START2030

ATLANTIS - Simulation model of the European electricity economy

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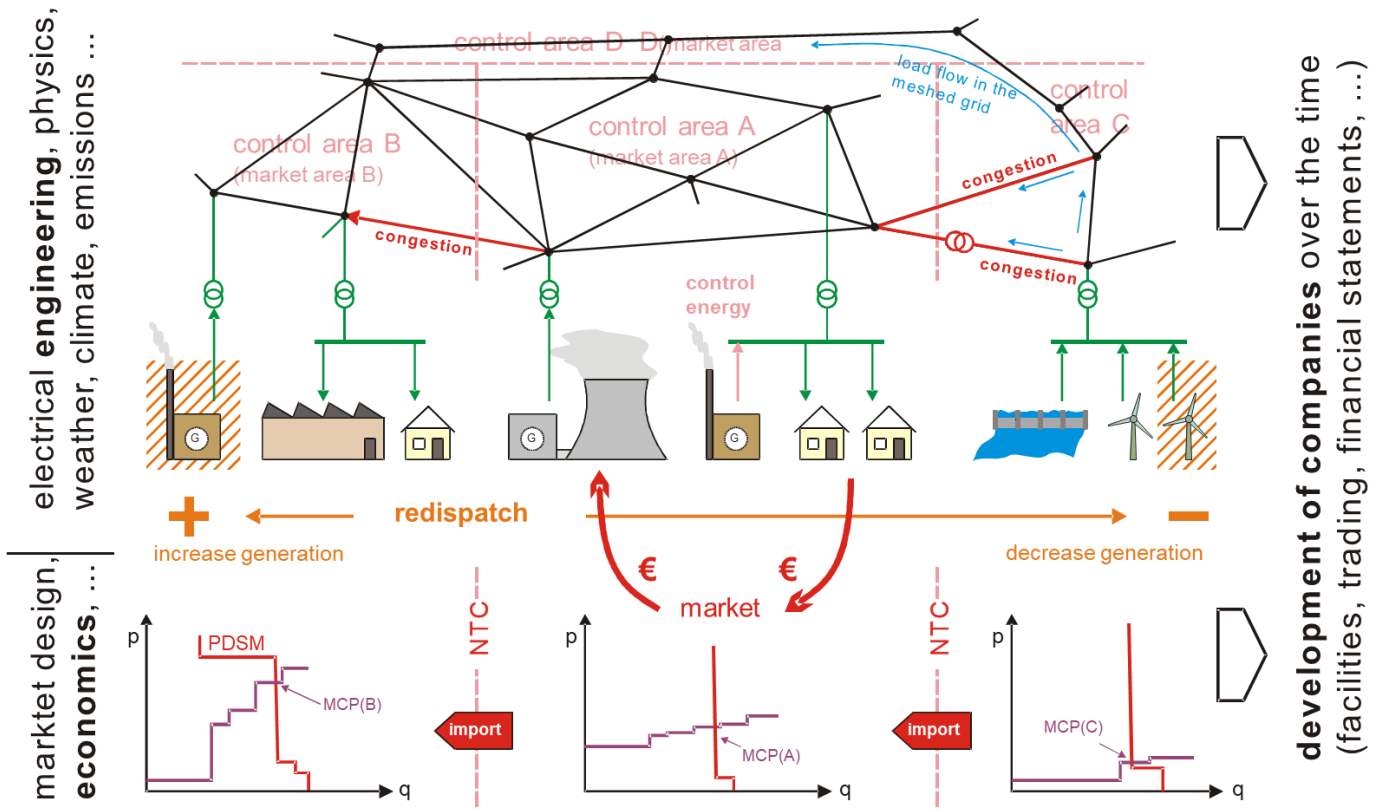
WIFO TU Graz CESAR Centre of Economic Scenario Analysis and Research

- Multifunctional **scenario model** (for alternatives to be examined)

- Combination of a **physical model**
  - power plants,
  - transmission lines,
  - power demand,
  - load flow
- with a **economic model**
  - stock exchanges,
  - market prices,
  - balance sheets,
  - profit and loss account



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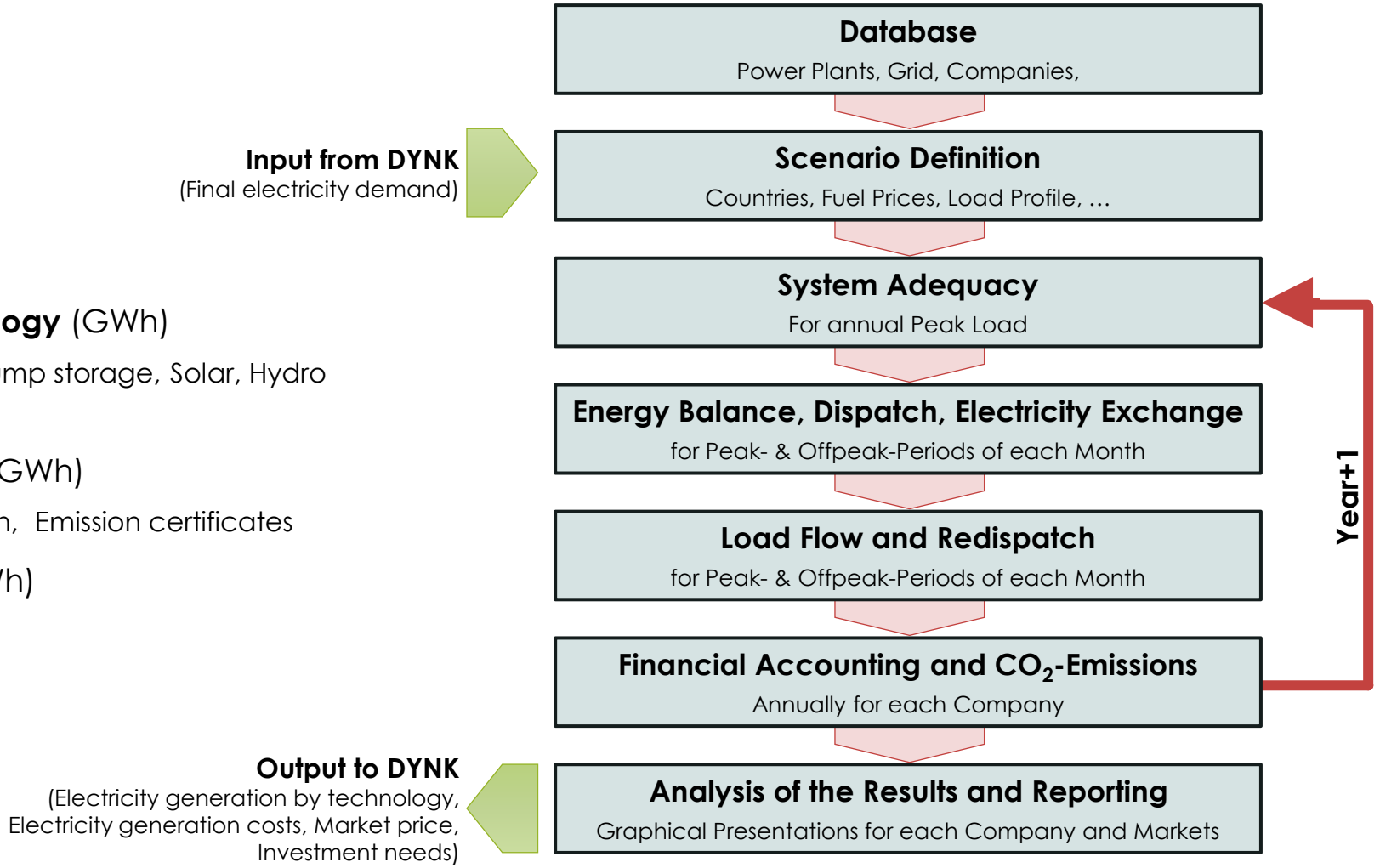
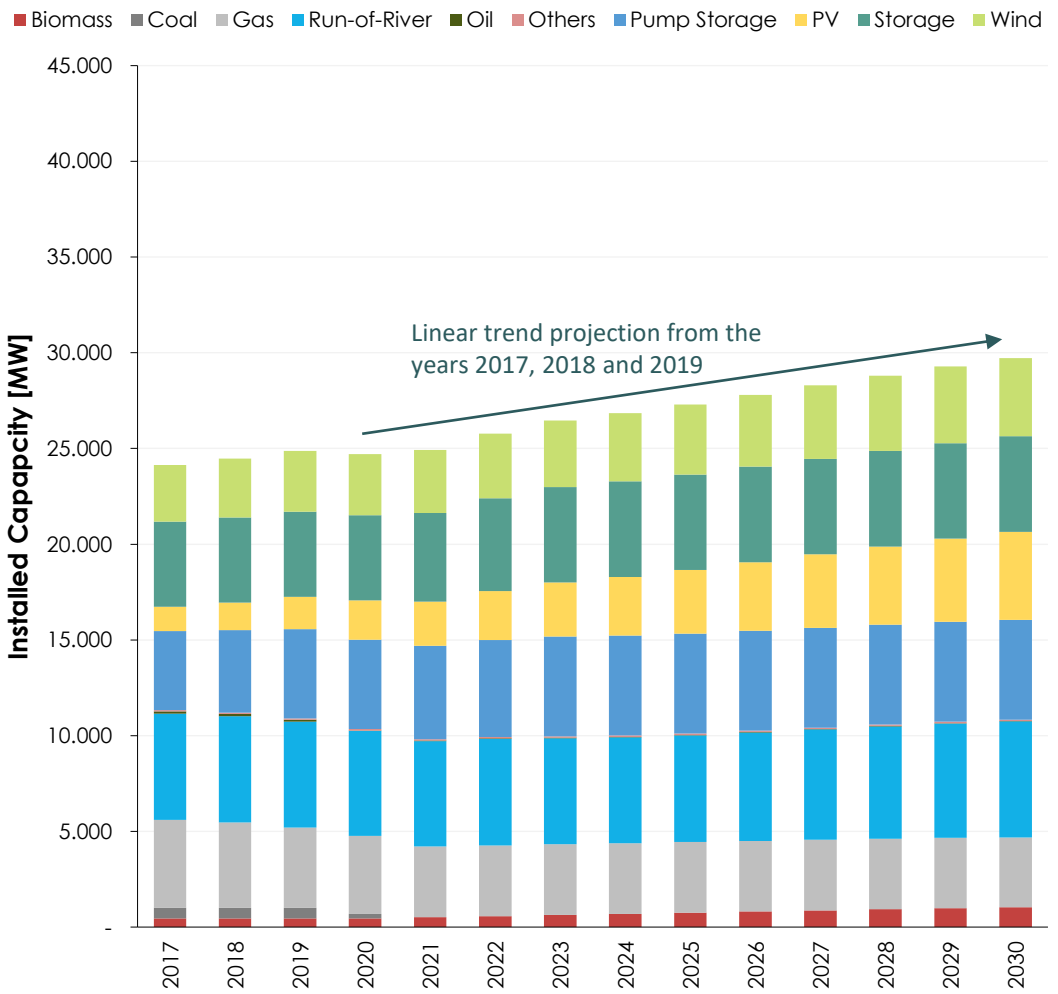
- DYNK ➔ ATLANTIS
  - **Final electricity demand** (TWh)

