

Hydropower Europe „Flexible Hydropower - Design & Experiences“

Gottfried Gökler, Vorarlberger Illwerke AG, Austria



HPE Hydropower Europe 2019 | 14th March, Brussels

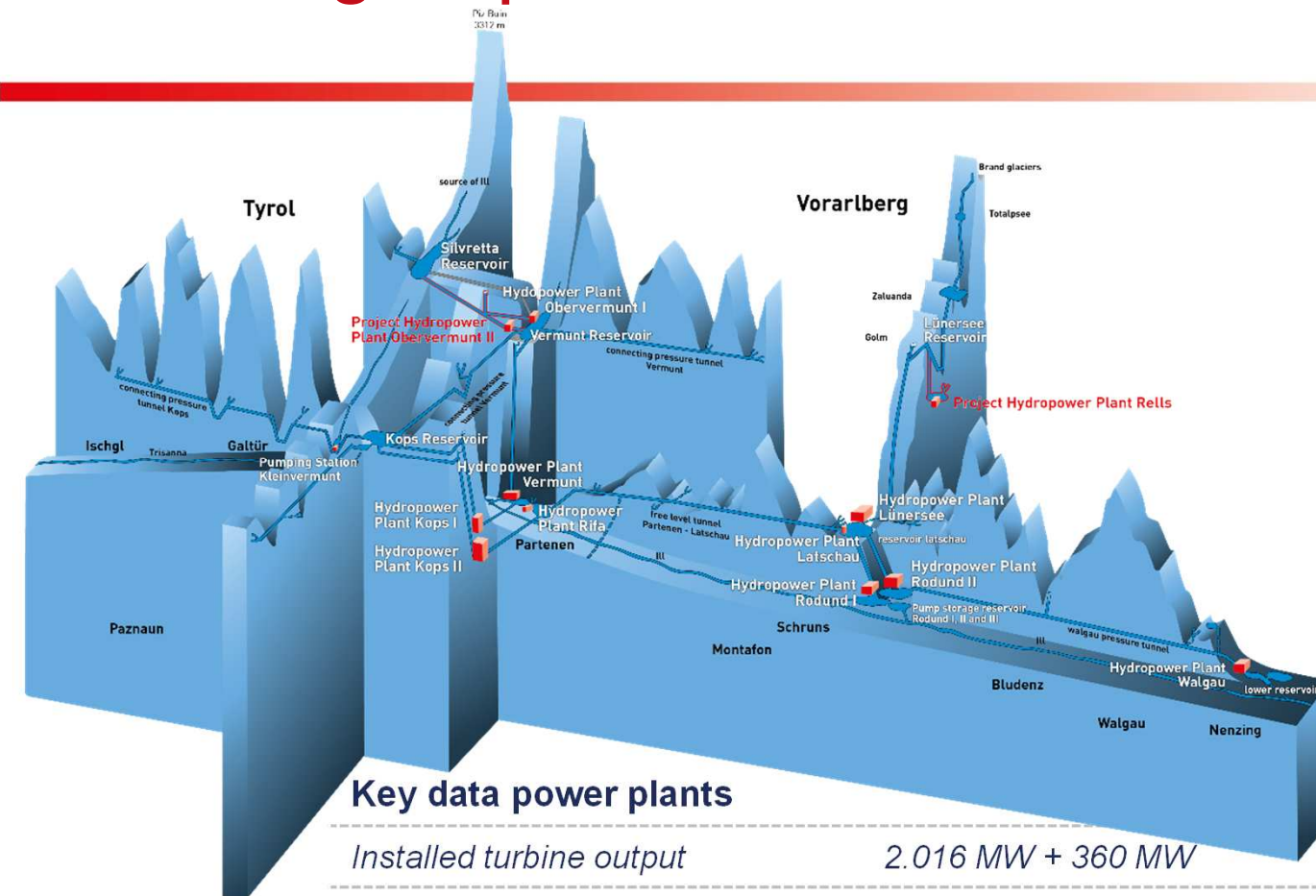
Topics

Flexible Hydropower – Design & Experiences

- Flexibility of Pumpstorage
 - Example: HPP-group “Obere Ill-Lünersee”
 - Changes and Constraints
- Ternary Units / Reversible Pump turbines
- Design decisions
 - Kops II
 - Obervermuntwerk II
- Experiences
 - operational
 - technical

