H2D Energy

The Hydrogen Democracy

Rari Nantes Valsugana

Preliminary Study & Budget Analysis

2021, Decemeber

Project Scope

Systems Description

Goal of the P.O.C. is to provide a renewable energy system with hydrogen accumulation capability able to fulfil 365/24 energy demand of Rari Nantes Valsugana

✓ Target Systems are:

- ➢ Water Heating
- ➢ Electrical Power;

✓ System operates commercially 17 hours a day 365;

✓ Some non core services operate 24/24;

✓ Electrical power demand has been provided by Rari Nantes;

✓ Methane demand has been provided by Rari Nantes.

✓ Current cost of energy

- ✓ Electrical Power: 0,5€/kWh
- ✓ Methane: 2,0€/m3

System Requirements

Power Demand – Hourly

Utenza 1 (kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Orario 5-22	10	10	10	10	10	10	10	10	10	10	10	10

Tabella 1 – Consumo orario motori elettrici per ricircolo dell'acqua

Utenza 2 (kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Orario 5-22	10	10	10	10	10	10	10	10	10	10	10	10

Tabella 2 – Consumo orario motori elettrici per ventilazione e ricircolo dell'aria

Utenza 3 (kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Orario 6-22	15	15	15	15	15	15	15	15	15	15	15	15

Tabella 3 – Consumo orario luci e altri carichi

System Requirements

Power Demand - Daily, monthly, annual

Consumo (kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Giornaliero	580	580	580	580	580	580	580	580	580	580	580	580

Tabella 1 – Consumo giornaliero di tutte le utenze

Consumo (MWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mensile	18	16	18	17,5	18	17,5	18	18	17,5	18	17,5	18

Tabella 2 – Consumo mensile di tutte le utenze

Consumo (MWh)	Jan - Dec	Total Cost (€)
Total year	212	106k

System Requirements

Methane Demand - Daily, monthly, annual

Consumo (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Giornaliero	312	290	229	173	98	61	69	71	98	169	224	293

Tabella 1 – Consumo giornaliero di tutte le utenze

Consumo (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mensile	9.658	8.093	7.079	5.182	3.025	1.812	2.125	2.192	2.920	5.236	6.711	9.070

Tabella 2 – Consumo mensile di tutte le utenze

Consumo (m3)	Jan - Dec	Total Cost (€)
Totale Annuo	63.103	126k

System Requirements

Methane consumption in kWh

Consumo (kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Giornaliero	2.880	2.672	2.110	1.597	902	559	634	654	900	1.562	2.068	2.705

Tabella 1 – Consumo giornaliero di tutte le utenze

Consumo (MWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mensile	89	75	66	48	28	17	19,5	20	27	49	62	84

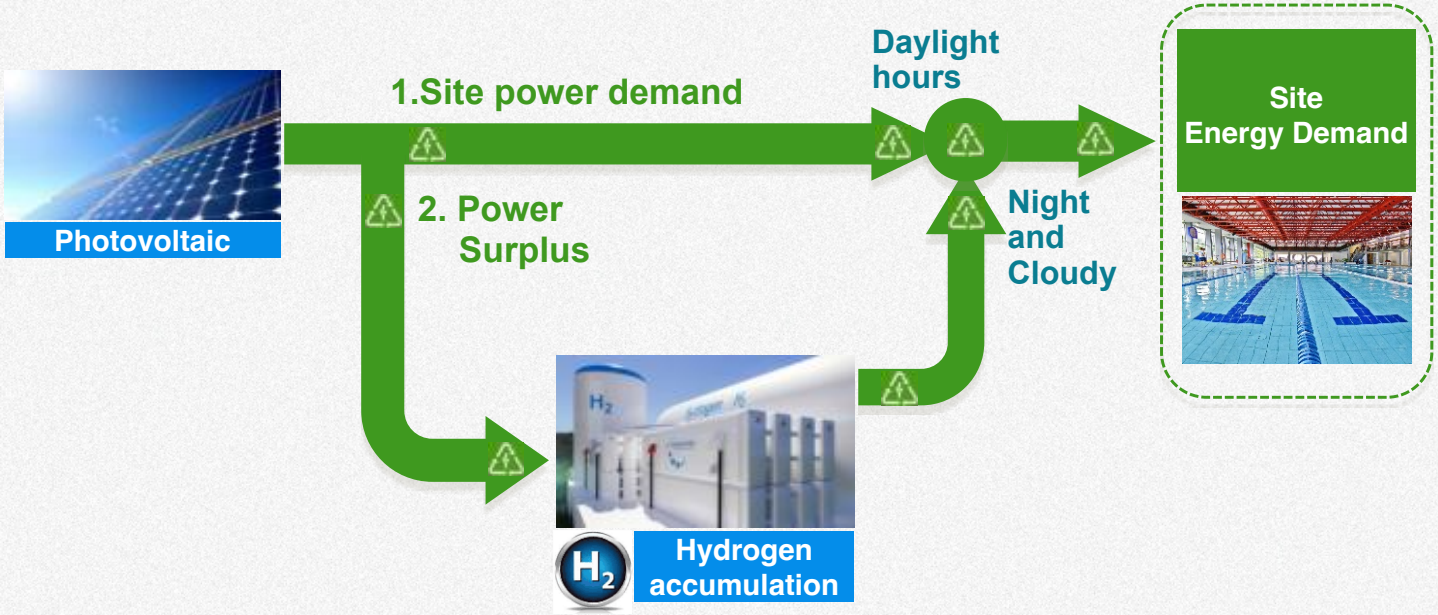
Tabella 2 – Consumo mensile di tutte le utenze

