Economic and legal aspects of Energy in Buildings - Support notes

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Energy Prices

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.

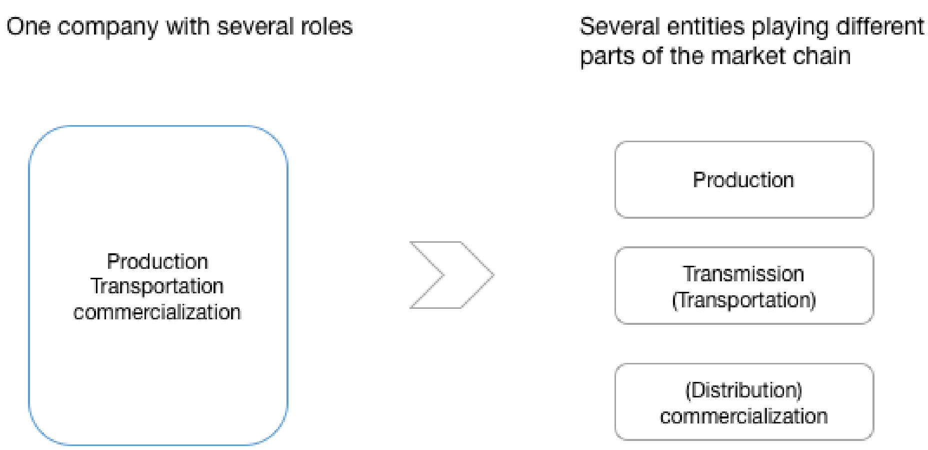


Figure 3.1:

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.

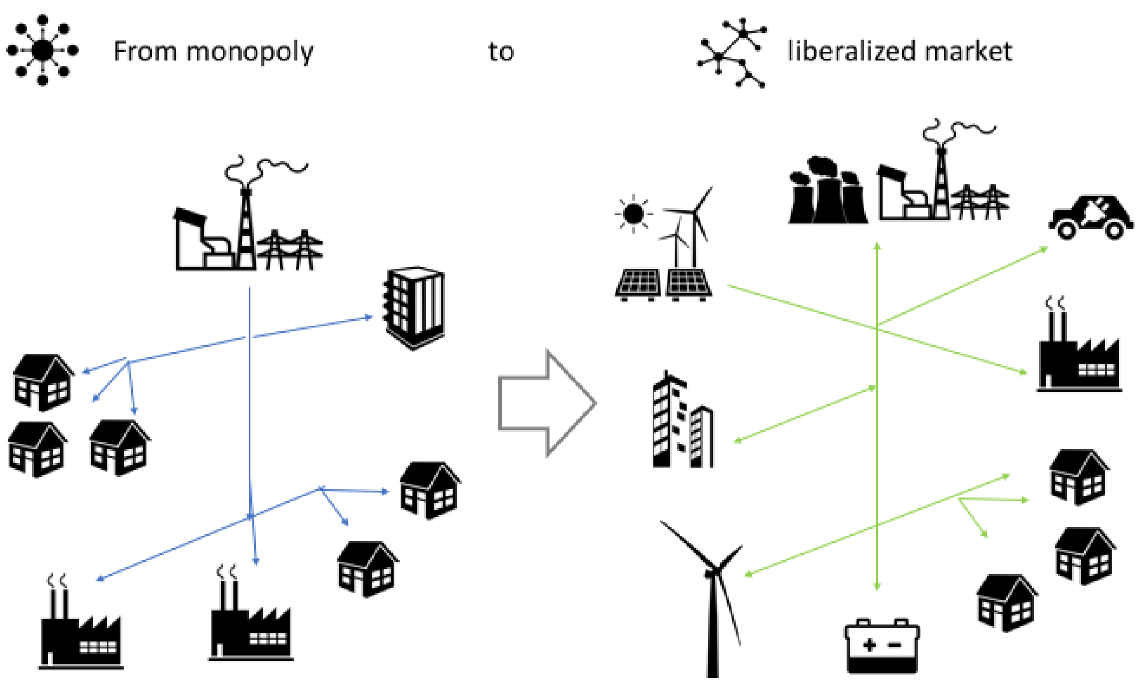


Figure 3.2: Market Shift

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

3.2.0.3 Electricity

Simplified diagram of AC electrcity distribution from generation stations to consumers

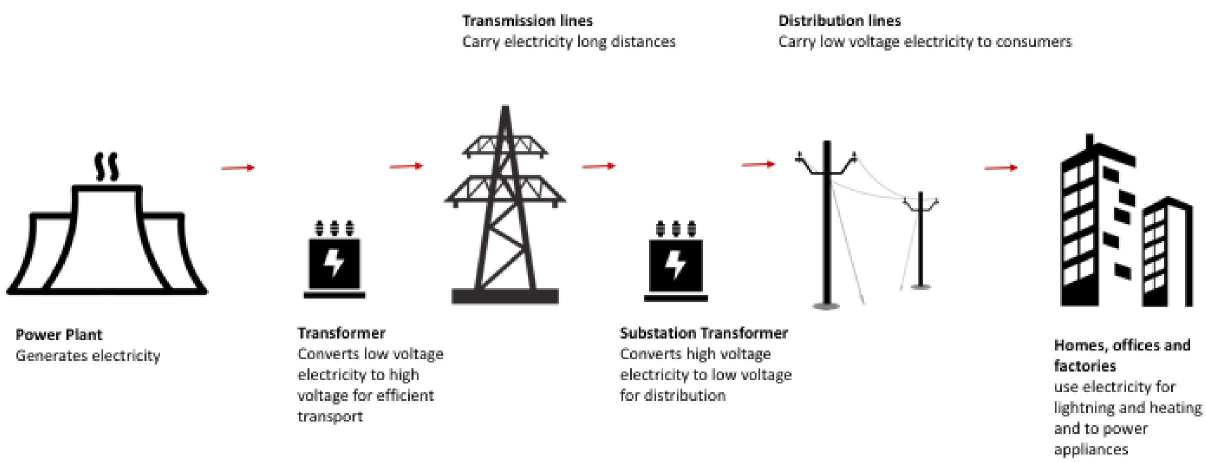


Figure 3.3: Simplified diagram of AC electrcity distribution from generation stations to consumers

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 (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.

3.2.0.4 Natural Gas

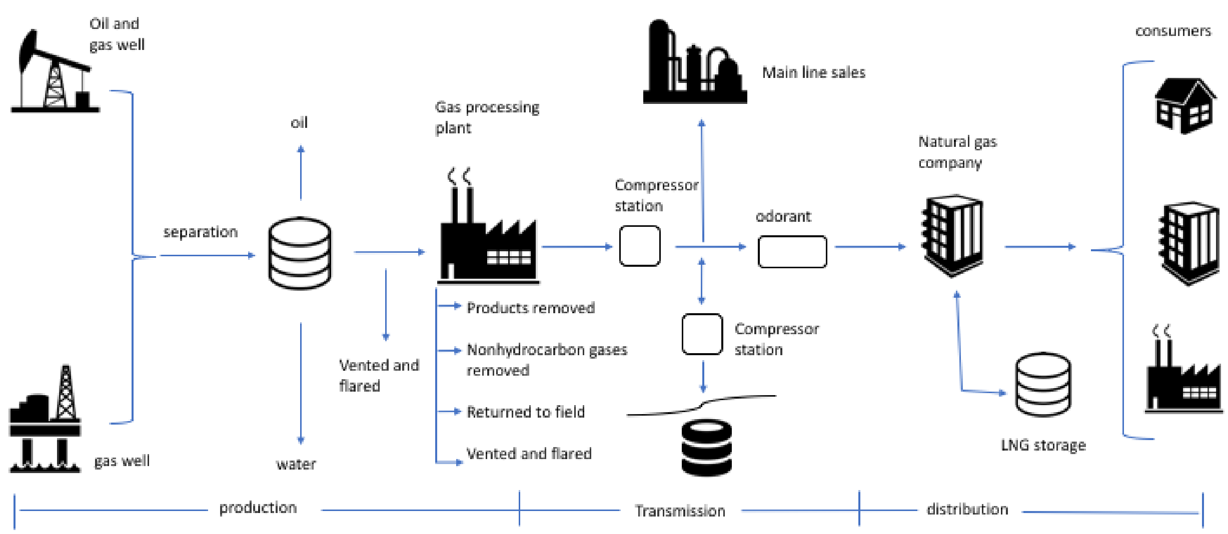


Figure 3.4: Natural gas production and delievery

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.

3.2.0.5 Oil & Gas

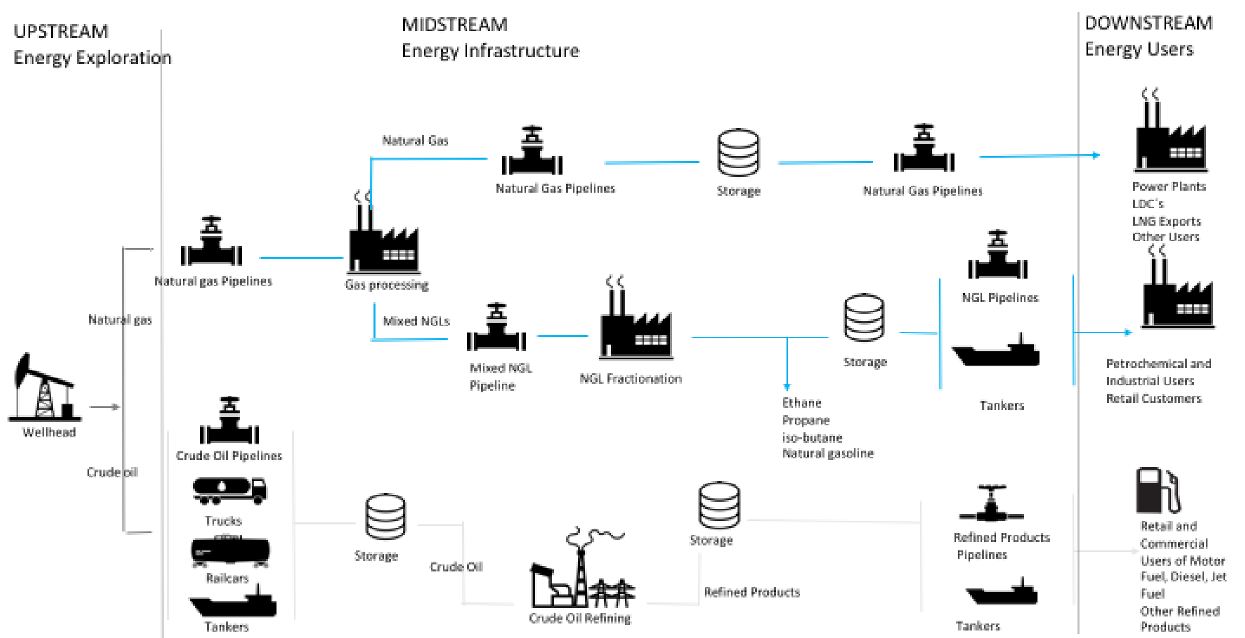


Figure 3.5: Oil & Gas production and delievery

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.

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.

Price for energy Components

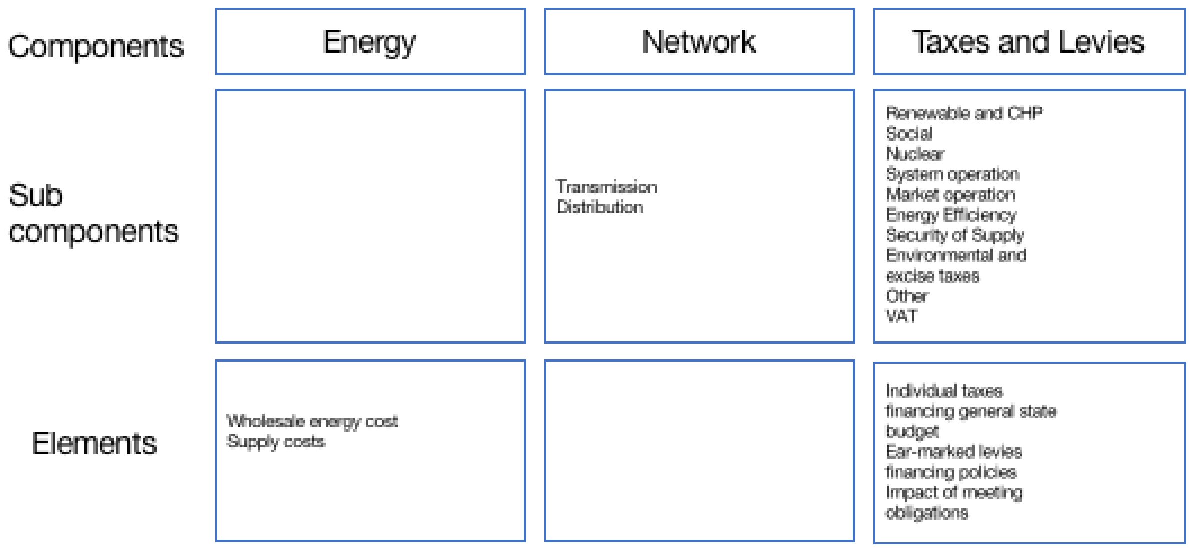


Figure 3.6: Price for energy Components

- 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 [1] 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

[1] REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Energy prices and costs in Europe (COM/2016/0769 final) of 30.11.2016, url:http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52016DC0769#footnoteref8

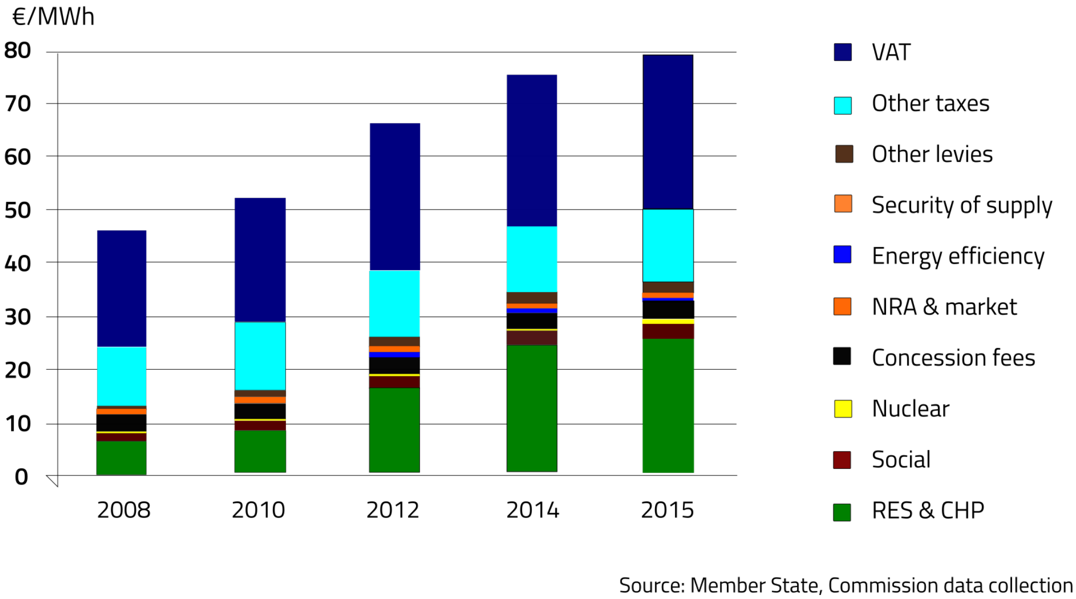
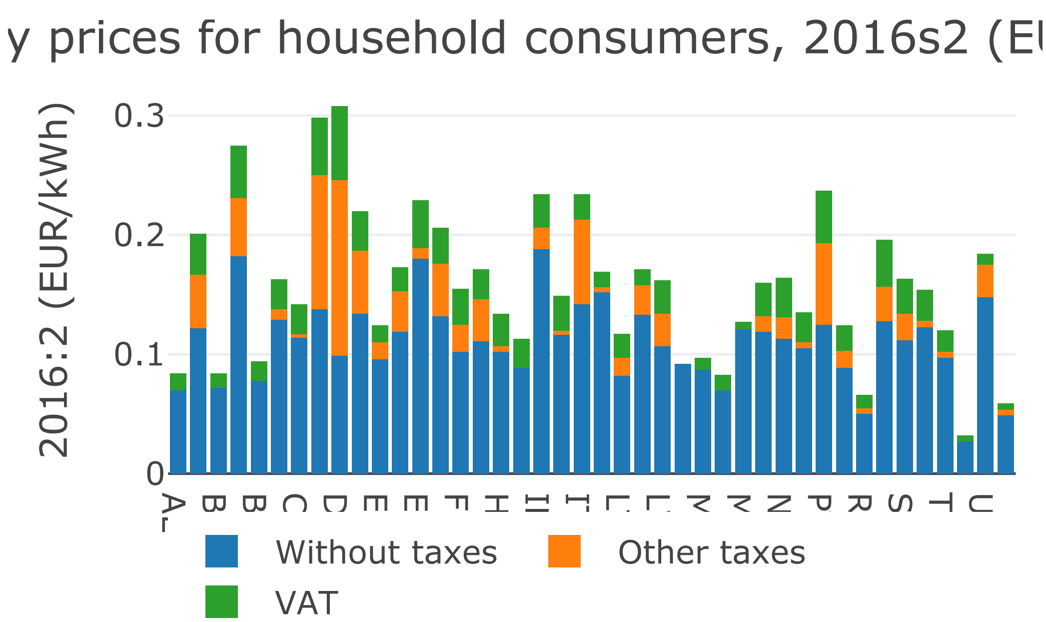


Figure 3.7:

the financial risk of the investors in this project, but is has been supported by the final users in the form of levies.

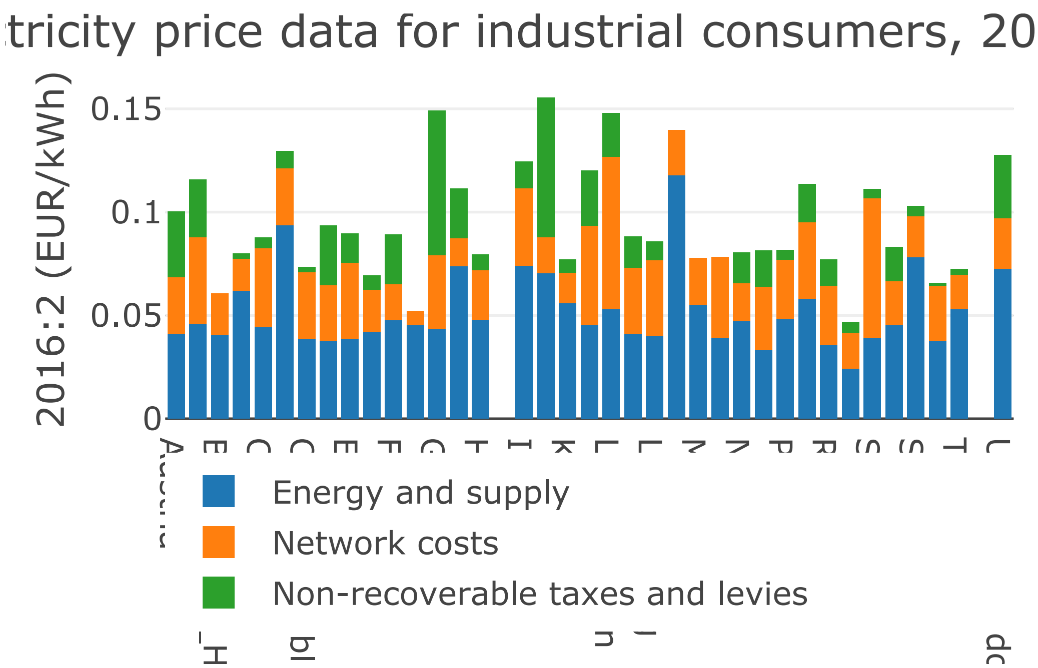
Another example are Levies in Energy Efficiency, which were also residual in 2008, but have been gaining importance in the overall taxes and levies of electricity prices.

3.3.0.1 Household consumers



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.

3.3.0.2 Industrial consumers



Note “The elements related to taxation policy can be grouped along several criteria to two or more subcategories. From the perspective of the taxpayer, the tax-related elements can be broken down into recoverable, partially recoverable and non-recoverable parts. Recoverable taxes or levies include full or partial recovery of taxes paid on purchases, either as a payment or as an offset against taxes owed to the tax authorities. VAT is an example of a recoverable tax but there may be more such taxes and levies which may be imposed on different administrative levels (local authorities, regions, states, federal authorities etc.). (…) In the case of non-recoverable taxes or levies, the full amount of collected proceeds is transferred to the tax authorities. This distinction is important when it comes to retail prices for different types of final consumers of electricity and natural gas. For example, the tax-related elements for households would most often be non-recoverable whereas at least some part of the taxes and levies companies that are paid by companies would be recoverable and companies may further benefit for some special exemption regime.” [2]

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

Thw 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.

[2]Source COMMISSION STAFF WORKING DOCUMENT Energy prices and costs report, url: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52014SC0020

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.

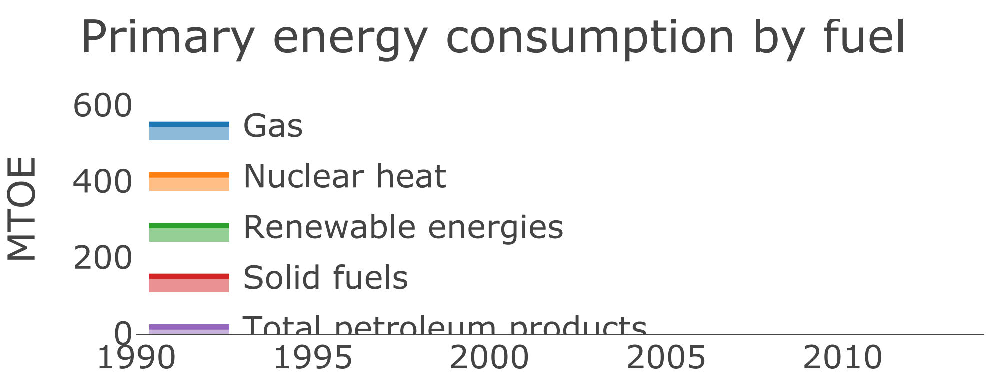
Regarding the conversion, the cost depends on the investment required to install a powerplant or a refinery, the operation and maintenance costs. Nonetheless, the final price is still largely dependent on the cost of the fuel. In the case of electricity, natural gas power plants are more efficient that 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.

3.4.0.1 The EU Energy Bill



This chart [3] gives you an idea of the relative importance of each fuel used in different activities.

