gtz Partner for the Future. Worldwide.

IGEN Workshop on

Renovation & Modernization and Water Optimization in Thermal Power Station

(30. June 2009, New Delhi)

Water Management in Coal-fired Power Plant

— A Case Study on Water Saving at a Chinese Coal-fired Power Plant

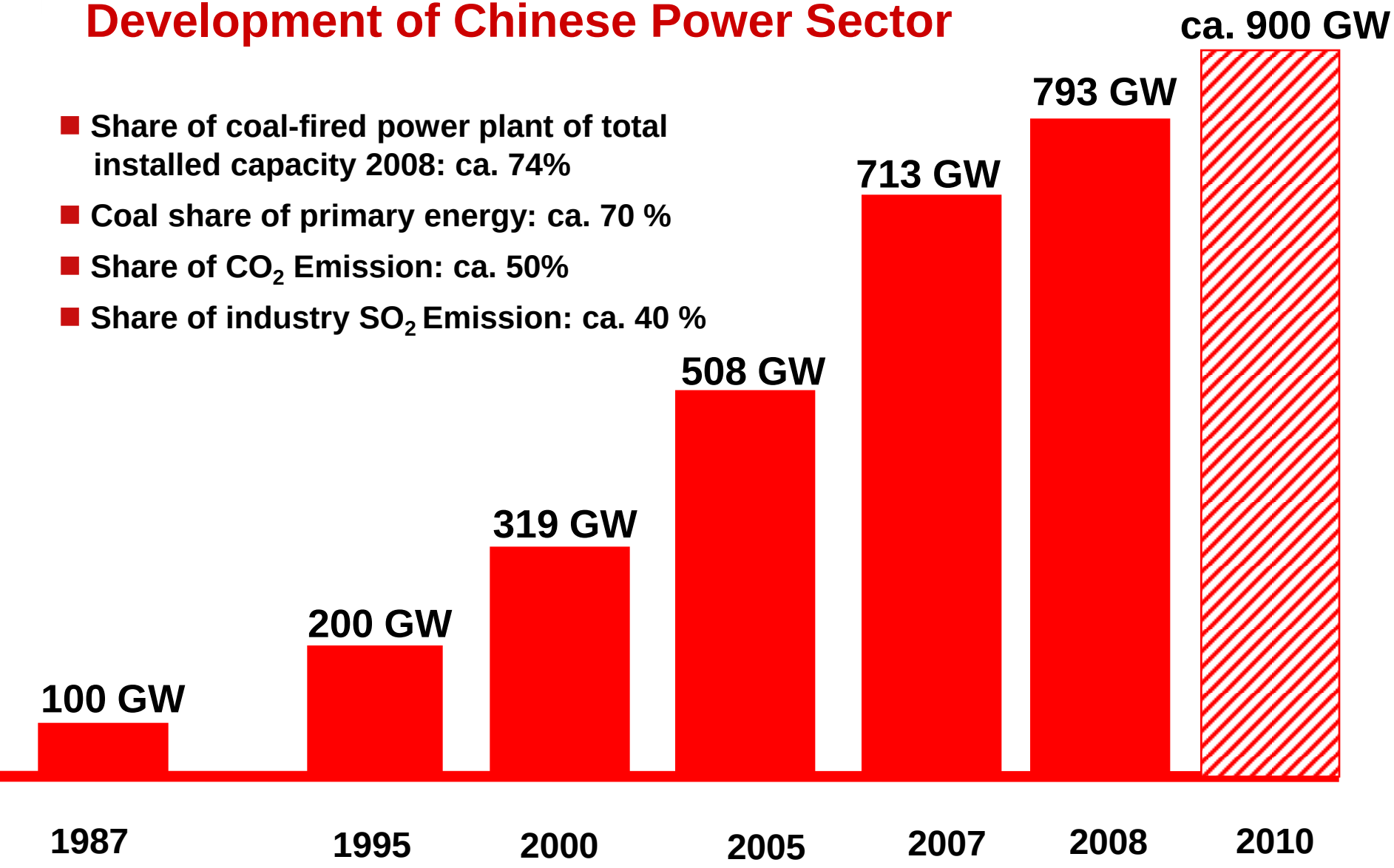
GTZ Programme

“Environmental Protection in the Energy Industry“ (EPEI)

Zhang shecan

Development of Chinese Power Sector

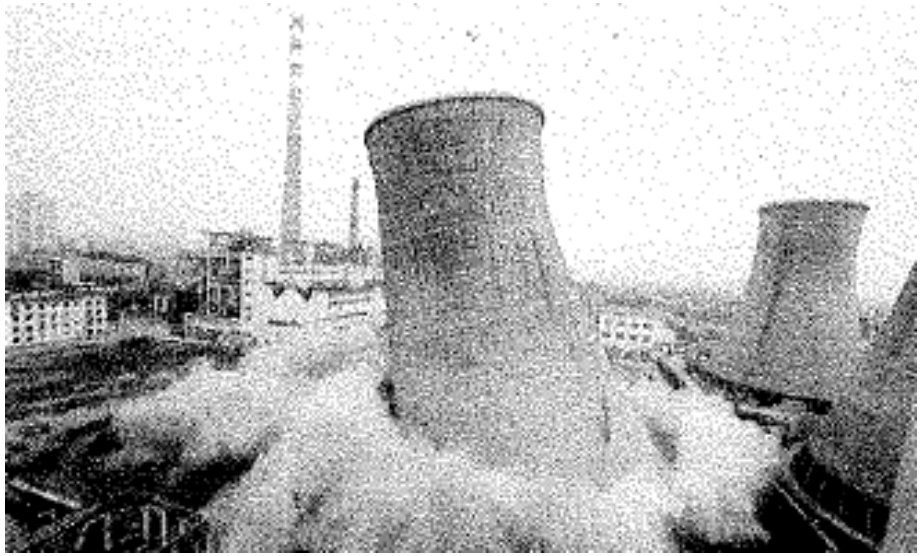
- Share of coal-fired power plant of total installed capacity 2008: ca. 74%
- Coal share of primary energy: ca. 70 %
- Share of CO_2 Emission: ca. 50%
- Share of industry SO_2 Emission: ca. 40 %



Targets of the Chinese Government (11th 5-Year Planning)