HPP group „Obere Ill-Lünersee“

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Key data power plants

Installed turbine output 2.016 MW + 360 MW

Installed pumping capacity 1.044 MW + 360 MW

Energy generation 2.886 GWh/a

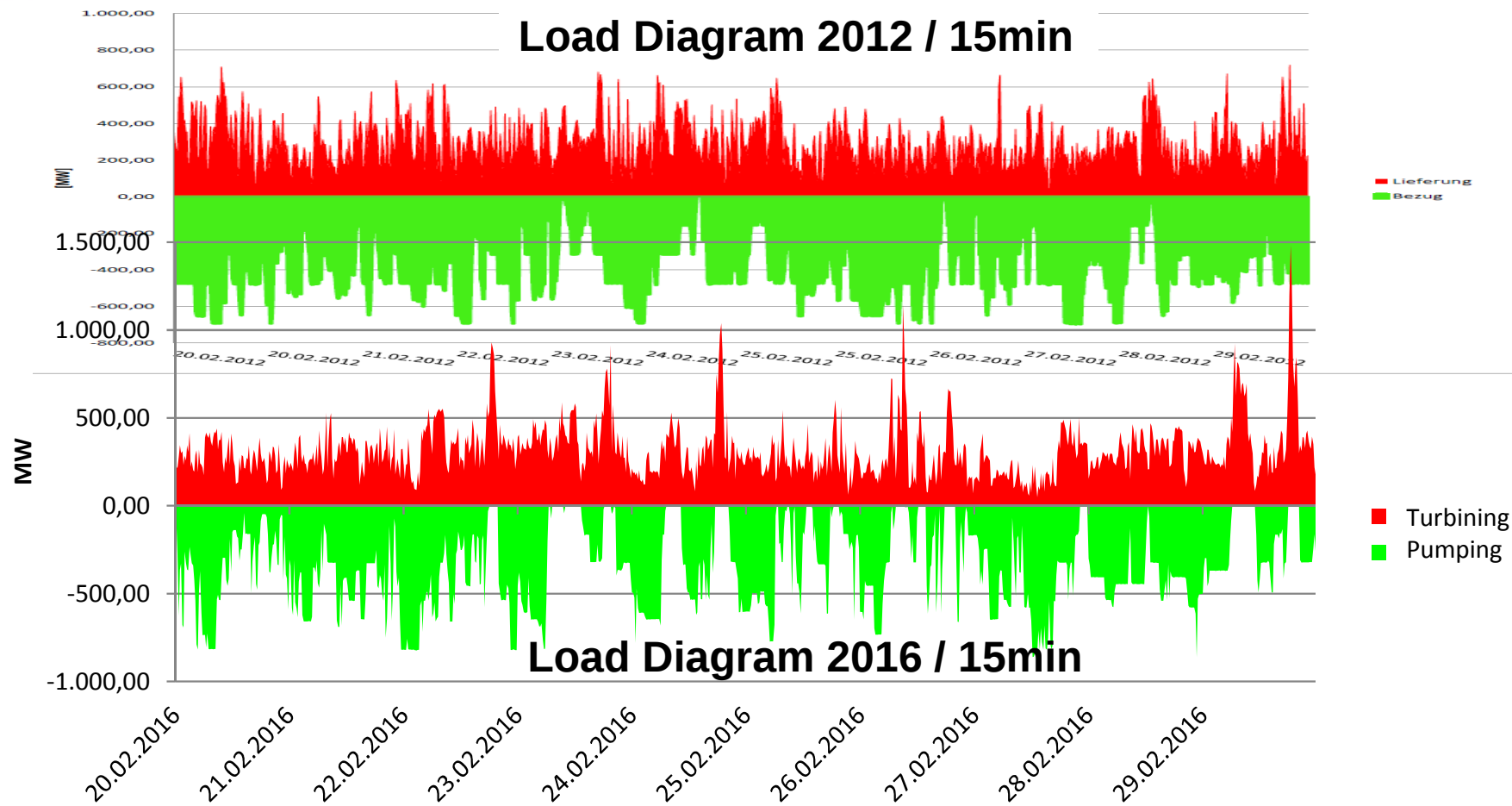
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- Hydropower plants over 300 MW
- Hydropower plants 200 MW to 300 MW
- Hydropower plants 30 MW to 200 MW
- Hydropower plants 4,000 kW to 30 MW
- Hydropower plants 0 to 4,000 kW

