LBE5010 Renewable Energies and Energy Planning

Techno-Economical Analysis of Energy Generation Power Plants

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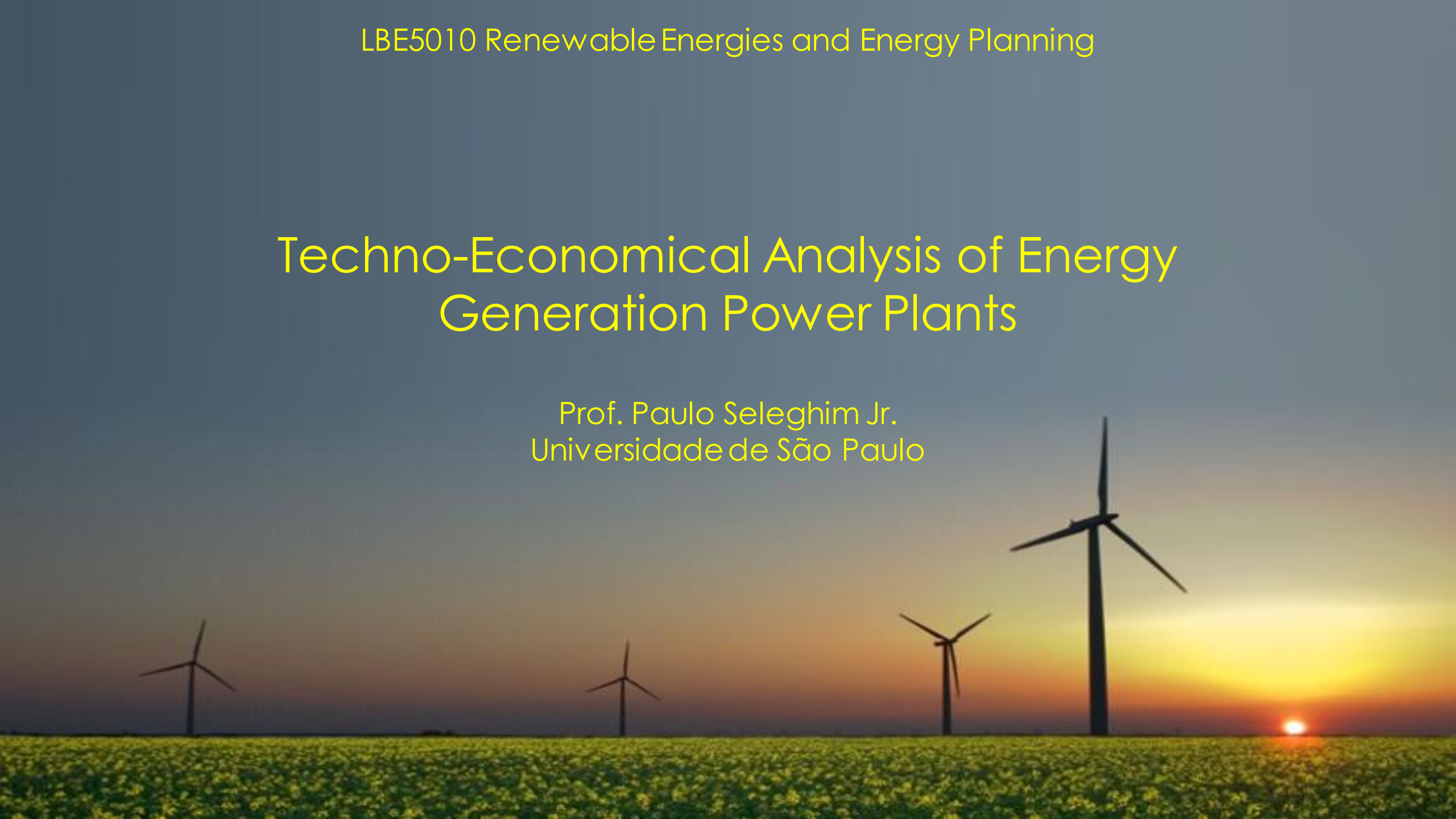
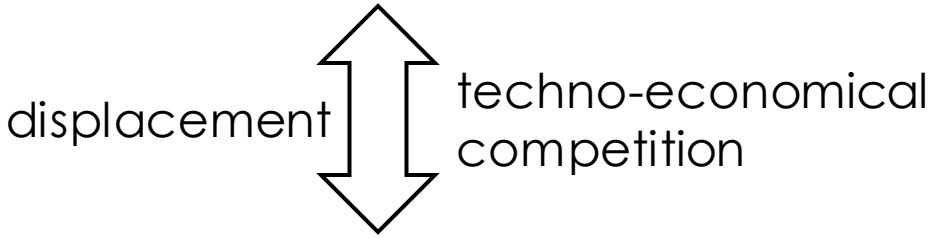
Universidade de São Paulo

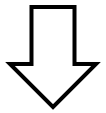


FOSSIL ENERGY SOURCES



RENEWABLE ENERGY SOURCES

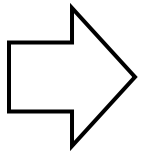
Techno-Economical Analysis of an Investment Project



Capital Budgeting

Development of an engineering project

Project: Conceptual
Analysis
Executive



Economic sustainability: success as a product and as an investment project

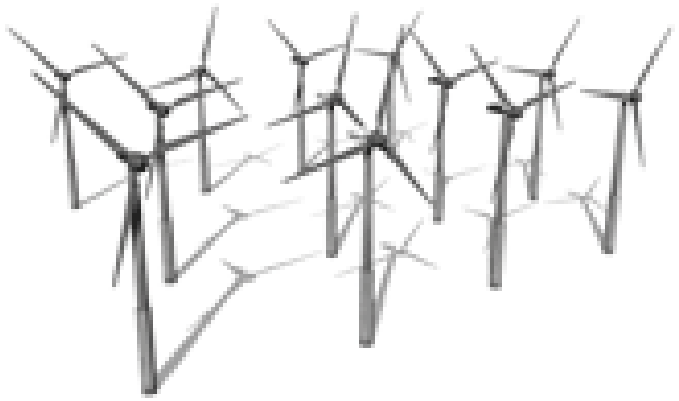
Execution: Implementation
Commissioning
Operation

Economic Engineering: application of techno-economical analysis tools to to the engineering project aiming at identifying the best choice between excluding alternatives…

Case Study:

Development of an engineering project

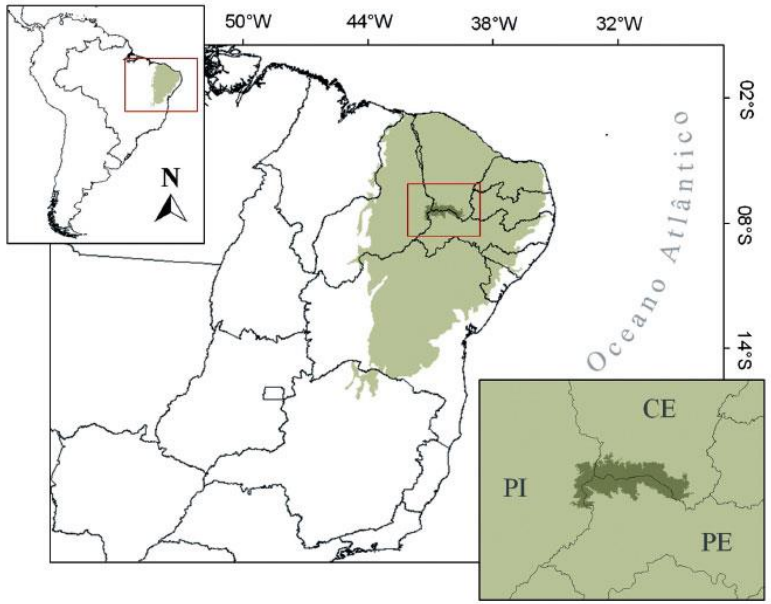
Case study: decision about investing R$ 1 billion in a photovoltaic power plant or in a wind farm (both greenfield)



Solar
Thermal ?

Development of an engineering project

Case study: decision about investing R$ 1 billion in a photovoltaic power plant or in a wind farm (both greenfield)



Chapada do Araripe

- **A) Queiroz Galvão**
  - Complexo Caldeirão Grande
  - 415.8 MW - 2016/2017 (ACL)
- **B) Chesf/ContourGlobal/Casa dos Ventos**
  - Complexo Picos
  - 205.1 MW Set/2015
- **C) Casa dos Ventos**
  - Complexo Ventos do Araripe
  - 210 MW set/2015
- **D) Chesf/ContourGlobal/Casa dos Ventos**
  - Complexo Ventos do Araripe II
  - 172,4 MW Jan/2016
- **D') Casa dos Ventos**
  - Complexo Ventos do Araripe II
  - 59,2 MW Jan/2016
- **E) Casa dos Ventos**
  - Complexo Ventos do Araripe III
  - 234.6 MW Mai/2018

Development of an engineering project

Case study: decision about investing R$ 1 billion in a photovoltaic power plant or in a wind farm (both greenfield)

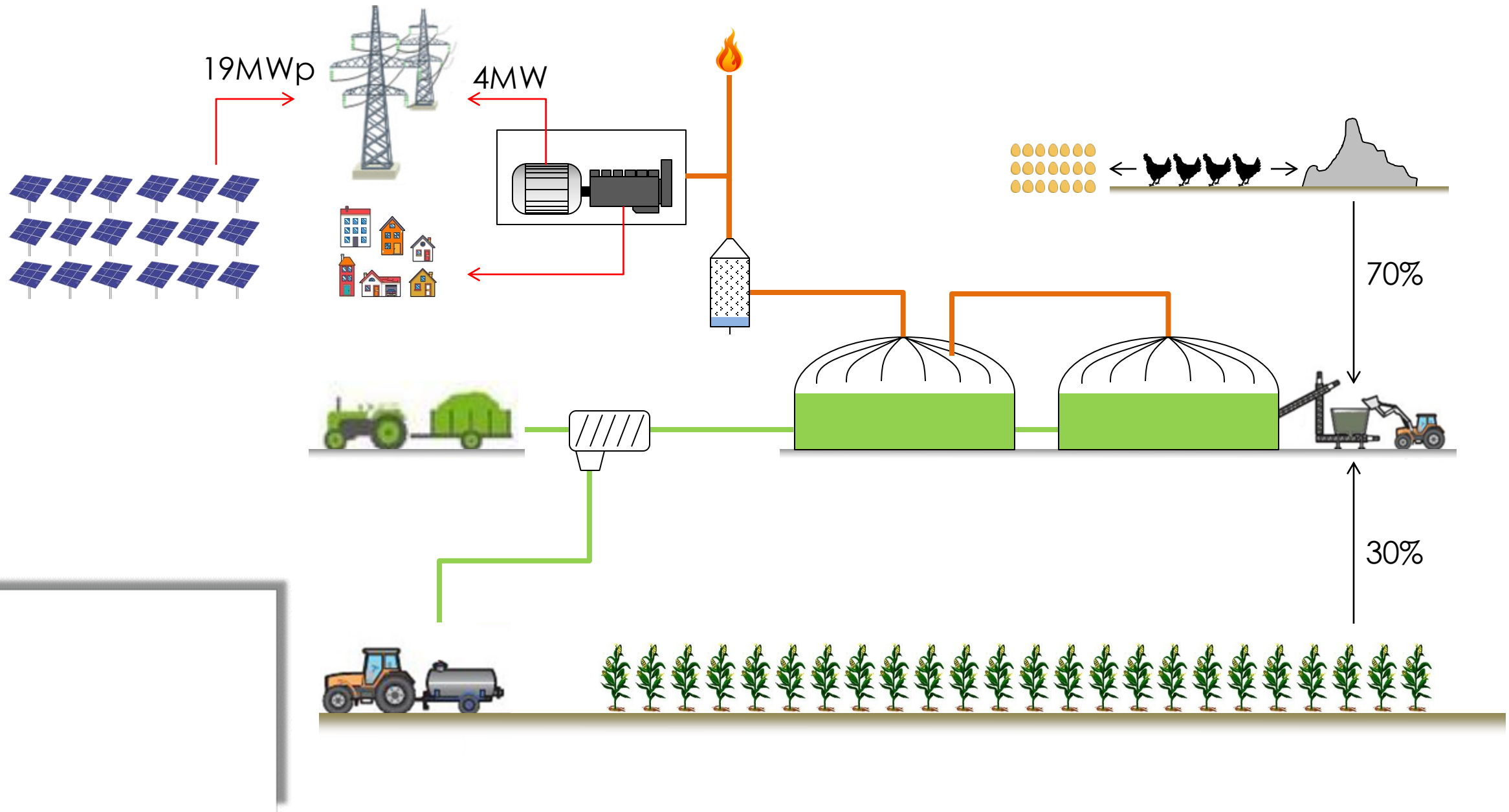
Staaken a 20km de Berlin

Development of an engineering project

Case study: decision about investing R$ 1 billion in a photovoltaic power plant or in a wind farm (both greenfield)

Staaken a 20km de Berlin

Werneuchen, 18.87 MWp



Development of an engineering project

Case study: decision about investing R$ 1 billion in a photovoltaic power plant or in a wind farm (both greenfield)

Staaken a 20km de Berlin

Development of an engineering project

Case study: decision about investing R$ 1 billion in a photovoltaic power plant or in a wind farm (both greenfield)

R$ 1 billion ⇨ Capital to be invested (**CAPEX**) from which it is expected some revenue (investment fund, etc.)

R$ 1 billion ⇨ **Alternative**: acquisition of government bonds (public debt, etc.) at fixed interest rates, having the same redemption term and virtually no risk

Development of an engineering project

Case study: decision about investing R$ 1 billion in a photovoltaic power plant or in a wind farm (both greenfield)

R$ 1 bilhão ⇨ Financial temporal simulation of the power plant, including expenditures occurring at the design and execution phases, as well as revenues and costs during the operation phase during the entire lifespam

R$ 1 bilhão ⇨ **Cash flow**

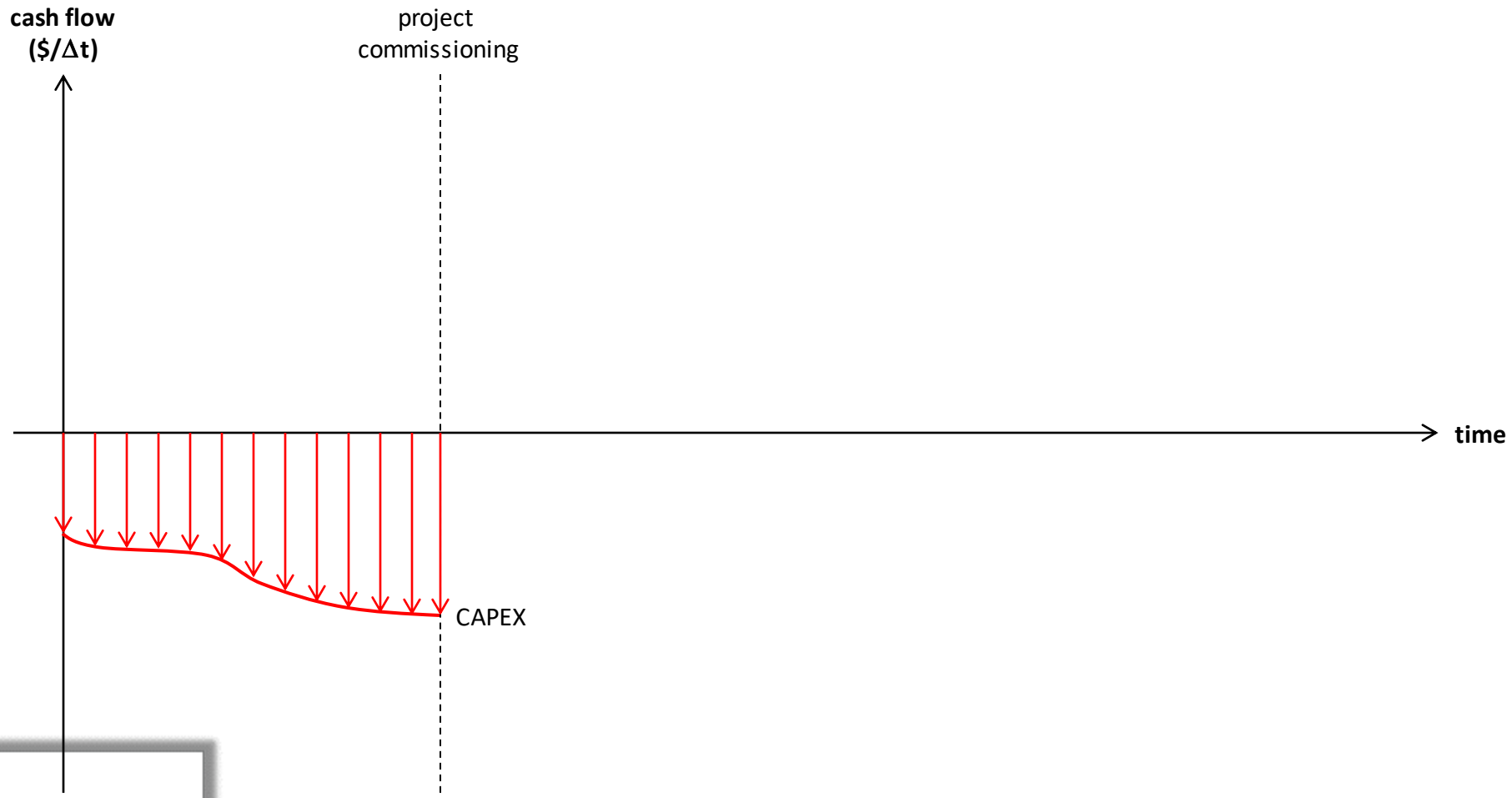
(capital budgeting)

Development of an engineering project

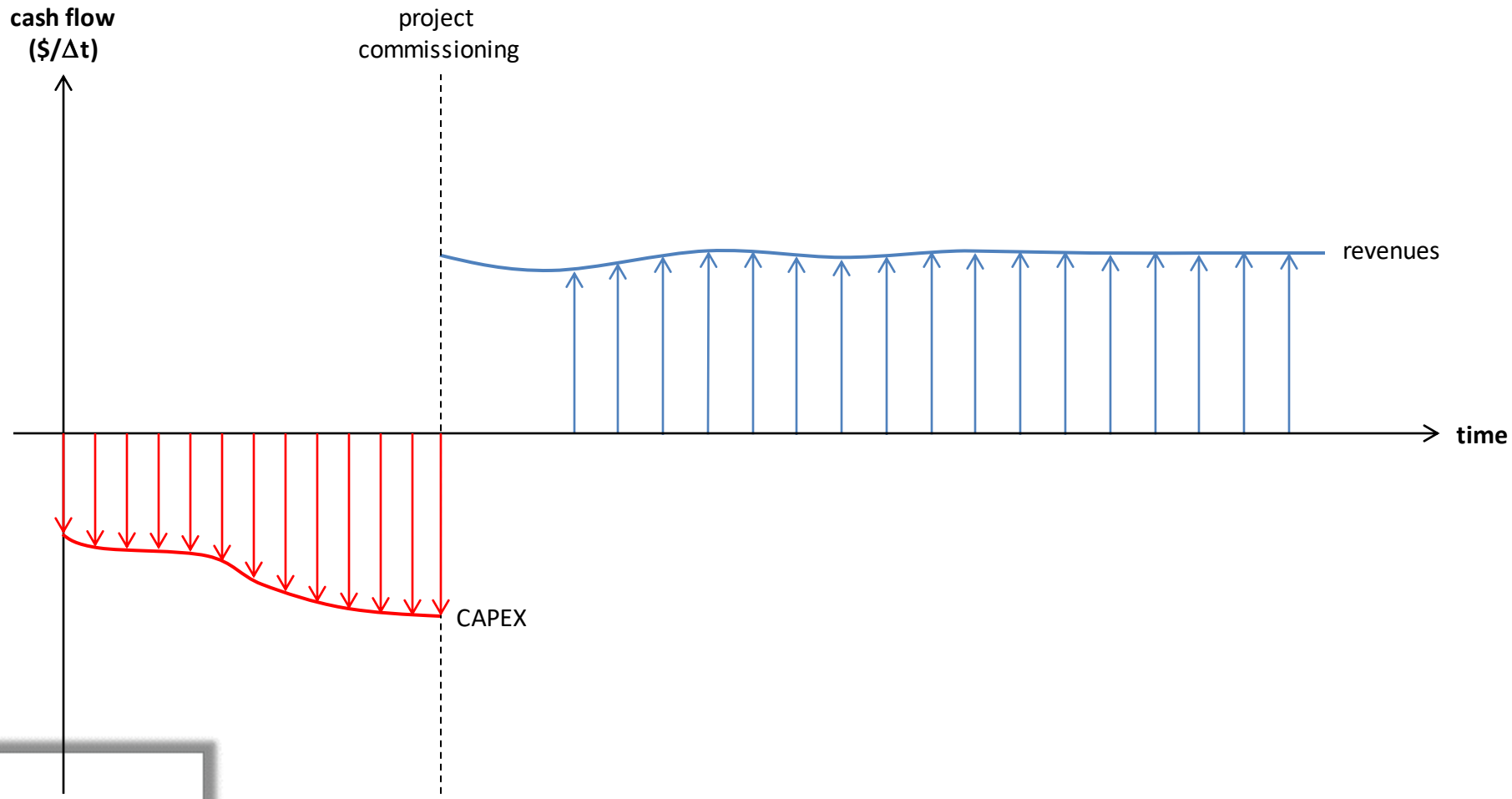
	Investment	Cost (in €)	Cost in Birr (ETB)	%	Cost (in USD)	Foreign invest.	Local invest.
1	61 Turbines (FOB) incl. Erection	42700000,0	443.267.933,1	75,34	51.423.512,9		
	Sea transport and inland transport	6100000,0	63.323.990,4	10,76	7.346.216,1		
	Crane 300t, incl. sea transport	120000,0	1.245.717,8	0,21	144.515,7		
	Crane works						
	Installation (3 days per turbine)	427000,0	4.432.679,3	0,75	514.235,1		
	Local installation	305000,0	3.166.199,5	0,54	367.310,8		
	Subtotal	**49.652.000,0**	**515.436.520,3**	**87,61**	**59.795.790,7**	59.795.790,7	
2	Civil works						
	Road access	427500,0	4.437.869,8	0,75	514.837,3		
	Crane pads	152500,0	1.583.099,8	0,27	183.655,4		
	Foundation	1891000,0	19.630.437,0	3,34	2.277.327,0		
	Cable trenches	600000,0	6.228.589,2	1,06	722.578,6		
	Control building	50000,0	519.049,1	0,09	60.214,9		
	Subtotal	**3.121.000,0**	**32.399.044,9**	**5,51**	**3.758.613,2**		3.758.613,2
3	Required electrical equipment						
	Extension of substation	200000,0	2.595.245,5	0,44	301.074,4		
	Civil works new substation	150000,0	1.557.147,3	0,26	180.644,7		
	Transformer (132kV / 33kV)	800000,0	8.304.785,6	1,41	963.438,2		
	Auxiliary equipment of substation	150000,0	1.038.098,2	0,18	120.429,8		
	132 kV components	360000,0	3.737.153,5	0,64	433.547,2		
	OHL 1x1x125mm^2; 5 km (132kV)	600000,0	6.228.589,2	1,06	722.578,6		
	Wind park cabling, earthing, Scada (20 km)	380000,0	3.944.773,2	0,67	457.633,1		
	4 x distribution stations on site	80000,0	830.478,6	0,14	96.343,8		
	Electrical equipment inside control building	120000,0	1.245.717,8	0,21	144.515,7		
	Auxiliary transformer at control building	15000,0	155.714,7	0,03	18.064,5		
	2 x cars for maintenance team	100000,0	1.038.098,2	0,18	120.429,8		
	Subtotal	**2.955.000,0**	**30.675.801,9**	**5,21**	**3.558.699,8**		3.558.699,8
4	Engineering						
	International enginering	550000,0	5.709.540,1	0,97	662.363,7	662.363,7	
	Local engineering	150000,0	1.557.147,3	0,26	180.644,7		180.644,7
	Subtotal	**700.000,0**	**7.266.687,4**	**1,24**	**843.008,4**	662.363,7	180.644,7
5	Others						
	Mitigation measures	244.870,1	2.541.992,0	0,43	294.896,5		294.896,5
	Subtotal	**244.870,1**	**2.541.992,0**	**0,43**	**294.896,5**		294.896,5
	Total	**56.672.870,1**	**588.320.046,6**	**100,00**	**68.251.008,6**	**60.458.154,5**	**7.792.854,1**