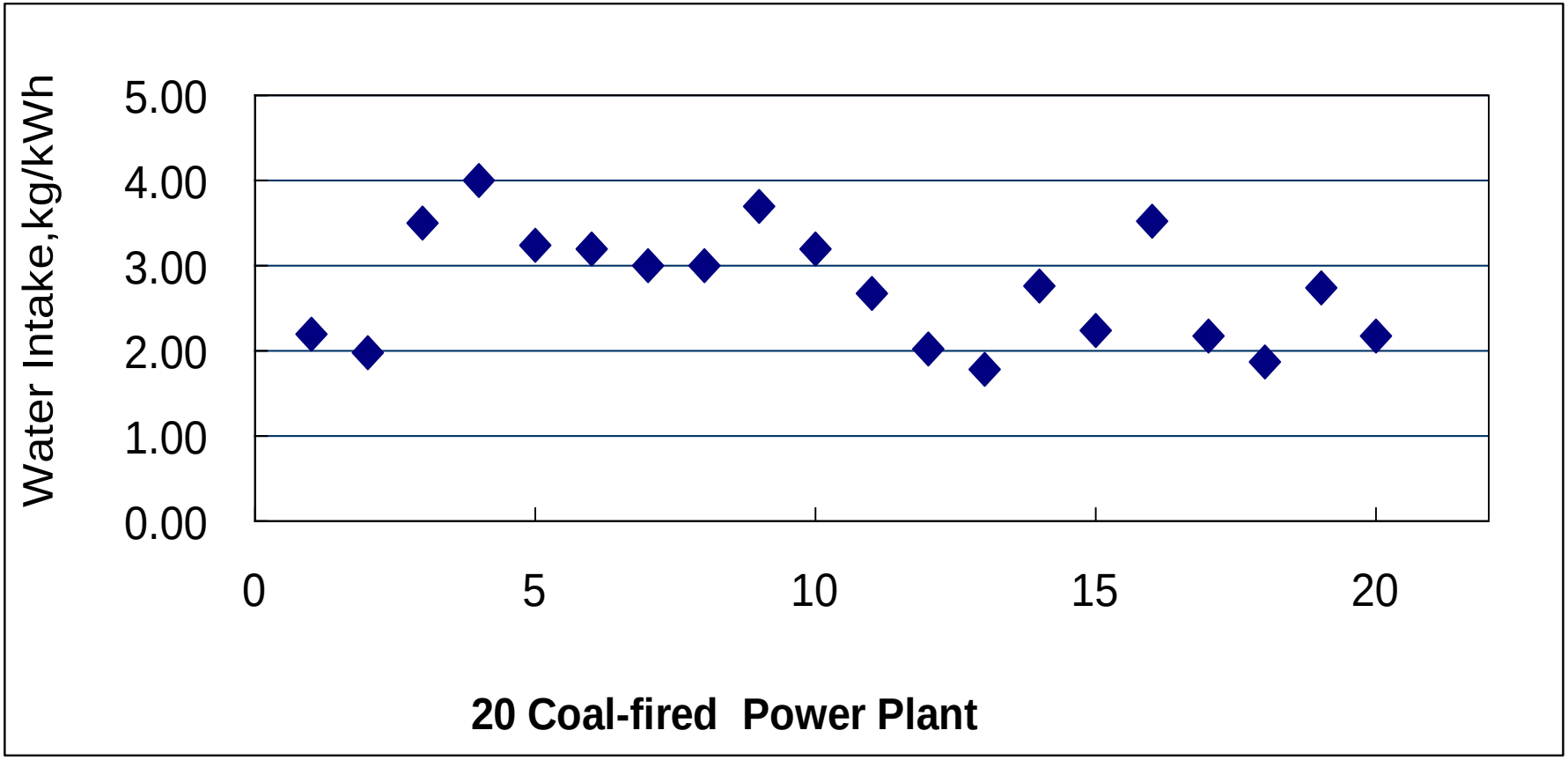
- **Increase of energy efficiency: 20 % per GDP-unit by 2010**
- **Reduction of harmful emission: 10 % by 2010**
- **Shut-down of small power units: 50 000 MW by 2010**

- **Average unit capacity in 2006: ca. 67 MWel**
- **Average capacity of new units: ca. 300- 400 MWel**
- **Shutdown of small units in last 3 years: 34210 MW (ca. 1250 units)**



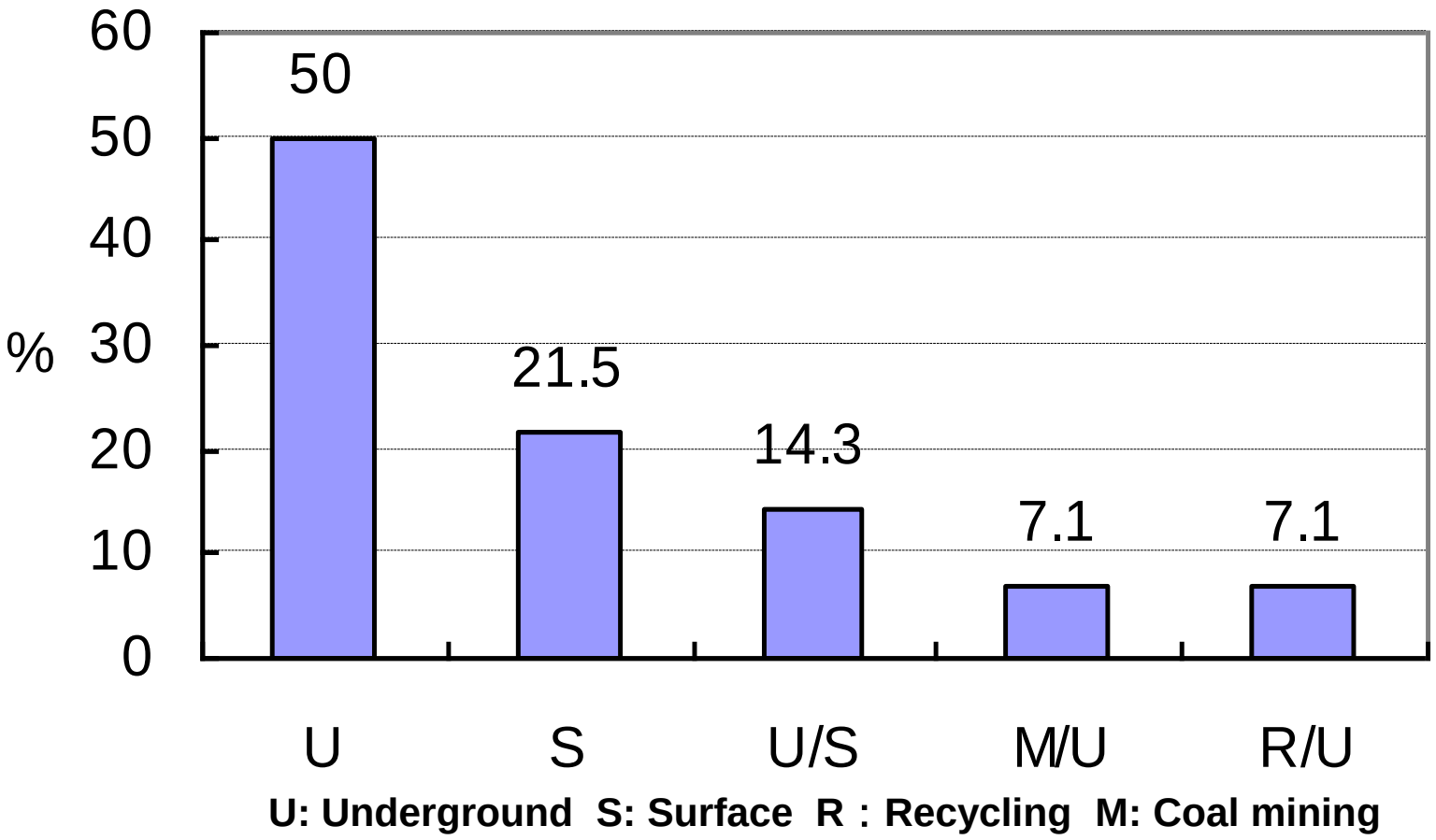
Detonation of an old unit, Source: China Power News

