



# The Rheinfelden IEEE Milestone Dedication Day 25 September 2014

A report presented by Gerhard Neidhöfer, IEEE Life Fellow



## IEEE Milestone

# Rheinfelden Hydroelectric Power Plant, 1898–2010

Dedication on Thursday, 25 September 2014



10.00 am **Welcome and refreshments**

10.30 am **Welcoming speeches**

*Dr. Martin Steiger*, CEO of Energiedienst Holding AG

*Dr. J. Roberto de Marca*, President and CEO of IEEE

*Prof. Dr. Istvan Erlich*, Chairman of IEEE/PES Germany

### **Keynote speeches**

*Prof. Dr. Gerhard Neidhöfer*, Laudation "Rheinfelden Hydroelectric Power Plant"

*Klaus Eberhardt*, Mayor of the German city of Rheinfelden

*Franco Mazzi*, Mayor of the Swiss city of Rheinfelden

### **Awards**

Best Diploma Award „Werner von Siemens“ for *Constanze Troitzsch*

2015 IEEE Herman Halperin Electric Transmission & Distribution Award for *Prof. Dr. Wolfram Boeck*

### **Unveiling the Rheinfelden Milestone Plaque**

at noon **Stand-up lunch**

1.00 pm **Tour and inspection**

- **Exhibition Pavilion "Kraftwerk 1898"**
- **New Rheinfelden Hydroelectric Power Plant**

2.00 pm Change of tour groups

4.00 pm **Get-together and closing refreshments**

# Reception and Welcome coffee



# Welcome address

Dr. Martin Steiger CEO Energiedienst Holding



**Roberto de Marca**  
IEEE President and CEO

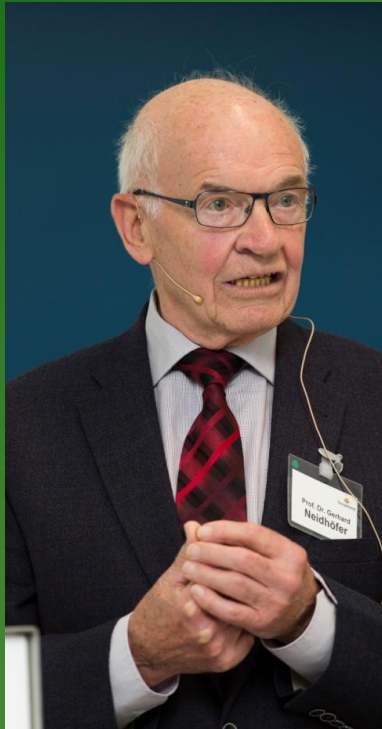


**Istvan Erlich**  
IEEE/PES Germany Chairman



## Welcome addresses





# The Rheinfelden Laudation

Gerhard Neidhöfer  
IEEE Life Fellow



# The RHEINFELDEN LAUDATION

## 25 September 2014

Picture 2009

**Technical and historical significance of  
the original Rheinfelden hydropower plant**

Gerhard Neidhöfer, IEEE Life Fellow

Professor Technical University Darmstadt Germany

Consultant Alstom Power Switzerland

The original Rheinfelden hydroelectric power plant symbolizes:  
1) Early large-scale generation of hydroelectric power in Europe

Selected projects  
prior to Rheinfelden ↓

Picture 1900

Lauffen/Neckar 1891  
Germany 600 HP



*Key player in the long-  
distance transmission to  
the International  
Electrical Exhibition in  
Frankfurt/Main 1891*



# Early large-scale generation of hydroelectric power in Europe

Selected projects  
prior to Rheinfelden ↘

Picture 1900

Niagara Falls 1895  
North America 15,000 (!) HP

3000 HP

600 HP

*Sensation:  
"First super station  
in the world"*

# Early large-scale generation of hydroelectric power in Europe

Sensation

in Europe →

Picture 1900



15,000 HP

Rheinfelden

1898

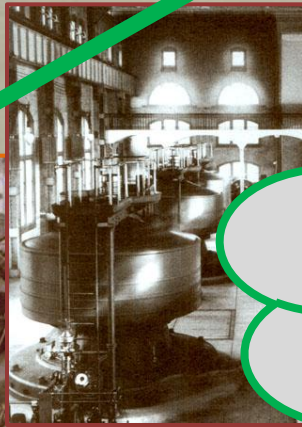
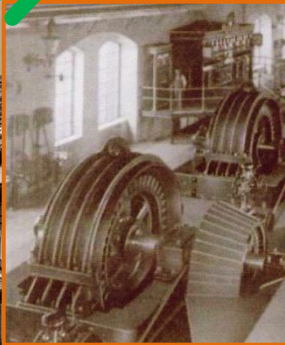
Germany/Switzerland

