Hydropeaking Mitigation Measures

Impacts on Use

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Hydropower and Fish

Partnership of R&D Hydropeaking

On behalf of the Austrian federal ministry of agriculture, forestry, environment and watermanagement as promotor in cooperation with the university of environmental sciencies Vienna, e3 expert for energy economy and steakholders of hydropower generators

Storage Power plants in Austria Renewable Energy – Renewable Capacity

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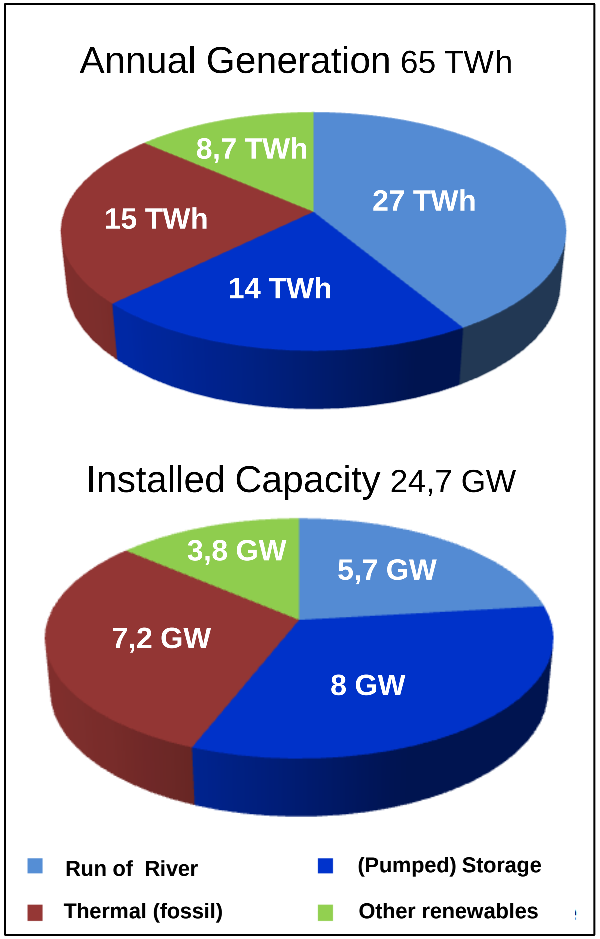
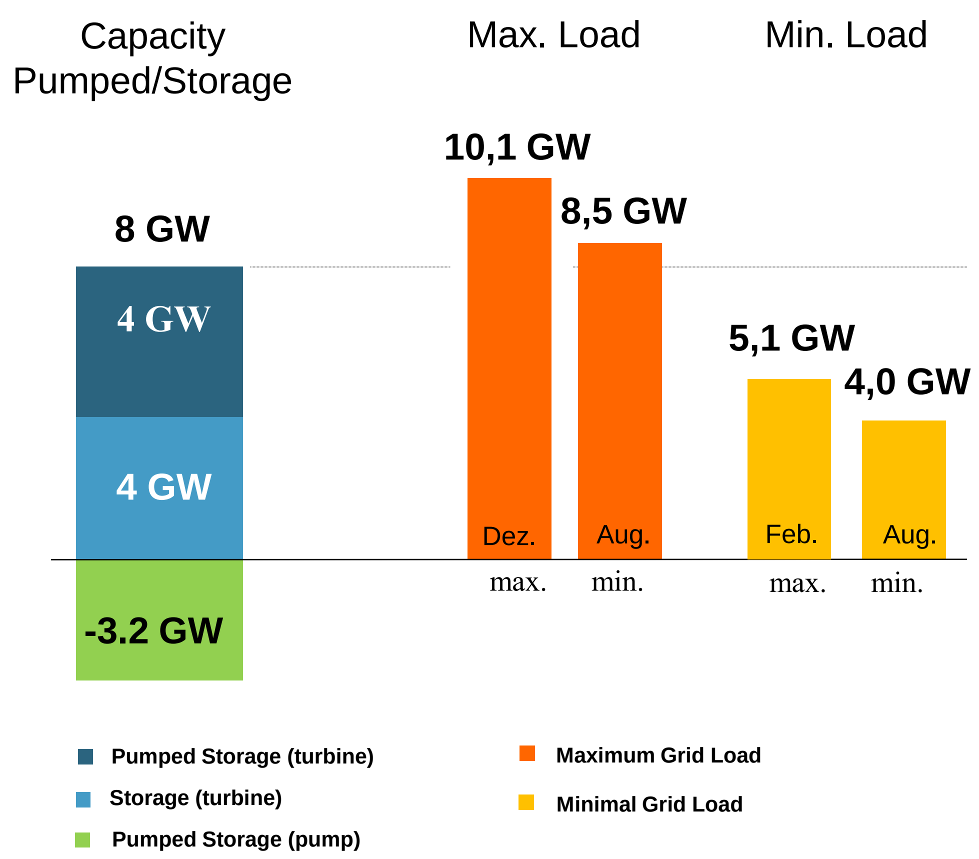