Specific Water Consumption of Coal-fired Power Plants (2006)



Source: TPRI

Raw Water Source in 13 Coal-fired Power Plants



Source: TPRI

Objective and Components of the EPEI-Program

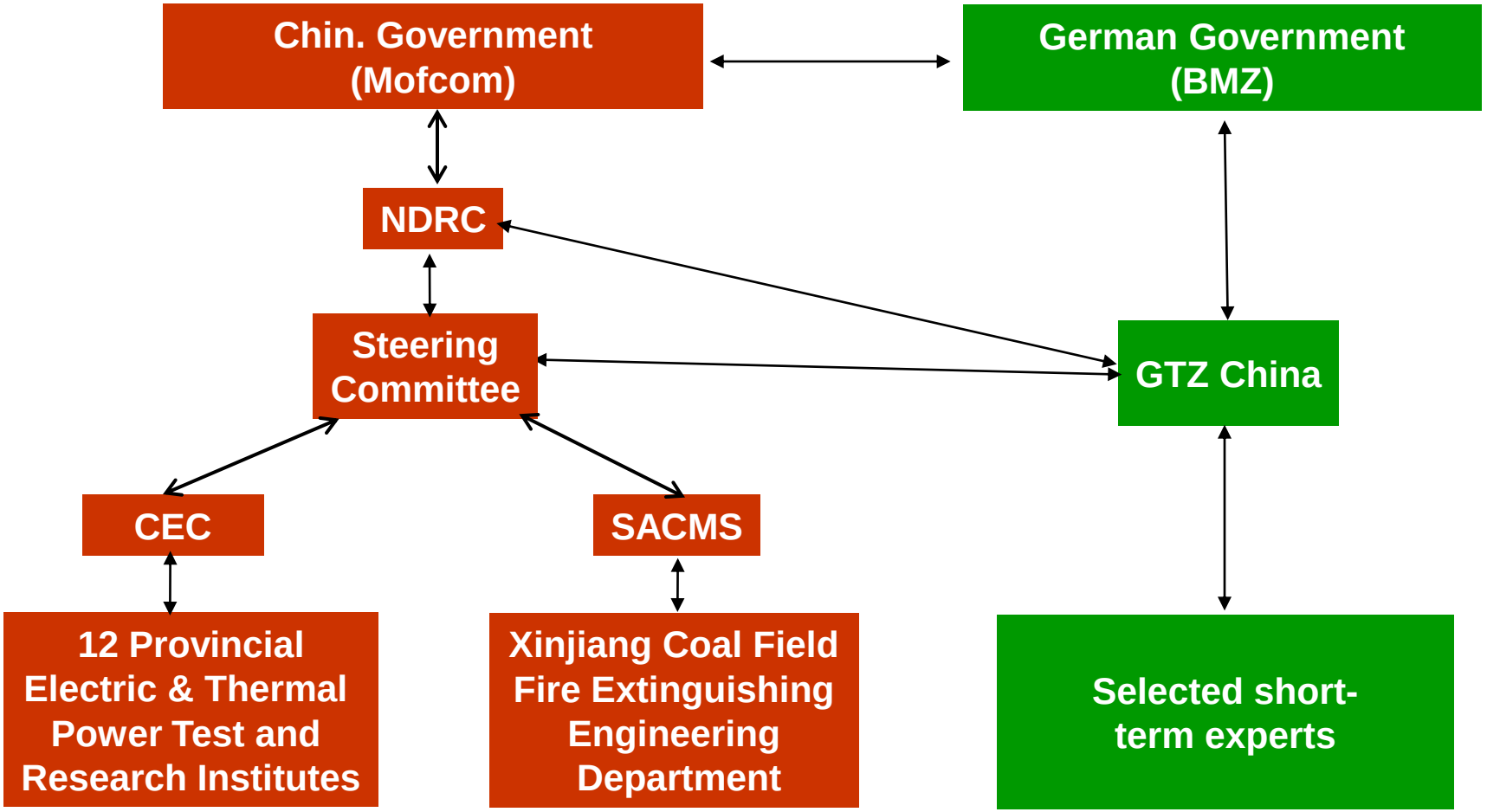
Overall Objective of Program

The environment friendly use of the resources coal and water in the examined power plants and the protection of the resource coal in its natural deposits is improved.

5 Components

- Policy advice in the field of environmental protection for the coal and power plant sectors
- Cleaner production (CP) in coal-fired power plants
- Process optimization in coal-fired power plants
- **Water management in coal-fired power plants**
- Extinguishing of coal-seam fires

Structure of the Program „Environmental Protection in the Energy Industry“



Partner Location of the EPEI-Program

Structure and Partner of Component 4

Water management in coal-fired power plants

Thermal power research institute (TPRI)

gtz

EVONIK INDUSTRIES

e·on Engineering

中国电力投资集团公司 CHINA POWER INVESTMENT CORPORATION

中国华能集团公司 CHINA HUANENG GROUP

中国大唐集团公司 China Datang Corporation

中国国电集团公司 CHINA GUODIAN CORPORATION

中国华电集团公司 CHINA HUADIAN CORPORATION

Coal-fired power plants in China

Main Working Contents of the Component 4

- **Training and consulting service**
  - Seminars in China for relevant managers & engineers
  - Study tours in Germany
  - Training in Germany for counterpart

- **Pilot project in 2 coal-fired power plants:**
  - On-site data collection and sampling
  - Compiling the water balance
  - Joint concepts and design plan
  - Supporting the implementation of pilot project
  - Investment in total: ca. 6.5 Mio. Euro
  - Potential water saving p. a.:
    - KW 1: 11,3 Mio. m^3 (2,79 auf 1,90 kg/kWh)
    - KW 2: 5,08 Mio. m3 (2,78 auf 1,90 kg/kWh)

Working Procedure Regarding Pilot Power Plants

- Joint selection of suitable coal-fired power plants
- Basic data (water balance) delivered by 2 power plants and TPRI
- Study of the water balance by the German experts (home work)
- Joint on-site survey in the pilot power plants
- Developing the concept both by TPRI and German experts
- Discussion about the concepts of both sides in China
- Fusion of 2 concepts into one joint concept
- Reporting the joint concept by the holding company (investment)
- Commitment of pilot projects through the holding company
- Joint JAR test in the pilot power plants
- Detailed design of process relevant main components through a Germen company (technical specification)
- Call of tender through the holding company
- Supporting the bid appraisal and the implementation by the German experts

