Energy Financing and Risk Management

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Energy projects

Financing mechanisms

Basic terms

Economic assessment of project

Criteria for investment decision making

- Net Present Value - NPV
- Internal Rate of Return – IRR
- Which margin is acceptable?

Cash flow of an investment

- Real/nominal values
- Project IRR/ Equity IRR

Basic terms

Time Value of Money

Money **has two distinctive properties**:

(a) the ability to **generate money** (in the form of currency units or other material goods); and

(b) the ability to **lose value**.

These two properties are in direct relation to

Basic terms

Time Value of Money

In general, an amount of money is more useful and therefore more value at present than a similar amount of money in the future.

This finding relates to both the fundamentals of the financial system and the human preferences and is summarized in the three-dimensional effect:

1. **Inflation**
2. **opportunity cost and**
3. **risk.**

Example

I have 100,000 euros in **Present Value**, with a 10% interest rate, means that this amount of money will be worth 110,000

Future Value (of today's 100,000) is 110,000 in 1 year since today.

Otherwise, if I want to have 110,000 euros in 1 year from today, I have to invest 100,000 today at 10% interest rate

Present Value (110,000 of 2018) is 100,000 currently (in 2017)

Basic terms

1.The <u>inflation</u> represents the **devaluation of the purchasing power of money,**

ie, over time with the same amount, fewer goods / services can be purchased.

The fall in the value of money is caused by the **rise in the prices of the various goods and services** and for this reason the inflation rate can be estimated in practice by recording the prices of a specific set of consumer goods and services (**consumer price index**) help with the following formula:

Basic terms

Inflation:

f= δ1/δ0 – 1

where δ0 and δ1 is the value of goods and services before 1 year and today, respectively.

It is noted that the rate at which money is devaluated due to inflation **is not constant for all goods (or services).**

Inflation is estimated by **collecting prices from over 700 kinds of products & services**

https://www.ecb.europa.eu/ecb/educational/hicp/html/index.el.html

Basic terms

2. <u>The opportunity cost</u> generally refers to the **commitment of a resource** to a particular use, which results in the **"abandonment" of other alternatives**.

Often, the opportunity cost refers to the value generated by a resource in the **best possible alternative**.

In the case of money, the opportunity cost usually refers to **the loss of an investment opportunity** and, consequently, the corresponding benefit, **due to the commitment of money to a particular investmen**t over a period of time.

Basic terms

Opportunity cost is the cost incurred:

• from the sacrifice of a good B, for the production of good A.

– Good B could be produced using the same **production factors** used for the production of commodity A.

Production factors are:

• **Capital**

• **Land**

• **Labour**

• **Entrepreneurship & Technology**.

Basic terms

Main Production Factors are:

- Capital
  - – Durable goods (eg infrastructure, buildings, machinery, equipment, investment funds ...) used for the production of other goods
- Land (Land / Natural Resources)
  - – All items are naturally available and can be used to produce goods
- Labor
  - – All human efforts, mental and physical, to produce material or services.

Land and Labor are **primary production factors**, while **Capital is a derivative** (or technical) factor of production.

If a good requires a high share of labor or capital to produce, then the production process is **labor-intensive or capital-intensive**

Functional forms of production functions

- Cobb Douglas (widely used): $Q = AK^{\alpha}L^{\beta}$
- Constant Elasticity of Substitution (CES):

  $$Q = (A_K K^{-\rho} + A_L L^{-\rho})^{-1/\rho}$$

- Elasticity of substitution:

$$\sigma = \frac{d\ln(L/K)}{d\ln(f_K/f_L)} = \frac{d(L/K)}{d(f_K/f_L)}\frac{(f_K/f_L)}{(L/K)}$$

- σ = 1 for Cobb-Douglas, 1/(1+ρ) for CES

Basic terms

Supplementary Production factors are:

- **Entrepreneurship**
  - Ability to combine the other production factors (including business idea, risk management ...)

- **Technology**
  - the scientific knowledge, the results of applied research and the systematized production experience
  - for some economists, technology is incorporated into technical capital (the means of production) and know-how (computing, specialization ...) in the training and specialization of the workers and therefore they are not a separate factor of production.

Basic terms

• **Business risk**, finally, is related to the uncertainty that exists in forecasting future conditions, for example:

– the collection of debts by third parties, in relation to the corresponding assurance (for example, the difference between bank lending rates for housing and consumer loans or credit cards)

– the production factors market in terms of availability, prices, etc.

– the retail market of the produced product, mainly in terms of demand, competition that may have an impact on prices, the development of substitute products, etc.

– in the wider economic environment (eg inflation, institutional framework, political stability, etc.