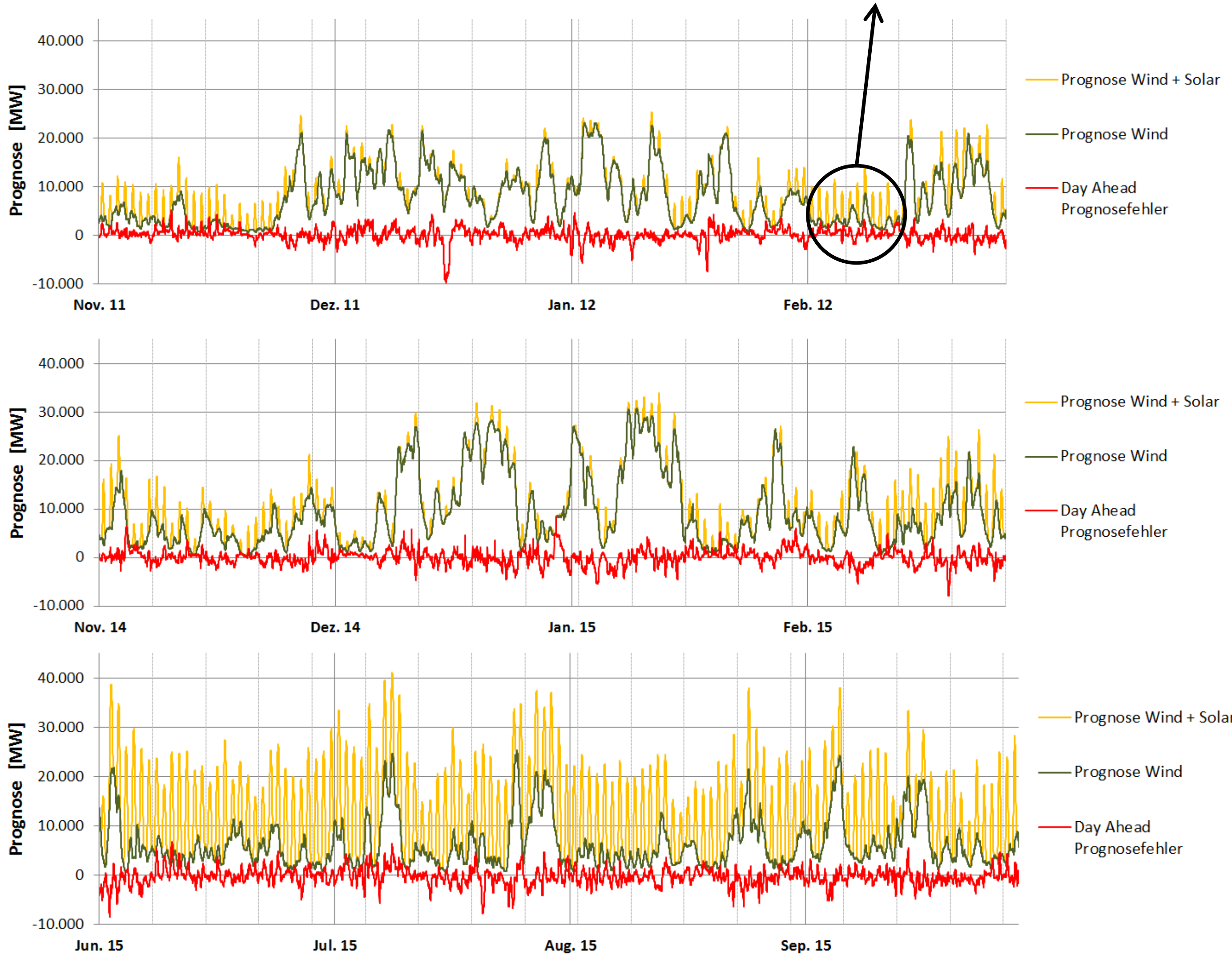
Source: E-Control

Intermittent production of Wind und PV (Germany)

Siberian High
→ Very cold
→ Very high demand
→ Low wind and pv generation

- The relevant Day-Ahead forecast values for the are shown
- Characteristic Summer – Winter
- Two winters - two different wind profiles
- Forecast errors greater than 5GW are common