Basic Data of Pilot Power Plant Dezhou

2 x 330 MW (1991)

2 x 300 MW (1994)

2 x 700 MW (2002)

∑ 2650 MW

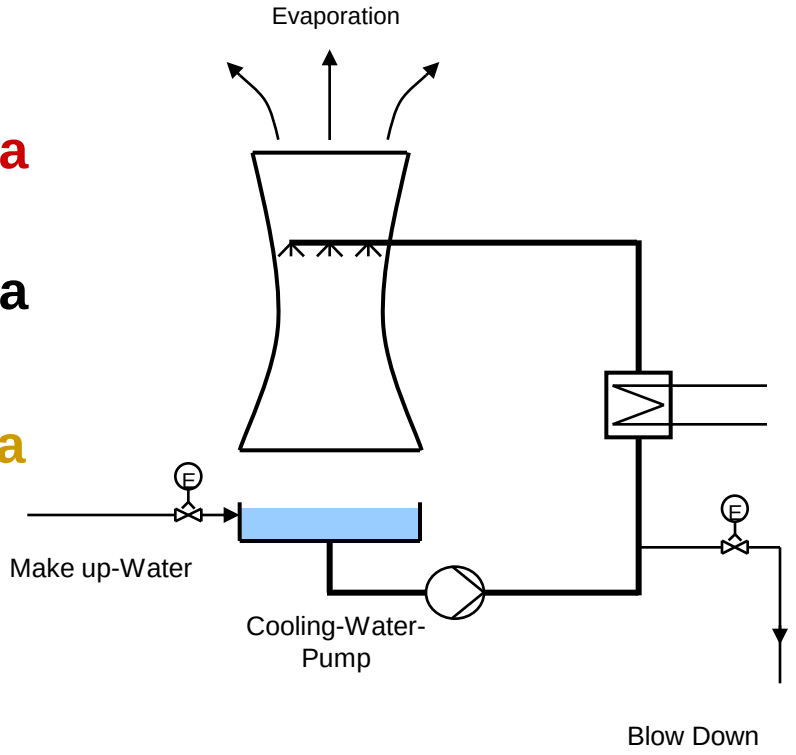
Power Production	2006	14.70	Mio. MWh
Water Consumption	2006	40.97	Mio. m^3
Specific Consumption	2006	2.79	m^3/MWh
Raw water source		Water reservoir	
Cost for raw water	2006	1.00	Yuan per m^3
Cost for waste water	2006	0.80	Yuan per m^3

Basic Data of Pilot Power Plant Dezhou

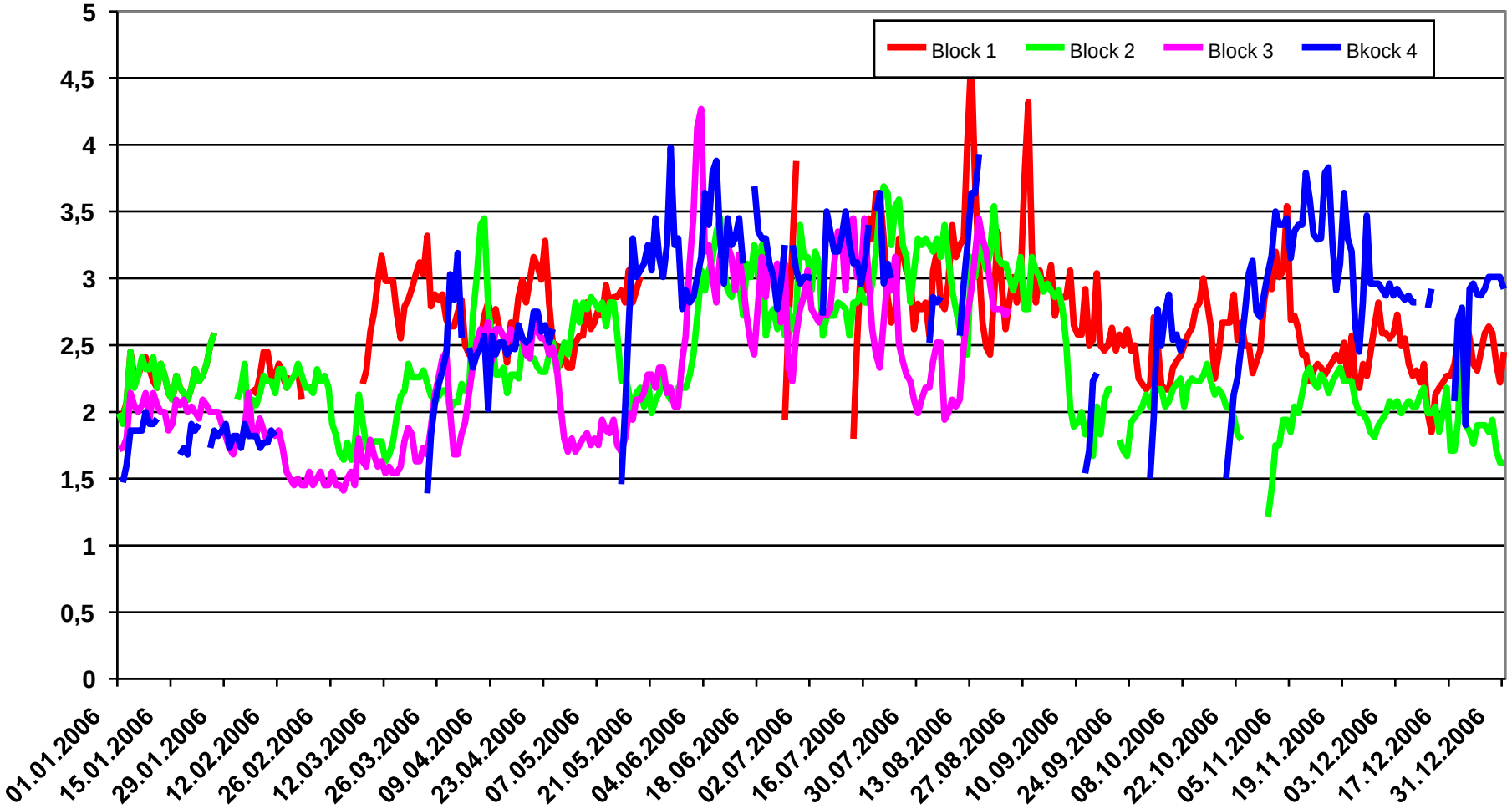
The cooling circuit is the biggest water consumer of the power plant