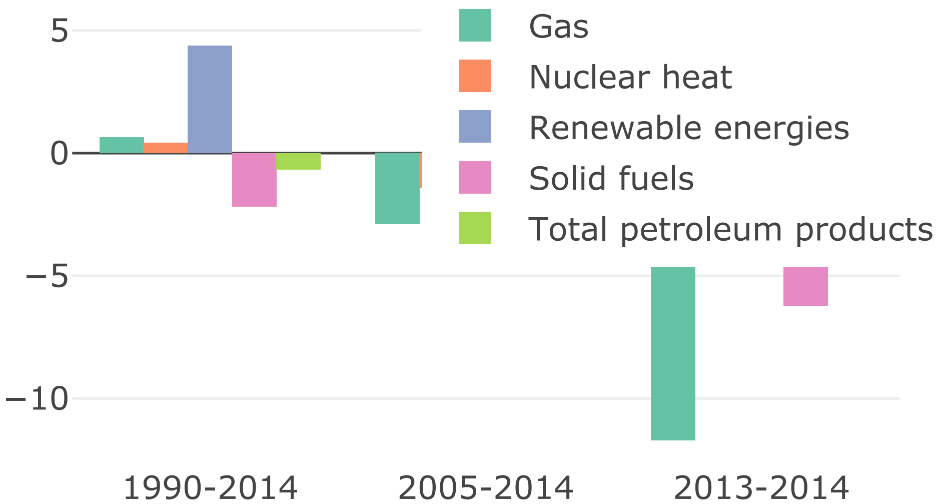
In 2014, primary energy consumption in the EU-28 countries amounted to 1 507 million tonnes of oil equivalent (Mtoe), 1.6 % above the 2020 target.

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.

[3] data source https://www.eea.europa.eu/data-and-maps/daviz/primary-energy-consumption-by-fuel-4#tab-chart_1

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 [4], there is a decrease of gas and an increases of RES.

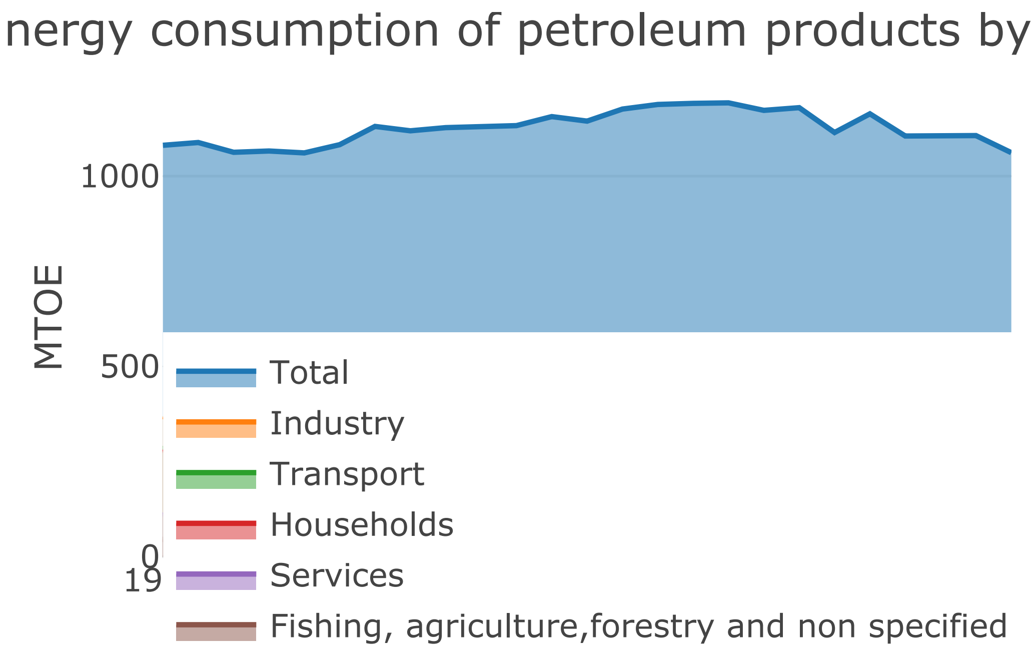
Considering the average annual growth rates for different fuels, there is a decrease of gas and an increases of RES. Still even having the most average annual growth, percentage wise, looking to its absolute numbers it is not still a main component of the energy mix.

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

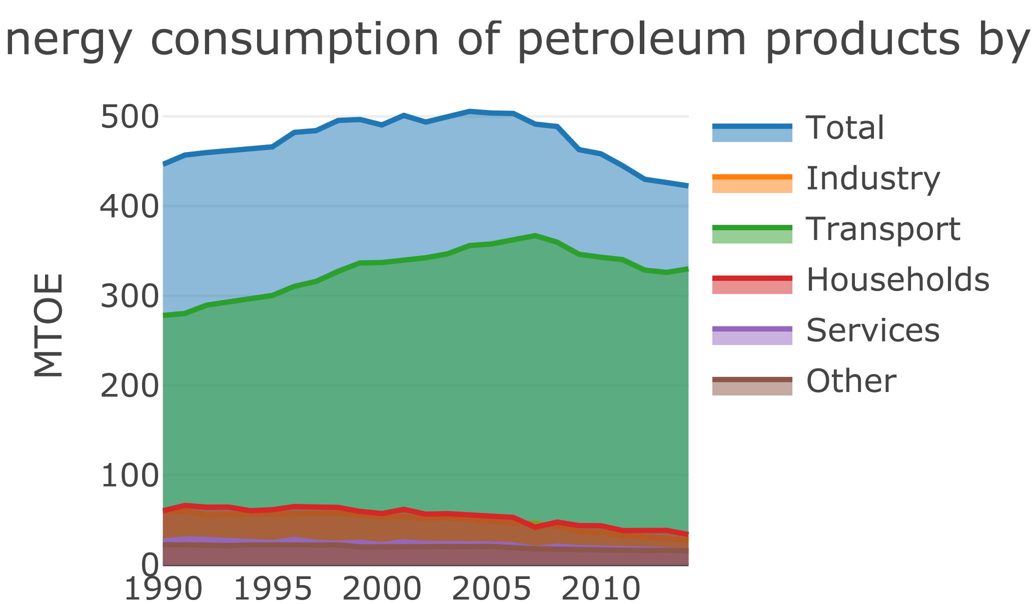
As you may be aware there are 3 main sectors: as transportation, industry, households.

[4]data source https://www.eea.europa.eu/data-and-maps/daviz/average-annual-growth-rates-4#tab-chart_4

3.4.0.2 Final energy consumption by sector [5]



Considering the Final energy consumption of petroleum products by sector [6] , most part is used in transportation.



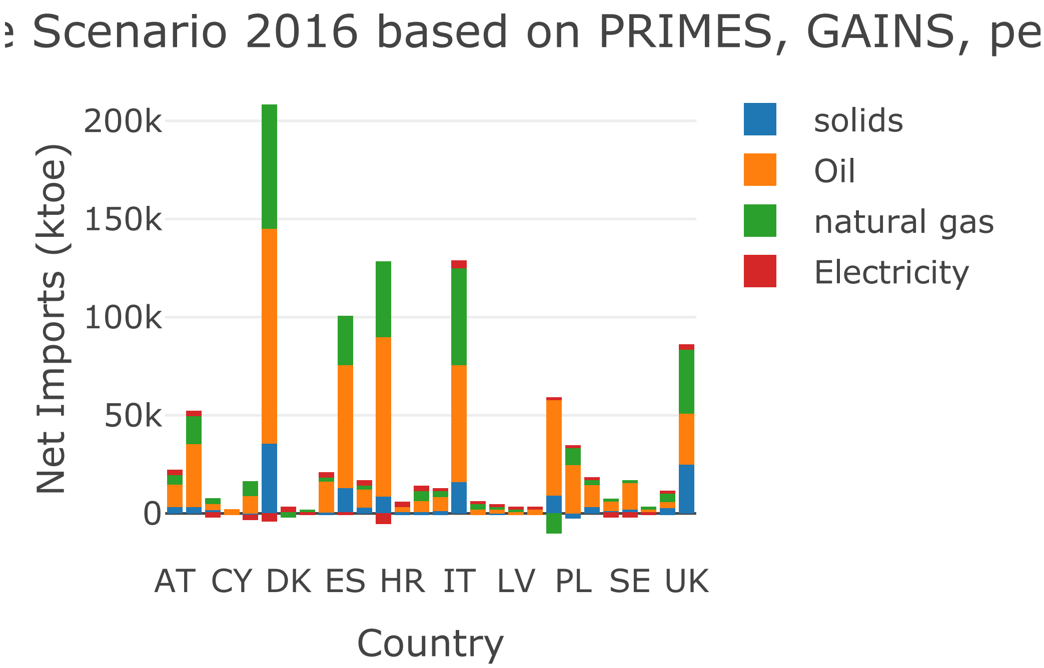
In Final energy consumption of natural gas by sector, households and industry are the two main sectors and Electricity is mostly used by households, industry and services. Buildings most are allocated to households and services sectors.

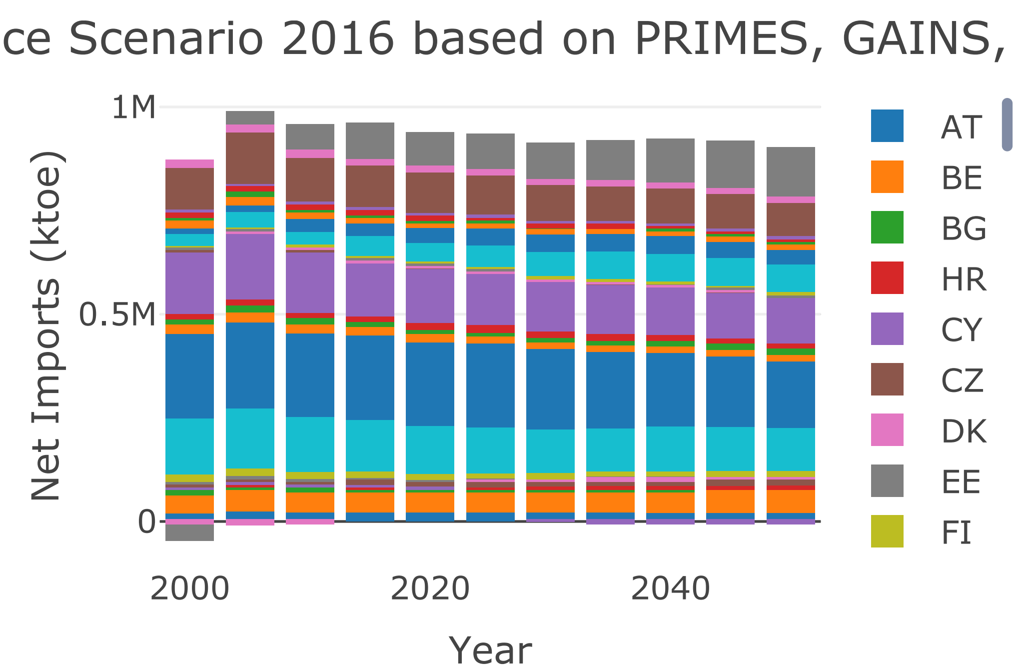
[5]data source https://www.eea.europa.eu/data-and-maps/daviz/total-final-energy-consumption-by-sector-3#tab-googlechartid_chart_41

[6]data source https://www.eea.europa.eu/data-and-maps/daviz/final-energy-consumption-of-oil-2#tab-chart_1

3.4.0.3 Net Imports

3.4.0.3.1 [Considering the EU Reference Scenario 2016 based on PRIMES, GAINS, per fuel and countries (2015)]Considering the EU Reference Scenario 2016 based on PRIMES, GAINS, per fuel and countries (2015) [7]





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

[7]Source: Source: EU Reference Scenario 2016 based on PRIMES, GAINS url: https://ec.europa.eu/energy/en/content/energy-modelling-interactive-graphs?type=scrollstackedcolumn2d&themes=s_28_net-imports,s_29_solids--5,s_30_oil--5,s_33_natural-gas--5,s_34_electricity--3. Cf. Energy dependence by product - % of imports in total energy consumption url http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=sdg_07_50&plugin=1 and EuroStat, Energy production and imports, url http://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_production_and_imports

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

3.4.1 Context

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.

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.

3.4.2 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.

3.4.2.0.1 [Total Consumption Daily Diagram (06/04/2017, Portugal)]Total Consumption Daily Diagram (06/04/2017, Portugal) [8]

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;

[8] source: REN url http://www.centrodeinformacao.ren.pt/EN/Pages/CIHomePage.aspx

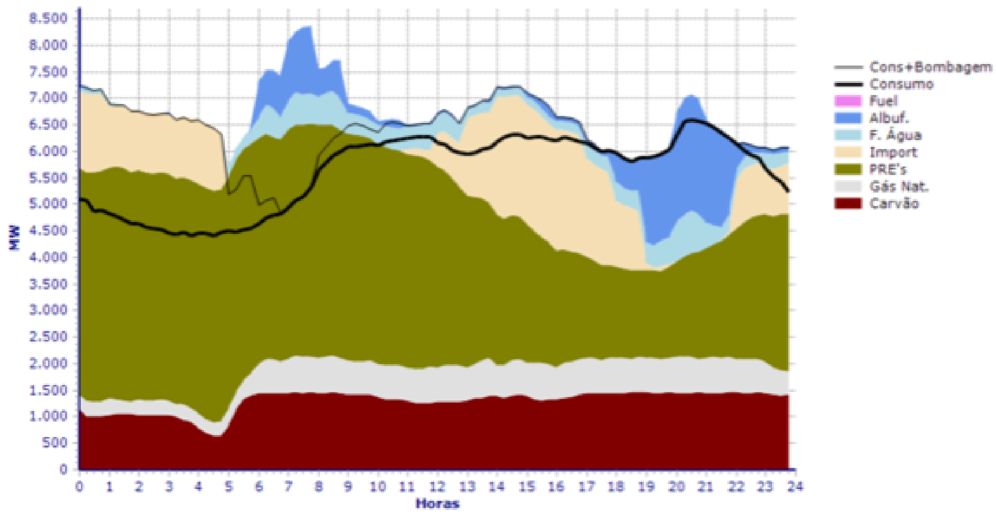


Figure 3.8: Total Consumption Daily Diagram

- 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.

3.4.2.1 Breakdown per source

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:

- Balancing demand and supply;
- 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.

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.

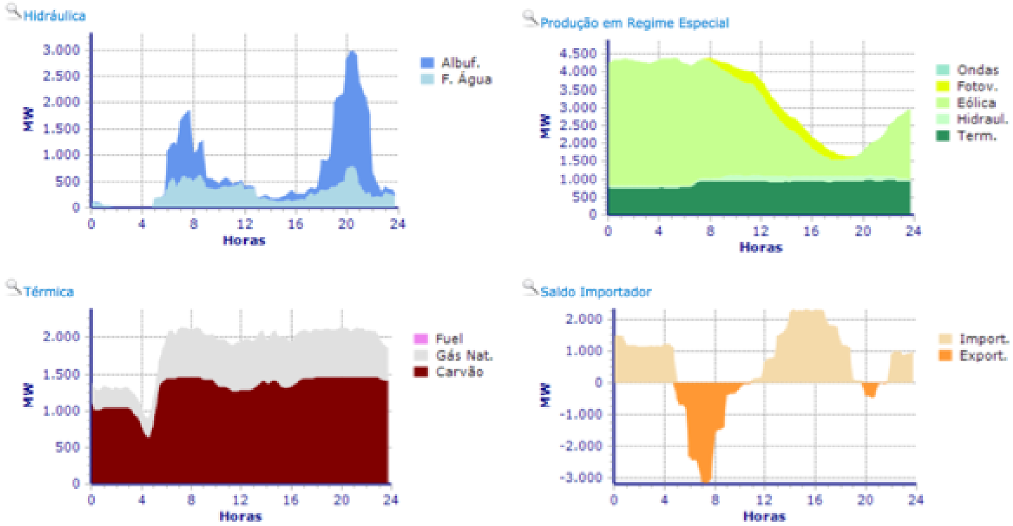
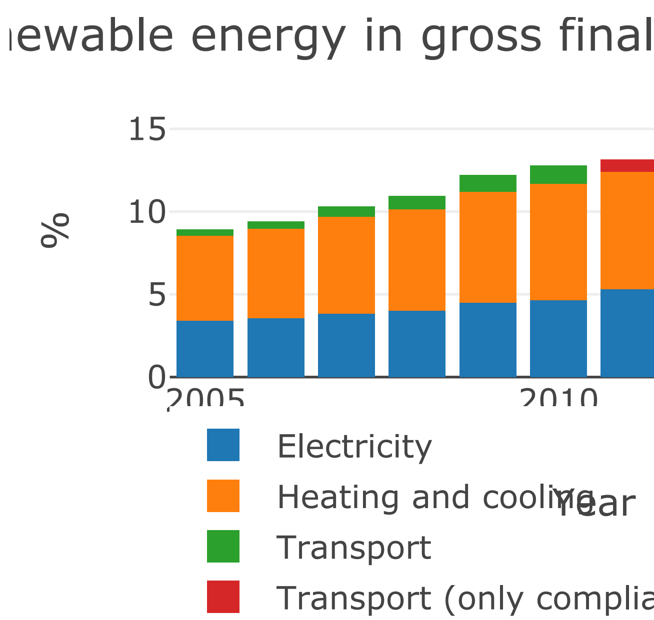


Figure 3.9: Breakdown per source



Share of renewable energy in gross final energy consumption - EU 28 [9]

You have to also take into account factor behind changes in energy consumption [10], witch changes across countries, such as:

- Change in Total Consumption.
- Consumption habit change;
- Increase in household stock and appliances
- Energy Savings

[9] Source https://www.eea.europa.eu/data-and-maps/daviz/share-of-renewable-energy-in-5#tab-chart_3_filters=%7B%22rowFilters%22%3A%7B%7D%3B%22columnFilters%22%3A%7B%22pre_config_country%22%3A%5B%22EU-28%22%5D%7D%7D

[10] Source: Changes in energy consumption in some Member States (2004- 2013), ODYSSEE database

3.4.2.2 Factors behind changes in energy consumption in some EU Member States 2005-2013

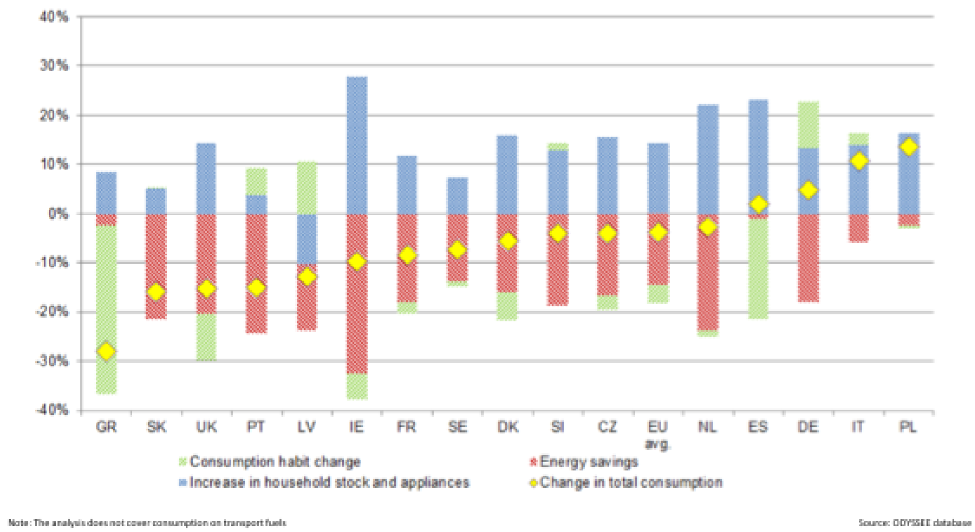
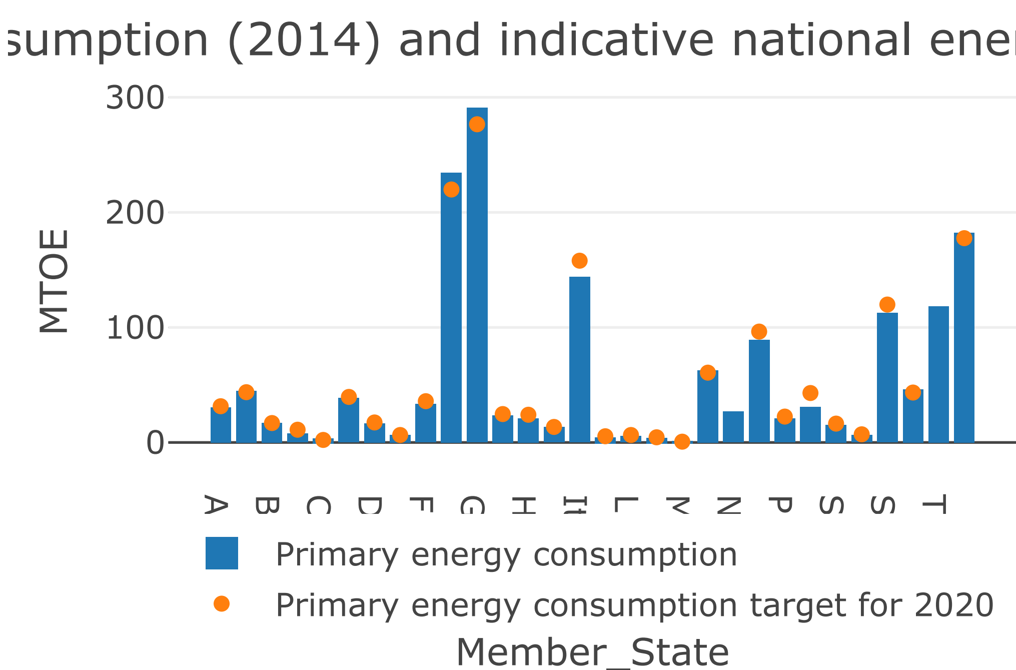


Figure 3.10: Factors behind changes in energy consumption in some EU Member States 2005-2013

As you may notice there is an overall increase in 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.

3.4.2.3 Energy efficiency targets for 2020 [11]

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



[11] source: https://www.eea.europa.eu/data-and-maps/daviz/member-states-primary-energy-consumption-1#tab-chart_4

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.

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.