In 2014 approx. 10,5% of Production were forecast error
→ ca. 8.8 TWh



Quelle: Netzkennzahlen von: Amprion, 50Hz, Tennet TSO GmbH, EnBW Transportnetze AG

Benefits of Storage Power Plants

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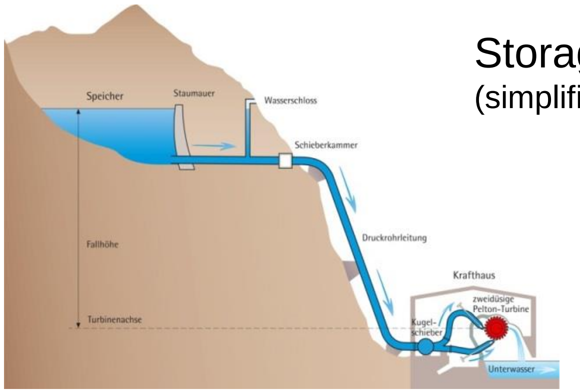
At high demand and/or low renewable production
→ Production (Turbine)

At low demand and/or high renewable production
→ No production (keep water in high reservoir)

Additional and simultaneous provision of flexibility and ancillary services

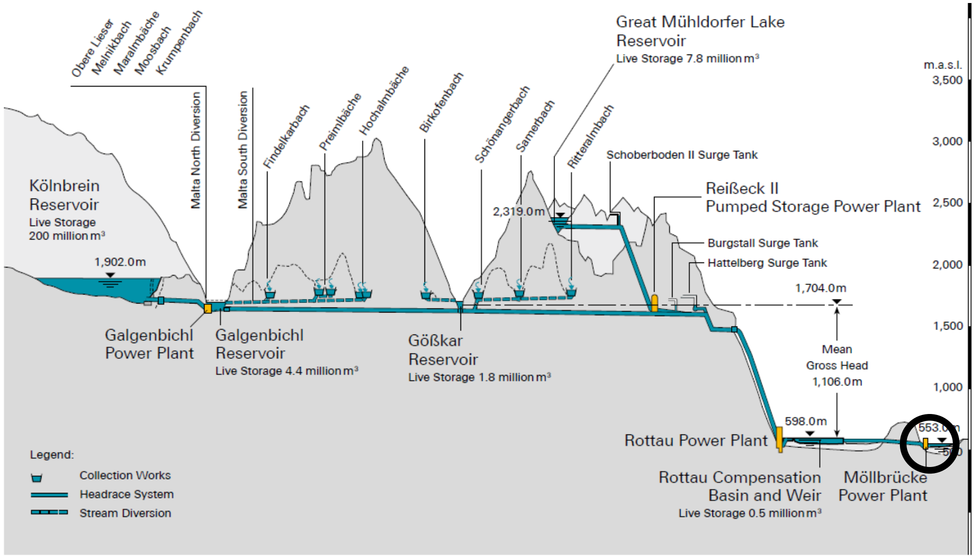
- Operating reserve
- Reactive Power
- Black start Capability
- Congestion Management
- Grid fault management
- …

Storage Power Plant
(simplified depiction)



Storage Power Plant Group
(real complexity!)

- Connected storage and pumped-storage power plants
- Strong interaction between power plants in the group (shared reservoirs, ..)