17,000 (!) HP



3000 HP

600 HP



Rheinfelden:

The top achievement in Europe  
- in both size and output

## The original Rheinfelden hydroelectric power plant symbolizes:

### 2) Promotion of the three-phase alternating current system

*Situation: When the Rheinfelden power plant was being planned, the question of current system was completely open.*

**“Battle of the current systems” during the 1890s:**

**1) Direct current DC** (Edison)

Deployment range below 1 km

**versus**

**alternating current AC !**

For larger supply areas and longer transmission distances

(Westinghouse)

**2) Single-phase**

Sufficient for electric lighting

**or**

**polyphase AC ?**

Essential for self-starting motors

**3) Two-phase**

Decisive factor:

**or**

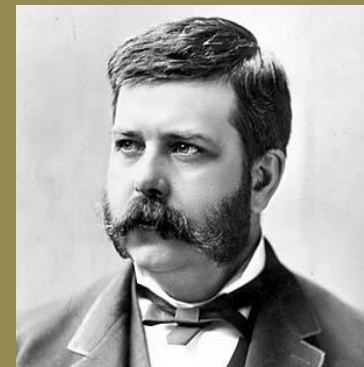
**three-phase AC ?**

Number of wires for

connection and transmission

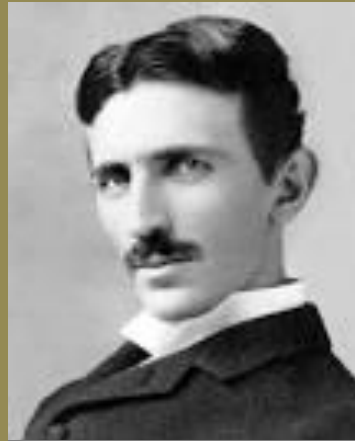


Thomas A. Edison



George Westinghouse

# Promotion of the three-phase alternating current system



Nikola Tesla

## Two-phase AC

Favorite of Tesla  
e. g. Niagara Falls

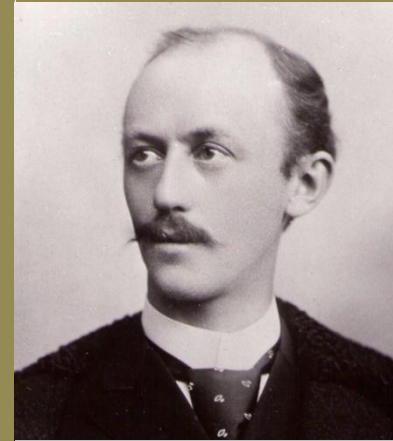
Needs 4(3) wires

## Three-phase AC

“would need 6 wires” ?

The interlinked three-phase AC  
Favorite of Dolivo-Dobrowolsky

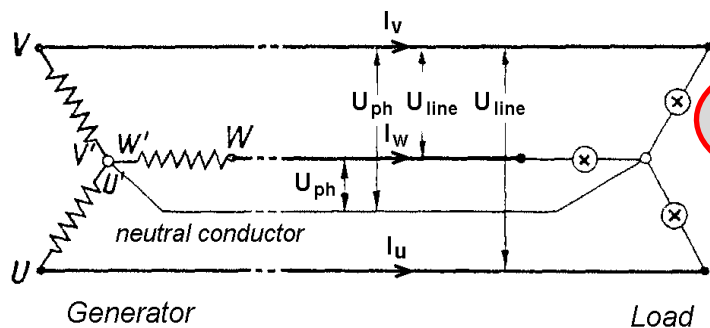
- Requires no return conductors
- Needs 3 wires only !



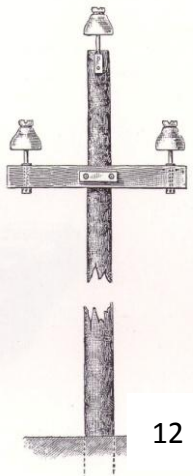
M. Dolivo-Dobrowolsky

**Challenge for Rheinfelden:** Find a multi-purpose current system !

**The decision of AEG:** “The advantages of the interlinked three-phase ac ... were in their totality decisive for applying this current system ...”