3.4.2.4 Adjusted load shapes as a result of DSM [12]

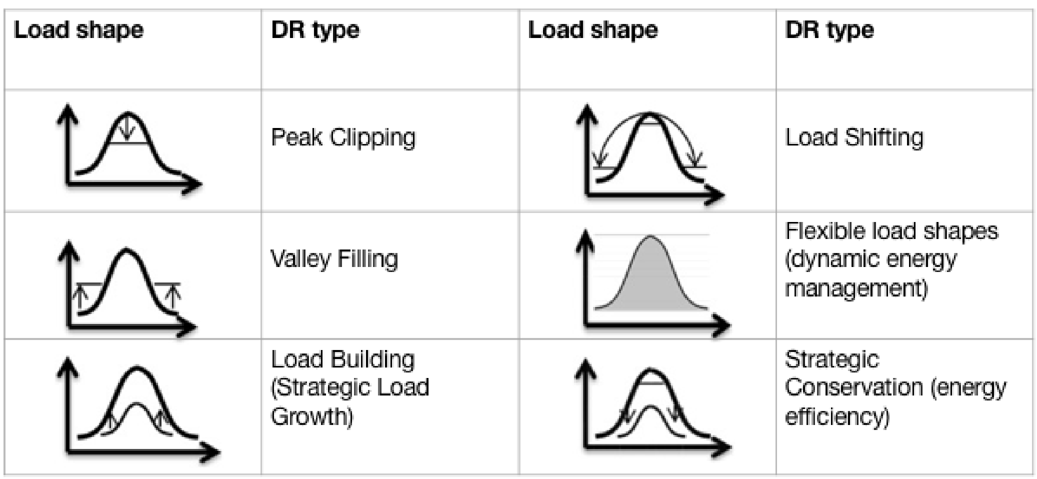


Figure 3.11: Adjusted load shapes as a result of DSM

3.4.3 Dynamic Pricing and Intervention in Prices setting Mechanisms

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

[12] “Adjusted load shapes as a result of DSM” (Chuang and Gellings, 2008; Gellings, 1985; Hakvoort and Koliou, 2014) as quoted in Cherrelle Eid, Elta Koliou, Mercedes Valles, Javier Reneses, Rudi Hakvoort,Time-based pricing and electricity demand response: Existing barriers and next steps,Utilities Policy,Volume 40,2016,Pages 15-25, ISSN 0957-1787,https://doi.org/10.1016/j.jup.2016.04.001. “Possible time-based pricing options for DER management (David and Lee, 1989; Faruqui and Sergici, 2009; Hakvoort and Koliou, 2014).” as quoted in Cherrelle Eid, Elta Koliou, Mercedes Valles, Javier Reneses, Rudi Hakvoort,Time-based pricing and electricity demand response: Existing barriers and next steps,Utilities Policy,Volume 40,2016,Pages 15-25,ISSN 0957-1787,https://doi.org/10.1016/j.jup.2016.04.001.

- the granularity of the period during which consumption is metered separately, and
- the dynamics/statics of Time-of-Use (ToU) prices.

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 each time band reflects the average wholesale price in the time band (low granularity-low dynamics). Although less common, a high granularity-low dynamics application is possible, where hourly consumption is priced at monthly average prices;

b) "critical peak pricing" is a dynamic pricing application in which a higher price is charged in limited periods when the consumption peak at the system level occurs (low granularity-high dynamics); and

c) "real-time pricing" is a dynamic pricing application in which the price is posted in real time and communicated to the consumer (high granularity-high dynamics).

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

3.4.3.1 Most commonly applied methods of dynamic pricing for electricity and gas supply and network charges [13]

Granularity of Dynamic Pricing	Supply	Network
	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)	
	A critical peak price/tariff is a price which is higher during short period which represent the critical peak in consumption	
	Other method of dynamic pricing supply price/tariff, which includes spot-based pricing for consumers on the basis of monthly spot-exchange prices	A dynamic network pricing method combines and defines capacity and energy component according to different pricing arrangements
		Interruptible network tariff options provide for the option to control a predefined amount of load in return for a lower network tariff
	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	

Source: ACER(2016)

Figure 3.12:

3.4.3.2 Share of standard household consumers supplied under dynamic pricing for supply and network charges of electricity in EU MSs – 2015 (%) [14]

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.

[13] ACER, "ACER Market Monitoring Report 2015 - ELECTRICITY AND GAS RETAIL MARKETS", 09/11/2016, p. 26,url http://www.acer.europa.eu/official_documents/acts_of_the_agency/publication/acer%20market%20monitoring%20report%202015%20-%20electricity%20and%20gas%20retail%20markets.pdfp.

[14] source url http://www.acer.europa.eu/official_documents/acts_of_the_agency/publication/acer%20market%20monitoring%20report%202015%20-%20electricity%20and%20gas%20retail%20markets.pdf p 27

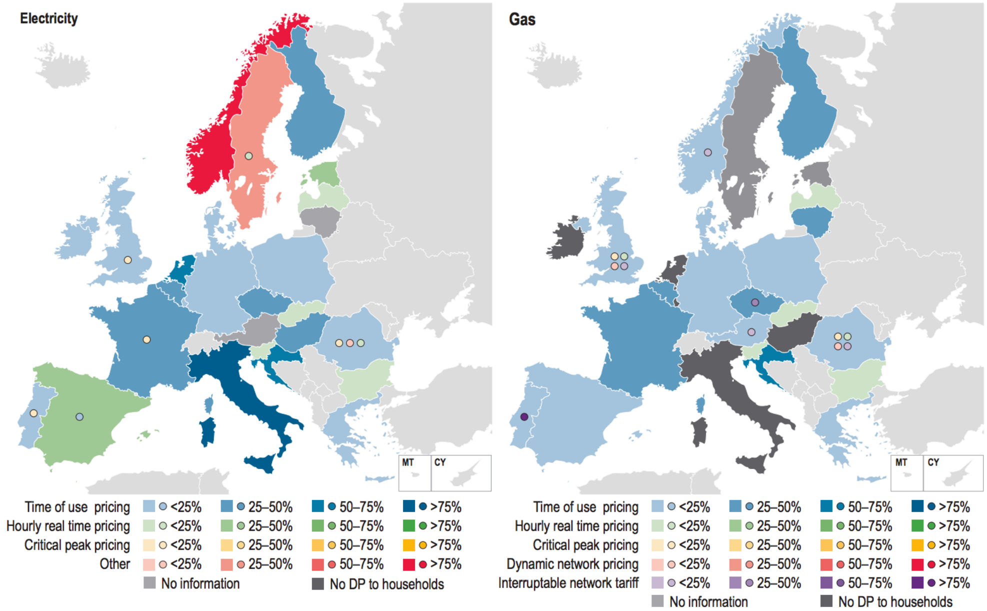
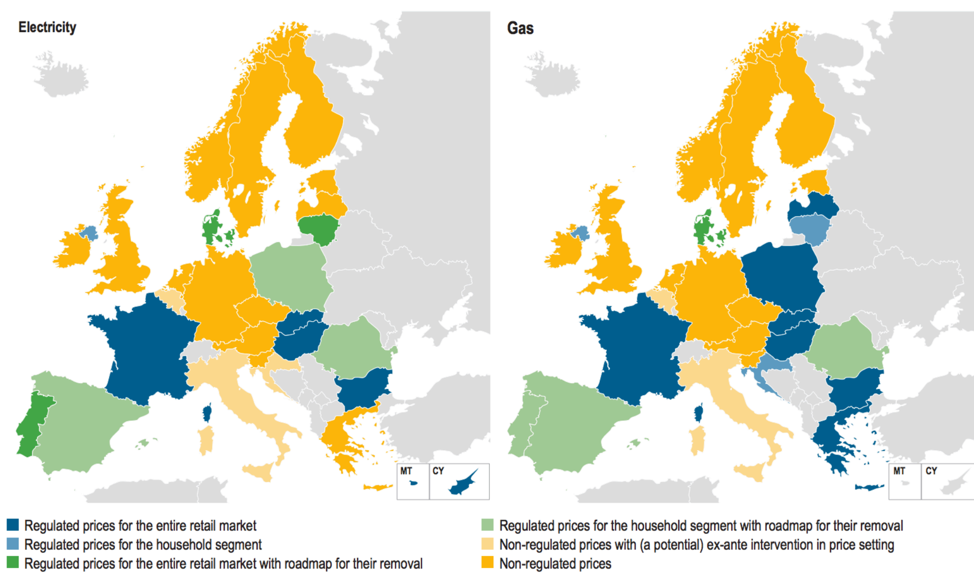


Figure 3.13:

3.4.3.3 Application of regulated end-user prices in retail electricity and gas markets in EU MSs and Norway – 2015 [^15]



[^15]: source url http://www.acer.europa.eu/official_documents/acts_of_the_agency/publication/acer%20market%20monitoring%20report%202015%20-%20electricity%20and%20gas%20retail%20markets.pdf p 47

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.

3.4.3.4 End-user regulation method for household segment in retail electricity and gas markets in the EU MS´s and Norway - 2015 [15]

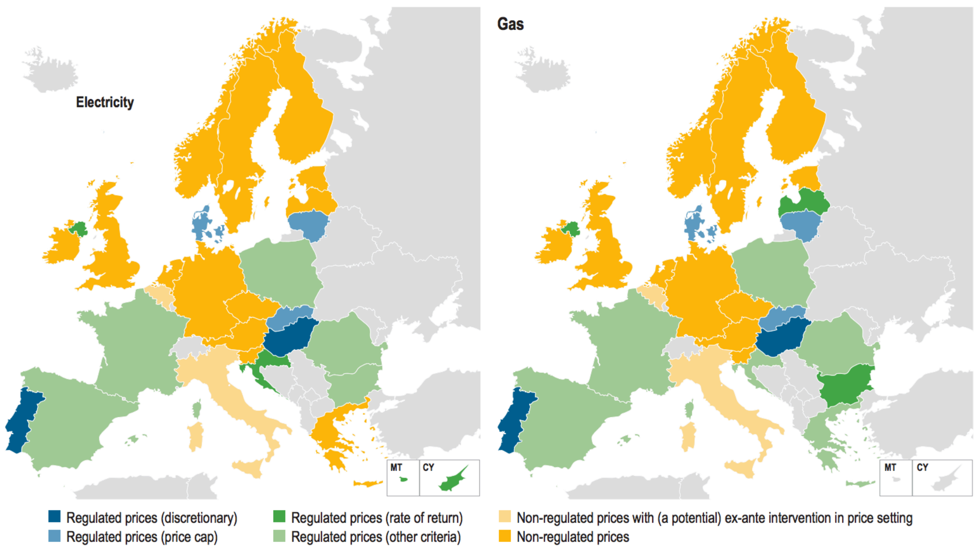


Figure 3.14:

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.

[15] http://www.acer.europa.eu/official_documents/acts_of_the_agency/publication/acer%20market%20monitoring%20report%202015%20-%20electricity%20and%20gas%20retail%20markets.pdf p 80

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.

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.

3.4.4 Further readings

1. Read “The Tragedy of the Commons” by Hardin (1968)

(Link: http://science.sciencemag.org/content/162/3859/1243)

Credits: Hardin, Science, 13 Dec 1968, Vol. 162, Issue 3859, pp. 1243-1248

2. Access “As referred by EU commission”Unbundling is the separation of energy supply and generation from the operation of transmission networks. If a single company operates a transmission network and generates or sells energy at the same time, it may have an incentive to obstruct competitors’ access to infrastructure. This prevents fair competition in the market and can lead to higher prices for consumers.”

In order to have an EU Energy Market, several instruments were designed, to create a competitive and fair energy market.

You can check here: https://ec.europa.eu/energy/en/topics/markets-and-consumers/market-legislation

https://ec.europa.eu/energy/en/content/energy-modelling-interactive-graphs?type=scrollcombidy2d&themes=s_69_-of-carbon-free-res-nuclear-gross-electricity-generation

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:

$$Opportunity\ Cost = Return\ on\ most\ Profitable\ Investment\ Choice - Return\ on\ Investment\ Chosen\ to\ Pursue$$

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).

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%

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).

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:

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

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

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

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:

C - Net amount of money (cash-flows) that goes in or out of a project

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.

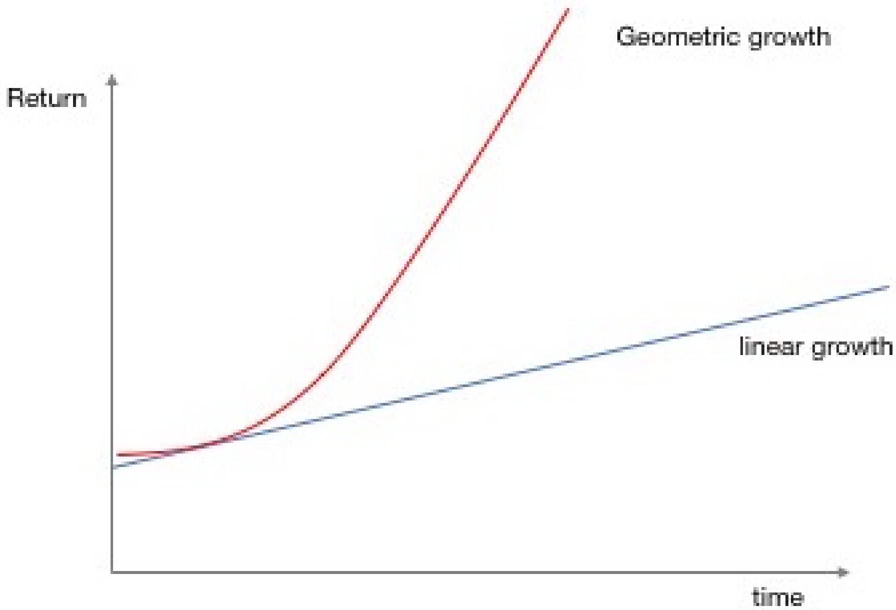


Figure 4.1: Geometric growth

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

$1010 = 1000 \times (1 + 0.01), with\ n = 1$

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€.

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:

example 3:

$990.01 = 1000/(1 + 0.01)$, 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, less cash outflows from the project during the period.

Discount 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.

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.

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:

$NPV = C»1(1+i) - nInitialInvestment$

In the above formula, C 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:

$NPV = C1 + C2 + C3 + ...Initial\ Investment$

$R_1 : (1+i)^1$

$R_2 : (1+i)^2$

$R_3 : (1+i)^3$

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 …

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

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:

$Year1 = 1 \sphericalangle (1+18\%)^1 = 0.8475$

$Year2 = 1 \sphericalangle (1+18\%)^2 = 0.7182$

$Year3 = 1 \sphericalangle (1+18\%)^3 = 0.6086$

$Year4 = 1 \lessdot (1 + 18\%)^4 = 0.5158$

The rest of the calculation is summarized below:

Year	Net Cash Inflow
1	$3,411
2	$4,070
3	$5,824
4	$2,065

Salvage Value

900

Total	Cash Inflow × Present Value Factor	
$3,411	0.8475	$2,890.68
$4,070	0.7182	$2,923.01
$5,824	0.6086	$3,544.67
$2,965	0.5158	$1,529.31

Total PV of Cash Inflows $10,888

− Initial Investment − 8,320

Net Present Value $2,568 thousand

4.2.1.1 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 (value used to buy an asset required to the project)
- Operating (value used to operate the asset required to the project)
- 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.

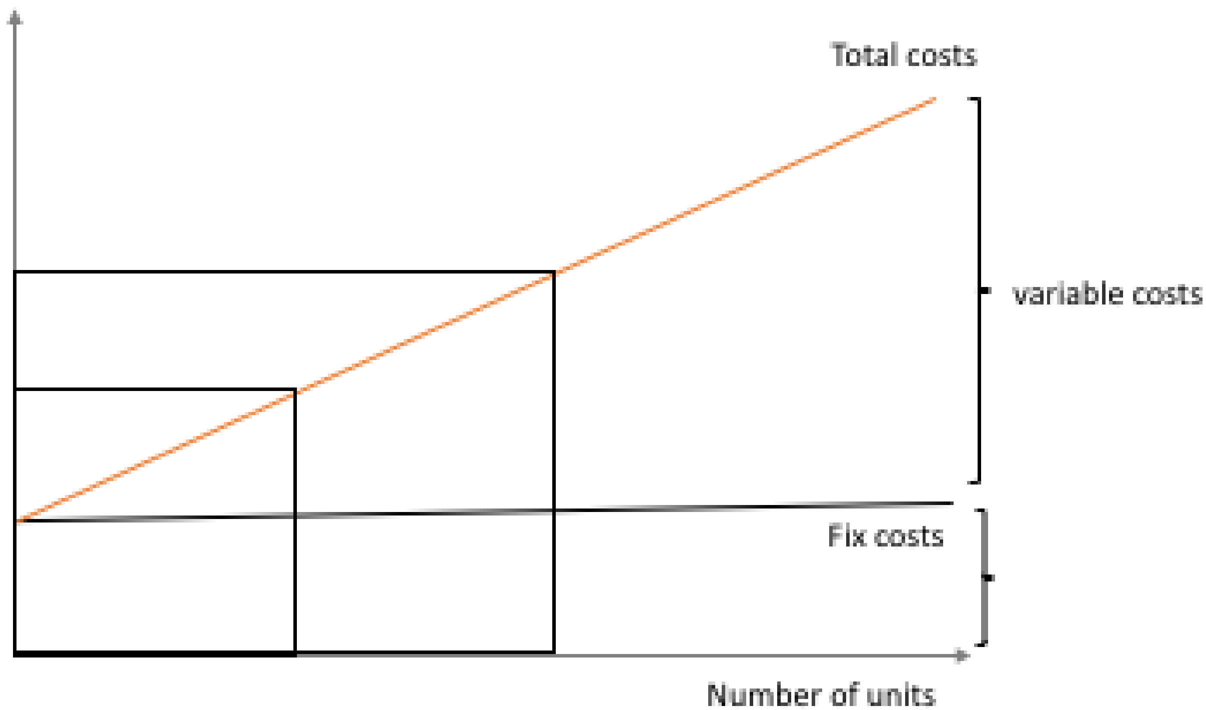


Figure 4.2:

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 light bulbs for a cost of €2 a light bulb. 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 light bulb.

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 light bulbs. If the company does not produce any light bulbs 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 light bulbs, its fixed cost remains the same. The variable costs change from zero to $2 million in this example.

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?

$$Fixed\ Costs \triangleleft (Price - Variable\ Costs) = Breakeven\ Point\ in\ Units$$

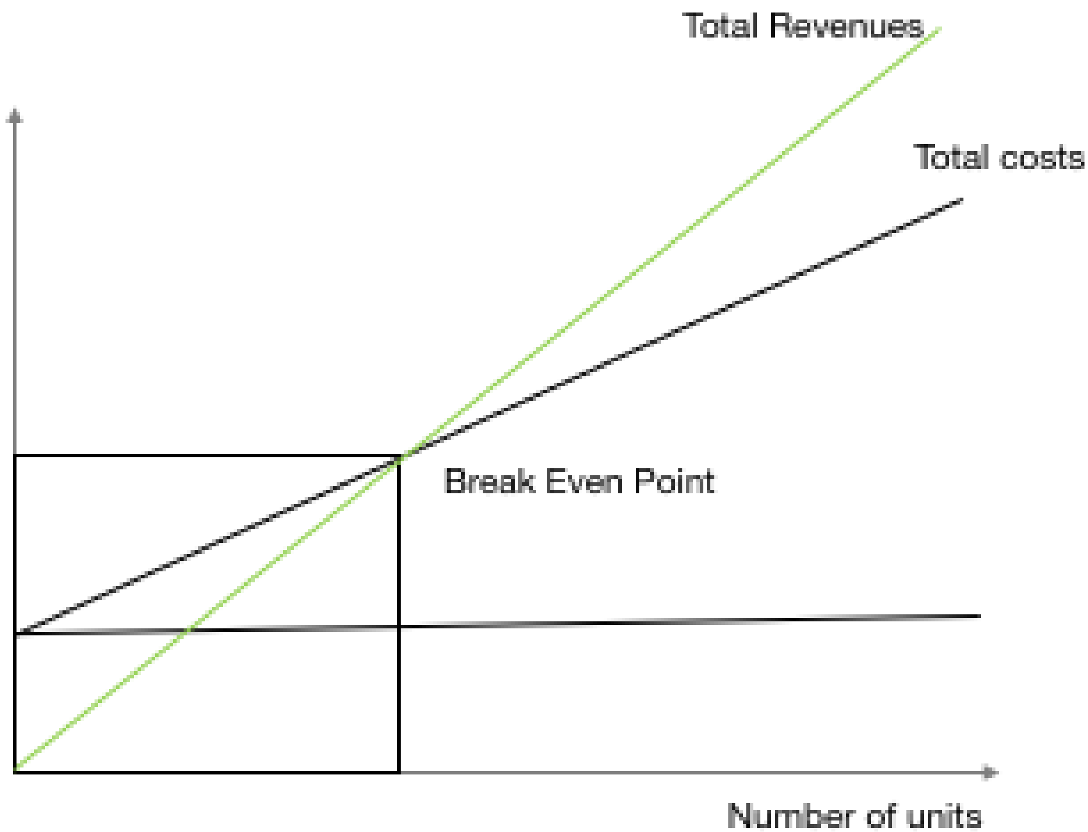

Total Revenues
Total costs
Break Even Point
Number of units

Figure 4.3:

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.

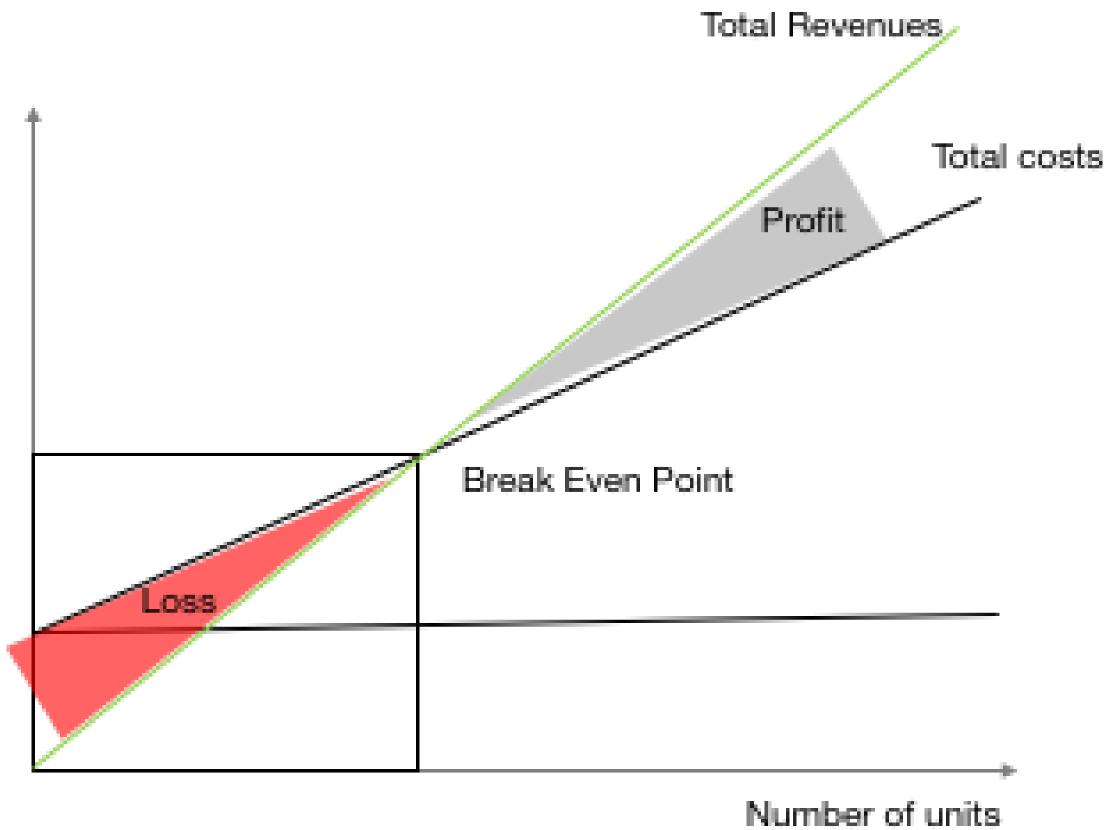


Figure 4.4:

If you look to the chart, 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;

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.