Itemized Investment Cost of and Ethiopian Wind project

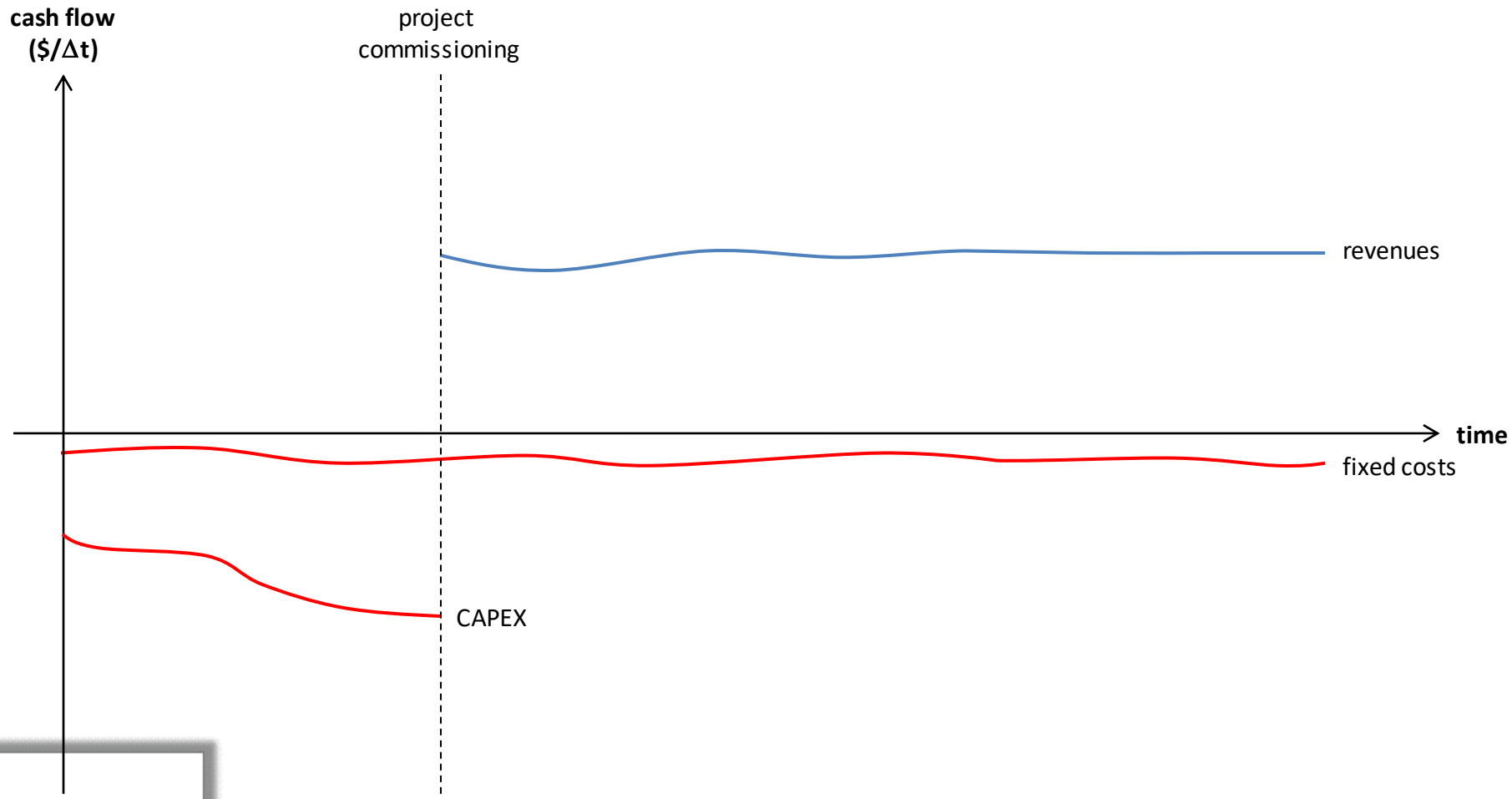
Cashflow analysis: expenses and incomes



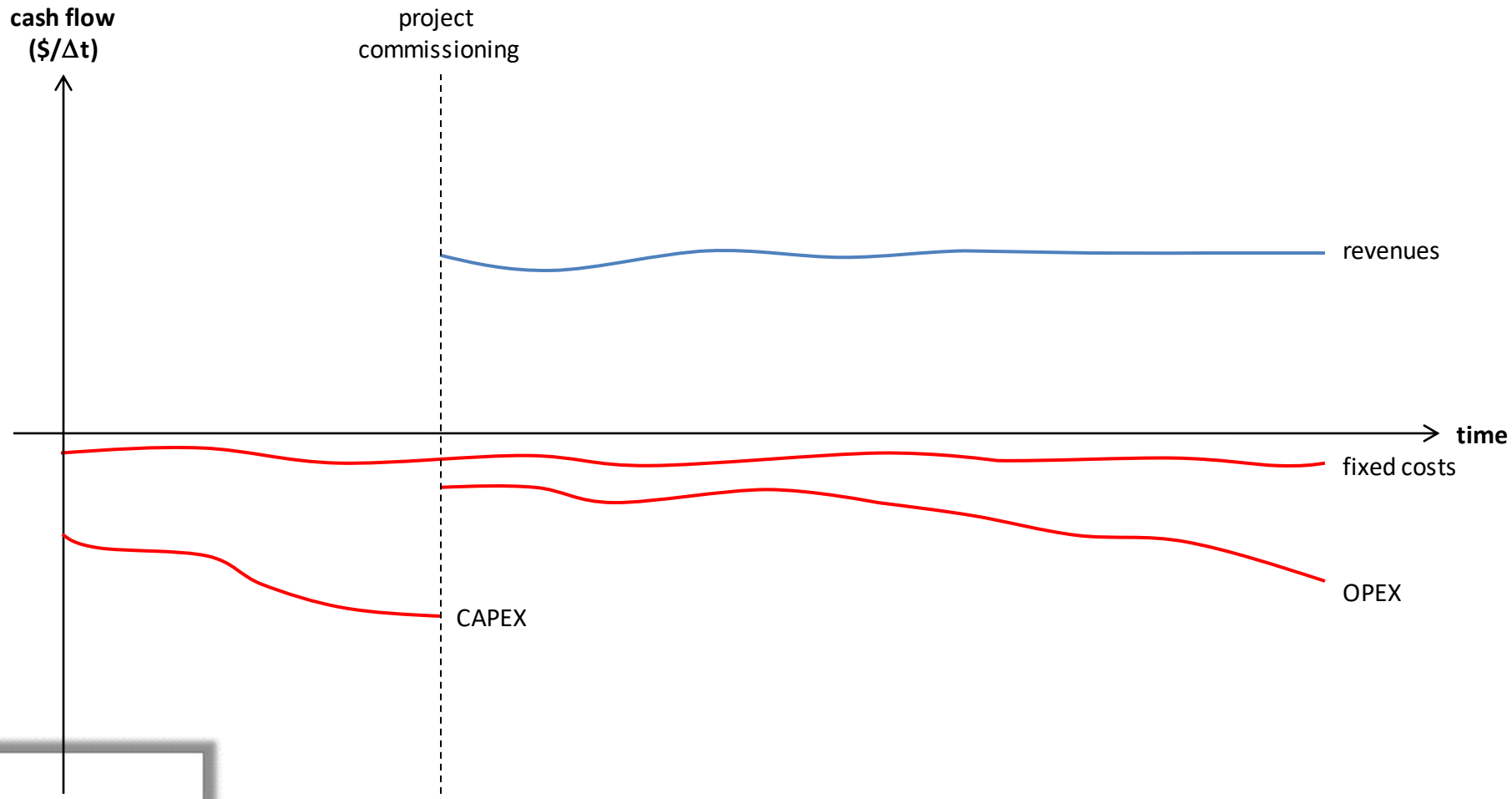
Cashflow analysis: expenses and incomes



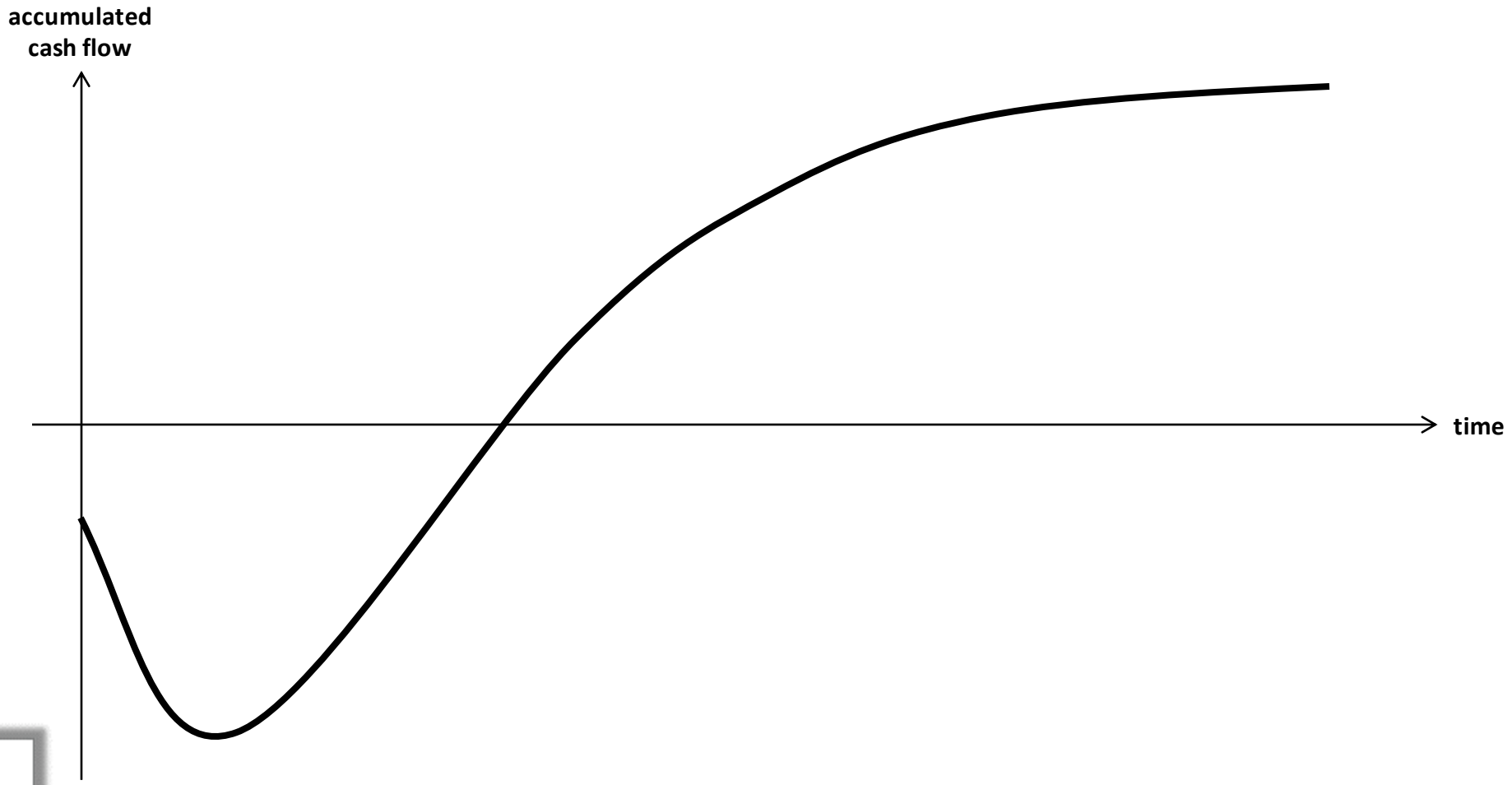
Cashflow analysis: expenses and incomes



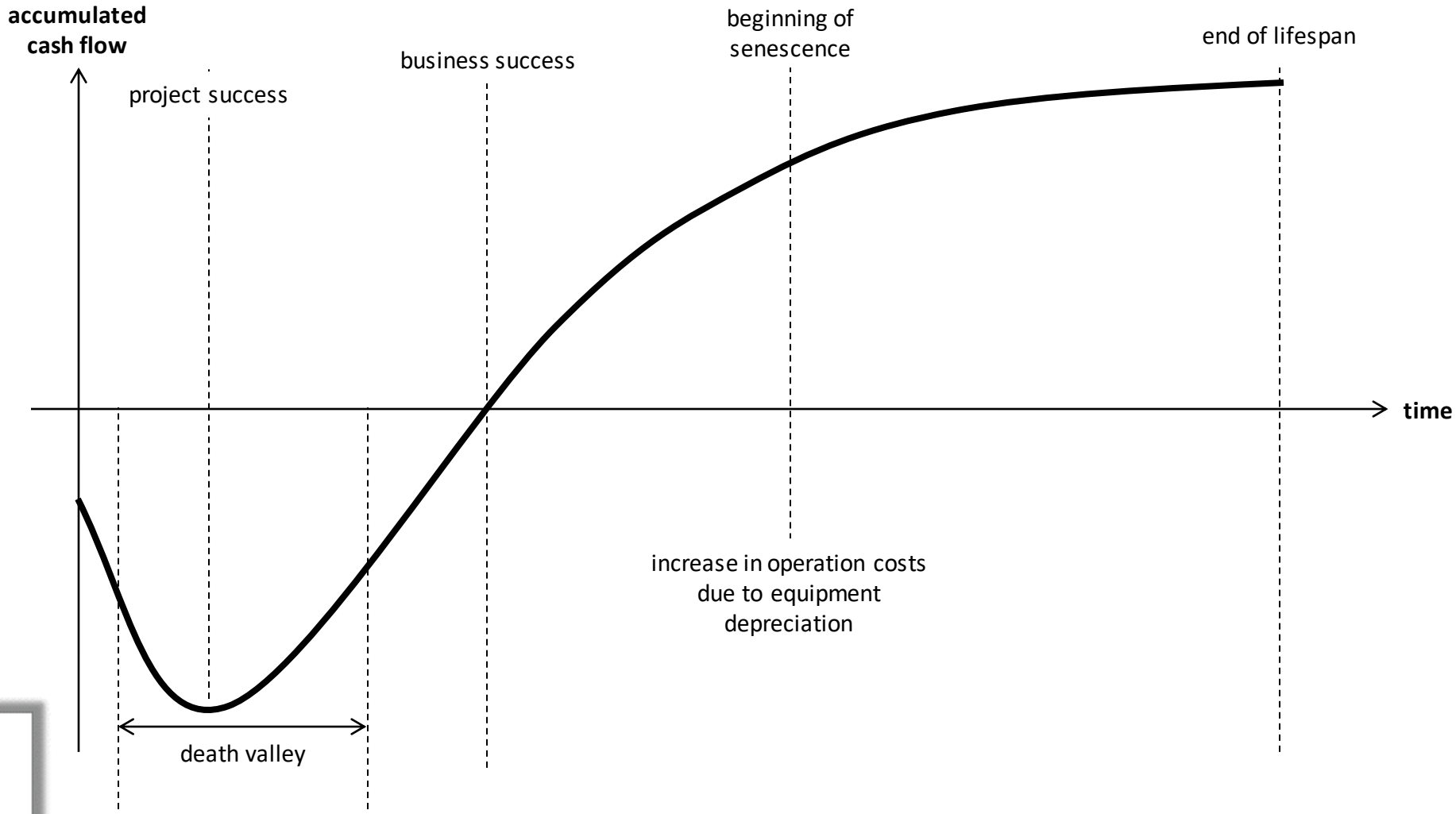
Cashflow analysis: expenses and incomes



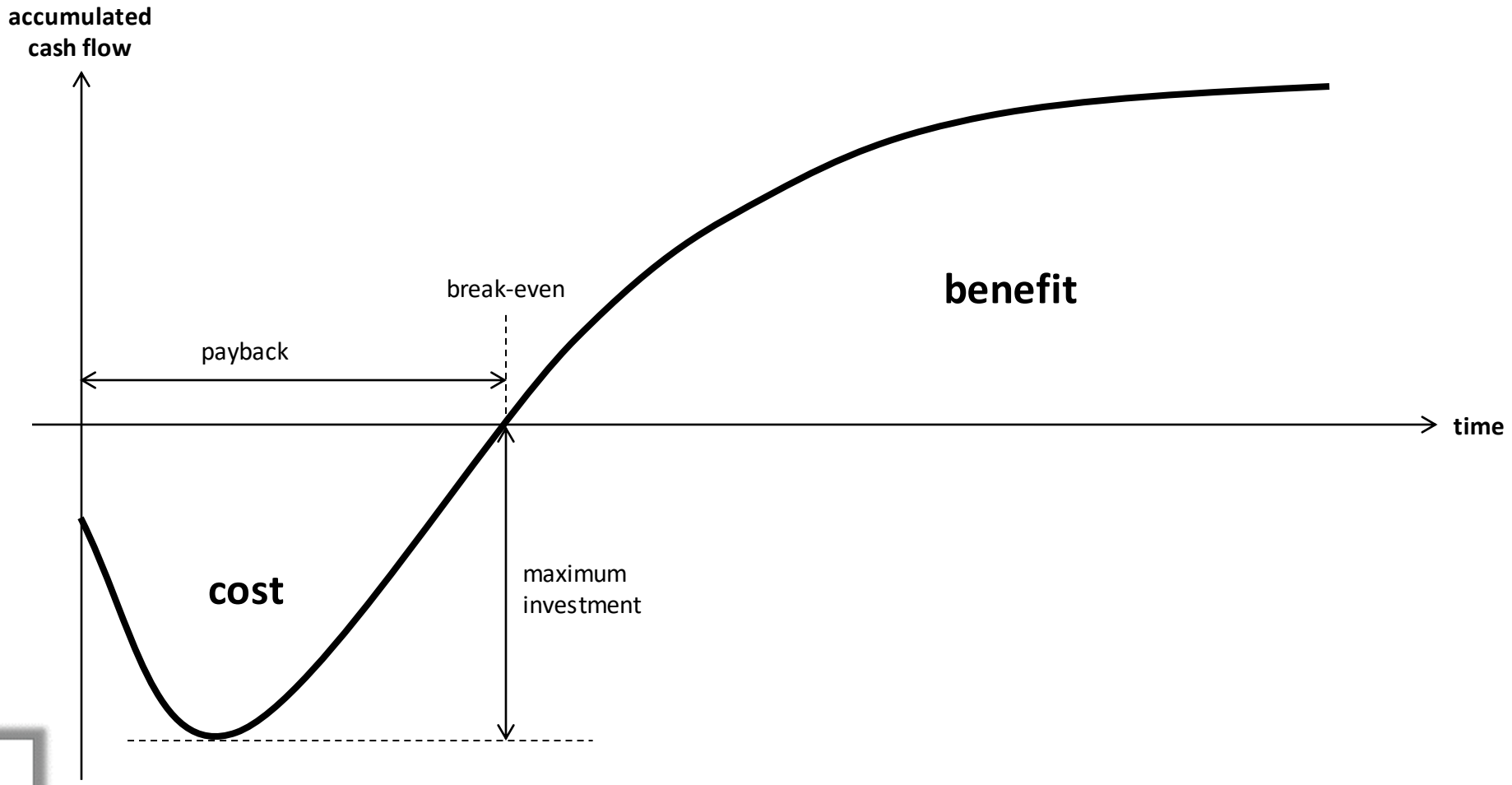
Accumulated cashflow:



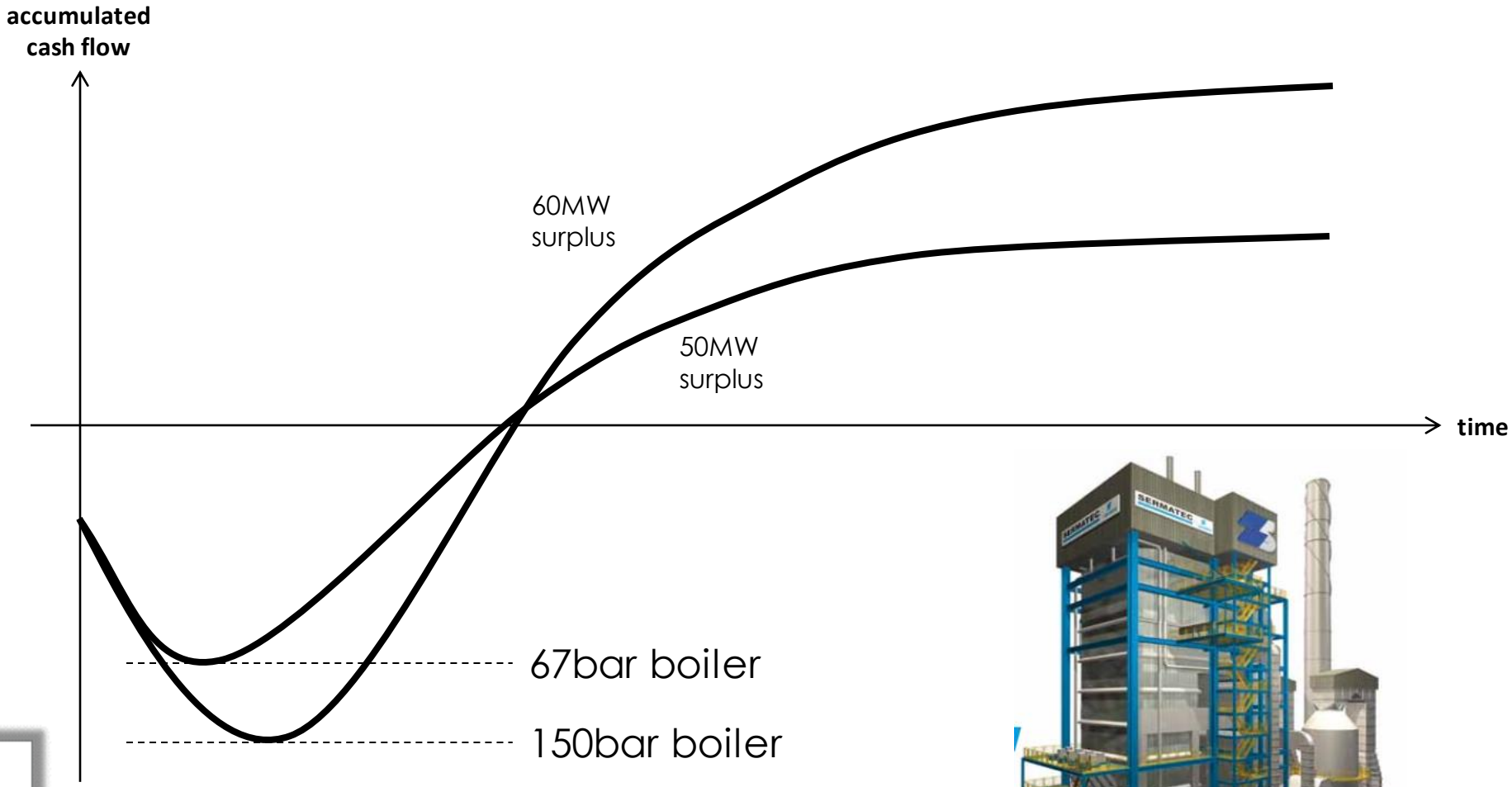
Accumulated cashflow:



Accumulated cashflow: characterization parameters

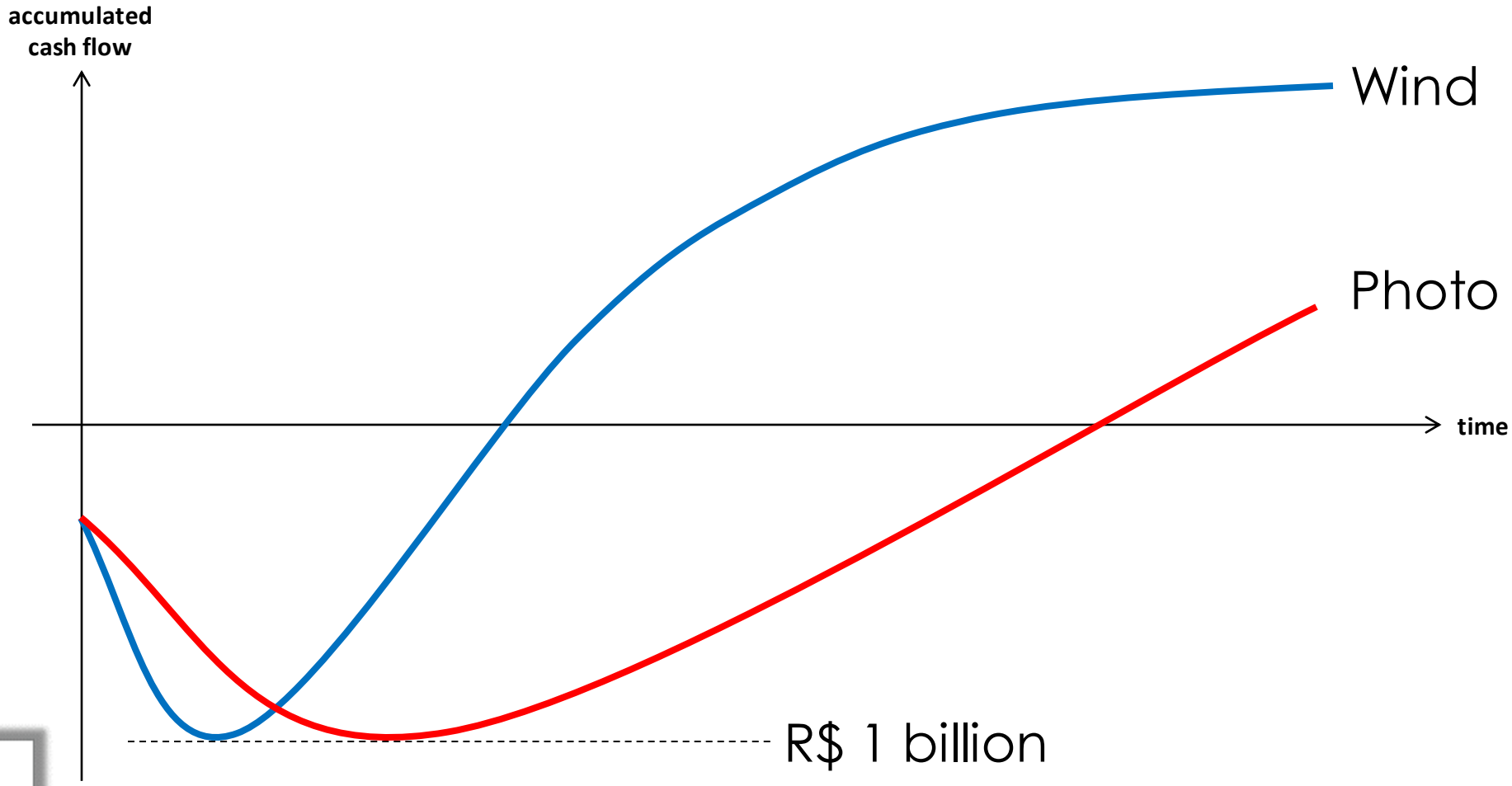


Parâmetros do fluxo acumulado – saldo do projeto

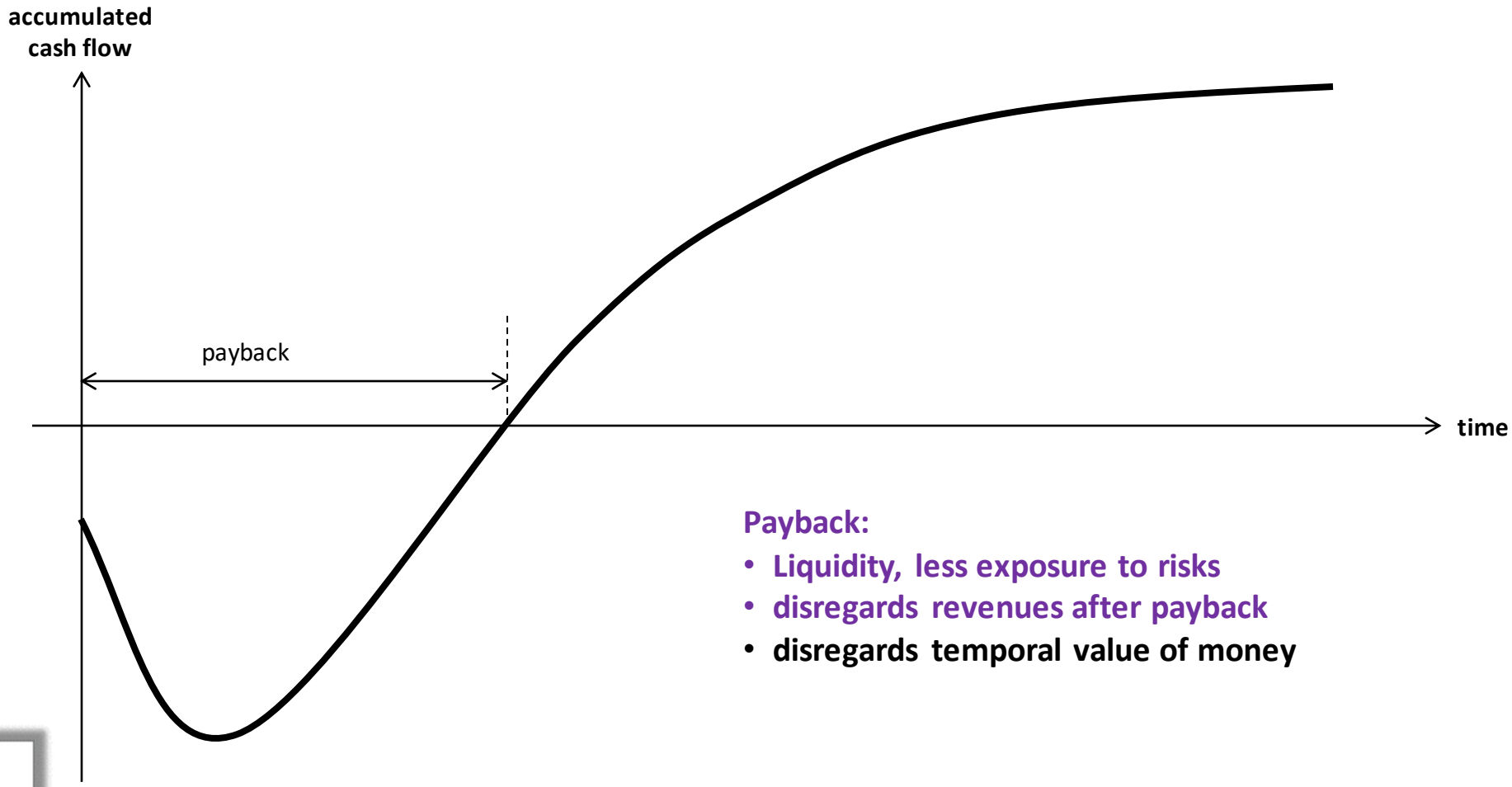


↑ CAPEX ⇨ ↑ Revenues

Which one is better?



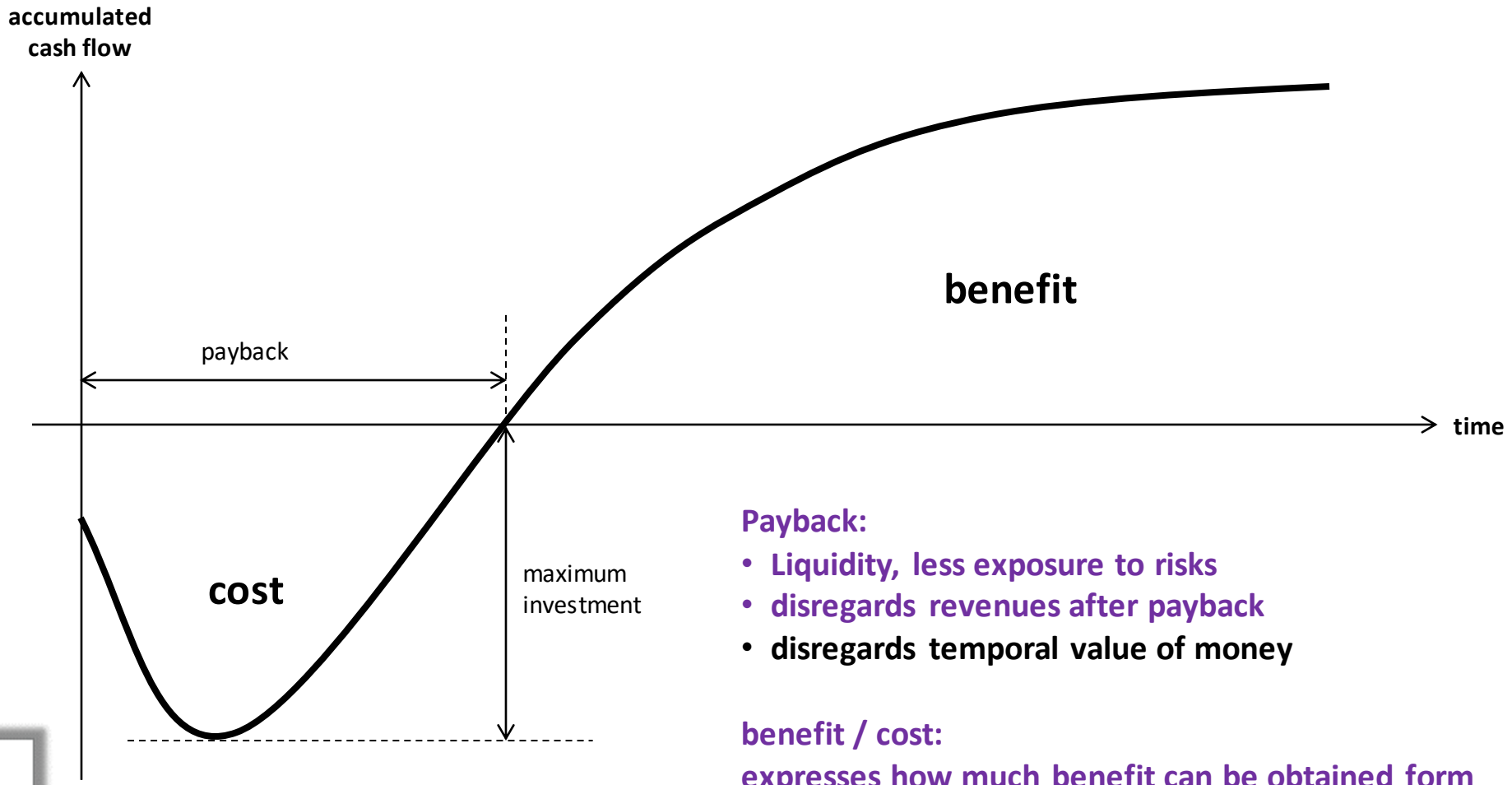
Objective decision criteria…



Payback:

- **Liquidity, less exposure to risks**
- **disregards revenues after payback**
- **disregards temporal value of money**

Objective decision criteria…



Payback:

- **Liquidity, less exposure to risks**
- **disregards revenues after payback**
- **disregards temporal value of money**

benefit / cost:

expresses how much benefit can be obtained form each unit of value invested…

- **disregards temporal value of money**

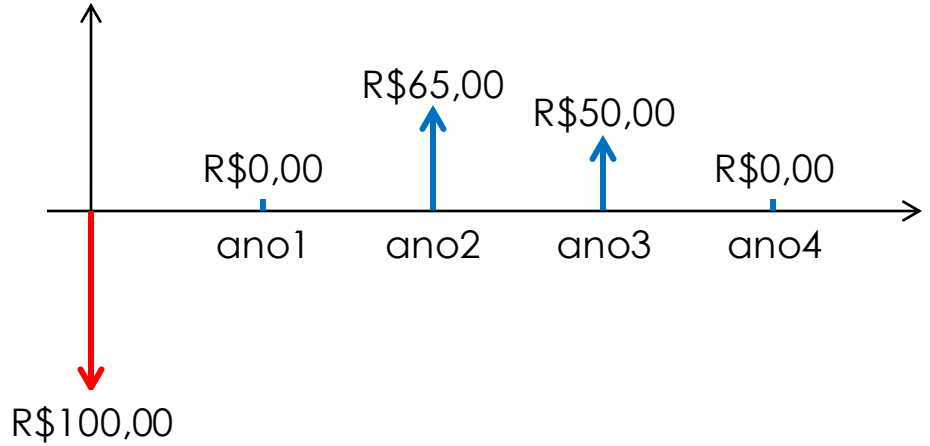
Temporal Value of Money

⇩

Internal Rate of Return

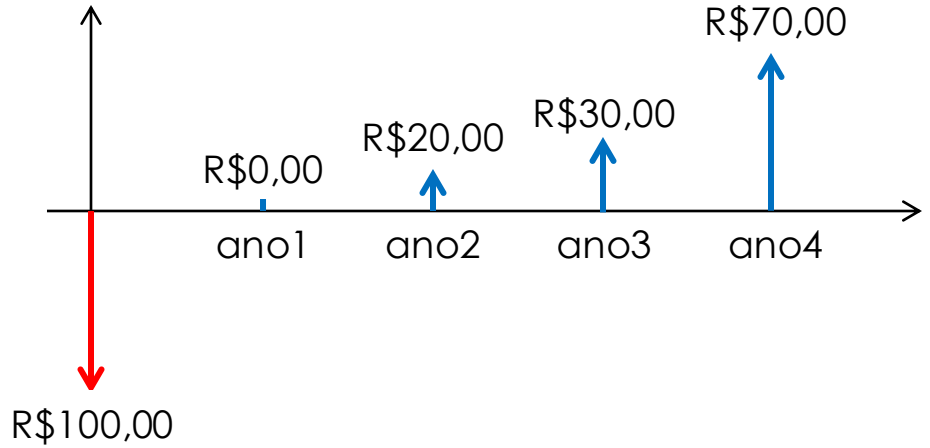
Which one is better?

Project A



R$100,00
3 years
R$115,00

Project B



R$100,00
4 years
R$120,00

Temporal value of money

Reference:
5% per annum
at virtually no
risk (example)

R$100,00

Temporal value of money

Reference: 5% per annum at virtually no risk (example)

R$100,00 $\xrightarrow{\times 1,05}$ **R$105,00**

future value
(year 1)

Temporal value of money

Reference: 5% per annum at virtually no risk (example)

R$100,00 $\xrightarrow{\times 1{,}05}$ **R$105,00** $\xrightarrow{\times 1{,}05}$ **R$110,25**

future value (1 year)

future value (year 2)

Temporal value of money

Reference: 5% per annum at virtually no risk (example)

R$100,00 $\xrightarrow{\times 1,05}$ **R$105,00** $\xrightarrow{\times 1,05}$ **R$110,25** $\xrightarrow{\times 1,05}$ **R$115,76**

future value (1 year)

future value (year 2)

future value (year 3)

Temporal value of money

Reference:
5% per annum
at virtually no
risk (example)

R$100,00 $\xrightarrow{\times 1,05}$ **R$105,00** $\xrightarrow{\times 1,05}$ **R$110,25** $\xrightarrow{\times 1,05}$ **R$115,76**

future value (1 year)

future value (year 2)

future value (year 3)

$$FV = PV \cdot (1 + r)^n$$

Temporal value of money

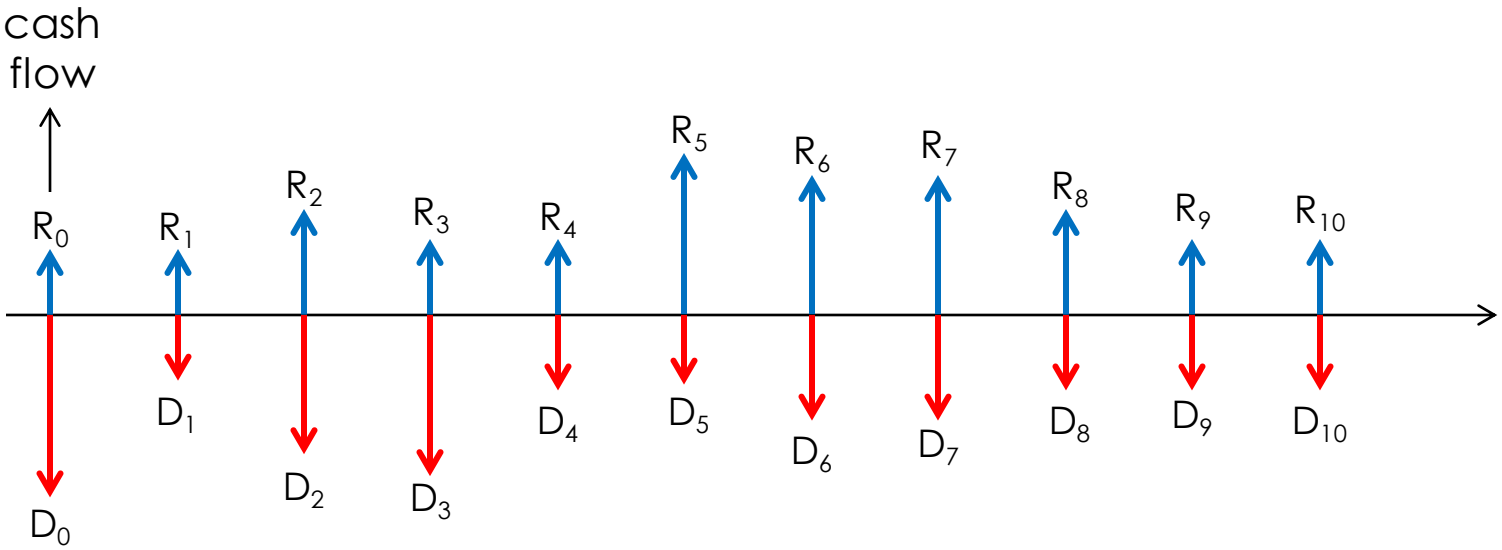
Reference:
5% per annum
at virtually no
risk (example)

