Alpine Hydropower -
Enabler of the Energy Transition

IMC 2019, Innsbruck, WS 3.1 E

Gottfried Gökler

illwerke vkw

Energie für Generationen.

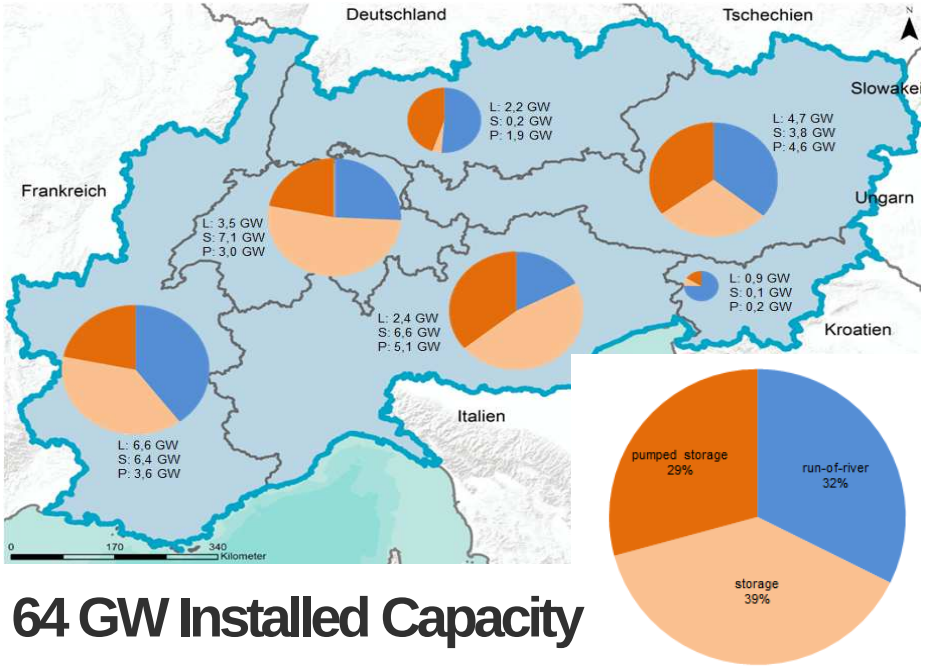
Hydropower in the Alps – Studies by AGAW ("Alpine Hydropwer")

"Status and Outlook of Hydropower Generation in the Alpine Region" (December 2017)

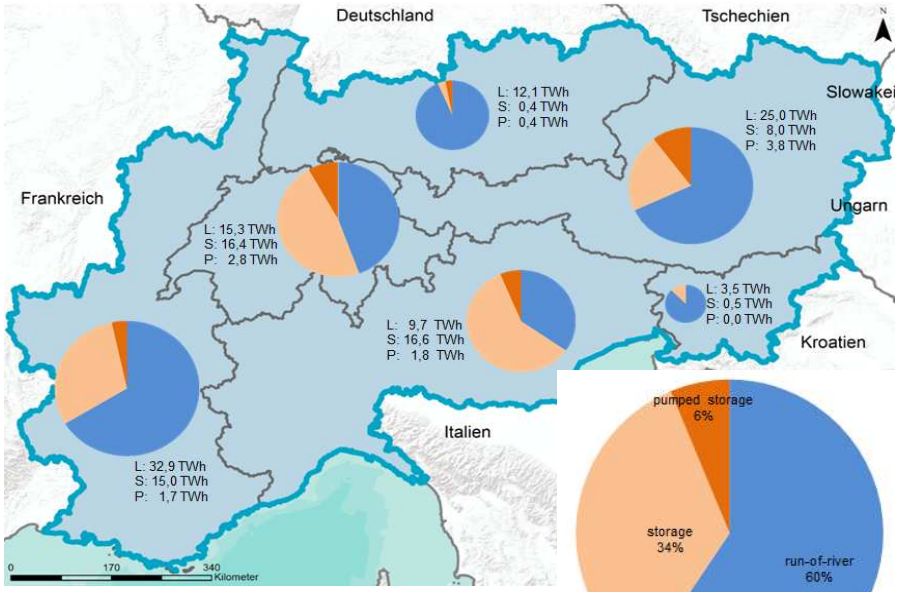
"Hydropower & Flexibility" (in preparation)

– The Alpine region: facts & figures

> 1,000 Hydroelectric Power Plants (≥5 MW) in the Alps



64 GW Installed Capacity



Energy Capability : 166 TWh/a

Hydropower in the Alps – Studies by AGAW ("Alpine Hydropwer")

"Status and Outlook of Hydropower Generation in the Alpine Region" (December 2017)

– The Alpine region: facts & figures

>1,000 hydroelectric power plants
(above 5 MW)