Basic terms

Business risk

Commitment of an amount of money now, either equity or loan for investment etc., involves the risk that this amount will be devaluated permanently for a variety of reasons (eg investment failure, economic environment, etc.). This risk must be paid by the investor. In addition, it excludes its alternative use (opportunity cost).

Basic terms

These parameters are included in the **discount rate**, which is used to calculate the **future value** of a current amount or the current (or **present) value** of a future amount.

- in the case of calculating the future value of an amoun of money, the rate is often called a **compounding** interest **rate**,
- in the case of calculating the present value of a future amount, the rate is referred to as a **discount rate**.

<u>Discount rate is an important factor in decision making for investments.</u>

Basic terms

- **Discounting factor**

Energy projects have large life cycles (> 5 years), so they require investment funds.

This factor takes into account the devaluation of money over time, through the discount rate,

which depends on the investor and the commercial environment that is moving (country of investment, borrowing, placement of funds ...):

A) cost of borrowing money

B) value of bank deposits

C) capital production from the issue of shares, bonds ...

Discounting factor

$$DF_n = \frac{1}{(1+r)^n}$$

i.e. for a discount rate r=5%, the Discounting Factor DF, over a period of years n, is:

when	n	DF_n
This year	0	1
In 2 years	2	0.91
In 5 years	5	0.78
In 10 years	10	0.61

1000 euro today have the same value of money with 610 euro in 10 years.

If the discount rate is 10%, then they have same value of money with 390 euro in 10 years.

The Discount Rare is **VERY IMPORTANT**

Social discount rate

Climate change has brought to the forefront the importance of an issue of **solidarity among generations**.

It has created a public debate among Economists such as Nicholas Stern and William Nordhaus in relation to the **<u>Social Discount Rate</u>** (%), which shows the relative weight that society gives in the future in relation to the present.

Stern argues for 1.4% or even zero discounting for future generations

Discounted Cash Flow

Annual Cash Flow (CFn) is the algebraic sum of the amount of money spent or earned at the end of each year of the time period of year n.

- Expenses for the purchase, operation, maintenance of equipment
- Profits (revenue)
- Taxation, interest

The **Discounted Cash Flow (DCFn)** for one year after the investment is:

DCFn= DFn * CFn, in euro/year

Cash Flows

In the assessment of investment plans for a description of the expected results (revenues and expense) of the investment (usually on an annual basis) **fixed periodic cash flows** are used.

Usually, however, they are not stable but fluctuating as revenues-expenditure relationships change.

Most "conservative" investors prefer fixed cash flows (however, with relative low rate of returns)

Loan installments

- **A company borrows 5,000,000 Euro with interest rate 5%.**
- With the help of the following formula, for interest rate ε = 5% and loan payment period of t = 10 years, we estimate:
- The Capital recovery factor

$$CRF = \frac{\varepsilon * (1+\varepsilon)^t}{(1+\varepsilon)^t - 1}$$

(CRF) = 0.1295 (annual fixed factor)

- So, the annual installment for the loan repayment for a period of ten years is:
- Annual installment= 0.1295 * 5,000,000 = 647,522,63 €
- In ten years, **<u>the bank will be credited 6.5 million euros, while the loan was 5 million Euros.</u>**

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Investment queries

- How many funds are needs?
- Which is the process (regulatory framework, licensing ...)?
- How many years will the investment funds be written off?
- What is the rate of return of the investment?
- Is the investment more profitable compared to other options?
- What are the uncertainties/risks of the investment?
- Can there be an effective Risk management;

Steps on decision making for investments

1. Identify alternative proposals.
2. Determine the investment period.
3. Determine the cash flows per proposal.
4. Determine the Discount Rate.
5. Compare the alternative proposals.
6. Sensitivity analysis for each proposal.
7. Risk assessment for each proposal.
8. Choose the most profitable proposal.

Steps on decision making for investments

- The study period does not have to be the same as the lifetime of the investment.
  - i.e. the study period of a lignite power plant is 20 years, with a life span of the plant is 40 years.

- If the study period is less than the lifetime of the investment, then the residual value (Salvage Value) must be taken into account.

- If the study period is longer than the lifetime of the investment, the need to periodically replace the equipment should be taken into account.

