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Vanadium

Redox Future

Businessplan for the lecture Business
Administration WS2014/15

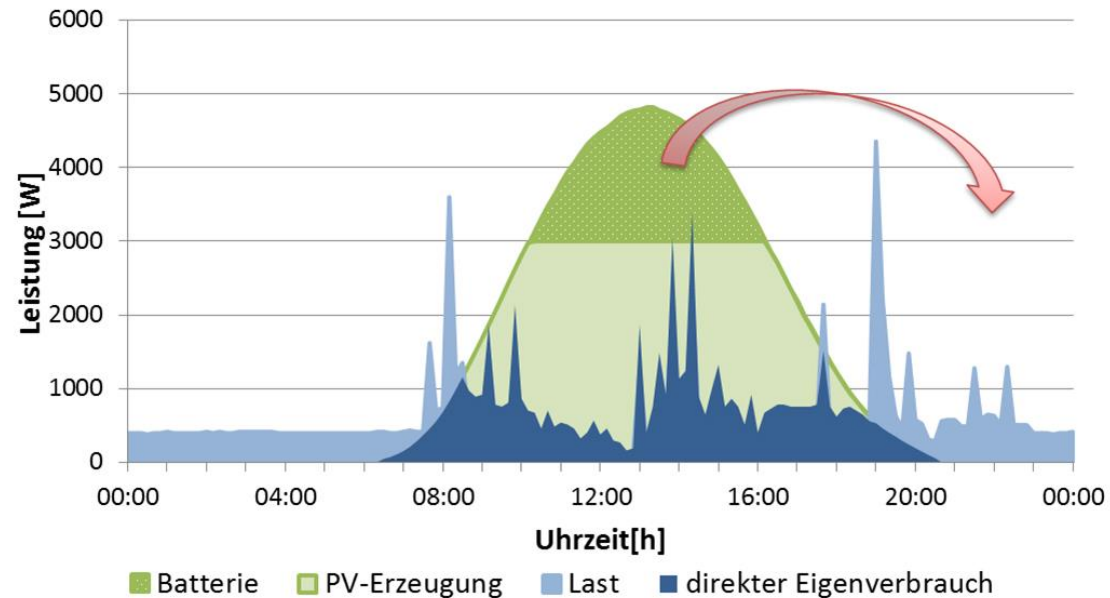
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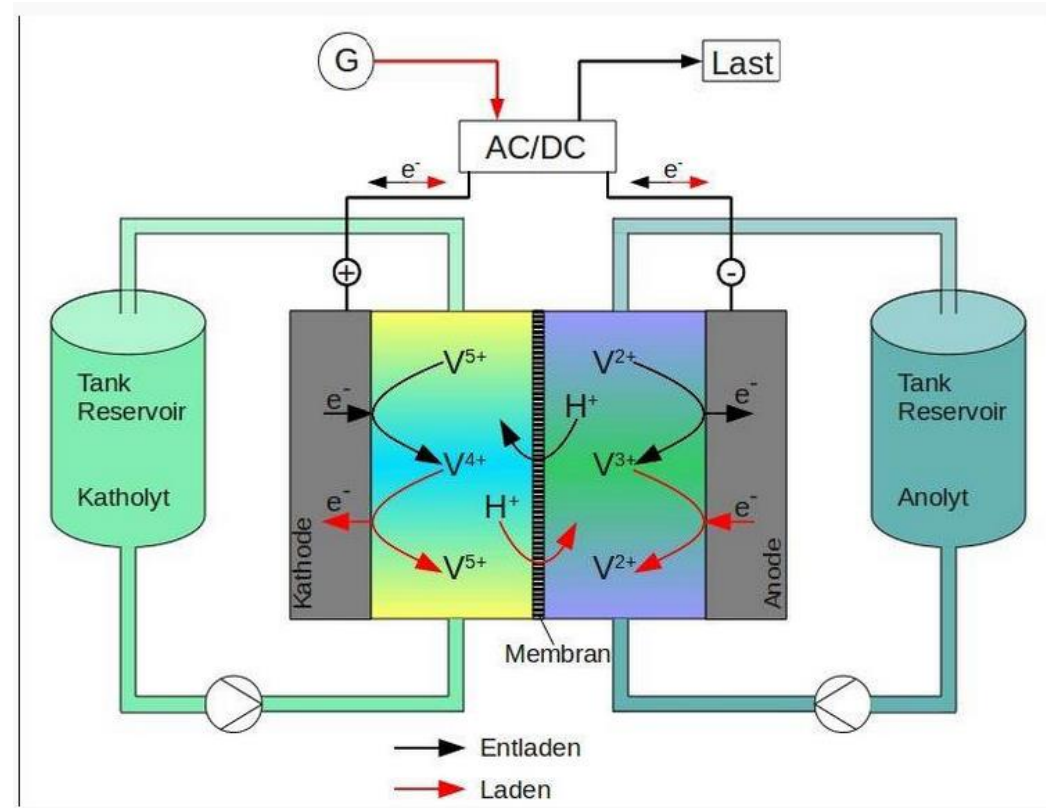
Background

