Hydro power case study Tyrol

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80 million people, 7 countries, 48 regions, mountains and plains addressing together common challenges and opportunities

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Hydropower (≥ 5 MW) in the alps

>1.000 hydropower plants

166 TWh/a hydropower capacity
- 99 TWh/a run-of-river
- 67 TWh/a storage

63 GW hydropower output
- 20 GW run-of-river
- 43 GW storage

18 GW flexible pumped-storage

300 TWh/a soved fossile energy

70 Mio. tonnes/a saved CO_2

hydropower is the backbone of alpine electricity exonomy

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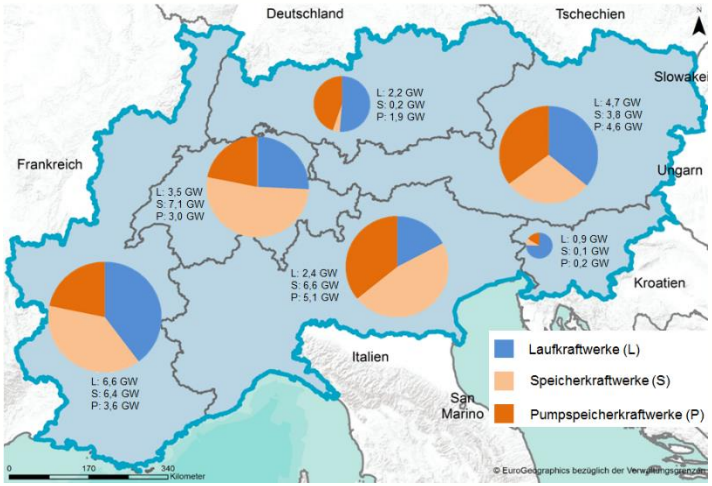
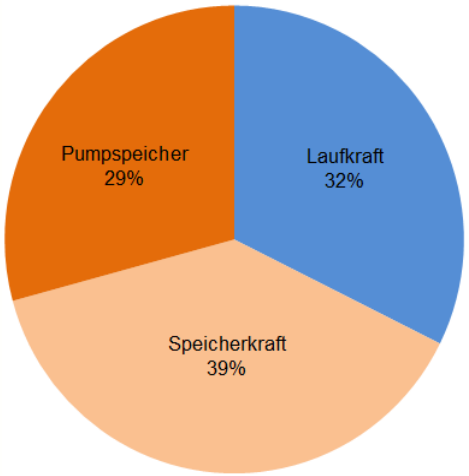
Hydropower (≥ 5 MW) in the alps - more than 63 GW hydropower output in the alps



- 20 GW run-of-river
- 24 GW storage
- 18 GW pumped storage

pumped storage



run-of-river

storage

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Energy Transition Is Everybodies Business

Energy transition causes every European country to use it's own natural generation and storage ressources at it's best.

Targets

- climate protection
- highly efficient use of ressources
- integrate renewables
- guarantee security of supply
- improve energy autonomy
- create socio economic welfare

Challenges

- Public and political acceptance
- volatility of generation
- guarantee system stability
- insure cost effficiency
- pan European Energy System Integration
- cordinated implementation (grid, generation, sector couplling, digitalisation, ...)

World climate change is rapidly ongoing. Temperature rise to be limited to 2°C.

Climate and energy policy as well as public needs to be adopted to these propositons consequently.

Energy transition indeed is a highly complex wide area experiment with an uncertain ending.

System reserves being worn out (Grid, generation, Flex-Tools).

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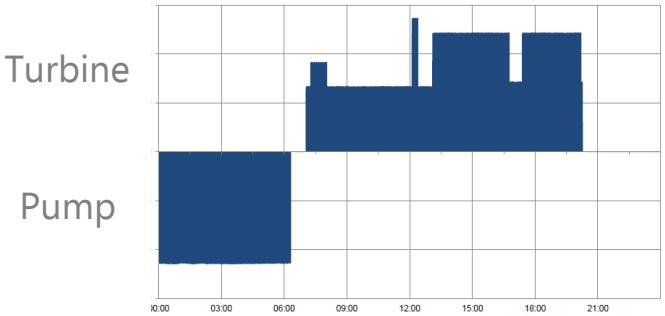
Volatile Renewables Increase System Dynamics
Ref.: TIWAG PHS Kühtai, Sellrain-Silz Group



Daily operational characteristics 2008

volatile

windpower
+
PV

Daily operational characteristics 2018

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Hydropower Meets System Needs