**Rheinfelden:**  
**Flagship station for three-phase ac which, later, was adopted around the world**



## The original Rheinfelden hydroelectric power plant symbolizes:

### 3) Implementation of 50 Hertz as a general-purpose frequency

*Situation: When the Rheinfelden power plant was being planned, widely different cycle numbers were in use.*

#### *“Battle of the frequencies”:*

- **133 $\frac{1}{3}$  125 83 $\frac{1}{3}$  70 Hz** *Best for electric lighting & distribution*
    - 66 $\frac{2}{3}$  65 60 50 Hz
    - 45 $\frac{1}{3}$  42 41 $\frac{2}{3}$  40 Hz
  - **40 30 25 16 $\frac{2}{3}$  Hz** *Best for power generation & transmission*
- First ac generator 1886 (Westinghouse)
- Hochfelden 1892 (MFO)
- Frankfurt/Main 1894 (BBC)
- Lauffen/Neckar 1891 (MFO)
- Niagara Falls 1895 (Tesla, Westinghouse)

**Challenge in the case of Rheinfelden:**

*Break away from the jungle of cycles !*

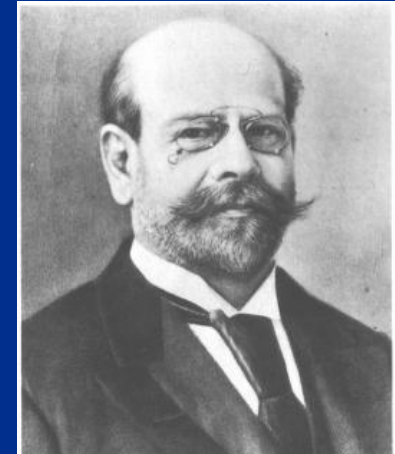
*Find the best frequency value !*

## Implementation of 50 Hertz as a general-purpose frequency

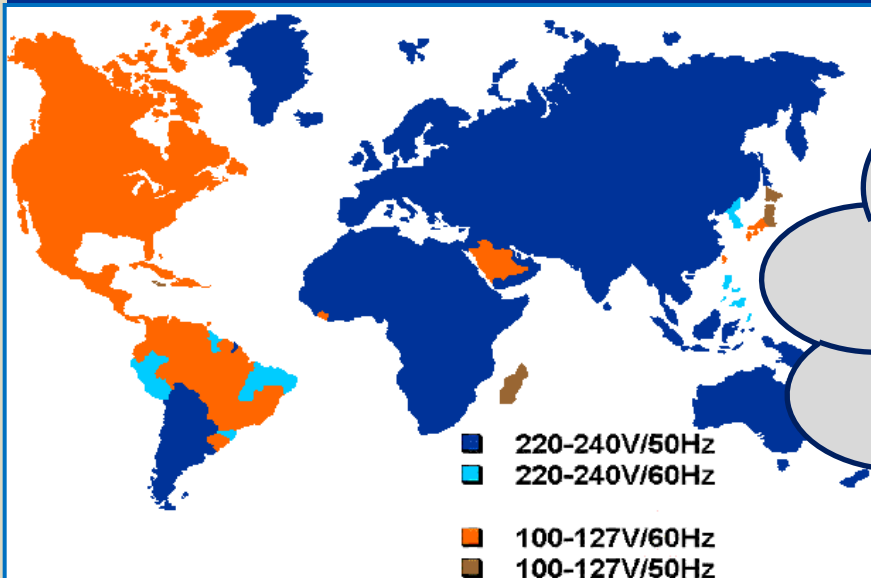
Emil Rathenau, general manager of the company  
Allgemeine Elektrizitäts Gesellschaft AEG in Berlin  
and director of the Rheinfelden Preparation Company, in 1896:

*“... After thorough investigations  
we decided for 50 periods per second.”*

*“... For the operation of transformers, motors and  
electric light bulbs this alternation number appears to be the best suitable ... .”*