166 TWh/a generation
- 99 TWh/a run-of-river
- 57 TWh/a storage
- 10 TWh/a pumped storage (only natural inflow)

64 GW capacity
- 20 GW run-of-river
- 44 GW storage

18 GW highly flexible pumped storage capacity

300 TWh/a avoided fossil energy

70 mio. tons/a avoided CO_2

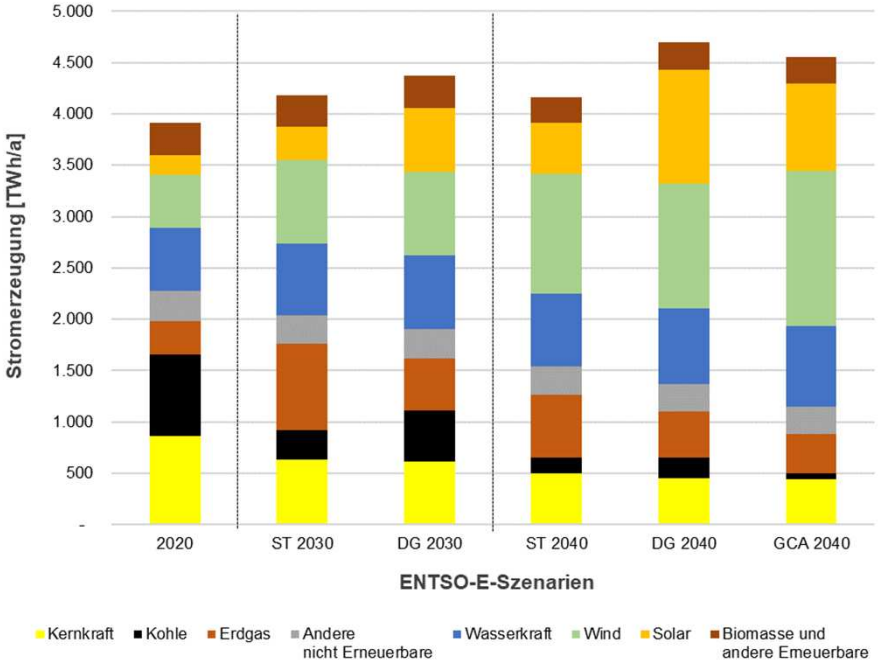
Hydropower is the backbone of the Alpine electricity generation

HP in the Alps takes on a key role in the stabilisation of a more and more volatile power grid

Prospects of the Energy Transition ("Energiewende")

ENTSO-E SCENARIOS (2030/2040)

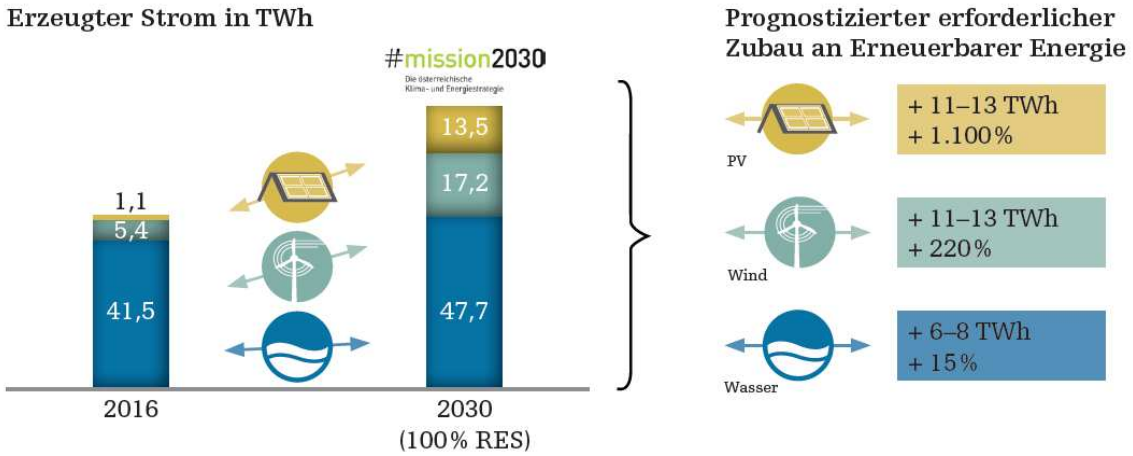
electricity generation mix 2040:
fossil and nuclear energy falls within all scenarios,
high increases of volatile RES (wind and PV),
constant generation from Hydro power



Source: TYNDP; Ten-Year Network Development Plan [ENTSO-E, 2018]

AUSTRIAN ENERGY STRATEGY #2030

Target 2030: 100% electricity generation from RES,
enormous installation of volatile RES (wind and PV), expansion of Hydro power generation
(Total technical –Economical potential 11 TWh)

