# Optimizing ATES performance by increasing warm well temperature and harvesting waste/solar heat

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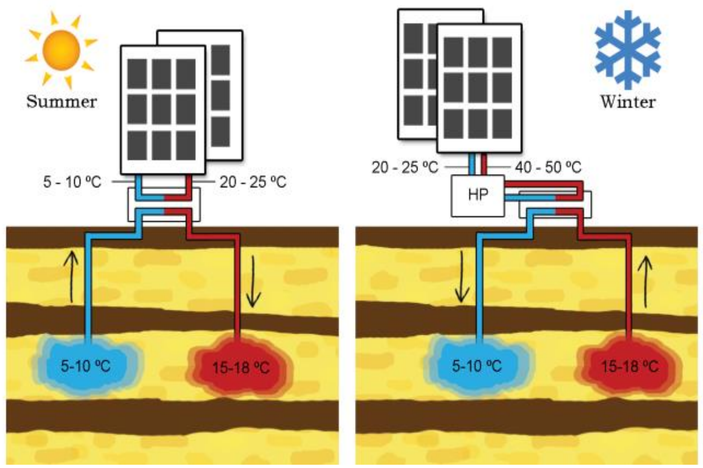
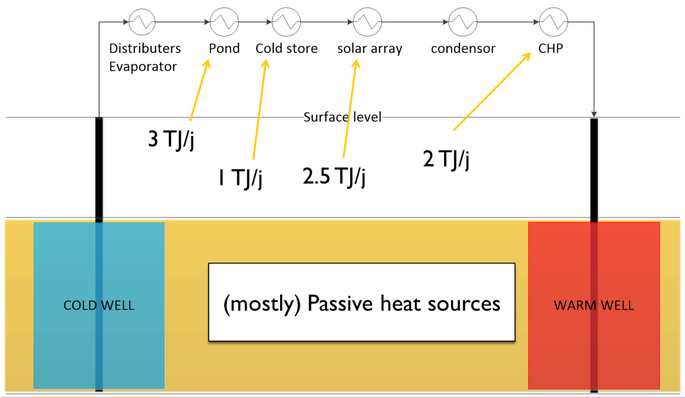
## 1. Existing LT-ATES system

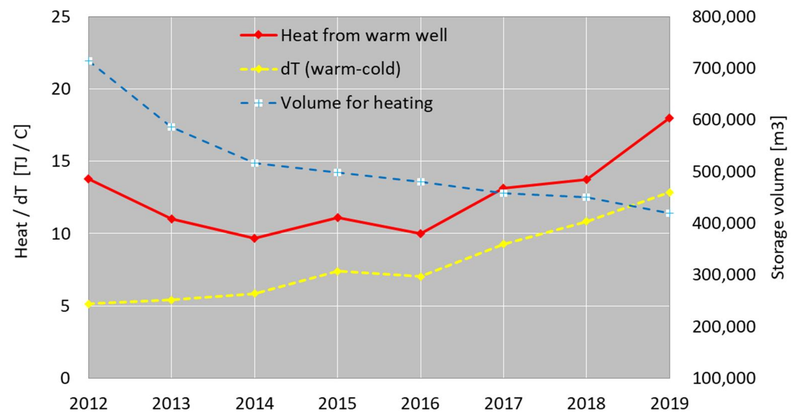



*Basic working principle of ATES (Aquifer Thermal Energy Storage)*

## 2. Harvest extra heat to increase warm well temperature




## 3. ΔT between warm-cold well increases from 6 to 12



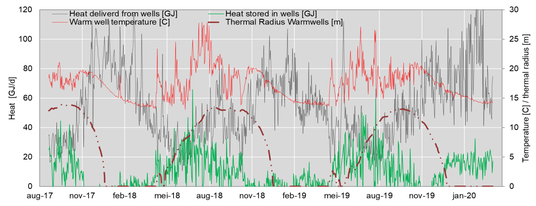

## 4. Energy / performance analysis

1.Conventional

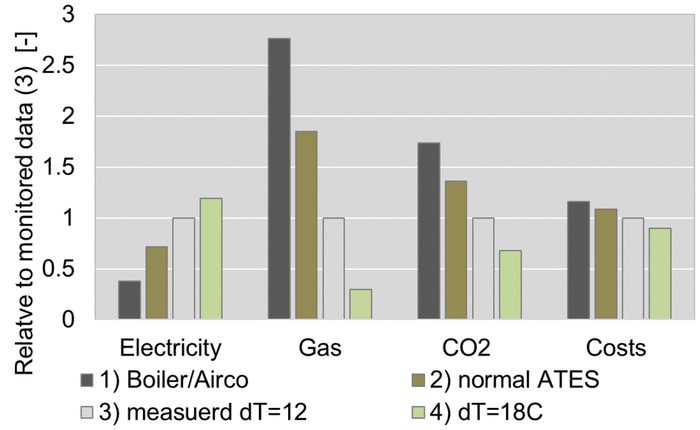
2.Normal LT-ATES (ΔT=6°C)

**3.Optimized ATES (ΔT=12°C) (2.5 years data)**

4.Further optimized ATES (ΔT=18°C)




## 5. Higher ΔT affects energy use, emissions and costs




## 6. Conclusions

Compared to normal ATES:
- Increase in ΔT from 6 to 12 °C results in 10% lower heat price
- And 30-70% lower emissions

Due to increase in ΔT:
- more heat is stored, a larger share of demand can be delivered by ATES
- Heat pump performance increases with 15%

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