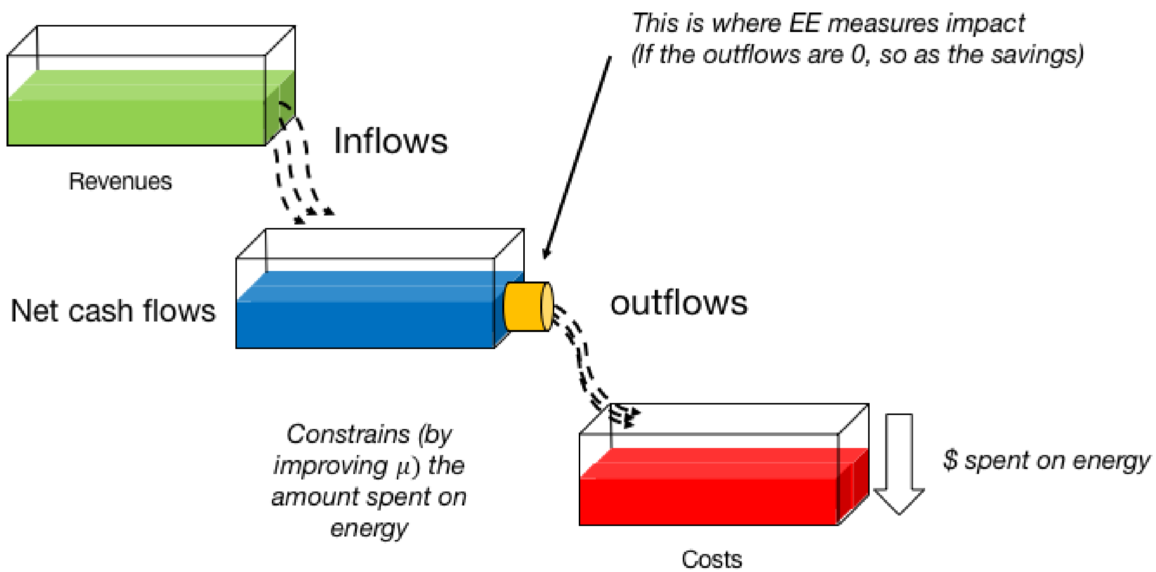


Figure 4.5:

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.

Multi-Step Format	Single-Step Format
Net Sales	Net Sales
Cost of Sales	Materials and Production

Multi-Step Format	Single-Step Format
Gross Income*	Marketing and Administrative
Selling, General and Administrative Expenses (SG&A)	Research and Development Expenses (R&D)
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.

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 Annuities

An annuity is a form of investment involving a series of periodic equal contributions made by an individual to an account for a specified term. Interest may be compounded at the end or beginning of each period. The term annuity is also used for a series of regular payments made to an individual for a specified time, such as in the case of a pension. The word annuity comes from the word “annual” meaning yearly. Pension funds involve making contributions to an annuity before retirement and receiving payments from an annuity after retirement. Calculations can be made to find out

(i) What a certain contribution per period amounts to as a fund
(ii) What size of contribution needs to be made to create of fund of a specific amount

When receiving payments from an annuity the present value of the annuity is the lump sum that must be invested now in order to provide those regular payments over the term.

Examples of annuities:

- Monthly rent payments
- Regular deposits in a savings account
- Social welfare benefits
- Annual premiums for a life insurance policy
- Periodic payments to a retired person from a pension fund
- Dividend payments on stocks and shares
- Loan repayments

The future value of an annuity is the total value of the investment at the end of the specified term. This includes all payments deposited as well as the interest earned.

4.3.7.1 Annuity-Immediate

Consider an annuity with payments of 1 unit each, made at the end of every year for n years. * This kind of annuity is called an annuity-immediate (also called an ordinary annuity or an annuity in arrears). * The present value of an annuity is the sum of the present values of each payment.

Example

Calculate the present value of an annuity-immediate of amount $100 paid annually for 5 years at the rate of interest of 9%.

Solution:

Table summarizes the present values of the payments as well as their total.

Present value of annuity

Year	Payment	Present value	
1	100	$100(1.09)^{-1}$	= 91.74
2	100	$100(1.09)^{-2}$	= 84.17
3	100	$100(1.09)^{-3}$	= 77.22
4	100	$100(1.09)^{-4}$	= 70.84
5	100	$100(1.09)^{-5}$	= 64.99
Total			388.97

We are interested in the value of the annuity at time 0, (the present value), and the accumulated value of the annuity at time n (the future value).

Suppose the rate of interest per period is i, and we assume the compound-interest method applies.

Let a_{ni} denote the present value of the annuity, which is sometimes denoted as a_n when the rate of interest is understood.

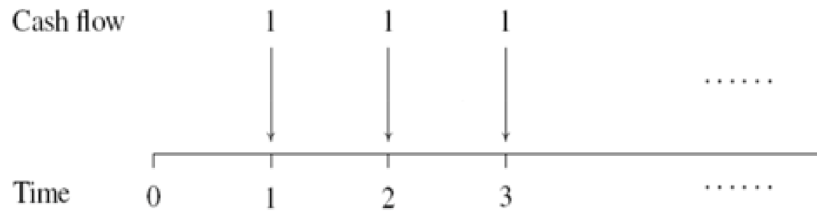
As the present value of the jth payment is v^j, where v = 1/(1+i) is the discount factor, the present value of the annuity is:

$a_n = v + v^2 + v^3 + ... + v^n$

$= v \times \left[\frac{1-v^n}{1-v}\right]$

$= \frac{1-v^n}{i}$

$= \frac{1-(1+i)^{-n}}{i}$



Time diagram of n payment annuity immediate

The accumulated value of the annuity at time n is denoted by s_{ni} or s_n

This is the future value of ane at time n. Thus, we have:

$s_n = s_n \times (i+1)^n$

$s_n = \frac{(1+i)^n - 1}{i}$

If the annuity is of level payments of P, the present and future values of the annuity are Pa_n and Ps_n, respectively.

4.3.7.2 Amortisation and amortised loans

The process of accounting for a sum of money by making it equivalent to a series of payments over time, such as arises when paying off a debt over time is called amortisation. Accordingly, a loan that involves paying back a fixed amount at regular intervals over a fixed period of time is called an amortised loan. Term loans and annuity mortgages (as opposed to endowment mortgages) are examples of amortised loans.

4.3.7.3 Regular payments over time – geometric series

Arrangements involving savings and loans often involve making a regular payment at fixed intervals of time. For example, a "regular savings" account might involve saving a certain amount of money every month for a number of years. A term loan or a mortgage might involve borrowing a certain amount of money and repaying it in equal instalments over time.

Calculations involving such regular payment schedules, when they are considered in terms of the present values of the payments as in loans will involve the summation of a geometric series.

4.3.7.4 Amortised loan example

When regular payments are being used to pay off a loan, then we are usually interested in calculating their present values (value right now) rather than their future values, because this is the basis upon which the loan repayments and/or the interest rate are calculated.

We have seen that the APR is the interest rate for which the present value of all the repayments is equal to the present value of the loan. In the case of an amortised loan, these present values form a consistent pattern that turns out to be a geometric series.

Example

A borrows €10,000 at an interest rate of 6%. He wants to repay it in five equal instalments over five years, with the first repayment one year after he takes out the loan. How much should each repayment be?

Solution Let each repayment equal A. Then the present value of the first repayment is A/1.06, the present value of the second repayment is A/1.062, and so on. The total of the present values of all the repayments is equal to the loan amount.

Total of the present values of all the repayments $A = \frac{A}{1.06} + \frac{A}{1.06^2} + ...\frac{A}{1.06^5}$

This is a geometric series, with n = 5,first term $a = \frac{A}{1.06}$ and common ratio $r = \frac{A}{1.06}$

The sum of the first 5 terms which is the loan amount is $S_5 = \frac{\frac{A}{1.06}\left(1-\frac{A}{1.06^5}\right)}{\left(1-\frac{A}{1.06}\right)} = 4.212363786A$

If S_5 has to equal the loan amount of €10,000, then $A = \frac{10000}{4.212363786} = 2373.96$

(could find s_n for a small number of terms by adding the terms individually first and then checking their answer by using the formula for Sn of a geometric series.)

This type of calculation is so common that it is convenient to derive a formula to shortcut the calculation for the regular repayment A. By considering the general case of an amortised loan with interest rate i, taken out over t years, for a loan amount of P, a geometric series can be used to derive the general formula:

$$A = P\frac{i(1+i)^t}{(1+i)^t - 1}$$

This formula gives the same result as (i) above: A = 10000

$$A = 10000\frac{0.06(1.06)^5}{(1.06)^5 - 1} = 2373.96$$

(The formula assumes payment at the end of each payment period.)

4.3.7.5 Amortisation formula

Terms associated with the amortisation formula revisited:

Present Value is the value on a given date of a future payment or series of future payments discounted to reflect the time value of money and other factors such as investment risk.

An annuity is a series of equal payments or receipts that occur at evenly spaced intervals. Each payment occurs at the end of each period for an ordinary annuity.

An amortised loan is a loan for which the loan amount plus interest is paid off in a series of regular payments. An amortised loan is an annuity whose future value is the same as the loan amount's future value, under compound interest. An amortised loan's payments are used to pay off a loan. Other types of annuities' payments can be used to generate savings as for example for retirement funds.

We can think of the situation in two ways which give the same end result:

1) The sum of the present values of all the annual repayment amounts = sum borrowed. (This principle is enshrined in European Law)
2) Future value of loan amount = Future value of the annual repayment amounts (i.e. future value of the annuity)

Given that A = annual repayment amount, the present value of one annual repayment amount paid in t years time is

$P = \frac{A}{(1+i)^t}$,where i is the annual rate of interest expressed as a decimal or fraction

So if I borrow €10,000 over 5 years, when I add up the present values of all the annual repayment amounts, this sum should equal €10,000.

$100000 = \frac{A}{(1+i)} + \frac{A}{(1+i)^2} + \frac{A}{(1+i)^3} + \frac{A}{(1+i)^4} + \frac{A}{(1+i)^5} = A = \frac{1}{(1+i)} + \frac{1}{(1+i)^2} + \frac{1}{(1+i)^3} + \frac{1}{(1+i)^4} + \frac{1}{(1+i)^5}$

Two methods of deriving the "Amortisation – mortgages and loans" formula

Loan amount = sum of the present value of all the repayments (assuming payment at the end of each payment period) P = Loan amount , A = periodic repayment amount, t = the number of payment periods i = the interest rate for the payment period expressed as a decimal or fraction

$A = \frac{1}{(1+i)} + \frac{1}{(1+i)^2} + \frac{1}{(1+i)^3} + \ldots . \frac{1}{(1+i)^t}$

$P = S_n$ of a geometric series , n = t = number of compounding periods , $a = \frac{A}{(1+i)^n}$, $r = \frac{1}{(1+i)}$

$P = \frac{a(1-r^n)}{(1-r)}$

$$= \frac{\frac{A}{(1+i)}}{(1-r)}, \frac{1-(1+i)^t}{(1+i)}(1-r)$$

$A = P\frac{i(1+i)^t}{(1+i)-1}$

Method 2 The future value of the loan amount P = sum of the future values of t equal repayments each of value A made at the end of each compounding period.

$P = (1+i)^t = A(1+i)^{-t} + A(1+i)^{-2t} + \ldots\ldots. A(1+i)^{-t}$

$P(1+i)^t = S_n$, of a geometric series

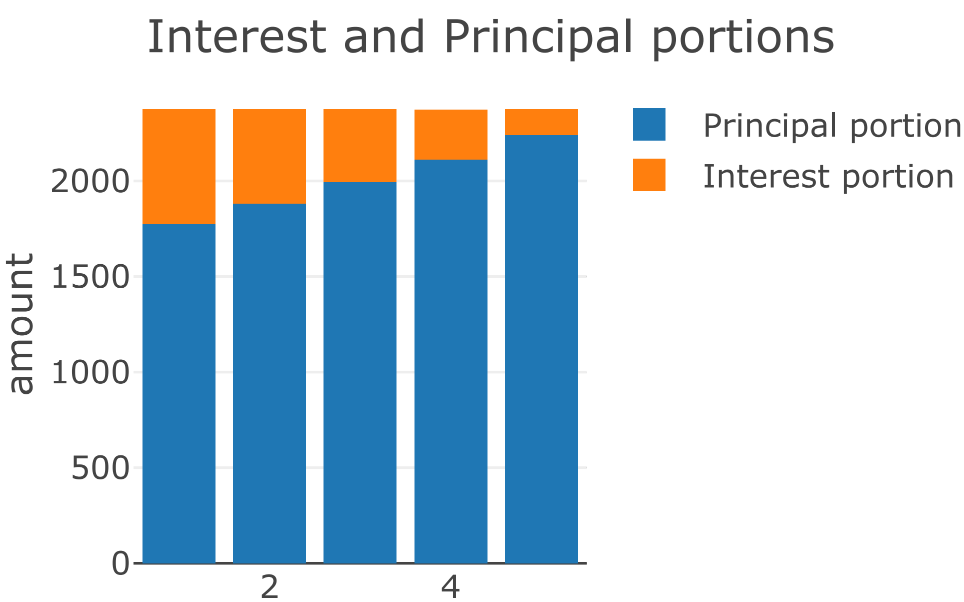
$S_n = \frac{a(1-r^n)}{(1-r)}$, where $a = A$,$r = 1+i, n = t$

$P = (1+i)^t = \frac{A((1+i)^t-1}{(1+i)-1}$

$P = (1+i)^t = \frac{A((1+i)^t-1}{i}$

$A = P\frac{(1+i)^t i}{(1+i)-1}$

Assuming a loan is repaid in fixed annual repayments – the annual repayment is made up of two parts – one part interest and the remainder is part of the capital sum borrowed, called "principal portion" in the graph below. The graphs below show that that even though the periodic payment is fixed, the part of it which is interest is decreasing as more of the loan is paid off and the part of it which is principal is increasing. The graph below refers to an amortisation schedule for a loan paid back monthly over 360 months.



Amortisation Schedule

An amortisation schedule is a list of several periods of payments, the principal and interest portions of those payments and the outstanding principal (or balance) after each of those payments is made. Below is the amortisation schedule, showing in figures the trends in the interest and principal portions of each payment for successive payments for the loan in example supra €10,000 loan paid back over 5 years at 6% interest rate involving a fixed annual repayment of €2376.96 per year.

Payment #	Fixed payment	Interest portion	Principal portion	balance
0				€ 10,000.00
1	€2,373.96	€ 600.00	€ 1,773.96	€ 8,226.04
2	€2,373.96	€ 493.56	€ 1,880.40	€ 6,345.63
3	€2,373.96	€ 380.74	€ 1,993.23	€ 4,352.41
4	€2,373.96	€ 261.14	€ 2,112.82	€ 2,239.59
5	€2,373.96	€ 134.38	€ 2,239.59	€ 0.00

Steps in an amortisation schedule:

1. Fill in the first balance = loan amount (payment number 0)
2. For payment 1, fill in the payment number and fixed repayment amount
3. For payment 1 row, find the interest on the previous balance using the simple interest formula
4. Calculate the debt payment (principal portion) = the repayment amount - the interest portion
5. Calculate the new balance = previous balance - the principal portion
6. Repeat Steps 3, 4 and 5 for all the other payments from payment 2 onwards
7. For the last payment, the principal portion = the previous balance
8. When all the payments have been made the final balance is €0.00

Explanation of the amortisation schedule

Payment #	Fixed payment	Interest portion	Principal portion	balance
0				Loan amount
1	Fixed repayment amount calculated using "Amortisation - loans and mortgages formula"	Simple interest on the previous balance	Repayment amount - interest portion	Previous balance - this payment's principal portion
2	Fixed repayment amount calculated using "Amortisation - loans and mortgages formula"	Simple interest on the previous balance	Repayment amount - interest portion	Previous balance - this payment's principal portion
Last	Fixed Repayment = principal portion + interest portion	Simple interest on the previous balance	Previous balance	€ 0.0

4.3.8 Capital Structure

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

What is the Basic Accounting Equation?

Assets = Liabilities + Owners Equity

Double entry bookkeeping and accounting is based on the basic accounting equation which states that the total assets of a business must equal the total liabilities plus the owners equity in the business.

Enterprise value (EV) = Equity value (QV) + Net debt (ND)

One side represents the assets of the business (buildings, inventory, vehicles etc), and the other side represents how those assets were funded (capital, retained earnings, loans, supplier credit etc.). Notice that owners equity includes amounts invested by the owners (capital) and profits of the business which have been retained.

The basic accounting equation is true at any point in time for a business and is also true for each individual double entry transaction. For example, if the business buys furniture on credit from a supplier for 200 then the basic accounting equation is shown as follows.

Accounting Equation Assets = Liabilities + Equity Furniture = Accounts payable + None 200 = 200 + 0

The two sides of the basic accounting equation are equal. On one side is the furniture coming into the business as an asset, on the other side is the funding for the asset which in this case is credit from a supplier.

The Expanded Accounting Equation Since owners equity is made up from capital injected and retained earnings of the business, the basic accounting equation can be expanded as follows:

Assets = Liabilities + Capital + Retained Earnings

In addition, retained earnings can be expanded to revenue less expenses less owners drawings, giving the fully expanded accounting equation shown below.

Assets = Liabilities + Capital + Revenue - Expenses - Drawings

It should also be noted that since revenue less expenses is equal to the net income of the business for the period the accounting equation can also be stated as follows.

Assets = Liabilities + Capital + Net income - Drawings The fully expanded accounting equation is summarized in the diagram below.

The owners drawings represent cash taken out of the business by way of salary, in a company this would be represented by dividends paid to the equity owners.

The expanded accounting equation effectively shows that retained earnings is the link between the balance sheet and the income statement. The income statement is in fact a further analysis of the equity of the business.

The expanded accounting equation diagram used in this tutorial is available for download in PDF format by following the link below.

Relationship Between Financial Statements The four main financial statements are used to show different aspects of a business. It is important to understand the relationship between financial statements as this allows a full understanding of the financial performance of the business when analyzing financial statements

The Four Financial Statements The 4 financial statements are as follows.

1. Balance Sheet – The balance sheet or statement of financial position, shows a financial snapshot of the assets, liabilities and equity of the business at a specific point in time.
2. Income Statement – The income statement shows the financial performance of the business over an accounting period in terms of its revenue, expenses, and net income.

3. Statement of Retained Earnings – The statement of retained earnings reconciles the beginning and ending retained earnings by adjusting for the net income and dividend distributions of the business.

4. Cash Flow Statement – The cash flow statement or statement of cash flows shows the cash inflow and cash outflow of the business over an accounting period.

Relationship Between Financial Statements The relationship between financial statements can be seen by reviewing the basic trading operations of a business.

4.3.8.1 Leverage and impact on Balance Sheet

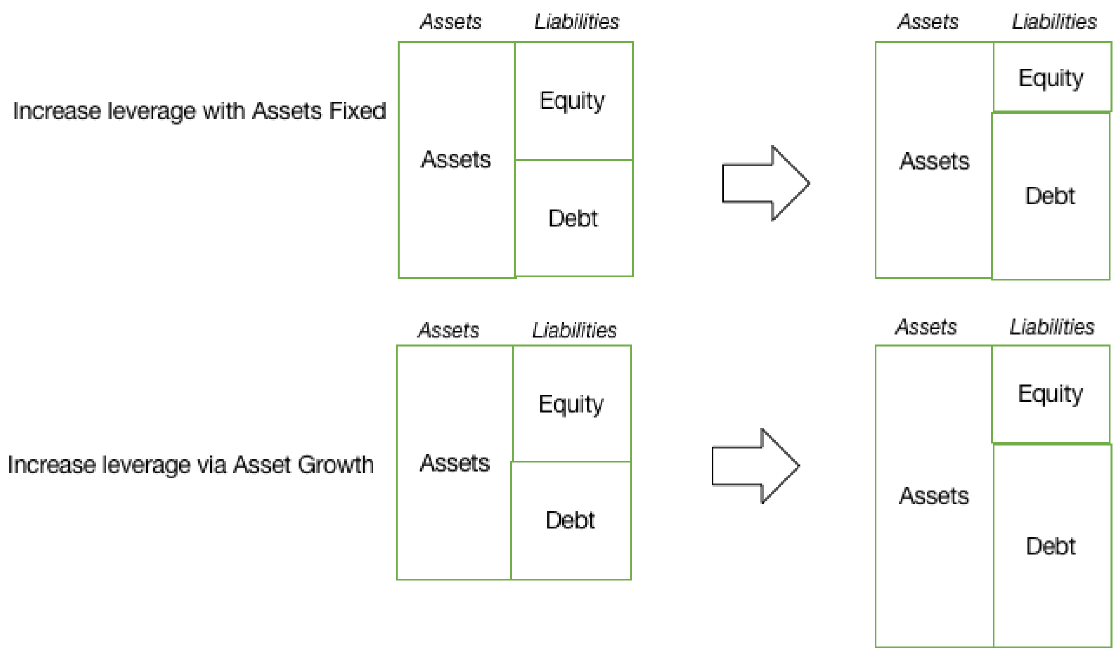


Figure 4.6:

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

A	B	
Investment	1000€	1000€
Equity	500€	1000€
Debt	500€	0€
Interest Rate	10%	
EBITDA	1000€	1000€
Interest expenses	(50€)	0
Taxable Income	950€	1000€
Corporate Tax (25%)	(237,5€)	(250€)
Net Income	762,5€	750€

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 Evaluation

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

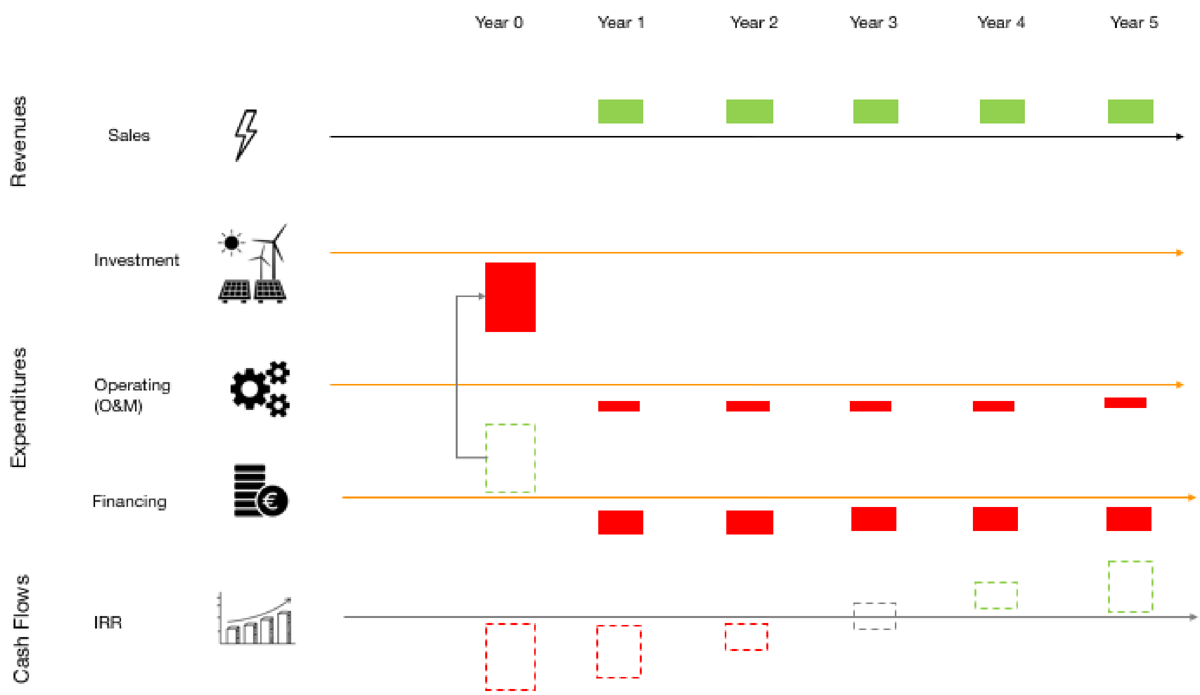


Figure 4.7:

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?