Emil Rathenau



**Rheinfelden:**  
**Promoter of 50-Hz frequency**  
**which became the standard**  
**in most countries**

# The original Rheinfelden hydroelectric power plant symbolizes:

## 4) Joint operation with other power stations

*Rheinfelden entered into joint operation with*

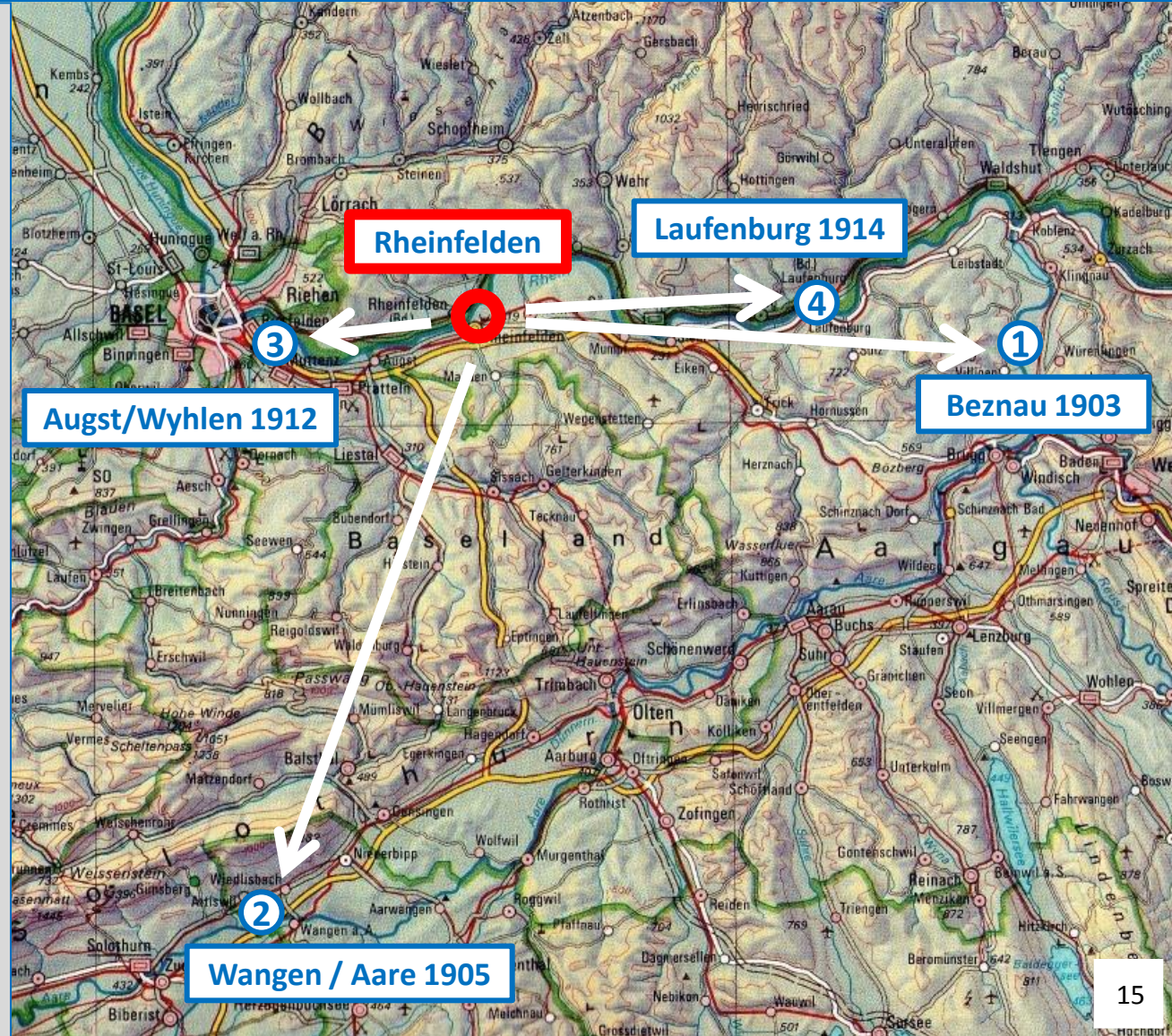
- 1) Beznau in 1903 (transborder power exchange!)*
- 2) Wangen / Aare 1905*
- 3) Augst / Wyhlen 1912*
- 4) Laufenburg 1914*