System Needs

- infrastructure to mitigate RES-E curtailment and to improve accomodation of flows
- infrastructure to improve system flexibiltiy (e.g. ramping gradients, storage for all time frames)
- infrastructure to enable grid restoration (black start, …), islanding opertation.
- infrastructure to enable price differentials
- electricity system cost reduction

(Pumped) Hydro Storage System Benefits

- flexibility (capacity and energy) short-, medium-, long term (seasonal)
- balancing services
- ancillary services (LFC, U/Q ctrl, …) and resilience
- black start capability, islanding op.
- GHG emission reduction
- RES-generation by natural inflow
- welfare for touristic areas (trafic nfrastructure, flood protection) and avoided public costs
- Investments for European industry, green jobs and ta

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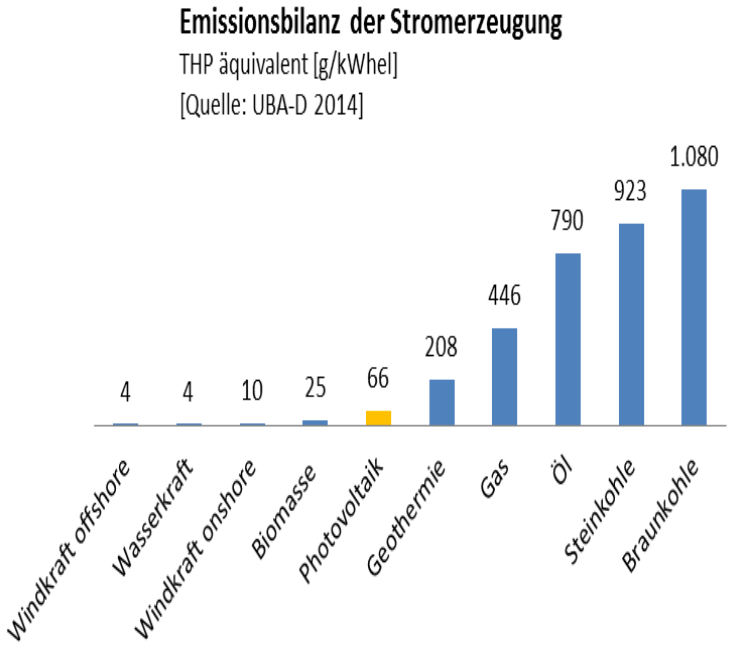
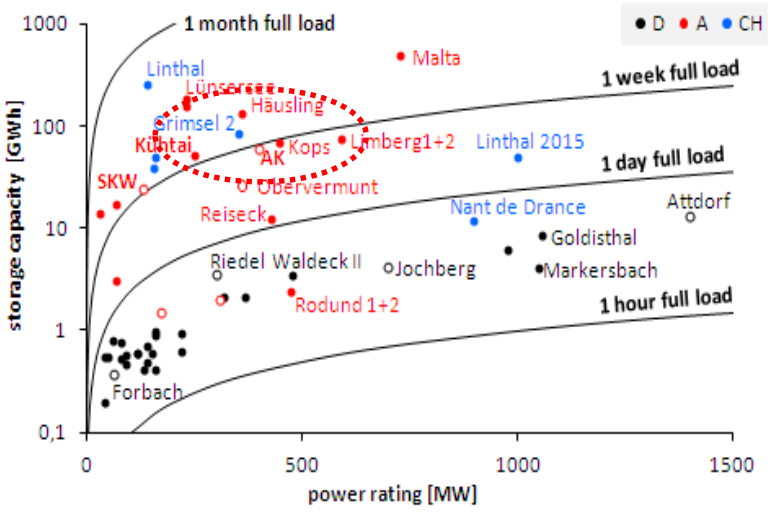
Lifecycle Carbon Footprint



AT 4 g/kWhel, hydropwer and offshore sind power have by far the best lifecycle carbon footprint of all electricity generation technologies currently in use (ef.: UBA-D, 2014)

Life cycle analysis!