- ATLANTIS ➔ DYNK
  - **Electricity generation by technology** (GWh)
    - Biomass, Coal, Gas, Hydro, Oil, Pump storage, Solar, Hydro storage, Wind, Battery
  - **Electricity generation costs** (per GWh)
    - Fuel, Personal, O&M, Depreciation, Emission certificates
  - **Market price** (Whole sale) (€/kWh)
    - Short term costs & grid costs
  - **Investment needs** (€/MW)
    - Power plants

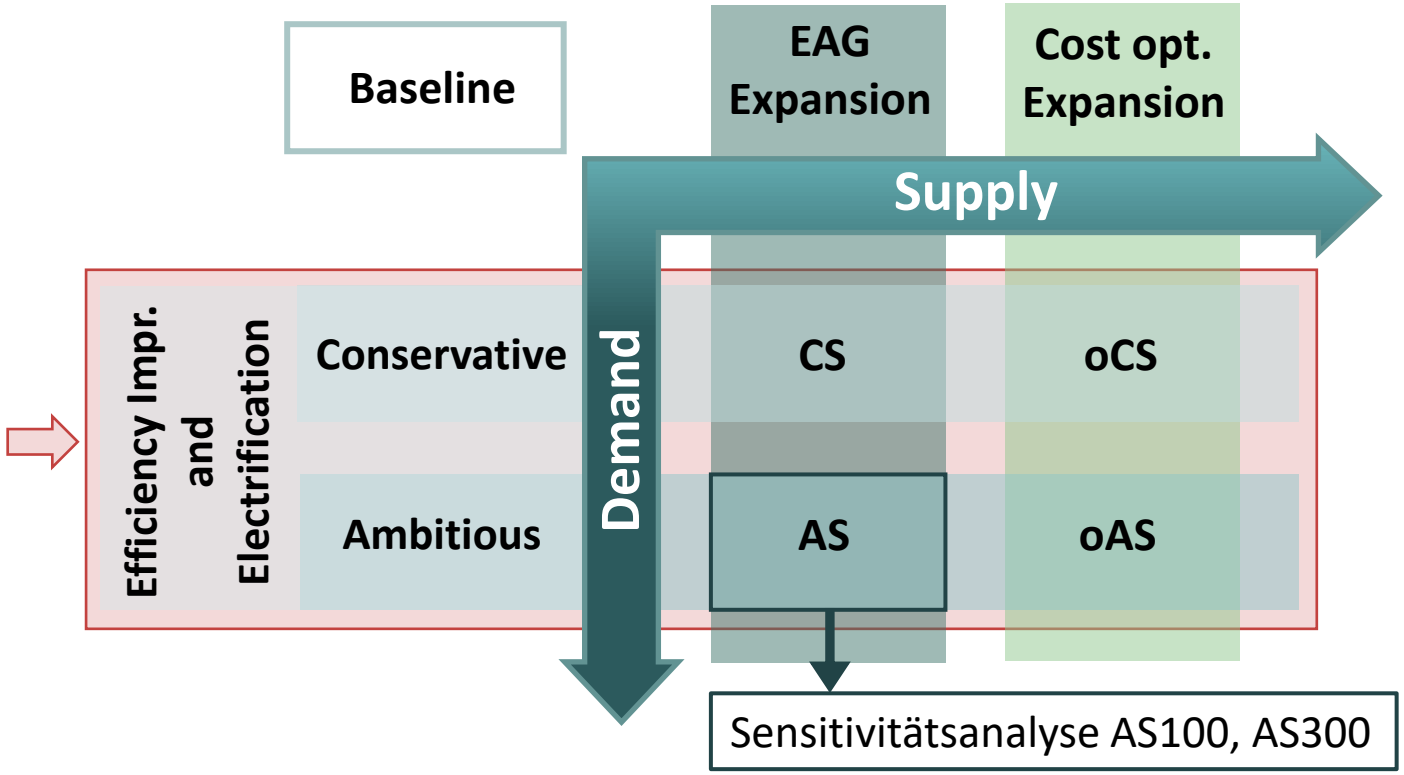


- 1 Baseline scenario
  - **Linear trend projection** of the **change** of **installed capacity** from the years **2017**, **2018** and **2019**



Scenarios Austria

- 1 Baseline scenario
  - **Linear trend projection** of the **change** of **installed capacity** from the years **2017**, **2018** and **2019**
- Matrix with 4 other scenarios
  - **Conservative** and **ambitious efficiency improvements** (different demand)



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  - **Linear trend projection** of the **change** of **installed capacity** from the years **2017**, **2018** and **2019**
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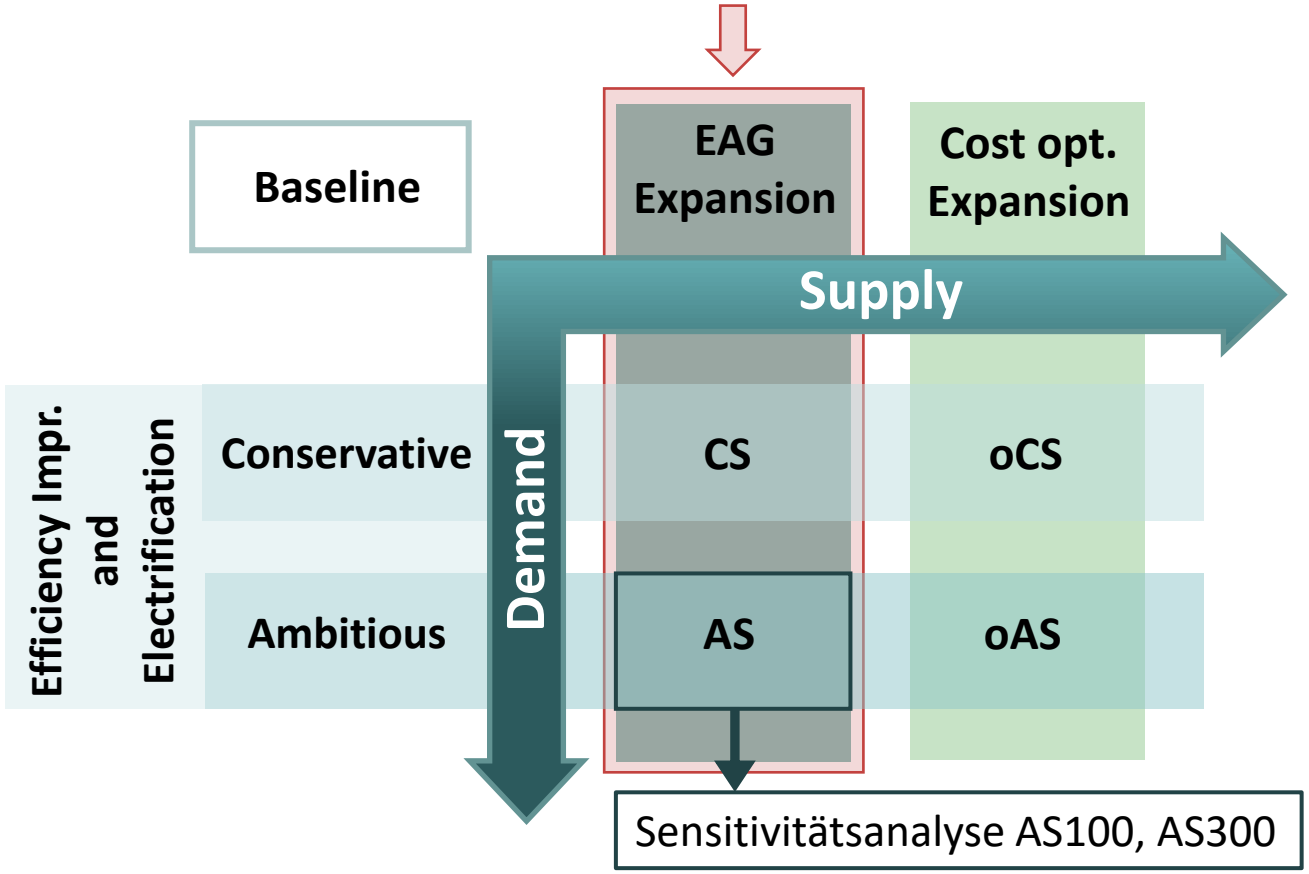
  - **EAG Expansion**
    - **CS** and **AS** with **same expansion** of **installed capacity** to **reach EAG**



Scenarios Austria

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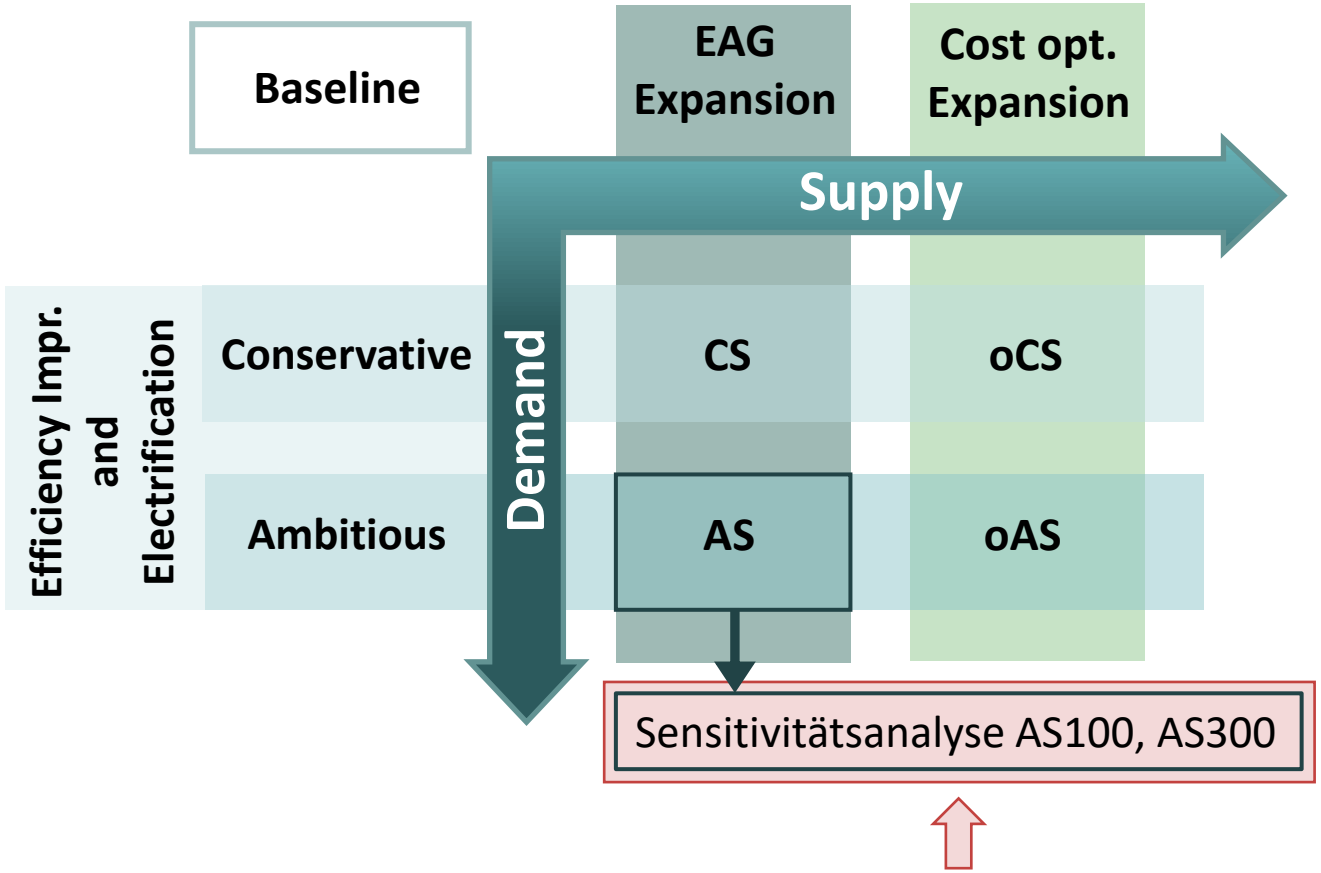
    - **Sensitivity analysis** for **gas price** based on AS



