Technical and economical analysis of an electric vehicle including design of a charging station fed by renewable energy

Studienarbeit von Mirco Zeiss

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TECHNISCHE
UNIVERSITÄT
DARMSTADT

**Department of Electrical Engineering
and Information Technology
Electrical Energy Conversion**

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1. Gutachten: Prof. #1
2. Gutachten: Prof. #2

Tag der Einreichung:

Todo list

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Acronyms

CO_2	Carbon dioxide
NEDC	New European Driving Cycle
ROR	Run-of-the-river hydroelectricity

Nomenclature

D		Examination days
H_{SR}		Hour angle at sunrise (+) and sunset (-)
L	°	Latitude
SC	W/m^2	Solar constant
$\bar{I}_0$	kWh/m^2 per day	Average solar irradiance
δ	°	Declination of the sun
n		Day in a year

1 Equations

Equation for extraterrestrial radiation with $\bar{I}_0$, SC, n, L, δ and H_{SR}.

$$\bar{I}_0 = \frac{24}{\pi} SC \left[1 + 0,034 \cos\left(\frac{360n}{365}\right) \right] (\cos L \cos \delta \sin H_{\mathrm{SR}} + H_{\mathrm{SR}} \sin L \sin \delta) \tag{1.1}$$

Equation for average wind power.

$$\overline{P}_w = \frac{c_1}{T} \int_0^T v_w^3 \, dt \neq c_1 \left(\frac{1}{T} \int_0^T v_w \, dt \right)^3 = c_1 \cdot \overline{v}_w^3. \tag{1.2}$$

2 Acronyms

Use package glossaries.

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3 Citations

This could be a sentence from a book.[9]

4 Page numbering

The template consists of four parts.

The first part includes the title and second page and doesn't have any page numbers.

The second part consists of the table of contents, list of figures, list of tables, acronyms and symbols. It has roman page numbers and starts at **I**.

The third part contains the main content. It has arabic page numbers and starts at **1**.

The fourth and last part includes the bibliography. It has roman page numbers and continues the counting from part two.

The title and second page don't have any page numbers. It is therefore important to start with the roman page numbering below the command **makethesistitle**. Otherwise LATEX will throw warnings like

```
pdfTeX warning (ext4):
destination with the same identifier (name{page.}) has been already used,
duplicate ignored
```

5 Table

Table 5.1 shows a simple example with footnotes.

Table 5.1: Economic situation in Austria [8, 10]

Year	Inflation rate in %[1]	Price trend[2]
2000	2,3	125,7
2001	2,7	129,1
2002	1,8	131,5
2003	1,3	133,2
2004	2,1	136,0
2005	2,3	139,1
2006	1,5	141,2
2007	2,2	144,3
2008	3,2	148,9
2009	0,5	149,6
2010	1,9	152,4
2011[3]	2,1	155,6
2012[3]	1,8	158,4

[1] Consumer price index
[2] Index 1990 = 100
[3] Forecast value

Table 5.2 shows a more complex example

Table 5.2: Technical data of the Mitsubishi i-MiEV [6]

Description	Specification	Value
Dimensions	Length	3475 mm
	Width	1475 mm
	Height	1610 mm
	Wheel base	2550 mm
Load capacity	Luggage space	227 / 860 liters
	Curb weight	1110 kg
	Permissible maximum weight	1450 kg
	Payload	340 kg
	Seats	4 People
Driving characteristics	Energy consumption	135 Wh/km
	Range	150 km[1]
	max. Velocity	130 km/h
Battery data	Nominal voltage	330 V
	Electric charge	50 Ah
	Theoret. energy	16500 Wh
	Mass	165 kg
	Energy density	100 Wh/kg
Motor data	Typ	Permanent Synchronous Motor
	Nominal power	35 kW
	max. Torque	180 Nm

[1] Data measured in NEDC

6 To-do notes

Very useful while writing the thesis. Don't forget to delete them before printing the final copy.

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Something else to do

7 Images

Figure 7.1 shows two pictures side by side with one caption.

Figure 7.1: The Mitsubishi i-MiEV [5]

8 Bar charts

This chapter shows how to render a simple bar chart, a stacked bar chart and a grouped bar chart.