Steps on decision making for investments

- If the alternative proposals have a **different lifetime** (eg Lignite unit 40 years, wind park 20 years, Energy efficiency project 15 years), one of the following is used as study period:

- The "horizon" of the business plan.
  - i.e 20 years
- Higher or shorter lifespan.
  - i.e. 15 years is the lifetime of energy savings
- The smallest multiple of lifetimes.
  - i.e. 5 years

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Net Present Value

Net Present Value (NPV) (in euros) is the sum of the total profits/losses for the investor through the lifetime of the project

It derives from the sum of Discounted Cash Flows (DCF) for all years of the project.

$$NPV = \sum_{i=0}^{n} DCF_i$$

A positive net present value indicates that the projected earnings generated by a project or investment exceeds the anticipated costs (in present value). Generally, an investment with a **positive NPV will be a profitable one** and one with a negative NPV will result in a net loss.

Net Present Value

If **NPV >0 , the investment is sustainable.**

$$NPV = \sum_{i=0}^{n} \frac{CF_i}{(1+r)^i}$$

Year 0, where the investment is made, we invest a Capital that leads to a Cash Flow Cfo,.

Moreover, there might be Salvage Value (SV), that can be revaluated in present value.

So, the NPV is:

$$NPV = CF_0 + \sum_{i=1}^{n} \frac{CF_i}{(1+r)^i} + \frac{SV_i}{(1+r)^i}$$

Example

I have an apartment and I want to sell it:

Offer a: 108,000 euros to be paid now

Offer b: 120,000 euros to be paid in one year

Offer b is more profitable than offer a, with a 10% discount rate, as:

NPVa = 108,000.

NPVb = 120,000 / 1.1 = 109,000

NPVb > NPVa

So I have to choose B Offer.

Behavioral Economics studies show, however, that in similar examples, people usually choose Offer a.

Behavioral Economics

Books

Daniel Kahneman (Nobel Laureate in Economics 2002), Think Fast & Slow.

Richard H. Thaler (Nobel Laureate in Economics 2017), and Cass Sunstein. *Nudge: Improving Decisions About Health, Wealth, and Happiness*.

Nassim Nicholas Taleb, The Black Swan: The Impact of the Highly Improbable

Rolf Dobeli, The Art of Thinking Clearly & The Art of Acting Clearly

Example

Investment Project A: Capital Cost: 100,000

Profits:

1st year: 50,000 euros

2nd year: 50,000 euros

3rd year: 50,000 euros

Investment Project B: Capital Cost: 100,000 Profits:

1st year: 40,000 euros

2nd year: 50,000 euros

3rd year: 60,000 euros

With a Discount Rate (10%), choose the most profitable investment, using the Net Present Value (CBA) method.

Example

Investment Project A:

NPV_A= 50,000/1.1 + 50,000/ (1.1*1.1) + 50,000 /(1.1*1.1*1.1) -100,000 = 24,300 euros

Investment Project A :

NPV_B= 40,000/1.1 + 50,000/ (1.1*1.1) + 60,000 /(1.1*1.1*1.1) -100,000 = 22,800 euros

$NPV_A > NPV_B$

Investment Project A is more profitable

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Internal Rate of Return

Internal Rate of Return (IRR)

Is the Discount Rate for which the return on investment over the lifetime of the project is equal to the amount of the investment.

That is, the **discount rate for which the Net Present Value (NPV) is zero**.

IRR = r , for NPV = 0.