- Higher supply in the electrical grid causes an increasing demand for operating reserves
- Possibilities are flexible loads, storages or flexible production
- Storages can supply electrical energy or store it.
- Redox-Flow-Batteries have high electrical efficiencies and a flexible scaling



Operation principle of Vanadium Redox Flow Batteries

- Redox Flow Batteries use Vanadium ions dissolved in a liquid.
- If different types of ions are brought together they react and produce electricity.
- The liquid can easily be stored in reservoirs



Operating numbers for RFB

- Energy density : 80 Wh/L
- Energy efficiency: >80% (Round-Trip)
- Self-discharge: no self-discharge
- Number of cycles : >10000
- Power costs: 1000 €/MW
- Capacity costs : 150 €/MWh



Technical potential – automotive sector

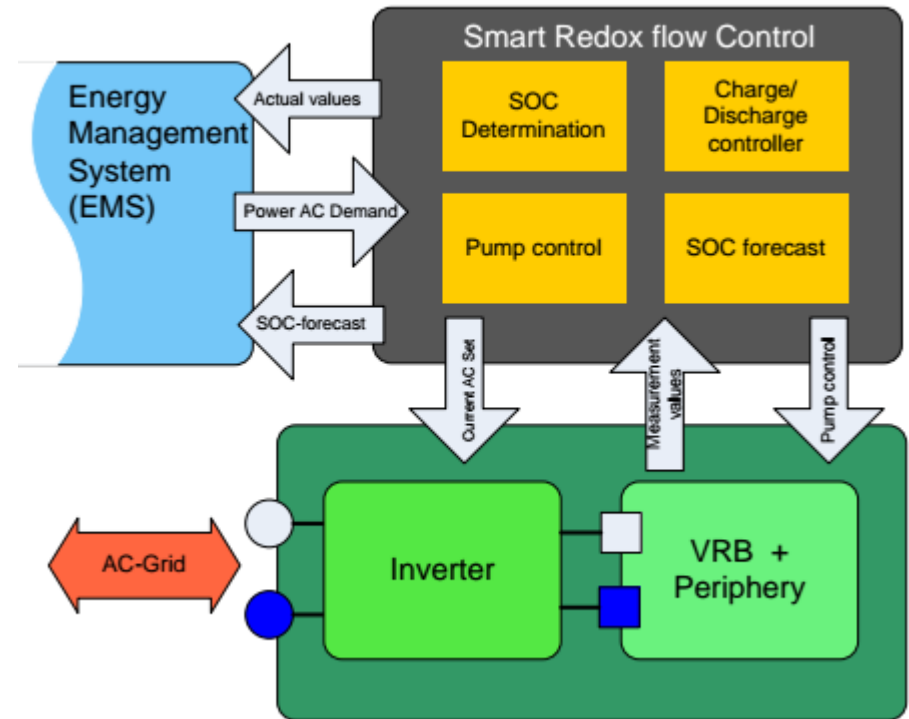
- RFB are also used as storage systems in the automotive sector
- In 2013 an american company developed a first car with a RFB as storage
- Power: 480 KW
- Range: up to 600 km