Malta Storage Power Plants, Longitudinal Section

Source: VERBUND Hydro Power GmbH

SuREmMa Case Studies

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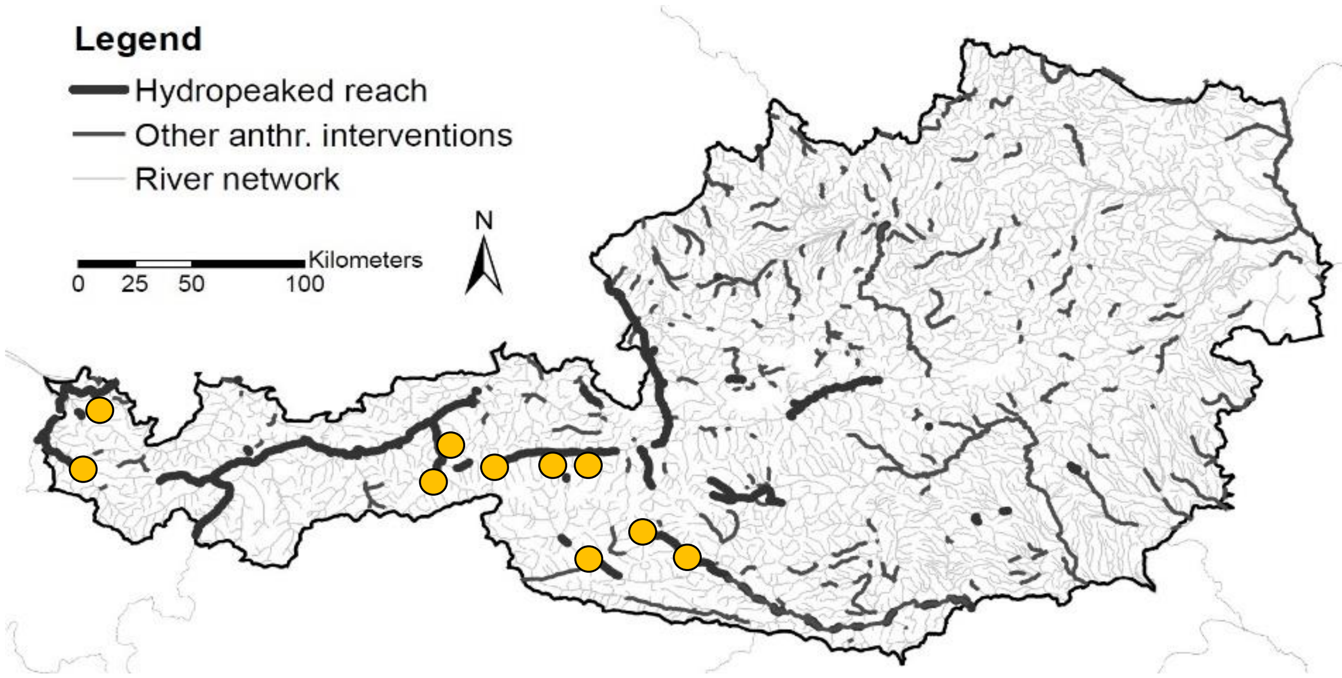
- Ten Storage Power Plant Groups at six rivers
- Representing 4000 MW flexible storage capacity

→ **Representing 50% of the total Austrian storage power plant capacity**
→ Projection of the effects on all of Austria is possible by applying a factor of two to the results of the SuREmMa project



Impacts of hydro peaking mitigation measures

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Evaluated measures

- Diversion power plant
- Construction of retention basin- for ramping rate attenuation
- Operational restrictions–ramping rate attenuation

Impacts on the electricity system and macro-economic effects

- Security of supply – Loss of flexible power
- Climate protection goals
- Additional costs of system operation