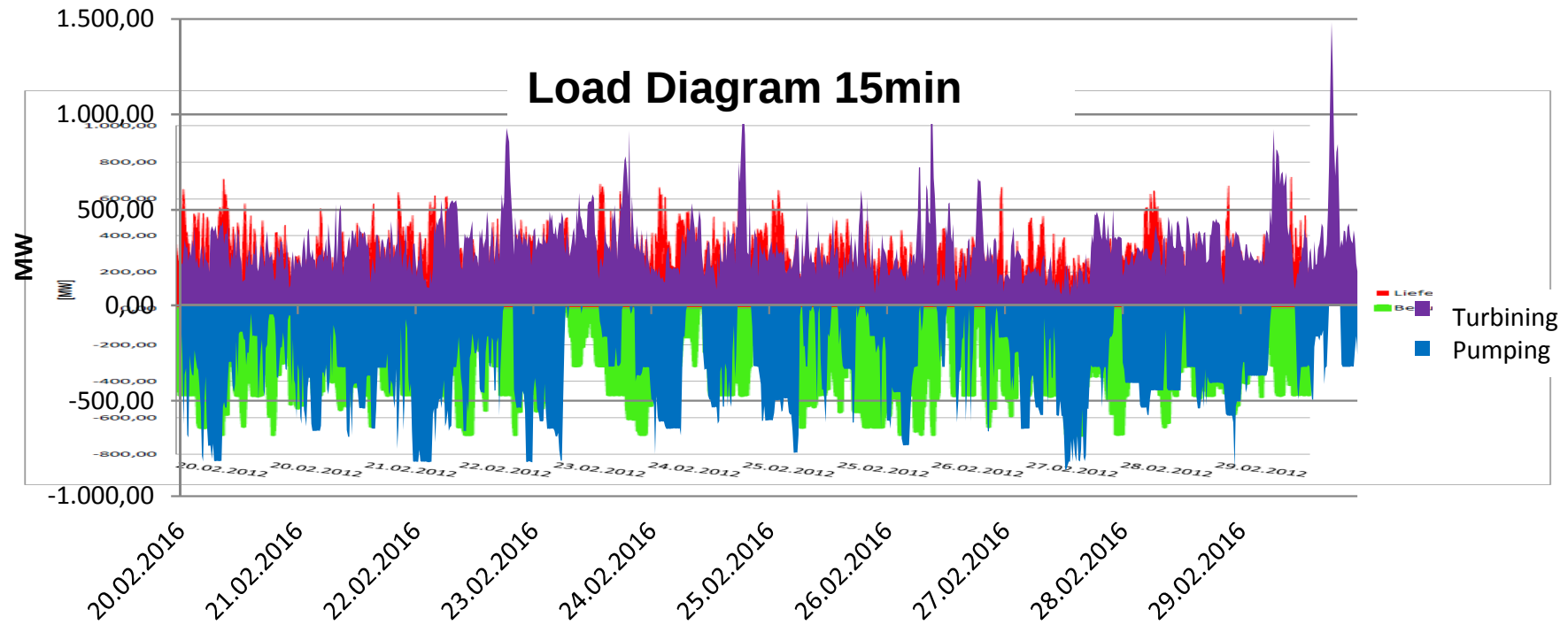
* Power plant with VKW majority share

Week-Load Diagrams 2012 / 2016



Week Load Diagramm

Differences between 2012 and 2016



Week Load Diagramm

Differences between 2012 and 2016

**Installed capacity power plant group Obere Ill Lünensee:
Turbine 2016 MW / Pump -1044 MW**

2012	Mean	Peak	Peak/Mean
positive capacity	320	700	2.18
negative capacity	-350	-750	2.14

2016	Mean	Peak	Peak/Mean
positive capacity	250	1470	5.8
negative capacity	-260	-820	3.2

- Increasing flexibility (positive and negative)
- decreasing number of calls
- shorter generation times of each request