Technical potential – „Smart Redox Flow Control“

Smart Redox Flow Control

- Control loops for devices of redox flow battery
- Determination of set points
- Optimization of the process cycle -> energy efficiency
- Interface with energy management system



Business model

- Installing a 20 MW/100 MWh RFB on an piece of land in the Aachen region
- Offer positive and negative primary operating reserves and earn money therefore
- The demand for operating reserves is tendered each week
- Cheapest offers are taken first, in the last time every offer had to be taken

Market analysis

- Prices for primary operating reserves are about 3500€/MW at the moment
- Increasing supply by renewables will increase the price for operating reserves in the future
- At the moment there are only 21 participants in the market for primary operating reserves, none with this capacity/power

Financing Concept

- Founding a GmbH with three shareholders, who invest 40% of the total costs
- Finance 60% of total costs with a bank loan with 2% interest rate
- Storage systems don't receive subsidies for their consumed/produced energy
- No special financing options available (KfW)

Cost calculation - Investment

Investment Good	Expenditures	Depreciation (%)	Depreciation (€)
Property	480,000 €	0	0 €
Power Installation	20,000,000 €	10	2,000,000 €
Energy Installation	15,000,000 €	5	750,000 €
Grid Connection	65,000 €	5	3,250 €
Unexpected	1,777,250.00 €		
	37,322,250.00 €		2,753,250.00 €

Cost calculation – Labour costs

Personnel	Number	Salary	Personnel direct cost
Technicians	3	60,000.00 €	180,000.00 €
Chemists	1	54,000.00 €	54,000.00 €
Security	1	60,000.00 €	60,000.00 €
Administration	3	96,000.00 €	288,000.00 €
Sales	2	84,000.00 €	168,000.00 €
			750,000.00 €

Financing plan

Total Investment	37,322,250.00 €	
40% own capital funds (shareholders equity)	14,928,900.00 €	
60% outside financing (bank loan)	22,393,350.00 €	
Interest Rate		2%
Period		10Years

Financing plan

Year	Balance Of Debt	Interest Rate (%)	Interest Costs	Repayment
1	22,393,350.00 €	2	447,867.00 €	2,239,335.00 €
2	20,154,015.00 €	2	403,080.30 €	2,239,335.00 €
3	17,914,680.00 €	2	358,293.60 €	2,239,335.00 €
4	15,675,345.00 €	2	313,506.90 €	2,239,335.00 €
5	13,436,010.00 €	2	268,720.20 €	2,239,335.00 €
6	11,196,675.00 €	2	223,933.50 €	2,239,335.00 €
7	8,957,340.00 €	2	179,146.80 €	2,239,335.00 €
8	6,718,005.00 €	2	134,360.10 €	2,239,335.00 €
9	4,478,670.00 €	2	89,573.40 €	2,239,335.00 €
10	2,239,335.00 €	2	44,786.70 €	2,239,335.00 €
			2,463,268.50 €	

Self costs

	1. Year	2. Year	3. Year
Utilization of capacity	60%	80%	100%
Quantity of capacity	12	16	20
Depreciation Costs	2,753,250	2,753,250	2,753,250
Operation & Maintenance	175,000	175,000	175,000
Labour costs	750,000	750,000	750,000
Financing costs	447,867	403,080	358,294
Repayment credit	2,239,335	2,239,335	2,239,335
Total of costs	6,365,452	6,320,665	6,275,879
Self costs per MW	10609,1	7900,8	6275,9

Cost calculation – Turn over / revenue

	1. Year	2. Year	3. Year	4. Year	5. Year	6. Year	7. Year	8. Year	9. Year	10. Year
Capacity Utilization	60.00%	80.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Power (MW)	20	20	20	20	20	20	20	20	20	20
Accepted (Weeks)	50	50	50	50	50	50	50	50	50	50
Operating Reserve (€/MW)	3,774.73 €	4,126.10 €	4,477.47 €	4,828.84 €	5,180.21 €	5,531.58 €	5,882.95 €	6,234.32 €	6,585.69 €	6,937.06 €
	2,264,839.10 €	3,300,881.47 €	4,477,471.84 €	4,828,841.84 €	5,180,211.84 €	5,531,581.84 €	5,882,951.84 €	6,234,321.84 €	6,585,691.84 €	6,937,061.84 €