Micro-economic effects

- Direct costs (investment, operation)
- Reduction of revenue

Effects of operational restrictions

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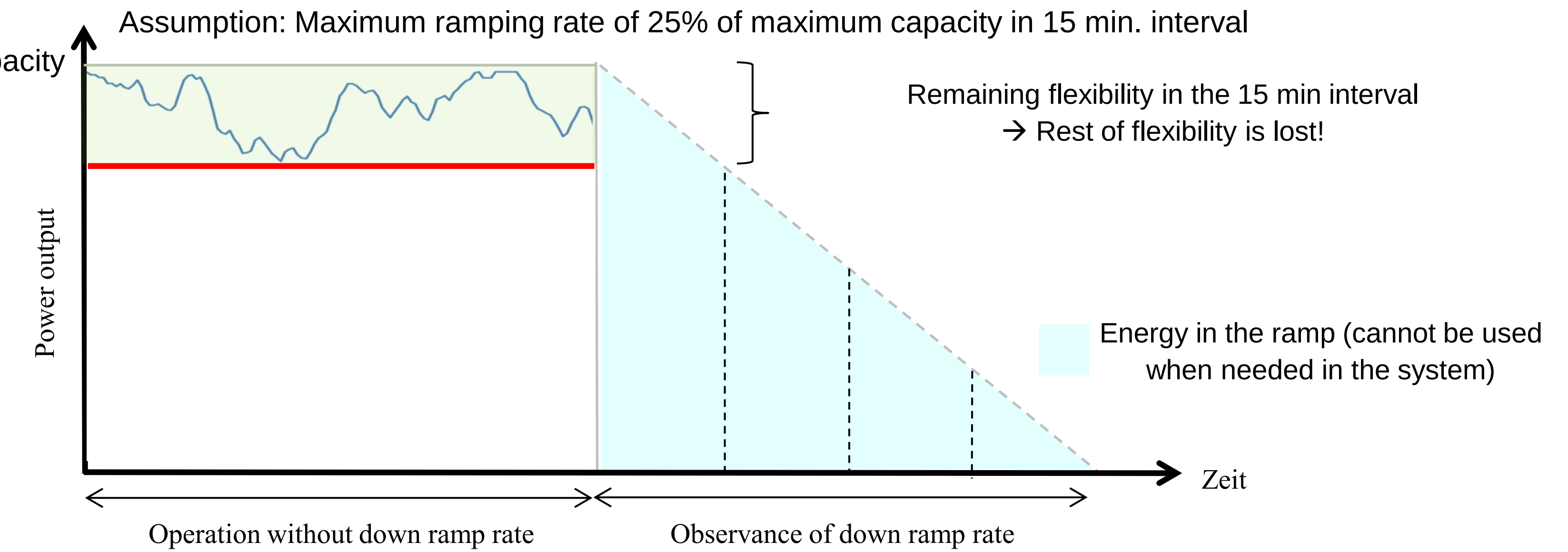
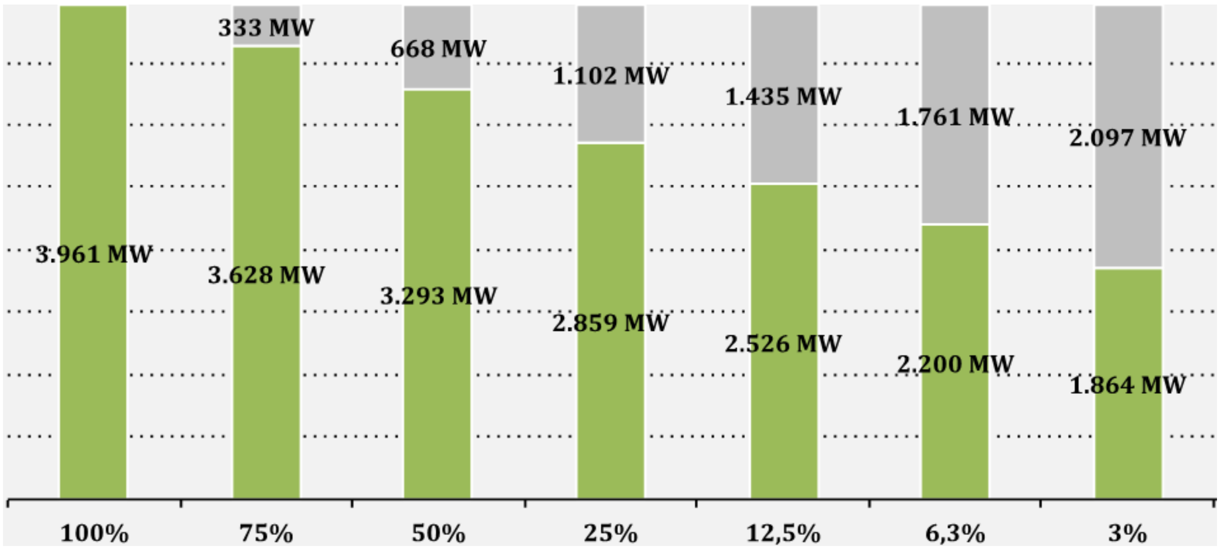


Flexibility of storage power plant is highly reduced!

→ Significant negative impact on the electricity system and macro-economic effects
- Security of supply – loss of flexible power
- Climate protection goals
- Additional costs of system operation

→ Very strong negative Micro-economic effects
- Reduction of revenue

Operational restrictions: Loss of flexible Power



Gray: Sum of the lost flexible power of the ten SuREmMa case studies in the in dependence of the intensity of ramping rate attenuation. Green: Sum of remaining flexible Power

<u>More than 50% of flexible power are lost at high ramping rate attenuation!</u>

Projection for all of Austria:
→ <u>Loss of over 50% of flexible power of storage power plant groups</u> at high down ramp rate attenuation (ca.. 4000MW)
→ Comparable to <u>10 big gas fired combine-cycle power plant blocks</u>!

Operational restrictions : Additional CO_2 Emission

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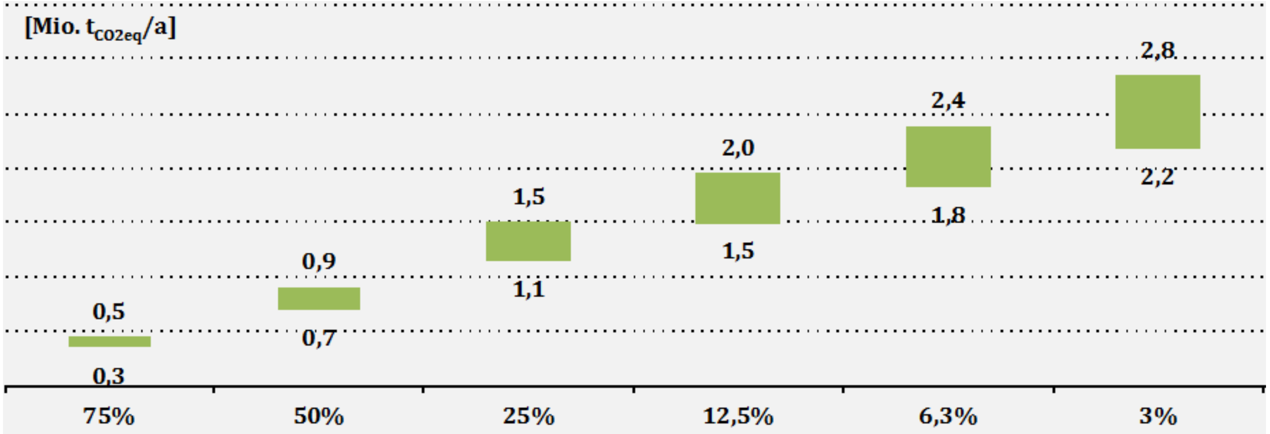
Rise of CO_2 emissions in the electricity system due to not integrateable renewable energy (wind and pv).