8.1 Simple bar chart
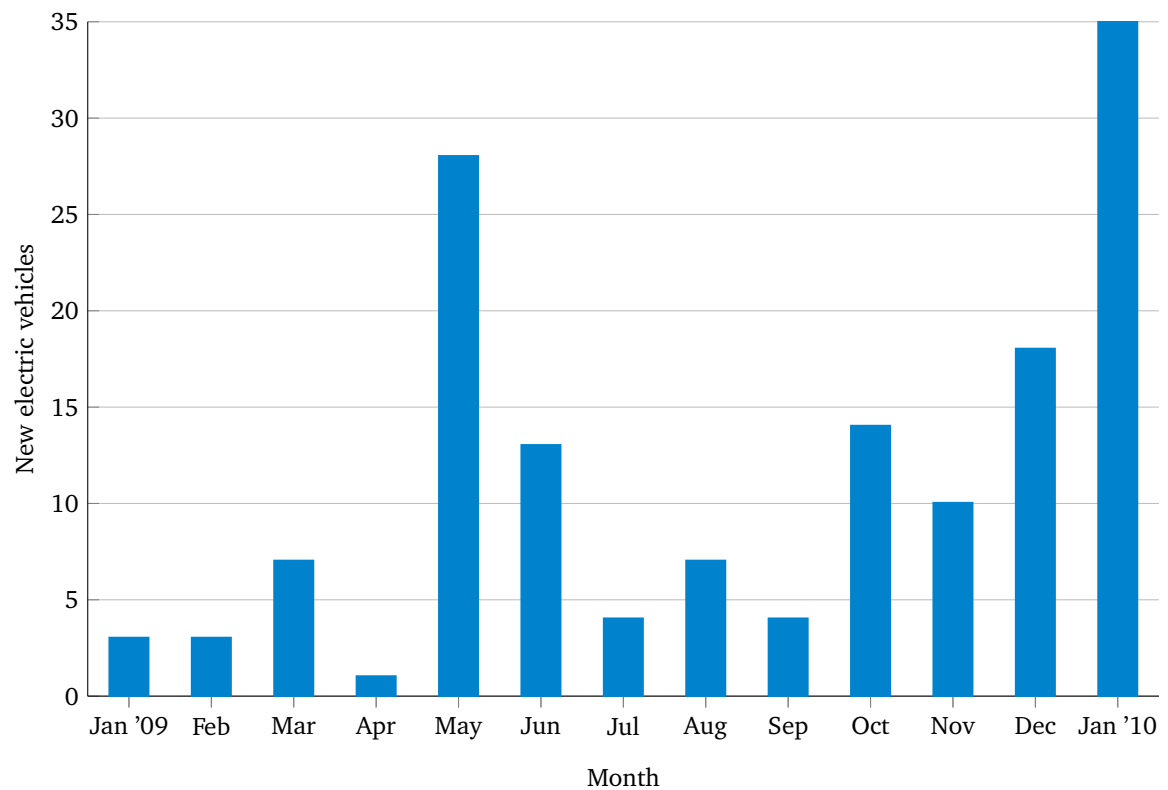
Figure 8.1 shows a simple bar chart.

Figure 8.1: New electric vehicles between Januar 2010 and Januar 2011 [7]