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Scenarios Austria

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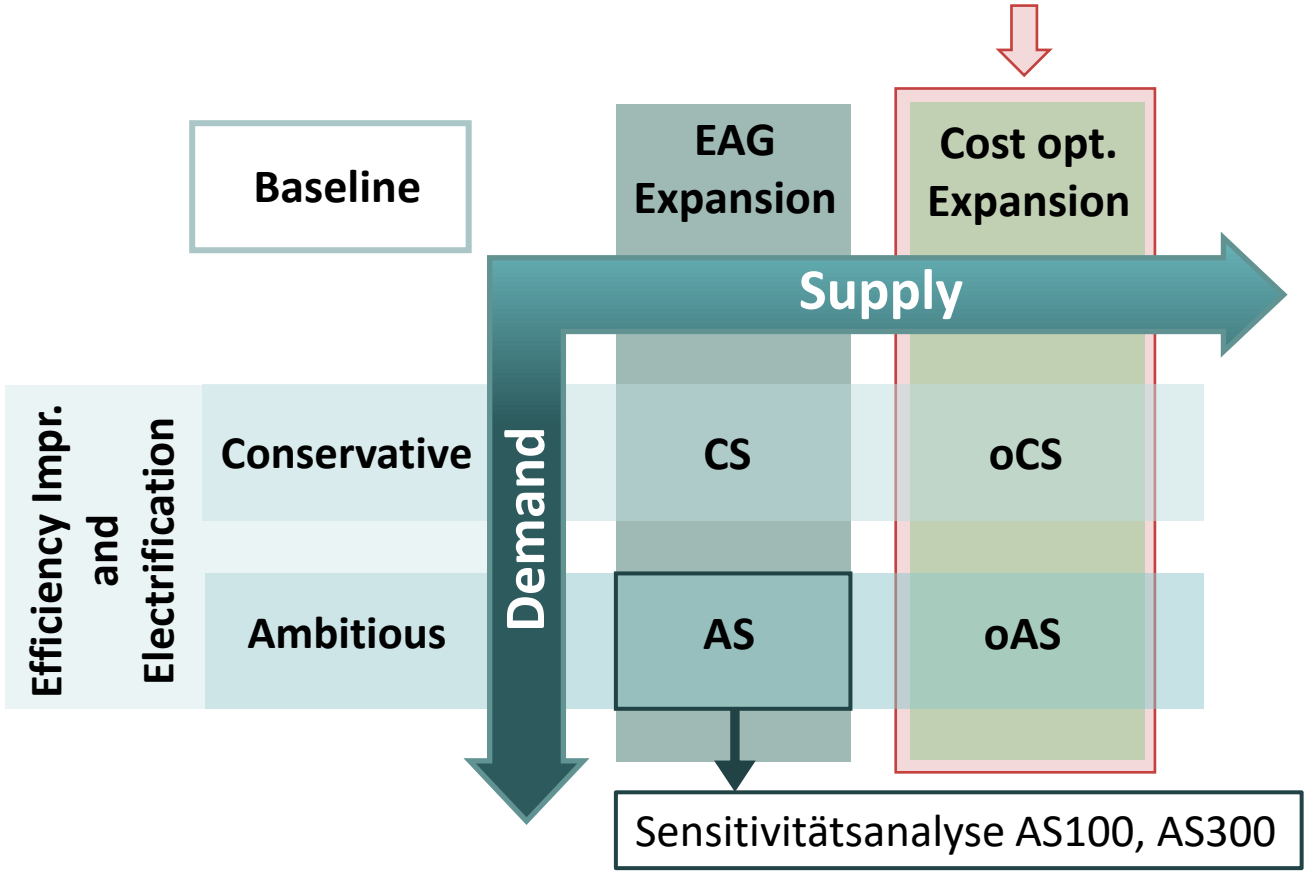
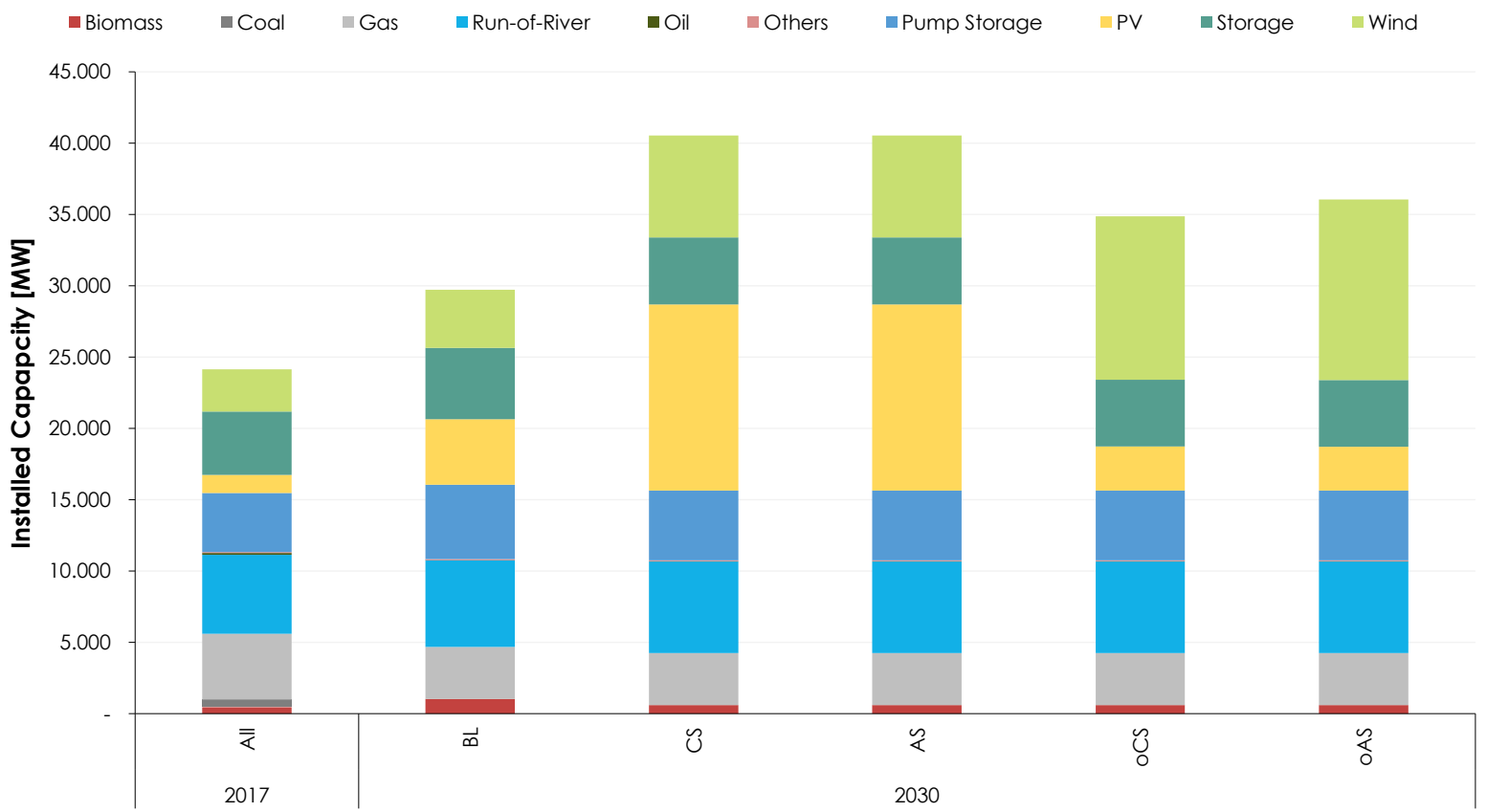
  - **Linear trend projection** of the **change** of **installed capacity** from the years **2017**, **2018** and **2019**
- Matrix with 4 other scenarios
  - **Conservative** and **ambitious efficiency improvements** (different demand)
  - **EAG Expansion**
    - **CS** and **AS** with **same expansion** of **installed capacity** to **reach EAG**
    - **Sensitivity analysis** for **gas price** based on AS
  - **Cost optimized Expansion**
    - **Different expansion** of **installed capacity** for **oCS** and **oAS** because it is also **based** on **demand**



