

Indications from Italian side for future trends

Reference: Discussions at Italian MS HyWays workshop held in Rome, the 18th of July 2006

By-product

The availability of hydrogen as by-product can be important in the first phase of its deployment, but will play a minor role in the long term. Therefore it is important to look at the places considered as the early user centres for the first large hydrogen applications. Looking at the selected sites, the only ones which can have the hydrogen as by-product are Venice, which is close to Porto Marghera industrial site, and Sicily where there is the petrochemical site of Priolo.

For Porto Marghera [1] (<http://www.technologyreview.it/index.php?p=article&a=80>), at least 4.500 tons/year of hydrogen come from the plant electrolytic chlorine-soda; as gas of high purity. Until 2002 the hydrogen was used in the production cycle of chemicals. Presently, due to the start up of a new reforming plant the hydrogen is used as fuel and is burnt together with the natural gas. Other 2500 hydrogen tons/year come from the plant of thermal cracking (production of ethylene / propylene); it is a by-product with a lower degree of purity and is always sent off to combustion. Further 1.000 tons/year can be produced at marginal costs from the first plant due to some margins of capacity exceeding the requirements of the cycle.

Therefore looking only to the high purity hydrogen it is possible to consider to have available at least 5.000-6000 tons/year of hydrogen able to feed fuel cells.

For Priolo [2] there is just the information on the ethylene plant which has a possibility to produce up to 22 ktons/year of hydrogen. Considering that just 20% of this can be used out of the site, it is possible to consider about 4500 tons/year of hydrogen available as by-product for Priolo.

Wind

From GRTN, the manager of the national electric grid, the statistics on the present Italian production of electricity from wind are available [3]. The wind applications are summarised in the following table.

	Year	2003	2004
	Unit		
No. of wind plants	#	107	120
Electric Power	MW	873.6	1131.5
Electric energy	GWh	1458.4	1486.5

For the future it is possible to look at the study in [4] that appears of interest for a first evaluation, although it is presumable to use the indications for the year 2020, instead that the year 2010 which is taken as reference.

The table that follows is related to the sites above 2000 hours/year, the sites between 1750 and 2000 hours/year and the total corresponding to sites above 1750 hours/year. It is taken the value of 25 MW/Km² as wind mills density for square kilometre. In the table a factor of 2% has been used to consider the territory where it is really possible to deploy the wind mills providing an average of 25 MW/km², which can be considered credible as results in an average of 1250 km² where the wind mills are deployed.

Site features (wind hours per year)	Area (Km ²)	Max Power (GW)	Max Energy (TWh)	Wind energy (TWh)
More than 2000 hours	35053	875	1'750	35
Between 1750 e 2000 hours	27073	677	1185	25
Available sites total	62126	1552	2935	60

It is to be finally observed that the strategic potential of about 30 GW is in good agreement with other evaluations.

The forecast of electric energy produced is 60 TWh that is about 20% of the 2004 electric energy consumed in Italy (301 TWh).

This forecast considers only the on-shore wind mills; if at 2020 also off-shore plants could be economically viable this could increase the potential considerably. In particular at least other 30 TWh of energy from off-shore plants could be added as safe option.

The consequence to have 20% or more wind electric energy production has in any case the disadvantage that cannot be easily controlled, unless some storage of energy is taken into account. The hydrogen can be the mean to address and solve also this issue.

Urban waste

For the urban waste potential there are no “official” forecasts for the future, but some data can be extrapolated from the documents provided by the National Observatory on Waste, the Italian body responsible to collect and analyse the waste data. In [5] a complete overview of the present situation of collection, treatment and disposal of urban wastes is provided. In particular, looking at the following table, it is possible to have an idea of the average production of wastes in the different Italian regions. The average production at national level is 533 kg/year. The effect on national scale is that in the year 2004 about 31 Mtons of urban wastes have been produced. It is possible to assume that in the future the average waste production remains constant, while an increasing