•Per MW of flexible power 1,5 und 2 MW of fluctuating renewable power can be integrated. Corresponding to 2.600 bis 3.400 MWh per year.

•Quantified as substituting this energy with a modern gas fired combine-cycle power plant



Sum of additional CO_2-emissions of the ten SuREmMa case studies in the in dependence of the intensity of ramping rate attenuation.

Additional CO_2-emissions of 2,2 -2,8 Mio.t CO_2-equivalent per year in the SuREmMa Case studies at high down ramp rate attenuation!

Projection for all of Austria:

→ <u>Additional CO_2-emissions comparable to almost 25% of Austrian traffic</u> (ca. 4,4 – 5,6 Mio.$t_{CO2eq/a}$)

Operational restrictions: Additional costs of system operation

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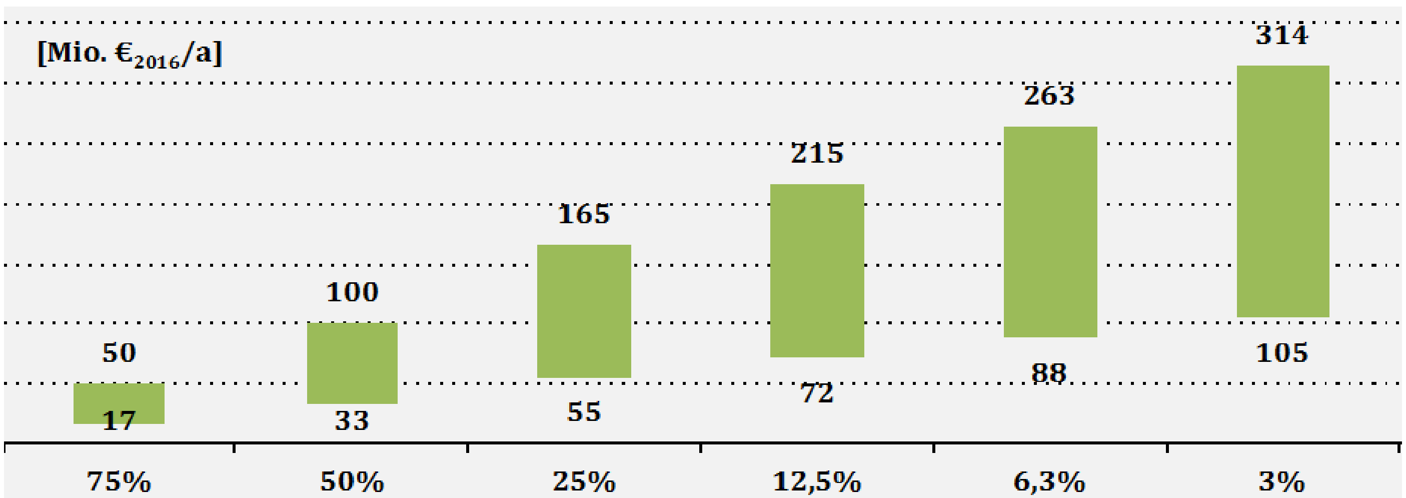
Investment in alternative sources of flexibility leads to a rise in system operation cost.[1)]