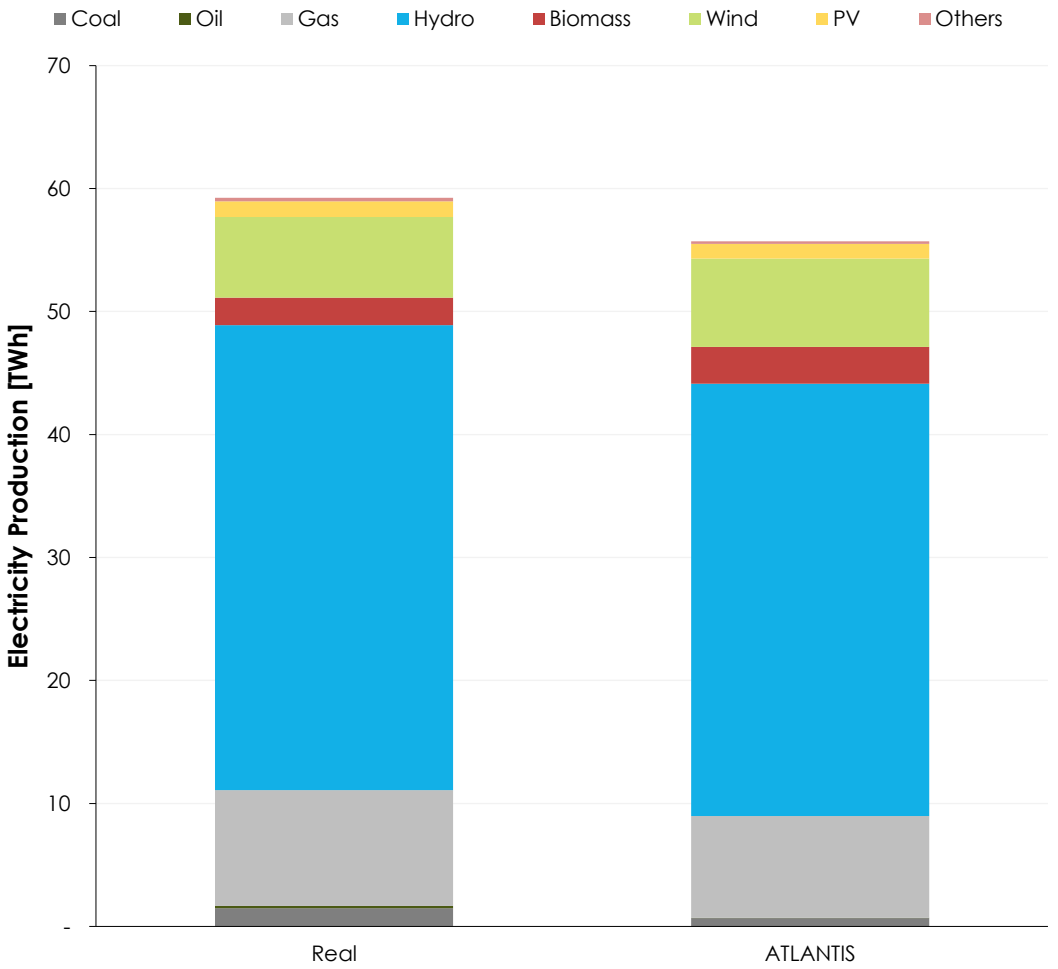
Installed Capacity for 2017 (all scenarios) and 2030



Model Calibration
Based on year 2017

- **6% difference** between real production and ATLANTIS

- **Mainly** due to **hydro production**
  - Based on **average weather year** ➔ variability from year to year not depicted
  - **Over-calibrating** hydro production in 2017 would have lead to **too high production in following years**



Source Real values: Gesamtenergiebilanz Österreich

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Results

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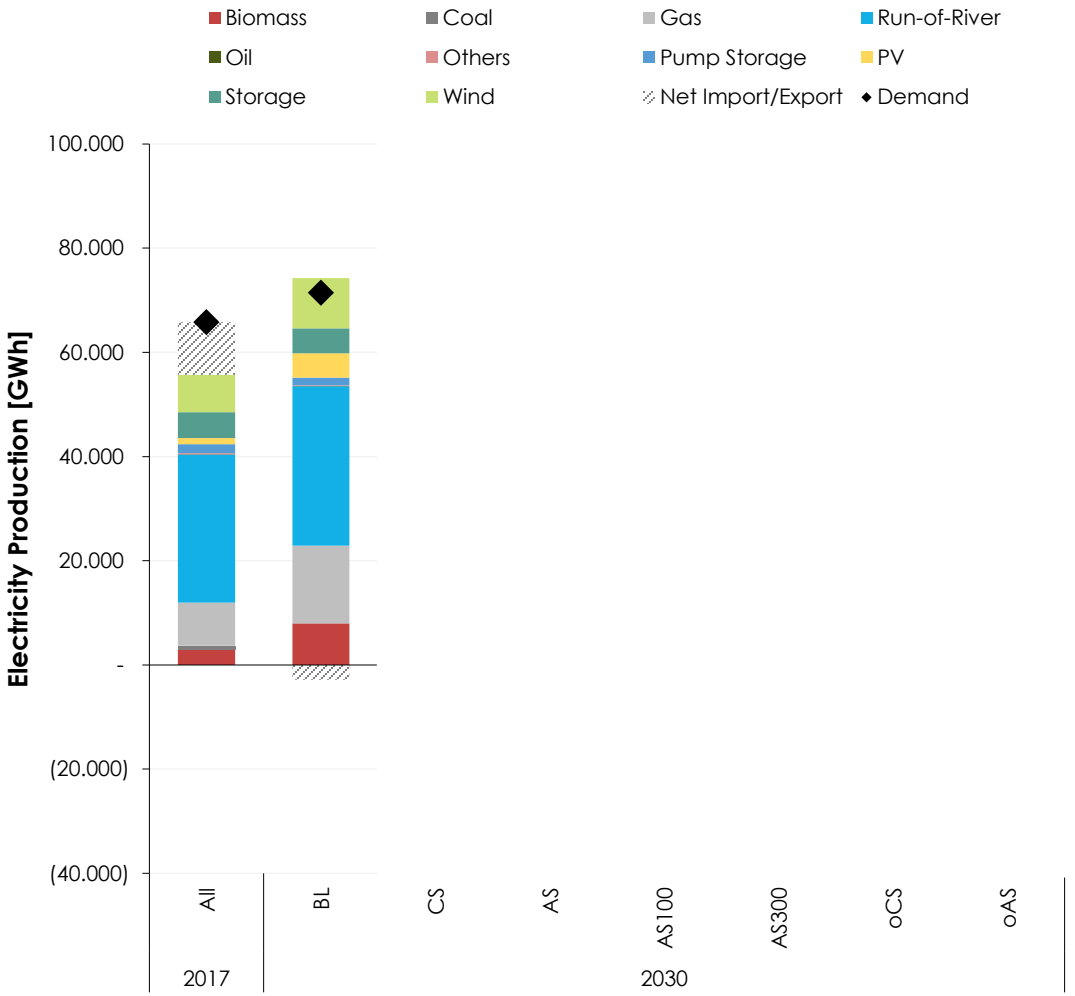
Results
Electricity Production (2030 compared to 2017)

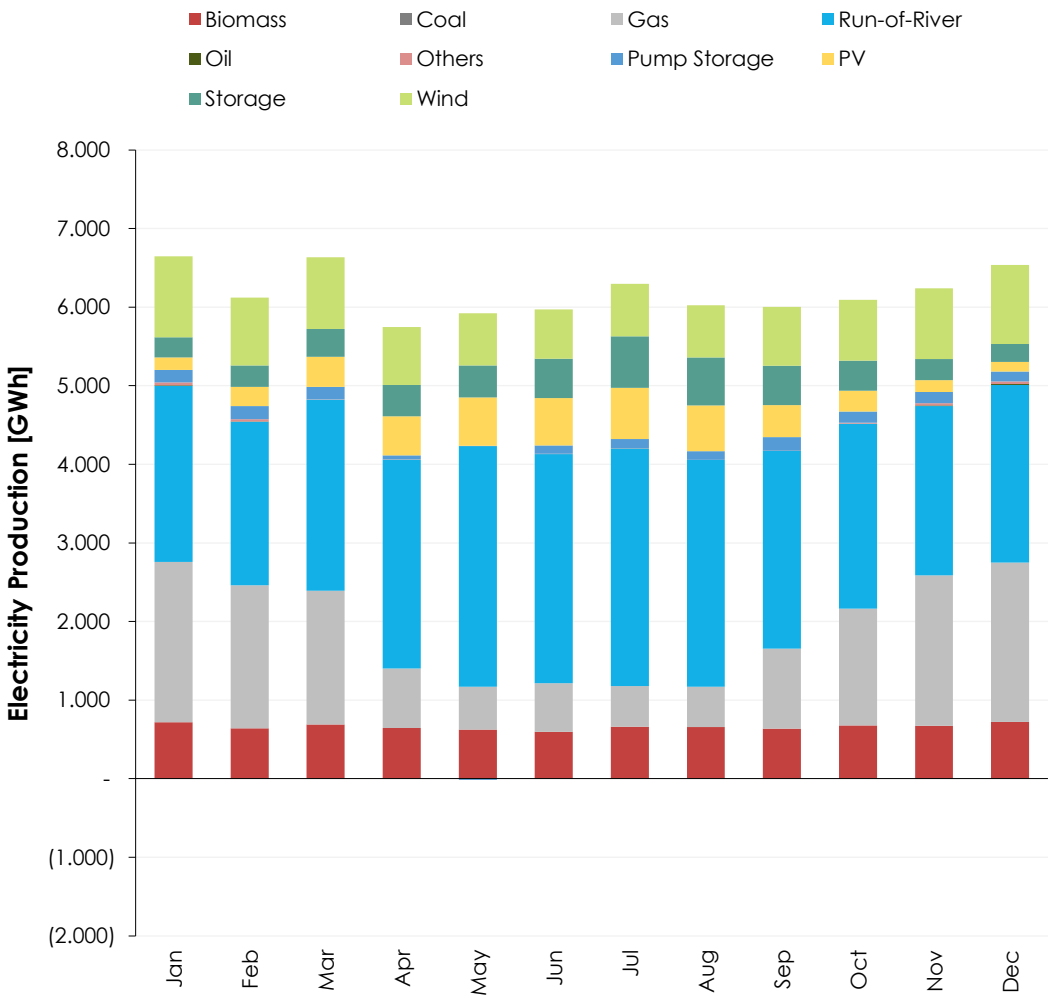
- **Baseline Scenario** (BL)
  - +5,0 TWh Biomass
  - +6,7 TWh Gas
  - +1,7 TWh Hydro [RoR & (Pump) Storage]
  - +3,5 TWh PV
  - +2,4 TWh Wind

- **Growth in renewables plus increased gas production** leads to **export** in 2030



