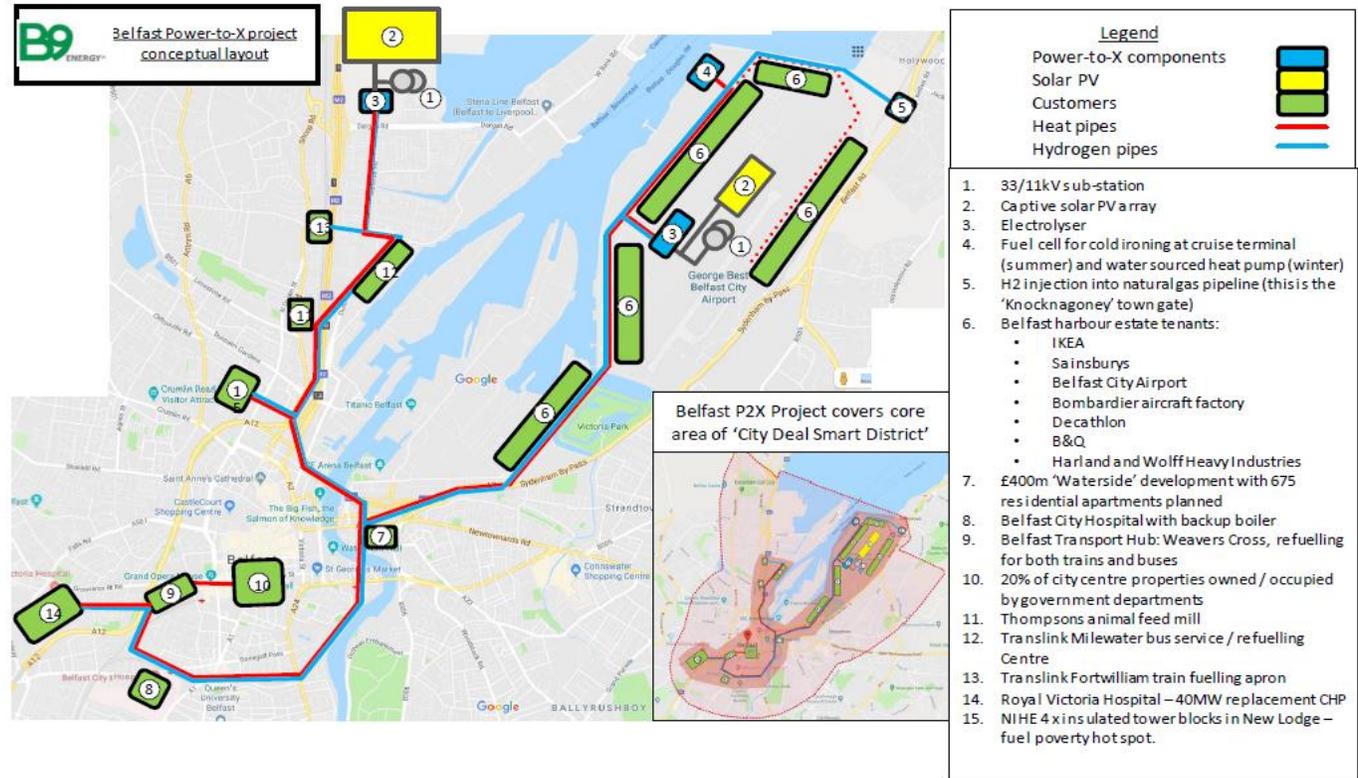


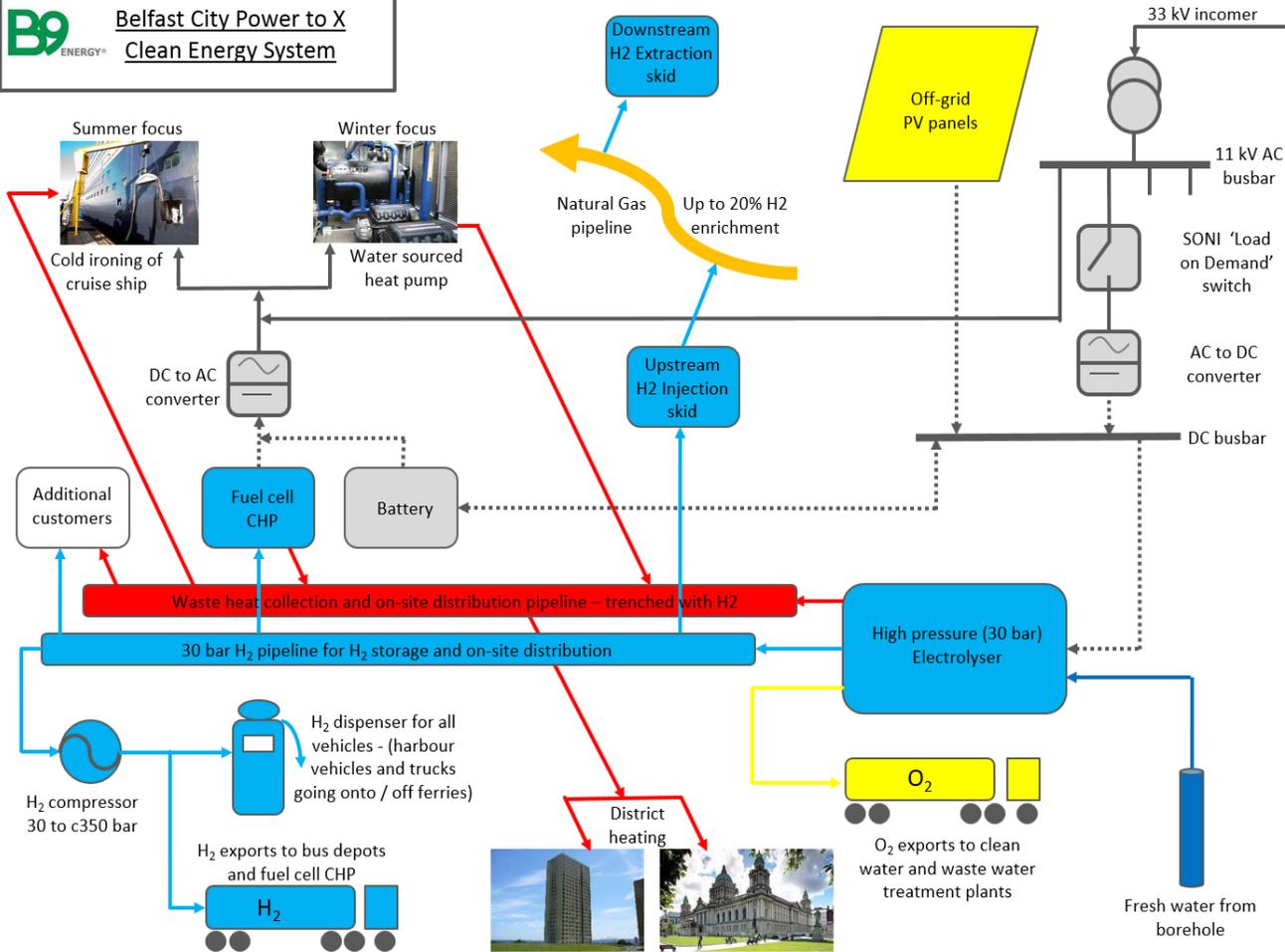
Best Practice Examples - NORTHERN IRELAND

Background – Belfast City Power to X

Northern Ireland has exceptionally high instantaneous penetrations of wind power on its electricity grid, with a target limit of 75% by 2020 being set through the utilities 'DS3' program. As a result, it is a regular occurrence for wind turbines to be switched off by the System Operator (SONI) if there is not enough system load to provide balance. These 'curtailment' events normally happen during the night when the load is low and when winds are their strongest. (see graph below). This project will provide the system operator an alternative solution to defer or avoid this wasteful curtailment using large scale, long duration, controllable load, in the form of hydrogen electrolyzers to deliver a balancing service.

Because there is little curtailment during daylight hours the project can make use of multi-MW installed capacity of ground mounted solar PV panels during the day. The panels are not grid connected so there are savings on associated electrical equipment and the DC power flows directly to the DC busbar.





Hydrogen storage and on-site distribution

The 30bar hydrogen is stored and distributed around Belfast City via a dedicated pure hydrogen pipeline which is 10" in diameter and approximately 10km in length. The pipeline network can be extended over time to increase storage capacity and deliver renewable fuel / feedstock to additional retail, commercial and industrial customers at different locations. The route chosen for the hydrogen pipeline follows the existing railway tracks

Hydrogen use in automotive sector

When needed as an automotive fuel, the hydrogen is compressed to 350bar and dispensed directly to vehicles locally or to vehicle fleets off-site using road mobile tube trailers. This supply is likely to be for HGVs, buses, trains, agricultural tractors and specialist terminal tractors used for loading/unloading unaccompanied trailers in confined space vehicle decks of cross channel ferries. The majority of the supply will go to Translink buses and trains through the new Weavers Cross transport hub and existing refuelling aprons at Milewater bus centre and Fortwilliam train centre.