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

NPV=0 ,IRR


FLORA
NATURE
LEAF
GREEN
WORLD
GROWTH
GLOBAL
ECO
PROTECT
TREE
PLANET
RECYCLE
LIFE
FLORA
NATURAL
PROTECT
GLOBA
ORGANIC
RECYCLE
PLANET
PLANT
TREE
GREEN
ENVIRONMENT
RECYCLING
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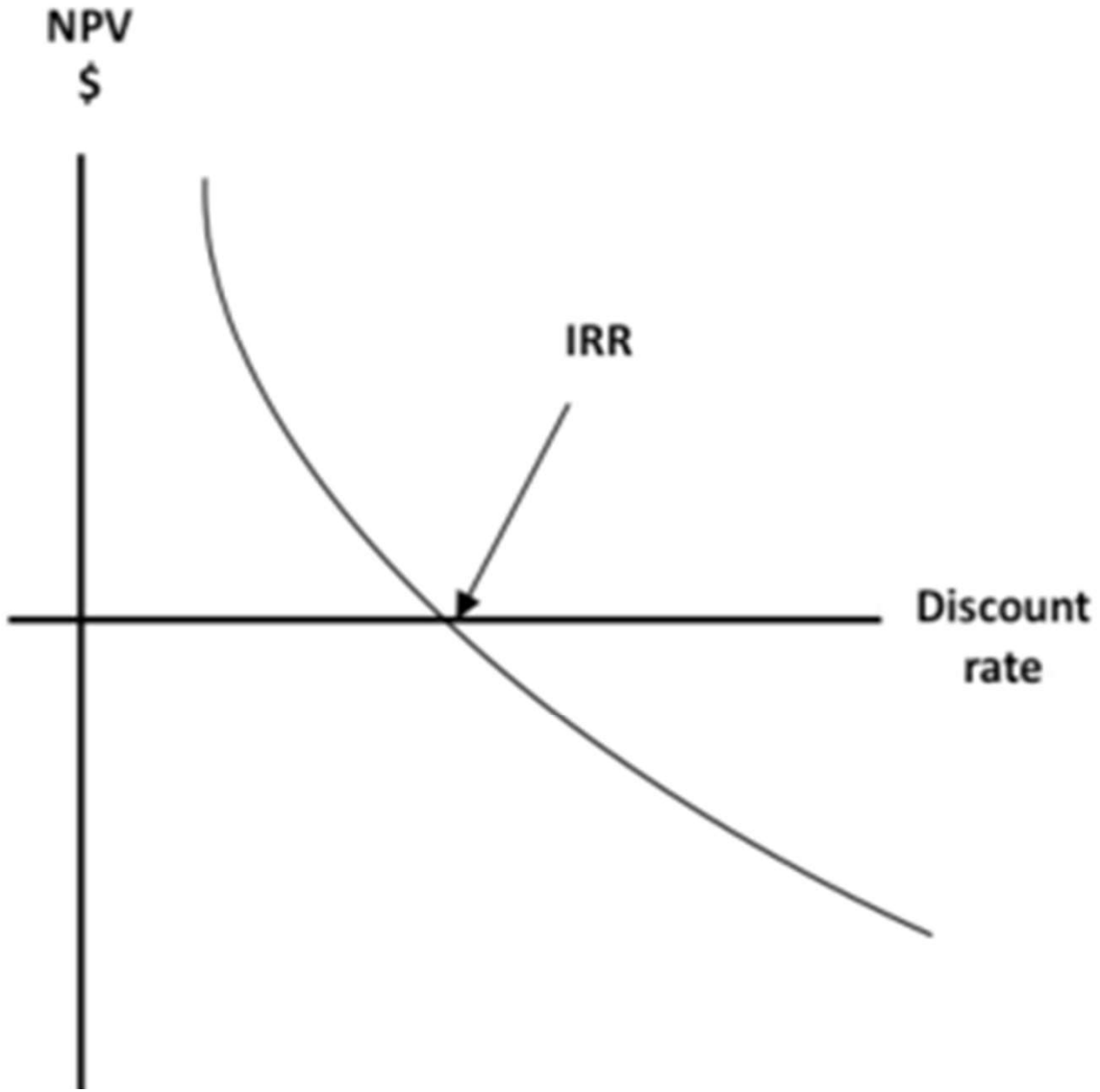
NPV
$
IRR
Discount
rate

Internal Rate of Return

The **Internal Rate of Return (IRR) shows the performance of an investment plan**.

Similarly, with the interest rate given by a deposit account to a bank, the annual yield of a bond, a share ...

If the Internal Rate of Return is greater than the desired, then the investment is accepted.

Criteria for decision making on investments

When considering an investment plan independently of the alternatives, then the terms of acceptance or rejection in relation to these **two criteria (NPV or IRR)** are formulated as follows:

a. For the **Net Present Value (NPV)**

- NPV > 0, the investment is considered to be profitable and is approved
- NPV = 0, the assessment of the investment is marginal and is approved when there is no better alternative
- NPV <0, the investment is rejected

Criteria for decision making on investments

b. For the **Internal Rate of Return (IRR)**:

- **IRR > from the minimum acceptable discount rate**, the investment is considered to be profitable and is approved
- IRR = with the minimum acceptable discount rate, the investment is considered marginal, and is approved when there is no better alternative
- IRR < from the minimum acceptable discount rate, the investment is rejected.

Criteria selection

Irrespective of the criterion used, when comparing two or more alternative investment plans, the best performing plan, ie **the highest NPV or higher IRR is preferred.**

As mentioned, both methods are widely used and combined, as **each of the two methods presents advantages and disadvantages**

Other criteria

- **Benefit – Cost Ratio** criterion, known as Present Value Ratio.
  - Used for the estimation oft the Overal Rate of Return.

- **Payback period**.
  - Defined as the amount of time required to cover the cost of the initial investment from the annual cash flows after taxes

Levelized Cost of Energy (LCOE)

Levelized Cost of Energy – LCOE in Euro/MWh

Average price at which the production of the investment must be compensated for depreciation of both:

- the initial investment costs (and borrowing) and
- the total operating and maintenance costs.