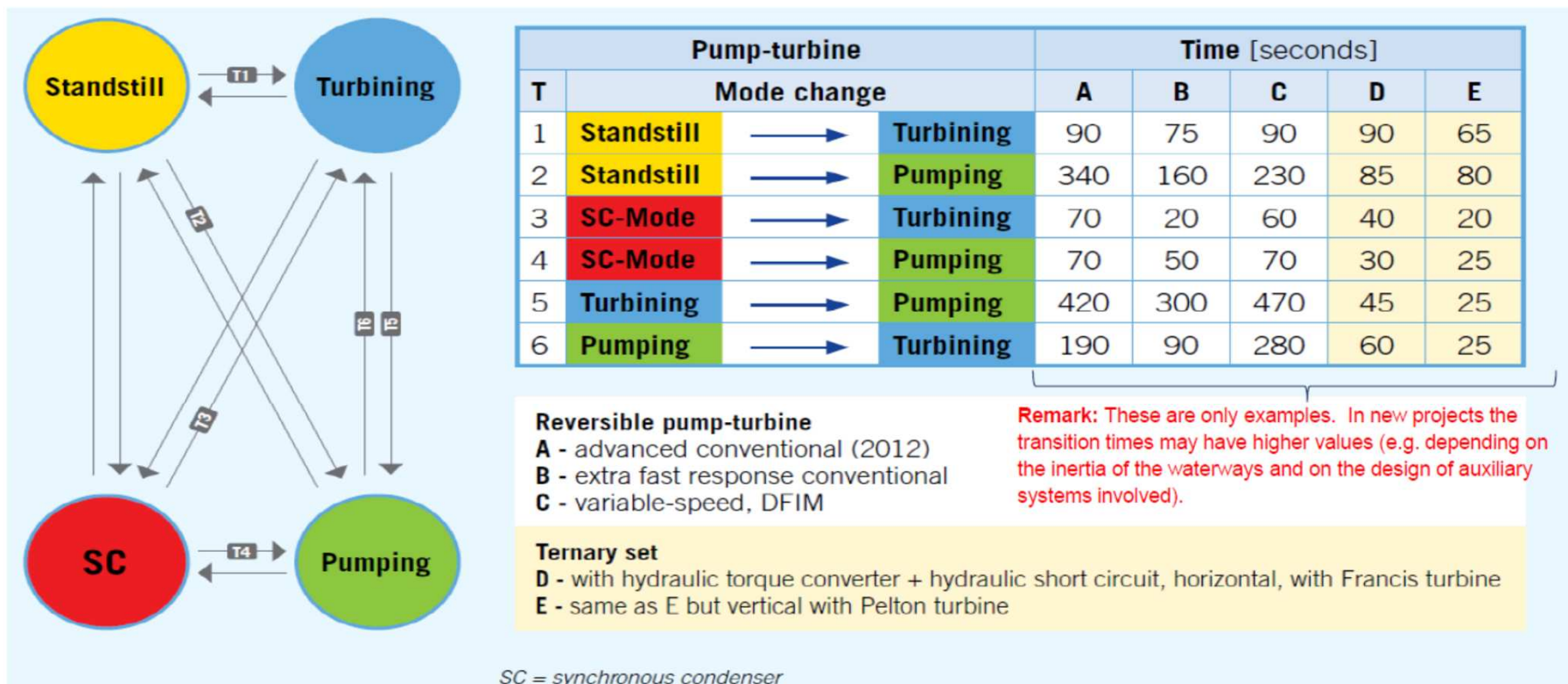
Design: Ternary Set / Reversible pump-turbine

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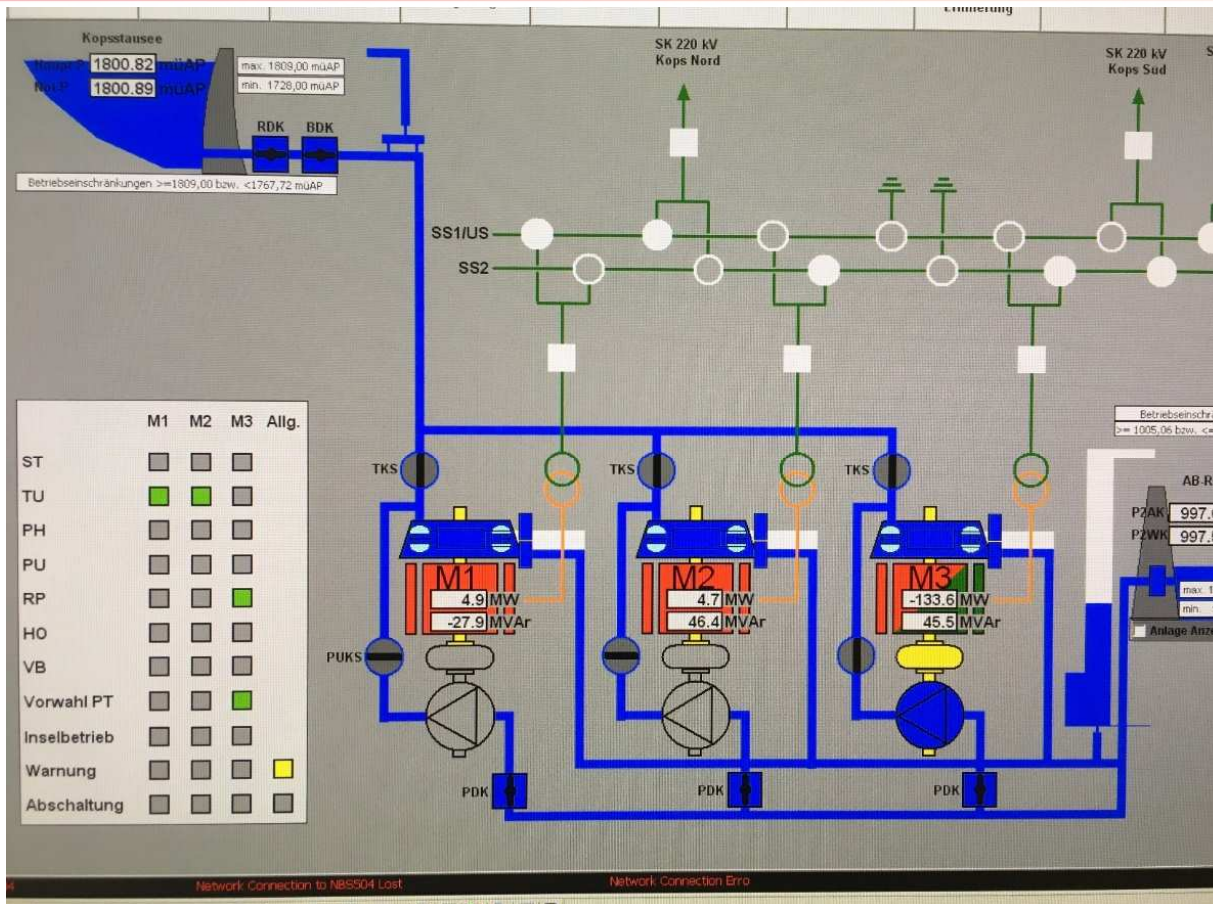
VOITH