Hydrogen use for Combined Heat and Power (CHP)

There is increasing demand for CHP solutions using both hydrogen fuel cells and/or hydrogen IC engines. This is because of their higher conversion efficiency and zero emissions performance. This project provides hydrogen supply at sufficient scale to stimulate the deployment of CHP:

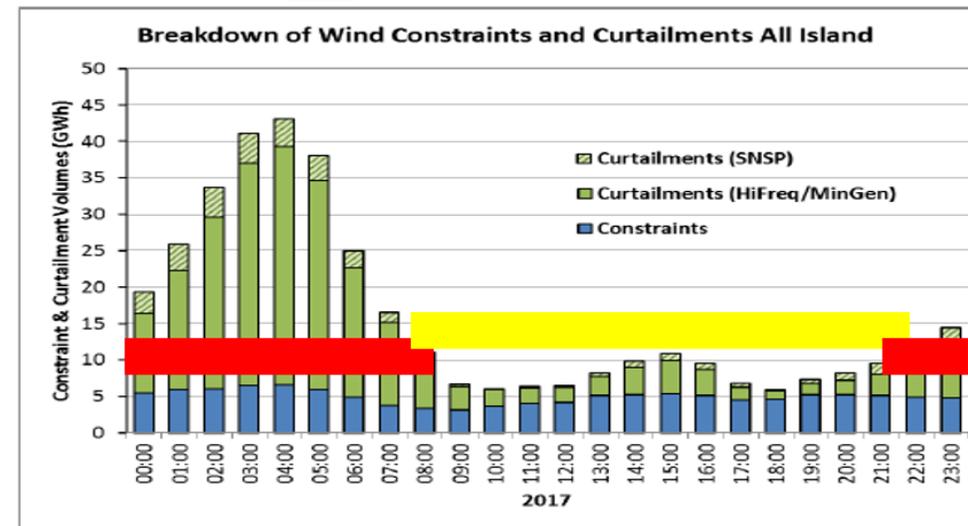
- i) within the Belfast City area, using the hydrogen pipeline network,
- ii) at off-site locations using compressed hydrogen moved in road mobile tube trailers, and
- iii) at off-site locations using hydrogen stored and delivered through existing natural gas pipelines

CHP application for 'cold ironing'

A particular novel application of hydrogen CHP in a port setting is for 'cold ironing'. This term originated in military naval procedures to describe how naval ships, which spend a lot more time in port than commercial ships, are more economically powered from shore side connections rather than from their own engines. In this condition the ironwork of the engines becomes cold. The Belfast Harbour application of cold ironing is to allow visiting cruise vessels to switch off their fossil fuelled on-board generators whilst in port. The result is a step reduction in gaseous emissions and associated particulates that would otherwise contribute to Belfast's air quality problem and because the CHP fuel is renewable there are climate change benefits too. Most modern cruise vessels are fitted with convenient electrical connection interface arrangements and some also have the ability to utilise flow and return hot water services from the fuel cell CHP. Cruise ships only visit during summer months allowing the CHP plant to a drive water sourced heat pump during the winter.

Hydrogen enrichment of natural gas

Trials are underway in GB that should allow natural gas in pipelines to be enriched with hydrogen up to a limit of 20% without causing problems with existing gas appliances such as cookers and boilers. This will provide an additional buffer storage vector for hydrogen and enable access to new emerging markets for predominantly heat. Pressure Swing Adsorption, H₂ gas filter separators and H₂ pumps will allow down stream extraction of hydrogen for industrial processes and to safeguard equipment such as gas engines that may be intolerant of the hydrogen content.



Oxygen

There are many existing uses for oxygen in both pressurised gas and liquid forms. We have concentrated our early market research on the water utility sector which needs about 40 tons per day in Northern Ireland alone and so will be able to absorb most if not all of our oxygen production. The gas can be used to make ozone which disinfects drinking water before it leaves the clean water treatment plant. It can also be used to increase capacity / extend life of existing waste water treatment plants by substituting aeration for oxygenation in the activated sludge treatment process. In each case, conversion to using imported renewable oxygen from electrolysis will save energy, reduce emissions and defer the costs of plant expansion.