8.2 Stacked bar chart

Figure 8.2 shows a stacked bar chart. Data from Energy Control Austria. Chart shows energy production from Run-of-the-river hydroelectricity (ROR), Storage power plant, Thermal power station and Renewable energy.
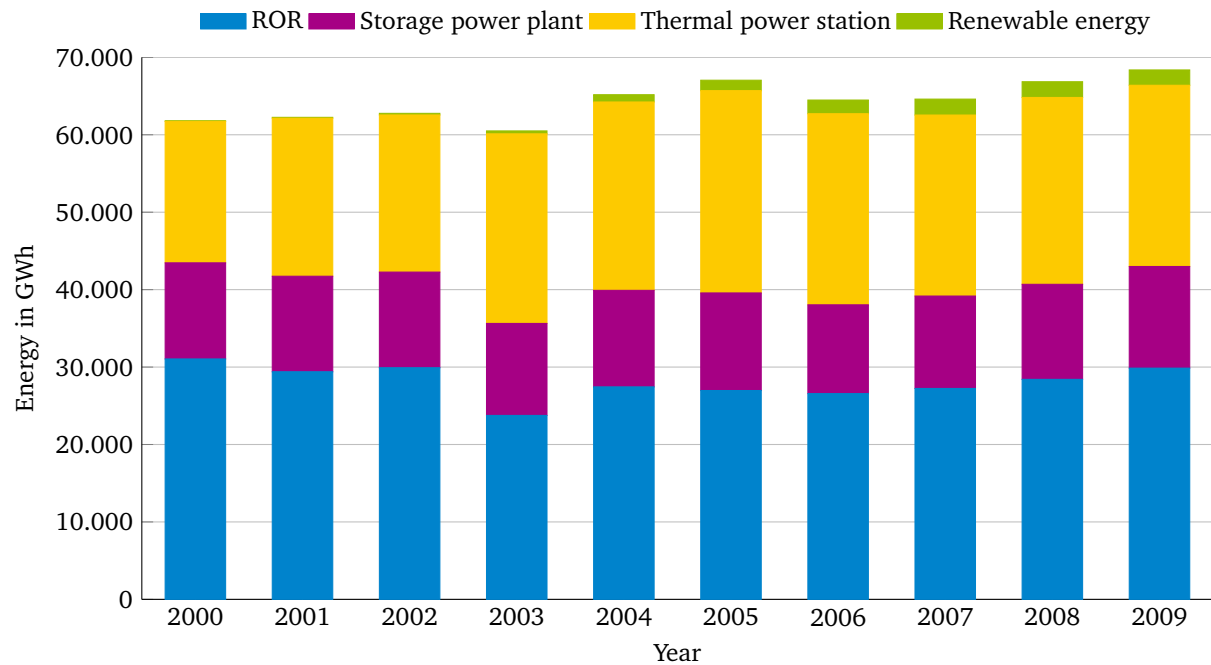
Figure 8.2: Energy production in Austria [2]

8.3 Grouped bar chart

Figure 8.3 shows a grouped bar chart. some ref to co2 CO_2. Taken from Systemmodell zur Optimierung der Integration von Windenergieanlagen in Österreich und Deutschland page 126
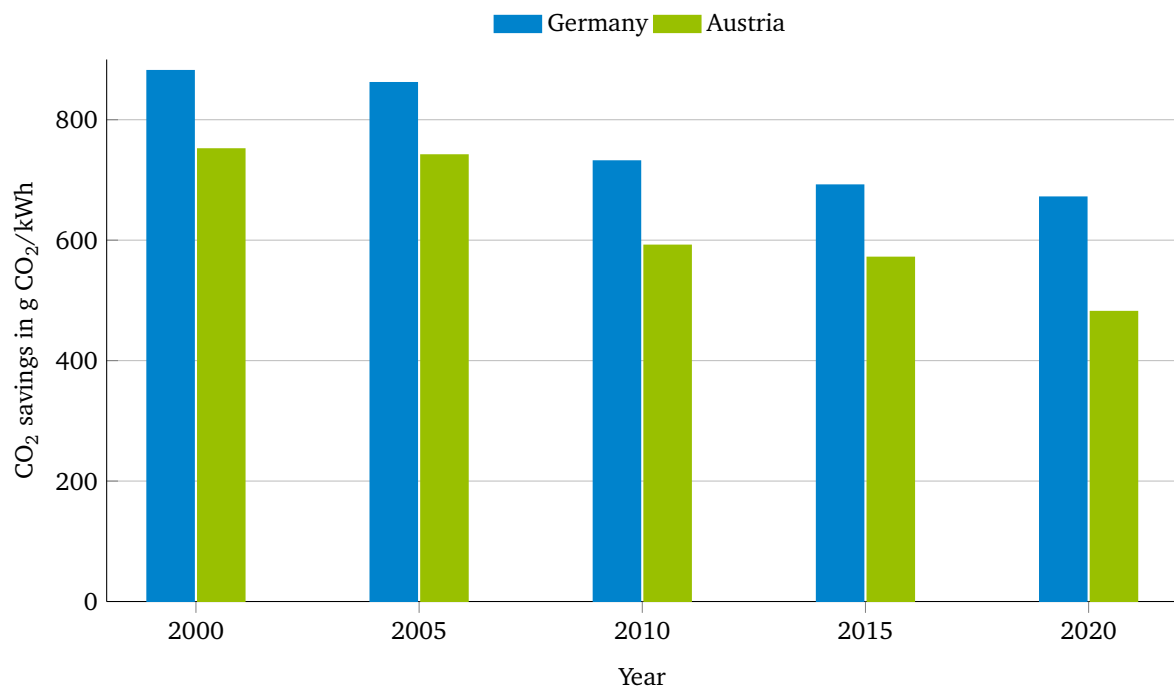
Figure 8.3: CO_2 savings from wind turbines in Germany and Austria [1]