Flexibility is significantly influenced by mode change times

Source: Pumped Storage Power Plants and Energy Transition / Dr. Klaus Krüger / 2018



Flexible Operation - Charge and Discharge



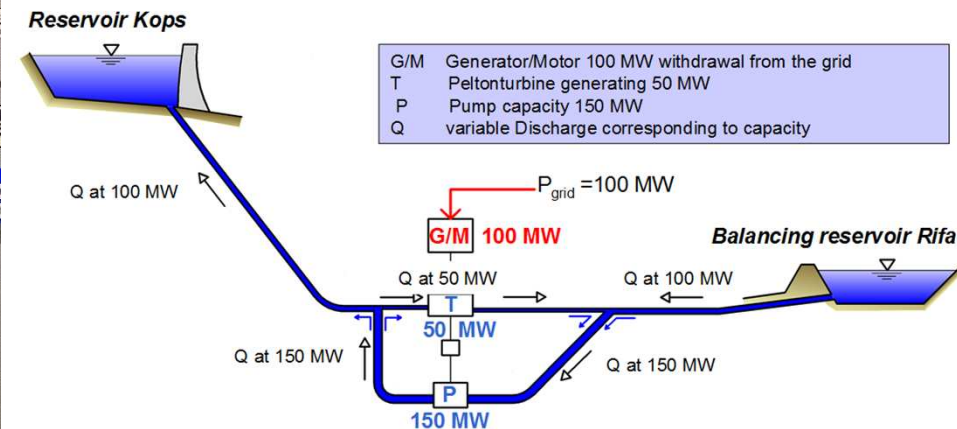
Kops II:

3 ternary units (-450 MW/+525 MW)