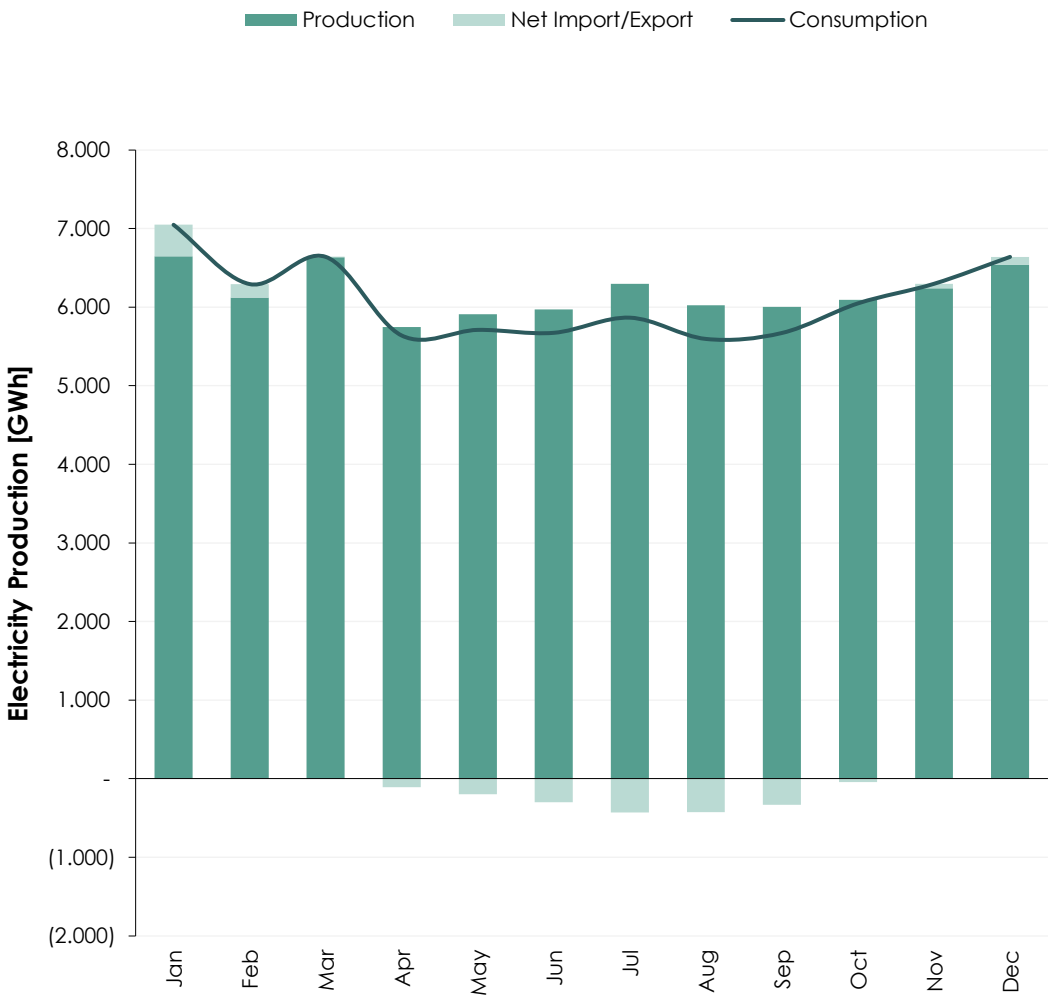
Results
Monthly Electricity Production – Baseline Scenario

- **More gas** needed in **winter months**
  - Higher demand
  - Less PV production
  - Less Run-of-River production



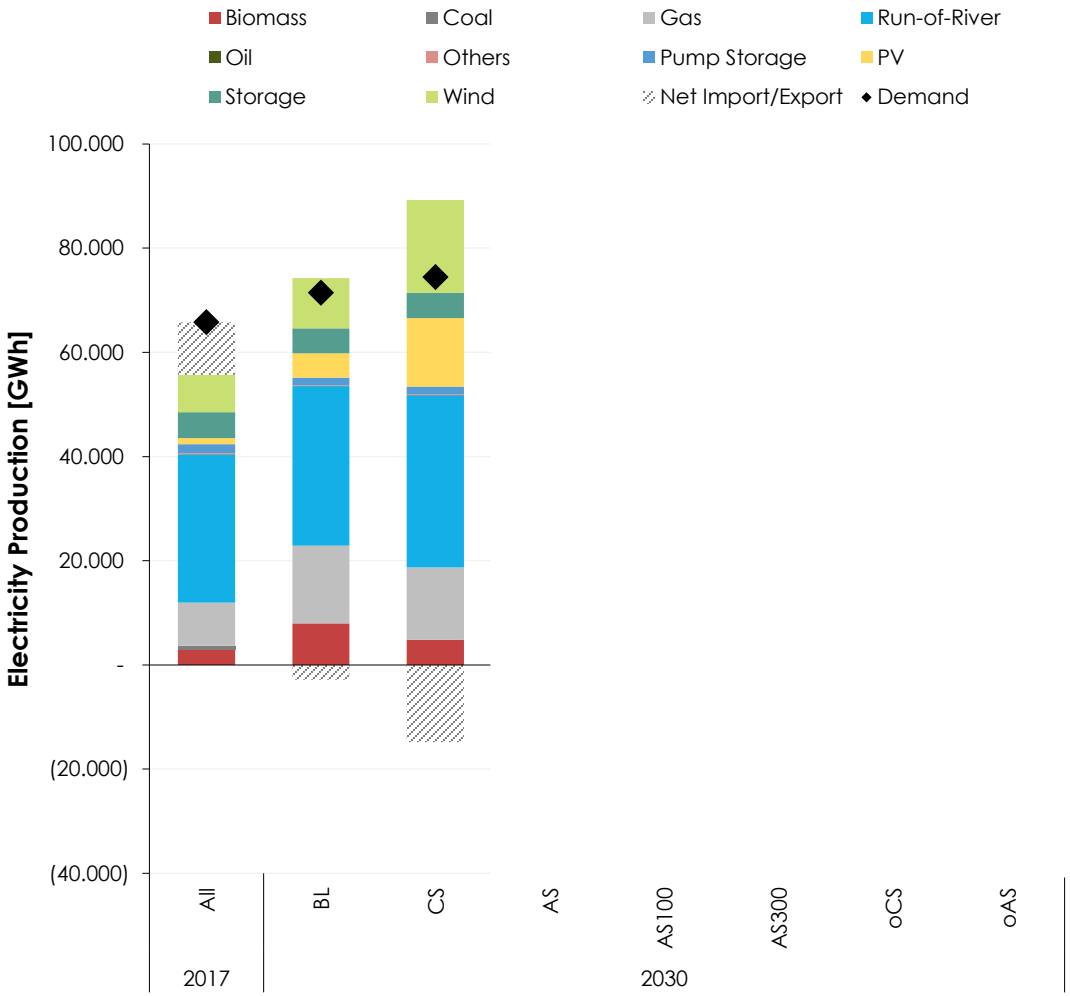
Results
Monthly Electricity Production – Baseline Scenario

- **More gas** needed in **winter months**
  - Higher demand
  - Less PV production
  - Less Run-of-River production
- **Net-Imports** mainly in **winter months**



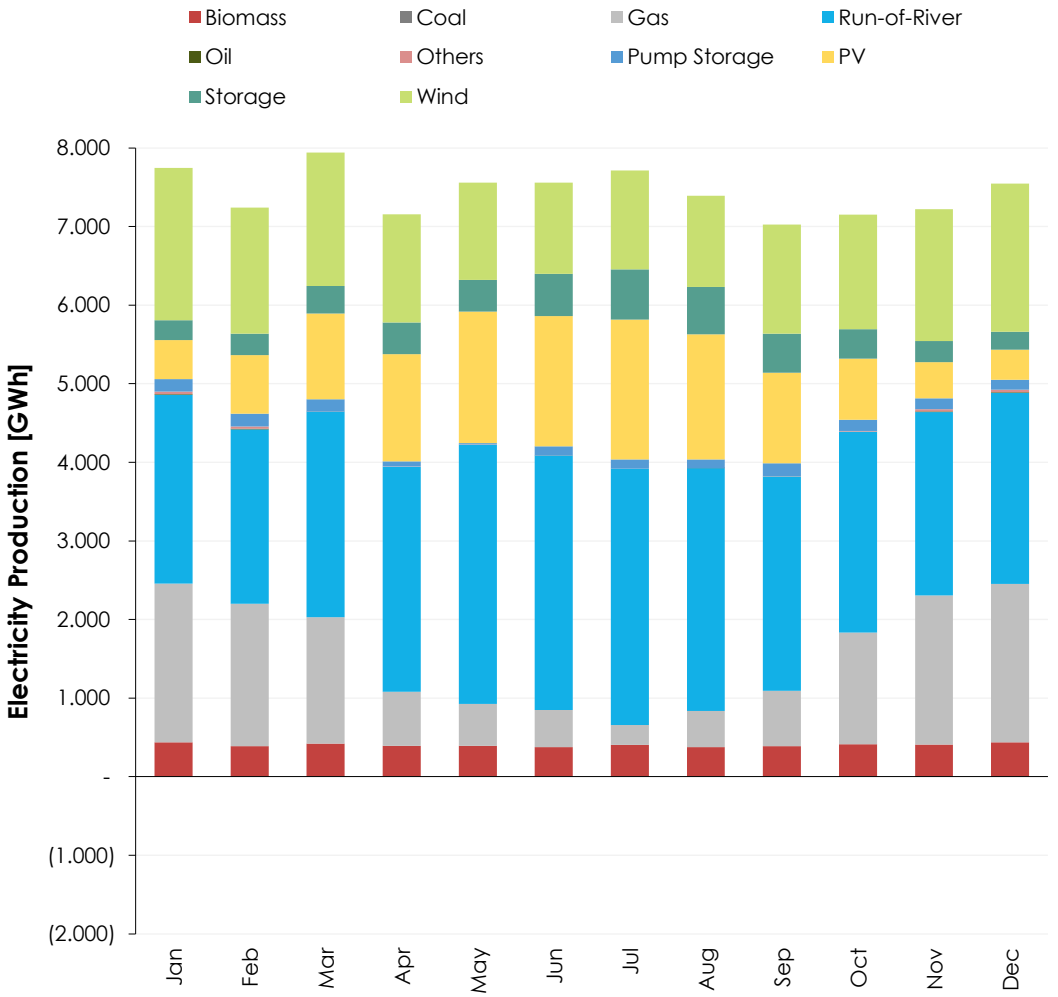
Results
Electricity Production (2030 compared to 2017)

- **Conservative Scenario** (CS)
  - +1,8 TWh Biomass
  - +5,6 TWh Gas
  - +4,2 TWh Hydro [RoR & (Pump) Storage]
  - +11,8 TWh PV
  - +10,7 TWh Wind
- **100% RES** in 2030 (national balance)
- **Times** when **RES** production **too little**
  - **Gas power plants** step in
  - **Despite RES expansion +5,6 TWh Gas**
- **Times** when **RES** production **higher than demand**
  - **Export** and **Storage**