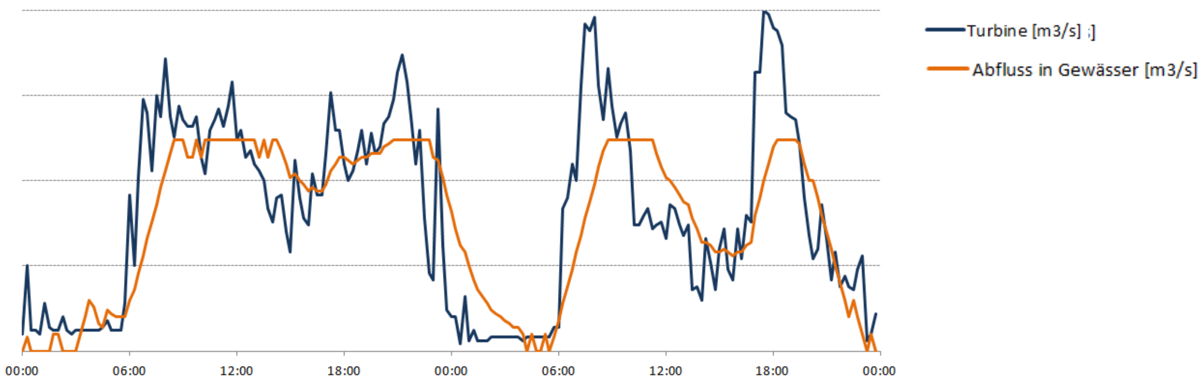
Sum of additional costs of system operation of the ten SuREmMa case studies in the in dependence of the intensity of ramping rate attenuation.

Additional system costs of 105 – 315 Mio. € per year in the SuREmMa Case studies at high down ramp rate attenuation!

Projection for all of Austria:
→ <u>Increase in system operation cost up to 2 ‰ of Austrian GDP</u> (200 – 630 Mio. € per year)

1) Costs of alternative sources of flexibility are between 50.000 – 150.000 €/MW per year.

Effects of retention basins



Flexibility of storage power plant remains!

→No negative impacts on the electricity system or macro-economic effects
→Impact on land use and landscape (narrow alpine valleys, availability of land)

→ Micro-economic effects
•Investment and operational costs

Effects of Diversion power plant

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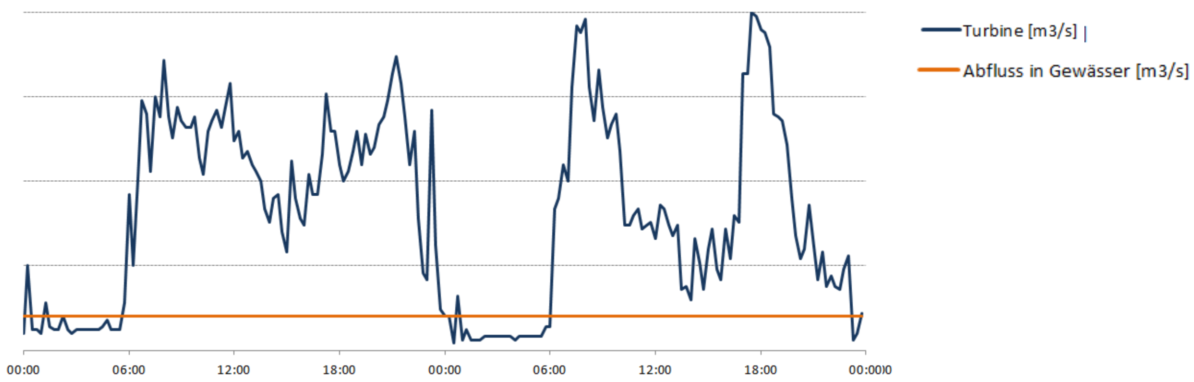

Flexibility of storage power plant remains

→ <u>Positive impacts on the electricity system and macro-economic effects</u>

•Security of supply – Additional installed peak capacity

•Climate protection goals – Additional renewable energy

•Costs of system operation – Avoided additional cost of energy production

→ Micro-economic effects

•In the current market situation diversion power plants are often not profitable (Missing revenues)

→ Not possible at all locations

Key findings regarding the mitigation measures

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Diversion power plant

- Highest ecological benefits. Renovation of hydro peaking in the entire length of the river.
- Positive impacts on the electricity system and macro-economic effects
- In the current market diversion power plants are often not profitable (Missing revenues)
- Not possible at all locations