Turbine capacity: 0 – 175 MW

Pump capacity: 150 MW

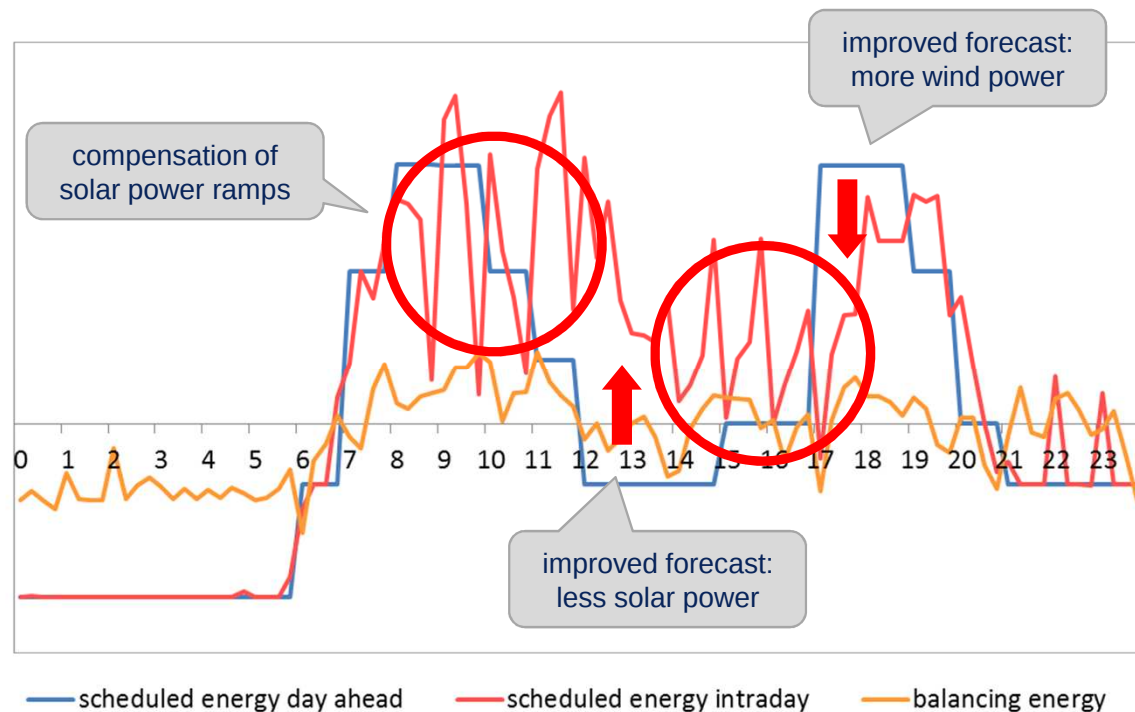
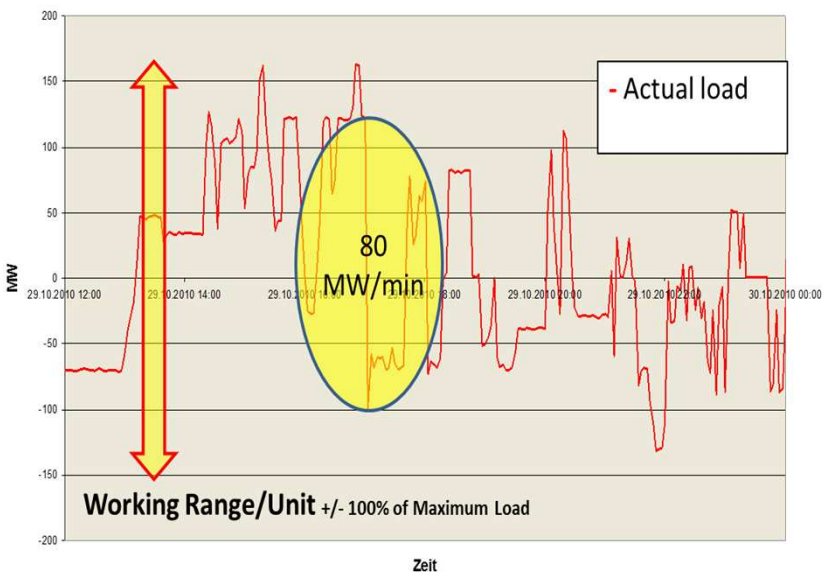
“Controllable” Pump (hydraulic short circuit)



e.g. power withdrawal 100 MW from the grid

Example: Dispatch PHS

Typical load diagramm of 1 unit



Kopswerk II

3 Ternary units with Pelton turbines

10 years of experiences

- 8.000 hours annual operation per unit
- 10 – 20 daily mode changes Pump/Turbine
- quick mode changes: 20 sec. ± 450 MW until 0 load
- 40 sec. from full load pump to turbine operation