Figure 9.1 shows a pie chart.
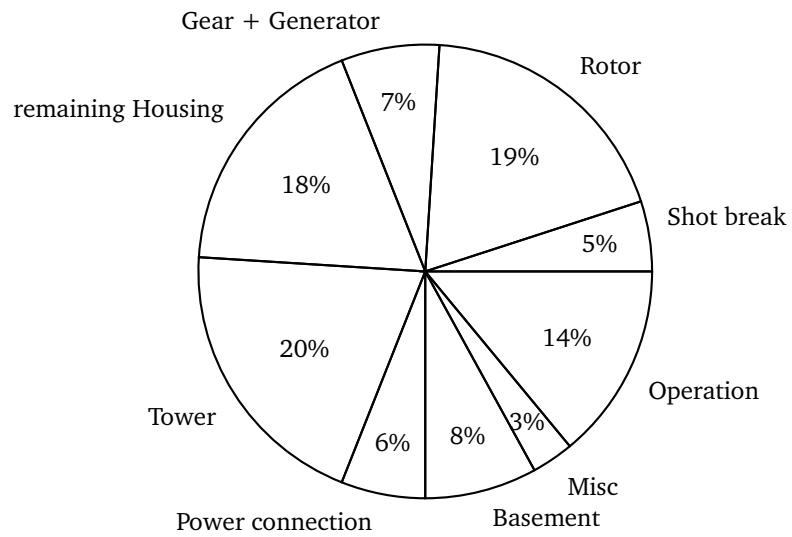
Figure 9.1: Break down of the CO_2 emissions of a wind turbine [3]
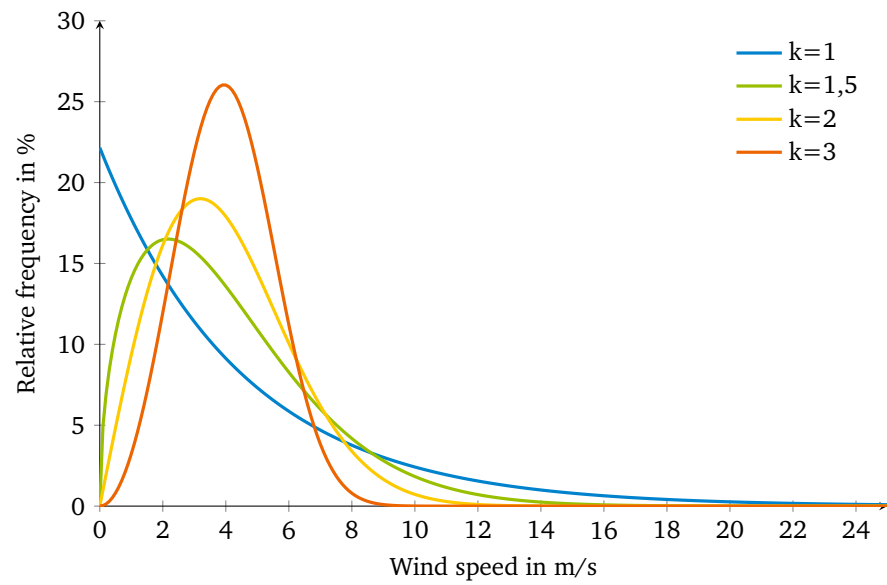
Figure 10.1 shows a line graph.