R$86,38 ←(÷1,05)— **R$90,70** ←(÷1,05)— **R$95,24** ←(÷1,05)— **R$100,00**

present value (1 year) | present value (year 2) | present value (year 3)

$$PV = FV \cdot (1+r)^{-n}$$

Temporal value of money: expenses and incomes



$$NPV = \sum_k PV_k$$

$$NPV = \sum_{k=0}^{N} \frac{R_k - D_k}{(1+r)^k}$$

- R_k are incomes @ k-th period
- D_k are expenses @ k-th period
- r is the discount rate reflecting the opportunity cost

Spreadsheet formulae...

taxa	5%						
ano	0	1	2	3	4	Total	Benefício/Custo
valor	-R$ 100.00	R$ -	R$ 65.00	R$ 50.00	R$ -	R$ 15.00	15%
	R$ -						
	R$ 58.96	1/(1+r)^2					
	R$ 43.19	1/(1+r)^3					
	R$ -	1/(1+r)^4					
PV Total	R$ 2.15						
Benefício/Custo	2.15%						

taxa	5%						
ano	0	1	2	3	4	Total	Benefício/Custo
valor	-R$ 100.00	R$ -	R$ 20.00	R$ 30.00	R$ 70.00	R$ 20.00	20%
	R$ -						
	R$ 18.14	1/(1+r)^2					
	R$ 25.92	1/(1+r)^3					
	R$ 57.59	1/(1+r)^4					
PV Total	R$ 1.64						
Benefício/Custo	1.64%						

Spreadsheet formulae...

taxa	5.60%						
ano	0	1	2	3	4	Total	Benefício/Custo
valor	-R$ 100.00	R$ -	R$ 65.00	R$ 50.00	R$ -	R$ 15.00	15%
	R$ -						
	R$ 58.29	1/(1+r)^2					
	R$ 42.46	1/(1+r)^3					
	R$ -	1/(1+r)^4					
PV Total	R$ 0.75						
Benefício/Custo	0.75%						

taxa	5.60%						
ano	0	1	2	3	4	Total	Benefício/Custo
valor	-R$ 100.00	R$ -	R$ 20.00	R$ 30.00	R$ 70.00	R$ 20.00	20%
	R$ -						
	R$ 17.94	1/(1+r)^2					
	R$ 25.48	1/(1+r)^3					
	R$ 56.29	1/(1+r)^4					
PV Total	-R$ 0.30						
Benefício/Custo	-0.30%						

NPV: limitations

Net Present Value: limitations

Project A

Initial investment
R$ 10 milions

⇩

NPV = R$ 2 millions

Project B

Initial investment
R$ 2 billions

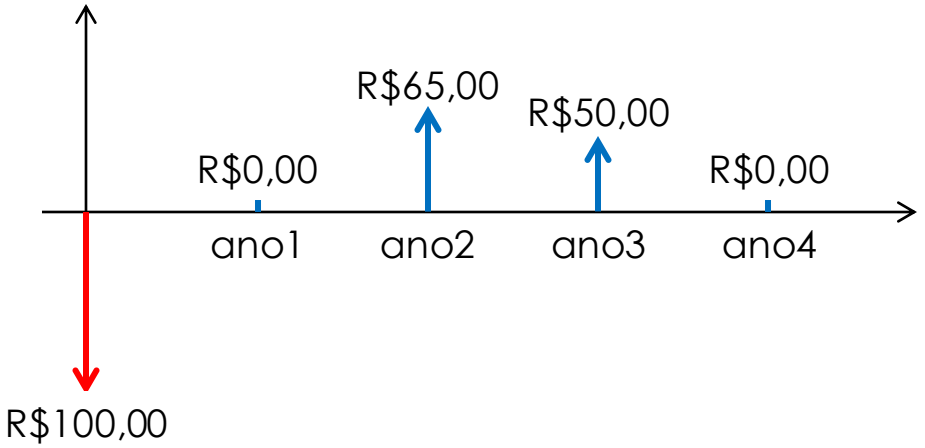
⇩

NPV = R$ 3 millions

Execute B because $VPL_B > VPL_A$, however ...

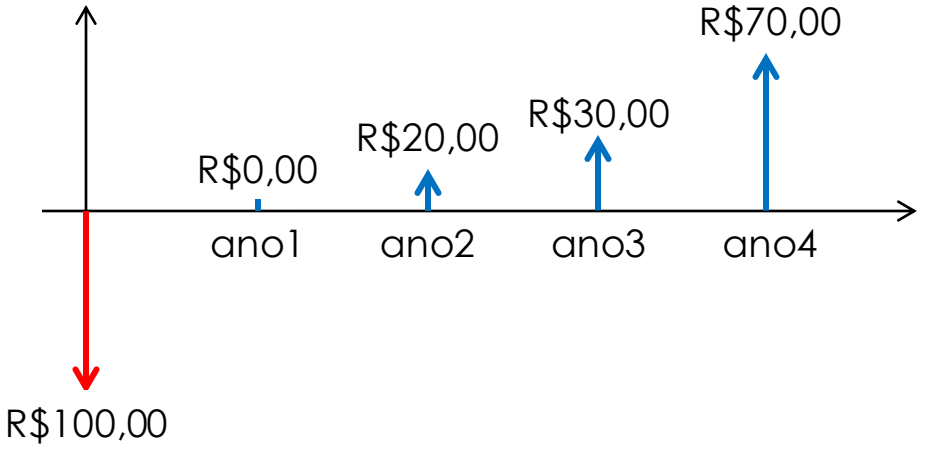
Variation of the NPV in function of the discount rate...

Project A



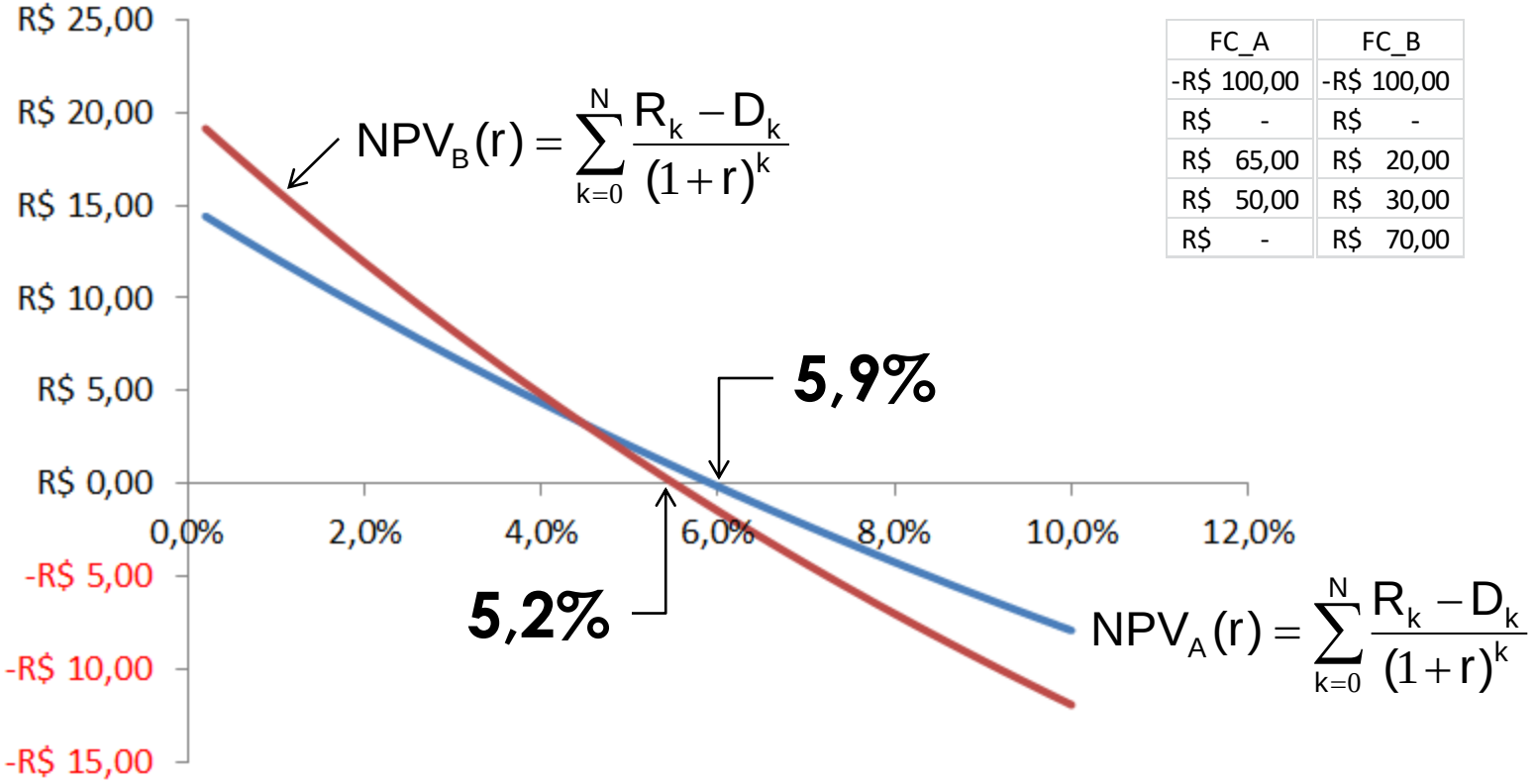
$$NPV_A(r) = \sum_{k=0}^{N} \frac{R_k - D_k}{(1+r)^k}$$

Project B



$$NPV_B(r) = \sum_{k=0}^{N} \frac{R_k - D_k}{(1+r)^k}$$

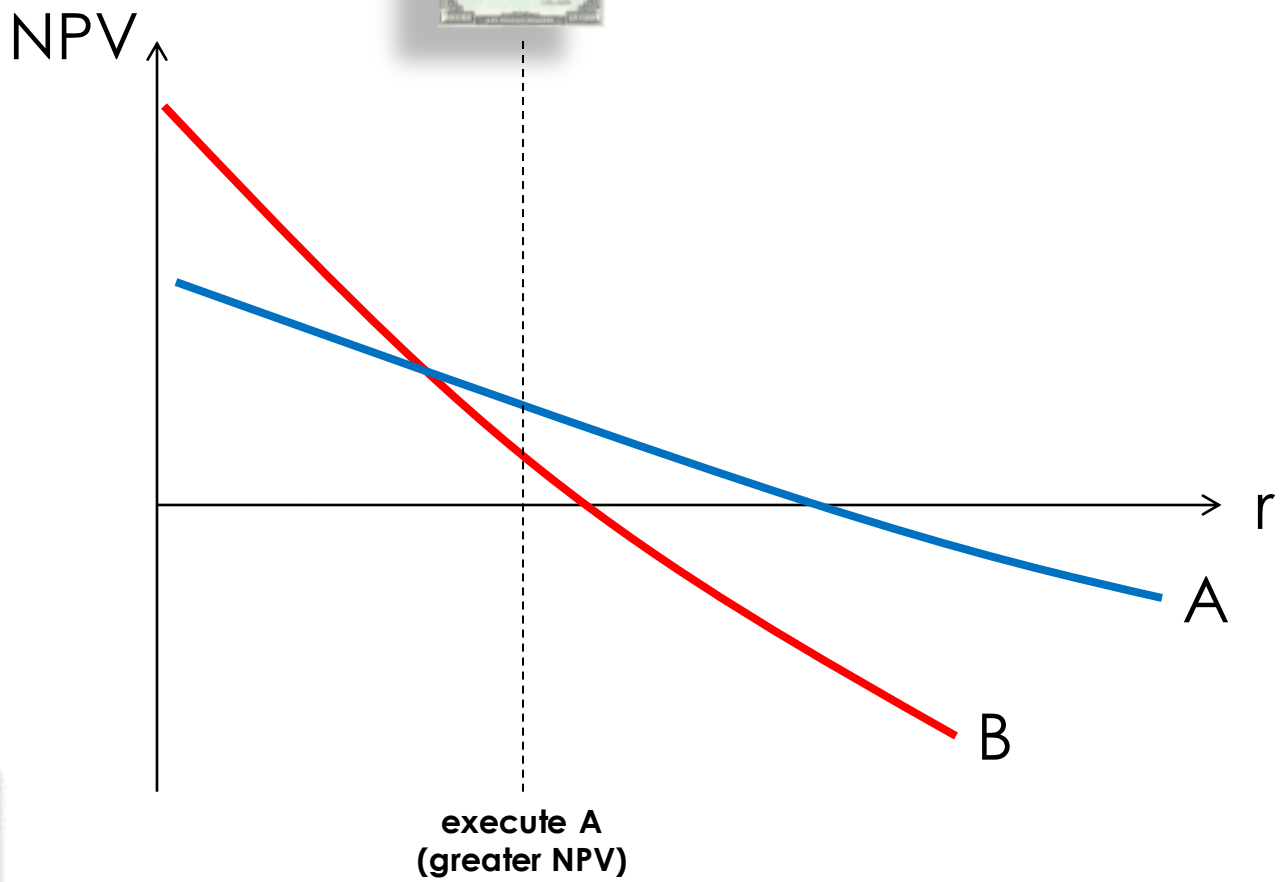
Variation of the NPV in function of the discount rate...



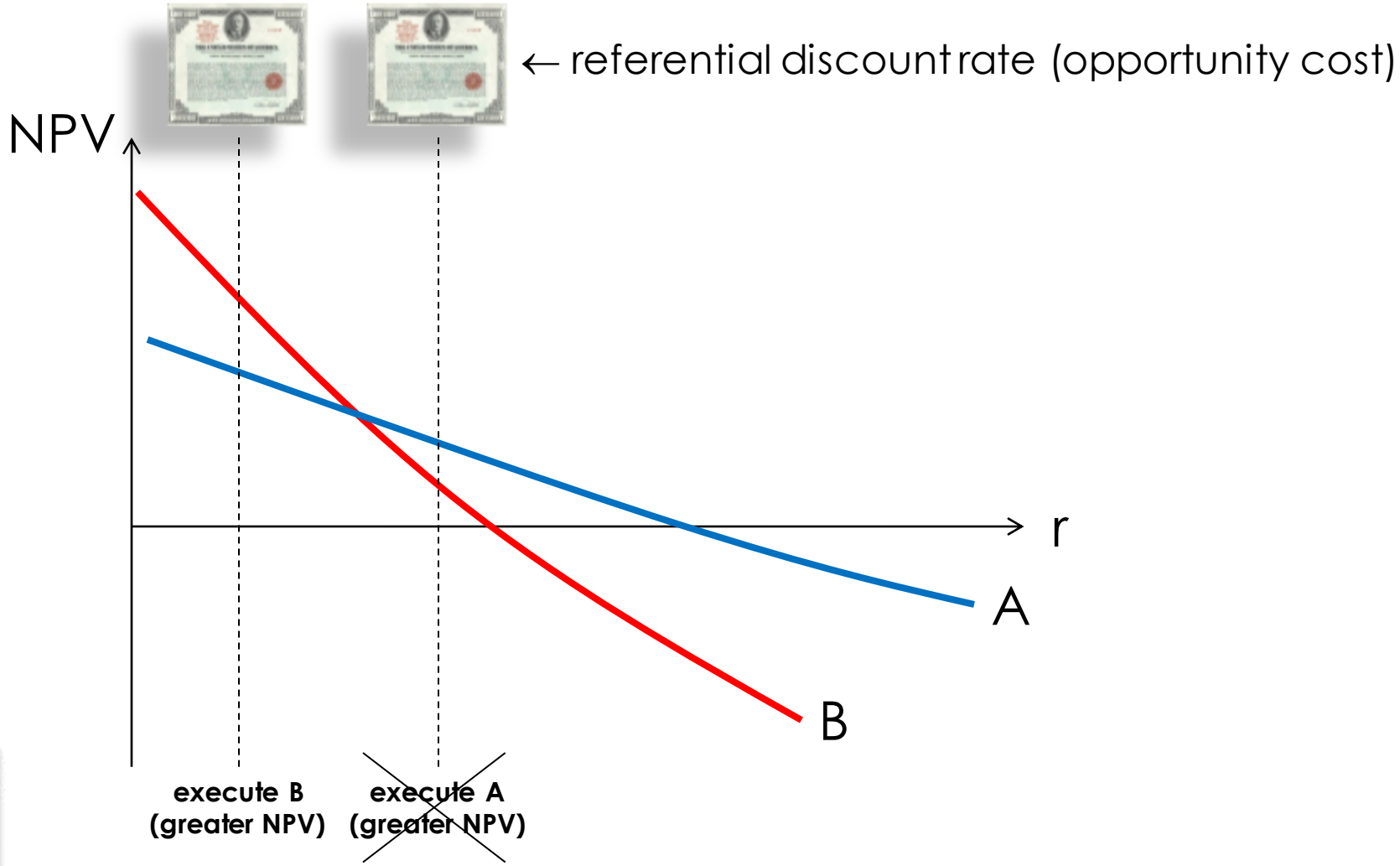
FC_A	FC_B
-R$ 100,00	-R$ 100,00
R$ -	R$ -
R$ 65,00	R$ 20,00
R$ 50,00	R$ 30,00
R$ -	R$ 70,00

Variation of the NPV in function of the discount rate…

← referential discount rate (opportunity cost)

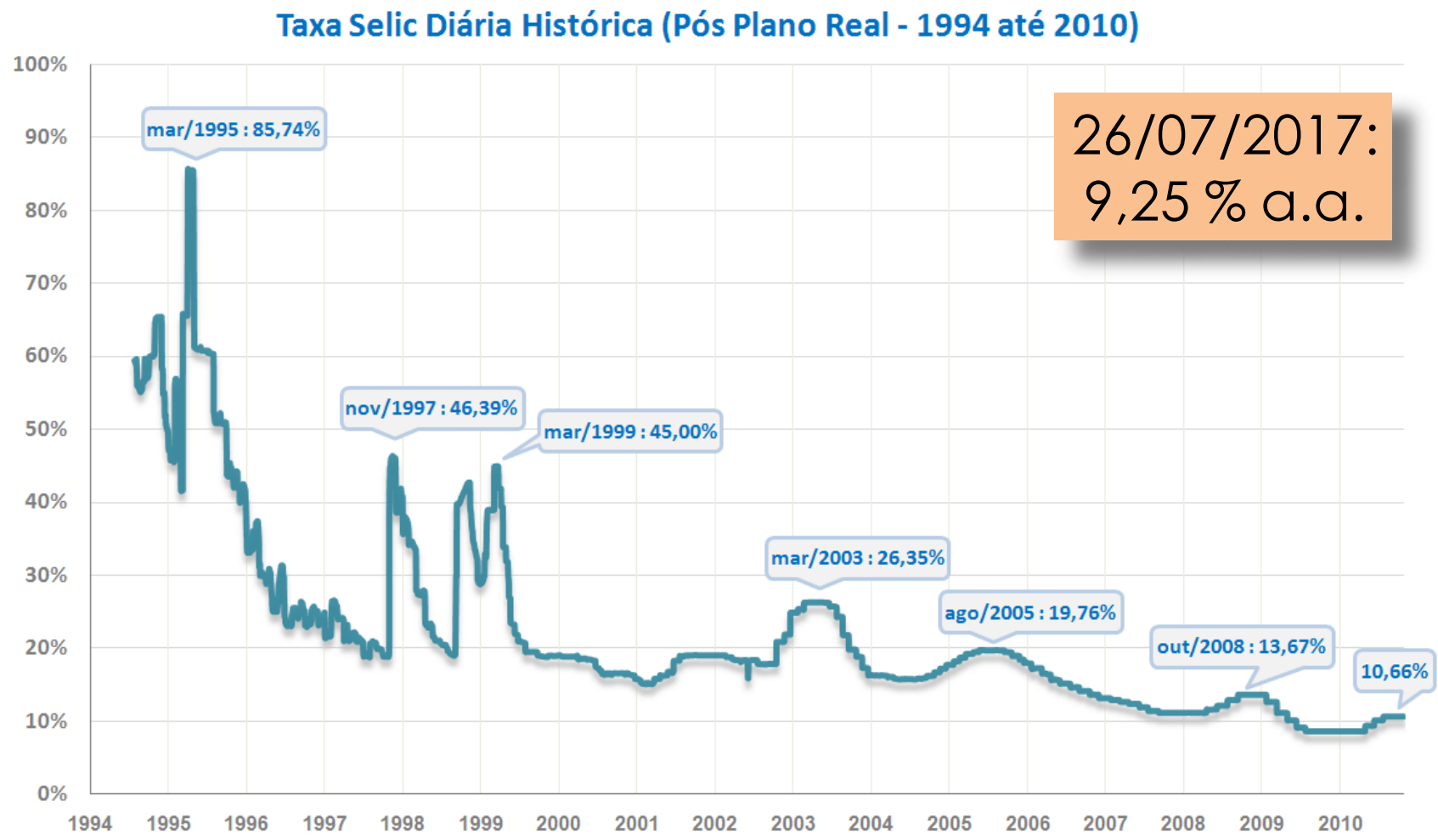


Variation of the NPV in function of the discount rate…

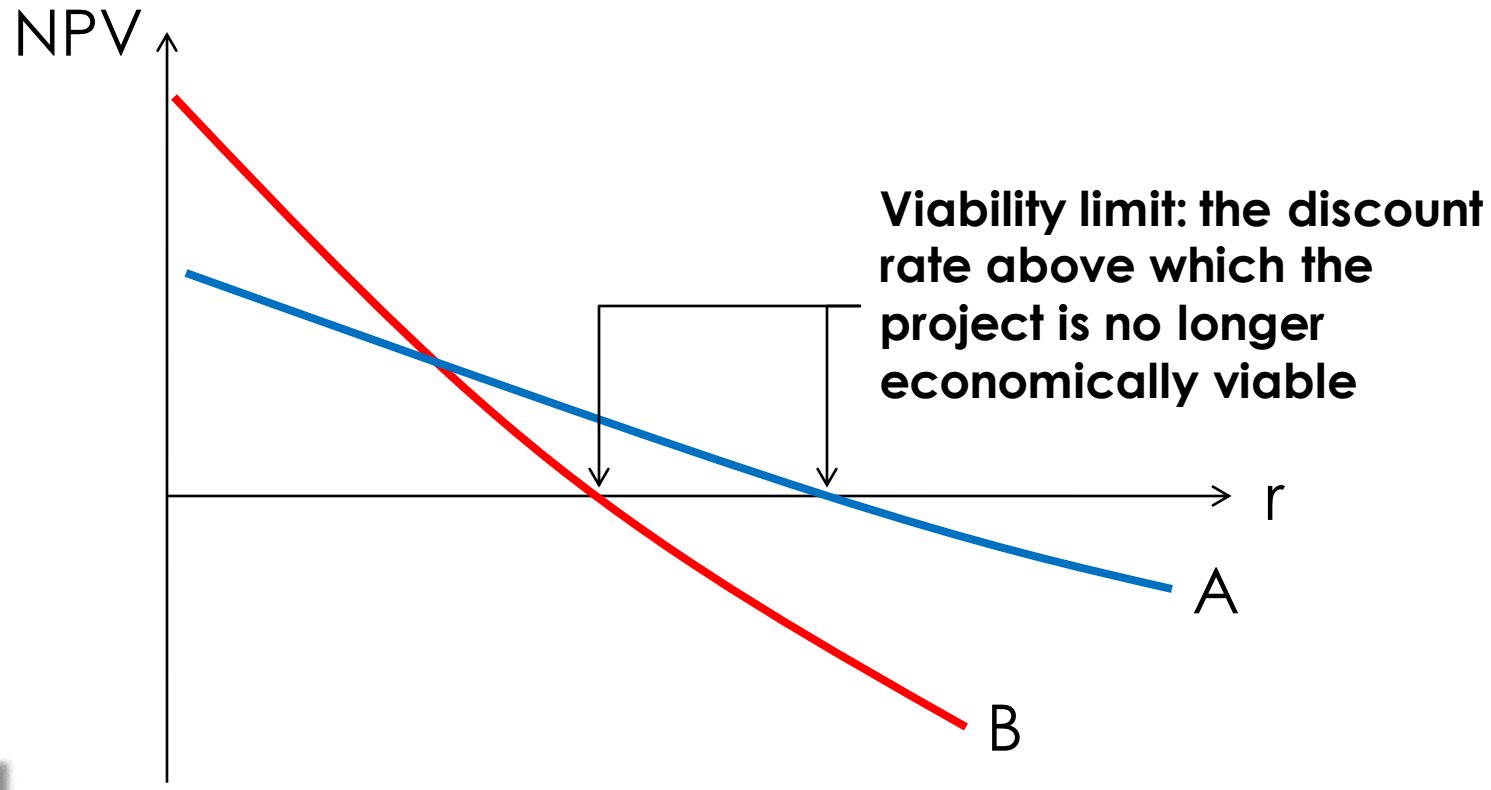


How to evaluate the opportunity cost by setting the discount rate ?