This price is the minimum acceptable selling price of the energy produced, in order that investment is sustainable. LCOE is typically calculated as the quotient of total costs to total energy production over the lifetime of the investment (generally 20 to 40 years), expressed in present values.

Levelized Cost of Energy (LCOE)

Levelized Cost of Energy – LCOE) in Euro/MWh

the quotient of total costs to total energy production over the lifetime of the investment, expressed in present values

$$LCOE = \frac{\left(\sum_{i=1}^{n} \frac{IC_i + OC_i}{(1+r)^i}\right) - \frac{SV_n}{(1+r)^n}}{\sum_{i=1}^{n} \frac{Egen_i}{(1+r)^i}}$$

ICi: investment costs in period i

OCi: operation costs in period i

r: discount rate

Egeni: produced energy in period i

SVn: salvage value in period n

NPV or IRR

The two methods <u>are not equivalent</u>. Many times (practically most of the time) the **two methods lead to the same conclusion**.

The Net Present Value (NPV) is usually preferred by the bibliography, but most business executives use IRR .

IRR gives results in percentages, more attractive and comprehensible than NPV currency results.

NPV	IRR
1. It measures the wealth accumulation volumes, which is compatible with economic theory, eg. maximizing utility. However, **it does not determine whether the capital is effectively used.**	It measures the degree of wealth accumulation or the rate of change of wealth. It highlights **the effectiveness of the use of capita**l, but not the overall result of the project.
2. The size of the NPV is **dependent on the discount rate and on the size of the initial investment**. The NPV increases for projects of a larger size.	**IRR is independent of the size of the initial investment**. In order to grow the IRR, the investment must be more profitable.
3. Requires prediction for costs and revenues.	Requires prediction for costs and revenues.

NPV	IRR
4. It requires the choice of an **external discount rate** and since the selection is **difficult** it is described as a weakness of the method.	IRR does not require ex-post knowledge of the **minimum acceptable margin** for comparison.
5. It considers that the annual dividends are reinvested by the **company's capital cost.**	It considers that the annual dividends are reinvested at the **interest rate equal to the IRR**.
6. It is often reported that the NPV has only one value in contrast to the **IRR that exhibits the problem of multiple roots**.	Multiple roots (IRR values) may exist. Then the NPV is preferred. (occurs when there are at least 2 changes to the sign of cash flows).
7. NPV correctly classifies mutually exclusive projects under conditions of limited capital	IRR correctly classifies mutually exclusive projects under conditions of limited capital.

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Accepted margin

Which IRR is acceptable?

We expect an IRR considerably higher than the interest rate of a bang account, which is an option with low risk.

- Unless we expect a haircut (and we want to invest even in not very profitable projects) or
- The investment aims at “legalizing illegal revenues”

If a project has **IRR higher than the Cost of Capital** used for the financing of the project,

the surplus is the profits for the shareholders fo the project.

WACC

Weighted Average Capital Cost (WACC) is a commonly used indicator of the Capital Cost.

A project is acceptable if the **IRR of the project is at least higher than WACC.**

IRR >= WACC

WACC

The Weighted Average Capital Cost is the minimum **Accepted Rate of Return** for a project.

WACC

There exist different methodologies for estimating the WACC

i.e.

- Bonds and
- Capital shares
  - Dividend Valuation Model
  - Capital Asset Pricing Model.

Accepted margin

IRR is usually uncertain, however it might be **regulated**.

Example: The expected revenue of networks

WACC is high and is regulated by the Regulatory Authority of Energy for the TSOs and DSOs

i.e. For TSO, there might be a **premium for the implementation of big projects** (interconnection of islands)

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Cash Flows

The financial analysis aims at calculating the **cash flows** that will result from the implementation of the investment plan under investigation.

The cash flow is defined by **the difference** of two sizes:
cash inflows and cash outflows.

This difference may be **positive or negative**

.

Cash Flows

Cash flow refers to a specific time period, usually an annual period.

Therefore, for an investment project, the **table of annual cash flows** for the economic life of the investment is estimated for the whole examijed period of the project i.e. 20 years

Cash Flows Table

In order to draw up the cash flow table it is necessary to know the following sizes:

- of the total **capital needed for the investment**

- **annual expenditure** (fixed and variable operating expenses, interest, amortization, income tax, additional capital disbursements, eg for equipment renewal)

- **annual revenue**

- the annual **depreciation**

Cash Flow Table

Annual depreciation

- the accounting for the loss in the value of the asset with the use or over time

- Depreciation is not a cash flow and therefore, when drawing up the cash flow table, it is not included in operating expenses.
  - is used for estimation of the tax

- The Ministry of Finance defines depreciation rates of fixed assets by economic sector