Figure 10.1: Weibull distribution with varying scaling factor $\bar{v}_\mathrm{w} = 4\,\mathrm{m/s}$, scaling factor $A = 4{,}51\,\mathrm{m/s}$ and varying form parameter k

11 Two y-axes

One on the left and one on the right side.

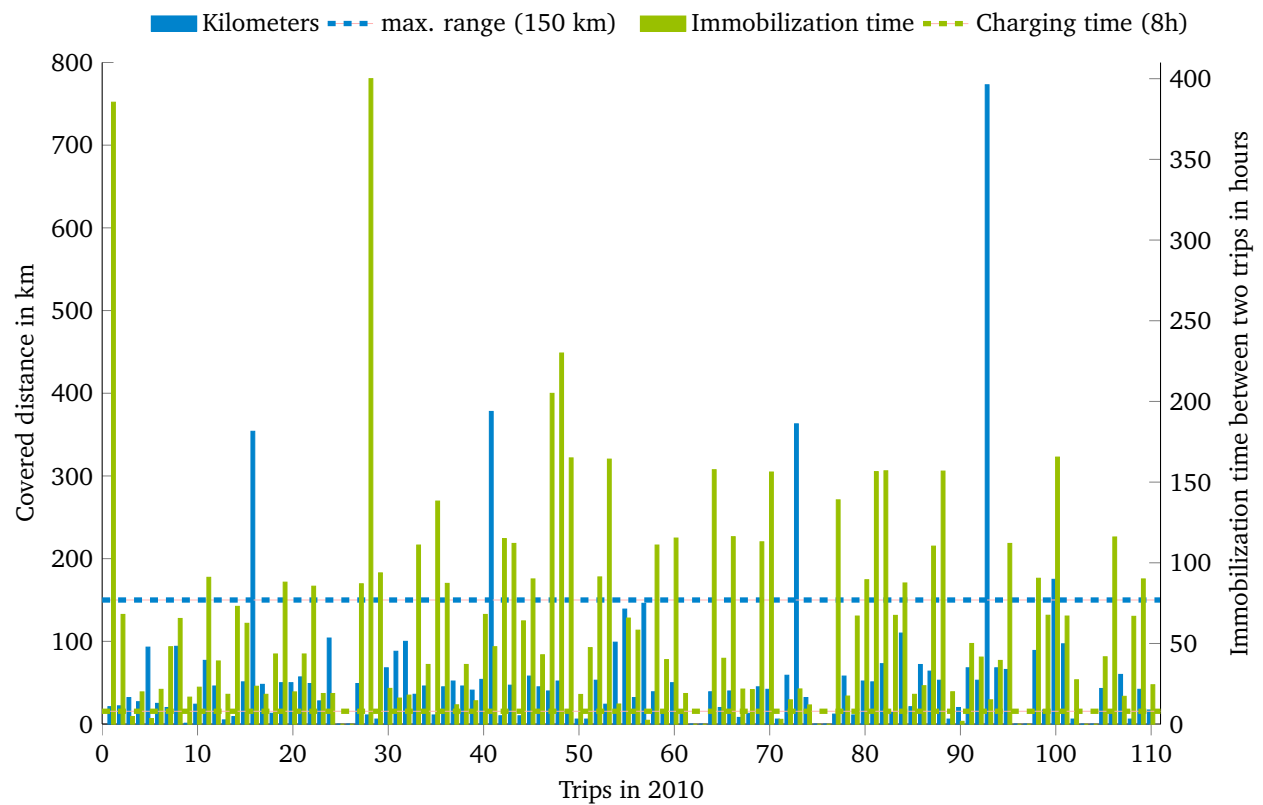**Figure 11.1:** Covered distance per trip and immobilization time between two trips of my awesome electric vehicle in 2010

When using psfrag it is important to use **latex** and not **pdflatex** for rendering.