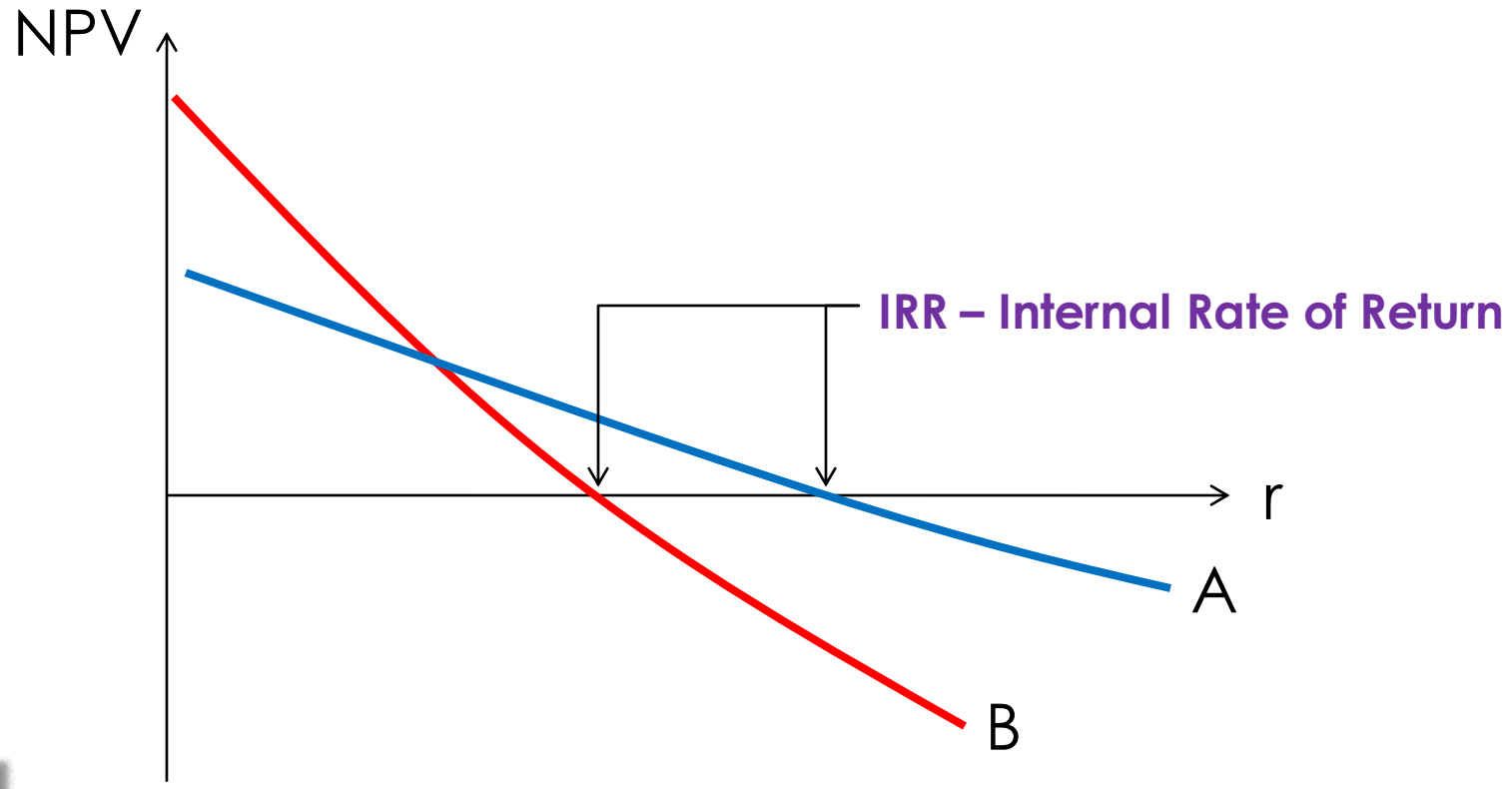
Variation of the NPV in function of the discount rate…



Variation of the NPV in function of the discount rate…

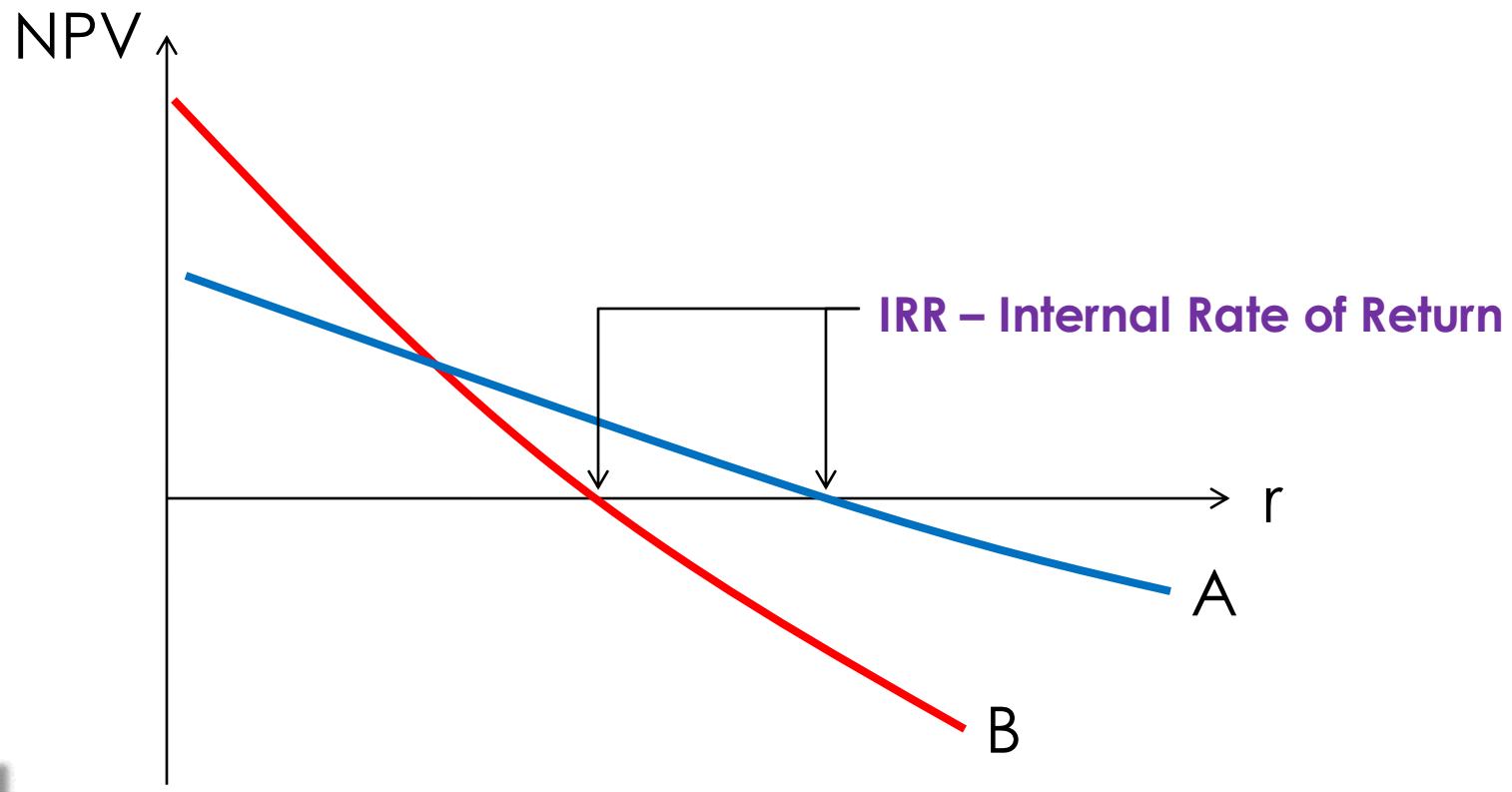


Variation of the NPV in function of the discount rate…



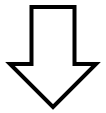
$$r \Rightarrow NPV(r) = 0 \Rightarrow \sum_{k=0}^{N} \frac{R_k - D_k}{(1 + TIR)^k} = 0$$

Variation of the NPV in function of the discount rate…



$IRR_A > IRR_B \rightarrow$ A is more resiliente than B

Techno-Economical Analysis of an Investment Project



Capital Budgeting

Techno-Economical Analysis of an Investment Project (Capital Budgeting):

Capital

Techno-Economical Analysis of an Investment Project (Capital Budgeting):

Capital

⇩

Engineering Project

Techno-Economical Analysis of an Investment Project (Capital Budgeting):

Capital

⇩

Engineering Project

⇩

CAPEX/OPEX

Techno-Economical Analysis of an Investment Project (Capital Budgeting):

Capital

⇩

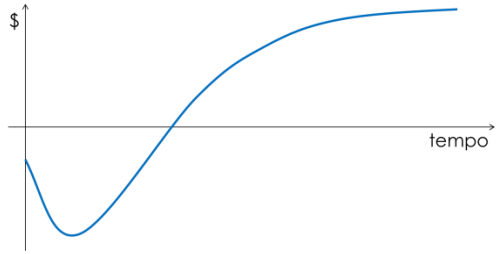
Engineering Project

⇩

CAPEX/OPEX

⇩

Cash Flow



Techno-Economical Analysis of an Investment Project (Capital Budgeting):

Capital

⇩

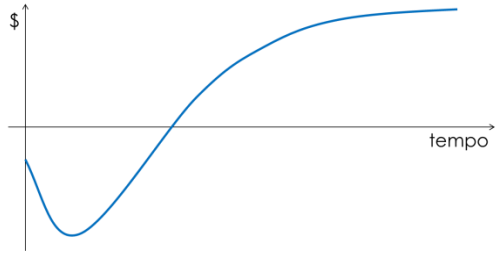
Engineering Project

⇩

CAPEX/OPEX

⇩

Cash Flow



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Decision Parameters

Techno-Economical Analysis of an Investment Project (Capital Budgeting):

Capital

⇩

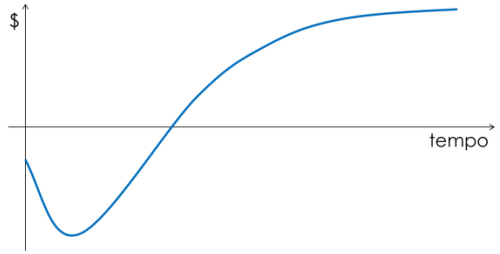
Engineering Project

⇩

CAPEX/OPEX

⇩

Cash Flow



⇩

Decision Parameters

⇩

Execution

Techno-Economical Analysis of an Investment Project (Capital Budgeting):

Capital

⇩

Engineering Project

⇩

CAPEX/OPEX

⇩

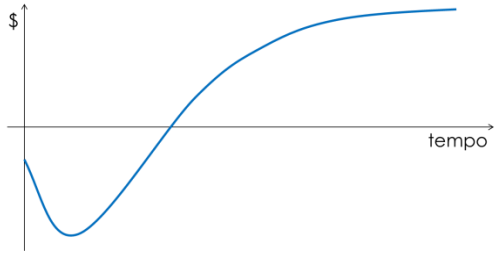
Cash Flow

⇩

Decision Parameters

⇩

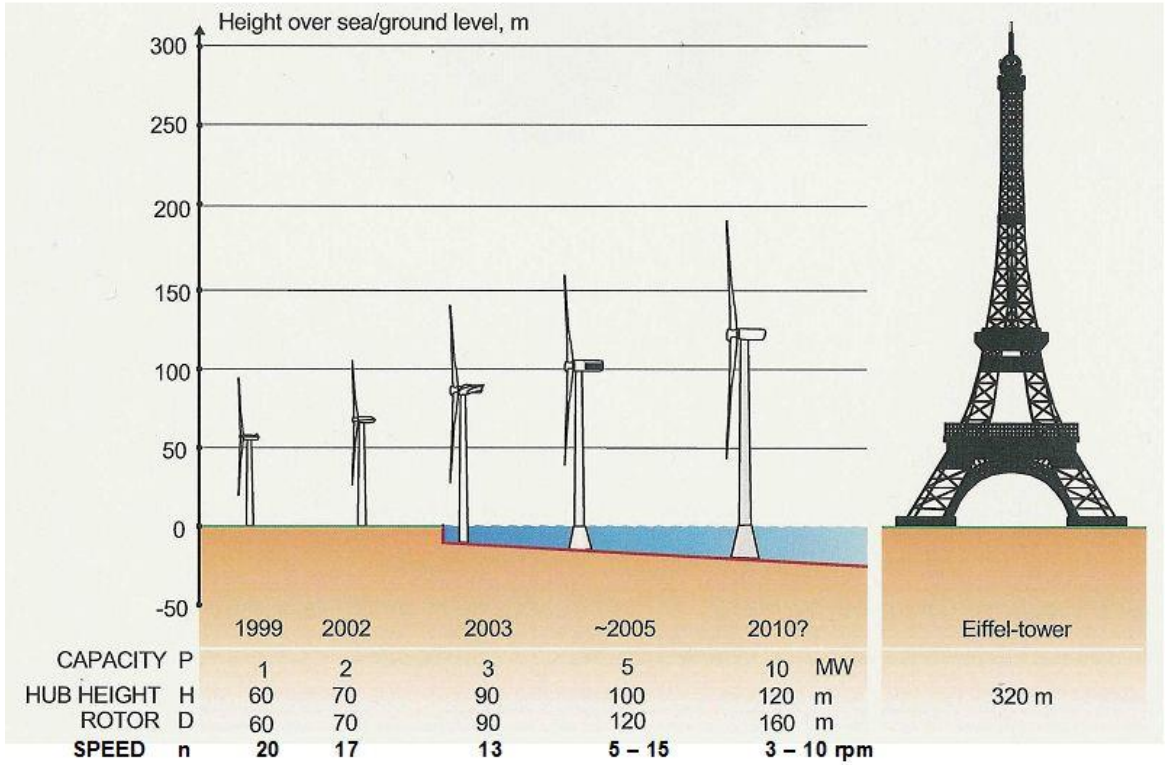
Execution



CAPEX / OPEX

Obs.: solar thermal

Wind power plants: CAPEX/OPEX



Current LCOE	**4,50 ¢/kWh**
Blade	2%
Controls/Sensors	3%
Drivetrain	2%
Generator	2%
Electrical	1%
Tower	2%
Pitch System	1%
Foundation	1%
Nacelle	1%
Pitch Control	2%
Condition Monitoring	2%
SCADA	2%
Yaw System	1%
Castings/Forgings	1%
Systems	1%
Yaw Control	1%
2025 LCOE	**3,75 ¢/kWh**

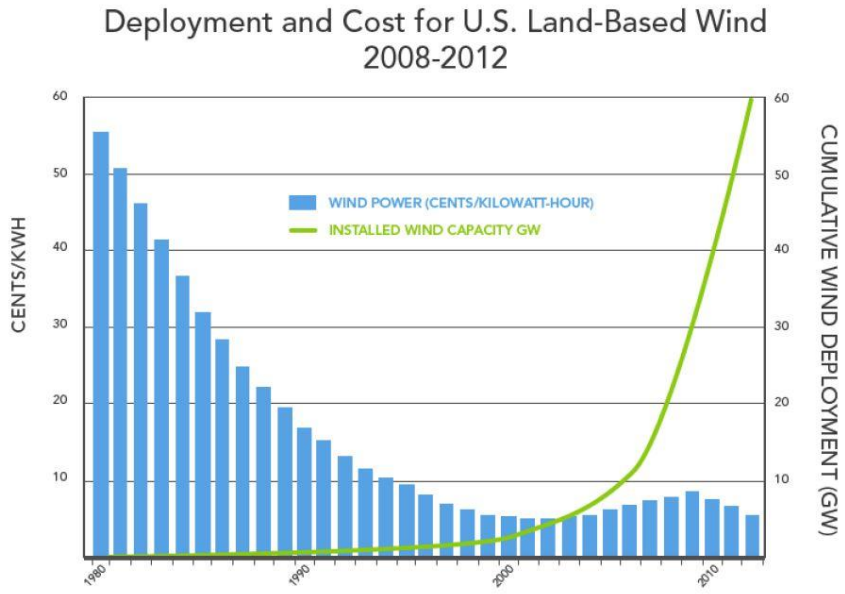
25% reduction in CAPEX

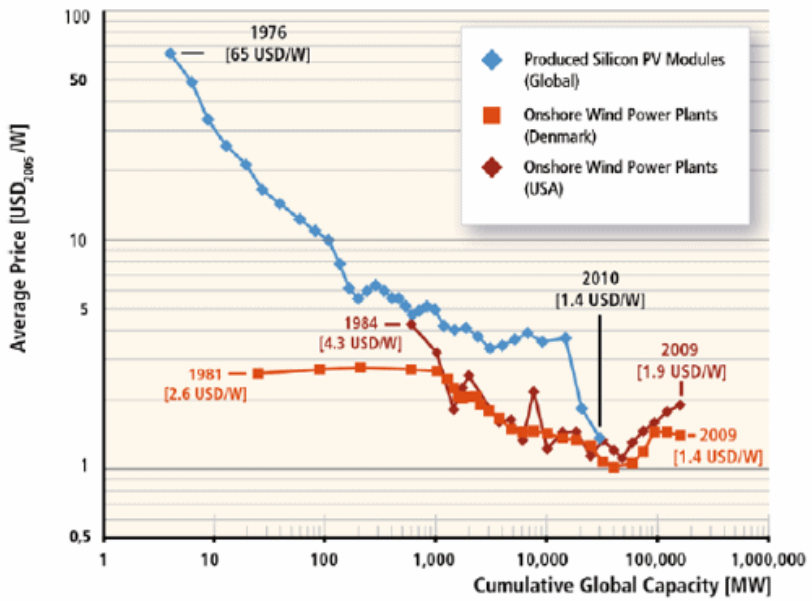
Current LCOE **4,50 ¢/kWh**

Blade	2%
Controls/Sensors	3%
Drivetrain	2%
Generator	2%
Electrical	1%
Tower	2%
Pitch System	1%
Foundation	1%
Nacelle	1%
Pitch Control	2%
Condition Monitoring	2%
SCADA	2%
Yaw System	1%
Castings/Forgings	1%
Systems	1%
Yaw Control	1%