Amounts of units 1-6, 2006

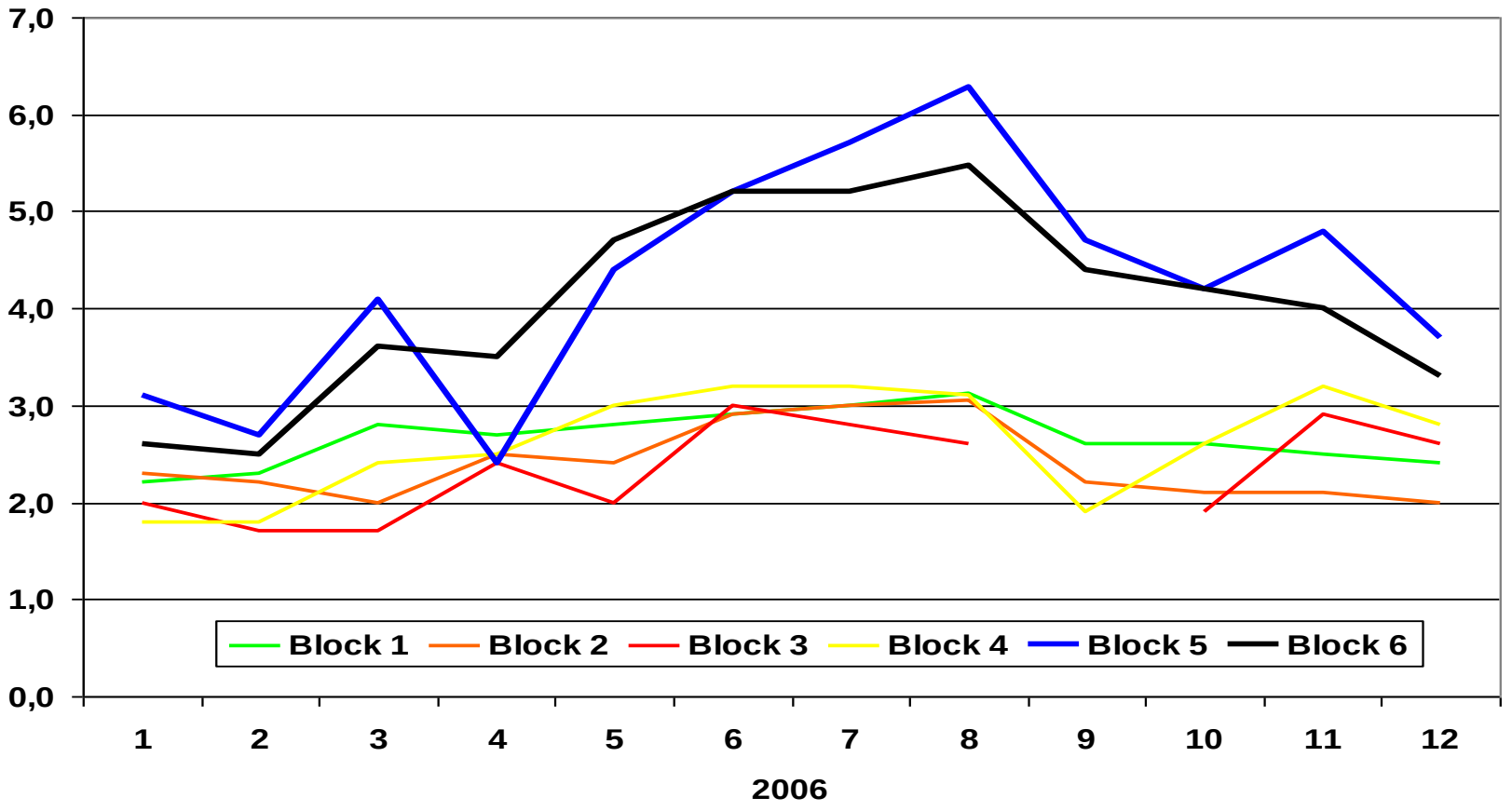
1. **Make up water** **34.5 Mio m³/a**
2. **Evaporation** **23.2 Mio m³/a**
3. **Blowdown** **11.3 Mio m³/a**



Thickening Factor Fluctuation in 2006 of Unit 1-4 in Power Plant Dezhou



Thickening Factor (monthly average values) of Units 1-6



Proposals for Power Plant Dezhou

Yearly average thickening factors and proposed values

Proposal 1: Actual thickening with a better dosing of chemicals

Proposal 2: Thickening with automatic control

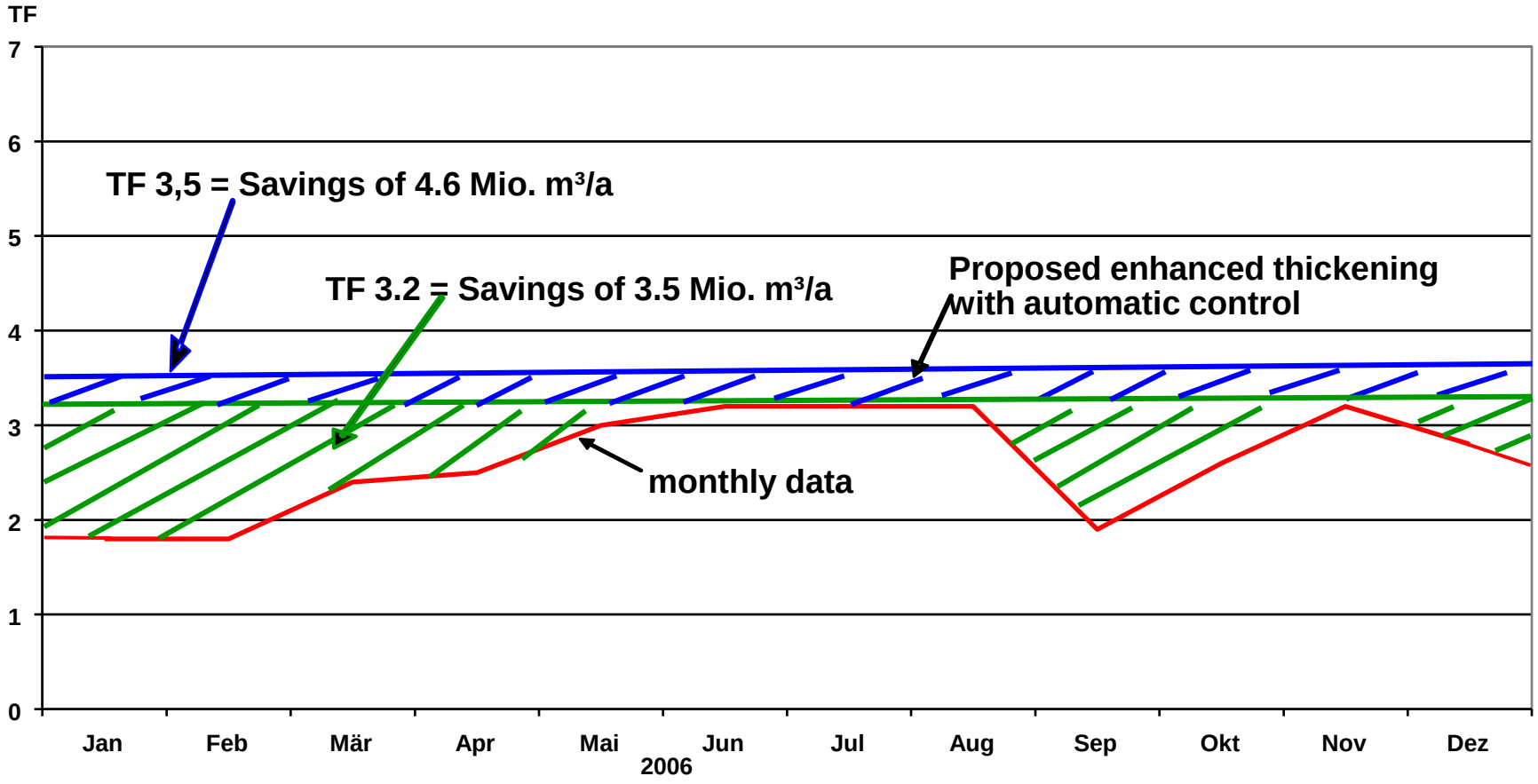
Proposal 3: Thickening with pre-treated water by lime decarbonization