*and gradually with other plants, e.g.:*

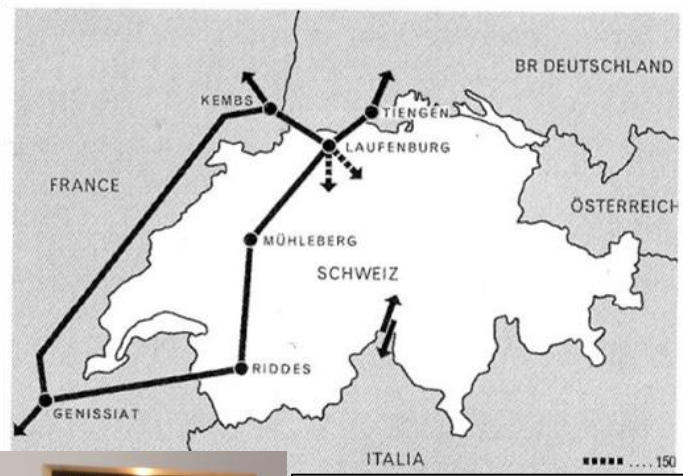
- 1) Beznau 1903*
- 2) Wangen / Aare 1905*
- 3) Augst / Wyhlen 1912*
- 4) Laufenburg 1914*

...

...



## Joint operation with other power stations ...



*In 1958  
the French,  
German  
and Swiss  
220-kV  
networks  
were  
interconnected*



**IEEE Milestone 2010:  
Star of Laufenburg  
Interconnection, 1958**



*... Rheinfelden:  
Nucleus of the  
continental European  
interconnected network*





The Rheinfelden power plant scenery in 2008

New power plant  
for operation from 2010

Original power plant  
operated 1898–2010

# The Rheinfelden power plant scenery in 2014

New power plant  
in operation since 2010



← ↑  
Fish ascent and  
spawning waters

↑  
Exhibition pavilion and  
Milestone plaque site



## Photo credits

- Foil 1 Henri Leuzinger Rheinfelden
- Foil 2,3,4 Deutsches Technikmuseum Berlin DTMB, AEG-Archiv: Rheinfelden (background) Archives ABB Switzerland : Lauffen Archives Siemens Switzerland: Wynau DTMB: Rheinfelden
- Foil 11, 12 Energiedienst Holding AG Rheinfelden

## the Milestone Community again



## The Rheinfelden mayors



**K. Eberhardt (D) F. Mazzi (CH)**

## Other speakers



**A. Richter**  
Chair IEEE  
Germany



**K.-P. Brand**  
IEEE/PES  
Switzerland



**W. Fischer**  
IEEE/PES  
Germany

## Award recipients

**IEEE  
Herman Halperin  
Electric T & D  
Award 2015  
for  
Wolfram Boeck**



**Best  
Diploma Award  
“Werner  
von Siemens”  
2014 by IEEE  
for  
Constanze Troitsch**



# The highlight: Unveiling the Milestone Plaque



# IEEE MILESTONE IN ELECTRICAL ENGINEERING AND COMPUTING

## Rheinfelden Hydroelectric Power Plant, 1898–2010

The original Rheinfelden plant was an outstanding achievement in Europe's early large-scale generation of hydroelectric power. It was important for its 17,000 horsepower (12,500 kilowatt) output, for pioneering three-phase alternating current later adopted around the world, and using 50-Hertz frequency which afterwards became standard in most countries. Gradually, Rheinfelden entered into joint operation with other stations, from which the interconnected network of continental Europe evolved.