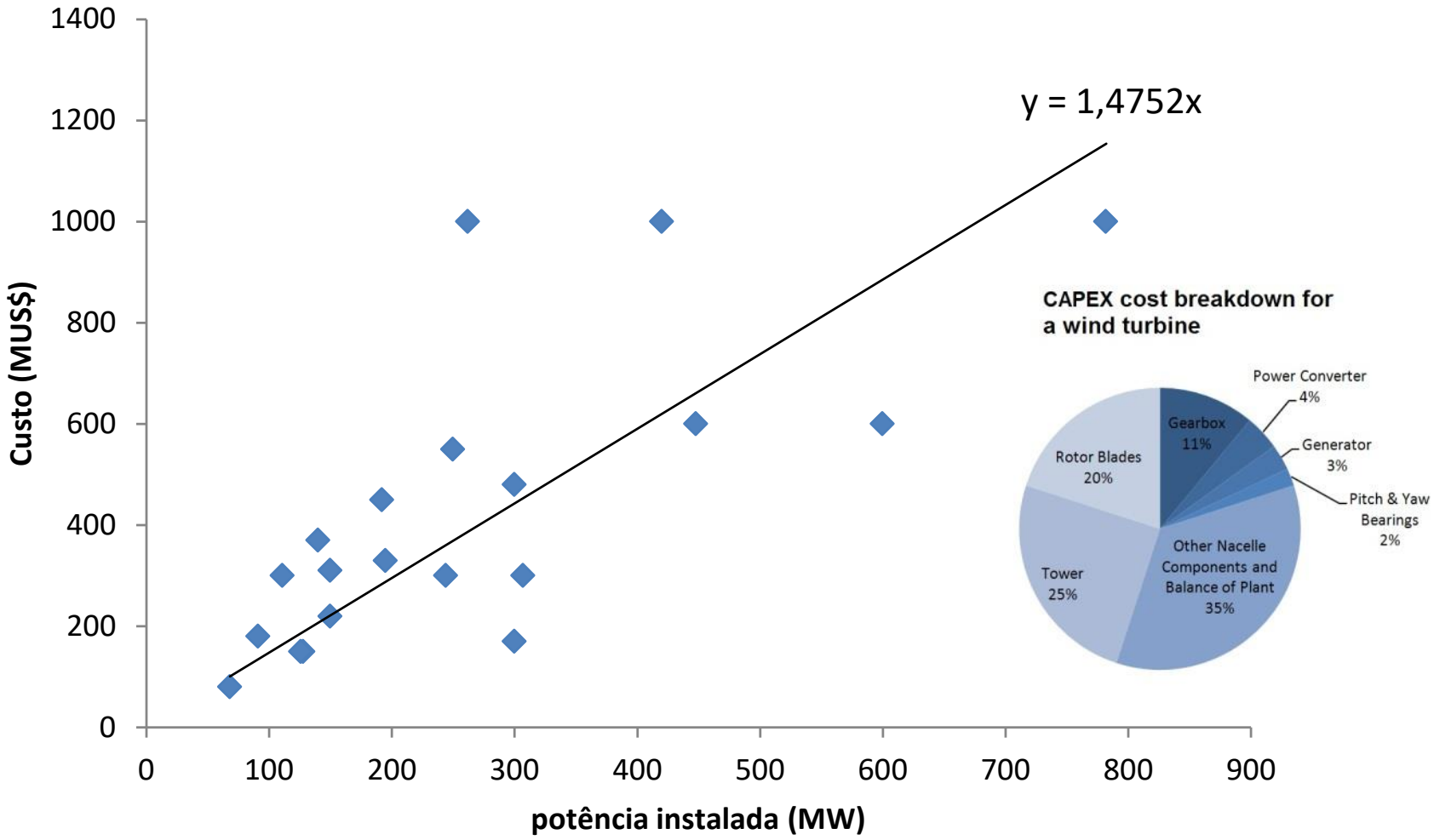
25% reduction in CAPEX

2025 LCOE **3,75 ¢/kWh**





Wind power plants: CAPEX/OPEX



Wind power plants: CAPEX/OPEX

características típicas	usina solar fotovoltaica	unidade
insumo energético primário	vento	-
capacidade instalada típica	28,00	MWp
FECC Nordeste	35,00	%
Tempo médio de implantação	18	meses
utilização de mão de obra	baixa	-
Qualificação da mão de obra	alta	-
característica de operação	intermitente	-
custo dos insumos	baixo	-
custo operacional	médio	-
emissão GEE	baixa	-
grau de maturidade tecnológica	TRL9	-
parâmetros	**valor**	**unidade**
custo capital	3,23	kR$/kW
custo operacional	7,91	R$/kW/mês
venda eletricidade (13/12/2013)	120,37	R$/MWh

Wind power plants: CAPEX/OPEX

características típicas	usina solar fotovoltaica	unidade
insumo energético primário	vento	-
capacidade instalada típica	28,00	MWp
FECC Nordeste	35,00	%
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emissão GEE	baixa	-
grau de maturidade tecnológica	TRL9	-
parâmetros	**valor**	**unidade**
custo capital	3,23	kR$/kW
custo operacional	7,91	R$/kW/mês
venda eletricidade (13/12/2013)	120,37	R$/MWh

← depreciation

Wind power plants: CAPEX/OPEX

R$ 1 billion → 310 MWp

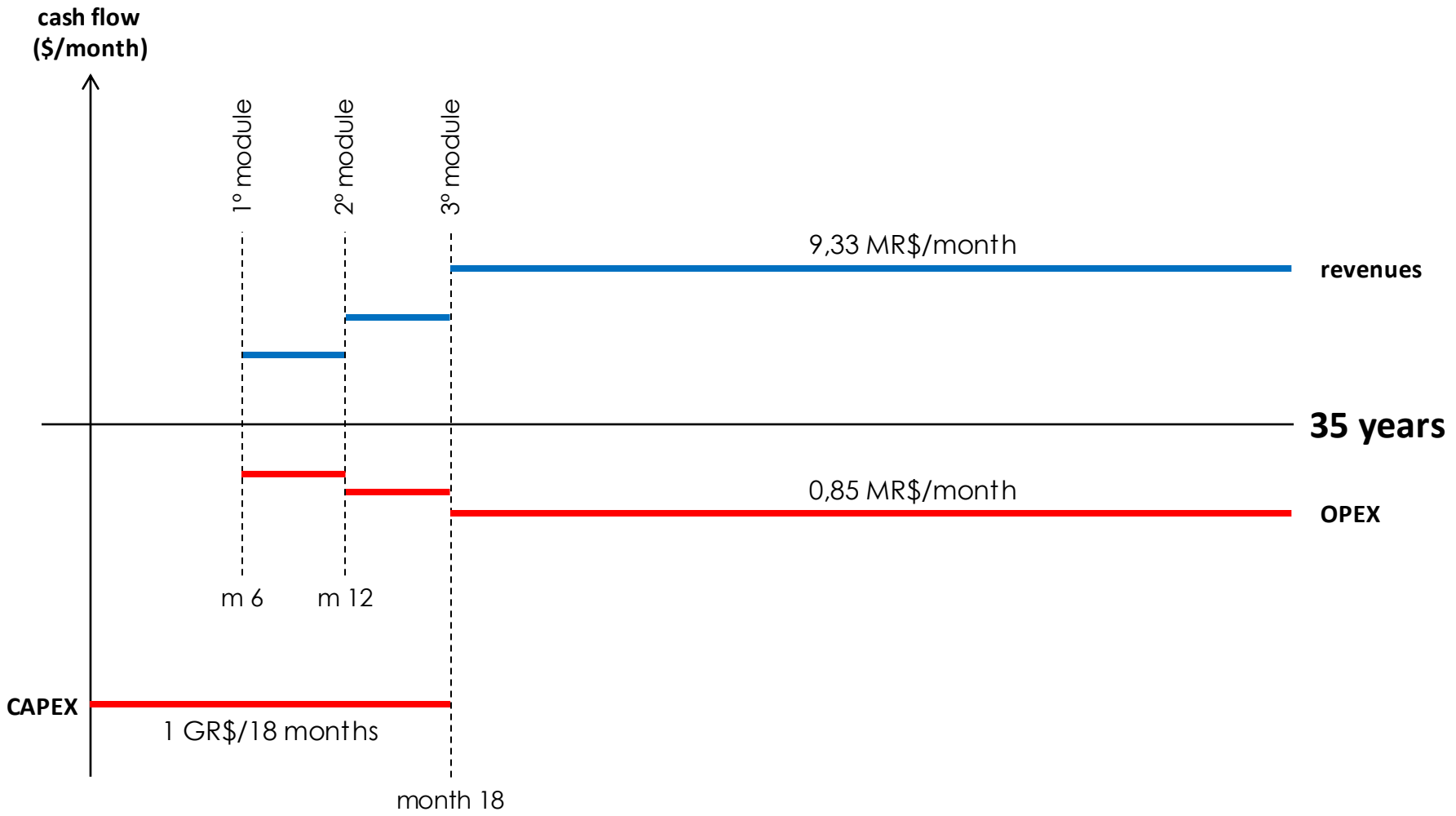
310 GWp $\xrightarrow{35\%}$ 108 MW

108 MW → 0,85 MR$/month

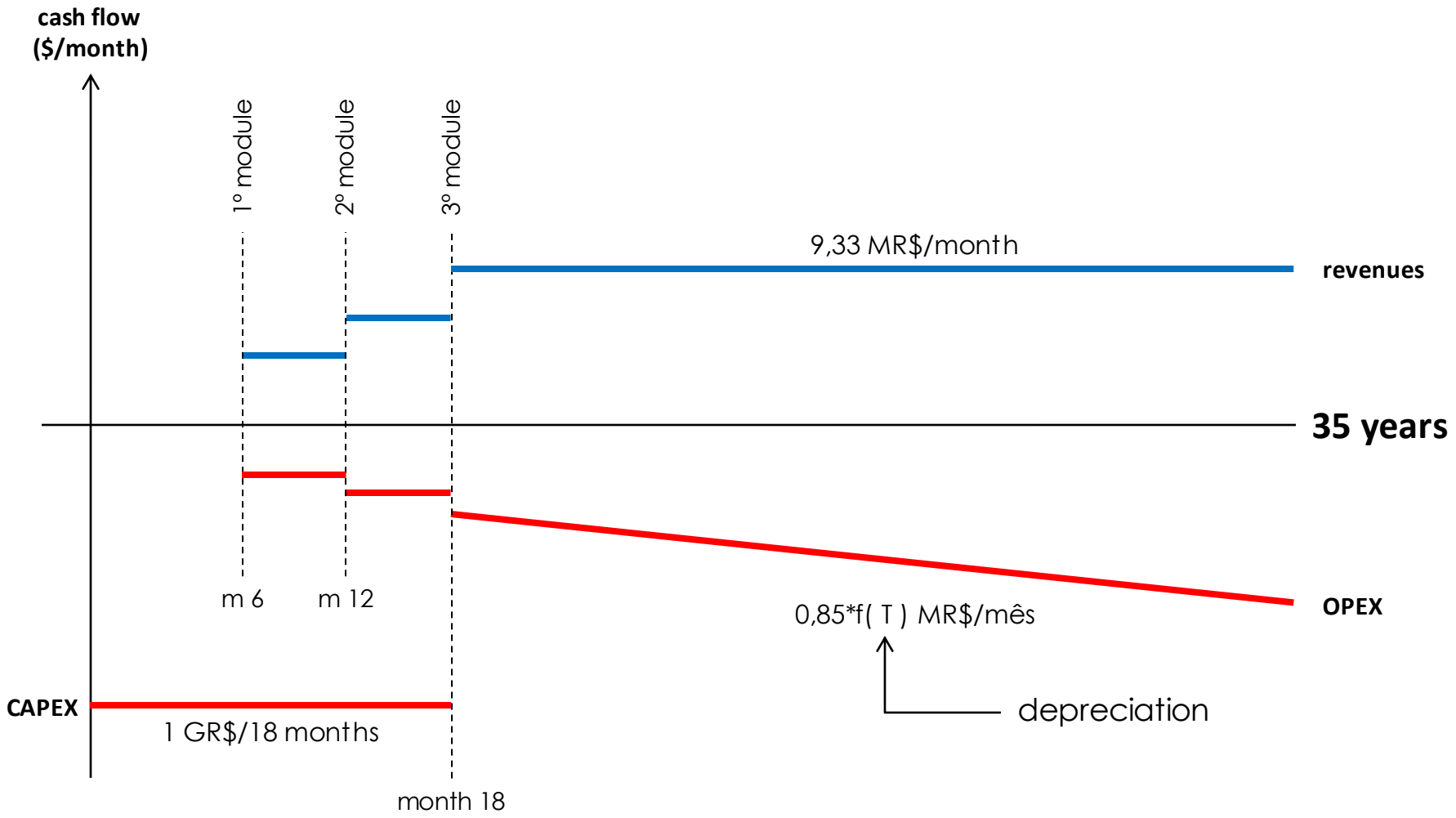
108 MW → 9,33 MR$/month

$$108\,\text{MW} \cdot 120 \cdot \frac{\text{R\$}}{\text{MWh}} \cdot \frac{24 \cdot 30 \cdot \text{h}}{\text{month}} = 9{,}33\,\text{MR\$/month}$$

Wind power plants: cash flow



Wind power plants: cash flow

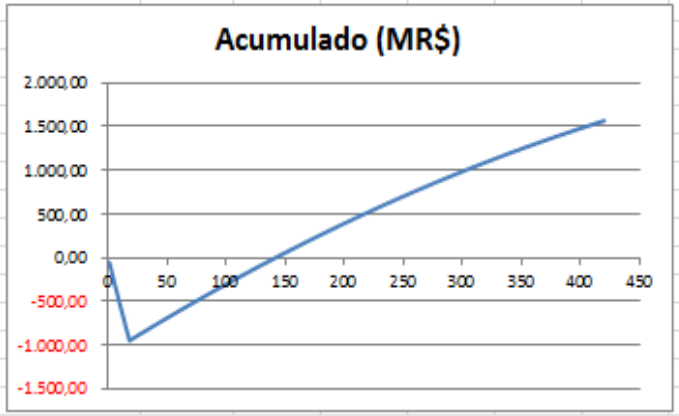


PVPF - Microsoft Excel

Arquivo | Página Inicial | Inserir | Layout da Página | Fórmulas | Dados | Revisão | Exibição | Desenvolvedor

$$D_n = 0{,}85 \cdot \left(1 + d \cdot \frac{n}{N}\right)$$

	A	B	C	D	E	F	G	H	I	J	K
1	mês	Capex (MR$)	Opex (MR$)	Despesas (MR$)	Receitas (MR$)	Fluxo (MR$)	Acumulado (MR$)		depreciação	5	
2	1	55,56		55,56		-55,56	-55,56		taxa de desconto	0,54%	ao mês
3	2	55,56		55,56		-55,56	-111,11		VPL	42,20	MR$
4	3	55,56		55,56		-55,56	-166,67		TIR	0,65%	ao mês
5	4	55,56		55,56		-55,56	-222,22		TIR	7,81%	ao ano
6	5	55,56		55,56		-55,56	-277,78		Benefício/Custo	1,1274	R$/R$
7	6	55,56	0,28	55,84	3,11	-52,73	-330,51				
8	7	55,56	0,28	55,84	3,11	-52,73	-383,24				
9	8	55,56	0,28	55,84	3,11	-52,73	-435,96				
10	9	55,56	0,28	55,84	3,11	-52,73	-488,69				
11	10	55,56	0,28	55,84	3,11	-52,73	-541,42				
12	11	55,56	0,28	55,84	3,11	-52,73	-594,15				
13	12	55,56	0,43	55,98	4,67	-51,32	-645,47				
14	13	55,56	0,43	55,98	4,67	-51,32	-696,78				
15	14	55,56	0,43	55,98	4,67	-51,32	-748,10				
16	15	55,56	0,43	55,98	4,67	-51,32	-799,41				
17	16	55,56	0,43	55,98	4,67	-51,32	-850,73				
18	17	55,56	0,43	55,98	4,67	-51,32	-902,04				
19	18	55,56	0,85	56,41	9,33	-47,08	-949,12				
20	19		1,04	1,04	9,33	8,29	-940,84				
21	20		1,05	1,05	9,33	8,28	-932,56				
22	21		1,06	1,06	9,33	8,27	-924,29				
23	22		1,07	1,07	9,33	8,26	-916,03				
24	23		1,08	1,08	9,33	8,25	-907,79				
25	24		1,09	1,09	9,33	8,24	-899,55				
26	25		1,10	1,10	9,33	8,23	-891,32				
27	26		1,11	1,11	9,33	8,22	-883,11				
28	27		1,12	1,12	9,33	8,21	-874,90				
29	28		1,13	1,13	9,33	8,20	-866,70				
30	29		1,14	1,14	9,33	8,19	-858,52				
31	30		1,15	1,15	9,33	8,18	-850,34				
32	31		1,16	1,16	9,33	8,17	-842,17				
33	32		1,17	1,17	9,33	8,16	-834,02				
34	33		1,18	1,18	9,33	8,15	-825,87				
35	34		1,19	1,19	9,33	8,14	-817,73				