Cash Flow Table

	0	1	2	v
(1) Capital investment				
(2) Revenues				
(3) Expenditures				
(4) Net Profits = (2)-(3)				
(5) Depreciation i.e. in 5 years period = 20% factor				
(6) Loan interest				
(7) Taxed Income =(4)-(5)-(6)				
(8) Tax = (7) * Tax rate i.e. 29%				
(9) Net revenues after taxation = (7)-(8)				
(10) Loan installment				
(11) Net cash flow after tax =(9) +(5) – (10) +(1)				

Project and Equity IRR

Project and Equity IRR

<u>Project IRR) is usually lower from the Equity IRR.</u>

Project IRR can be higher from Equity IRR, <u>when the Cost of Debt is higher from the Project IRR.</u>

Practically when it is expensive to borrow money.

i.e εa project with 50-50 % Own Capital-Loan, the Loan (with the Taxation rate) has a rate higher than 10% and the Project IRR is 10%, then the Equity IRR is lower than 10%.

IRR

The **Internal Rate of Return - IRR** is the **basic criterion** for deciding an investment,

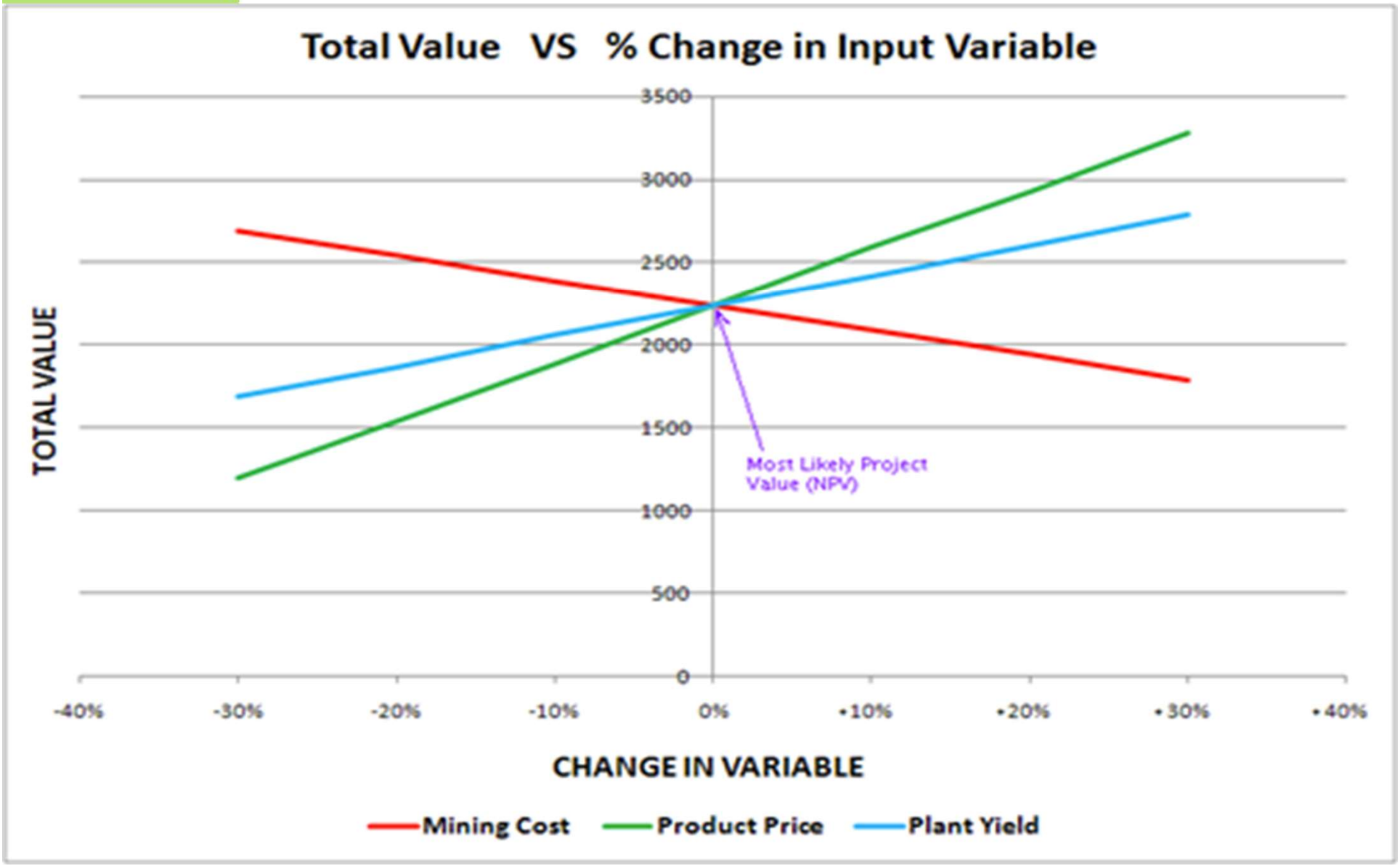
IMPORTANT is also the **cashflows**, as there might be *negative cash-flows*, which means further capital and loan to cover the operational expenses of the project

