PtX and Water Management

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Abstract: Rising precipitation, ground water and seepage constitute increasing problems to farmers, residential areas, industry and utilities. However, the rising Power to X (PtX) industry needs industrial scale amounts of water free of salts. Or as free of salts as possible. High quality water from the deep aquifers may be of less quality than the large volumes of surface water and seepage handled in sewer network and ponds. Before extracting new volumes of potable water to PtX, volumes and quality of surface water should be carefully considered. The PtX volumes are so large that they call for both energy and water management.

Keywords: PtX, water quality, management

Background and introduction

Power to X (PtX) has been embraced internationally in general and in Denmark in particular as one of the most promising ways to realize necessary ambitions to achieve carbon neutrality by 2050. On the one hand, the technology can substitute heavy fuels used in sea and air transport; and on the other, the technology can play a part in storing energy from fluctuating, renewable sources (KEFM 2021). So, what is not to like?

In embracing the new technology and new ideas, the major focus has been on access to electricity from renewable sources. Secondary, also the use of excess heat generated in the electrolysis processes should be considered (IDA 2020, ENS 2021). However, very little to no focus has been on one of the major components in PtX, namely access to large amounts of water of best available quality. Apparently, this resource has been taken for granted.

Water requirements for the PtX industry

Feedstocks for any PtX products will be both power and water. Water is used for hydrogen production via electrolysis of water. The water quality required for feeding an electrolyzer is ultra-pure demineralized water (DMW). DMW can be produced from any water source with existing water purification technologies. The production cost of ultra-pure DMW will increase with increasing salinity. This is why the use of surface water is so interesting. The retention water from the production of ultra-pure DMW may be reduced to 10 % when using surface water of sufficient quality, compared to 30% when using potable water.

The best location for a PtX plant will be where there is abundant renewable power and water resources. Such a location is found in Lemvig, Denmark, where three new world scale marine wind parks are under development along with solar (PV) parks. In parallel to this abundance of renewable energy, Lemvig Vand and consumers are struggling with increasing amounts of surface water.

Aa a rule of thumb the water consumption in PtX plants for hydrogen or ammonia is 0.2 t/h water/MW. So, for the first PtX demonstration plant of 10 MW in Lemvig, the water

consumption will be 2 t/h of ultra-pure DMW. For a large size PtX plant of 1000 MW, the annual consumption will be around 1.7 Mm3

Water management

Changes in the water cycle, increasing precipitation, rising ground water and increased seepage constitute seemingly perpetual problems to water utilities. The rising PtX, industry may have the potential to take out so large volumes that the entire water cycle is affected. If considered carefully, the effects could be positive.

The water quality and volume requirements of the PtX industry invites to recycling of surface water resources and mitigation of surface water abundance. In the short term, current excess water may be used by the rising PtX industry. In the intermediate term, it may be considered to direct roof, road and other surface water resources to the PtX industry. In the long term, new extraction of ground water resources should be kept at a minimum. However, the utility is already maintaining ground water levels under several hundred hectares of residential areas. If this water is of sufficient quality, we may never need to consider the intermediate or long term perspective.

Understanding of water quantity and quality becomes of increasing importance for due planning and water management, and it is necessary to understand local conditions and potential threats and opportunities before deciding the location of new plants that will require not just access to electricity but also access to water.

Planning perspective – The Thyborøn case

With an outset in PtX being a potential solution not just in the energy system perspective but also with respects to water management, Thyborøn may prove the ideal case. The city of Thyborøn, Figure 1, is endangered by rising precipitation, rising sea level and subsidence (C2C CC 2020). The ground water level is typically situated 70 cm below hundreds of private houses and businesses. Five pumping stations have kept the ground water under control for 50 years and extracted 1.3 Mm3 of drainage water in 2020, see Figure 1. The abundance of renewable energy and water in Thyborøn seems an invitation to the rising PtX industry.