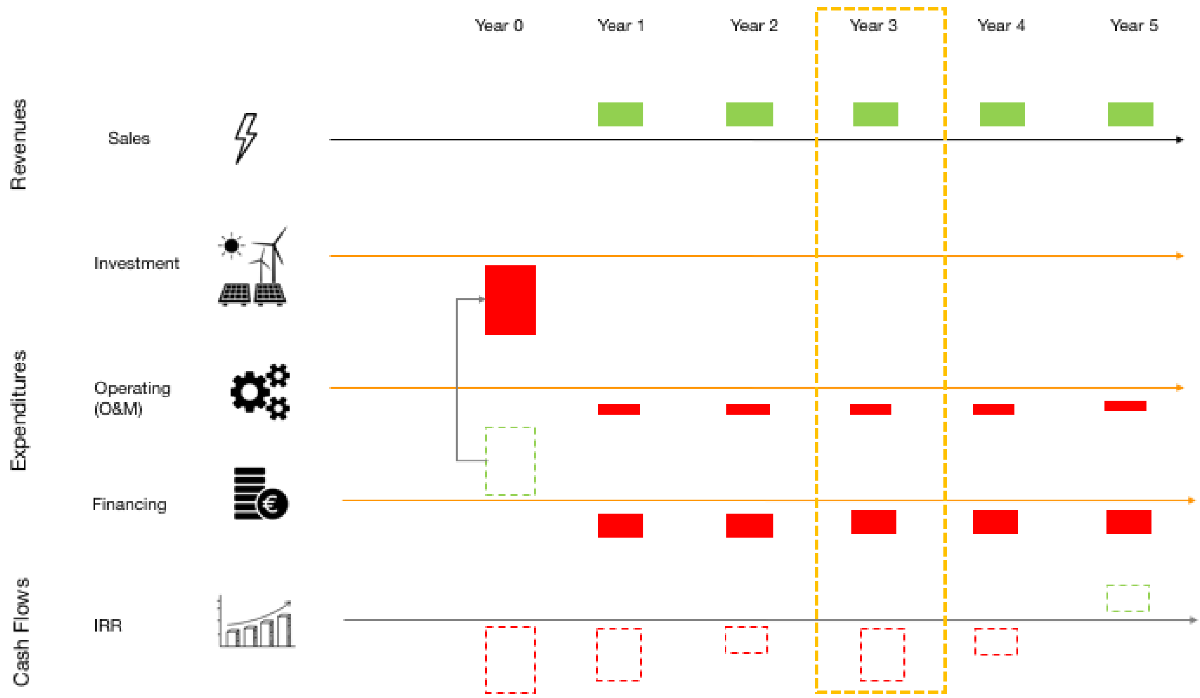


Figure 4.8:

4.5 EE metrics

4.5.1 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:

$$LCOE = \frac{sum\ of\ cost\ \ over\ lifetime}{sum\ of\ eletrical\ energy\ produced\ over\ lifetime} = \frac{\sum_{t=1}^{n} \frac{I_t+M_t+F_t}{(1+r)^n}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^n}}$$

I_t = Investment expenditures in year t (including financing) M_t = Operations and maintenance expenditures in year t F_t = Fuel expenditures in year t E_t = Electricity generation in year t r = Discount rate n = Life of the system

Note on degrading factor

Figure 2. Histogram of reported degradation rates for all degradation rates (a), for Si only (b), and for thin-film technologies only (c). Median, average and number of reported rates are indicated. In addition, Si and thin-film are color-coded by date of installation into pre-2000 and post-2000.

0.2%/year to 4.2, with average going from 0.7 to 0.8 and median of 0.5%

The ability to accurately predict power delivery over the course of time is of vital importance to the growth of the photovoltaic (PV) industry. Two key cost drivers are the efficiency with which sunlight is converted into power and how this relationship changes over time. An accurate quantification of power decline over time, also known as degradation rate, is essential to all stakeholders—utility companies, integrators, investors, and researchers alike. Financially,degradation of a PV module or system is equally important, because a higher degradation rate translates directly into less power produced and, therefore, reduces future cash flows [1]. Furthermore, inaccuracies in determined degradation rates lead directly to increased financial risk [2]. Technically, degradation mechanisms are important to understand because they may eventually lead to failure [3]. Typically, a 20% decline is considered a failure, but there is no consensus on the definition of failure, because a high-efficiency module degraded by 50% may still have a higher efficiency than a non-degraded module from a less efficient technology. The identification of the underlying degradation mechanism through experiments and modeling can lead directly to lifetime improvements. Outdoor field testing has played a vital role in quantifying long-term behavior and lifetime for at least two reasons: it is the typical operating environment for PV systems, and it is the only way to correlate indoor accelerated testing to outdoor results to forecast field performance.

Photovoltaic Degradation Rates — An Analytical Review Dirk C. Jordan and Sarah R. Kurtz url: https://www.nrel.gov/docs/fy12osti/51664.pdf

Increase in Costs:

The inflation rate is widely calculated by calculating the movement or change in a price index, usually the consumer price index.

A consumer price index (CPI) measures changes in the price level of market basket of consumer goods and services purchased by households.

The CPI is a statistical estimate constructed using the prices of a sample of representative items whose prices are collected periodically. Sub-indices and sub-sub-indices are computed for different categories and sub-categories of goods and services, being combined to produce the overall index with weights reflecting their shares in the total of the consumer expenditures covered by the index. It is one of several price indices calculated by most national statistical agencies. The annual percentage change in a CPI is used as a measure of inflation. A CPI can be used to index (i.e., adjust for the effect of inflation) the real value of wages, salaries, pensions, for regulating prices and for deflating monetary magnitudes to show changes in real values. In most countries, the CPI, along with the population census, is one of the most closely watched national economic statistics.

To illustrate the method of calculation, in January 2007, the U.S. Consumer Price Index was 202.416, and in January 2008 it was 211.080. The formula for calculating the annual percentage rate inflation in the CPI over the course of the year is:

$$\left(\frac{211.080-202.416}{202.416}\right)\times 100\% = 4.28\% \left(\frac{211.080-202.416}{202.416}\right)\times 100\% = 4.28\%$$

The resulting inflation rate for the CPI in this one-year period is 4.28%, meaning the general level of prices for typical U.S. consumers rose by approximately four percent in 2007.

Monetarists assert that the empirical study of monetary history shows that inflation has always been a monetary phenomenon. The quantity theory of money, simply stated, says that any change in the amount of money in a system will change the price level. This theory begins with the equation of exchange:

$MV = PQ$ $MV = PQ$ where

M M is the nominal quantity of money; V V is the velocity of money in final expenditures; P P is the general price level; Q Q is an index of the real value of final expenditures; In this formula, the general price level is related to the level of real economic activity (Q), the quantity of money (M) and the velocity of money (V). The formula is an identity because the velocity of money (V) is defined to be the ratio of final nominal expenditure (PQ PQ) to the quantity of money (M).

Monetarists assume that the velocity of money is unaffected by monetary policy (at least in the long run), and the real value of output is determined in the long run by the productive capacity of the economy. Under these assumptions, the primary driver of the change in the general price level is changes in the quantity of money. With exogenous velocity (that is, velocity being determined externally and not being influenced by monetary policy), the money supply determines the value of nominal output (which equals final expenditure) in the short run. In practice, velocity is not exogenous in the short run, and so the formula does not necessarily imply a stable short-run relationship between the money supply and nominal output. However, in the long run, changes in velocity are assumed to be determined by the evolution of the payments mechanism. If velocity is relatively unaffected by monetary policy, the long-run rate of increase in prices (the inflation rate) is equal to the long-run growth rate of the money supply plus the exogenous long-run rate of velocity growth minus the long run growth rate of real output.

4.5.1.1 environmental costs

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:

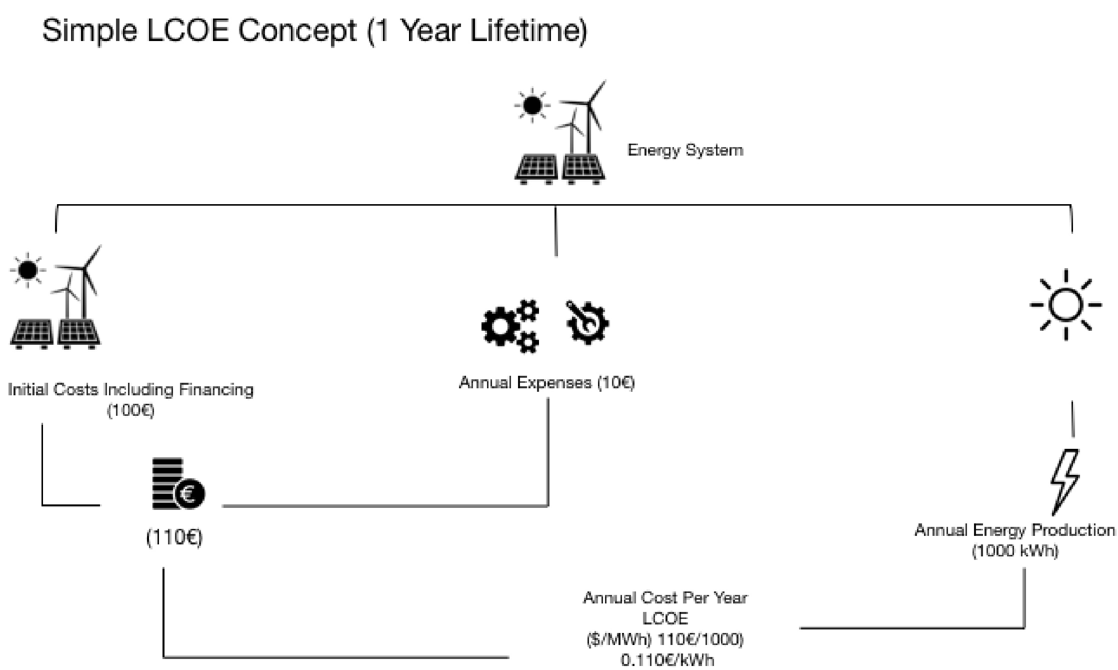


Figure 4.9: Simple LCOE Concept (1 year Lifetime)

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

4.5.2 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".

Figure 1. Calculation scheme according to CEN/TR 15615 (umbrella document).

Source: Cost-optimality - Discussing methodology and challenges within the EPBD recast. Ecofys for BPIE 2010.

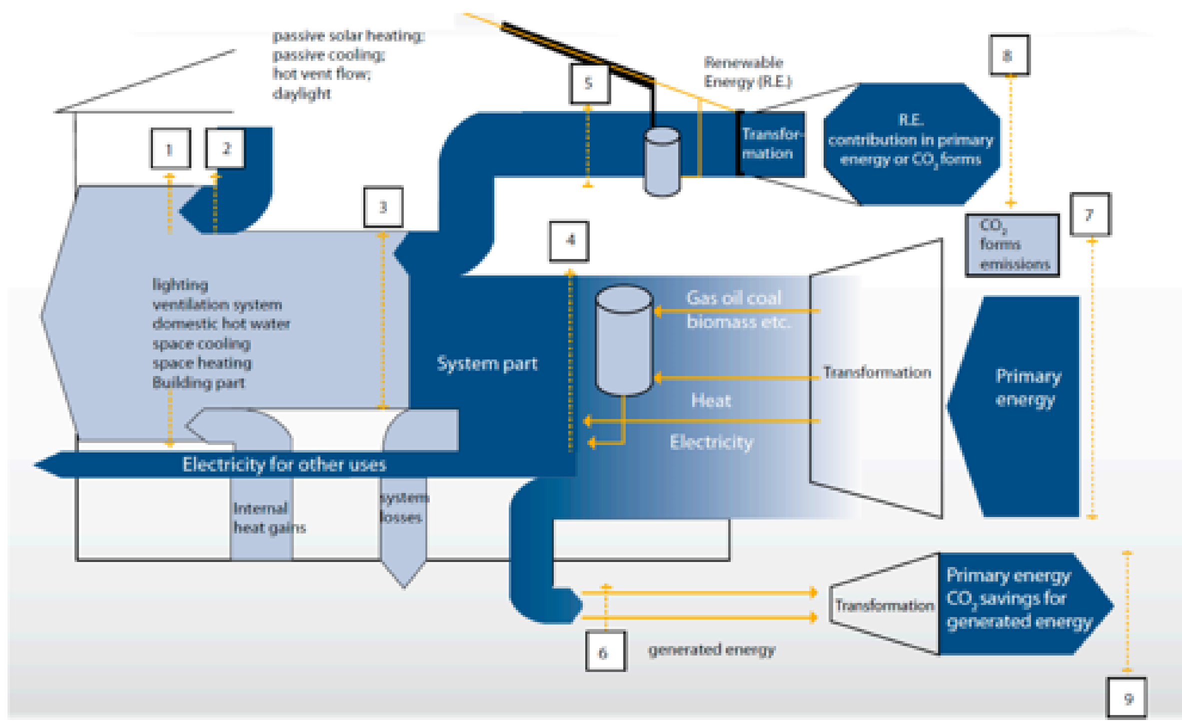


Figure 4.10:

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

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

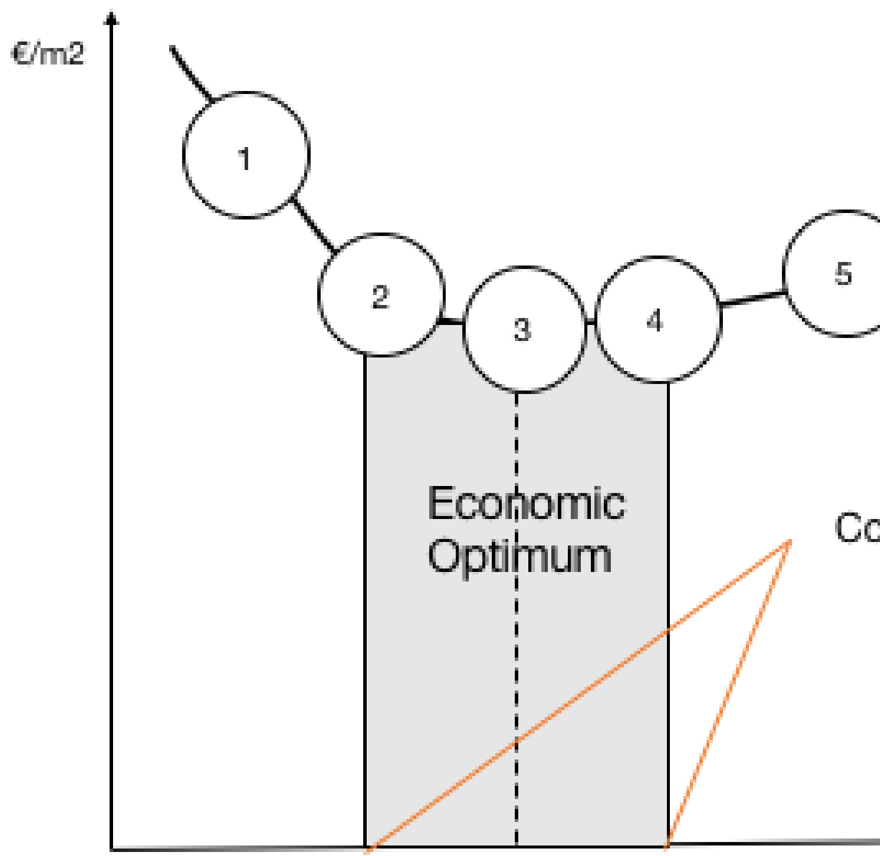
Where:

$Cg(t)$ 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.



According to EN15459, the Cost optimal range

Source http://bpie.eu/wp-content/uploads/2015/10/Implementing__Cost__Optimality.pdf pp.74-75

4.5.3 Other metrics

Assessing the Economic Value of New Utility-Scale Renewable Generation Projects Using Levelized Cost of Electricity and Levelized Avoided Cost of Electricity, url https://www.eia.gov/renewable/workshop/gencosts/

4.6 Scenario and Risk Analysis

4.6.1 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).

4.6.2 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:

1. Certain manufacturer states stat a certain equipment works for a determined use and need repairs and maintenance every x year of other parameter.

2. 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.

3. Until a certain day where either have a huge accident or the systems breaks.

4. 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.

4.6.3 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.

4.6.4 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.

4.6.5 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

4.6.5.1 Notes on Excel and other tools

NPV function in spreadsheets doesn't really calculate NPV. Instead, despite the word "net," the NPV function is really just a present value of uneven cash flow function.

Net present value is defined as the present value of the expected future cash flows less the initial cost of the investment. "Net" always means that something has been subtracted. In any case, there are two common ways to calculate the real NPV in

Excel:

1. Use the NPV function, but leave out the initial outlay. Then, outside of the NPV function, subtract the IO. (Note, the initial outlay is often entered as a negative number, so it will actually be added.)
2. Use the NPV function and include the initial outlay in the range of cash flows. In this case, the "NPV" will be in period -1 so we must bring it forward one period in time. So, multiply the result by (1 + i), where i is the per period discount rate.

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)

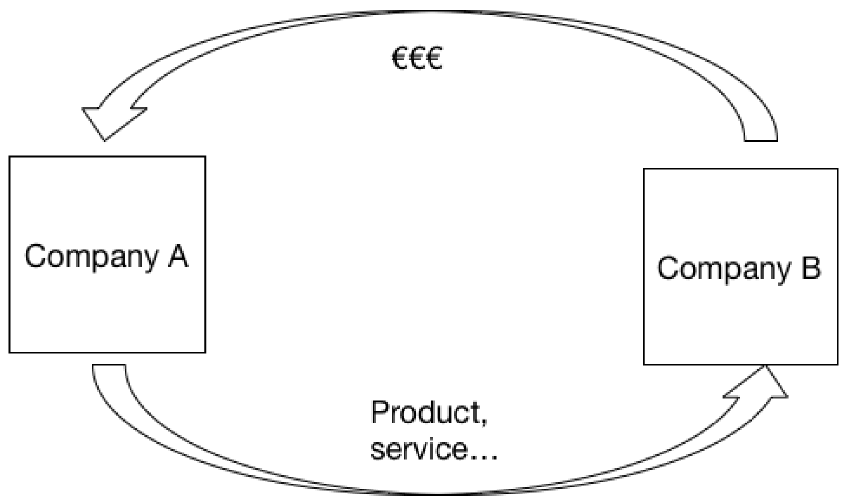
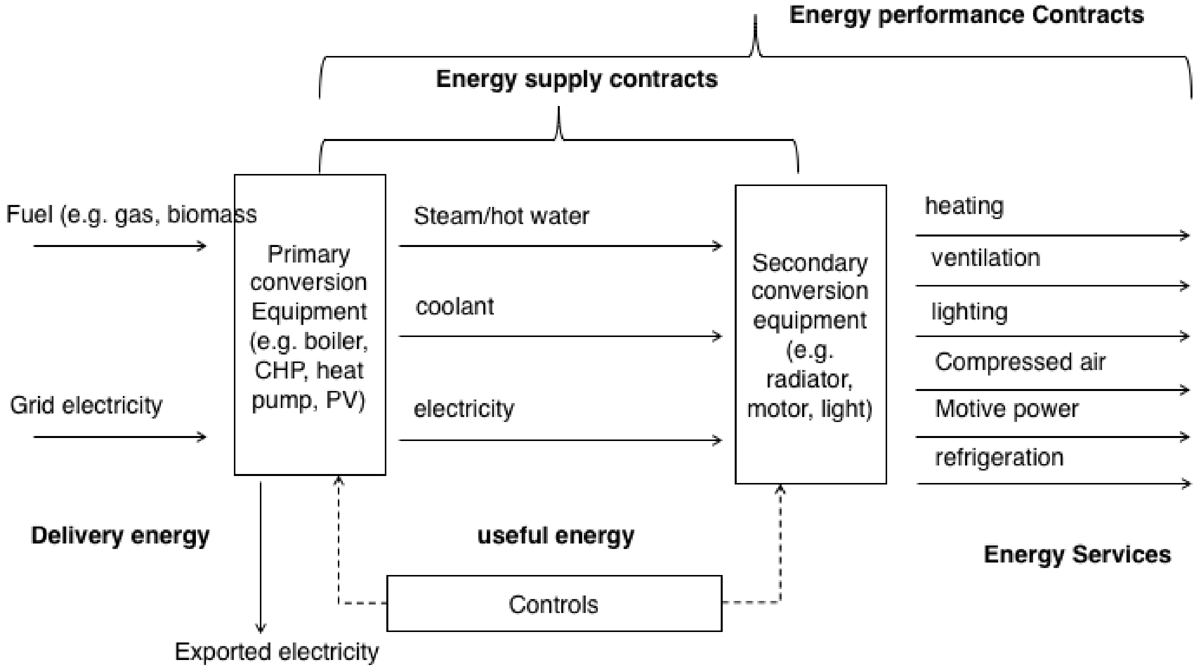


Figure 5.1:

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.