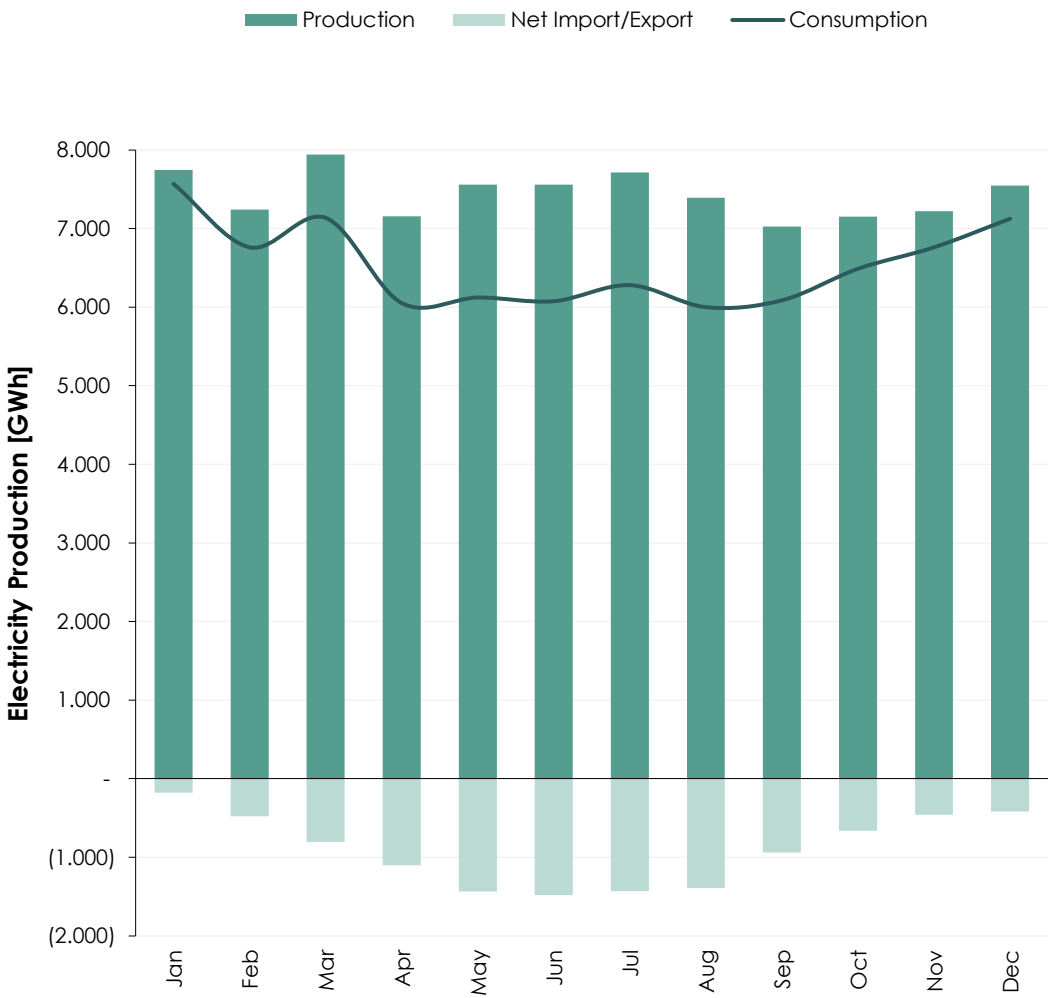
Results
Monthly Electricity Production – Coservative Scenario

- **More gas** needed in **winter months**
  - Higher demand
  - Less PV production
  - Less Run-of-River production



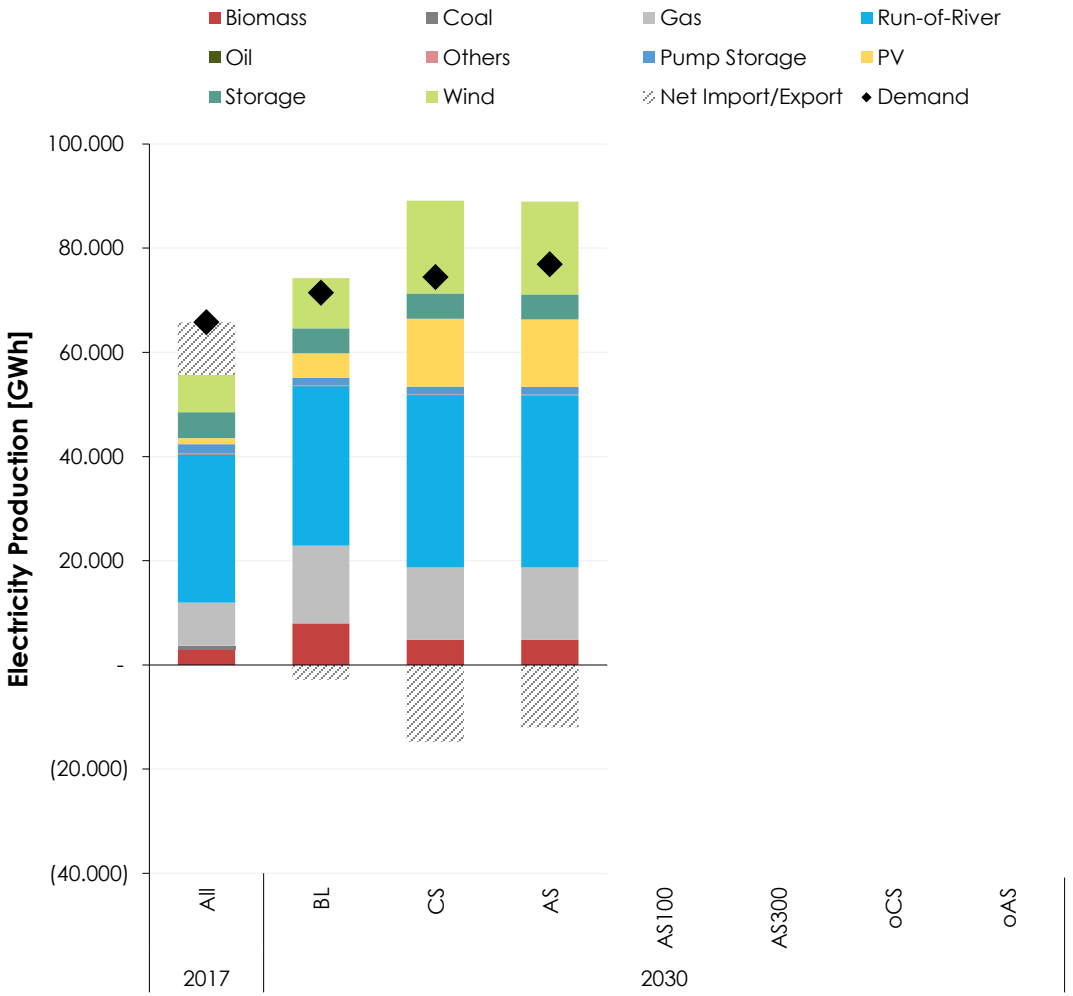
Results
Monthly Electricity Production – Coservative Scenario

- **More gas** needed in **winter months**
  - Higher demand
  - Less PV production
  - Less Run-of-River production
- **Net-Exporting every month**



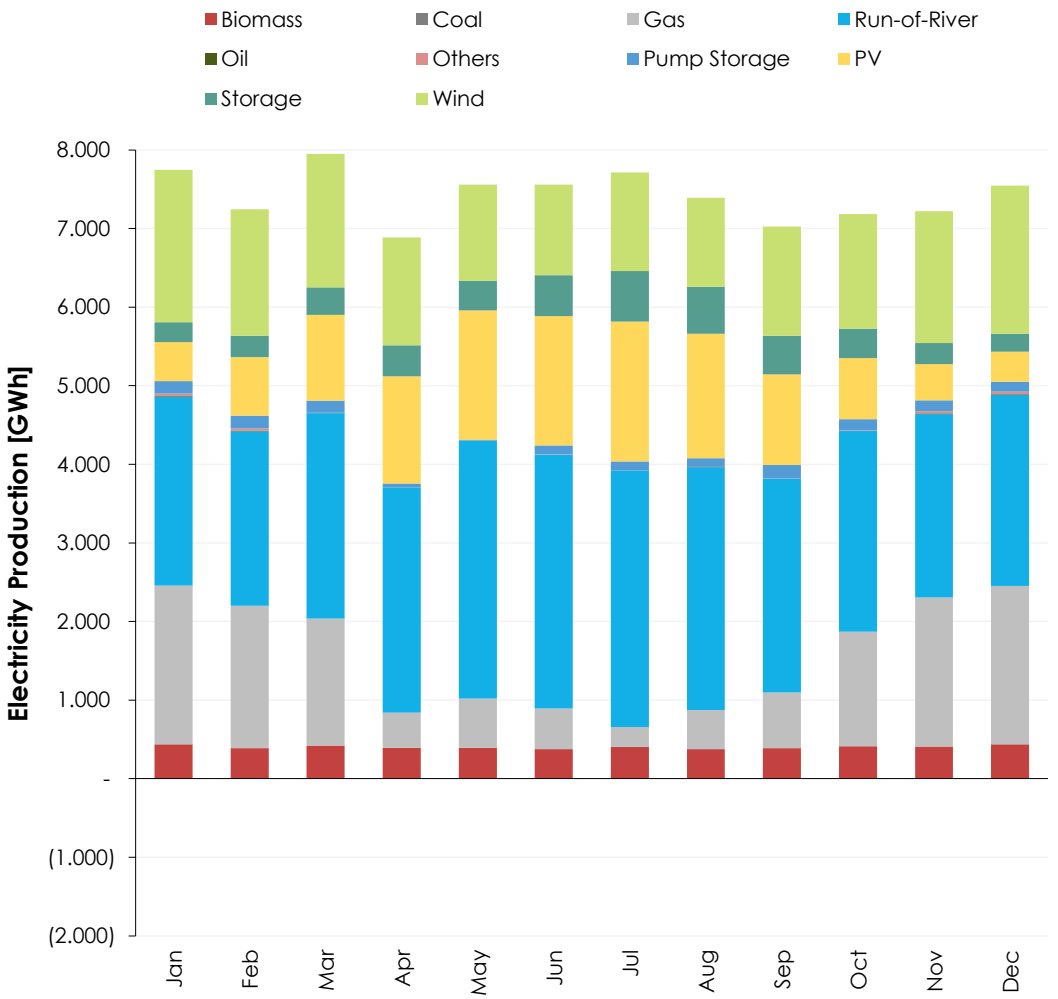
Results
Electricity Production (2030 compared to 2017)

- **Ambitious Scenario** (AS)
  - +1,8 TWh Biomass
  - +5,6 TWh Gas
  - +4,1 TWh Hydro [RoR & (Pump) Storage]
  - +11,8 TWh PV
  - +10,6 TWh Wind
- **Similar** to **Conservative Scenario** (CS)
- **2,5 TWh higher consumption** leads to **2,5 TWh less export**