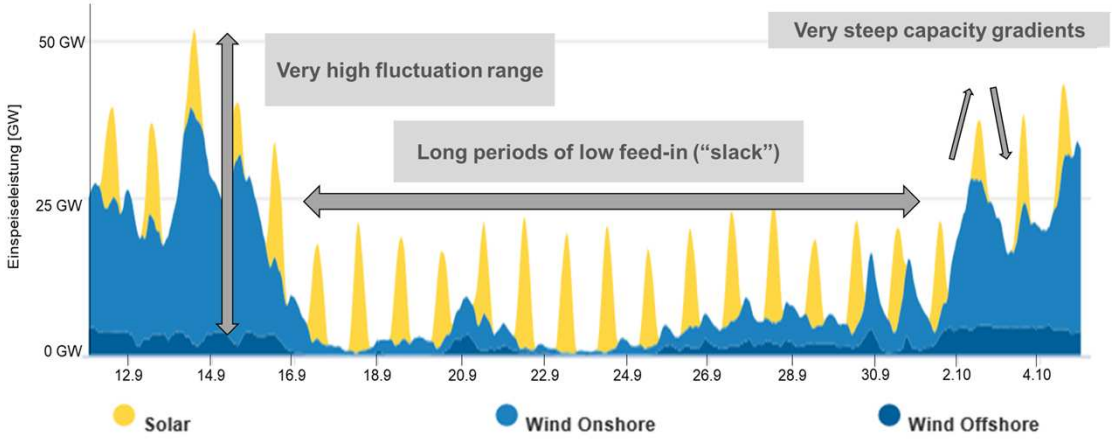


Quelle: Oesterreichs Energie 2018; Energieagentur Österreich 2018, TU Wien 2018 gemäß #mission2030 – Klima- und Energiestrategie der Bundesregierung

Energy Transition: Consequences

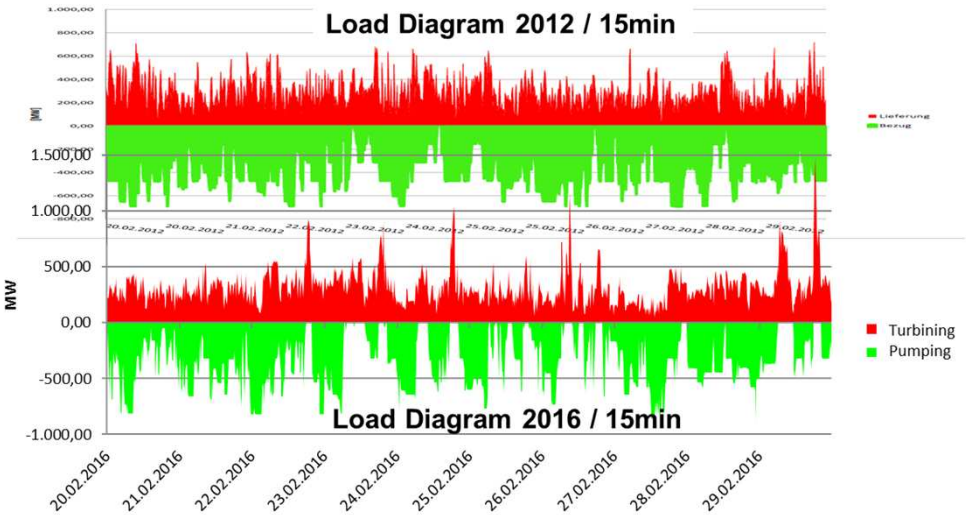
The expansion of electricity generation from wind and photovoltaic leads to higher volatility

EXAMPLE: WIND AND PHOTOVOLTAIC FEED-IN – GERMANY: 11/09 TO 05/10/2017 [GW]



Source: based on Agora Energy Revolution (2019): Agorameter

GENERATION ILLWERKE VKW – HP PLANT GROUP OBERE ILL-LÜNERSEE



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

Need for STORAGE and FLEXIBILITY !

- **Flexibilitiy of HP especially pumpstorage is essential for the integration of volatile RES (wind, PV)**
- **Quality: Flexible from seconds to weeks, steep ramps**
- **Quantity in Europe: Alpine region,** Scandinavia

Solutions for flexibility: Pumpstorage & Ternary machinery sets

The flexible operation can exactly fulfill the demand of the volatile energy market!

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
- fast mode changes: 20 sec. ±450 MW until 0 load
- 40 sec. from full load pump to turbine operation

OBERVERMUNTWERK II –
2 TERNARY UNITS WITH FRANCIS TURBINES

Started in operation 2018:

- fully adjustable turbines from 100% to 0% without any part-load limit and without additional air for stabilizing francis turbine
- Additional sets to Kops II (“backbone”)
- 30-40 sec. ±360 MW until 0 load, 60 sec. from full load pump to full load turbine operation

Conclusions and possible Solutions:

Climate and energy strategies are creating high pressure on the Alpine regions

Storage options:

- Improving the utilisation of existing reservoirs
- Sustainable sediment management
- Smooth heightening of existing dams for enlarging storage volume
- glacier retreat: new reservoirs?

Flexibility options:

- Pumpstorage: Mature technology and examples for Flexible HP
- Reapproval: preservation and upgrading of existing HP-plants
- Improving of plant-efficiency

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