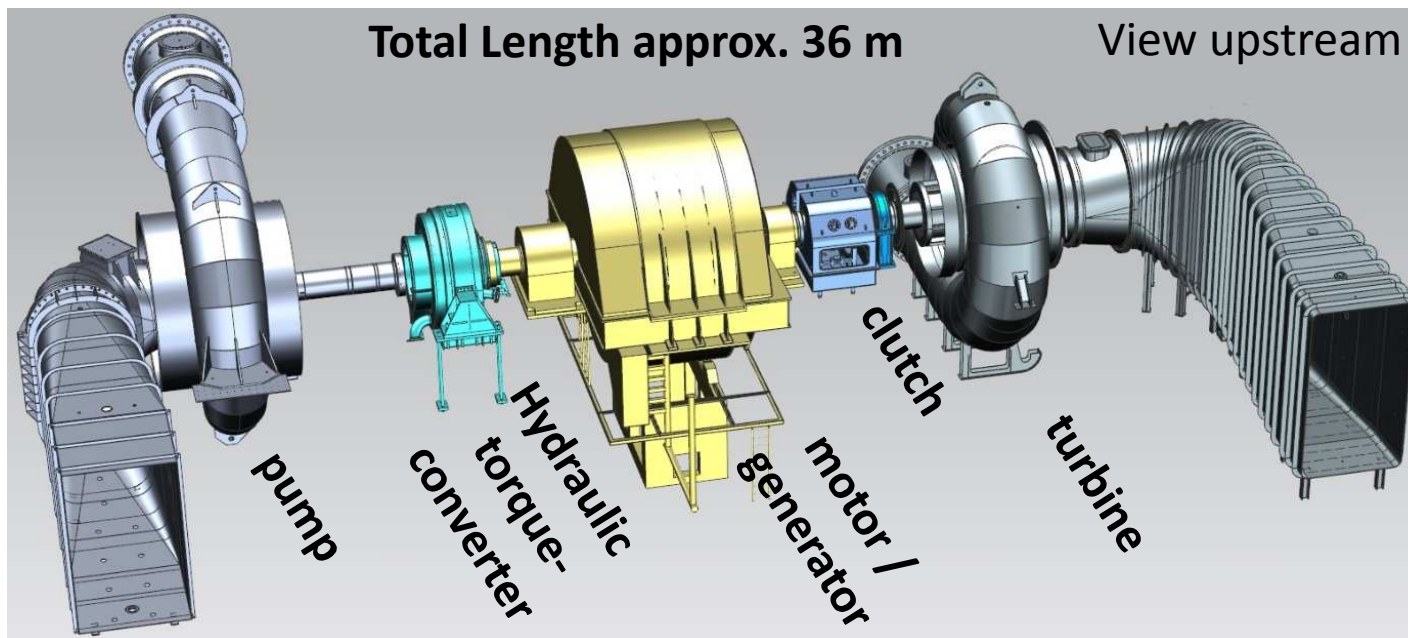


- This flexible operation has met exactly the demand of the volatile energy market!

Obervermunt II

2 Ternary Francis units

- The turbines are full adjustable from 100% to 0% without any part-load limit and without additional air for stabilizing the francis turbine
- Additional sets to Kops II (“backbone”) with nearly the same mode change times
- 30-40 sec. $\pm$ 360 MW until 0 load, 60 sec. from full load pump to full load turbine operation