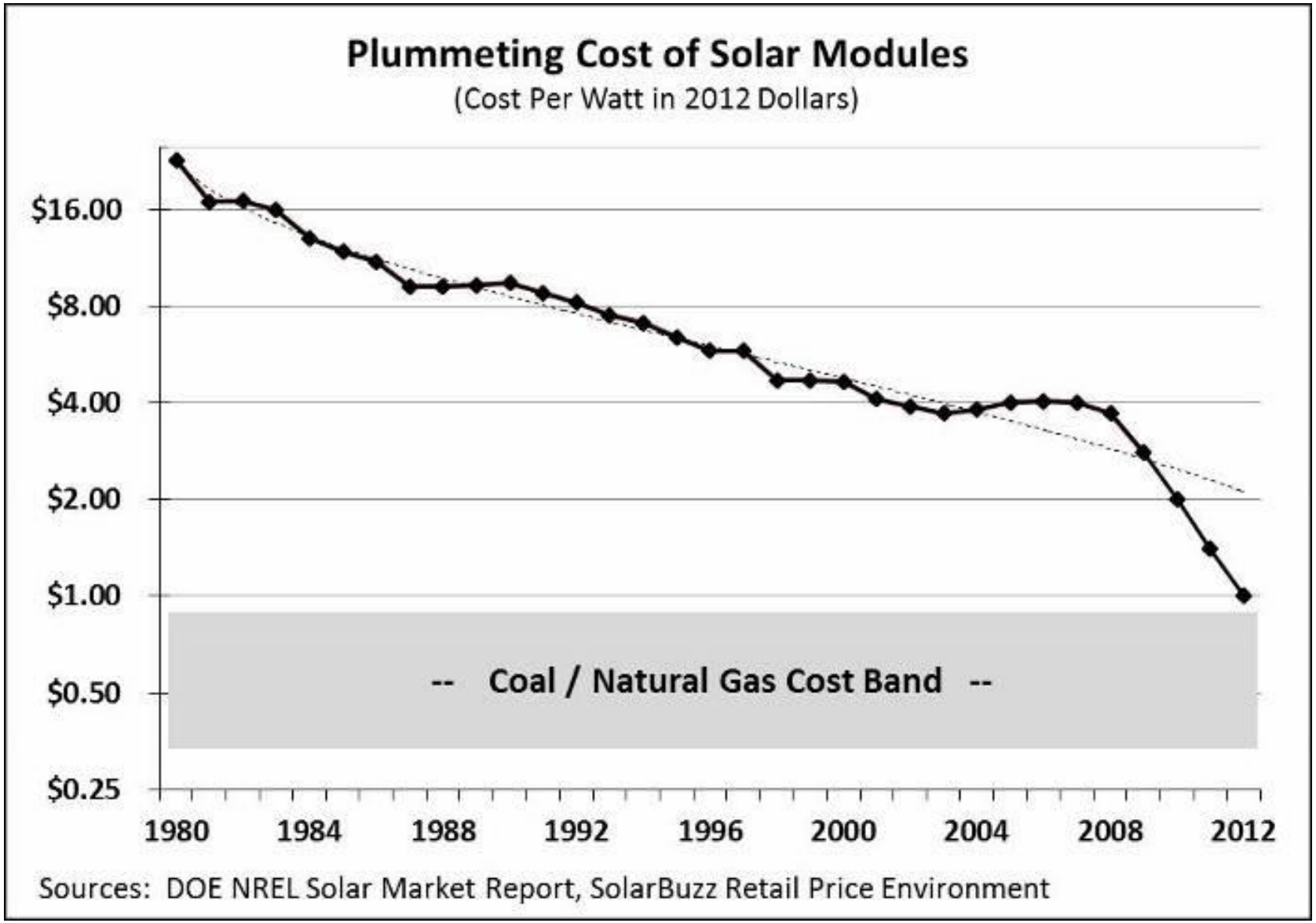
Plan1 | wind | photo | Plan3

Pronto

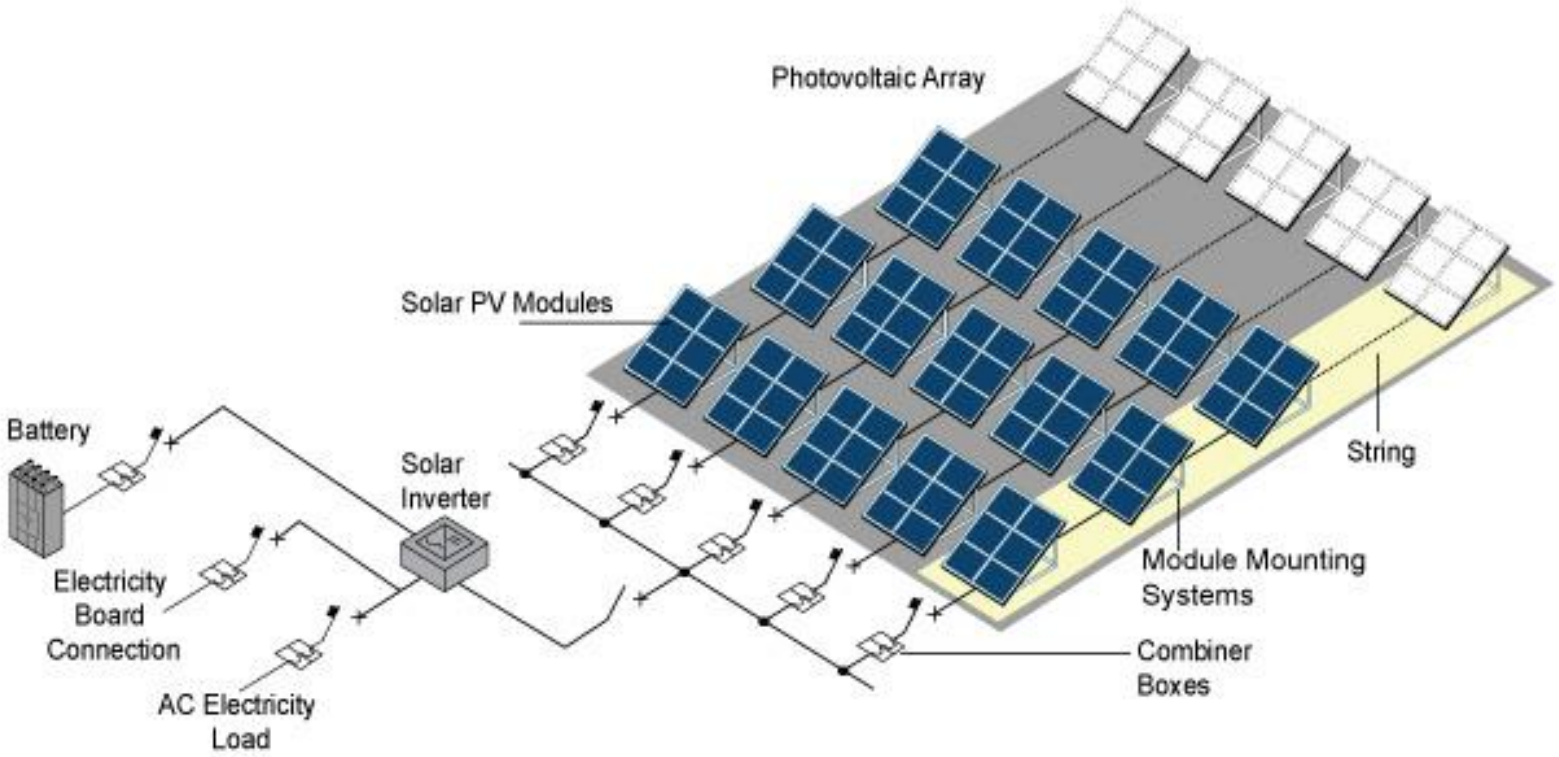
70%

Photovoltaic power plants: CAPEX/OPEX

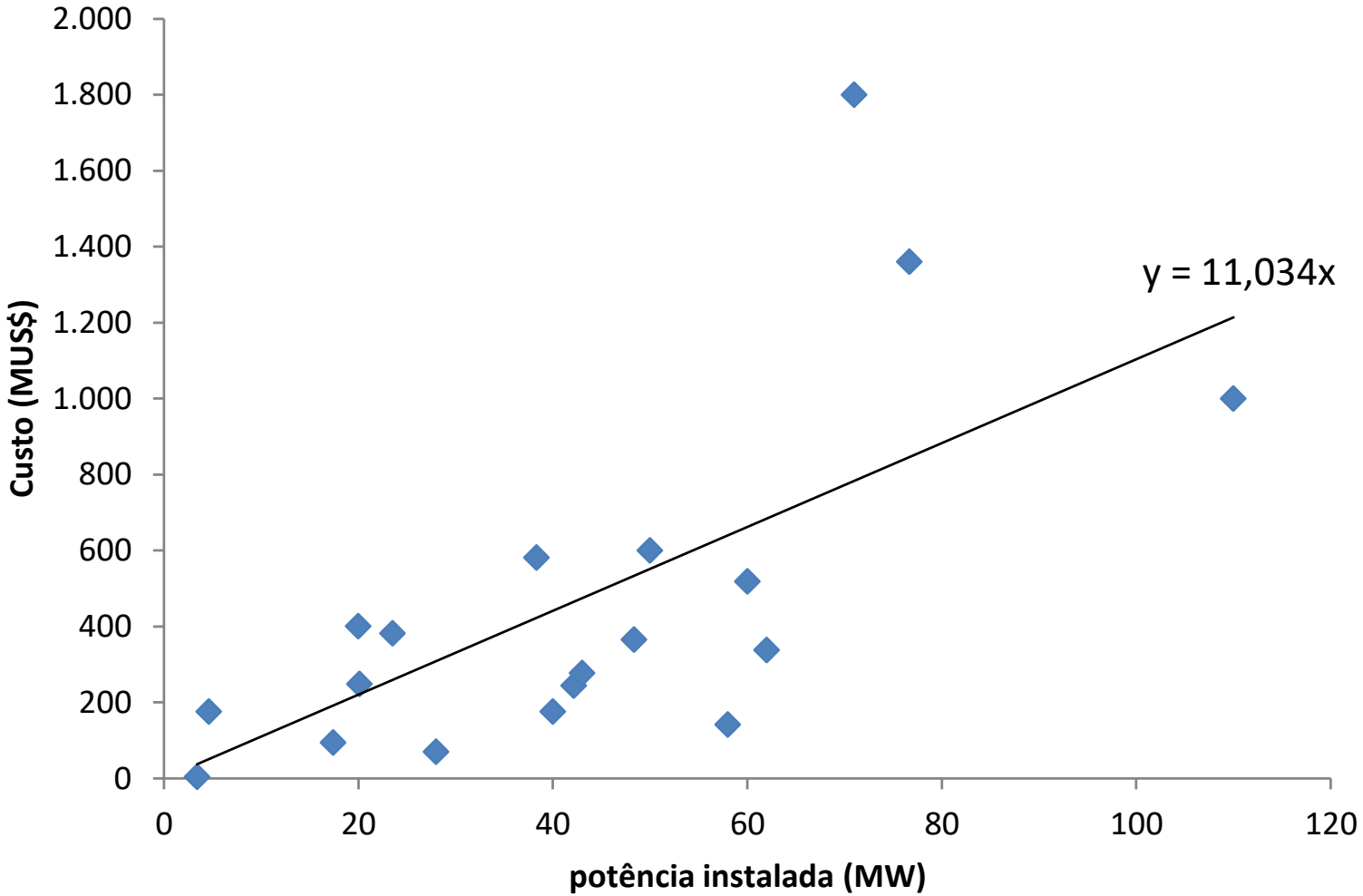
Photovoltaic power plants: CAPEX/OPEX



Photovoltaic power plants: CAPEX/OPEX



Photovoltaic power plants: CAPEX/OPEX



Photovoltaic power plants: CAPEX/OPEX

características típicas	usina solar fotovoltaica	unidade
insumo energético primário	luz solar	-
capacidade instalada típica	40,00	MWp
FECC Nordeste (5)	30,00	%
Tempo médio de implantação	36	meses
utilização de mão de obra	baixa	-
Qualificação da mão de obra	alta	-
característica de operação	intermitente	-
custo dos insumos	baixo	-
custo operacional	médio	-
emissão GEE	baixa	-
grau de maturidade tecnológica	TRL8	-
parâmetros	**valor**	**unidade**
custo capital (30MW) (1) (2) (3)	13,31	kR$/kW
custo capital (300MW) (1) (2) (3)	11,25	kR$/kW
custo capital (60MW) (1) (2) (3)	13,08	kR$/kW
custo operacional (1)	6,93	R$/kW/mês
venda eletricidade (4)	215,12	R$/MWh

Photovoltaic power plants: CAPEX/OPEX

características típicas	usina solar fotovoltaica	unidade
insumo energético primário	luz solar	-
capacidade instalada típica	40,00	MWp
FECC Nordeste (5)	30,00	%
Tempo médio de implantação	36	meses
utilização de mão de obra	baixa	-
Qualificação da mão de obra	alta	-
característica de operação	intermitente	-
custo dos insumos	baixo	-
custo operacional	médio	-
emissão GEE	baixa	-
grau de maturidade tecnológica	TRL8	-
parâmetros	**valor**	**unidade**
custo capital (30MW) (1) (2) (3)	13,31	kR$/kW
custo capital (300MW) (1) (2) (3)	11,25	kR$/kW
custo capital (60MW) (1) (2) (3)	13,08	kR$/kW
custo operacional (1)	6,93	R$/kW/mês
venda eletricidade (4)	215,12	R$/MWh

← depreciation

Photovoltaic power plants: CAPEX/OPEX

R$ 1 billion $\rightarrow$ 89 MWp

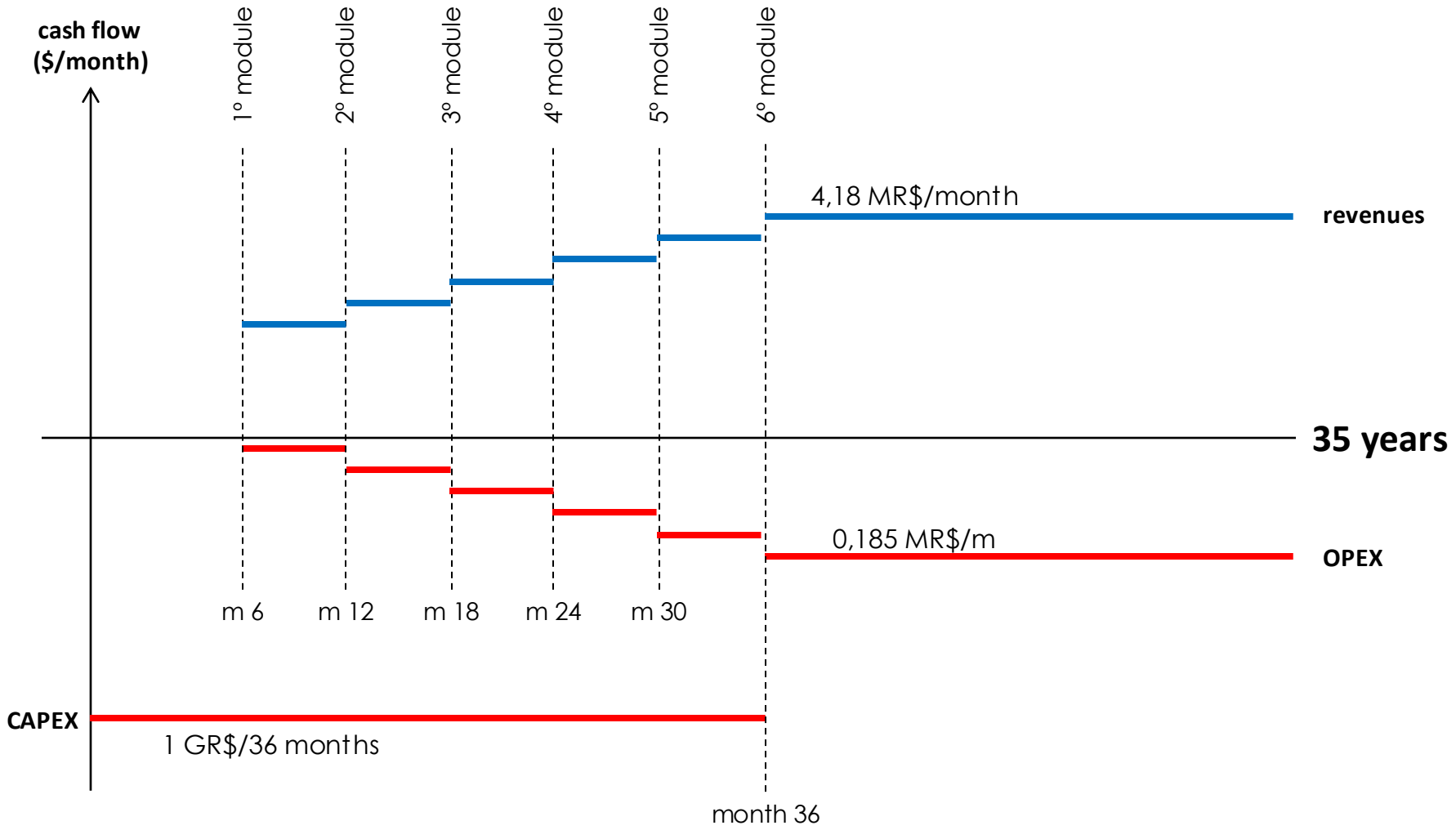
89 GWp $\overset{30\%}{\rightarrow}$ 27 MW

27 MW $\rightarrow$ 0,185 MR$/month

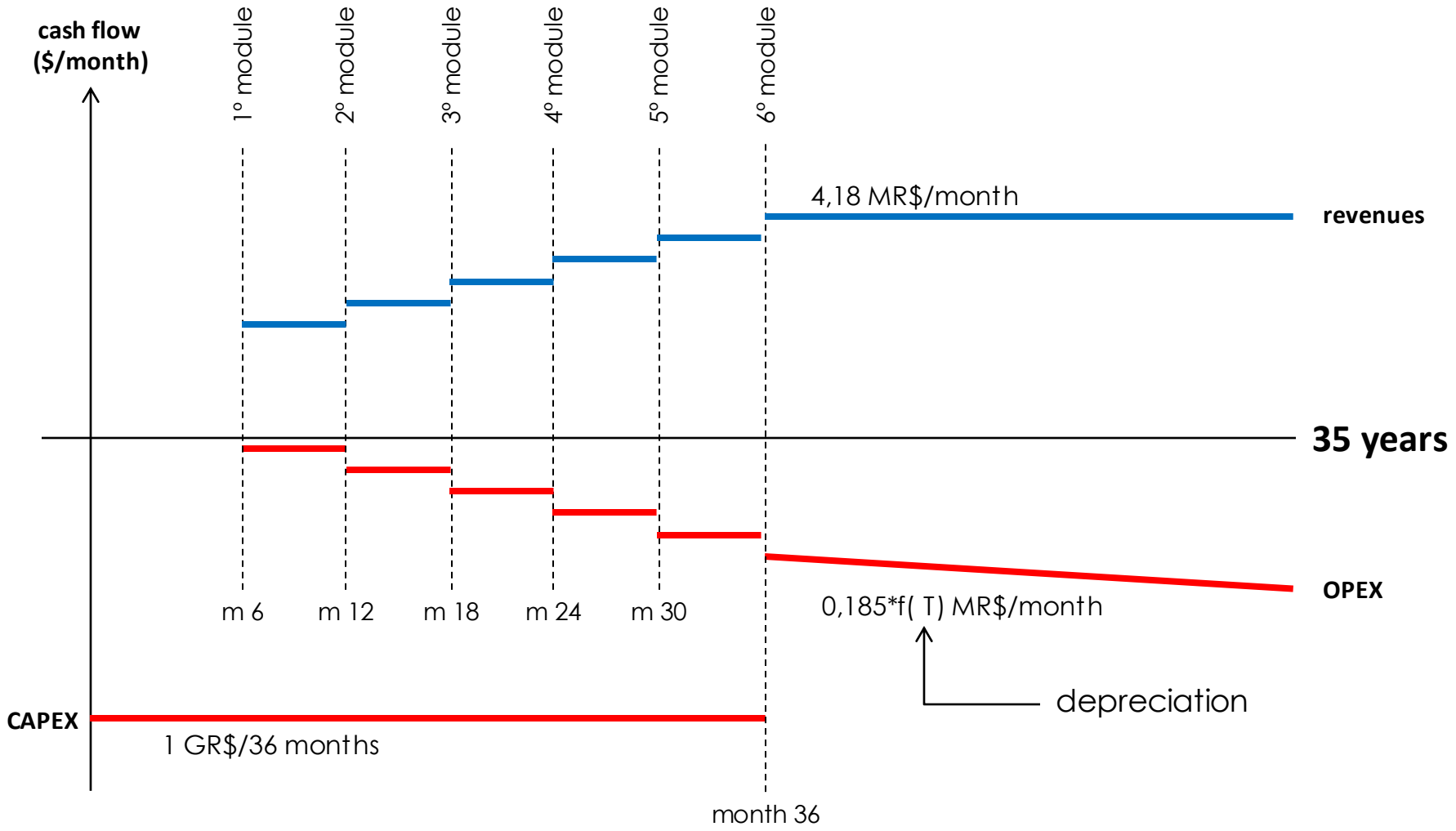
27 MW $\rightarrow$ 4,18 MR$/month

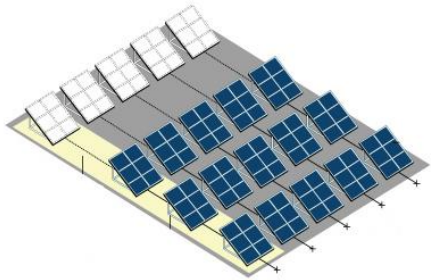
$$27\,\text{MW} \cdot 215{,}12 \cdot \frac{\text{R\$}}{\text{MWh}} \cdot \frac{24 \cdot 30 \cdot \text{h}}{\text{month}} = 4{,}18\,\text{MR\$/month}$$

Photovoltaic power plants: cash flow



Photovoltaic power plants: cash flow





PVPF - Microsoft Excel

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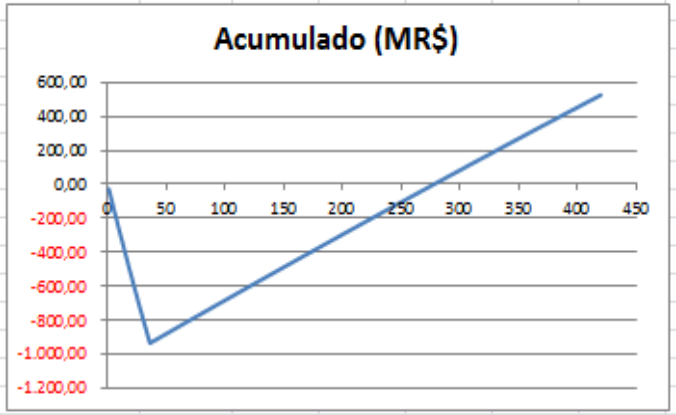
$$D_n = 0{,}85 \cdot \left(1 + d \cdot \frac{n}{N}\right)$$

	A	B	C	D	E	F	G	I	J	K
1	mês	Capex (MR$)	Opex (MR$)	Despesas (MR$)	Receitas (MR$)	Fluxo (MR$)	Acumulado (MR$)	depreciação	2	
2	1	27,78		27,78		-27,78	-27,78	taxa de desconto	0,54%	ao mês
3	2	27,78		27,78		-27,78	-55,56	VPL	-401,50	MR$
4	3	27,78		27,78		-27,78	-83,33	TIR	0,23%	ao mês
5	4	27,78		27,78		-27,78	-111,11	TIR	2,77%	ao ano
6	5	27,78		27,78		-27,78	-138,89	Benefício/Custo	0,6632	R$/R$
7	6	27,78	0,0308	27,81	0,70	-27,11	-166,00			
8	7	27,78	0,0308	27,81	0,70	-27,11	-193,11			
9	8	27,78	0,0308	27,81	0,70	-27,11	-220,22			
10	9	27,78	0,0308	27,81	0,70	-27,11	-247,34			
11	10	27,78	0,0308	27,81	0,70	-27,11	-274,45			
12	11	27,78	0,0308	27,81	0,70	-27,11	-301,56			
13	12	27,78	0,0617	27,84	1,39	-26,45	-328,01			
14	13	27,78	0,0617	27,84	1,39	-26,45	-354,45			
15	14	27,78	0,0617	27,84	1,39	-26,45	-380,90			
16	15	27,78	0,0617	27,84	1,39	-26,45	-407,35			
17	16	27,78	0,0617	27,84	1,39	-26,45	-433,79			
18	17	27,78	0,0617	27,84	1,39	-26,45	-460,24			
19	18	27,78	0,0925	27,87	2,09	-25,78	-486,02			
20	19	27,78	0,0925	27,87	2,09	-25,78	-511,80			
21	20	27,78	0,0925	27,87	2,09	-25,78	-537,58			
22	21	27,78	0,0925	27,87	2,09	-25,78	-563,36			
23	22	27,78	0,0925	27,87	2,09	-25,78	-589,14			
24	23	27,78	0,0925	27,87	2,09	-25,78	-614,92			
25	24	27,78	0,1233	27,90	2,79	-25,11	-640,03			
26	25	27,78	0,1233	27,90	2,79	-25,11	-665,15			
27	26	27,78	0,1233	27,90	2,79	-25,11	-690,26			
28	27	27,78	0,1233	27,90	2,79	-25,11	-715,38			
29	28	27,78	0,1233	27,90	2,79	-25,11	-740,49			
30	29	27,78	0,1233	27,90	2,79	-25,11	-765,61			
31	30	27,78	0,1542	27,93	3,48	-24,45	-790,05			
32	31	27,78	0,1542	27,93	3,48	-24,45	-814,50			
33	32	27,78	0,1542	27,93	3,48	-24,45	-838,95			
34	33	27,78	0,1542	27,93	3,48	-24,45	-863,40			
35	34	27,78	0,1542	27,93	3,48	-24,45	-887,85			

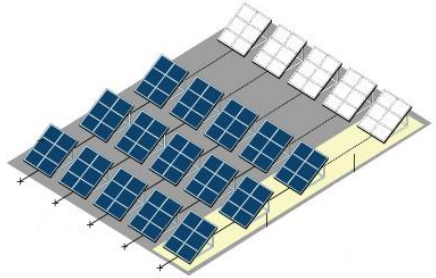


Plan1 | wind | photo | Plan3

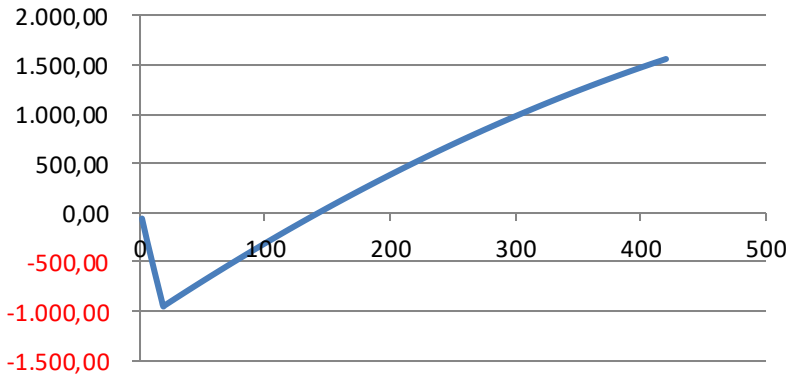
Pronto

70%

Analysis of the Investment Projects (Capital Budgeting)

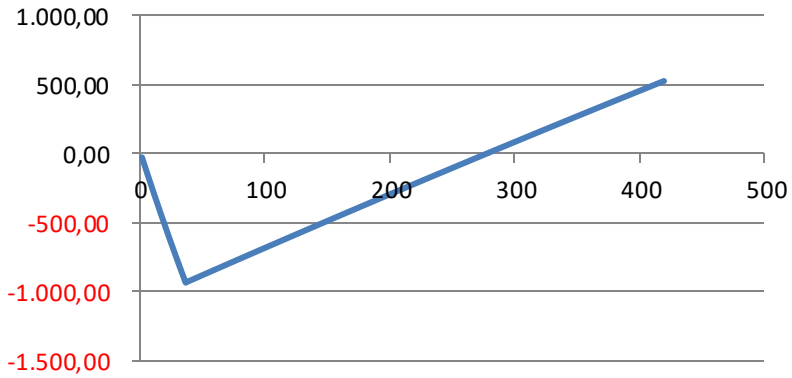


Acumulado (MR$)