	Actual Situation	Proposal 1	Proposal 2	Proposal 3
Unit 1	2,65	3,20	3,50	6,00
Unit 2	2,39	3,20	3,50	6,00
Unit 3	2,35	3,20	3,50	6,00
Unit 4	2,73	3,20	3,50	6,00
Unit 5	4,49	5,70	6,00	6,00
Unit 6	4,20	5,70	6,00	6,00

Proposals for Power Plant Dezhou

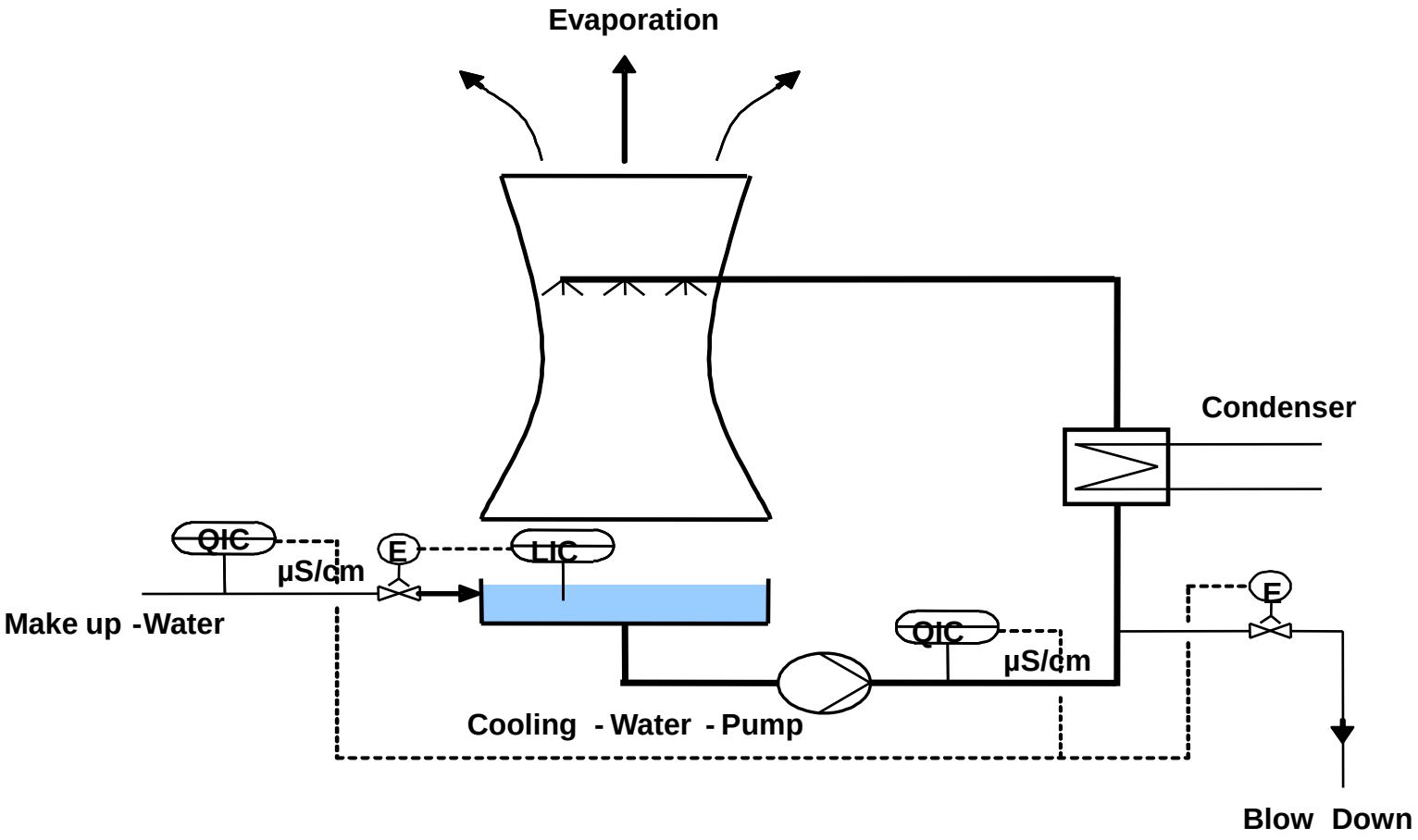
Savings by automatic controlled thickening factor