Consumo (MWh)	Jan - Dec		Cost/kWh (€)
Totale Annuo	584,5		0,216

Proposed Solution

Functional Design

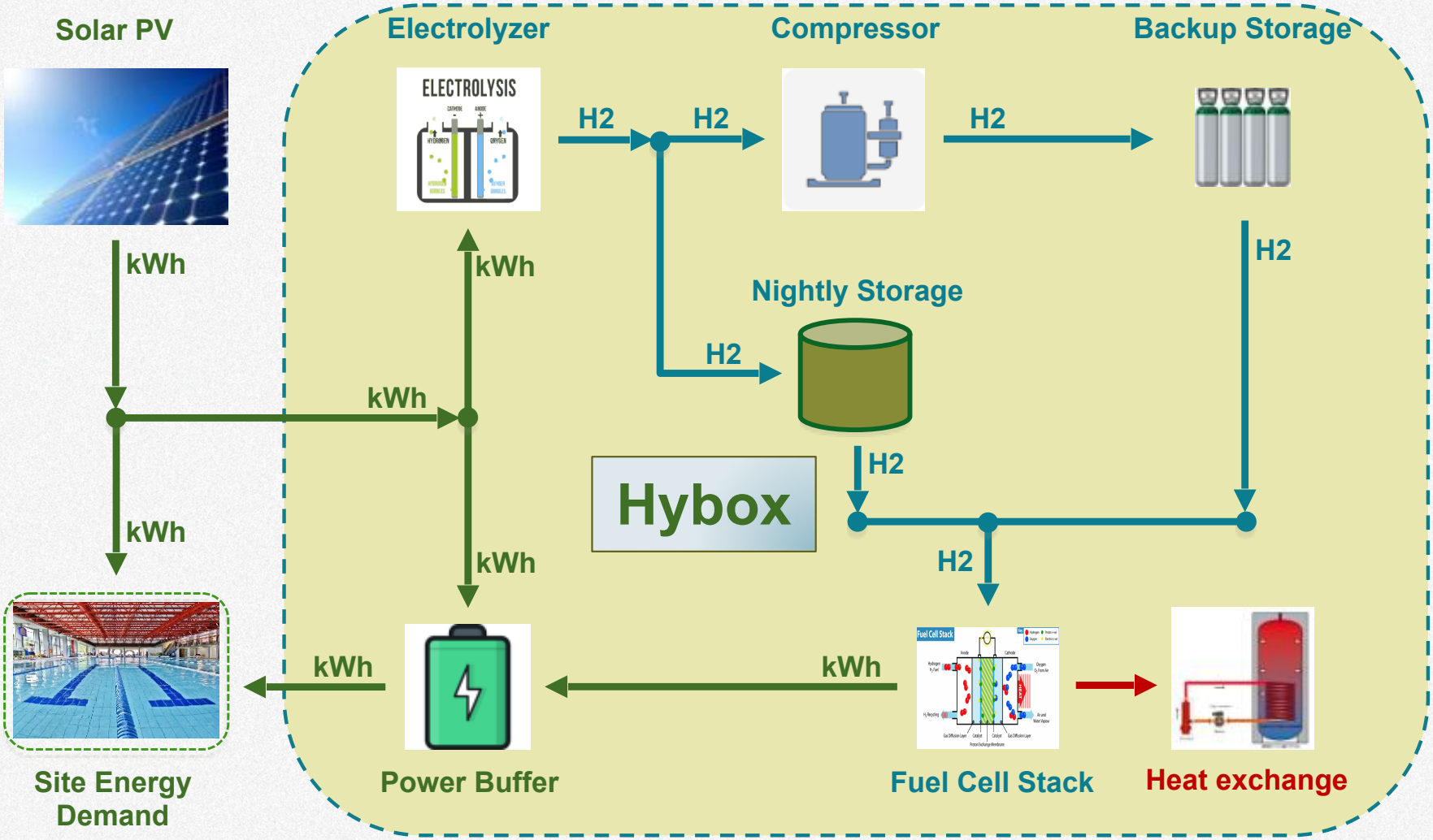
The solution proposed for Rari Nantes **Energy Independence** is based on a combination of Solar PV with Hydrogen accumulation, to generate Power during the night and Heat from Hydrogen during day and night.