5.1.0.1 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
- Energy Services Agreement (ESAs)
- Power Purchase Agreements (PPAs)
- Energy Performance Contracts (EPCs)
- Energy Management Contracts (EMCs)

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.

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".

5.1.0.2 nontechnical guide to breakdown a basic contract structure

5.2 Energy Services Contracts

An Energy Service Agreement or Contract it´s use with a large range of scopes.

As it is defined by Lay and Sorrell, Energy service contracts have been variously defined and categorized in relation to the nature of the energy services covered such as:

- the source of finance for new investment;
- the ownership of the relevant assets;
- the provision of guarantees for savings in energy; consumption and/or costs and;
- the degree to which control of energy services together with the associated risks is transferred to the contractor.

Various definitions of energy service contracting have been proposed, but few satisfactorily describe the diversity of contractual arrangements that are available or the range of activities involved.

There is little consensus on which combination of these distinguishes energy service contracts from more conventional (namely under one single market supplier, or a monopoly) or market relationships (as energy/fuel supply Contracts under liberalized market).

Terminology use varies from one country to another, reflecting Financial and Fiscal schemes which aim to promote EE measures and, as a result the types of contract change in line with those policies.

There are several configurations of energy services contracts, most specific to each country.

To name a few, so you can analyze the range of contractual terms that can be under the "energy service Contract"´ terminology.

"Delivery Contracting" - also known as Supply Contracting or Energy Supply Contracting (ESC) - is focused on the supply of a set of energy services (such as heating, lighting, motive power, etc.) mainly via outsourcing the energy supply.

Chauffage, one of the most common contract types in Europe besides EPC, is a form of Delivery Contracting. In a chauffage arrangement the fee for the services is normally calculated based on the client's existing energy bill minus a certain level of (monetary) savings, with a guarantee of the service provided. Alternatively, the customer may pay a rate, for instance, per square meter. The ESCO (or ESPC) may also take over the purchase of fuel and electricity.

A Contract Energy Management (CEM), which means "the managing of some aspects of a client's energy use under a contract that transfers some of the risk from the client to the contractor (usually based on providing agreed 'service' levels)"

"comfort contracting" In the Nordic countries/Scandinavia, contracts similar to Delivery Contracting are referred to as "comfort contracting", and in these contracts the provision of the level of comfort or level of service is outsourced to the ESCO firm. These contracts will go beyond the provision of energy for the level of comfort, and take care of full maintenance, including a healthy indoor environment, aesthetics, etc.

"heat supply contracts" In Italy, "chauffage", or "heat supply contracts" ("Servizio Calore", in Italian). These are however substituted by the stricter "Energy Service Plus contracts" ("servizio energia plus"), which also includes a commitment by the provider to reduce the consumption of primary energy for winter heating by at least 10% with respect to what is indicated in the building certificate. Furthermore, it commits to the installation of a temperature control system, when possible.

A BOOT model involves an ESCO designing, building, financing, owning and operating the equipment for a defined period of time and then transferring this ownership across to the client. This model resembles a special purpose enterprise created for a particular project. Clients enter into long term supply contracts with the BOOT operator and are charged accordingly for the service delivered; the service charge includes capital and operating cost recovery and project profit.

Integrated Energy Contracting (IEC) is a new model, which combines "Engineering, Procurement, and Construction" (EPC) Contract and Delivery Contracting and thus increase the amount of energy cost savings. When designing the project, demand side measures are planned as a priority, and the remaining level of energy needs are covered by more energy efficient supply, when possible. Therefore an IEC combines the benefits of the demand and supply side measures, there forereaching a higher cost-benefit. At the same time, the contract is simpler than a normal EPC, which also reduces expense.

Utility energy service Contracts (UESC) were initially Authorized by the Energy Policy Act. A utility energy service contract (UESC) is a limited-source contract between a federal agency and its serving utility for energy- and water-efficiency improvements and demand-reduction services.

Energy Savings Performance Contracts (ESPCs), also known as Energy Performance Contracts (EPC), originally from the US, are an alternative financing mechanism designed to accelerate investment in cost effective energy conservation measures in existing Federal buildings. The Energy Policy Act of 1992 (EPACT 1992) authorized Federal agencies to use private sector financing to implement energy conservation methods and energy efficiency technologies. An ESPC is a partnership between a Federal agency and an energy service company (ESCO). The ESCO conducts a comprehensive energy audit for the Federal facility and identifies improvements to save energy. In consultation with the Federal agency, the ESCO designs and constructs a project that meets the agency's needs and arranges the necessary financing. The ESCO guarantees that the improvements will generate energy cost savings sufficient to pay for the project over the term of the contract. After the contract ends, all additional cost savings accrue to the agency.

The Energy Services Agreement services offer may be, alone or as a combination of:

- Energy analysis and audits;
- Project identification and appraisal;
- Project design and implementation
- Energy management
- Property/facility management
- Monitoring and evaluation of savings
- Maintenance and operation
- Equipment supply
- Provision of services (space heating/cooling, lighting, etc.).

- Fuel or electricity supply
- Project financing and
- Others.

Depending on the final setup, the contractual terms offered may be presented as:

- Project financing;
- Delivery contracting;
- BOOT (Building-Own-Operate-Transfer);
- Guarantee of performance;
- Shared savings (EPC) or
- Guaranteed savings (EPC)
- Insurance coverage (insurance policy against events that can imply financial penalties for the ESCO) and
- Others.

You can think as set of services, products, including construction being provided by one of more entities under a certain contractual arrangement. This combination depends on your needs, your present and future resources, as income and the final agreed structure.

We are going to cover some of the most relevant issues covered by the terms of an energy service contract.

Remember that most of the times are contracts with a long period of time, so its term may be subjects to several changes or events during the period of the contract.

When we refer to new equipment (for example, new heating or cooling system, PV system) that needs to be installed you should be aware of:

- Specification, selection, cost, responsibility for installation and commissioning
- Depending on the terms offered, this equipment can be owned by the beneficiary of such EE measures or not.
- When referring "Equipment ownership" and along with it comes the definition of: rights during and after contract, buyback provisions

As an example, you need a car to get to work. You either decide to buy one. If you don´t have enough capital to pay upfront, you can either ask for a loan (but the car it´s yours, so as the risk) or, you can do a leasing contract, where you can use the car, but the ownership of the car remains in the leasing company. In the end of the leasing Contract you can buy the car for a residual price or not.

Maintenance, means who is accountable for monitoring and maintenance a certain equipment, if it's a shared responsibility of not. You may have two sets of maintenance duties: preventive and corrective.

Operation, or who is responsible for operating or how coordination is defined

Performance and quality standards - May range from pressure and temperature in the case of steam supply to complex mix of comfort standards in the case of building energy services (e.g. temperature, lighting levels, air exchange, user control)

Reliability standards - Maximum downtime, provisions for immediate and backup service in the event of malfunction

Service standards - Acceptable parameters for temperature, lighting, air exchange and other factors

Monitoring and verification - Methods for monitoring and verifying energy provision, consumption and savings, including the use of standardised protocols

Calculation of cost savings - Baseline energy consumption and operating conditions, assumptions, formulas, adjustment protocols

Pricing and payment provisions - Fixed and variable components of pricing, guarantees to client, division of savings

Adjustment to external changes - Adjustment to inflation, changes in energy prices and other factors

Provisions for early termination - Buyout provisions, compensation, equipment removal provisions, restoration of facility

Other - Insurance, dispute resolution, penalties for contract breach, force majeure, etc.

As you already may notice, monitoring plays a central role in a energy service Contract, besides a typical issues related to equipment installation, bear in mind that the premise to install new equipment relies on the promise of future savings.

Usually, most disputes are related to the fulfillment , or not, that a certain service, was executed in accordance with the agreed terms, or usually disputes emerge on clauses related to how payments and saving are calculated, if a certain services was provided within a certain quality standard, if something needs to be repaired or replaced, who has the duty to repaid, replace (and pay).. and so on.

5.3 EPC

An “ ‘energy performance contracting’ means a contractual arrangement between the beneficiary and the provider of an energy efficiency improvement measure, verified and monitored during the whole term of the contract, where investments (work, supply or service) in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement or other agreed energy performance criterion, such as financial savings;”

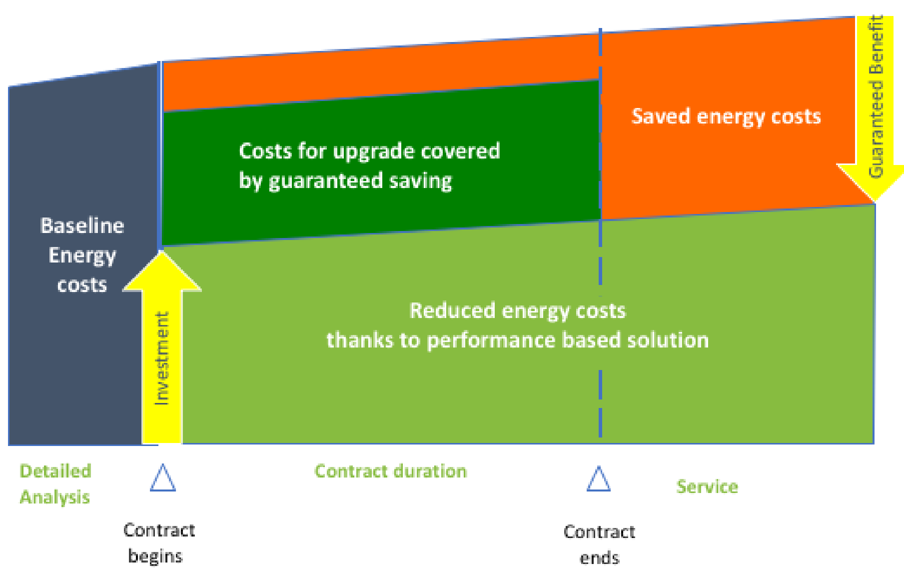


Figure 5.2:

The EPC proposal can be designed as follows:

Baseline Energy Costs its done to access investment need to implement EE measures.

After implementation of such measure the the company will pay less energy cost, but has to pay back the ESE company pack, at least until refunded the initial investment;

Depending on the terms, this savings may be guaranteed or shared;

After the term of the contract the company will still benefit of such measures, but will save the whole saved energy costs.

So when looking to the Contract Lifecycle, starting from left to right:

Figure 5.3:

- There is an initial assessment or audit; then
- A proposal with the Energy Efficiency Measures, Savings and General terms;
- An acceptance of such offer; (or not, and goes back to proposal until you are satisfied with an offer); then the
- Investment and Implementation and lastly;
- Operation and Maintenance of the Energy Efficiency measures.

One of the most important features, when analyzing such proposals is to understand if it is:

> Is a Guarantee performance or best efforts to get a certain performance?

The first, guarantees, the last just makes a promise to make the best efforts. It may sound like the same things, but is not. The promise on the first carries more certainty and commitment

Depending on the contractual terms it may have:

- Shared Savings and the risk and benefit of such saving is spit among the parties,

Assessment or results (or Monitoring and verification) plays a central role in this type of contract, because completion and fulfillment of a certain performance relies on Monitoring and verification.

Industry uses international standards to define what “Guarantee of energy efficiency improvement” is.

In the EN 15900:2010 define as ”commitment of the service provider to achieve a quantified energy efficiency improvement”.

The European standard EN 15900:2010 defines energy efficiency services (EES) as an agreed task or tasks designed to lead to an energy efficiency improvement and other agreed performance criteria.

According to EN 15900:2010 EES shall include an energy audit (identification and selection of actions) as well as the implementation of actions and the measurement and verification of energy savings. A documented description of the proposed or agreed framework for the actions and the follow-up procedure shall be provided. The improvement of energy efficiency shall be measured and verified over a contractually defined period of time through contractually agreed methods. A core element of each EES is thus an energy efficiency improvement (EEI) action, which is any action that directly leads to a reduction in energy consumption. EEI actions may be the substitution of technology, improvement of technology, better use of technology, and behavioural change.

Like most of the Typical Energy services Contracts, the Terms and Conditions of a EPC are quite similar.

An EPC usually carries:

- Investment (also referred as CAPEX) + O&M (usually there is some bundling, depending on the amortization of the CAPEX during O&M);

Or you can thing a typical Engineering and construction Contract with a Services Contract to perform O&M

Regarding the overall EPC (you should be aware of whom is carrying the risk, usually falls into who has the ownership of such investment);

Are usually defined as well:

- Guaranties and Maintenance (i.e if are included or not, etc);
- Savings (results or best efforts?) - saving: kWh or final bill or, combination of those?
- Verification and Audits (initial assessment and during the contract);
- Payments (how there are calculated, due dates, etc);

Provisions and scenarios that should be considered when designing the EPC (or does the national legal system has a solution to these and/or some provisions should be added to the agreement) like:

- Changes (from initial assessment), of energy source, supplier, etc;
- Price change (namely under liberalized market) and dynamic pricing (it can also be a form of savings, namely financial ones)
- Base scenario change: i.e machinery, higher consumption. (long duration (due to a big payback time, around 5-8 years, you may want to considerer);
- Change of ownership (in Portugal, this type may be obligations “propter rem”, meaning that they are attached to the asset, not the person. If someone sells the asset, for example a house, the debts may stay with it (for example due condominium bills..);
- Change of circumstances (usually there is some price increase, annually, according to some Price Index, still if i.e. electricity prices increase more than what could be expected, depending on jurisdiction parties may have to right to change pricing (i.e for consumer, the supplier may have a right to unilaterally change pricing but has to give the right to step out too. This could impact the savings´ calculation or other terms that use this variable;
- Inclusions and exclusions (as. maximum number of support hours, replacements (for example, something is damaged and needs replacement);
- Integration with different suppliers (i.e gas and electricity);
- Authorizations (passive or active management) – that could be in a form of a mandate to act in behalf of the final client, for example to negotiate energy supply contracts)
- Controls and minimum services (what are the minimum services, for example in case of interruption of services (not related to energy supply), time to reestablish services, penalties, etc);
- Breach of contract (remedies)
- Early Termination (of the contract)
- Other duties: as confidentially (may follow into “sensitive data” category, if you are dealing with households and using consumption profiles, you also have to be aware of that historical data of end users, has special duties and obligations)

You also have the typical Events of Default, similar to any energy service contract such as:

Typical Events of Default:

- Failure to make payments;
- Failure to maintain credit support;
- Breach of reps and warranties (usually subject to materiality);
- Breach of transfer/change of control restrictions;
- Other material breaches of obligations;

Where there are Notices and opportunity to cure remediable breaches and Typical remedies can range from :

- Actual damages, subject to mitigation and capped
- Termination
- Termination payment
- Step-In-Rights for lenders in case of a default event

5.4 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)

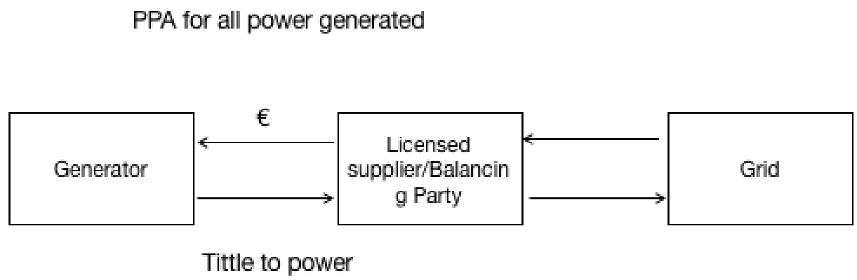
Sale through the grid

- 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:

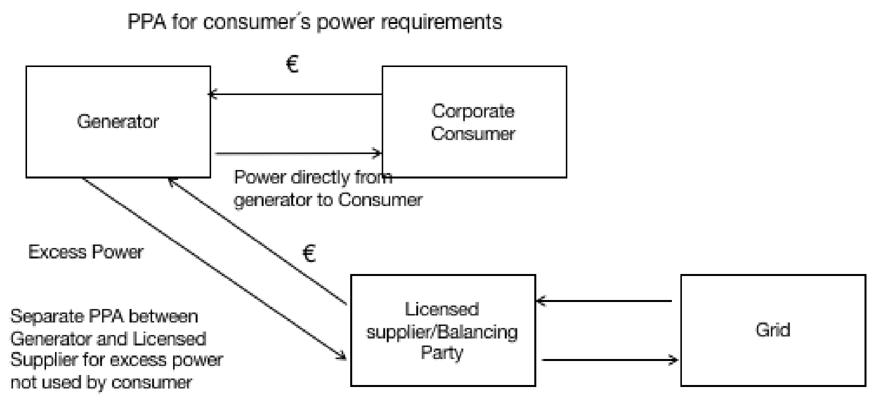
- Onsite direct wire PPA

- Sleeved off-site PPA
- Synthetic PPA
- Mini-utility
- Wholesale PPA



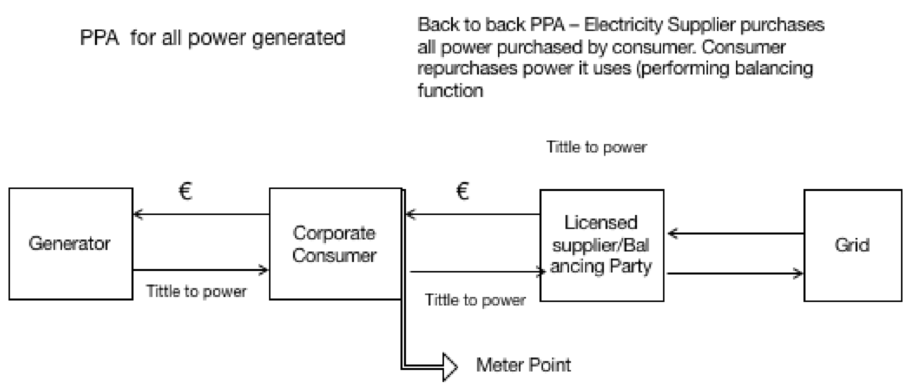
Wholesale PPA

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.



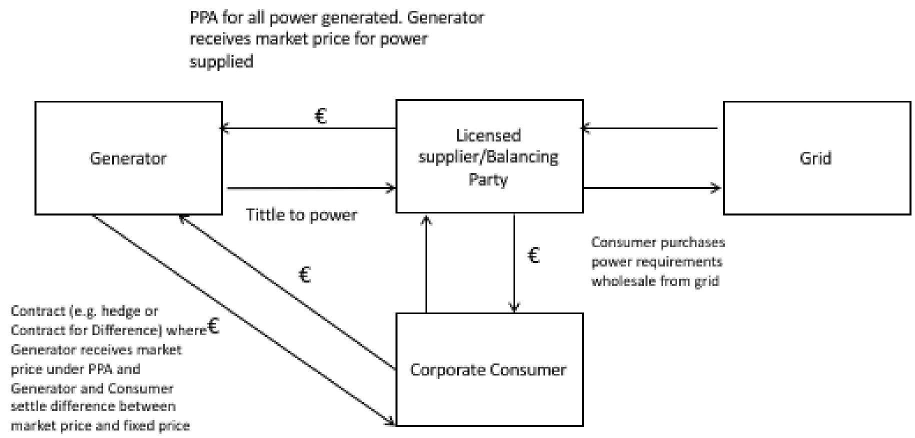
Onsite direct wire PPA

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.



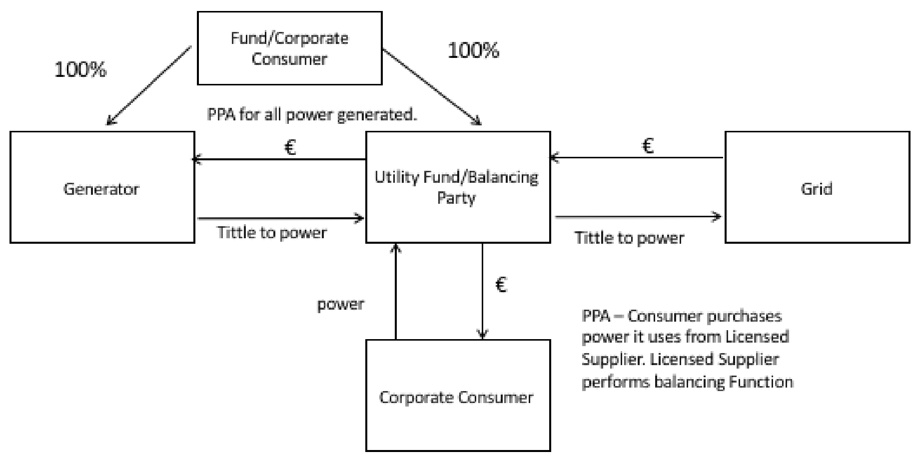
Sleeved off-site PPA

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).



Synthetic PPA

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.



Mini-utility

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

5.4.1 Curtailments

There are what so called Default provisions related to Curtailments

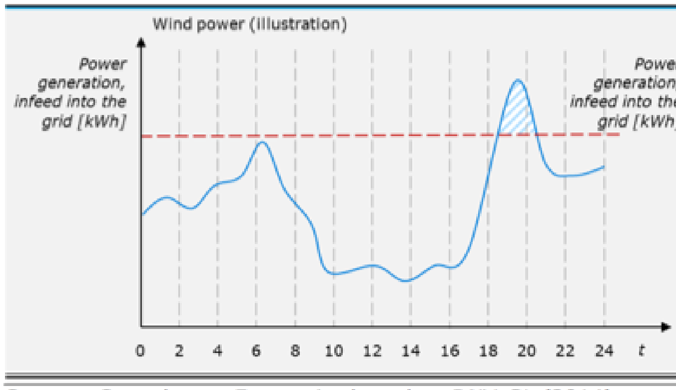


Illustration of wind/solar peaks and the curtailment pontencial

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

5.5 Energy Management Contracts (EMC)

Active and Passive Management

Definition of mandate contract

- With representation
- Without representation

Types: * 'contracts of mandate'; * contracts to perform a specified task or work; and * 'contracts of management'.

A classic contract of mandate does not concern the performance of work but the performance of an action for the benefit of someone else. In practice, contracts of mandate are usually concluded as contracts for the performance of services, on whose basis the 'mandator' commissions the 'mandatary' to perform a certain action. Contract to perform a specified task or work

There are more differences between the contract to perform a specified task or work and the contract of employment than in the case of the contract of mandate. First, the person performing the task or work is not subordinated to the 'orderer' (a mandatary is sometimes obliged to observe the instructions of the mandator). Second, it is a so-called 'contract for result', which means that its objective is the performance of a given task or work rather than the performance of work itself. Management Contract

The term 'contract of management' may be used in both cases, but it usually refers primarily to civil law contracts for the performance of services. A classic contract of management is a so-called 'innominate contract' (ie a contract which is not separately regulated by the Civil Code) which specifies the conditions of performing services (eg managing a firm) by a manager. Since such a contract is based on the mandate model, Civil Code regulations concerning mandates apply.