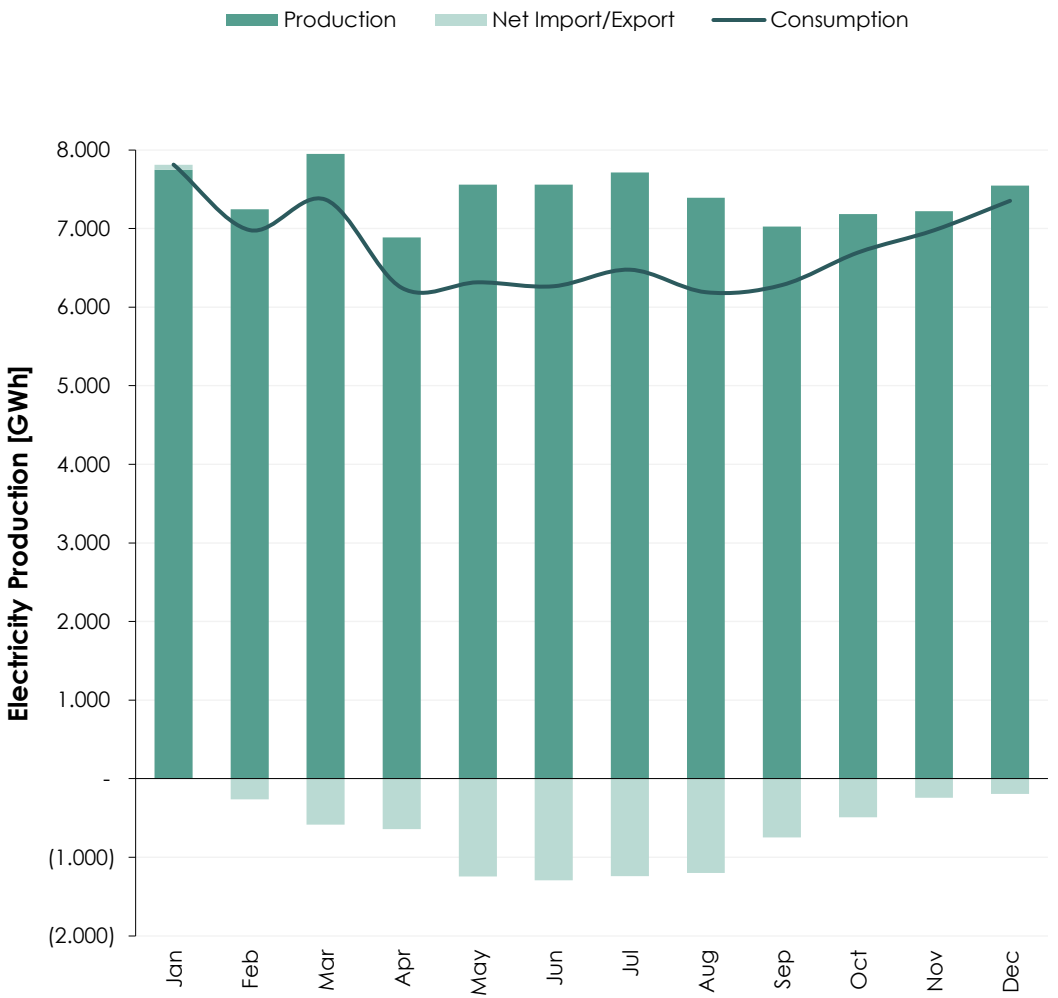
Results
Monthly Electricity Production – Ambitious Scenario

- **Similar** to **Conservative Scenario**



Results
Monthly Electricity Production – Ambitious Scenario

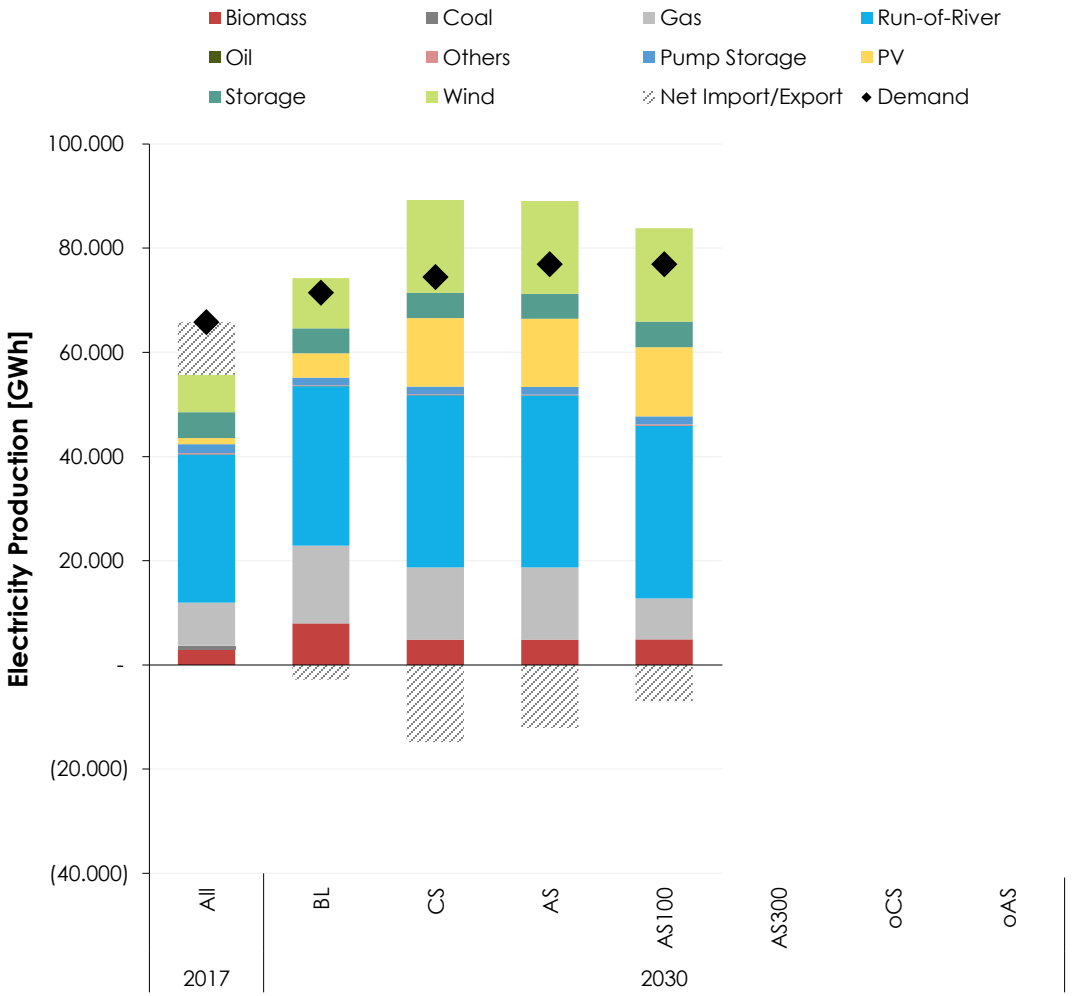
- **Similar** to **Conservative Scenario**
- **Higher demand** leads to **January** beeing an **net-importing** month



Results
Electricity Production (2030 compared to 2017)

- **Ambitious Scenario** with **100€/MWh Gas price** (AS100)
  - +1,9 TWh Biomass
  - -0,4 TWh Gas
  - +4,4 TWh Hydro [RoR & (Pump) Storage]
  - +11,9 TWh PV
  - +10,8 TWh Wind

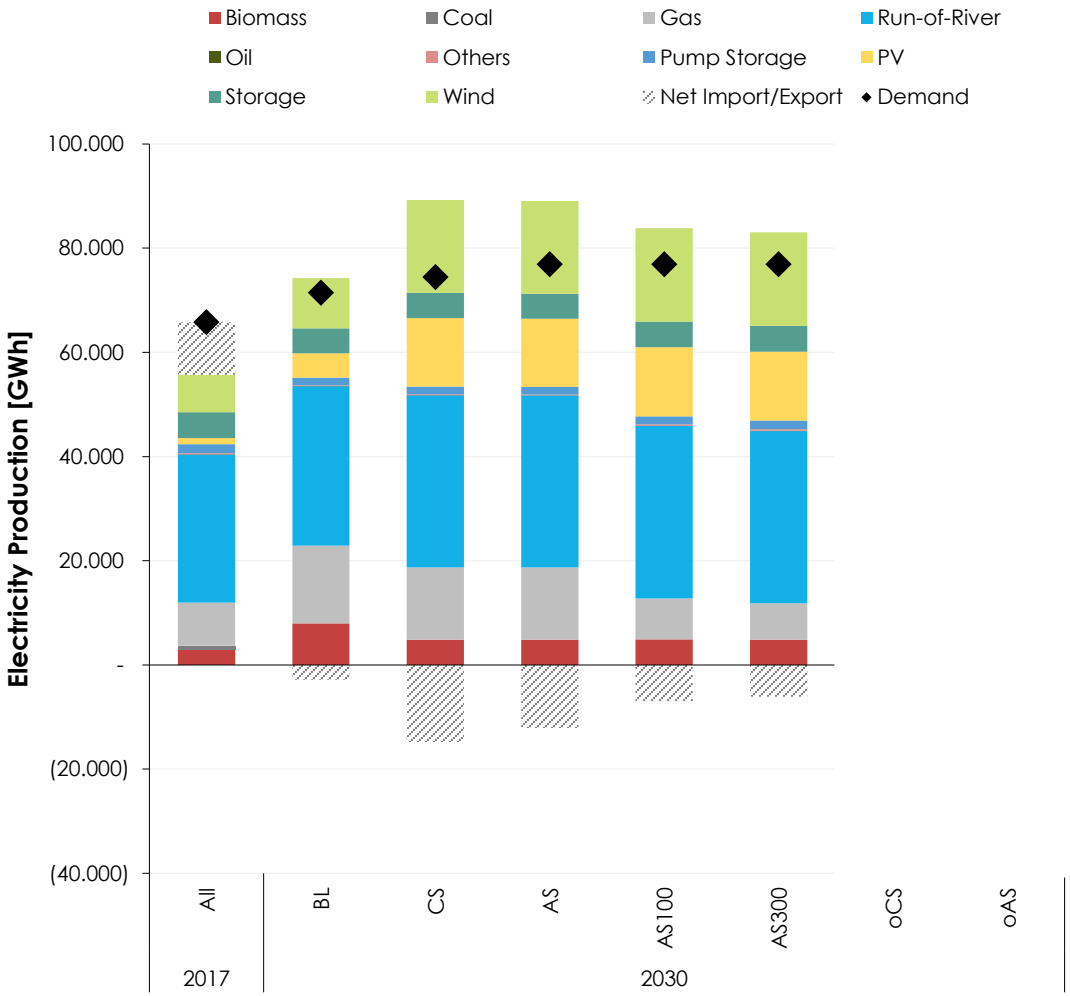
- **Higher gas price**
  - **Smaller production** from **gas-fired power plants**
  - **Smaller export** (6,8 TWh)



Results
Electricity Production (2030 compared to 2017)

- **Ambitious Scenario** with **300€/MWh Gas price** (AS300)
  - +1,9 TWh Biomass
  - -1,3 TWh Gas
  - +4,5 TWh Hydro [RoR & (Pump) Storage]
  - +11,9 TWh PV
  - +10,8 TWh Wind