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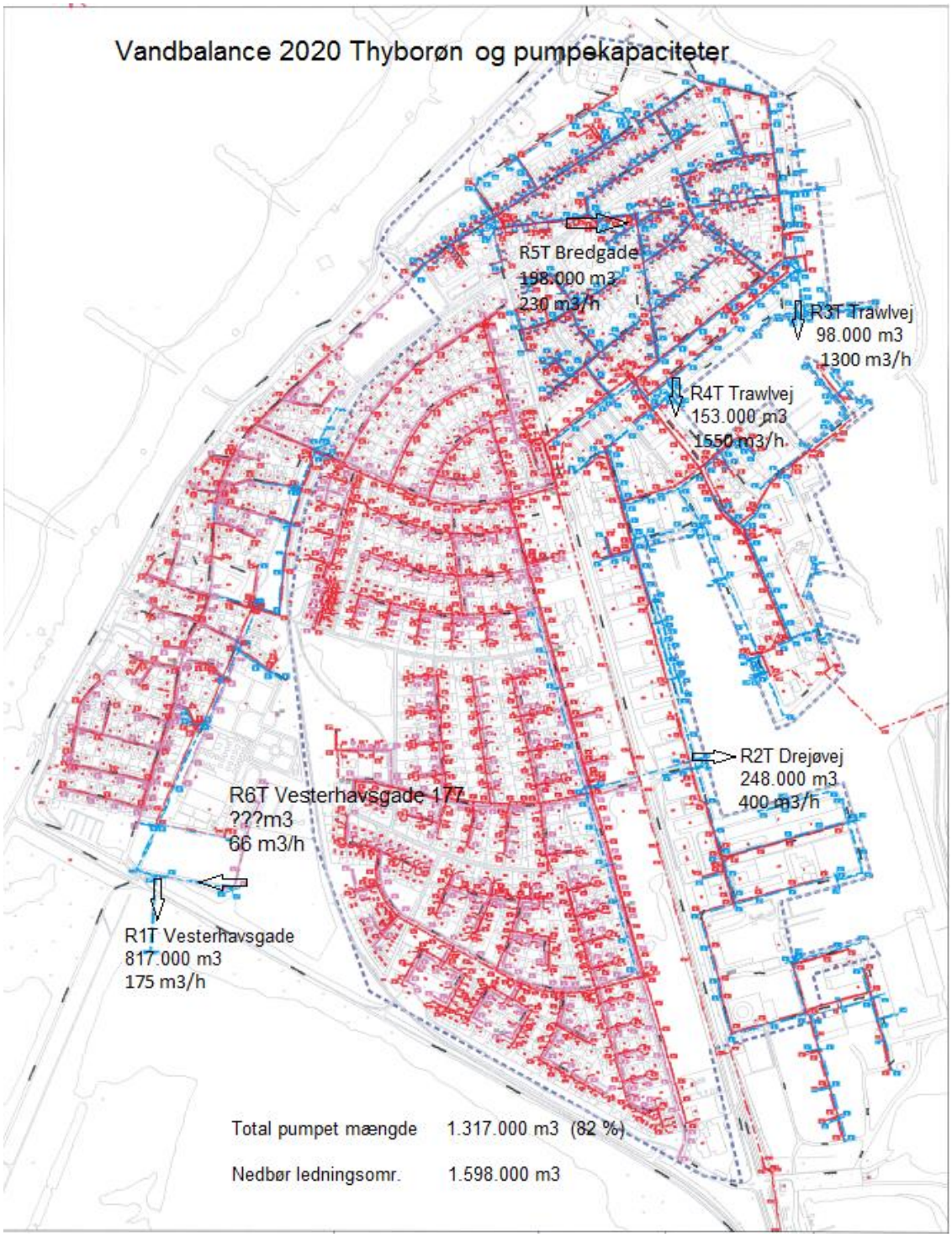

Figure 1 Water balance 2020 Thyborøn - problem or valuable ressource?