Energy Conservation Contracts

Definition Demand Side Management

Definition Data Access and Management

Att definition of services contract (data)

Definition Energy data Access to energy data and benchmarking Energy profiles Standards and Interoperability Data storage and portability Data security and privacy

another potential contract that aims to active manage someone's energy on their behalf.

So we will reference what this contract may look like and the importance of energy data, namely access to perform such obligation.

We will reference algorithmic decision making and how can that be insert in a given contract and a lastly other models, namely distributed ones.

- Active and Passive Management
- Energy Conservation Contracts
- Demand Side Management
- Data Access and Management

5.5.1 Energy data

Access to energy data and benchmarking

Energy profiles

Standards and Interoperability

Data security and privacy

Data storage and portability

The role of the ORD in data access

Algorithmic decision making and other decision processes

Other (Distributed models)

Increase of:

Frequency

Granularity

Why, new models

i) assuming that there will be more granularity of data and more frequently, it will more common to contract active energy management (such as active portfolio management), where it is a human or algorithm to make the choices, it is irrelevant ii)if is human to push the button or to draw a system of rules, in the last resource is always the human, that is the understanding), for the verification. With introduction of dynamic pricing, it will be more relevant.

5.5.2 Active and Passive Management

c) interconnected with b) energy data company, in the UK (here is EDP Distribution, it is their BD that counts), there are protocols and initiatives like "http://www.greenbuttondata.org/", etc. Because I have to confirm, but EDP (without being READY), it does not have API (it should leave excel, if it is like the ones I have, it should be a typical integration problem and I do not know if it is real time). Apart from cases like Denmark, the problem is even given and authorization of orders to do management.

d) these contracts may be similar to those of O&M (what I call services) of an EPC, but do not involve investment, nor is there any guarantee of savings. These can be of active management (in legal it is spoken in mandates, etc.).

To manage on behalf (or to deliver the management to a third party)

5.5.3 Mandate and authorizations

What is to manage on behalf one third party?

In simple terms is to make decisions on someone behalf that will affect their legal rights and duties or, you are substituting someone (or a company) to make de such decision, this may include:

A) negotiate terms and conditions of a given contract;

B) to perform certain duties;

C) to make payments, etc

One the most important thing are the extend of such mandate (or limit), where for certain acts (usually out of this scope) may demand more formalities.

Also you must take note of 2 things:

A) you are performing on the best interest of a third party;

B) you should report on the activities taken on their behalf;

C) if you are going to make payments on their behalf always slip what where the expenses taken from your fees and separate such itens.

- energy management,
- energy conservation
- demand side management contract

sometimes they appear under the name of energy management, energy conservation and demand side management contract).

Depends on the extension and type of service agreed.

5.5.4 Role of Data energy Companies

When managing energy a central issue is access to the reading used from energy billing, so you must know:

A) time to giver such data;

B) time to ask rectifications

C) what elements do you need

D) …

Data Access and Management

Energy data

Access to energy data and benchmarking

Energy profiles

Standards and Interoperability

Data security and privacy

Data storage and portability

5.5.5 EU General Data Protection Regulation (GDPR)

Bear in mind that energy data belongs to the company and you may be using to extract consumption patterns (like when is most used a certain service), you have to consider the EU General Data Protection Regulation (GDPR).

If you are doing also profiling, for example for comparison, make sure to not "personal data"

Bundling with IT services

- "as it is clauses";
- Pricing on response time (availability rather than quantity);
- benchmarking (what is really good or bad management of behalf of third party?

f) E.on has a solar clone now in Germany, in which it is basically a clearing account (type of the bank or the one called "jumbo accounts") with tokens, reminiscent of ethereum.

g) Contracts, for example, from amazon SW3, always have "as it is" clauses, like who wants to be guaranteed that they always have paid access more, that is, what should happen is that they give priority to these calls "power contracted") As cloud is things hosted on their servers (and has backups ..), eg, when a site is down, I can get a version hosted on my machine, or their servers .. (or even web archieve ..)

h) Then there is the one that confuses contract with form (just as a "paper" is only a representation, a means of "documentary" proof, of will, of certain order, contract (because things have no will), blockchain is the equivalent to "paper" .. I think more "smart" ML, than the timestamp of clearance .. The question is more or less this: there are no "smart contracts", there is a (or several) centralized database , But distributed (or the form of validation) and a series of problems with to solve, that still has no solution (the name nowadays is going to give to create n distributed "private" ledgers and I already asked if it is not open, how do I know that object A1, which has derivative A2, if it is in different legers, is correct and basically has to go through n distributed ledgers to validate … (representation problem, image) ..

5.5.5.1 Algorithmic decision making and other decision processes

(Nest, IBM examples)

Rule based

Case based

(data)

Uncertainty

Other (Distributed models)

E.ON Cloud proposal (by compensation, tokens (virtual credits))

Blockchain as register/clearance/DB

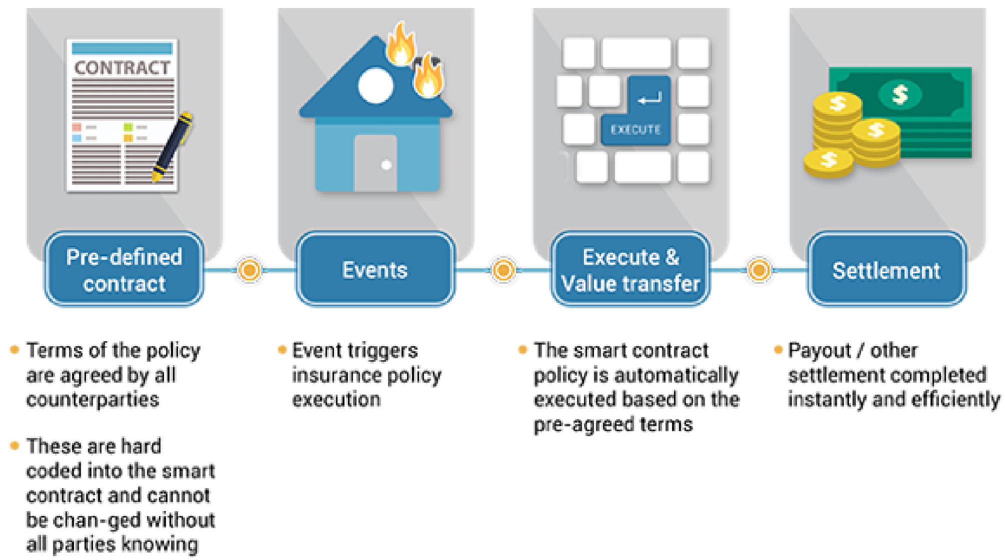


Figure 5.4:

The original paper

Active Energy Manager to monitor and manage the power and cooling needs. systems can also be monitored using metering products, such as power distribution units (PDU), sensors, and integration with facility software.

Monitoring power consumption data

Collecting power consumption data

Managing power, which includes

Setting power savings options

Setting power caps

Automating power-related tasks

Configuring metering devices, such as PDUs and sensors

Exporting data

Viewing events

Calculating energy cost

Calculating estimated energy savings

Setting thresholds

Creating and setting power policies

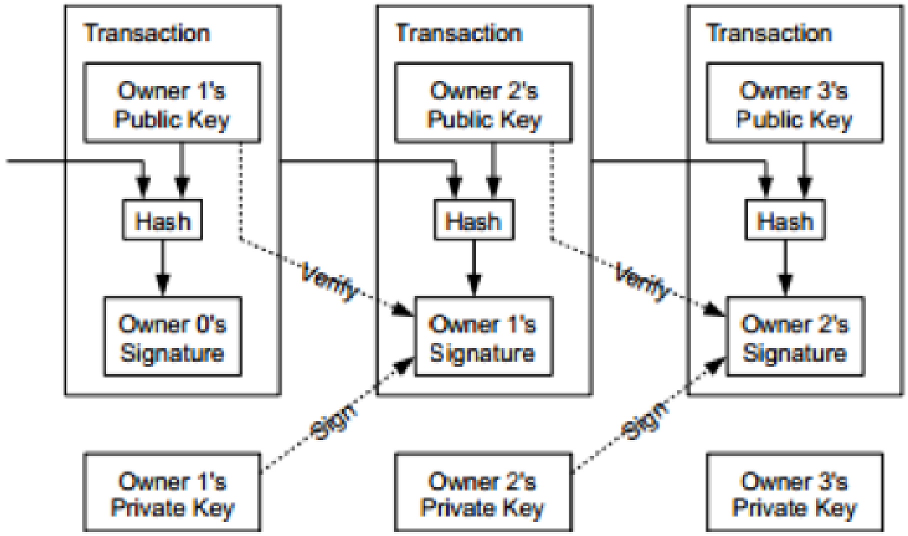


Figure 5.5:

Monitoring of power and cooling equipment that affect the IT resources

The first step in making a datacenter run more efficiently is to understand the power and cooling characteristics of the individual pieces of equipment. This can be done using real-time monitoring , steps can be automatically taken to save energy costs.

Energy management functions are also integrated with functions. For example, setting energy-related thresholds is done using the same user interface used to set other thresholds that can be set. Also, when viewing system properties, resource navigator, you can also view active energy properties. A thumbnail view of an energy trending graph can even be displayed in order to call attention to the most critical systems. In addition, most tasks are scriptable using the systems management command-line interface (smcli).

5.5.5.2 EU General Data Protection Regulation (GDPR)

GDPR requires robust, centralised systems to handle even the most basic of customer information. Businesses will need to get data records in order, understand what has been stored, and how different departments are using customer data. They will also a need to maintain a strong audit trail of permissions that customers have given for use of their data, and how this information flows through an organisation, to be able to fulfil the key principles set out in the regulation.

'data portability' requirement that stipulates that data can be transferred to a new 'controller' at the request of the 'subject'. When switching energy supplier, a customer can request that all data held on them by their original provider be transferred to the new one and that any record of that data then be forgotten. To meet these requirements companies will need to become more versatile and able to share and compartmentalise data more efficiently. This will open up opportunities to use data to improve customer communication. For instance, combining usage data from smart meters with a customer's postcode might enable the company to provide them with geographically relevant information on the most cost-effective times to turn their heating on. Equally, in-home sensors could provide early warnings of when equipment develops a fault or is operating inefficiently. Having robust IT infrastructure and data systems to back this up will be needed to give firms the back-office muscle needed to proactively communicate this information with customers in meaningful, simple and relevant ways.

The GDPR... * Applies to all companies, inside or outside the EU, that target or monitor EU individuals or provide services into the EU * Enforces fines of up to €20 million or 4% of global turnover, whichever is greater * Imposes a 72 hour window for companies to report a breach if there is risk to affected individuals * States that where an individual's consent is deemed necessary for the processing of data, that consent must be unambiguous and informed * Affords individuals the 'right to be forgotten' in certain cases, and enhanced rights of access to their personal data * Implements 'privacy by design' – privacy can no longer be an afterthought to operations * Applies a more prescriptive statutory regime to data processors * Sets up a 'one stop shop' – companies only have to register with one data protection agency * Requires some companies who systematically process data to appoint a Data Protection Officer (DPO)

while power suppliers will know customers' energy usage and bank account details

The role of the ORD in data access

Algorithmic decision making and other decision processes (Nest, IBM examples)

Does it make a difference if it is a human or not? (Explain)

Other (Distributed models) E.ON Cloud proposal (by compensation, tokens (virtual credits)) Blockchain as register/clearance/DB

5.6 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

- non SME´s,
- Specific industries (large combustion plants),
- Energy intense activities;
- Public sector, etc)

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.

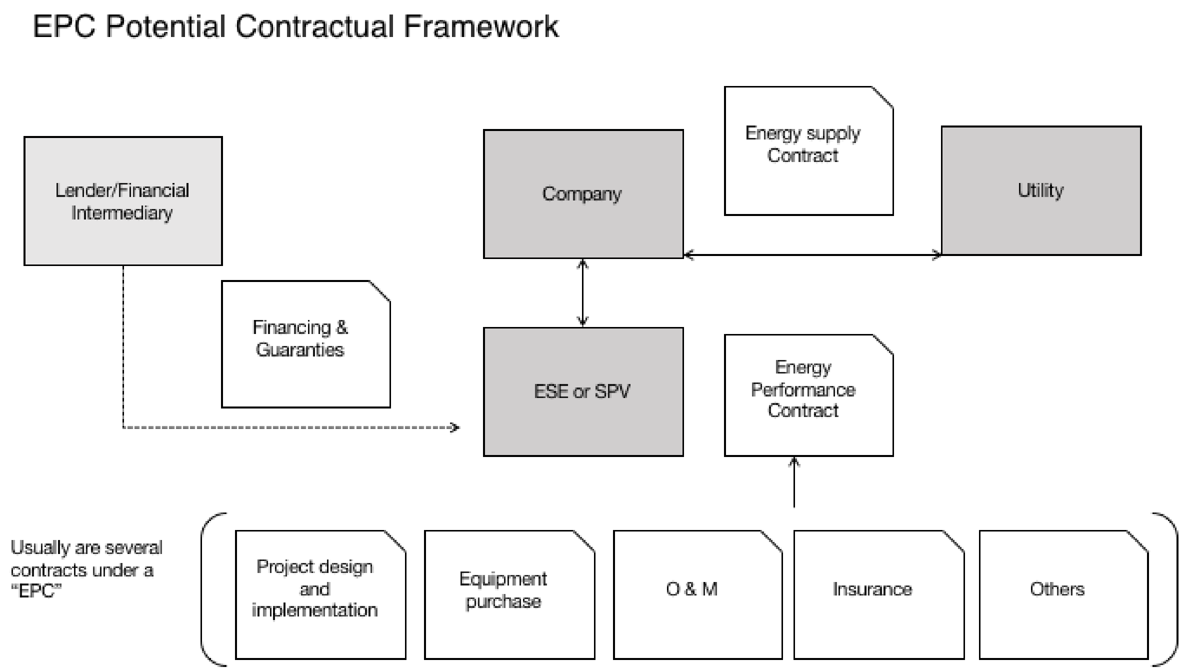


Figure 5.6:

A EPC Potential Contractual Framework, may look like this, where, an EPC integrates a set of contracts.

Besides the Energy Performance Contract you may also have a Financing Contract, you still maintain or start a new energy supply Contract.

An ESE may act on your behalf when setting up Financial Agreements and even the Energy Supply Contract, and you only have to deal, directly with the ESE, but this does not mean you are just bonded the ESE.

5.7 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.

Activities under concession (public interest)

Activities under:

- liberalized market
- Regulated market

So there are several connected subjects, you may want to have under consideration:

- Market structure ("ownership unbundling model"), which activities are under market conditions, which may fall under "basic services" and the ones that need special permits and authorization.
- Difference between energy supply, energy management and energy performance (understanding each party´s role so as its legal framework);

5.7.0.1 Access

Some activities - as distribution, metering - may be granted to a concession or can be purchase under liberalized or regulated market (typical example are the electricity supply contracts).

If the proposal also carries some change in supply (as self-production, decentralized and/or local energy supply), besides specific regulation for installing ,using the grid (etc), there are special provisions for this type of activities under private law (objective responsibility, activities that carry a special level of danger, safeguard provisions)

Understanding the market structure is important to know what is needed to get a permit (administrative law), what is under market conditions (private law) or when public procurements rules have to be fulfilled (administrative law). There are activities that are not under concession, like commercialization in Portugal, but under liberalized market.

For example on how bundled a "energy service contract" can be:

A Contract with PV and remote monitoring, where can emerge issues such as:

- Self-consumption (pricing and authorizations to install them change across countries, ie: Spain (there is "sun taxation" and Germany (has coops);
- Who is responsible for metering, who owns the meters, data and data access (namely for monitoring);
- Besides all related to investment and O&M (that can demand public procurement if dealing with a public entity or EU funds);

As a final mark, you can always decompose a contract to its simple elements, understand how each element relates to each other, be aware of the risks and run several simulations for the long run, with several default events and potential remedies in case of such event occurs.

Chapter 6

Regulation & Standards

6.1 Intro Regulation

We will start by understanding how policy and legal documents evolved until today.

Then we will introduce to some basic concepts of different legal documents and how they related to each other, so as its dependencies.

We will move on to scope, or answering the question "what are these documents trying to achieved?" How they related to connected areas, as building codes, environment and urban planning.

Afterwards we will introduce the main legal documents, or the cornerstones of most national regulations and lastly, how they related and set the tone for national frameworks.

Looking to the evolution and overall History, or how it evolved to its current shape.

We can trace from the 50´s.

6.1.1 Trends and international agreements

In the 70´s the evidence and acknowledgment of the externalities and impact, namely of the use of fossil fuels and other specially pollutant industries starts , where the recognition of the environment as a good in its own right (sometimes referred as the Third generation rights) but, nevertheless one that was always be vulnerable to tradeoffs against other similarly privileged but competing objectives, including the right to economic development.

Consensus begins to form in the 1980´s and in 1988 the WMO established the Intergovernmental Panel on Climate Change with the support of the UNEP.

The Kyoto protocol was the first agreement between nations to mandate country-by-country reductions in greenhouse-gas emissions. Kyoto emerged from the UN Framework Convention on Climate Change (UNFCCC), which was signed by nearly all nations at the 1992 .The framework pledges to stabilize greenhouse-gas concentrations "at a level that would prevent dangerous anthropogenic interference with the climate system". That treaty was finalized in Kyoto, Japan, in 1997, and it went into force in 2005.

As a replacement of the Kyoto Protocol, in December 2015, 195 countries adopted the first-ever universal, legally binding global climate deal. known as the Paris Agreement.

The agreement sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to well below 2°C.

Along with that the UN set The Sustainable Development Goals (SDGs), successor to the Millennium Development Goals). Out of the 17 SGD´s, 4 related with this course:

Goal 7: Affordable and Clean Energy

Goal 11: Sustainable Cities and Communities

Goal 12: Responsible Consumption and Production

Goal 13: Climate Action

Looking to overall History of Energy Efficiency in Buildings

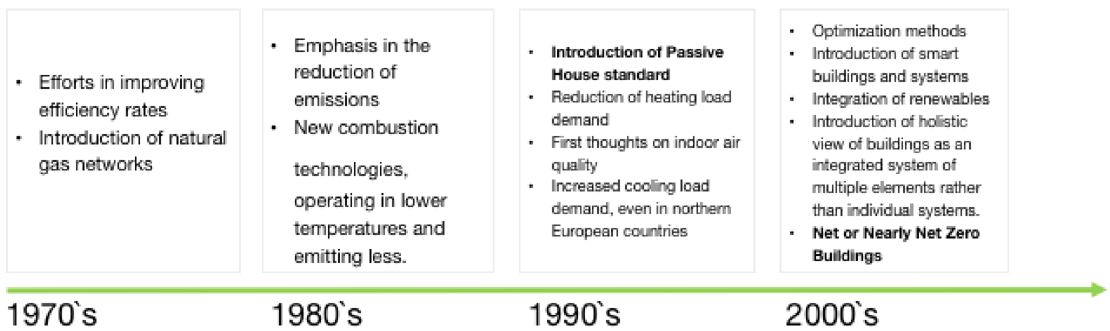


Figure 6.1:

Looking to the Scope and Background of EU, The main goals is the freedom of movement of goods persons services and capital.

The early measures up to the end of the 1970s, and then describes three main steps: the internal market; the climate change package; and the first steps towards a security of supply framework.

So went from trade agreement to common Energy Policy, or

From

European Coal and Steel Community (ECSC), administrative agency established by a treaty ratified in 1952, designed to integrate the coal and steel industries in western Europe. The original members of the ECSC were France, West Germany, Italy, Belgium, the Netherlands, and Luxembourg. The organization subsequently expanded to include all members of the European Economic Community (later renamed the European Community) and the European Union. When the treaty expired in 2002, the ECSC was dissolved.

To

Energy Union

The Energy Union Strategy is a project of the European Commission to coordinate the transformation of European energy supply. It was launched in February 2015, with the aim of providing secure, sustainable, competitive, affordable energy.

The European Council concluded on 19 March 2015 that the EU is committed to building an Energy Union with a forward-looking climate policy on the basis of the Commission's framework strategy, with five priority dimensions:

- Energy security, solidarity and trust
- A fully integrated European energy market
- Energy efficiency contributing to moderation of demand

- Decarbonising the economy
- Research, innovation and competitiveness.

The strategy includes a minimum 10% electricity interconnection target for all member states by 2020, which the Commission hopes will put downward pressure onto energy prices, reduce the need to build new power plants, reduce the risk of black-outs or other forms of electrical grid instability, improve the reliability of renewable energy supply, and encourage market integration.

We can spilt 3 main waves, which reflect concerns and events of that time, so as overall incremental regulation, moving from basic needs, as supply and trade, to negative externalities, to full integration of economic and sustainable goals.

As the same way regulation of basic human implementation was achieved, new layers and goads were pursuit.

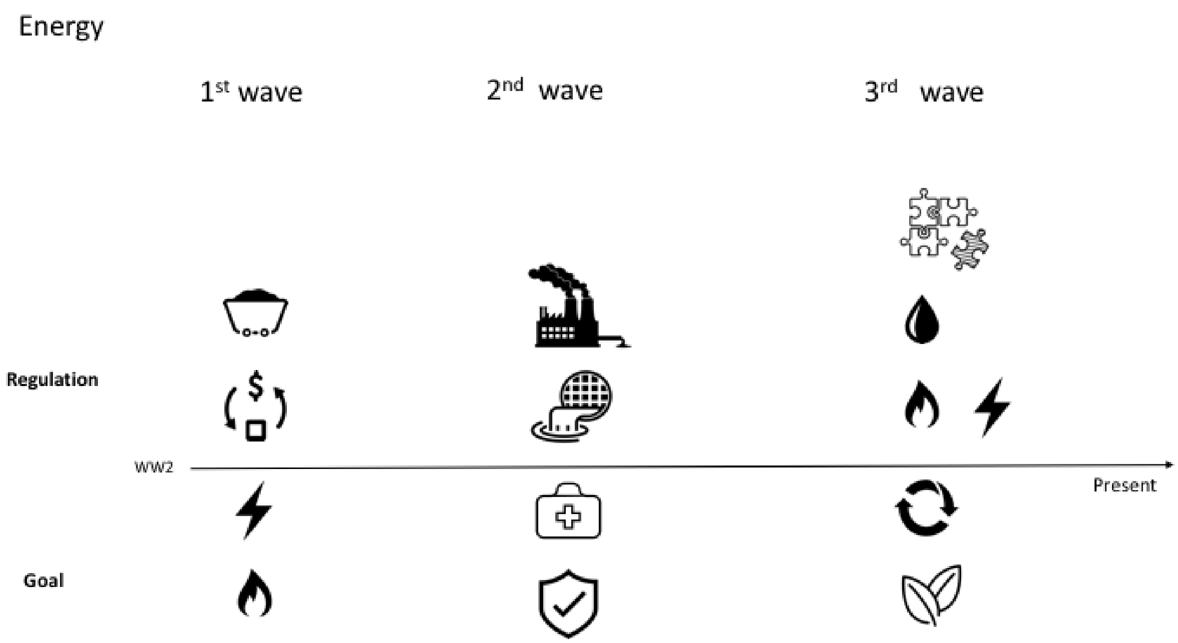


Figure 6.2:

1st Wave, where the goal was access to goods, namely coal, so we can trace back to the European Coal and Steel Community (ECSC), where regulation was related to trade and tariffs.