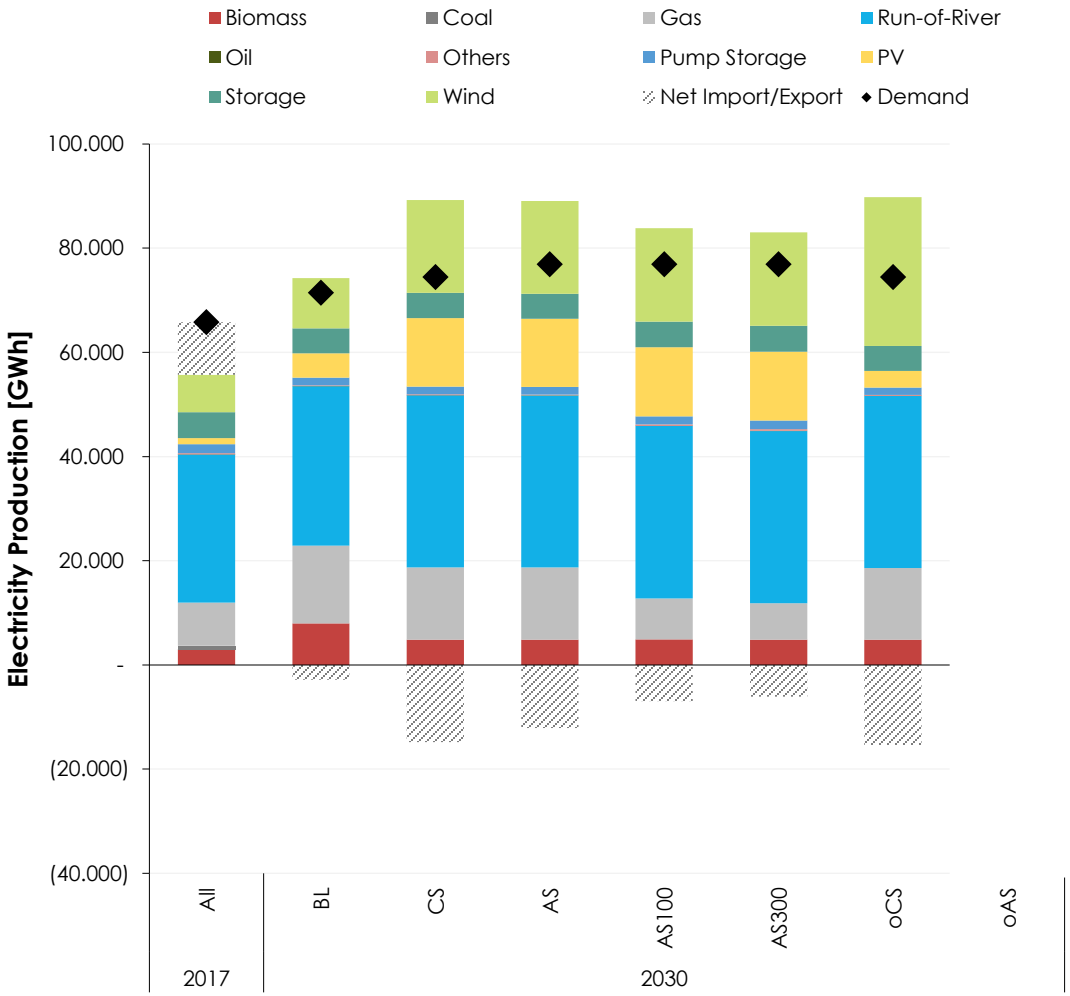
- **Even higher gas price**
  - **Even smaller production** from **gas-fired power plants**
  - **Even smaller export** (6,0 TWh)



Results
Electricity Production (2030 compared to 2017)

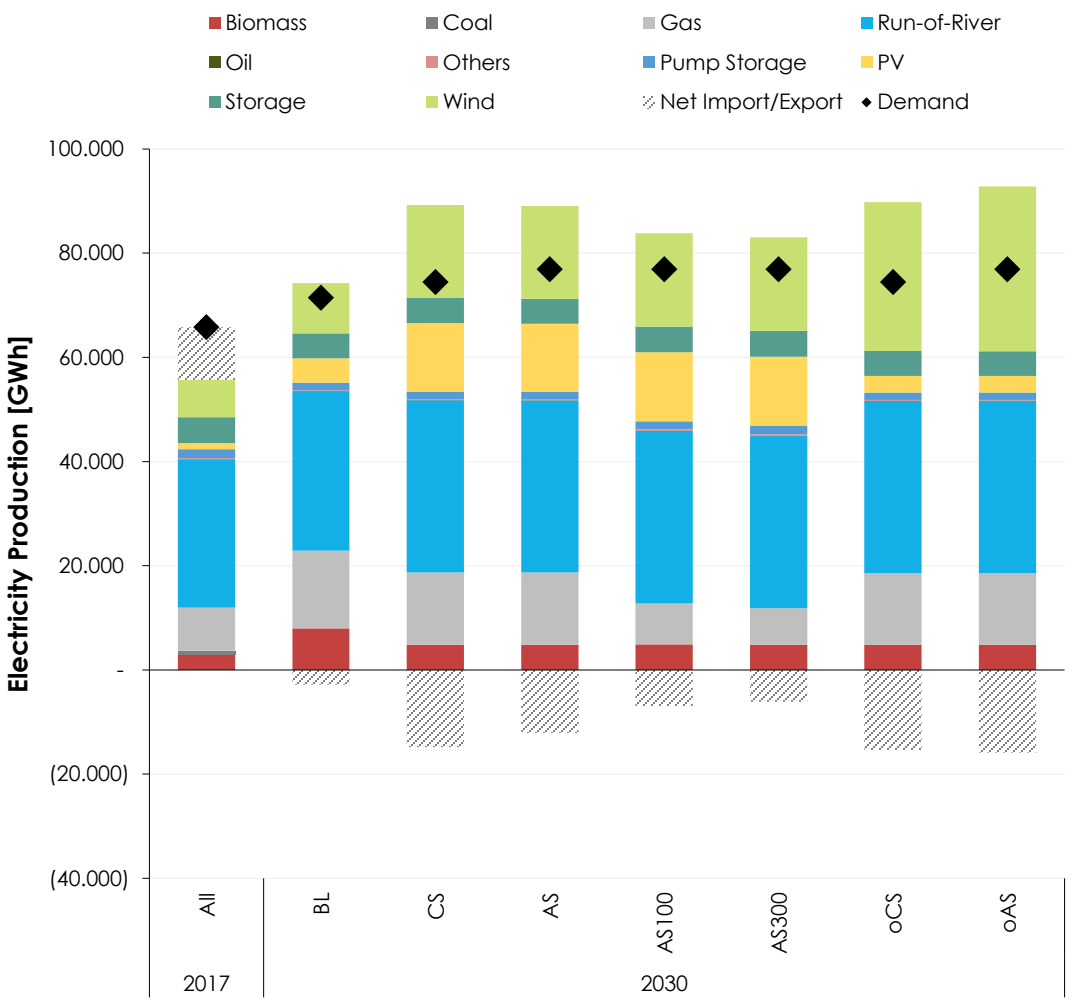
- **Optimized Conservative Scenario** (oCS)
  - +1,9 TWh Biomass
  - +5,5 TWh Gas
  - +4,1 TWh Hydro [RoR & (Pump) Storage]
  - +2,0 TWh PV
  - +21,4 TWh Wind

- Optimised on overall system costs
  - More wind capacity ➔ **More wind generation**
  - Less PV capacity ➔ **Less PV generation**
  - **No investments** in **batteries**



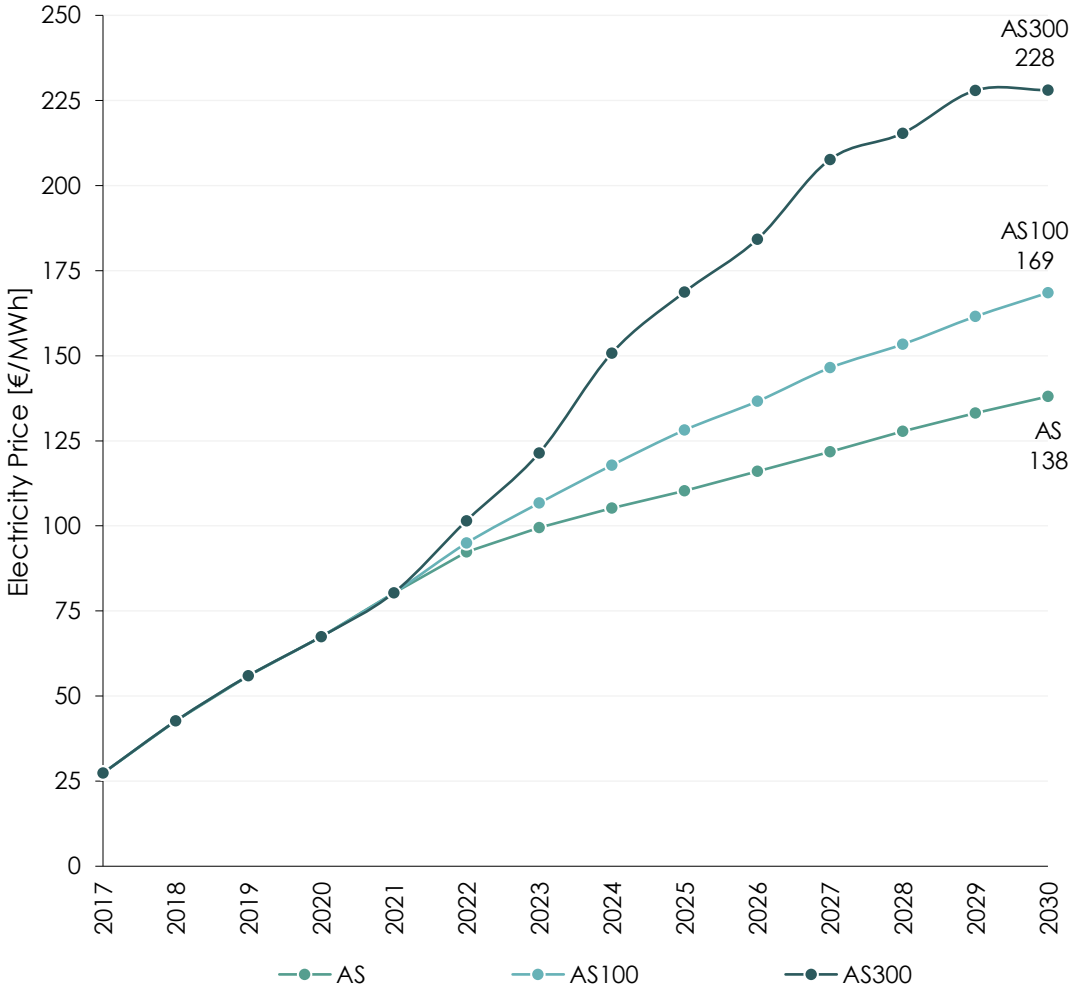
Results
Electricity Production (2030 compared to 2017)

- **Optimized Ambitious Scenario** (oAS)
  - +1,9 TWh Biomass
  - +5,5 TWh Gas
  - +4,1 TWh Hydro [RoR & (Pump) Storage]
  - +2,0 TWh PV
  - +24,4 TWh Wind
- **Similar** to **Conservative Scenario** (CS)
  - **Higher demand** leads to **more wind investments**



Results
Electricity Price

- **Electricity price** between **138 €/MWh** (AS) and **228 €/MWh** (AS300)
- **Highly dependent** on **gas price**



Conclusions

- **Austria** becomes an **net electricity exporting country** in all scenarios
- **More export** in **summer months** than winther months
- **Variability** in **demand** in scenarios **mostly effects exports**
- **Electricity production** from **gas-fired power plants** only **decreases** in scenarios **with high gas prices**

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Thank you!

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