Namely, a project with high IRR in a period of 20 years, but has negative cash-flows in the first five years, due to loan installments and requirements for cash for daily operations

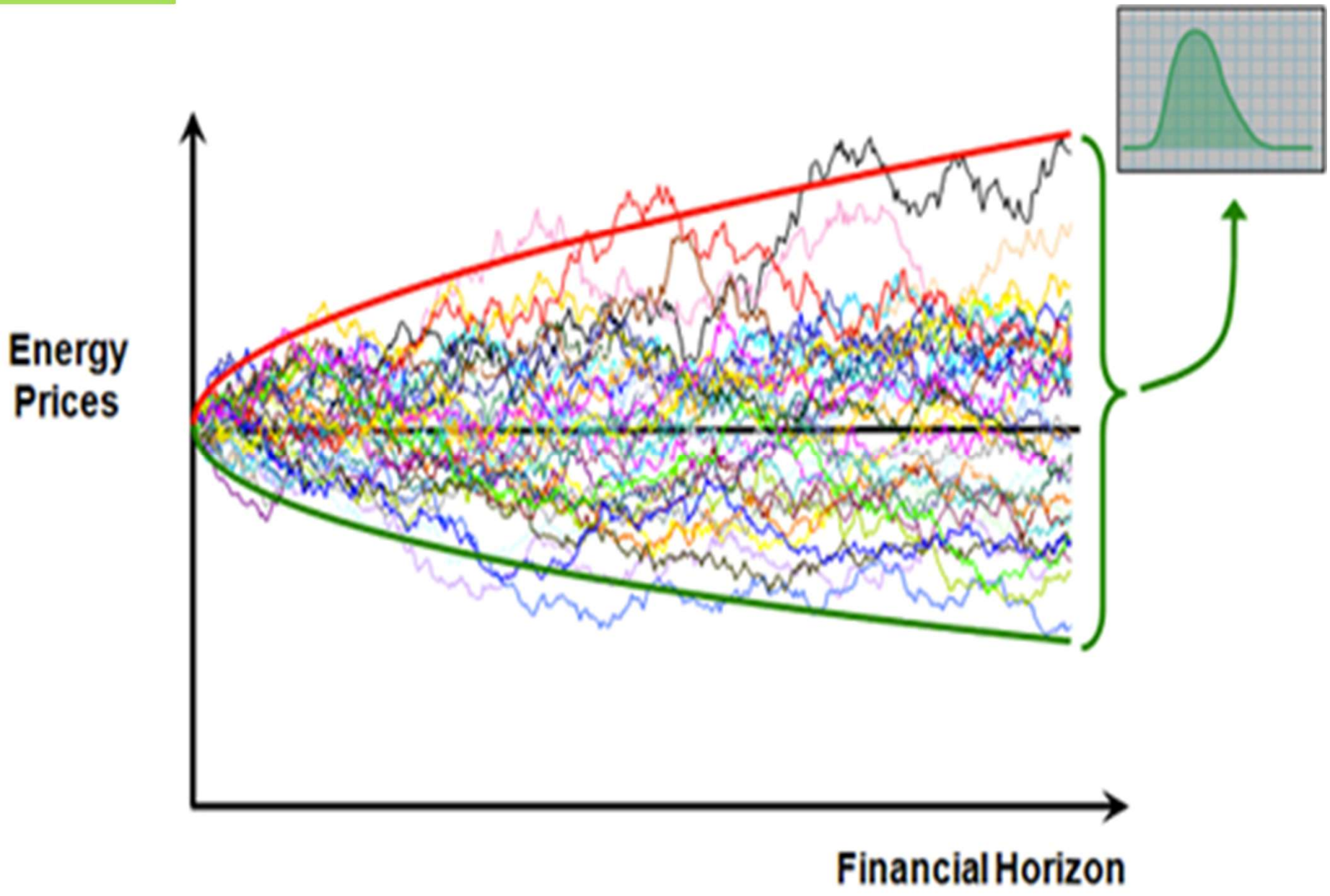
Risk analysis

- **Sensitivity analysis,**
  - Examines the effect of changes in parameters (i.e. +-20% in energy prices) in the final outcome (i.e. IRR of project)
  - Creation of base and alternative scenarios
- **Decision trees**
  - Show the interconnection of present and future decisions, and how they affect the cashflow of an investment
- **Break even point**
  - the point (value of a parameter) where an investment becomes profitable.
- **Monte Carlo simulation**
  - Choose solution with higher frequency
  - Estimation of distribution function of critical parameters (i.e. energy prices, volume of the market ...),
  - Considers the random evolution of several uncertain parameters at the same time