The system uses hydrogen to store photovoltaic power. During the daylight hours, the photovoltaic power is used to fulfil Microgrid demand (1), while the surplus power (2) is stored in the form of hydrogen. Hydrogen is released and transformed into electrical power to fulfil Microgrid power demand whenever photovoltaic energy is not available, e.g. cloudy day, night, etc..

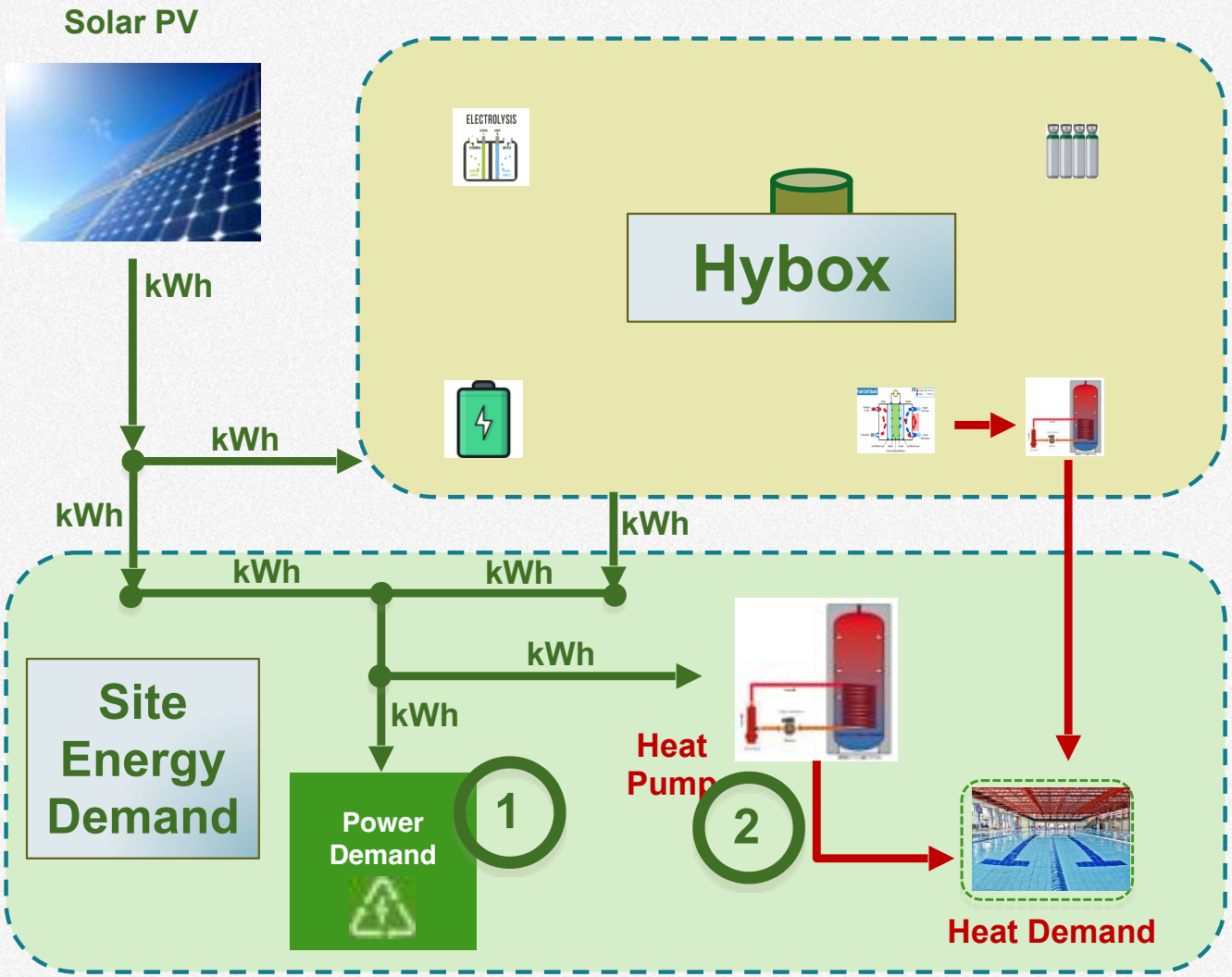
Hybox – from Inside

General power generation cycle



Hybox – from Inside

Heat generation detail



Energy demand is fulfilled 100% with electrical power, through the a Photovoltaic System and the H2D Hybox. The Hybox will store PV power and provide power for the Current site Power Demand and for the site Heat Demand. Heating Demand will be fulfilled using an Electrical Heat Pump.

Tecnical Configurationa for Power Demand

1

Capex - PV Nominal Power:	**150 kWp**	**130k€**
Opex - PV O&M:	**6% year**	**7k€**
Electrolyser Nominal Power:	**30 kW**	**85k€**
Fuel Cell Power (output):	**20 kW**	**90k€**
Long-term Storage (Hydrogen):	**3.000 kWh**	**70k€**
Space for Storage System:	**15 m2**	
Short-term Storage (battery):	**500 kWh**	**280k€**
Integration	**Hw, Sw, Services**	**110k€**
CAPEX forecast:		**635k€**
Storage O&M (10 years) - Opex	**3% year**	**19k€**

(includes: on site operations, maintenance, software and remote surveillance 24/365)

COST per kWh, lifecycle amortization (20y):	**0,242€/kWh**
Current COST per kWh	**0,5€/kWh**

System Requirements for Heat Generation

Power required by Heat Pumps to generate same thermic power as Methane @page 7