Alpine PHS Capacity to Complete Low Mountain Range Sites



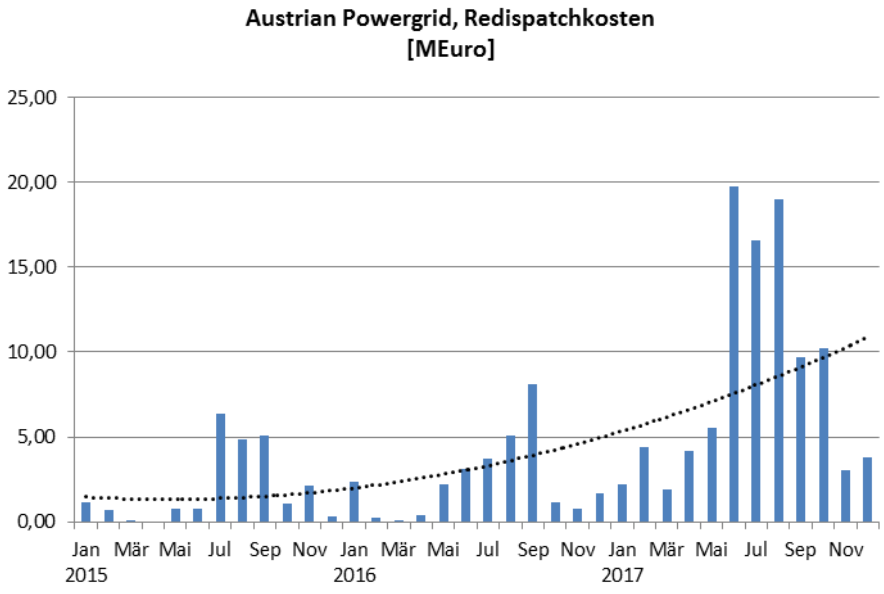
[Ref.: EE, BES/TIWAG 2018]

Reservoir – volumes and drop hights limit German hydro power storage facilities for short-term operation to a maximum of 1 day.

All relevant strategy studies expect from 2030 on a significant increase of medium and seasonal storage when baseload capacity is reduced stepwise and renewables' share becomes dominant.

The challenges until 2030 can be met mainly by increased power installation (turbines and pumps) while post 2030 power and energy storage is needed urgently.
New Alpine HPS reservoirs will meet these challenges by progressive power and capacity development.

Thermal Drop Off Also Longs For Redispatch Replacement



Ref.: APG Austrian Power Grid, Jan. 2018

PV and wind power cause wide area loop flows in the European electricity system. Austrian tie lines are affected.

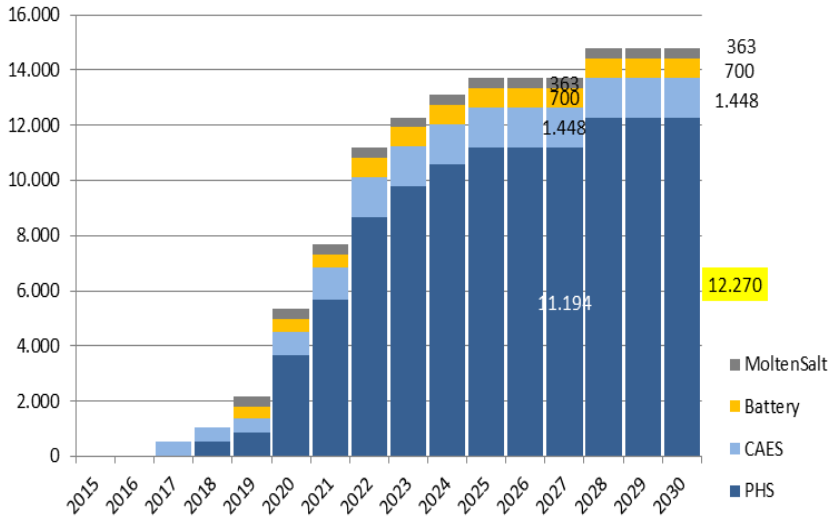
The Austrian transmission system more and more is at it's thermal edge.

Redispatch demand increases exponentially.

Highly flexible hydropower (storage and pumped storage) will be the most important solution to replace thermal redispatch capacities.

More Than Ever PHS Is the European System Stability Backbone

Ref.: ENTSO-E, TYNDP 2016



PHS = Pumped Hydro Storage
CAES = Compressed Air Energy Storage
Battery = large central battery storgae
Molten Salt

Within the coming 15 years in total additional approx.
15 GW storage capacity will be installed in the European electricity system.

Expected investment: 15 bn Eur.

Highly efficient pumped hydro storage plants share 12 GW (83%) comparably at low price.

Austrian projects share approx. 11 %.