Less Consumption of 4,6 Mio. m³ per year units 1-6



Proposals for Power Plant Dezhou

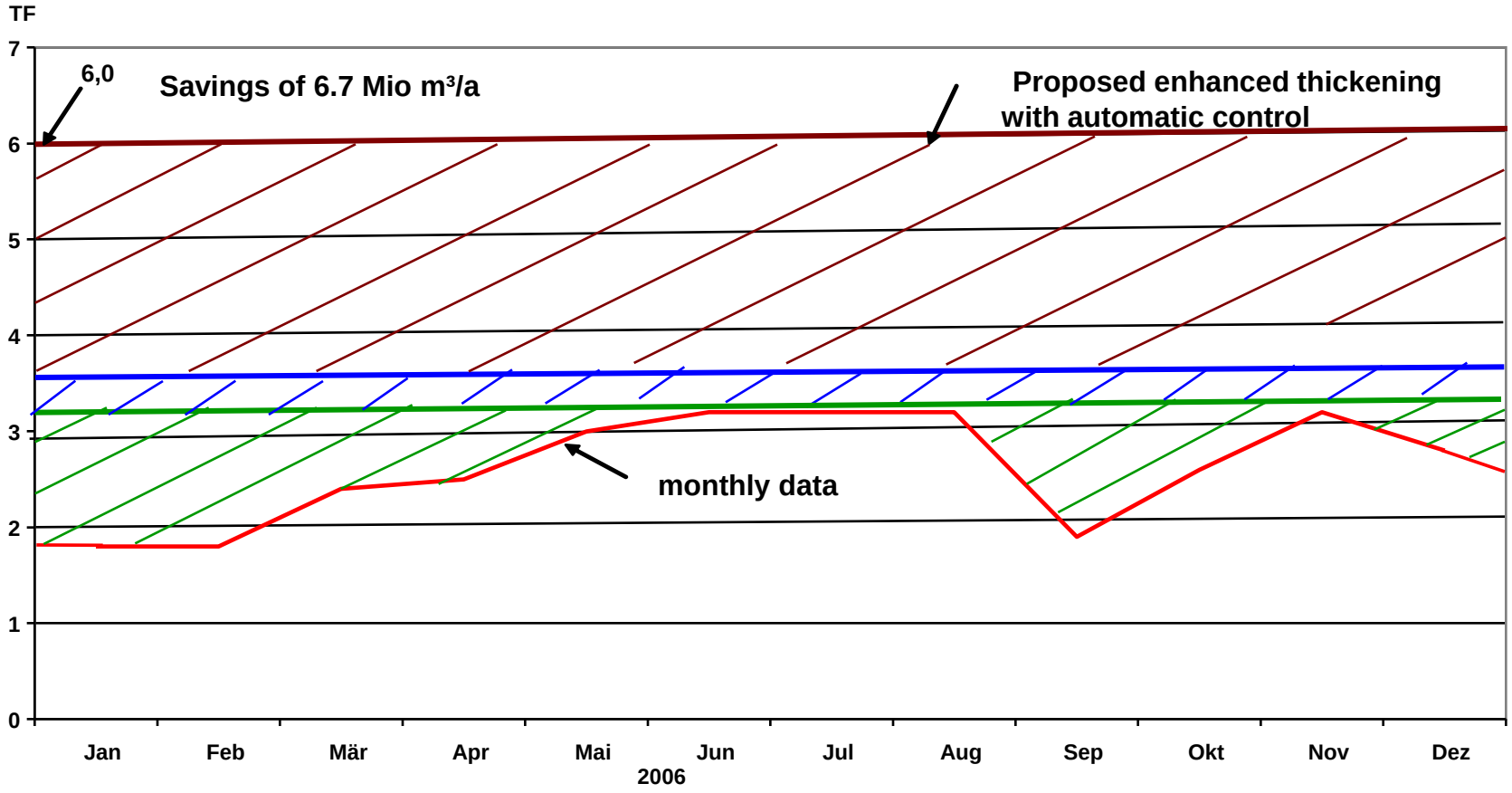
Thickening factor with automatic control



Proposals for Power Plant Dezhou

Savings by lime decarbonisation for the make-up-water

Less consumption of 6,7 Mio m³ per year units 1-6 (19.4%)



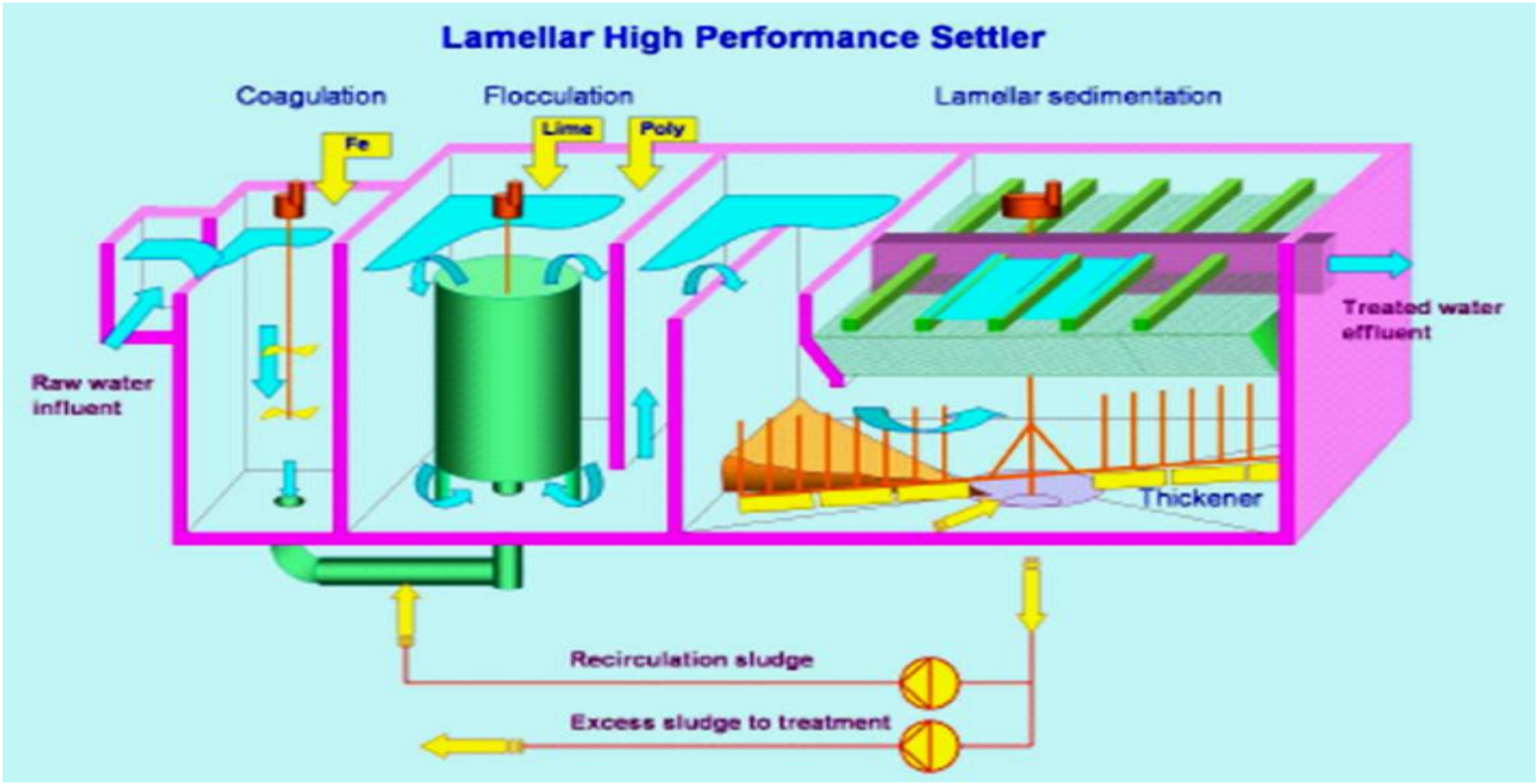
Treatment for Make-up-Water

1. **Acid Decarbonisation**
   - Increasing conductivity (more sulphate)
   - No reduction of silica, organics, solids
   - low investment and operation costs

2. **Decarbonisation by Weak Cation Exchanger**
   - Decreasing of conductivity
   - Regeneration water with high salt content
   - No reduction of silica, organics, solids
   - higher investment and operation costs