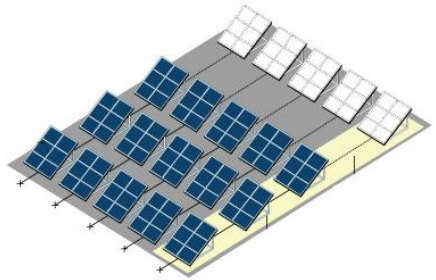
depreciação	5	
taxa de desconto	0,54%	ao mês
VPL	42,20	MR$
TIR	0,65%	ao mês
TIR	7,81%	ao ano
Benefício/Custo	1,1274	R$/R$

Acumulado (MR$)

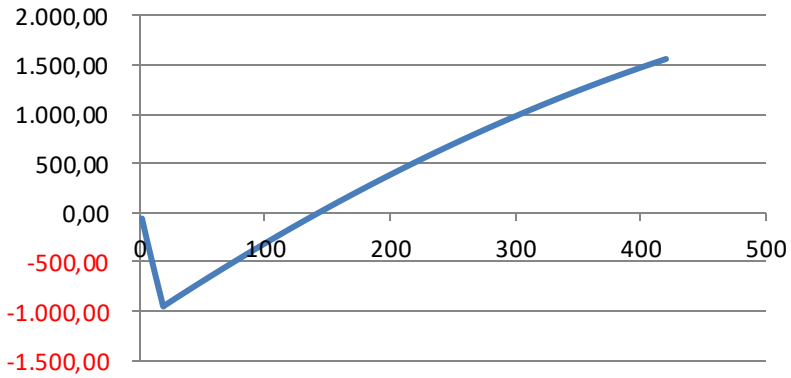


depreciação	2	
taxa de desconto	0,54%	ao mês
VPL	-401,50	MR$
TIR	0,23%	ao mês
TIR	2,77%	ao ano
Benefício/Custo	0,6632	R$/R$

Analysis of the Investment Projects (Capital Budgeting)

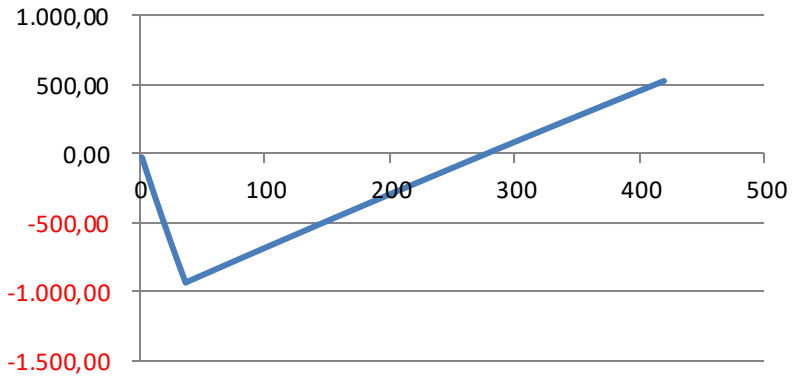


Acumulado (MR$)



depreciação	5	
taxa de desconto	0,54%	ao mês
VPL	42,20	MR$
TIR	0,65%	ao mês
TIR	7,81%	ao ano
Benefício/Custo	1,1274	R$/R$

Acumulado (MR$)



depreciação	2	
taxa de desconto	0,54%	ao mês
VPL	-401,50	MR$
TIR	0,23%	ao mês
TIR	2,77%	ao ano
Benefício/Custo	0,6632	R$/R$

DECISION: WIND. However...

Photovoltaics at the 10/2014 bid: 202 MWp @ R$ 215,12 / MWh

× R$ 100 / MWh

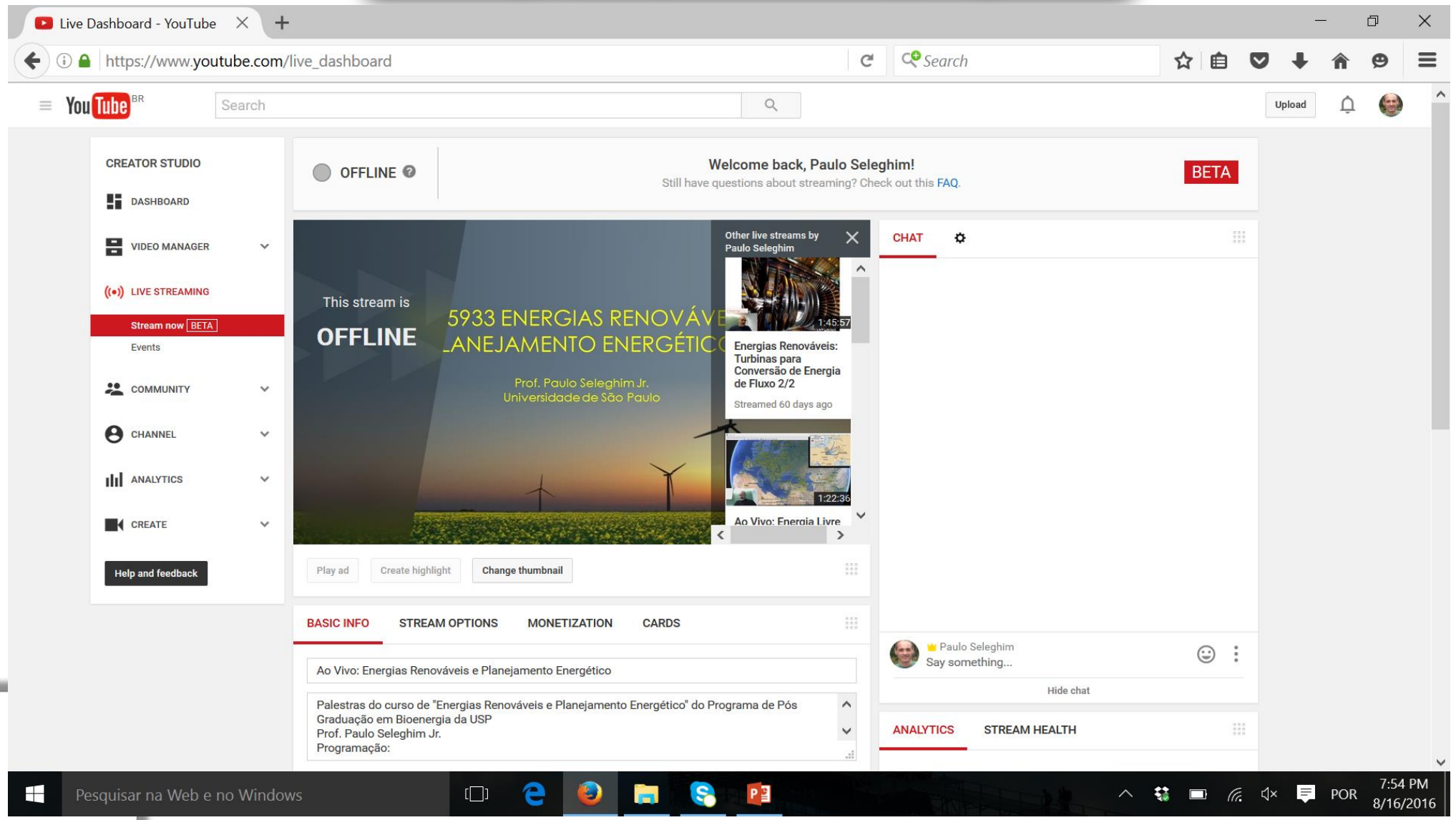
diversification of energy sources

Installed capacity in MW

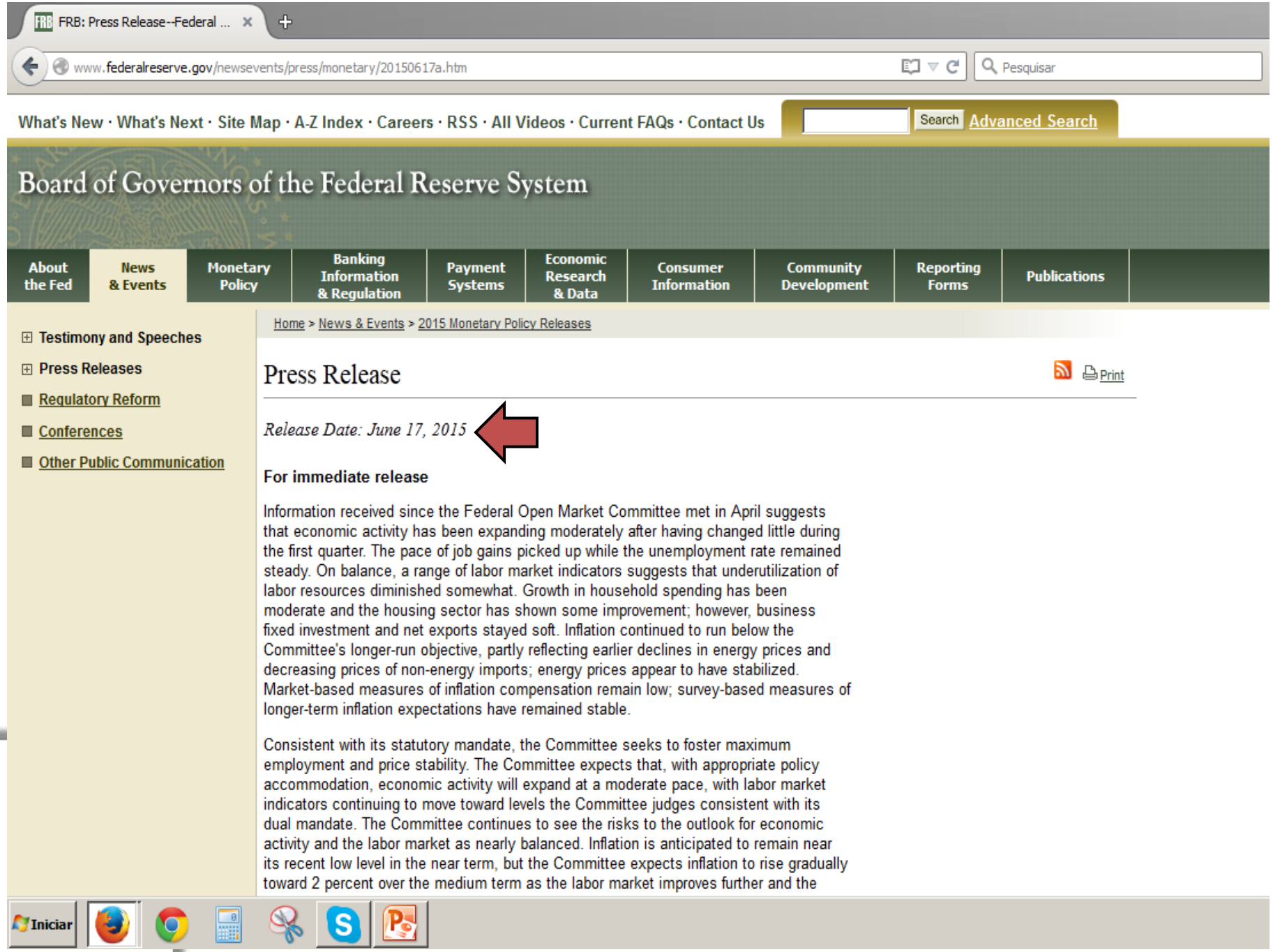
Fonte	2015	2016	Δ 16/15
Hidrelétrica	91.650	96.925	5,8%
Térmica[2]	39.580	41.276	4,3%
Nuclear	1.990	1.990	0,0%
Eólica	7.633	10.124	32,6%
Solar	21	24	13,1%
Capacidade disponível	**140.874**	**150.338**	**6,7%**

Tax incentives, exemption from taxes for equipment, differentiated tariffs, etc.

Streaming = www.youtube.com/c/pseleghim/live



Next class: conversion of thermal energy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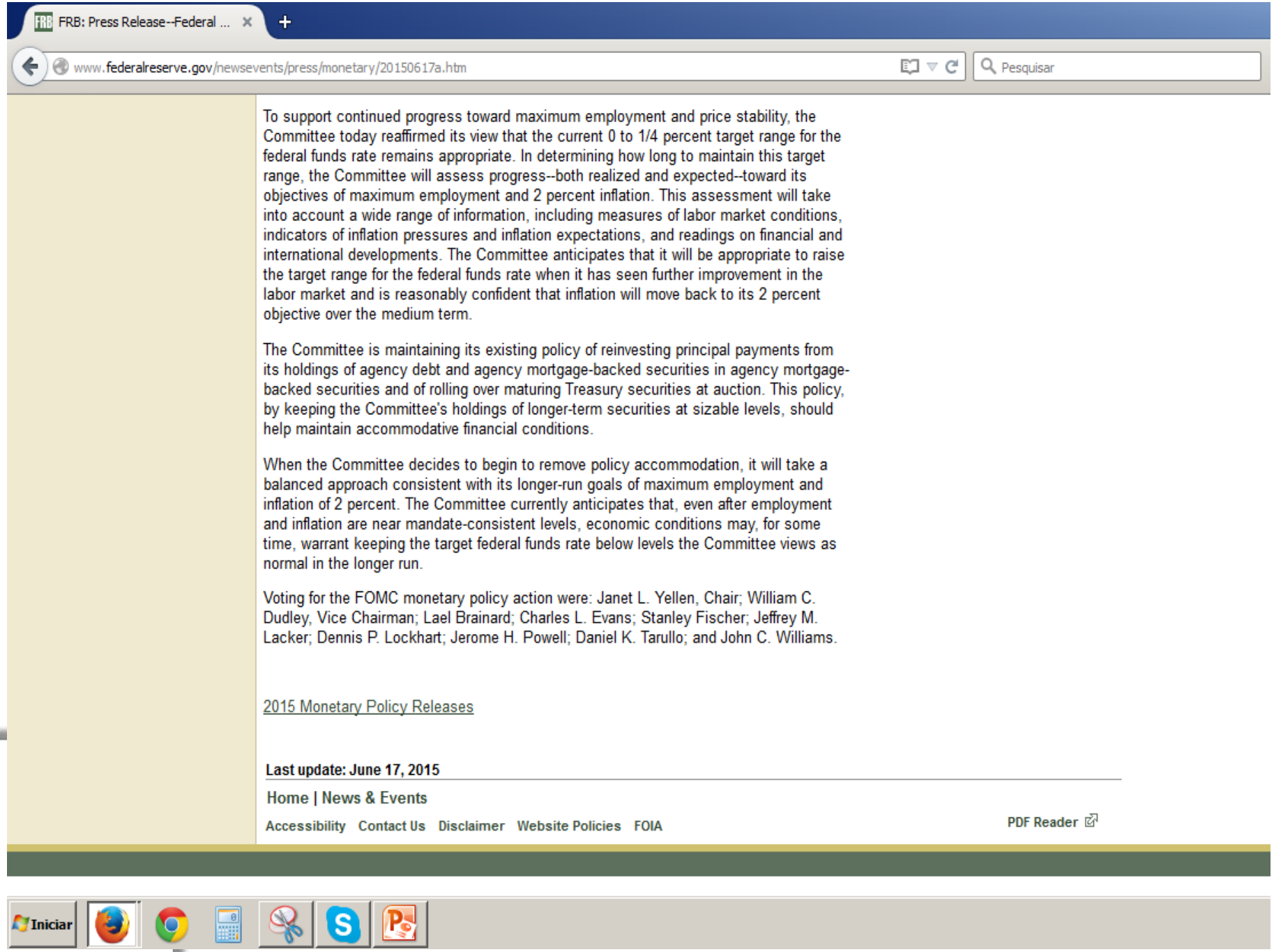
Home > News & Events > 2015 Monetary Policy Releases
Press Release
Print
Release Date: June 17, 2015
For immediate release
Information received since the Federal Open Market Committee met in April suggests that economic activity has been expanding moderately after having changed little during the first quarter. The pace of job gains picked up while the unemployment rate remained steady. On balance, a range of labor market indicators suggests that underutilization of labor resources diminished somewhat. Growth in household spending has been moderate and the housing sector has shown some improvement; however, business fixed investment and net exports stayed soft. Inflation continued to run below the Committee's longer-run objective, partly reflecting earlier declines in energy prices and decreasing prices of non-energy imports; energy prices appear to have stabilized. Market-based measures of inflation compensation remain low; survey-based measures of longer-term inflation expectations have remained stable.
Consistent with its statutory mandate, the Committee seeks to foster maximum employment and price stability. The Committee expects that, with appropriate policy accommodation, economic activity will expand at a moderate pace, with labor market indicators continuing to move toward levels the Committee judges consistent with its dual mandate. The Committee continues to see the risks to the outlook for economic activity and the labor market as nearly balanced. Inflation is anticipated to remain near its recent low level in the near term, but the Committee expects inflation to rise gradually toward 2 percent over the medium term as the labor market improves further and the
Iniciar



To support continued progress toward maximum employment and price stability, the Committee today reaffirmed its view that the current 0 to 1/4 percent target range for the federal funds rate remains appropriate. In determining how long to maintain this target range, the Committee will assess progress--both realized and expected--toward its objectives of maximum employment and 2 percent inflation. This assessment will take into account a wide range of information, including measures of labor market conditions, indicators of inflation pressures and inflation expectations, and readings on financial and international developments. The Committee anticipates that it will be appropriate to raise the target range for the federal funds rate when it has seen further improvement in the labor market and is reasonably confident that inflation will move back to its 2 percent objective over the medium term.

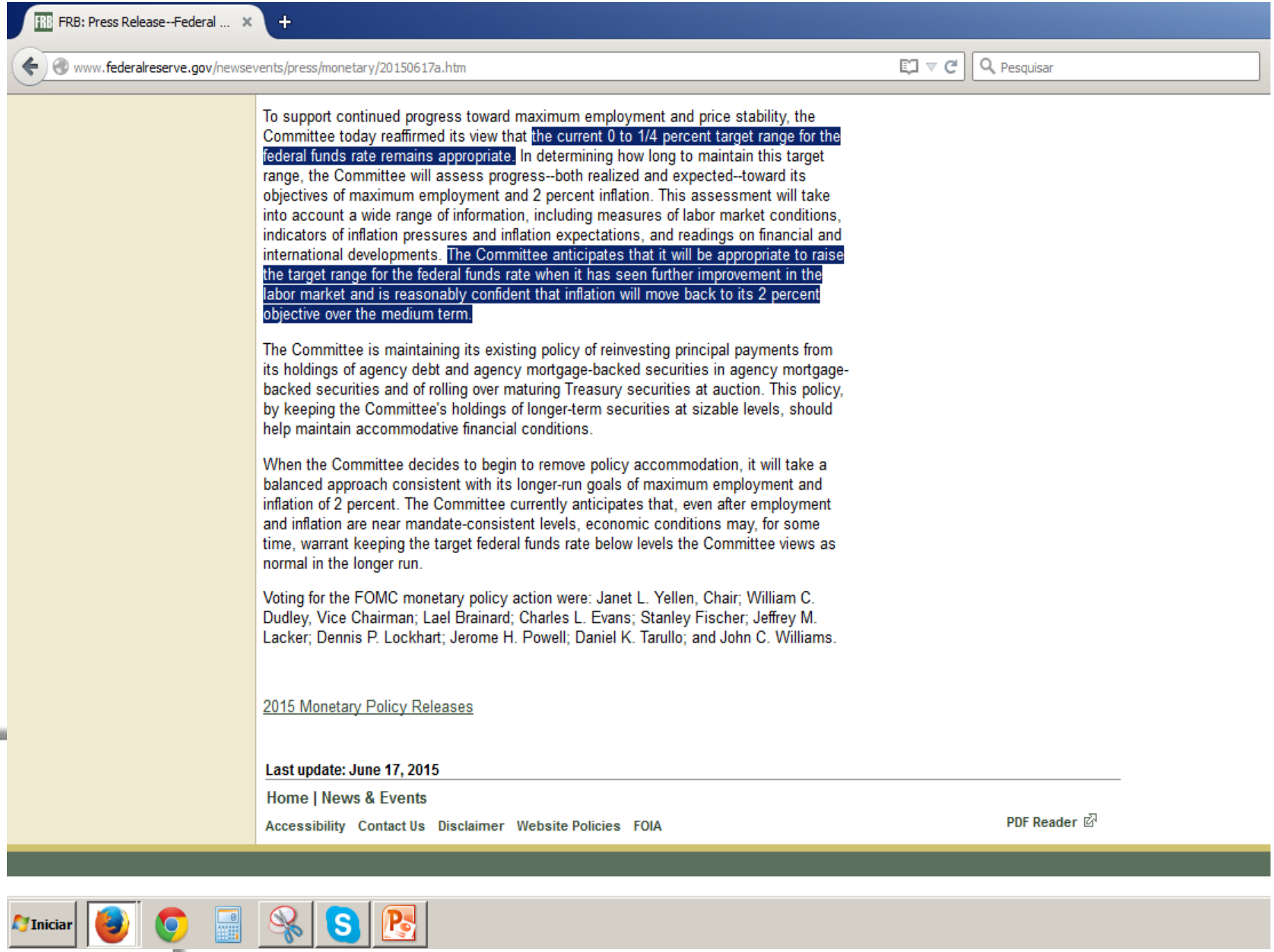
The Committee is maintaining its existing policy of reinvesting principal payments from its holdings of agency debt and agency mortgage-backed securities in agency mortgage-backed securities and of rolling over maturing Treasury securities at auction. This policy, by keeping the Committee's holdings of longer-term securities at sizable levels, should help maintain accommodative financial conditions.

When the Committee decides to begin to remove policy accommodation, it will take a balanced approach consistent with its longer-run goals of maximum employment and inflation of 2 percent. The Committee currently anticipates that, even after employment and inflation are near mandate-consistent levels, economic conditions may, for some time, warrant keeping the target federal funds rate below levels the Committee views as normal in the longer run.

Voting for the FOMC monetary policy action were: Janet L. Yellen, Chair; William C. Dudley, Vice Chairman; Lael Brainard; Charles L. Evans; Stanley Fischer; Jeffrey M. Lacker; Dennis P. Lockhart; Jerome H. Powell; Daniel K. Tarullo; and John C. Williams.

2015 Monetary Policy Releases

Last update: June 17, 2015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