- 2 weeks each year are planned for maintaining
- Using current figures, our storage will be used each week

Cash flow with fixed power price

(in €)	1. Year	2. Year	3. Year	4. Year	5. Year	6. Year	7. Year	8. Year	9. Year	10. Year
Revenue	2,100,000	2,800,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000
Depreciation costs	2,753,250	2,753,250	2,753,250	2,753,250	2,753,250	2,753,250	2,753,250	2,753,250	2,753,250	2,753,250
Operation & Maintenance	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000
Labour costs	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000
Financing costs	447,867	403,080	358,294	313,507	268,720	223,934	179,147	134,360	89,573	44,787
Loss carried forward	0	-2,026,117	-3,307,447	-3,843,991	-4,335,748	-4,782,718	-5,184,902	-5,542,298	-5,854,908	-6,122,732
Profit before tax	-2,026,117	-3,307,447	-3,843,991	-4,335,748	-4,782,718	-5,184,902	-5,542,298	-5,854,908	-6,122,732	-6,345,769
Taxes (40%)	0	0	0	0	0	0	0	0	0	0
Profit after taxes	-2,026,117	-3,307,447	-3,843,991	-4,335,748	-4,782,718	-5,184,902	-5,542,298	-5,854,908	-6,122,732	-6,345,769
Cash-flow (net profit + depreciation)	727,133	-554,197	-1,090,741	-1,582,498	-2,029,468	-2,431,652	-2,789,048	-3,101,658	-3,369,482	-3,592,519
Repayment credit	2,239,335	2,239,335	2,239,335	2,239,335	2,239,335	2,239,335	2,239,335	2,239,335	2,239,335	2,239,335
Dividend	-1,512,202	-2,793,532	-3,330,076	-3,821,833	-4,268,803	-4,670,987	-5,028,383	-5,340,993	-5,608,817	-5,831,854
Total Dividend	-42,207,480									

All numbers in Euro

Cash flow with increasing power prices

(in €)	1. Year	2. Year	3. Year	4. Year	5. Year	6. Year	7. Year	8. Year	9. Year	10. Year
Revenue	2,264,839	3,300,881	4,477,472	4,828,842	5,180,212	5,531,582	5,882,952	6,234,322	6,585,692	6,937,062
Depreciation costs	2,753,250	2,753,250	2,753,250	2,753,250	2,753,250	2,753,250	2,753,250	2,753,250	2,753,250	2,753,250
Operation & Maintenance	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000
Labour costs	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000	750,000
Financing costs	447,867	403,080	358,294	313,507	268,720	223,934	179,147	134,360	89,573	44,787
Loss carried forward	0	-1,861,278	-2,641,727	-2,200,798	-1,363,714	-130,472	0	0	0	0
Profit before tax	-1,861,278	-2,641,727	-2,200,798	-1,363,714	-130,472	1,498,926	2,025,555	2,421,712	2,817,868	3,214,025
Taxes (40%)	0	0	0	0	0	599,571	810,222	968,685	1,127,147	1,285,610
Profit after taxes	-1,861,278	-2,641,727	-2,200,798	-1,363,714	-130,472	899,356	1,215,333	1,453,027	1,690,721	1,928,415
Cash-flow (net profit + depreciation)	891,972	111,523	552,452	1,389,536	2,622,778	3,652,606	3,968,583	4,206,277	4,443,971	4,681,665
Repayment credit	2,239,335	2,239,335	2,239,335	2,239,335	2,239,335	2,239,335	2,239,335	2,239,335	2,239,335	2,239,335
Dividend	-1,347,363	-2,127,812	-1,686,883	-849,799	383,443	1,413,271	1,729,248	1,966,942	2,204,636	2,442,330
Total Dividend	4,128,013									

All numbers in Euro

Conclusion

- With only 21 competitors it is likely for us to be taken, even with higher prices
- Calculating with the current price doesn't give a profitable business model
- For a profitable company an increasing price for the operating reserves is needed
- The trend from the past years shows an increasing price for primary operating reserves
- Because of the small markets there is a good chance for high revenues

Sources

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