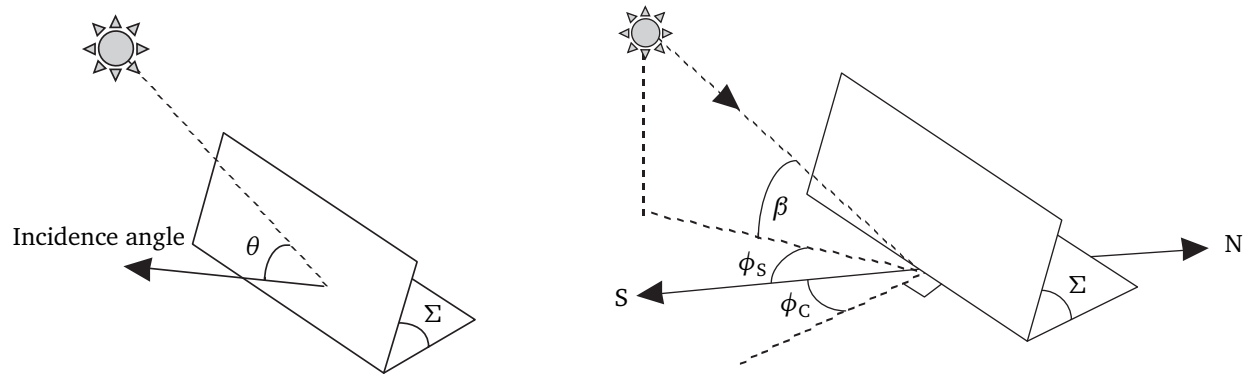**Figure 12.1:** Geometric conditions between solar irradiation and alignment of the photovoltaic panel [4]

Use the **tikz** package to draw electronic circuits and more.
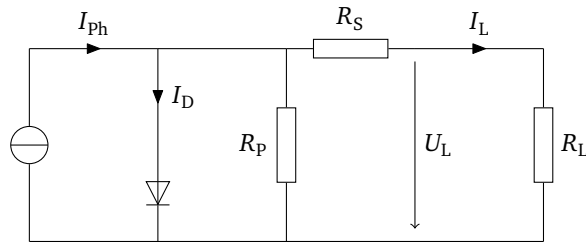

Figure 13.1: One diode equivalent circuit of a real solar cell [9]

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[1]   Auer, H. et al.: Systemmodell zur Optimierung der Integration von Windenergieanlagen in Österreich und Deutschland. Tech. rep. Bundesministerium für Verkehr, Innovation und Technologie, 2006.

[2]   Energie-Control GmbH: Betriebsstatistik - Jahresreihen. URL: http://www.e-control.at/de/statistik/strom/betriebsstatistik/jahresreihen (visited on 02/25/2011).

[3]   Kaltschmitt, M.; Streicher, W.; Wiese, A.: Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Berlin: Springer Verlag, 2006.

[4]   Masters, G. M.: Renewable and Efficient Electric Power Systems. Wiley-Interscience Verlag, 2004.

[5]   Mitsubishi Motors Deutschland: Mitsubishi i-MiEV betritt die europäische Bühne. URL: http://presse.mitsubishi-motors.de/press.php?id=201008310 (visited on 12/07/2010).

[6]   Mitsubishi Motors Deutschland: Technische Daten Mitsubishi i-MiEV. URL: http://www.imiev.de/docs/iMiEV-daten.pdf (visited on 03/15/2011).

[7]   Statistik Austria: Kraftfahrzeuge Neuzulassungen. URL: http://www.statistik.at/web_de/statistiken/verkehr/strasse/kraftfahrzeuge_-_neuzulassungen/index.html (visited on 03/07/2011).

[8]   Statistik Austria: Verbraucherpreisindizes im Überblick. URL: http://www.statistik.at/web_de/statistiken/preise/verbraucherpreisindex_vpi_hvpi/zeitreihen_und_verkettungen/index.html (visited on 03/02/2011).

[9]   Wagner, A.: Photovoltaik Engineering: Handbuch für Planung, Entwicklung und Anwendung. Heidelberg: Springer Verlag, 2010.

[10]   Wirtschaftskammer Österreich: Wirtschaftslage und Prognose. URL: http://www.wko.at/statistik/prognose/inflation.pdf (visited on 03/02/2011).