Control Range of units

Ternary Units

Control Band of Ternary Sets

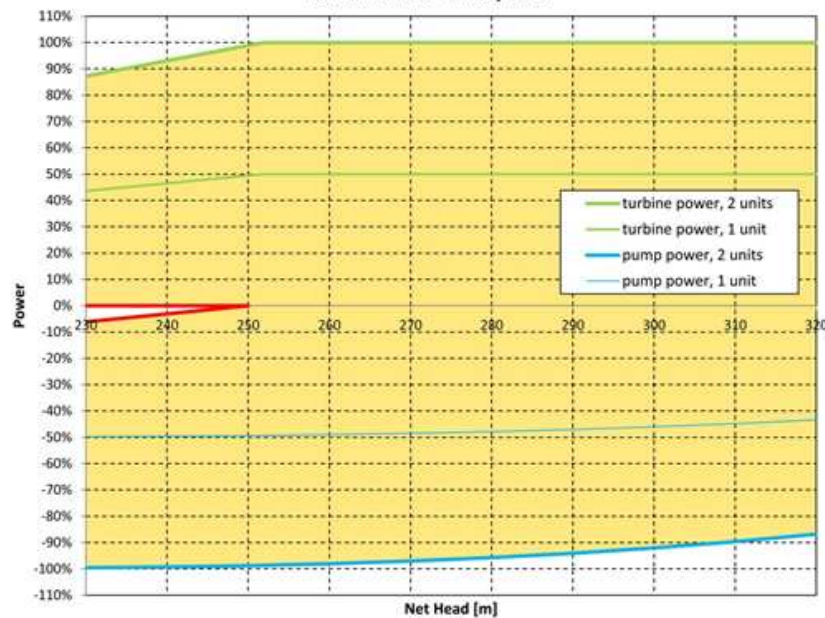


Fig. 1: Power control band of a ternary set

Pumpturbines

Control Band of Pumpturbines

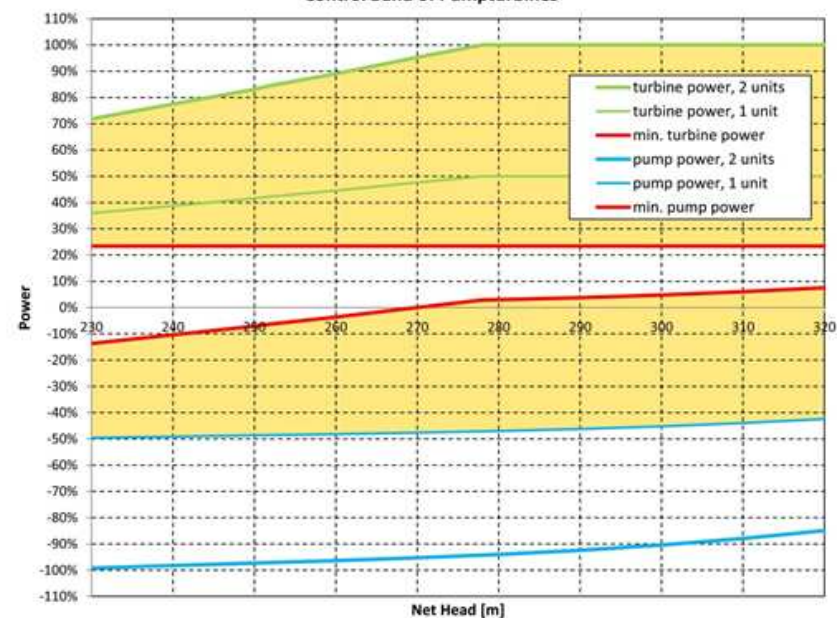
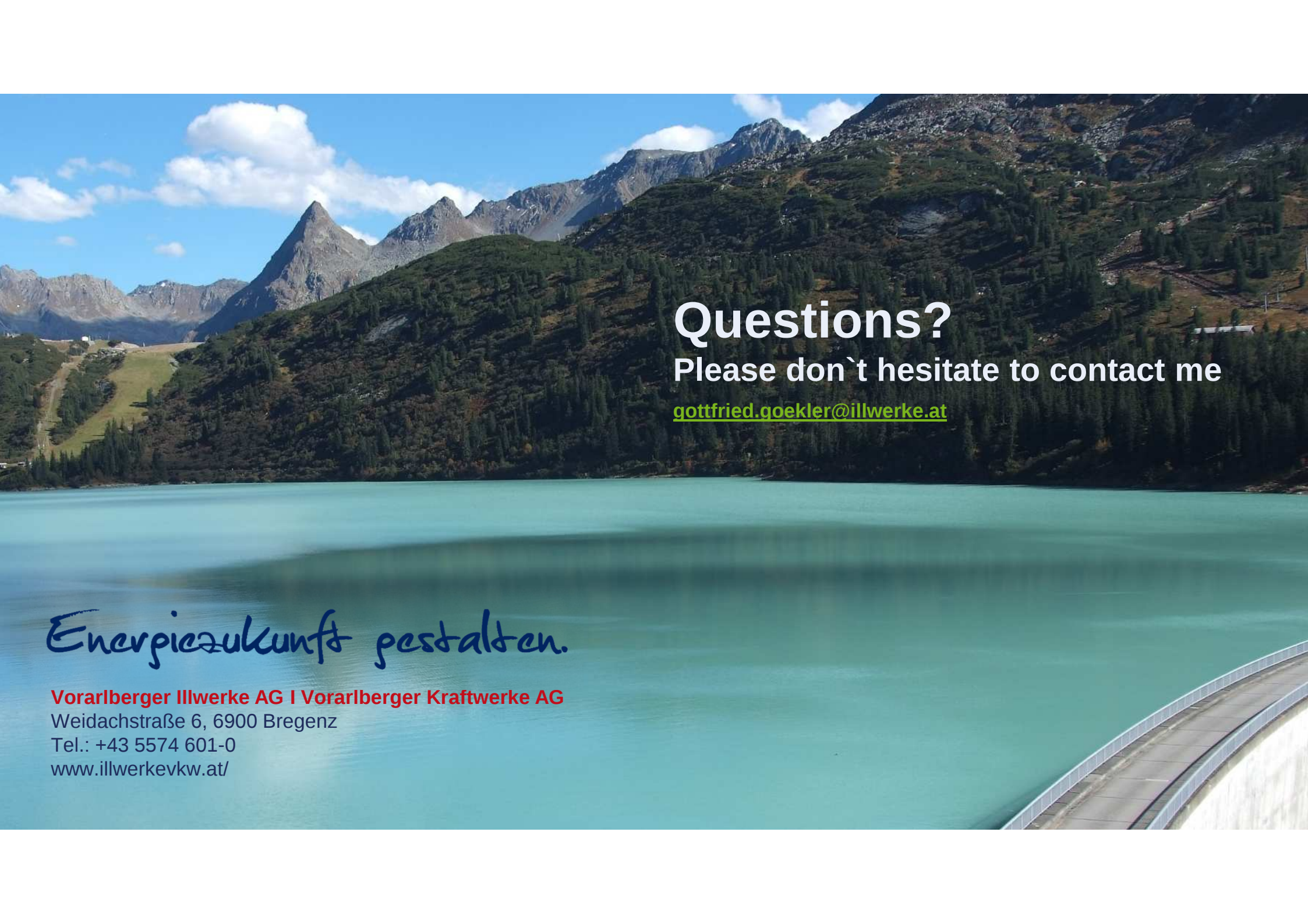


Fig. 2: Power control band of a pumpturbines without part-load stabilisation

Source: Vorarlberger Illwerke AG, P. Meusburger, L. Werle,
Pumped Storage Power Plant Obervermuntwerk II – The hydraulic machinery, 18. Internationales Seminar Wasserkraftanlagen, TU Wien



Questions?

Please don't hesitate to contact me

gottfried.goekler@illwerke.at

Energiezukunft gestalten.

Vorarlberger Illwerke AG | Vorarlberger Kraftwerke AG

Weidachstraße 6, 6900 Bregenz

Tel.: +43 5574 601-0

www.illwerkekw.at/