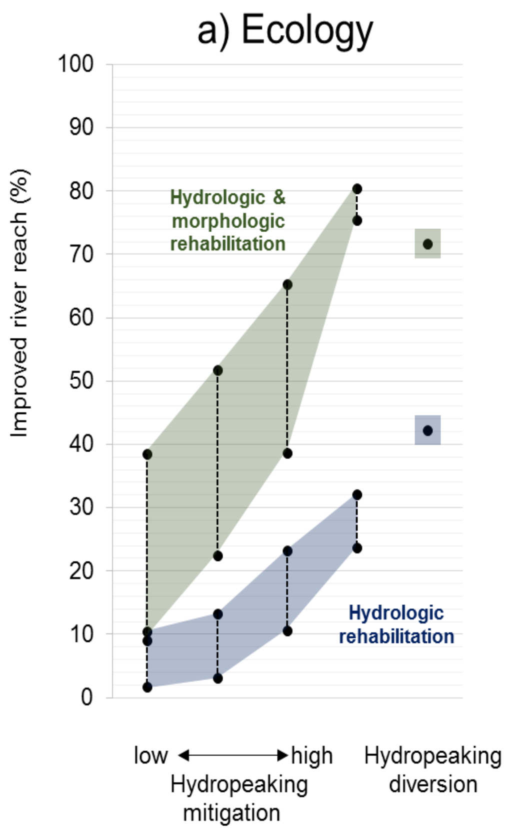
Retention basin

- Ecological benefits regarding down ramp and up ramp rate
- No impacts on the electricity system and macro-economic effects
- Micro-economic effects through investment and operational costs
- Impact on land use and landscape (narrow alpine valleys, availability of land)

Operational restrictions

- Ecological benefit only evaluated for down ramp rate
  - Significant negative impact on the electricity system and macro-economic effects
  - Very strong negative Micro-economic effects

Result - SuremMa



Decision Making Tool

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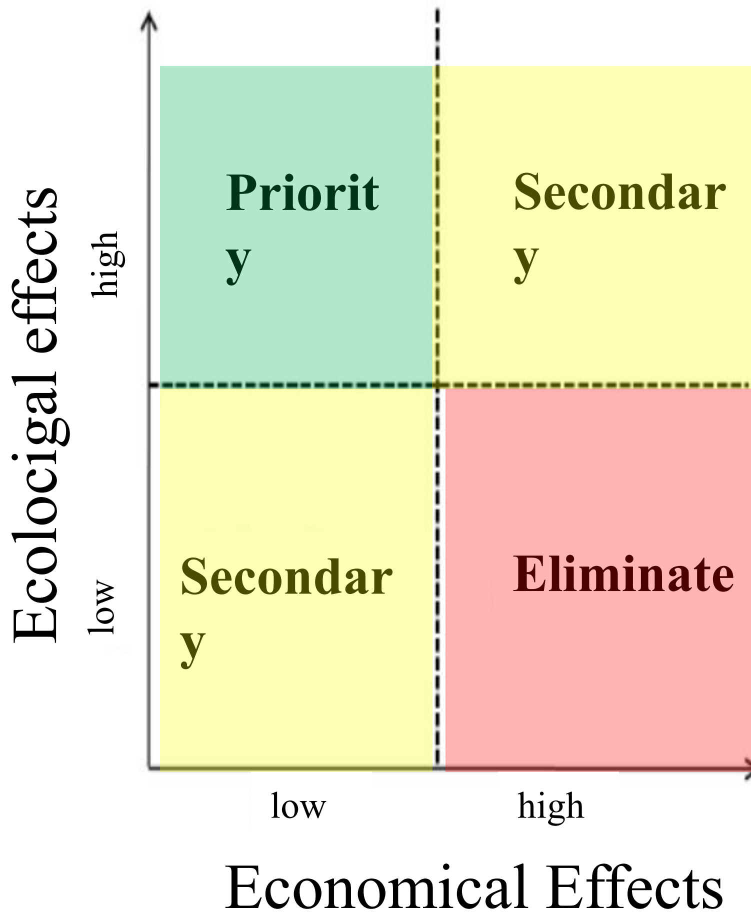

Procedure to meet the target GEP

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1. significant ecological improvement?
2. significant economical restriction?
3. significant impact on use?
4. Balancing between all relevant public interrests, the GEP and the economy to find the less servere measures

	Signifikante ökologische Verbesserung	Signifikante Einschränkung der Nutzung	Unverhältnismäßig Mehrbelastungen
MK1	+	X	X
MK2		X	
MK3	++++		X
MK4	++		
MK5	++		Annahme: Günstiger als MK4
MK6	+++		

Progress, Solutions and Remaining Challenges

Path of challenge:

- **Process of understanding**: common basis = from mutual distrust to mutual trust
- **Fact finding mission** on all fields
- Common discussion and finally acceptance of the facts
- **Based on clear facts** we´ll have to find a common balanced solution

Conclusion for mutual success of implementation WFD

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1. **Ecology:** to be aware of the trade-offs between climate target and WFD – the needed balancing of Wind and PV with Hydro
2. **Economy:** Hydro generators should be aware of the needed fish habitats – e.g. stranding of fishes in the larval stadium
3. **Authority:** the best possible way – support the public interests - for mitigation measures is to utilise the legislative bargained latitude.

Additional Examples of Prosperous Cooperations

Questions?

Please don`t hesitate to contact me

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