- Council Directive 90/531/EEC of 17 September 1990 on the procurement procedures of entities operating in the water, energy, transport and telecommunications sectors
- Directive 94/22/EC of the European Parliament and of the Council of 30 May 1994 on the conditions for granting and using authorizations for the prospection, exploration and production of hydrocarbons
- Directive 2013/30/EU of the European Parliament and of the Council of 12 June 2013 on safety of offshore oil and gas operations and amending Directive 2004/35/EC
- The Oil Stocks Directive (Council Directive 2009/119/EC) of 14 September 2009 imposing an obligation on Member States to maintain minimum stocks of crude oil and/or petroleum products.
- Directive 2003/54/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in electricity

2nd Wave, where the goal was improve and guarantee common safety and health standards. The Regulation of most industries, namely its externalities, as emissions and waste.

As for example:

- Solutions to prevent and minimize environmental damages are a requirement to companies of a large number of industries that want to have licenses to operate in the market. Currently the following main pieces of legislation apply in this field
- The IPPC Directive (Integrated Pollution Prevention & Control), that establish the politics on prevention of pollution;
- Several sectorial directives, which lay down specific minimum requirements, including emission limit values for certain industrial activities (large combustion plants, waste incineration, activities using organic solvent and titanium dioxide production).
- The Directive on industrial emissions 2010/75/EU (IED) that has entered into force on 6January 2011 and has to be transposed into national legislation by Member States by 7January 2013.
- EU European Trading Scheme (ETS) Policy, launched in 2005, works on the "cap and trade"principle. The number of allowances is reduced over time so that total emissions fall.
- Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community (Text with EEA relevance)
- Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006

  3rd wave, with the aim of setting a decarbonized economy, so as an efficient and sustainable use of resources, where Regulation falls into energy markets, as electricity, gas, so as the integration of a single EU Energy Market.
- Directive 2009/28/EC on the promotion of the use of energy from renewable sources (RES)
- Directive 2012/27/EC on energy efficiency
- Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC

And finally the Winter Package:

- Commission Regulation (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management
- Commission Regulation (EU) 2016/1719 establishing a guideline on forward capacity allocation
- Commission Regulation (EU) 2016/1447 establishing a network code on requirements for grid connection of high-voltage direct current system and direct current-connected power park modules
- Commission Regulation (EU) 2016/631 establishing a network code on requirements for grid connection of generators
- Regulation on laying down guidelines relating to the inter-transmission system operator compensation mechanism and a common regulatory approach to transmission charging (838/2010/EU)

On Urban Planning and Buildings we can state:

1st wave, namely after the war to reallocate, reconstruct cities and provide housing at affordable prices, so regulation was towards construction, access (housing) and property rights.

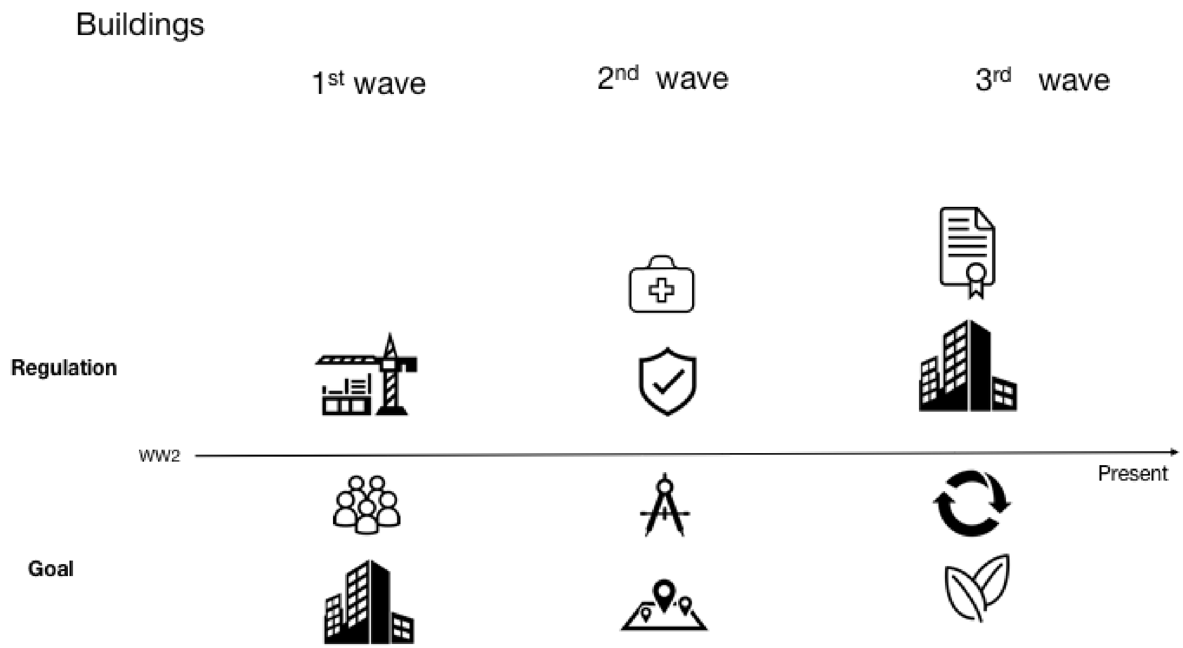


Figure 6.3:

2nd wave, with the goals to set overall urban planning and assume basic standards of safety, hygiene and public health, regulation was in setting minimum standards of the last 3 goals.

3rd wave, promoting sustainable cities and communities, regulation for buildings, use of resources and setting standards, as the Energy Certification in Buildings for these assets be traded and used.

Unlike in Energy, regulation from EU regarding Buildings, only emerges in this 3rd wave, where the fist two were typical competences of local governments.

6.1.2 European and National Legal Frameworks - Types of Regulatory mechanisms

The aims set out in the EU treaties are achieved by several types of legal act. Some are binding, others are not. Some apply to all EU countries, others to just a few.

The legal basis for the enactment of directives is Article 288 of the Treaty on the Functioning of the European Union (formerly Article 249 TEC), under section 1 “THE LEGAL ACTS OF THE UNION”

According to Article 288:

To exercise the Union’s competences, the institutions shall adopt regulations, directives, decisions, recommendations and opinions.

A regulation shall have general application. It shall be binding in its entirety and directly applicable in all Member States.

A directive shall be binding, as to the result to be achieved, upon each Member State to which it is addressed, but shall leave to the national authorities the choice of form and methods.

A decision shall be binding in its entirety. A decision which specifies those to whom it is addressed shall be binding only on them.

Recommendations and opinions shall have no binding force.

Types of EU legal acts:

- Directive;
- Regulation,
- Decision;
- Recommendation
- Opinion

A "directive" is a legislative act that sets out a goal that all EU countries must achieve. However, it is up to the individual countries to devise their own laws on how to reach these goals. One example is the is the Energy Efficiency Directive.

A "regulation" is a binding legislative act. It must be applied in its entirety across the EU. For example, when the EU wanted to make sure that there are common safeguards on goods imported from outside the EU, the Council adopted a regulation.

A "decision" is binding on those to whom it is addressed (e.g. an EU country or an individual company) and is directly applicable. For example, the Commission issued a decision on the EU participating in the work of various counter-terrorism organisations. The decision related to these organisations only.

A "recommendation" is not binding. When the Commission issued a recommendation that EU countries' law authorities improve their use of videoconferencing to help judicial services work better across borders, this did not have any legal consequences. A recommendation allows the institutions to make their views known and to suggest a line of action without imposing any legal obligation on those to whom it is addressed.

An "opinion" is an instrument that allows the institutions to make a statement in a non-binding fashion, in other words without imposing any legal obligation on those to whom it is addressed. An opinion is not binding. It can be issued by the main EU institutions (Commission, Council, Parliament), the Committee of the Regions and the European Economic and Social Committee. While laws are being made, the committees give opinions from their specific regional or economic and social viewpoint. For example, the Committee of the Regions issued an opinion on the clean air policy package for Europe.

Directives usually don´t have an Direct effect.

Even though directives were not originally thought to be binding before they were implemented by member states, the European Court of Justice developed the doctrine of direct effect where unimplemented or badly implemented directives can actually have direct legal force. Also, in Francovich v. Italy, the court found that member states could be liable to pay damages to individuals and companies who had been adversely affected by the non-implementation of a directive.

6.1.3 "Soft Law"

Lack of features (vs "hard law" such as:

- obligation,
- uniformity,
- justiciability,
- sanctions,
- and/or an enforcement staff

In the discussion of new governance in the European Union, the concept of “soft law” is often used to describe governance arrangements that operate in place of, or along with, the “hard law” that arises from treaties, regulations, and the Community Method. These new governance methods may bear some similarity to hard law. But because they lack features such as obligation, uniformity, justiciability, sanctions, and/or an enforcement staff, they are classified as “soft law” and contrasted, sometimes positively, sometimes negatively, with hard law as instruments for European integration.

“Soft law” is a very general term, and has been used to refer to a variety of processes. The only common thread among these processes is that while all have normative content they are not formally binding.

In his definition, Snyder describes soft law as “rules of conduct which in principle have no legally binding force but which nevertheless may have practical effects.” In recent years there has been an increase in interest in soft law in the EU.

There are several examples of “Soft Law”:

- Industry standards (as ISO´s, ..);
- Market costumes and practices;
- Recommendations and opinions;

They may be have similar strength of hard law, still are not enforceable. For example the “Best Available techniques (BAT´s), like stated in Industrial Emissions Directive and IPPC Directive, concerning mitigation and prevention mechanics.

Source: http://eippcb.jrc.ec.europa.eu/reference/

http://www.cres.gr/greenbuilding/PDF/prend/set4/WI_29_TC-approval_version_prEN_15459_Data_requirements.pdf

6.1.4 Scope and Articulation between EU, National Frameworks and International Standards

The use of the commons and property rights (Coase) it´s a well studied case of where externalities, such as pollution, if not internalized, individuals will have an incentive to over exploit (commons), so several schemes try to internalize such externalities or mitigate public interest with private interest, by setting trade offs.

When analyzing the legal system, using the classical distinction between:

Private Law - applies to relationships between individuals (and companies) in a legal system (e.g. Contract Law)

Public law applies to the relationship between an individual (and Companies) and the Government. (e.g., Administrative Law)

We can see conflicting areas

- Energy and Environmental;
- Property Rights (Real Estate) and Urban Planning;

For example:

Property rights are delimited by Administrative Law provisions (when you need a permit to construct) or

when environmental provisions cap use and access to natural resources (for example, when is required Environmental Impact Study,for starting operating large combustions plants, or by limiting the type and capacity of energy generation for self-consumption.

To close, it is important to understand how each documents relates to each other. Or how Directives, National Regulation and other reference documents interconnect with each other.

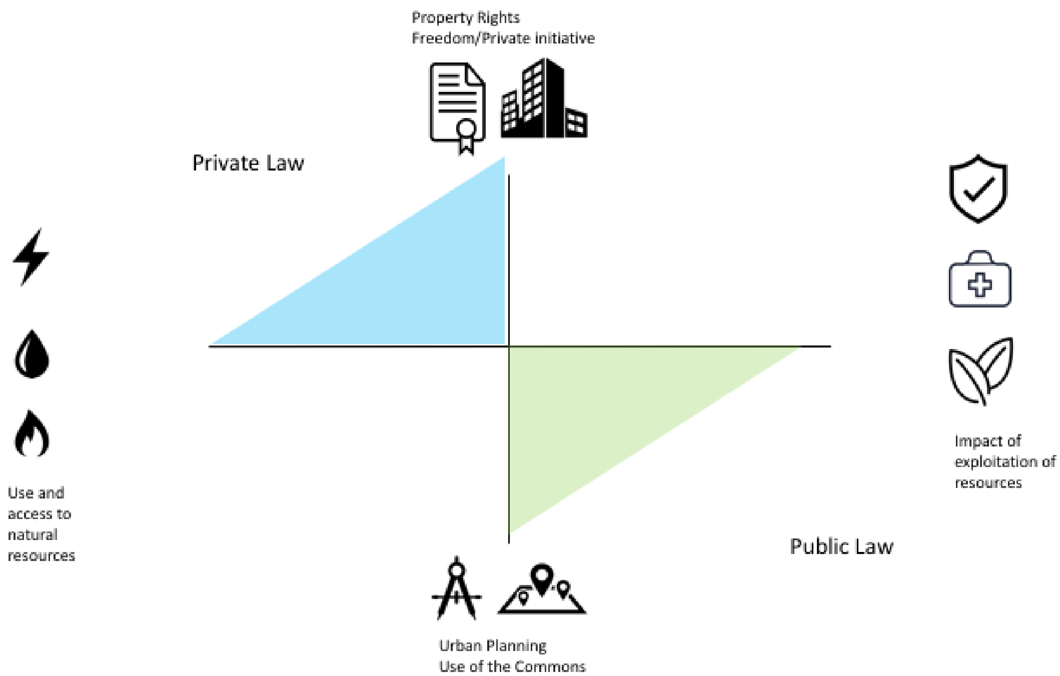


Figure 6.4:

We already know that Directives, in principle, do not have a direct effect and Member States have to fulfill internally those guidelines.

Directives are approved, and Member States have a certain period to transpose these Directives into national Law. Usually there is some freedom for adaptation, because each country has its own realities and system. EU states a goal, MS have to, internally, with their own legal tools, produce the mechanics to fulfill theses goals.

Parliaments, can either decide incorporate all definitions and procedures into a single piece of legislation or, attribute competence and authorization to a certain governmental entity, for fulfilling the details. A typical case are regulations to fulfill a certain piece of legislation. These entities are also mandate to execute, regulate, de application of such regulations.

Technical standards, they can either be incorporated into legislation and regulations or, a certain law or legislation send the interpretation to these technical standards produced by industry or professional peers. So theses documents even not having a originate features of hard law, they end having similar strength due to being used by enforceable legal pieces of legislation or regulation.

A typical example would be:

EU set a Directive to improve EE, Parliament transpose Directive into national law and mandates a regulatory agency to execute the attributions within this law. The regulatory agency, writes a regulation that uses as standards an international standard to define what EE means and how its measure.

6.1.5 EU regulation

6.1.5.1 EU Directives

- Energy Performance in Buildings Directive (2002/91/EC,2006/32/EC, 2010/31/EU)

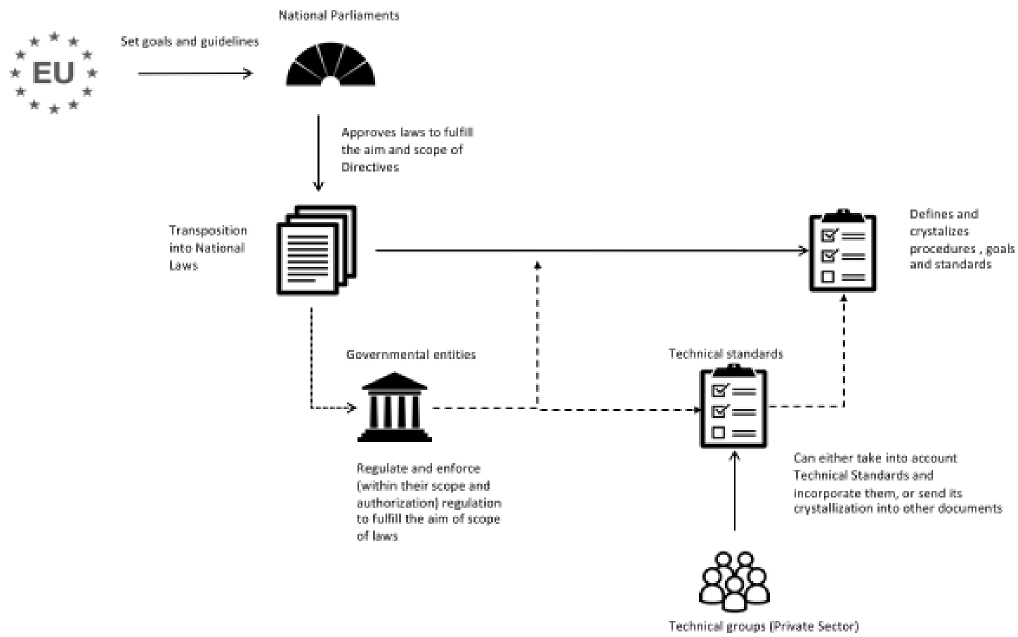
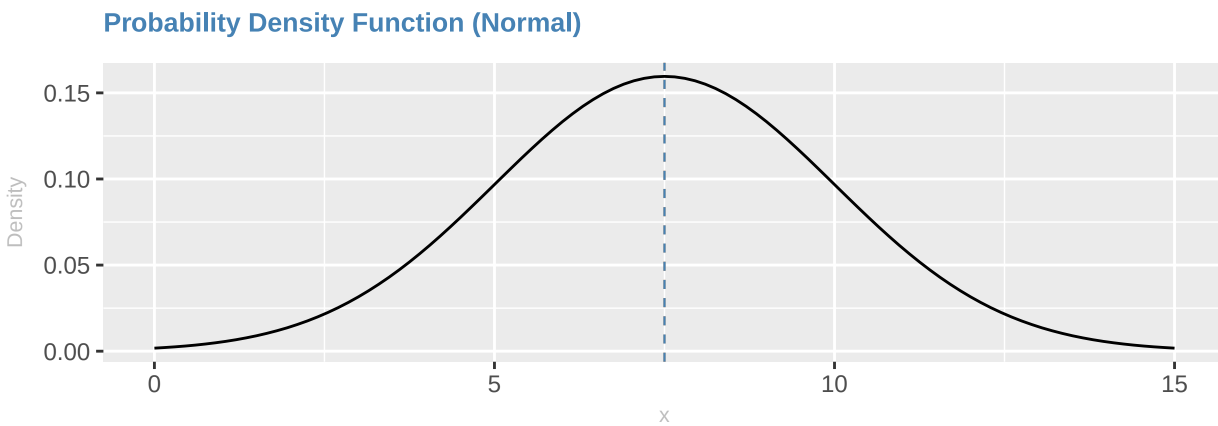
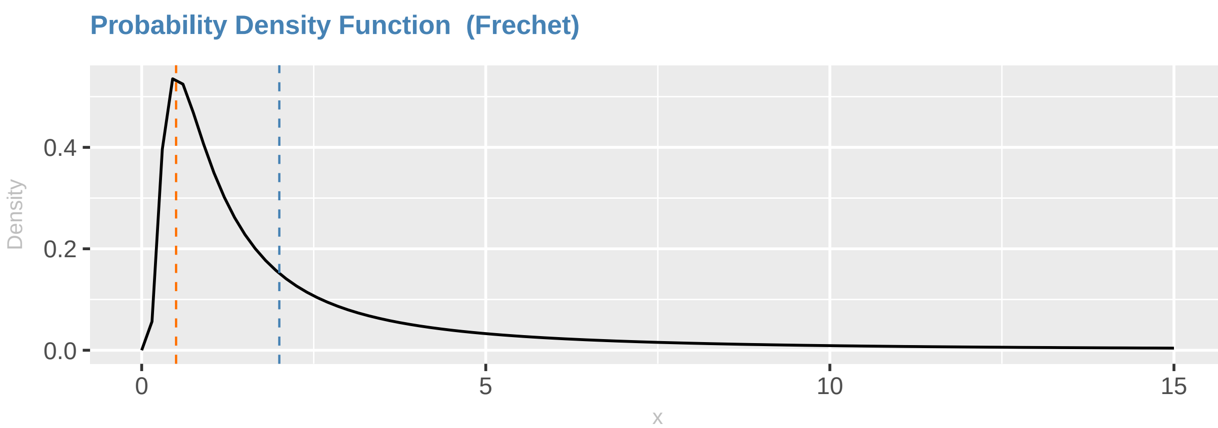


Figure 6.5:

- Energy Efficiency (2012/27/EU)

- Renewables Energy Directive (2009/21/EU)


Probability Density Function (Normal)
Density
0.15
0.10
0.05
0.00
0
5
10
15
x


Probability Density Function (Frechet)
Density
0.4
0.2
0.0
0
5
10
15
x

Chapter 7

Annexes

ESCO Market Report 2013, JCR Link: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC89550/jrc_89550_the%20european%20esco%20market%20report%202013_online.pdf

Financing building energy renovations, Current experiences and ways forward (2014), JCR Link: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC89892/final%20report%20on%20financing%20ee%20in%20buildings.pdf

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7.0.1 EU Directives

1. Energy Efficiency Directive (EDD) Link: http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1399375464230&uri=CELEX:32012L0027
2. Energy Performance of buildings Directive (EPBD) Link: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32010L0031
3. Directive 2014/24/EU on public procurement Link: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32014L0024
4. Directive 2014/25/EU on procurement by entities operating in the water, energy, transport and postal services sectors Link: http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32014L0025
5. Directive 2014/23/EU on the award of concession contracts Link: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2014.094.01.0001.01.ENG

Regulamento Relações Comerciais Link: http://www.erse.pt/pt/electricidade/regulamentos/relacoescomerciais/Paginas/default.aspxk

Medição Link: http://www.erse.pt/pt/electricidade/regulamentos/mediacaoeconciliacaodeconflitos/Paginas/default.aspx

PNAEE Link: http://www.erse.pt/pt/planodepromocaodaeficiencianoconsumoppec/Paginas/default.aspx

UK

https://www.ofgem.gov.uk/environmental-programmes/eco/about-eco-scheme

USA https://energy.gov/eere/femp/utility-energy-service-contracts-federal-agencies

EVO (Efficiency Evaluation Organization) Link: http://evo-world.org/en/

The Buildings Performance Institute Europe (BPIE)/Data & Tools Link: http://bpie.eu/focus-areas/buildings-data-and-tools/

IEA/Building Energy Efficiency Policies Link: http://www.iea.org/beep/Portugal/

Chapter 8

Formulae

8.0.1

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")

[1] REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Energy prices and costs in Europe (COM/2016/0769 final) of 30.11.2016, url:http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52016DC0769#footnoteref8

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)

Bibliography