Tabella 2.2 : Serie storica produzione procapite RU nelle diverse regioni

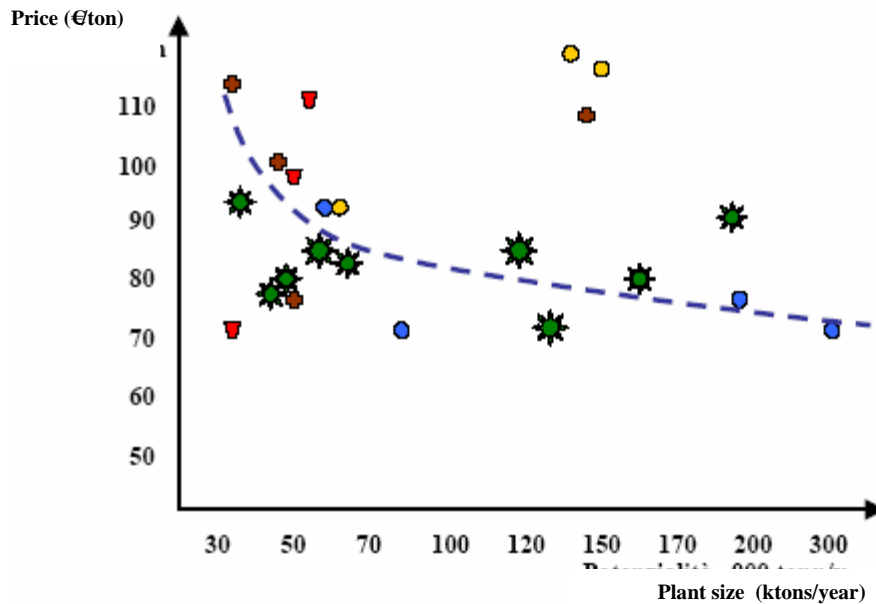
	Procapite kg/ab/anno 1991	Procapite kg/ab/anno 1999	Procapite kg/ab/anno 2000	Procapite kg/ab/anno 2001	Procapite kg/ab/anno 2002	Procapite kg/ab/anno 2003	Procapite kg/ab/anno 2004
Piemonte	427	468	476	494	504	504	515
V. D'Aosta	336	520	569	580	584	643	591
Lombardia	460	472	488	502	503	508	510
Trentino A.A.	458	543	561	547	504	485	490
Veneto	239	468	470	477	476	467	465
Friuli V.G.	366	483	500	498	506	494	490
Liguria	492	553	570	591	607	616	599
E. Romagna	348	608	632	631	654	648	657
NORD	396	499	514	524	529	528	530
Toscana	439	595	622	653	669	680	693
Umbria	585	505	509	549	561	566	555
Marche	553	521	515	531	535	534	543
Lazio	447	528	532	582	579	569	597
CENTRO	469	546	557	595	601	600	617
Abruzzo	282	476	453	474	480	496	522
Molise	471	347	408	363	385	373	382
Campania	391	443	449	484	465	468	481
Puglia	473	441	435	436	449	459	489
Basilicata	336	361	356	364	383	413	396
Calabria	367	400	376	403	428	443	470
Sicilia	347	502	513	488	507	518	508
Sardegna	459	480	490	504	509	520	532
SUD	391	452	454	463	469	479	491
ITALIA	408	492	501	516	521	524	533

Fonte: APAT 2005

portion of wastes is recycled to produce energy. To this end the conversion into hydrogen could represent an interesting option as it could make easier the public acceptance of such plants. Presently the portion of the urban wastes used to produce electric energy is about 22%. In the future it is possible to increase such share, according the following table

	unit	2005	2010	2015	2020	2025	2030
Share of urban wastes for energy production	%	22	35	47	57	64	70
Amount	Mtons	4,81	7,65	10,27	12,46	13,99	15,30
Energy produced	PJ	62,9	100,0	134,3	162,9	182,9	200,1

These forecasts are made considering that some of the wastes can be recycled (paper, plastics, etc.) are fully or partially recycled and therefore they don't contribute to the energy production. The remaining materials can provide an average Heating Value of about 3100 kcal/kg (13.1 MJ/kg) of the collected wastes that can be converted to hydrogen through pyrolysis processes. Unfortunately it is quite hard to provide data for the conversion process; to this end the same process considered for the biomass can be considered as reference with some increase of the costs (20 %?) in order to consider the chain for the hydrogen production with an efficiency of about 50%. The only data that can be provided is the price from the waste company for the present plants where the wastes are



converted into electric energy, for which a reference value of 80 €/ton can be assumed, considering the plants of higher size [6].

References

- [1] A. Ovi " Venice hydrogen perspectives"
<http://www.technologyreview.it/index.php?p=article&a=80> (in Italian)
- [2] "Priolo petrochemical site - outlook" September 2004 (in Italian)
- [3] GRTN "Statistics on renewable sources in Italy – 2004"
<http://www.grtn.it/ita/Pubblicazioni/fontirinnovabili/StatisticheFontiRinnovabili2004.pdf> (in Italian)
- [4] E.Ronchi, P. degli Espinosa, N.M. Caminiti, Giuseppe Onufrio "The development of wind energy in Italy", Department "Sustainability Policies"- DS Roma, 1 July 2005 (in Italian)
- [5] "Environmental and economic indicators in the urban waste system" National Observatory on Waste, 2005 - <http://digilander.libero.it/lucixk/dossiereolico.pdf> (in Italian)
- [6] "Definition of the average price to collect and process the urban wastes on the basis of plant type and characteristics" Emilia-Romagna Regional Authority, 2003 (in Italian)