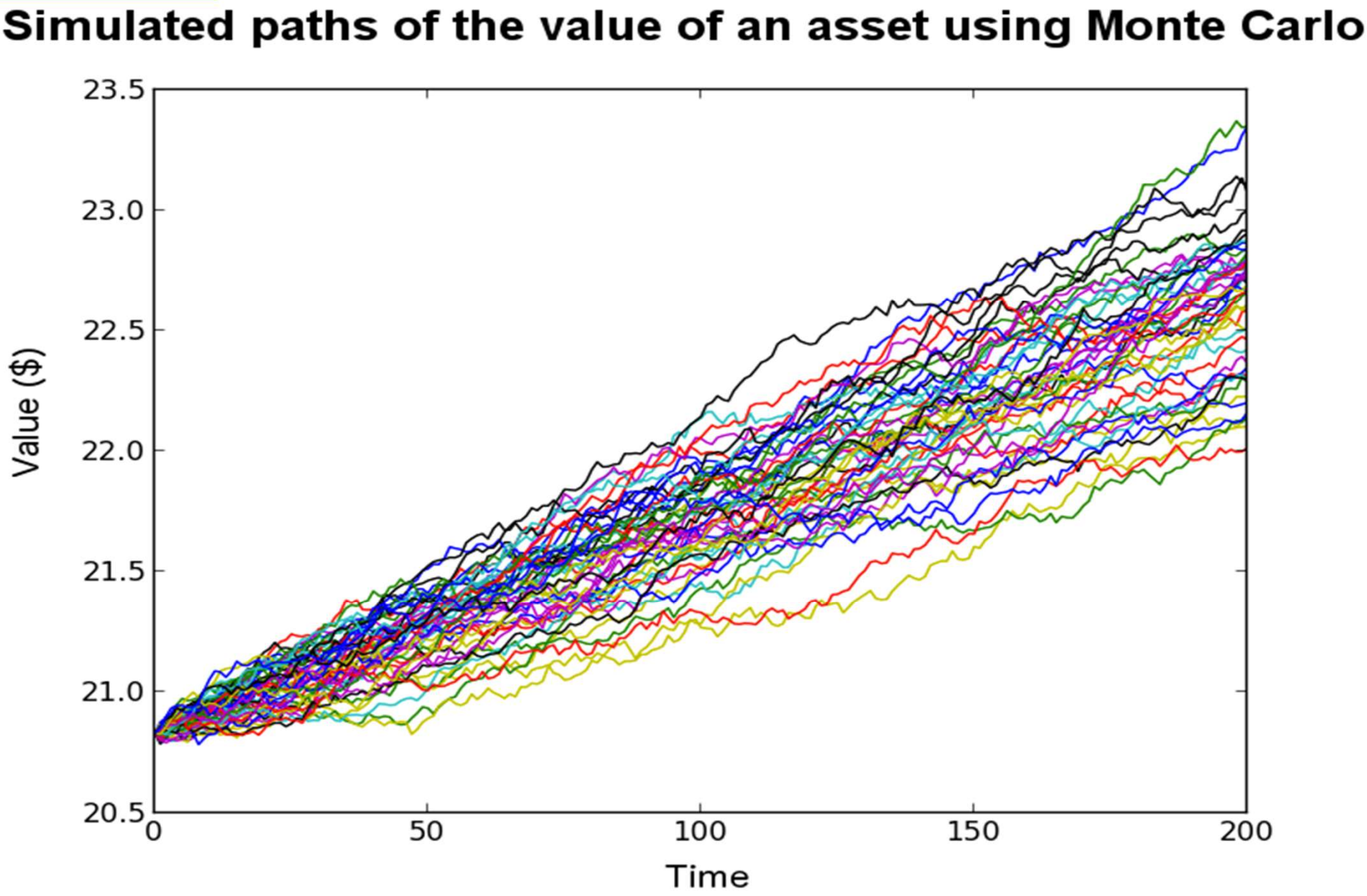
Sensitivity analysis



Monte Carlo simulation



Monte Carlo simulation



Monte Carlo simulation

electroproduction cost from PVs in different areas