8.0.2.9 Solar Gains

$$Q_{solar} = AI[T + U(\sigma^{\alpha})]$$

Where:

A : Area

I:irradiation

$TU(\sigma^{\alpha})$: Coefficient that depends on the transmissivity and the absorbed radiation by the surface, through each radiation enters the room

8.0.2.10 Hot water modelling

Changing Product Temperature - Heating up the Product with Steam

The amount of heat required to raise the temperature of a substance can be expressed as:

$$\Delta U = mc_p \Delta T$$

Where:

ΔU : quantity (difference) of energy or heat (kJ)

m : mass of substance (kg)

c_p : specific heat of substance (kJ/kg K)

ΔT : temperature (difference) rise of substance

c_p 4.18 kJ/kg.K

8.0.2.11 Pipe Losses

$$q_p = \pi(T_2 - T_1)/ln(D_{out}/D)$$

8.0.2.12 Enthalpy

The enthalpy change associated with the change in temperature and specific humidity of the present state and a reference state, by:

$$\Delta h = h - h_{ref} = [Cp_{dry\,air}T + w(Cp_{water\,vapour}T + h_{fg})] - [Cp_{dry\,air}T + w(Cp_{water\,vapour}T + h_{fg})]$$

Since the reference conditions are typically considered to be ° C and dry, enthalpy air from the reference state is calculated by:

$$h = Cp_{dry\,air}T + w(Cp_{water\,vapour}T + h_{fg})$$

This expression is usually analyzed according to a sensitive component $\Delta h_{sen} = (Cp_{dry\,air} + w \times Cp_{water\,vapour})T$ and is a latent component $h_{lat} = (h_{fg})w$. Since the specific humidity takes very low values in climatization situations, the psychrometric chart is defined by the axis of dry temperature and specific humidity. Generally, the following values are considered for specific heat and enthalpy of phase:

$$h = 1.01 \times T + w(1.9T + 2480)$$

8.0.2.13 Relative humidity

The relative humidity is calculated by the ratio between the effective vapor pressure and the maximum vapor pressure. The maximum vapor pressure corresponds to the saturated vapor pressure temperature (pvsat (T)).

$$RH = \frac{p_v}{p_{vsat}(T)} \times 100\%$$

8.0.2.14 Saturated Vapor Pressure

The saturated vapor pressure is obtained directly from the water vapor tables, being a function of temperature, and can be obtained by the following correlation, where T is in ° C and pvsat in kPa.

$$p_{vsat}(T) = 10^{(28.59051 - 8.2log(T+273.16) + 0.0024804(T+273.16) - \frac{3142.31}{(T+273.16)})}$$

8.0.2.15 Specific humidity

While the relative humidity establishes a relationship between the volume and the vapor the maximum possible vapor volume, the specific humidity establishes a mass ratio between water vapor and dry air present in the mixture, being defined by:

$$w = 0.622\frac{p_v}{p_{atm} - p_v}$$

where patm is the atmospheric pressure, which assumes the normal value of 101,325 kPa.

8.0.2.16 Dry temperature and wet temperature

The dry and humid temperature are related by the following expression:

$$p_v = p_{vsat}(T_h) - 0.000666(T_s - T_h)$$

8.0.2.17 Lighting Concepts

Luminous Flux ($\Phi\ : lm \setminus m^2$)

8.0.2.18 Illuminance from a Light Source

$$E = \frac{lcos\Phi}{d^2}$$

Where: E : illuminance from a certain place (lux)

d : distance to the light source

Φ : Angle from the light source

I: light source luminous intensity (lm)

8.0.2.19 Lighting Service (L)

Amount of time that the activity takes place

$$L = E \times A \times \Delta T(lm.s)$$

Where:

E : Required level of illuminance in a certain place (lux)

A : Area which requires a certain level of illuminance (m^2)

Δ : time period

8.0.2.20 Inverse Square Law

(The intensity of illumination produced by a point source varies inversely as square of the distance from the source.)

$$E = \frac{I}{d^2}$$

Where:

I: intensity of illumination

d: distance from the source

8.0.2.21 Cosine Law (Lambert's Law)

$$E_H = \frac{I}{d^2} \cos \Theta$$

I: intensity of illumination

d: distance from the source

Θ: angle from the light source

8.0.2.22 Cosine Cubed Law

$$E_H = \frac{I}{d^2} \cos^3 \Theta$$

8.0.2.23 Useful Lumen Output (ULO)

$$ULO = (n \times N \times F) \times (UF)$$

Where:

n: lamp number per fixture

N: total fixture number

F: Individual Lamp Lumem output

UF:utilisation factor

8.0.2.24 Illumination Average Area

(rate of the portion of Lumen Output with influence in the lighting of an area)

$$E = (n \times N \times F \times UF \times LLF)/A$$

Where:

E: Illuminance Average (in lux)

n: lamp number per fixture

N: total fixture number

F: Individual Lamp Lumem output

UF:utilisation factor

A:Area

LLF: Light Loss Factor

8.0.2.25 Efficacy Index

$$P(W)/100(lux)/m^2$$

(it shoud be < 5)

8.0.2.26 Electrical Potential

$$P = U \times I$$

Where:

P : Power (Watt)

U: voltage (volts)

I: current (Amperes)

8.0.2.27 Shape Factor

(indicator of the compacness of a building)

$$FF = \frac{A}{V}(m^2/m^3)$$

Where:

A: Area (m^2)

V: Volume (m^3)

http://d-vf.github.io/cmvm-relatorio-de-capital-de-risco-2007

http://d-vf.github.io/cmvm-relatorio-de-capital-de-risco-2008

http://d-vf.github.io/cmvm-relatorio-de-capital-de-risco-2009

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Chapter 9

Something

‘r if (knitr:::is_html_output())

Bibliography