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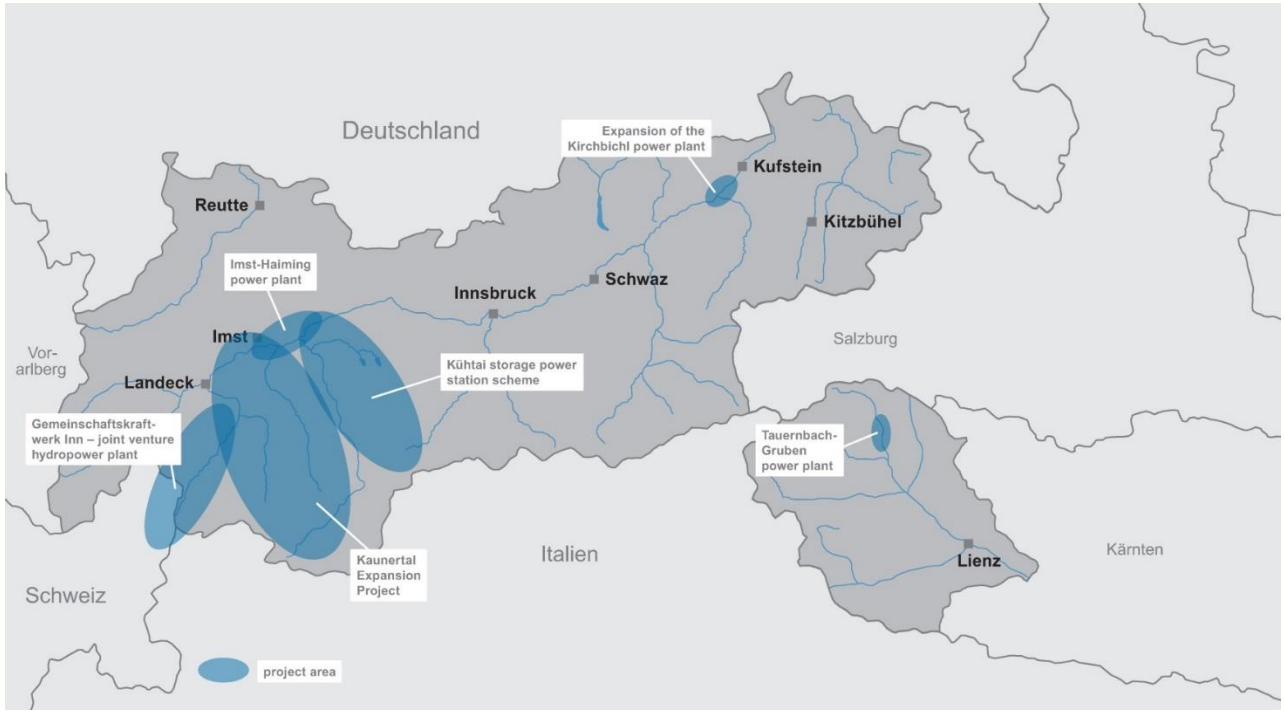
Locations of TIWAG development projects



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TIWAG development projects

Kaunertal Power Plant Expansion

New Components

- Platzertal reservoir (new)
- Versetz pumped storage power plant
- Prutz 2 power plant
- Imst 2 power plant
- Headrace channels
- Transmountain water diversion tunnel: 23 km
- Water intakes (in the back of Ötztal Valley)
- Capacity: 1.013 MW
- Average working capacity per year (total): 787 GWh

TIWAG development projects

Kühtai Storage Power Plant

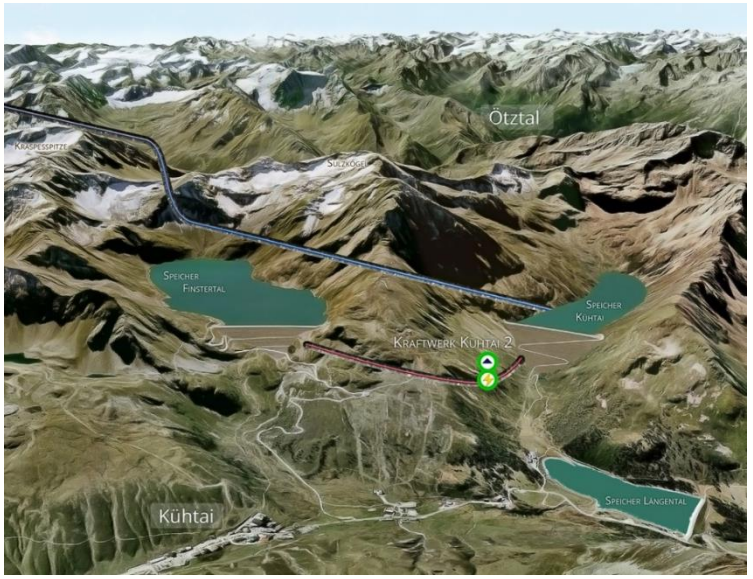
The **Kühtai storage power plant** scheme is an extension to the existing Sellrain-Silz series of power plants. The construction of the new Kühtai 2 pumped storage power plant and the Kühtai reservoir will ensure that renewable energy can be generated without temporal constraints and create a storage installation for power from other renewables.