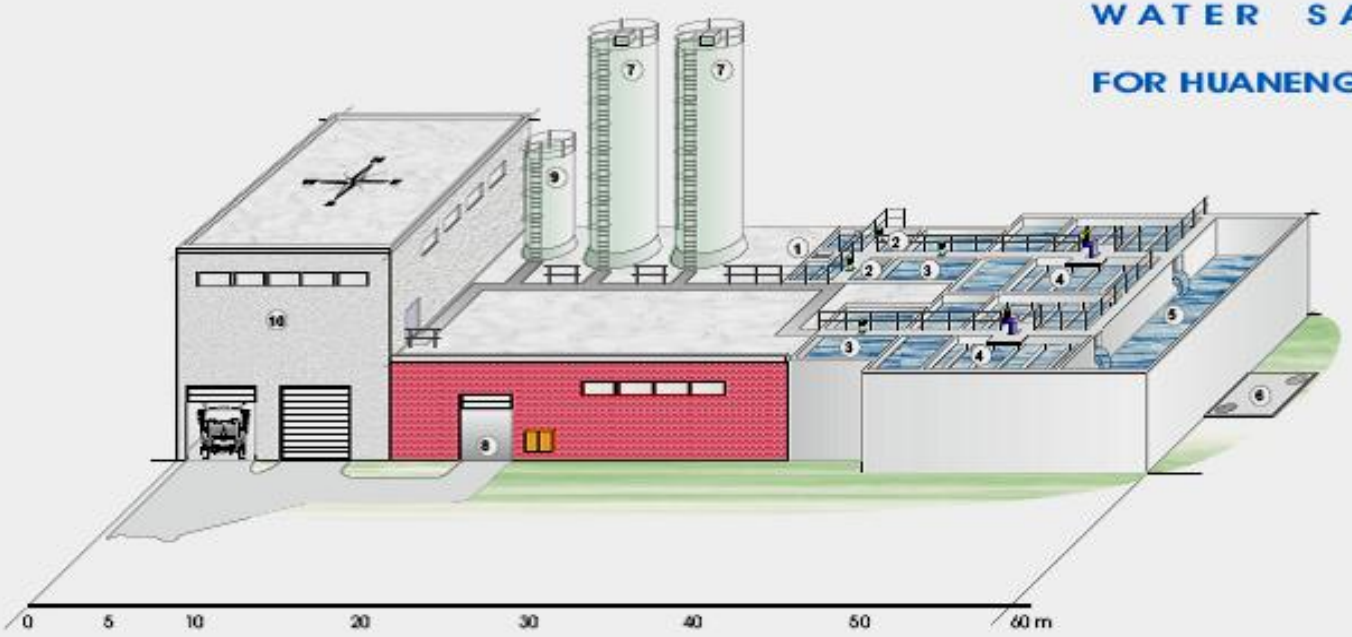
3. **Decarbonsation by Lime-milk**
   - Decreasing of conductivity
   - Sludge production in the process
   - Good reduction of silica, organics, solids
   - higher investment and operation costs
   - Best performance for the environment

Treatment Make-up-Water by Lime Decarbonization



WATER SAVING PROJECT

FOR HUANENG DEZHOU POWER PLANT



1. Raw water inlet
2. Coagulation chamber
3. Flocculation chamber
4. Sedimentation basin
5. Clear water tank
6. Outlet to the cooling towers
7. Lime silo
8. Chemicals dosing stations
9. Sludge buffer tank
10. Dewatering building
11. MCC - Room
12. MCC and Control Room

Profitability Analysis

1. **Water price：**
   - Raw water (2009): 1.68 RMB /m^3 ,
   - Waste water (2009): 0.80 RMB /m^3。
2. **Investment cost in total：** 45.88 Mio RMB (app. 3.0 Mio RMB for KZA)
3. **Operation costs:** 6.75 Mio RMB p. a.
4. **Water savings：** 24.38 Mio RMB p. a.
5. **Amortization：** approx. 2.6 years

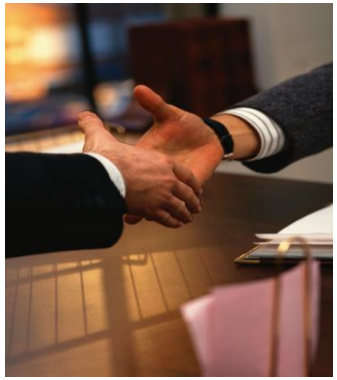
The most important things are:

Water-Reduction for a better environment and Cost-Reduction while operation

Stage of the Pilot Project

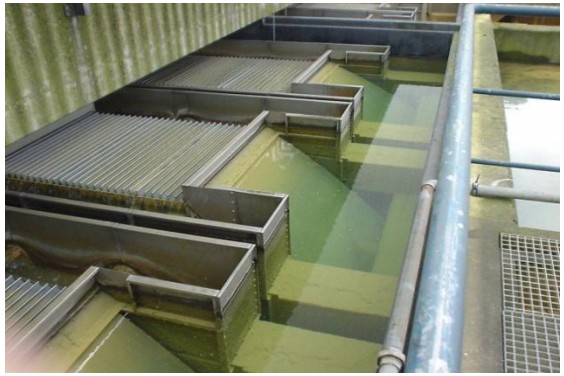
Beginning of the civil work: June 2009

Delivery time of the chamber filter press (bottleneck): Nov. 2009



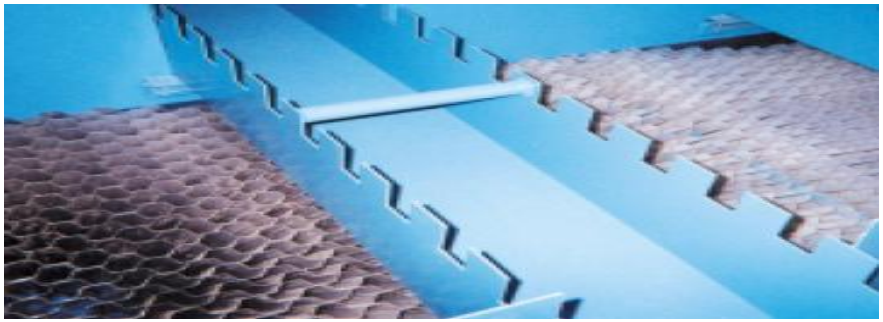
Commissioning: December 2009

Official acceptance and handover: Jan. 2010



Things to take Care of

1. **Detailed water balance**
2. **Different water quality in summer and winter (dry or raining season)**
3. **Find out the best chemicals** — **JAR Test**
4. **Check the best dosing concentration** — **JAR Test**
5. **Optimizing the conditions (Cooling circuit corrosion aspects)** — **Coupon Test**
5. **Proof the Re-use of waste water for FGD** — **No Foaming**, **Good Crystallization**



Thank You For Your Attention

Contact

Tel.: +86 (10) 8426 4080

Fax: +86 (10) 8427 4070

Email: shecan.zhang@gtz.de

www.gtz-powerandcoal.com