September 2014



# Visiting the new Power Plant

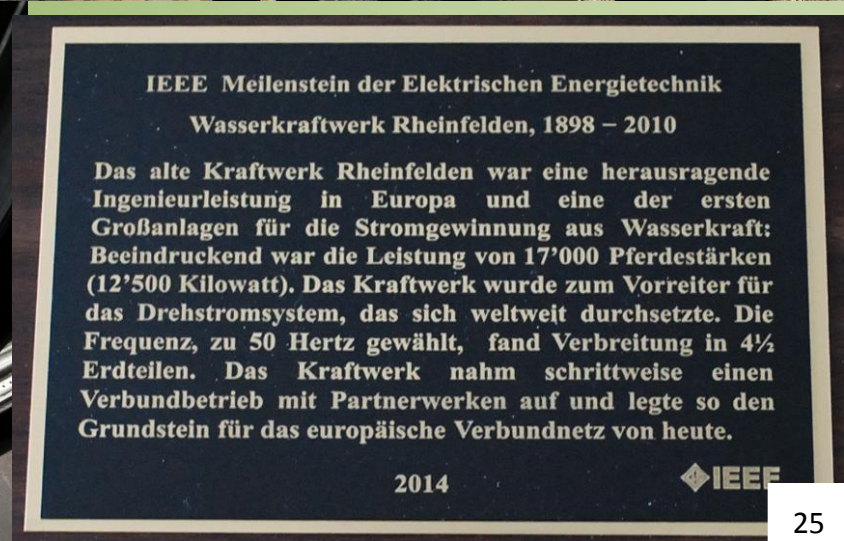


# Visiting the Exhibition pavilion "Kraftwerk 1898" ...





.... and the  
(German language) Milestone plaque





↙ Pavilion  
Dolivo Platform ↘

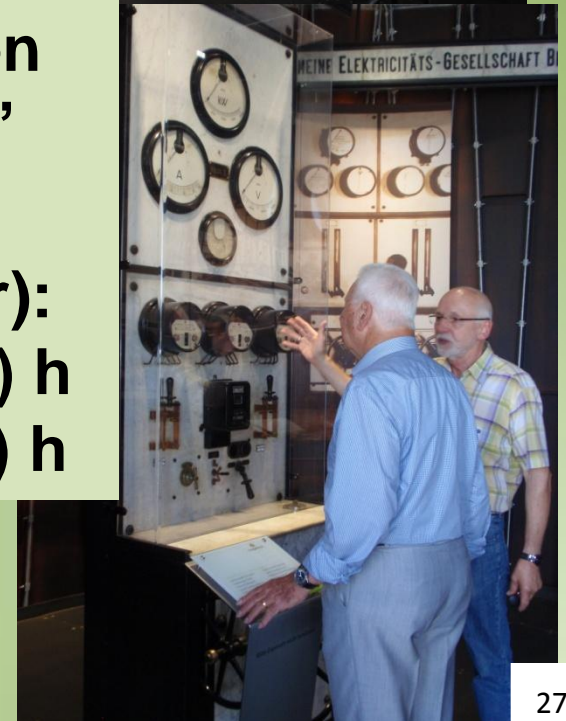
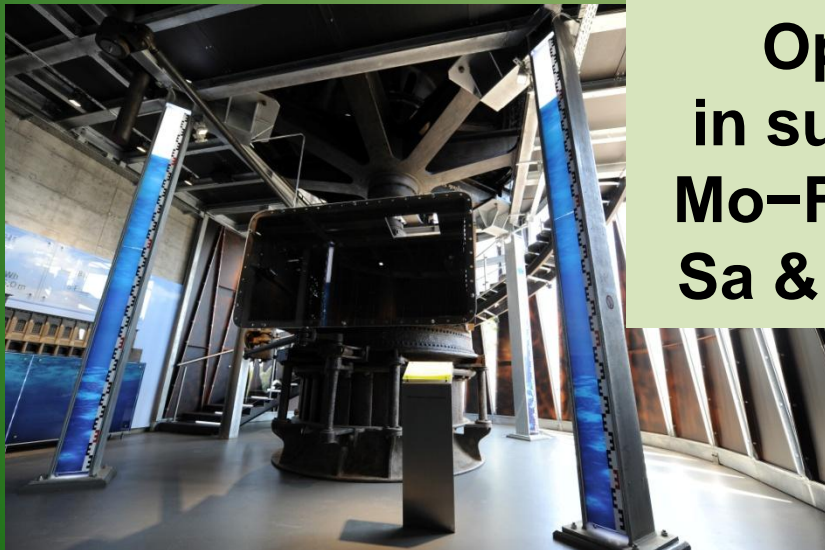


Invitation to visit the  
Exhibition Pavilion  
“Kraftwerk 1898”



## Exhibition Pavilion "Kraftwerk 1898"

Opening hours  
in summer (winter):  
Mo-Fr 14-18 (16) h  
Sa & Su 11-18 (16) h



IEEE MILESTONE IN ELECTRICAL ENGINEERING  
AND COMPUTING

Rheinfelden Hydroelectric Power Plant, 1898–2010

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September 2014



- Exhibition Pavilion “Kraftwerk 1898“
- New Rheinfelden Hydroelectric Power Plant

2.00 pm Change of tour groups

4.00 pm **Get-together and closing refreshments**

ny

hydroelectric Power Plant”

*Troitzsch*

tribution Award for *Prof. Dr. Wolfram Boeck*

Thank you

for

your attention