Facts & Figures

- Mean capacity of Kühtai 2 power plant
  - In trubine mode: 130 MW
  - In pump mode: 140 MW
- Average working capacity per year: 260 GWh
- Electricity needed for pumping: 44 GWh
- Transmountain water diversion tunnel: 25.5 km
- Catchment area: 68.3 sq. km

New Components

- Kühtai reservoir
- Kühtai 2 power plant
- Water diversion gallery with six water intakes



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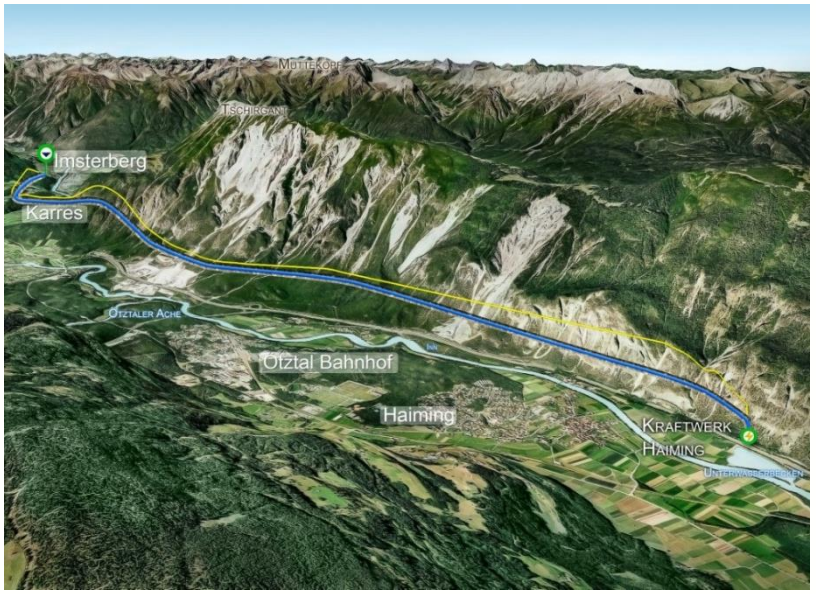
TIWAG development projects

Imst-Haiming Power Plant

The **Imst-Haiming power plant** scheme on the River Inn has been designed as a diversion power plant which will be connected to the existing Prutz-Imst power plant.

Aim: Haiming powerhouse will only use water already harnessed by the existing Prutz-Imst plant to generate electricity. Therefore, no further water will be abstracted from the River Inn at Imst.



Facts & Figures

- Rated capacity of turbines: 43.5 MW
- Average working capacity per year: 270 GWh
- Design flow: 85 cubic meters per second
- Catchment area: 2.885 sq. km
- Mean head: 63 metres

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Kirchbichl Power Plant Expansion

The **Kirchbichl power plant** will be repowered (its efficiency increased) through the construction of a residual flow power station and an additional powerhouse**.** Furthermore, the development scheme will significantly enhance flood protection at the existing facility, guarantee safe fish passage und refurbish the existing headrace channel.

Facts & Figures

- Total capacity (after completion): approx. 38 MW
- Average working capacity per year (after completion): 165 GWh
- Catchment area: 9.310 sq. km
- Max. head (existing and new powerhouse): 9.7 metres
- Max. head (residual flow power station): 6 metres
- Construction completion: 2021

TIWAG development projects

Tauernbach-Gruben Power Plant

The **Tauernbach-Gruben power plant** has been designed as a diversion power plant with a water intake in the area of the Schildalm mountain huts and a powerhouse below the transalpine oil pipeline pumping at Gruben in East Tyrol.

Facts & Figures

- Capacity: 27 MW
- Average working capacity per year: 85 GWh
- Design flow: 9 cubic metres per second
- Catchment area: 78 sq. km
- Gross head: 380 metres
- Pressure tunnel: 2.2 km
- Penstock: 6.1 km

TIWAG development projects

Upper Inn Joint Venture Hydropower Plant

'**GKI**' stands for **Gemeinschaftskraftwerk Inn GmbH**, a company whose project partners are TIWAG-Tiroler Wasserkraft AG (86 %) and Engadiner Kraftwerke AG (14 %).

Facts & Figures

- Project Area: at the Swiss-Austrian border
- Capacity: 89 MW
- Average working capacity per year: 446 GWh
- Design flow: max. 75 cubic metres per second
- Catchment area: 1.960 sq. km
- Gross head: 160 metres
- Construction completion: 2020/2021

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Recomendations for EUSALP

- Build acceptance for PHS
  - National Goverments
  - NGOs
  - Citizens
- Public subsidies must not only include PV end wind but also hydropower