Consumo (kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Giornaliero	823	890	703	532	258	140	158	145	180	347	517	676

Tabella 1 – Consumo giornaliero di tutte le utenze

Consumo (MWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mensile	25,5	25	22	16	8	4,2	4,9	4,4	5,4	11	15,5	21

Tabella 2 – Consumo mensile di tutte le utenze

Consumo (MWh)	Jan - Dec
Totale Annuo	163

Tecnical Configurationa for Heat Demand

2

Capex - PV Nominal Power:	**400 kWp**	**346 €**
Opex - PV O&M:	**6% year**	**21k€**
Electrolyser Nominal Power:	**30 kW**	**85k€**
Fuel Cell Power (output):	**15 kW**	**70k€**
Long-term Storage (Hydrogen):	**2.000 kWh**	**45k€**
Space for Storage System:	**10 m2**	
Short-term Storage (battery):	**500 kWh**	**280k€**
Heat Pumps:	**200 kW**	**300k€**
Integration	**Hw, Sw, Services**	**145k€**
CAPEX forecast:		**841k€**
Storage O&M	**3% year**	**23k€**

(includes: on site operations, maintenance, software and remote surveillance 24/365)

COST of energy year along lifecycle:	**107k€**
CURRENT COST year:	**126k€**

Key Findings

- ✓ From the Energy point of view, Solution it's feasible
- ✓ Total space for PV system could be an Issues (1.700 m2);
- ✓ Final actual configuration could be defined only after DETAILED Study of
  - ✓ Actual Load Curve;
  - ✓ Analysis of current electrical systems;
  - ✓ Environmantal parameters (i.e., thermic features of the building, construction materials, external temperature, site policies, all environmental parameters, etc.)
- ✓ Assumptions: see pages 1 – 7.